A Post Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations

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ABSTRACT

An ex ante and ex post cost analysis was conducted on selected rules in California to compare the accuracy of both the industry's and regulator's estimated cost impacts with the actual cost of the rule after implementation. Ten candidate rules were identified from public hearing records at the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD). More in-depth research of these public records yielded ex ante cost information for eight of the ten rules. Three different efforts to contact stakeholders yielded ex post cost information, of varying degrees, for six of the eight rules. A comparison was made between the ex ante costs developed by the regulatory agency as well as the stakeholders to the ex post costs for the six rules. The regulatory agencies estimated capital cost impacts similar to actual impacts on five of the six rules fully analyzed. For cost per ton reduced, the agencies estimated very similar costs to the actual in two cases, overestimated somewhat for three cases, and underestimated in one of these cases. In the remaining case, the ex post cost information obtained was anecdotal and not sufficient to allow conclusion. In each case, the projection of the economic impact of the rule made by the stakeholders is significantly higher than the projection made by the agency. The capital costs comparison is considered more robust and accurate than analyses considering emissions data due to the difficulty in obtaining actual emissions reduction from stakeholders. A complete analysis of each rule along with recommendations for improving the process and availability of ex post information is discussed.

EXECUTIVE SUMMARY

The regulatory process in the state of California requires the California Air Resources Board (CARB) and local air districts to make projections of the cost of compliance for every proposed rule. Typically the entities that will be regulated by the proposed rule (referred to as *stakeholders*) make their own estimation of the economic impacts, and quite often, the two estimates are dramatically different. To ensure its cost projections are as accurate as possible, the California Air Resources Board (CARB) requested the University of California at Riverside (UCR) conduct a "post audit" of actual costs of implementation of seven to ten rules. The goals of this project were to identify seven to ten rules where both the agency and the stakeholder projected cost estimates (*ex ante*) are documented, determine what the actual costs of implementation were (*ex post*), highlight any substantial and systematic discrepancies between actual costs and projected costs when possible, and ascertain if there are any recommendations to be made to improve the agencies cost projection process for the future.

Initially, ten rules were selected for review. Six of these rules were implemented by CARB and four by the South Coast Air Quality Management District (SCAQMD) between the years of 1985 and 1998 (See Table I-1 for a list of the ten rules selected). The projected cost estimates of both the agencies and the stakeholders were compiled and summarized for a majority of these rules and these data are documented in the body of the report. As expected, the projection of the economic impact of the rule made by the stakeholders is significantly higher in each case than the projection made by the agency.

Several obstacles were encountered during the effort to determine the actual cost of each rule. As a result, actual implementation costs to the stakeholder (ex post) were not obtained for three of the rules that were originally selected.

For the remaining seven rules, actual implementation costs have been estimated, and conclusions drawn for all but one in regard to the predictive accuracy of the agency. For all but two of the rules, 1173 (VOC Emissions from Petroleum facilities) and 90-5-1 (Ethylene Oxide Emissions), it appears that the agency's projected costs for the rule implementation was in line with or slightly overstated the actual costs derived from this study. For Rule 1173, the VOC Emissions from Petroleum facilities Rule, it appears the district probably underestimated the costs to comply. For Rule 90-5-1, the Ethylene Oxide (EtO) rule, it appears that the cost to comply has significantly contributed to most hospitals, clinics, and other small users to discontinue operating their own EtO sterilizers and therefore, the contract sterilization industry has consolidated considerably. Beyond that, the anecdotal ex post cost information obtained was insufficient to allow a conclusion to be reached. Table I-1 summarizes the availability of cost data and the cost comparisons.

The completion of this research was made difficult by the lack of records concerning control decisions by the impacted businesses and turnover of knowledgeable staff. This problem could be remedied to a great extent by requiring businesses to maintain records of steps taken to comply with the various rules and possibly report the steps taken and associated cost to comply back to the original regulatory agency.

In general, it appears that the ex-ante cost estimates did not fully address the impacts of future technology development or industry trends, especially toward consolidation. The result of this lack of analysis is that the rule costs were overstated by the adopting agency in several cases. The accuracy of ex-ante cost estimates could be improved if regulators can develop methods to better forecast the impacts of technology development and industry trends/reactions that might occur subsequent to the rulemaking process.

BODY OF REPORT

I. INTRODUCTION

In California, authorities for air quality management rules are required to project the implementation cost of proposed rulemaking and consider that cost during their deliberation on the rulemaking proposal. It is not uncommon for agency-projected implementation costs to vary significantly from cost projections developed by the industry sector affected by the proposed rulemaking. The actual cost following adoption of the rule is generally not tracked and, subsequently, it is not clear whether the agency-projected cost is more or less accurate than the stakeholder-estimated cost. In an effort to ensure its cost projections are as accurate as possible, CARB requested the University of California at Riverside to undertake a study. The goals of the study were to: 1) determine the agency-projected cost (*ex ante*) for seven to ten rulemakings; 2) determine the stakeholder-projected cost for those same rulemakings; 3) determine the actual implementation cost to the stakeholders (*ex post*); 4) compare both agency and stakeholder projections to the actual cost and determine which projection had been more accurate; 5) if stakeholder cost projections turned out to be more accurate in any of the rulemakings, determine the source(s) of error in the agency projection and recommend approaches to avoid such error in future cost projections.

I.A. Rule Selection Process

Ten rules were initially selected for review: six of these rules were implemented by CARB and four by SCAQMD between 1985 and 1998. The process used to select these ten rules, with criteria developed and agreed upon by both agencies, relied on information obtained from the initial rule making process (e.g., the minutes from the board meetings during which the rules were approved). The criteria required that any selected rule must (i) be unique to California (i.e., not the outfall from a federal rule), (ii) have a clear stakeholder list, (iii) show evidence of detailed ex ante cost information and emission data, and (iv) have been approved and implemented so that compliance had already been met. Of the 678 regulations that were initially looked at, only 109 appeared to meet the criteria specified above. Closer examination and critiques produced 37 regulations. Of those 37, 6 regulations were selected from CARB rules and 4 from SCAQMD. Table I-1 identifies the ten specific rules and the relevant regulated sectors. Section III describes the rule selection procedure and criteria process in detail.

Table I-1: Rules Initially Selected for the Study

Case #	Hearing Date	Hearing Number	Regulation	Affected Sector
1	July 1990	1153	Volatile Organic Compound emissions from Bakeries	Commercial bakeries
2	May 1989	1173	Control of VOC Leaks and Releases from Components at Petroleum Facilities and Chemical Plants	Petroleum facilities
3	Sep 1990	1174	Control of VOC Emissions from the Ignition of Barbecue Charcoal	Charcoal producers
4	Nov 1997	1138	Control of Emissions from Restaurant Operations	Restaurants
5	5/10/1990	90-5-1	Airborne Toxic Control Measure for Ethylene Oxide Emissions from Sterilizers and Aerators	Hospitals, laboratories, veterinary care facilities, and museums
6	6/8/1989	89-10-2	Amendments to Regulations Regarding Exhaust Emission Standards, Test Procedures and Durability Requirements Applicable to Passenger Cars and Light-Duty Trucks for the Control of Hydrocarbon, Carbon Monoxide and Benzene Emissions	Automobile manufacturers
7	2/ 18/1988	88-2-2	Airborne Toxic Control Measure for Hexavalent Chromium Emissions From Chrome Plating and Chromic Acid Anodizing Facilities	Hard plating, anodizing and decorative plating facilities
8	10/14/93	93-12-2	Airborne Toxic Control Measure for Perchloroethylene Emissions from Dry Cleaning Operations and a Regulation for an Environmental Training Program for Perchloroethylene Dry Cleaning Operations	Dry cleaning facilities
9	6/29/ 1995	95-6-3	Onboard Refueling Vapor Recovery Standards and Test Procedures and Modifications to Evaporative Test Procedures Applicable to 1998 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles	Automobile manufacturers
10	11/ 1/1991	91-11-1	Amendments to Regulations Regarding Reformulated Gasoline (Phase 2 Gasoline Specifications), and the Wintertime Oxygen Content of Gasoline	Petroleum refineries

Table I-2. Availability of Ex Ante and Ex Post Cost Information

Case	Rule/Ref.	Regulation	Ex Ante Cost Information		Ex Post Cost Information Identified	Comparisons / Comments
			Regulator	Industry		
1	1153	Volatile Organic Compound emissions from Bakeries	$174m to $589m	$625m to $748m	$441m to $852m	Regulator ex ante average cost estimates lower than industry ex ante cost estimates. Both overestimate ex post cost per ton.
2	1173	Control of VOC Leaks and Releases from Components at Petroleum Facilities and Chemical Plants	$36 mm District Total	Comments on technical feasibility only	$90mm to $100mm for 2 refineries	Regulator ex ante cost estimates considerable lower than ex post costs.
3	1174	Control of VOC Emissions from the Ignition of Barbecue Charcoal	Yes	yes (only comments)	Yes	Regulators ex ante costs slightly overestimate ex post costs.
4	1138	Control of Emissions from Restaurant Operations	$3300/ton	$1180 to $8730/ton	$1085 to $1250/ton	Industry ex ante cost estimates higher than regulator. Both overestimate ex post costs.
5	90-5-1	Airborne Toxic Control Measure (ATCM) for Ethylene Oxide Emissions from Sterilizers and Aerators	Yes	Yes	Anecdotal and insufficient	Industry ex ante cost estimates slightly higher than regulator.
6	89-10-2	Exhaust Emission Standards, Test Emission Standards, Test Procedures, and Durability Requirements: Applicable to Passenger Cars and Light-Duty Trucks for the Control of Hydrocarbon, CO, and Benzene Emissions	Yes	Yes	No	Cooperation between industry and regulatory seemed to address major issues. Differences existed.
7	88-2-2	ATCM for Emissions of Hexavalent Chromium from Chrome Plating and Chromic Acid Anodizing Operations	$550/pound reduced	No data	$100 to $50/ pound reduced	Regulator ex ante estimate significantly overestimates ex post cost per ton estimates
8	93-12-2	ATCM for Perchloroethylene Emissions from Dry Cleaning Processes	$55m to $83m	No Data	$76m to $83m	Regulator ex ante estimates fairly close to ex post estimates.
9	91-11-1	Reformulated Gasoline	Yes	no	No	Not evaluated
10	95-6-3	Onboard Refueling Vapor Recovery Standard	No	no	No	Not evaluated

I.B. Ex Ante Cost Analysis

Considerable effort was spent analyzing and interpreting both the agency and stakeholder cost estimates for each of the 10 proposed rules. In this analysis process, it was decided in conjunction with CARB that two of the original 10 rules would not be analyzed due to difficulties in the ability to obtain information and other extenuating circumstances. Section III and the appendices describe this process and documents estimates obtained from the meeting minutes of the various board meetings. This effort produced positive returns. A summary of the ex ante cost estimates for each rule is included in Section IV.

I.C. Ex Post Analysis and Comparison

Following the ex ante analysis, an ex post analysis and comparison was attempted for the 8 rules. Significant effort was mounted to obtain ex post data from the industry affected in each rule through three different techniques. These techniques and the difficulties encountered in obtaining the ex post information are described in detail in Section V. The data collection effort was successful enough to develop an ex post rule analysis for six of the eight rules. More often than not, though, efforts to collect an abundance of ex post cost data were severely hampered by informational shortfalls arising from a reluctance or inability on industry's part to participate. While strategic reasons are partly to blame, so too was the lack of an incentive to companies to divert scarce monitoring and data-keeping resources to assist us in these data collection efforts. These and other obstacles are discussed in more detail below. When ex post information was obtained, it was compared with both agency and stakeholder projections. Finally, an analysis of which projection had been more accurate and causes for discrepancies are described.

I.D. Summary

This report contains, then, an ex ante analysis of eight rules and a complete analysis of six rules. Section II describes some previous studies on cost analysis and guidelines for conducting cost analysis for rules. The case studies for each of the 8 rules are presented in Section IV, and include a rule description, ex ante and ex post analysis and comparison. Experiences associated with efforts to obtain ex post estimates are enumerated and suggestions for increasing the likelihood of future success are made in Section V. Section VI summarizes the recommendations and conclusions from this effort. The appendices provide updated lists and other contact-related information.

It should be noted that all cost estimates – both *ex ante* and *ex post* – are presented in 2004 dollars unless otherwise noted using a general inflation-adjustment calculator from the United States Department of Labor - Bureau of Labor Statistics (Appendix I). Many different types of indices could be used to make this adjustment given the heterogeneity across and within rules with respect to the products and control factors priced. While the absolute magnitude of the cost differences are likely to vary some depending on which index is used, the ordinal ranking across alternatives is unlikely to change, nor are our conclusions about (i) whether industry ex ante cost estimates are typically lower or higher than the regulator's ex ante cost estimates and (ii) whether industry and the regulator's ex ante estimates under or over-estimate the ex post estimates.

II. LITERATURE REVIEW

II.A. Procedures for Conducting Ex Ante and Ex Post Cost Evaluations

From a methodological perspective, a very comprehensive study that highlights important factors to consider when one intends to perform an ex ante and ex post cost comparison is contained in a report presented to the South Coast Air Quality Management District entitled "Criteria and Resources for Facility-based and Post-Rule Assessment" (BBC 2002). The purpose of the report was to provide guidance on how to choose the best rules to perform either a facility-based assessment (FBA) or a post-rule assessment (PRA). A FBA consists of collecting information about a potentially regulated industry and, among other things, estimating the costs of the proposed rule. Alternatively, a PRA requires gathering and analyzing information on, among other things, the costs incurred by firms to meet existing rules. Many of the guidelines outlined in the BBC report on how to conduct a successful FBA and PRA were followed in this study.

The information provided in the BBC (2002) report is extremely relevant to future endeavors to estimate both ex ante and ex post costs of regulations. For instance, the report lists three steps to consider when performing a FBA. First, consider the type of rule. It suggests not focusing on administrative rules or consumer product rules but rather rules that impact industrial processes. Second, consider the significance of the rule and whether it targets an industry that has been regulated in the past. If it has been regulated, there will be difficulty in dealing with the cumulative effects of both regulations. Third, consider the feasibility of completing the FBA. The more difficult it will be to complete, the less meaningful the results may be. The report suggests focusing on rules where this is some degree of homogeneity across the production processes of potentially impacted businesses.

Interestingly, the BBC (2002) report presents information on the time required to perform such analysis. This can be useful to future efforts in terms of better aligning information demands with the scarce supply of resources. For instance, it is estimated that it took the BBC staff approximately 240 staff hours (6 weeks) for each FBA rule. They stress, though, that this process typically involves much more total time since there is much waiting involved. So, the 240 staff hours is spread out over a much longer period. As a rough estimate, they estimate that it will take approximately 1 to 3 months to complete an FBA. Clearly, these are general estimates and will vary by rule and the quality expected.

Alternatively, the lessons associated with performing a PRA include familiarizing oneself with the uncertainty associated with the compliance costs at the time of the rule's adoption. The greater the uncertainty, the greater the difficulty in drawing conclusions about ex ante versus ex post costs. Also, if there is feedback from the industry after adoption, this can provide useful information. The report stresses the importance of reporting and data tracking procedures at the outset of the rule adoption to aid in the success of performing a PRA. The report also stresses the types of entities regulated as influencing the feasibility of successfully performing a PRA. As the report suggests, PRA will require the use of existing data on industry performance, data that may be limited or nonexistent to the general public, even more so when a rule is very narrowly tailored. As an example, BBC (2002, page 4) that "…it would be more feasible to perform a PRA of economic effects for a rule involving the wood furniture industry (which comprises most of a 2-digit SIC code) than for a rule involving the dry cleaning industry (which is a 4-digit SIC code). A PRA on the economic impacts of rules which pertain to only a subset of firms within a 4-digit SIC code (such as restaurants using charcoal broiling processes) will be most difficult of all."

In terms of resources devoted to accomplishing a PRA, if the focus is on compliance costs alone, BBC (2002) estimated an effort of between 120 to 400 staff hours to complete an estimate. If the costs included a wider economic impact study, then the time to complete a PRA was estimated to be between 160 to 360 staff hours. Again, these are crude estimates suggested in the report and will vary by characteristics of the particular rule. Yet, given that so few of these assessments have been done, having any information on what the resource commitments might be will certainly aid in more effectively assigning the appropriate amount of resources to the task to increase the probability of a successful effort.

Finally, it should be emphasized that the ease of performing an ex post assessment is primarily driven by data availability, a point emphasized in BBC (2002). With this in mind, they suggest that if one wants information only on the compliance costs associated with a regulation, then the impacts of consumer product regulations and market based regulations can be easily ascertained from observed market prices.

II.B. Ex Ante and Ex Post Cost Evaluation Studies

The literature on estimating ex ante and ex post costs of a regulation is evolving. Recent studies by Resources for the Future (RFF) (Harrington, Morgenstern, and Nelson 1999), the Natural Resources Defense Council (NRDC 2004), BBC Research and Consulting (BBC 2002), and Hammitt (2000) provide a comprehensive and detailed summary of evidence at the federal, state, industry and firm-level that suggest ex ante costs by both the regulator and the regulated have underestimated and overestimated the ex posts costs. For instance, of the over two dozen environmental and occupational safety regulations reviewed by Harrington et al. (1999), 12 of the 25 rules provided strong evidence that the ex ante costs overestimated the ex post direct costs of the rule, while 6 of the rules were characterized by ex ante costs that underestimated the ex post direct costs. Interestingly, if one focuses on per unit costs, there is approximately an equal mix of rules where the ex ante costs both over- and under-estimate the ex post costs. Finally, if one focuses on regulations that employed economic incentives, per unit costs are consistently overestimated. The conclusions of the RFF study suggested that whether ex ante cost estimates systematically under- or overestimated ex post realized costs was partially a function of how costs are defined – e.g., per unit, total, direct, indirect, whether general equilibrium effects or health impacts are included. They are also a function of the fact that unanticipated innovations do occur (and are more likely to occur under incentive-based policy instruments) and policies do change in terms of what firms/industries need to do to achieve compliance relative to what was assumed in the ex ante estimation.

It should be noted that of the rules analyzed by RFF, 11 could be categorized as rules affecting industrial processes, 5 could be categorized as a consumer product mandate, and 5 could be classified as a market based approach. Interestingly, of the 10 ex post analyses on non-federal regulations that RFF could identify that included ex ante cost information, all were either consumer product or market-based regulations. Interestingly, none of the rules we analyzed were rules that included market-based regulations and only one, Rule 1174, could be classified under the consumer product moniker.

While evidence of ex ante cost over-estimation by the regulator does exist, there seems to be much stronger evidence and occurrence of ex ante cost over-estimation by the regulated community. Perhaps the poster child of this artifact is the industry cost estimates to achieve Sulfur Dioxide emissions reduction under the Clean Air Act Amendments of 1990. Early industry estimates suggest per unit costs of $1500 per ton of emissions reduced, while actual permit prices (a common metric for the per unit abatement costs) were around $150 per ton (Harrington et al. 1999).

The Natural Resources Defense Council (NRDC 2004) also provided analysis and commentary on the ability of both regulators and industry to accurately predict ex post costs estimates. Focusing on the compliance costs to the automobile industry, NRDC surmises that regulator's ex ante costs have typically overestimated the actual costs by a factor of between 1 and 2, while the automobile industry's ex ante estimates range between 2 and 10 times the actual costs. The reasons they give for the potentially large divergences between ex ante and ex post costs include (NRDC 2004, p. 6): unanticipated innovation, conservative estimates by regulators and industry, asymmetric information on the regulators side, and strategic behavior on industry to weaken or delay the regulation. Supporting their claims are case studies, many involving California's Low Emission Vehicle (LEV) program. Other examples the NRDC cites provide strong evidence supporting their claims includes regulations associated with (i) the 1966 California HC and CO standards, (ii) 1975 requirement for catalytic converters, and (iii) the LEV I and II program.

The difficulty of estimating the cost of a regulation, be it ex ante or ex post, may vary with the extent of the impacts one is interested in considering. That is, accounting for the larger indirect impacts (e.g., employment effects within and across industries) or downstream impacts of a rule (e.g., impacts on human health) clearly complicates the estimation process and requires many more (possibly heroic) assumptions. Yet estimating and comparing the ex ante and ex post costs of a regulation that will focuses on the implementation of a particular technology alone has its difficulties as well. For instance, often at the time of the regulatory process the technology has only been applied in limited situations, and the only certain costs are those associated with these initial pilot applications. The cost reductions associated with widespread use of a new technology and further manufacturing innovations are difficult to make and often much disputed. Furthermore, the accuracy of reported cost estimates is confounded by uncertainty surrounding the specifics of the regulation, inadequate data, and even strategic behavior (Goodstein 1997).

For instance, consider the following example illustrating the difficulty of estimating the costs and effectiveness of a new technology provided in Hammitt (2000) in his analysis of the ex ante and ex post costs of meeting the CFC Phase-out requirements under the Montreal Protocol. The two groups providing cost estimates were RAND and the EPA. RAND, based on the lack of development of substitute compounds, seemed to err on the side of conservatism in estimating the time and costs to bring these compounds to development. EPA, which performed its study 2 years later than RAND, had additional information on which to base its more optimistic predictions of the ability of firms to develop these substitute compounds. Additional reasons for the poor predictions were that firms and regulators failed to reasonably predict the impact of incentive-based instruments on encouraging innovation. There is clear evidence that ex post control costs of meeting the CFC Phase-out requirements under the Montreal Protocol were substantially smaller than the earlier ex ante estimates. Hammitt (2000, p. 296) concludes by suggesting, "Cost overestimates appear to be more likely when compliance involves the innovation and diffusion of a technology not currently in commerce…"

Another example of the difficulty in estimating the cost and emission reductions is illustrated by the SCAQMD's regulation of NOx from natural gas fired power plants and the 1990 CARB vehicle regulatory process (Lents et al., 2000). Both took place in the 1988 to 1991 timeframe. At the time of the power plant regulation adoption, the SCAQMD estimated the cost of this NOx control to be on the order of $25,000 per ton of NOx controlled. The industry estimate at the time was about $45,000 per ton of NOx controlled. By 1995, when the requirements were coming into effect, NOx control was being applied to power plants for about $12,000 per ton. Costs have continued to drop for this technology since then. Similarly, in 1990, CARB estimated vehicle control costs for the proposed regulation to be about $170 per vehicle while the industry argued that the costs would be on the order of $783 per vehicle. Subsequent experience has indicated that the original CARB cost estimates, while overestimating the actual costs, were closer to the actual estimates than were the industry's estimates (Lents et al., 2000).

Hammitt (2000) provides an explanation as to why ex ante costs might be overestimated. First, an information asymmetry exists such that the firms have more up-to-date information than regulators about alternatives for meeting the stipulations of the regulations. Such information provides the opportunity for strategic behavior from the firm's perspective to overestimate the costs of the regulation. Second, firms are likely to have under-invested in identifying low cost compliance measures such that when push comes to shove and the regulation is implemented, it is in the firm's best interest to invest, investigate, and implement lower cost alternatives that were un- or underdeveloped prior to the rule implementation.

Finally, it should be noted that not all industry ex ante costs overestimate ex post costs. Indeed, some control options may not have been as cost effective as originally anticipated. For example, Inspection/Maintenance programs were less cost effective than originally anticipated (Cackette, 2000). Also, the original vehicular OBD (on-board diagnostics) requirements did not meet initial expectations.

III. RULE SELECTION

Through discussions with the California Air Resources Board (CARB) and the South Coast Air Quality Management District, approximately 10 rules would be targeted for analysis. The following approach was discussed, agreed upon, and executed.

The initial intention was to focus on approximately 7 air quality regulations approved by CARB and 3 approved by SCAQMD. It was agreed upon that a few more might be evaluated if time and other resource constraints do not become binding. These 10 rules would be the result of an iterative process by which all the rules approved by CARB and SCAQMD between 1/1/85 and 12/31/98 would be identified and analyzed for possible selection. Project associates from UCR and CECERT would identify all rules between these dates that appeared to be amenable to economic analysis. Of the candidate rules identified by these associates, between 15 and 20 would be selected by the PI and Co-Investigator along with associates as being a representative set of the approved air quality regulations and for which data was available, or could be collected, for analysis. From these 15 to 20 rules, the final 10 would be identified at a meeting with the relevant UCR/CECERT and CARB members.

To this end, project team associates traveled to Sacramento to identify any rules between the designated time frame that contained economic data or provided information that economic data could be collected within a reasonable time frame to maintain project deadlines. The majority of the associates work consisted of going through the electronic copies of the CARB hearings from 1985 through 1998. From this two-day activity, annual tables of rulemaking actions along with copies of hearing summaries covering the rulemaking records were made. Perusing the hearings looking for rulemaking actions was an arduous task. The hearings, which consist of the minutes, and all written and oral testimony, were scattered throughout various sources, including books in the CARB library, the web, and on microfiche. It was discovered after the first day that individual rulemaking files are available through the Board Administrator and Regulatory Coordination Unit at CARB.[1]

Out of the approximately 700 rules that were looked at, 109 met the initial requirements for pre-selection. These 109 rules consisted of a variety of regulations ranging from VOC emissions reduction requirements, implementation of low-emission vehicles, evaporative emission requirements, and toxic control requirements, to name a few. Upon returning from Sacramento, the associates identified approximately 35 of the 109 rules that seemed the most appropriate and amenable for analysis. It was noted at that time that the rule making records were not ordered along a consistent timeline, some gaps in the archived microfiche existed between months and years.

In early January, 2003, the associates, PI, and Co-Investigator, narrowed the list down to 15 CARB rules and approximately 6 SCAQMD rules with the intention of selecting the

[1] We acknowledge the helpful assistance of Artavia Edwards in assisting us in obtaining and arranging the appropriate files.

final rules (7 CARB and 3 SCAQMD) in late January/early February 2003 with members of UCR/CECERT and CARB.

During a conference meeting in February 2003 in Sacramento between UCR/CECERT and CARB, 10 candidate CARB rules and 4 candidate SCAQMD rules were selected.

In early spring, 2003, members of the project team visited the SCAQMD and made copies of any documents containing information pertaining to the specific rules selected. The material consisted mostly of the minutes from board meetings when the rules were debated and voted upon. The specific rules at that time included:

- Rule 1138: Control of Emissions from Restaurant Operations
- Rule 1153: Volatile Organic Compound Emissions from Bakeries
- Rule 1173: Control of VOC Leaks and Releases from Components at Petroleum Facilities and Chemical Plants
- Rule 1174: Control of VOC Emissions from the Ignition of Barbeque Charcoal

These rules covered a wide variety of pollutants, with a large disparity in terms of the amount of information provided within the board meetings.

In the late spring months through August of 2003, members of the project team traveled to Sacramento to make copies of any documents that contained information on the specific CARB rules of interest. Again, most of the information was contained in the related board minutes subsequent and prior to the rule. The rules targeted included:

- Rule 89-10-2: Exhaust Emission Standards for the Control of Hydrocarbon, Carbon Monoxide, and Benzene Emissions
- Rule 90-5-1: ATCM for Ethylene Oxide Emissions from Sterilizers and Aerators
- Rule 88-2-2: ATCM for Hexavalent Chromium Emissions from Chrome Plating and Anodizing Operations
- Rule 93-12-2: ATCM for Perc. Emissions from Dry Cleaning Operations
- Rule 91-11.1: Reformulated Gasoline, Phase 2
- Rule 95-6-3: On board Refueling Vapor Recovery Standards

Two additional consumer product rules were initially discussed but dropped. The most difficult part the project at this point was timing. It took a much longer time to collect this information than anticipated, mostly due to scheduling conflicts both with the project team and operators of the CARB library where the information was held.

At this point, ten rules were selected for review after consultation and input from both agencies: six of these rules were implemented by CARB, four by SCAQMD (Table I-1). The rules were implemented between 1985 and 1998. The criteria used to select these rules, criteria developed and agreed upon by both agencies, consisted of using information obtained from the initial rule making process (e.g., the minutes from the board meetings during which the rules were approved). These criteria required that any selected rule must (i) be unique to California (i.e., not the outfall from a federal rule), (ii) have clear stakeholder list, (iii) show evidence of detailed ex ante cost information and emission data, and (iv) have been approved and implemented so that compliance had already been met. This information was all gleaned from files located at both agencies.

It should be emphasized that during the rule selection period the majority of work consisted of going through the electronic copies of CARB hearings from 1/1/85 through 12/31/98. From that, annual tables of rulemaking actions were created, along with copies of the hearing summaries covering the rulemaking contained in the tables. To some extent, those tables (as reported in the 1st two quarterly reports) reflect a culling of rulemaking actions along with changes to testing protocols that would not be appropriate subjects for the cost study. These rule action files contain the minutes, and all written and oral testimony provided by both the CARB, SCAQMD and affected parties.

An analysis and interpretation was performed on the agency and stakeholder cost estimates for each of the 10 proposed rules. Included in this report are all of the documented estimates obtained from the meeting minutes of the various board meetings and from other sources. Unfortunately, two rules were not completed - Rule 91-11-1 and Rule 95-6-3, neither for the ex ante cost estimate nor the ex post cost estimates. This should not be surprising when one considers the amount of time it has taken prior studies to complete one-half of a single rule. For instance, as discussed below in the *Literature Review* section, it is estimated that a single facility based assessment to analyze the ex ante costs of a proposed regulation can take up to 240 hours of staff time. These six weeks, unfortunately, are spread out over a much longer time given the logistics with obtaining this type of information from a variety of sources. In our particular case, the ex ante information from Rule 91-11-1 was collected but after review of initial rule making minutes and the subsequent law suits, it was concluded that any ex ante estimates derived might have been influenced by expectations associated with future enforcement of the rule, including perhaps when and if particular components of the rule would be relaxed. Initial efforts to contact industry were also unsuccessful. Indeed, our attempts to even copy the rule making minutes were delayed due to the fact that the documents were being held by lawyers involved in what appears to be an ongoing, or potential, lawsuit associated with this rule. For Rule 95-6-3, we were able to copy the minutes from the rule making sessions, but did not have enough time to follow up on estimating the ex ante nor ex post costs. Fortunately, we do not feel that the addition of these two rules would have added any additional information to this report beyond what is already included related to the relative size of industry and regulator ex ante cost estimates or how these estimates might compare with what actually occurs. An analysis of the basis for each estimate is included, and, where possible, an explanation of significant differences between the agency and stakeholders assumptions is given. A summary of the ex ante cost estimates for each rule is included in the next section.

IV. ANALYSES OF SELECTED RULES

IV.A. CASE 1 - SCAQMD RULE 1153

CONTROL OF VOLATILE ORGANIC COMPOUNDS (VOC) IN COMMERCIAL BAKERY OVENS

IV.A.1 Background

In 1987, ozone, which is formed by photochemical reactions between directly emitted nitrous oxides (NOx) and volatile organic compounds (VOC), was monitored at 28 locations in the South Coast Air Basin by the South Coast Air Quality Management District (SCAQMD). Measurements indicated that both federal and state ozone standards were exceeded at all locations, with Basin ozone levels often exceeding Federal standards by a factor of three. A primary health concern associated with elevated ozone concentrations is reduced lung function, particularly during vigorous physical activity. In response to these concerns, SCAQMD implemented a variety of control measures designed to reduce VOC emissions from stationary sources in pursuit of its commitment to attain the National Ambient Air Quality Standard (NAAQS) for ozone. One such measure, Rule 1153, was developed as part of the 1989 Air Quality Management Plan. The main purpose of Rule 1153, which was adopted in 1991, was to control VOC emissions from commercial bread bakery ovens, an industry which had not been targeted under any prior regulations.[2]

The specific target of Rule 1153 was VOC emissions, primarily ethanol, emitted from bakery ovens. Ethanol, along with carbon dioxide, is a by-product of the leaving process of bread. It is produced during the metabolic fermentation reaction among yeast enzymes, sugars and starches present in the dough. While carbon dioxide is retained in the dough, causing it to rise, ethanol remains as a liquid in the dough and is emitted during the baking process.

Prior studies contributed greatly to the development of Rule 1153, mostly through efforts to establish an emission factor for estimating ethanol emissions from bakeries. The Bay Area Air Quality Management District's (BAAQMD) Rule 42, for example, adopted on September 20, 1989, entailed actual source testing of bakery oven emissions. During the study, a total of 16 ovens were tested with results ranging from 0.3 lbs to 7.0 lbs of ethanol per 1,000 lbs of bread baked. The American Institute of Baking (AIB) conducted a study that further investigated the same bakeries as in Rule 42. The AIB study included efforts to control for the impacts on emissions from a variety of process parameters, including yeast and sweetener concentrations, fermentation time, process type (e.g., sponge dough vs. straight dough), product type (e.g., white bread or sourdough), and baking conditions (e.g., time and temperature). The results of the AIB study suggested a

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[2] Rule 1153 was amended once, in 1995. The amendment addressed modifications to test method specifications and was in response to a request by the USEPA to correct Sate Implementation Plan deficiencies and improve its enforceability.

strong relationship between ethanol emissions and initial yeast concentration, total fermentation time, and proof time.[3] Process type had a small, but noticeable, impact.

SCAQMD also performed a study to quantify ethanol emissions and determine the number, type, and characteristics of bakery ovens in the Basin. The study consisted of a survey questionnaire designed by its staff that was distributed to bakery operators in the newly formed Southern California Bakers' Air Quality Association (SCBAQA) to obtain actual operation data from the major bakeries in the Association. Results from the questionnaire suggested that 24 major bakeries using approximately 72 bakery ovens operated in the Basin. Total bread production in the Basin was estimated at 446,700 tons per year; total ethanol emissions from these major operators were approximately 4.1 tons per day. From these results, an average ethanol emission factor of 2.5 pounds of ethanol per 1000 pounds of bread produced was calculated. A 1989 report from the Air Quality Management Plan Control Measure #88-C-1 estimated daily VOC emissions from commercial bakery ovens at 5.8 tons per day. Alternatively, SCAQMD's Emission Inventory Unit also attempted to quantify ethanol emissions generated by bread bakeries. Based on their 1988 report, the total VOC emissions from bakeries in the South Coast Air Basin was 2,442 tons per year, or approximately 9.4 tons per day.

IV.A.2 Bread Production Process and Equipment

Large commercial bakeries use highly automated bread production processes. At full capacity, a single large bread bakery can produce up to 300,000 pounds of over 100 different varieties of bread and other bakery products per day. Mixing and blending of ingredients, as well as the working and dividing of the dough, is performed mechanically. The dough is continuously conveyed through each step of the process without any manual handling. Three basic dough processes are used by commercial bread bakeries: sponge dough, brew (also called liquid sponges), and straight dough. The sponge dough and brew processes are the mostly widely used by large commercial bakeries; straight dough processes are used for a few types of variety breads only.

Sponge Dough: The sponge dough process is the most common form of bread production. In a sponge dough process, the sponge is allowed to ferment for several hours, after which the remaining flour and water are mixed in. The dough then stands for an additional 40 minutes to relax before it is molded and divided to the individual loaves and put into pans on a tray conveyor. The panned dough are first conveyed to the proofing box, a humid chamber (100°F) where the dough are allowed to rise to the desired volume. Most breads are baked for approximately 20 minutes around 450°F, although some are baked for as little as 8 minutes. In the sponge dough process, 99% of the total VOC emissions occur during baking.

Brew: The liquid brew, or preferment process, allows for somewhat easier material handling. It differs from the sponge dough process primarily in that the initial mixture is a slurry containing only yeast, yeast food, and water, with little or no flour. Liquid brews are especially well-suited for continuous bread baking operations.

[3] Proof time is analogous to "rising time" of the bread before baking.

Straight Dough: The straight dough process is similar to home baking in that all of the ingredients are mixed together to form the dough in a single step. Straight dough are primarily used for sourdough and specialty breads. In the straight dough process, 75% of the total VOC emissions occur during baking.

Each bakery uses versions of these processes in accordance with its production equipment which further varies for each individual type of product.

Generally, large commercial bakeries operate one very large oven for baking high-volume products and one or more smaller ovens for producing short-run specialty breads. Large ovens have three basic configurations: tunnel oven, single lap oven, and a Lanham oven. Each oven is also equipped with a purge stack for discharging residual oven gases prior to burner ignition each day. The damper for this stack is normally closed during baking. When an oven is first installed, it takes approximately two weeks to balance the airflows before it is ready for production. Turbulence in the exhaust airflow can cause unstable flames, extinguished burner flames, and lead to non-uniform lateral heat distribution throughout the zones. This may result in some undesirable quality problems with the bread, such as poor texture or poor flavor.

IV.A.3 Best Available Control Technologies and Emissions

A number of VOC control technologies to reduce emissions from commercial bakery ovens exist, including thermal incineration, catalytic incineration, carbon absorption, scrubbing, condensation, biofiltration, and process changes. Each control technology requires an exhaust system ducting all stacks in multi-stack ovens through a single plenum for delivery to the control device. Incinerators were the most effective means of controlling exhaust streams with relatively high concentrations of organics. During the SCAQMD rule action period, only two control technologies were considered in estimating costs: regenerative thermal oxidation and catalytic oxidation. Although other technologies could be used, these two technologies appeared to be the most economically and technologically feasible. Implementation of Rule 1153 was expected to reduce VOC emissions from bakery sources by 83%, or by 3.4 tons of VOC per day.

Total bread production for the 30 bakeries that were potentially impacted by this rule in 1989 (which included the 24 that were part of the SCBAQA survey) was estimated at 446,700 tons/year. Total emissions were 1,077 tons/year (4.1 tons/day), and the desired total emission reduction target was 3.4 tons/day. In 1989, overall reduction efficiency was 83%. Bakery ovens that emitted less than 50 pounds of VOC per operating day were exempt from this rule.

IV.A.4 Cost Effectiveness for Ex-Ante Evaluation

Cost estimates related to the implementation of Rule 1153 were developed by both SCAQMD and industry. These estimates are summarized below.

Cost-Effectiveness Scenarios Developed by SCAQMD

SCAQMD performed cost calculations for nine different size ovens, of which is developed best estimates for construction, maintenance, and operation costs. For the regenerative thermal oxidation option, cost effectiveness estimates ranged from $760 to $26,600 per ton of VOC reduced.[4] Conversely, the cost-effectiveness estimates under the catalytic oxidation strategy varied from around $1,064 to $21,300 per ton.

Using these estimates, along with the distribution of oven size throughout the Basin, Basin-wide estimates of total costs and emissions reduction were calculated for each strategy. These estimates resulted in an average per ton estimate of $2,400 and $3,100 for the regenerative thermal oxidation and catalytic oxidation strategy, respectively. SCAQMD assumed that the implementation of Rule 1153 was expected to have minor price impacts, ranging from 0.09 to 2.28 cents per pound of bread baked. Basinwide annual compliance costs were $2.02 million to $2.69 million, respectively, depending on the selected control strategy.

Cost-Effectiveness Scenarios Developed by Industry
On the industry side, only the costs associated with the catalytic oxidation were estimated. The Southern California Bakers' Air Quality Association (SCBAQA) and some other companies also submitted their own cost estimates. Industry wide average cost effectiveness was estimated to be $6,100 per ton of VOC reduced.

There are many reasons for the differences in the ex ante cost estimates. For instance, given the different number of bakeries that each agency evaluated (30 for the SCAQMD and 24 for the SCBAQA), they assumed a different average oven size for the Basin. They also assumed different % heat exchange, emission factors, exit temperatures of stack emissions, heat recovery, time of operation, and cost of natural gas.

The bakery industry also had a regional economic analysis performed that would be similar to a social accounting matrix or input-output approach using regional multipliers. First, they estimated that bakery production has direct impacts on local communities in the SCAQMD Basin. Based on multipliers from a 1984 model (and in 1984 dollars), $640 million dollars worth of bakery products were produced (output) for the year of 1984. In 1984 the bakery industry employed about 10,000 persons in the Los Angeles Basin. The specific regional multiplier model categorized the region into 66 sectors. The direct effects of the proposed control measure are the annual operating costs of $204,500. The indirect effect of compliance with this control measure was to be $186,990 (in lost output). Income loss from lower wages and/or lost jobs was estimated to be $67,783. They estimated that for every job gained or lost in the bakery industry, an additional 2.8 jobs are generated or lost in other industries. When the total economic impact is considered, wages and salaries totaling $100,903 are lost due to compliance, $34,788 of which is directly linked to the bakery industry.

IV.A.5 Cost Effectiveness for Ex-Post Evaluation

This rule controls volatile organic compound (VOC) emissions from commercial bakery ovens with a rated heat input capacity of 2 million BTU per hour or more and with an average daily emission of 50 pounds or more of VOC. For a bakery with average daily

[4] As mentioned above (Section I.D), all dollar cost estimates are in 2004 dollars unless otherwise noted.

VOC emissions between 50 and 100 pounds per year, the VOC emissions must be reduced by at least 70%. For bakeries emitting over 100 pounds per day of VOC, the emissions must be reduced by at least 95%.

The baking industry has undergone considerable consolidation since the implementation of this rule. Thirty bakeries were listed as potentially being affected during the initial rule making process over 10 years ago. During this same time period, the SCBAQA identified 24 bakeries that would be potentially impacted by the rule. Contact was made with over 20 bakeries in the Southern California area and in the final analysis, 5 companies representing 7 bakeries that were impacted by Rule 1153 agreed to participate in our study. Some of the businesses agreed to participate only if there was a degree of confidentiality provided, and thus, individual bakeries' data will not be divulged in this report. It should be noted that only about 10 to 12 companies of the approximately 30 companies that were potentially affected by this rule are still in business. Conversations with the 5 companies suggest that other bakeries shut down or consolidated due to inefficient practices.

Appendix A shows the list of Bakeries that were attempted to be contacted during this study, and the progress made from that attempt. The five companies that agreed to participate are:

- Freund Baking
- Interstate Brands
- Kroger
- Entemanns/Oroweat Bakery (Bimbo)
- Fresh Start Bakeries

These five companies represent 7 bakeries with 17 ovens, venting into 11 catalytic oxidizers. The industry as a whole chose to install catalytic oxidizers instead of thermal oxidizers. This is consistent with pre-rule thinking of several industry experts. These 7 bakeries represent slightly more than 50% of the estimated pre-rule throughput of 446,700 tons/year of bread baked.

The aggregate cost of these 11 catalytic oxidizers is over $6 million, with the average cost being just over $550,000 per oxidizer. The least expensive oxidizer was installed in 1994 at a cost of $441,500, and one of the most expensive was installed in 1993 at a cost of $851,500. About half of the oxidizers have 2 ovens venting into them, while the others are tied to only one oven. Nine of the oxidizers are manufactured by CSM Worldwide Corp., and the other two by Anguile oxidizers. The total ex ante capital costs provided by the SCAQMD for the catalytic oxidizers ranged from $589,360 down to $173,750 depending on oven size, whereas the Industry's ex ante estimates of capital costs for a catalytic oxidizer ranged from $747,800 to $625,500. As it appears, the industry's estimates are slightly higher than the ex post estimates, while the District's estimates appear to be slightly on the lower side of the ex post estimates.

The bakeries that are fully utilized and operating at a high throughput present the best cost-effectiveness estimates by having the largest output. Four of the companies (representing 6 bakeries) show a minimal cost per pound of bread, at less than $0.01 per pound of bread baked. However, the other companies do not have as large a throughput to spread the cost over, and they spent essentially the same amount of money to comply. Their cost of compliance was $1.75/lb of bread baked. Compared with the ex ante estimates ($0.09 to $2.28), and assuming all real price differences are due to cost changes from implementing these technologies, the Districts ex ante estimates are certainly in line with the ex post estimates.

Only two companies provided emissions data. The cost of compliance per ton of VOC reduced ranged from about $400/ton to just over $1,250/ton VOC reduced. These estimates are considerably lower than both the District's and Industry's ex ante per ton average estimates - $3,100/Ton VOC reduced and $6,100/Ton VOC reduced, respectively.

IV.A.6 Conclusions

In developing this rule, the District consulted APC vendors and regulated industries for their cost estimates during rule action. The District performed a survey of the impacted industries. It tried to quantify ethanol emissions and determine the number, types and characteristics of bakery ovens operating in the Basin. Performing a survey prior to rule preparation offers more tangible and immediate benefits for both policy makers and stakeholders. Surveys and studies conducted prior to rule action offer opportunities for significant findings leading to modifications to the proposed rule and avoidance or mitigation of possible adverse impacts on the regulated community. Such efforts appeared to have very useful in aiding the District in its efforts to develop as accurate an ex ante cost estimates as possible. Yet, there were many parameters and assumptions that were valid in the construction of the cost estimates to create the justified differences in the ex ante cost estimates of the Industry relative to the District. As shown above, Industry ex ante estimates were higher than the District's estimates.

The results from our efforts to estimate the ex post costs of this rule suggest that considerable bakery industry consolidation has taken place in the past 10 or more years. Some of this might be attributed to increased regulation (like Rule 1153) driving the older and less efficient bakeries out of business. Other factors might include some companies purchasing competitor operations and running more than one bakery in the basin. There has also been a small amount of decentralization in the industry, with specialty operations, primarily in large chain grocery stores moving from the centralized bakery into the actual stores. Some grocery store centralized bakeries were sold, or shut down, and smaller, non regulated ovens were started up in individual grocery stores to make specialty products (fresh bread baked on premises). Although probably not a significant factor in VOC emissions, directionally this points to a potential weakness in the regulation where smaller operations can avoid regulations.

On the other hand, as indicated, this industry has gone through considerable consolidation, and that may have a significant impact on a surviving Company's profitability, and throughput, and thus the ex-post versus ex-ante differences. If consolidation resulted in larger firms, economies of scale might have resulted thereby lowering the overall average costs of production. Yet if more consolidation resulted in less competition, perhaps some monopolistic power resulted thereby encouraging firms to produce at a level greater than would occur under perfect competition; hence, increasing marginal costs of production could suggest higher per lb costs after consolidation. Analyses of these issues extend beyond the scope of the present research yet future ex ante analyses may want to consider, and in the very least enumerate, the potential effects of such consolidation.

Results from this study indicate that although the industry spent considerable capital to comply with this regulation, the overall cost per pound of bread baked was insignificant for fully utilized bakeries. The average cost of the catalytic oxidizers the industry installed was over $550,000. The estimated cost of this regulation per pound of bread baked ranged from an insignificant $0.01 for a fully utilized bakery to a much more significant $1.75 for a smaller, lower production bakery.

Emission data was obtained from only two companies, but the results indicate that the cost per ton of VOC reduced is quite low compared to the ex ante estimates. The per unit costs of VOC reduction ranged from $400/ton to just over $1,250/ton, compared to industry estimates of $6,100, and the District estimate of about $3,100.

IV.B. CASE 2 – SCAQMD RULE 1173

CONTROL OF CHEMICAL LEAKS AND RELEASES FROM COMPONENTS AT PETROLEUM FACILITIES AND CHEMICAL PLANTS

IV.B.1 Background

Rule 1173 was developed to implement Air Quality Management Plan (AQMP) Control Measure Number 88-B-13 and reduce fugitive emissions of reactive organic compounds (ROC) from specified components at affected facilities. These facilities are refineries, chemical plants, oil and gas fields, natural gas processing plants, and pipeline transfer stations operating within the South Coast Air Quality Management District jurisdiction. Equipment subject to leak control includes valves, pumps, compressors, pressure relief devices, diaphragms, fittings, sight-glasses, and meters. Going beyond AQMP Control Measure Number 88-B-13, the Rule provides additional reductions in ROC emissions. It also provides more stringent, uniform and clear definitions.

An allowable number of leaks is a “good performance” standard for each type of equipment at a given facility. All liquid leaks over 3 drops/minute or gross leaks for gases of over 50,000 PPM are violations of the Rule when detected by District inspections. Leaks detected must be fixed within a specified time period that depends on the severity of the leak. All facilities are required to permanently identify relevant pieces of equipment, and use a specific identification method for submitting inspection records to the District. Compliance with the Rule was scheduled for February 1991.

Fugitive reactive organic compound emissions from pumps, compressors, valves, and pressure relief valves in refineries, oil and gas production fields, and chemical plants had been under District Rules 466, 466.1, and 467 for over a decade. Rule 1173 expanded the list of equipment and affected facilities; provided more stringent and uniform leak control requirements and improved inspection, maintenance, and record keeping by the operator. The rule was also designed to meet or exceed the requirements of the Environmental Protection Agency (EPA) and eliminate other deficiencies found in existing District rules.

Emissions from valves and pumps generally depend on the type of fluid (light or heavy) processed, component size, inspection frequency, operating conditions and other parameters of lesser significance. Control of valve leaks can produce a significant amount of emission reductions because of the large population of valves involved. Compressors, which operate at higher pressures, generally show highest emission rates; yet their numbers are fewer. Hatches, sight-glasses, meters, and fittings usually generate less leakage. They require regular inspection and maintenance for leak-free operation.

Three sources of information on fugitive ROC in refineries supported the Rule during the rule action period. The Radian Corporation conducted an analytical study for CARB in 1986 to evaluate fugitive emissions and factors contributing to such emissions throughout

California. The study concluded that significant uncertainties existed in emission estimates from the database then available. Another finding was that refineries differed significantly in the number of leaking components. Emissions from non-exempt components had already been reduced by about 50% under pre-existing rules. At that time, these exempt components produced 40% to 80% of all fugitive refinery emissions.

The second source was the 1989 AQMP Control Measure Number 88-B-13. The 1989 AQMP had recommended further development for control of fugitive ROC. In 88-B-13 the control methods included use of equipment less prone to leaks, more stringent enforcement, self-auditing by operators, and the use of methane as a calibration compound for the measurement method. In the 1989 AQMP, fugitive ROC amounts were estimated in the District's air basin at 12.7 tons/day. Potential emission reduction under investigations was 11.4 tons/day. Average cost effectiveness, excluding valves in heavy liquid service, was found to be $15,000 per ton of ROC reduced.

The District conducted its own study in 1988 with the cooperation of affected refineries. Pieces of equipment under the leak control rule were surveyed at 13 refineries in the District. ROC emissions from valves, pumps, compressors, and pressure relief valves in refinery service within the District jurisdiction were estimated to be about 9.5 tons/day.

Rule 1173 was adopted on July 7, 1989, and amended on December 7, 1990, May 13, 1994, and December 7, 2002 as part of the State Implementation Plan (SIP).

IV.B.2 Air Quality and Best Available Control Technologies

Rule 1173 was enacted to reduce liquid and gaseous leaks from specified pieces of equipment in refineries, chemical plants, oil and gas production fields, natural gas processing plants, and pipeline transfer stations.

Commercial Natural Gas has been defined as a mixture of hydrocarbons with at least 80% methane, and less than 10% ROC. EPA recommends a limit of 1% (by weight) VOC in their Control Technology Guidelines. However, EPA also defines ethane as an "exempt" compound. Since the District does not exempt ethane it is included in the 10% ROC as defined in Rule 1173.

For purposes of identification, pieces of equipment are subdivided into major and minor categories according to detectable emission levels. This distinction reduces the identification burden on operators without compromising emission reductions. A 10,000 PPM threshold has been selected for the definition of major gas leaks, for all types of equipment except pressure relief devices (PRD). Their level is set at 200 PPM. The 10,000 PPM threshold was arrived at using data obtained from surveys conducted by the District as well as following EPA's standards.

Available control technologies are valves, pumps, compressors, and pressure relief devices which are inspected and maintained on a regular basis. These pieces of equipment are identified and tracked. Records of inspection, repair, and replacement are kept.

IV.B.3 Emissions and Emission Reductions

For Rule 1173, ROC will be used synonymously with ROG and VOC. Fugitive ROC emissions are dependent on the number of pieces of equipment present and on typical emission factors. These numbers are estimated from data compiled from a District database.

Rule 1173 was expected to affect approximately 18 refineries, 60 chemical plants, 300 oil and gas production fields, and 10 natural gas plants and pipeline transfer stations. The distribution of fugitive emissions among these facilities is as follows:

- Refineries - 60%
- Chemical plants - 20%
- Oil and gas production fields - 15%
- Remaining facilities - 5%

The contribution of refineries for rule-affected equipment was estimated at 10 tons/day, with fittings, hatches, sight-glasses, and meters producing 5% of this amount. The total annual emission reductions were estimated at 13.4 tons/day. Significant emission reductions can be achieved by correcting gaseous leaks above 10,000 PPM, measured as methane above background. Such leaks, called “major gas leaks,” result in nearly 80 to 95% of emissions from any particular type of equipment.

IV.B.4 Cost Effectiveness for Ex-Ante Evaluation

Control costs, estimated by the District for equipment such as valves, pumps, compressors, and pressure relief devices, were $5,445 for an inspection, $1,602 for repair and $20,352 for replacement.

Inspection costs were based on a labor rate of about $25 per hour, and average inspection time of 10 minutes for valves and small components, and 15 minutes for pumps, compressors, and PRD. Component repair costs were calculated assuming that 5% of the total equipment population inspected needing repairs, with an average expenditure of 1 man-hour for each repair.

In the Staff report, the total cost for the program was estimated at $27.4 million. This number included a 20% additional cost contribution for other components, such as fittings, sight-glasses, meters, and hatches, and an overhead of 10% for identification, recordkeeping, etc. The total cost of the program to affected facilities in the District was calculated as $36 million, with a cost-effectiveness of $7,400 per ton ROC reduced.

During the development of Rule 1173 no estimates of its cost effectiveness were prepared by the industry. There were some public comments about the rule, mainly about technical feasibility. They were made by the Western States Petroleum Association, the Southern California Gas Company, Chevron USA Inc., Chevron Chemical Company, PPG Industries, Inc., Kaman Sciences Corporation, the U.S. EPA, and CARB.

IV.B.5 Cost Effectiveness for Ex-Post Evaluation

SCAQMD sent the study team a list of permitted facilities which included 74 petroleum facilities. Telephone calls to all 74 facilities were made in November 2003. Only eight expressed interest in cooperating.

Three months later, however, and after several phone conversations, several fax messages, and emails, no data had been collected due to lack of cooperation from the stakeholders. Many of the smaller scale facilities said that the rule imposed very expensive record-keeping and that, due to limited budgets, they were unable to organize and compile data in a manner amenable to analysis. Appendix B contains documentation on the efforts to collect ex post cost data.

Efforts to estimate ex post costs from secondary sources were unsuccessful as well. Any pollution control expenditures associated with the SIC code for this industry would also include control costs from a myriad of other regulations (e.g., AQMP Control Measure #88-B-13). Hence, using such sources as the PACE survey would be unproductive. Finally, since the equipment is not necessarily air pollution control equipment, but rather necessary pieces of equipment in the production of the good, the survey of APC manufacturers would not be useful. Hence, without additional time and experts with contacts in this field, we are unable to collect information on ex post costs for this rule.

Another attempt to determine ex-post costs was made in March 2005 with limited success. Again, many facilities were reluctant to share information with the team, and in the final analysis, only 4 different companies agreed to participate. Of these 4, only 2 provided meaningful data. Both facilities requested that their company names not be used in this report, and that request has been honored.

Both facilities are refineries, with Refinery A being one of the larger facilities in the South Coast Basin, and Refinery B being a medium sized refinery. Both facilities indicated that they spent a considerable amount of time and money to comply with the rule, both in capital expenditures and on-going maintenance costs. Refinery A spent between $85 million and $90 million in capital projects to comply, and about $2 million the first year of the rule implementation to a contractor for tagging, and monitoring affected equipment. They spend about $800,000/year presently for the monitoring services (not including maintenance costs). Refinery B indicated they spent something between $5 million to $10 million for capital projects and approximately $1 million for the tagging and monitoring of equipment the first year.

The capital costs included factors such as replacing packing in pumps with mechanical seals, changing gasket materials on flanges, installing rupture discs under pressure relief valves, and replacing or connecting relief valves to a closed system.

IV.B.6 Conclusions

Because data from only 2 facilities was obtained during this study, any conclusions drawn from this analysis must be considered in that light. The sample size is clearly not sufficient enough to give a broad understanding of the impact of the Rule's implementation. That being said, there are some general conclusions that can be drawn from the data collected.

As with most other business sectors, the petroleum industry has certainly undergone considerable consolidation since the implementation of Rule 1173. This has been primarily due to market forces, but nevertheless, it can impact the ex post costs a company is willing or able to pay. Clearly the ex post costs of just these two refineries overwhelm the ex ante estimates of $36 million for the entire basin. By far the biggest contributor to the capital cost for Refinery A was the pressure relief valve project. Refinery A's management chose a conservative path and decided to connect all pressure relief valves that released to the atmosphere, into closed systems, and the recollection of the individuals involved is that that was the requirement of Rule 1173. In a conversation with the refinery manager at the time of the rule implementation, he stated that the decision was made to connect the refineries atmospheric relief valves to closed systems specifically due to Rule 1173. Currently the rule states that if a relief valve leaks or relieves more than 500 pounds of VOC twice in a 5 year period of time or more than 2,000 pounds of VOC in a 24 hour period, it has to be connected to a closed system, or a substantial fine ($350,000 per occurrence) can be paid. Again, Refinery A made the choice to spend the money and "over comply" it appears.

Refinery B did not choose to connect all atmospheric relief valves into a closed system, but did spend between $5 and $10 million for other compliance issues. In a conversation with the ex-refinery manager of Refinery B, he stated his facility decided to accept additional risk and comply with the minimal capital expenditure due to their smaller size and lower capital resources.

This Rule did allow the facility's management some latitude in interpretation, and thus each company's risk management philosophy had some impact on the final ex-post costs. However, it appears from these two data points, that independent of risk management philosophy, the district did considerably underestimate the cost to comply from a capital investment perspective. However, as noted earlier, one factor driving the high cost is the decision by the larger refinery to simply connect all relief valves into a central system, which significantly exceeded the direct requirements of the rule. One could interpret this decision as an indication that these extra expenditures could be made without substantially impacting the profitability of the operation.

In any case, there is nothing in the ex-ante cost estimates that forecasts interpretation of a rule or risk management principles. Likewise, consolidation of the industry, such as observed in this case, can also have an impact in terms of cost per pound of pollutant removed.

IV.C. CASE 3 – SCAQMD RULE 1174

CONTROL OF VOC EMISSIONS FROM THE IGNITION OF BARBECUE CHARCOAL

IV.C.1 Background

Rule 1174 applies to manufacturers, distributors, and/or retailers of materials and/or methods used to ignite barbecue charcoal. Emissions of volatile organic compounds (VOC) contribute to the formation of surface-level ozone. To attain federal and state ambient air quality standards for ozone, the SCAQMD investigated the control of sources which had not been previously targeted.

Air Quality Management Plan (AQMP) Control Number D-1 "Control of Emissions from Starter Fluid (ROG)" considered emissions from starter fluid used with barbecues. In the control measure, several approaches to reduce emissions were considered:

- Prohibit the sale of barbecues which require lighter fluid
- Require lighter fluid manufacturers to reformulate with less photo chemically reactive constituents
- Restrict use of lighter fluid on episode days
- Discourage use of lighter fluid in general through a public information program

Reactive organic compound emissions (ROG) from the use of charcoal lighter fluid in 1985 were estimated to be about 2 tons/day. The AQMP at that time projected emissions in year 2000 at 2.5 tons/day. Based on an overall 50 percent control efficiency, the control measure was designed to reduce annual emissions by 1.3 tons/day by year 2000.

Rule 1174 establishes a limit of emissions resulting from the ignition of barbecue charcoal. Any of a number of methods could be used to control the volatile organic compound (VOC) emissions, not ROG which was the focus of the AQMP, from ignition of barbecue charcoal as long as it received certification as a low-polluting method. Certification required that the demonstration that the VOC emissions resulting from the ignition of barbecue charcoal will be less than a baseline of 0.02 pound VOC per start. The following methods and materials used to ignite barbecue charcoal were exempt from certification requirements:

- Electric starter
- Chimney with paper tinder
- Propane
- Natural gas

The District's jurisdiction represented only 6.1% of the charcoal lighter fluid market. To prohibit the sale of this volatile substance in the same area would lead to industry revenue losses estimated to range from $3.3 to $8.4 million per year. Implementation of Rule

1174 was expected to result in average VOC reductions of 2 to 2.5 tons/day. During peak barbecue season (summer), VOC emissions were approximately 4 tons/day.

IV.C. 2 General Description of the Rule

Rule 1174 prohibits the supply, or sale, of materials or methods used to ignite barbecue charcoal unless they can be demonstrated to not generate emissions exceeding 0.02 pound VOC per start. According to the rule, manufacturers, retailers and/or distributors must provide the certification of a test which establishes the emissions level. They must clearly state the testing method or material, and label their product to show compliance. Subsequent material and/or method reformulation require recertification as well.

According to a SCAQMD technical report, implementation of rule 1174 would not result in any significant impact to the industry. Nonpolluting and inexpensive charcoal ignition methods are available, allowing consumers to continue barbecuing. The industries directly affected by the rule included manufacturers of charcoal lighter fluid, ready-to-light charcoal briquettes, gel starters, and solid starters. Other entities possibly affected were general merchandise and food stores, and consumers. Also affected were the manufacturers of charcoal lighter fluid, self-lighting charcoal, wax-coated charcoal, and bag-light charcoal such as Clorox Corporate, located in the Bay area, Boyle-Midway, located on the east coast, and Royal Oak Enterprise, Inc., located in Oregon and Missouri. The percentage of sales in the Basin varies by company, ranging from less than 1% for Royal Oaks Enterprise, to approximately 6% for Clorox Corp. The only affected manufacturer in the South Coast Air Quality Basin was Meteor Inc., located in Monrovia, California and a manufacturer of electric probes and metal chimneys.

Rule 1174 was adopted on October 5, 1990. Compliance with the rule was to be effective on January 1, 1992.

IV.C.3 Air Quality and Best Available Technologies for the Rule

A 1990 EPA report entitled “Estimation of Emissions from Charcoal Lighter Fluid and Review of Alternatives” estimated that 14,500 tons of VOC are emitted annually in the U.S. from evaporation and combustion of lighter fluid. Using population as a conversion factor, one can derive an estimate of 2 tons of emissions per day. For emissions from lighter fluid evaporation only, industry estimated emissions of 0.038 tons per day in the Basin. The SCAQMD supported an average estimated value for emissions from evaporation and combustion of 2 tons of VOC per day.

In 1990 SCAQMD conducted a study to assess VOC emission levels from the ignition of charcoal briquettes with various ignition methods. Two tests were performed. The first test consisted of 21 sampling sessions with lighter fluid, an electric charcoal lighter, and treated wood chips. The second test consisted of an improved testing configuration with lighter fluid, an electric charcoal lighter, treated wood chips, paraffin cubes, gel, a chimney charcoal lighter, and a portable propane gas grill in 44 sampling sessions. VOC emissions levels were relatively consistent throughout the testing sessions. The highest levels occurred with the lighter fluid ignition method. Lowest VOC emissions were observed with the electric, chimney, and propane ignition methods. Emissions from wood chips and gel ranged from 12 to 17 % of lighter fluid emissions. Paraffin cubes levels were about 24% of those of lighter fluid.[5]

IV.C.4 Emissions and Emissions Reductions

VOC emissions from charcoal lighter fluid and other ignition materials and methods are difficult to quantify. Evaporative VOC emissions occur from the lighter fluid itself, and additional VOC emissions result from the combustion of saturated charcoal briquettes. Some ignition materials or methods, such as chimney with paper tinder and electric starters, do not produce evaporative emissions. Ignitions using these methods nevertheless result in emissions from the combustion of the charcoal itself. Self-starting materials such as presoaked briquettes and bag-light charcoal produce emissions from the volatile components of the briquettes or bag, and the combustion of the charcoal itself. The combustion of natural gas and propane also produce emissions.

Emissions estimates were calculated based on annual sales in the U.S. and the findings adjusted by a proportional population factor. An evaporation rate of 10 to 25 % prior to ignition was assumed. Emission factors of 0.1 and 0.25 were used to generate two estimates. ROC emissions from fluid were 0.0813 lb/start. The density of lighter fluid was assumed to be the same as for kerosene. Using these assumptions and factors, the District estimated emissions to be between one and two tons per days.

IV.C.5 Cost Effectiveness for Ex-Ante Evaluation

Table IV-1 lists the ex ante cost estimates developed by SCAQMD for a number of methods. The two least cost methods were chimneys with paper tinder and electric starters. A chimney, which resembles a metal stovepipe, can be purchased from retail stores or home-improvement centers for $16 to $23 each. Depending on size, an electric starter sells for $7 to $22. The average cost of lighter fluid was assumed to be $2.18 per quart. A final option that was considered was a freestanding or tabletop propane grill for outdoors cooking. The marginal cost of owning a 26,000 BTU propane grill was $171, a figure slightly less than twice the cost of conventional grills such as a freestanding barbecue kettle.

Converting from starter fluid to chimney or electric starters was estimated to add only 5 to 10% to the cost of charcoal per barbecue use. Barbecuing cost of using chimney and electric starters ranged from $0.87 to $0.94 while using a propane grill was from $0.17 to $0.62. Chimney and electric starters have the lower cost per use when compared to options of ready-to-light charcoal briquettes, lighter fluid, and solid and gel starters.

Data provided to the study team indicated that barbecuing with natural gas is the least expensive of the three alternatives and is less time consuming than barbecuing with charcoal briquettes. Charcoal barbecuing costs were almost thirty times more than natural gas barbecuing and propane barbecuing was almost three times more.

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[5] SCAQMD. Report on Pollutant Emissions Resulting from Various Methods of Igniting Charcoal Briquettes, El Monte, California, October 6, 1989.

Table IV-1. The Total Cost per Use of Alternative Controls (2004 dollars)

Alternatives	Average Cost of Equipment	Capital Cost/Use	Cost of Materials/Use	Total Cost/Use
Chimney Starter	$22.30	$0.15	$0.80	$0.94
Electric Starter	$16.05	$0.07	$0.80	$0.87
Free-Standing Propane Grill (40,000 Btu)	$275.50	$0.62		$0.62
Free-Standing Propane Grill (26,000 Btu)	$171.00	$0.38		$0.38
Tabletop Propane Grill	$43.50	$0.17		$0.17
Self-starting Charcoal in Bag			$2.31	$2.31
Self-starting Charcoal			$1.55	$1.55
Charcoal Briquettes with Solid Starter			$1.33	$1.33
Charcoal Briquettes with Lighter Fluid			$1.02	$1.02
Charcoal Briquettes with Gel Starter			$1.00	$1.00

Source: The staff' report of Rule 1174, 1990.

According to the District, Rule 1174 affects manufacturers, distributors such as general merchandise and food stores, and the consumers of starter fluid. However, the manufacturers of these products are not located in Southern California. For that reason implementation of Rule 1174 was not expected to have an adverse economic impact on local industries. Distributors can alternatively sell low-emitting substitutes such as electric and chimney starters.

In the rule making process, industry was represented by the Barbecue Industry Association (BIA), a group of manufacturers of charcoal, grills, lighter products and other accessories for backyard barbecuing. The BIA provided some comments about SCAQMD's Environmental Assessment Report (EA) and its technical feasibility. While the study team did not find any ex ante cost estimates for comparison, two complaints were filed by the BIA. First, the BIA suggested that the SCAQMD EA did not consider the cost of retrofitting and replacing recreational barbecues. In a letter provided to the District, BIA claimed that based on the need for a durable and permanent barbecue at park and recreation sites, the costs to install these grill would easily exceed $1.5 million. We found no comment from the District contending this claim. Second, the BIA made claims that the District's ex ante estimates were likely too conservative since the method of estimating emissions was flawed and lead to an overestimate of current emissions (this would lead to a greater reduction in emissions thereby lowering the average costs of emissions reduction). Coordinated efforts between the District and a large industry representative, Kingsford, eventually led to an agreed upon usage estimate of approximately 550,000 gallons in 1988. Hence, the rule went forward with essentially only cost estimates from the District.

IV.C.6 Cost Effectiveness for Ex-Post Evaluation

Adoption of Rule 1174 by the South Coast Air Quality Management District required owners of charcoal fueled barbeque grills to take one of five steps. They could:

- Purchase approved low emitting lighter fluid or self-starting briquettes for starting their grills.
- Purchase a chimney starter that required waste paper to start their grill.
- Purchase an electric starter to start their grill.
- Convert to a propane fired grill.
- Convert to a natural gas fired grill.

When the study team contacted SCAQMD for permitted and/or registered facilities list, the district sent a list of approved manufacturers for Charcoal Ignition Products in Southern California under Rule 1174. In the list, 93 companies are identified by name, but no telephone number or contact name were listed. Initial efforts to compile this contact information via other routes (e.g., the internet) resulted in virtually no information. Following a first round effort to contact potentially affected companies resulted in a mere four companies indicating they were willing to participate. After several follow up calls, no data was collected from these companies. Appendix C details the effort to collect ex post cost data.

Subsequent efforts were more fruitful. Information on viably certified strategies is presented below.

Liquid Starters

At the time of rule adoption there were no complying lighter fluids. However, within two months of adoption of the rule, the major producers of lighter fluids announced complying liquids. The complying liquids were marketed at the same price as the original liquids at the time of introduction based on a brief survey by the author near the time of rule adoption (Lents 2005). Thus, to the consumer there was in essence no additional cost to purchasing approved low emission lighter fluid. This does not guarantee that there was no cost increase to producing the fuels. The producers could have believed that an increase in cost would jeopardize sales and thus they absorbed the cost and realized lower profit margins on this product. It is overwhelmingly likely, however, that liquid manufacturers continued then and today to make an adequate profit or they would have discontinued producing the liquid starters.

Manufacturers were contacted seeking information on the process used to develop complying liquids. They provided no information on the reformulation process or associated costs after repeated contacts. They did indicate that they complied by adding heavier hydrocarbons to the mix to reduce volatility. These statements indicate that the compliance issue involved some initial fuel reformulation, which could be spread over the long term with little or no additional cost. A survey was carried out to establish present cost for approved liquid starter fuels to see if values have changed significantly from the SCAQMD's initial studies. Table IV-2 presents pricing for the fuels.

Table IV-2: Retail Pricing of Charcoal Grill Liquid Starting Fuels (1994$)

Retail Outlet	Size	Low End Price (per oz)	High End Price (per oz)
Vons Grocery Store	32 oz	$0.0859	$0.1091
Ralphs Grocery Store	32 oz	$0.0622	$0.0997
Albertsons Grocery Store	32 oz	$0.0747	$0.0934
Wallmart Store	32, 64 oz	$0.0459	$0.0378
	Average	$0.0672	$0.085

As can be seen in table IV-2, there is considerable variation in the price of complying liquid fuels; however, the range of present prices includes the price originally used by the SCAQMD at rule adoption. According to the Kingsford web site (www.kingsford.com), 2 ounces of liquid starter are required to start a typical barbeque grill and recommend that the briquettes be stacked to speed up the lighting process. Kingsford also indicates that it should take 20 minutes for coals to be ready to use and recommends 1.5 pounds of charcoal for a typical grilling (1 pound of meat). The website www.ehow.com indicates that 4 ounces of starter liquid should be used to start a typical grill, that it requires 30 minutes for the charcoal to be ready to use, and that a typical grilling will require 2 pounds of charcoal. An antidotal check of persons who use liquid starters suggest that an amount on the order of 4 ounces is more typical with little stacking of the briquettes due to the hand soiling that they cause. The SCAQMD appears to have assumed that 16 ounces were typically used to start a barbeque. This seems to be high based on the more recent data collected. For this analysis a conservative 2-4 ounces per start will be used. Based on data in table 3.2 and assuming 2 ounces to 4 ounces of fluid per start results in an estimate of a cost range to start a barbeque of $0.134 to $0.340.

Chimney Starters

Chimney starters were available, although not widely sold, at the time of adoption of Rule 1174 and were defined in the rule to be automatically compliant with the rule at the time of adoption. There was some effort at the SCAQMD to get retailers to feature chimney starters shortly after rule adoption since they produced lower emissions than complying liquid starters. Initially, chimneys were readily available in most retail outlets in the South Coast Air Basin. In the recent survey to establish liquid fuel costs, chimneys were found to be available only at a few local retail outlets, perhaps because it was the winter season at the time of the survey. The Home Depot did offer chimney starters. Chimney starters are widely available through web marketers. Table IV-3 indicates the cost for chimney starters found on web sites. These costs are comparable to the Home Depot price of $14.95.

Table IV-3: Advertised Cost of Chimney Starters

Brand	Cost
Charcoal Companion by Kodar	$14.95
Chimney by Cummins Industrial Tools	$9.99
Charcoal Chimney by Onward Manufacturing	$11.09
Chimney by USA Hardware	$14.99
Chimney by Weber	$15.99
Sears Chimney	$12.99
Average	$13.33

It should be noted that the value originally assumed by the SCAQMD during the original rule making was $22.30. This significantly exceeds the present cost of the chimneys indicating that improvements in the manufacturing process have reduced the cost over time. While there were no studies available on the life of a chimney starter, they are typically made of heavy gauge galvanized metal with no moving parts and should be expected to last for 20 years with reasonable care. This appears to be the value assumed by the SCAQMD in its original analysis. If it is assumed that the typical charcoal grill owner barbeques 8 times per year (the SCAQMD chose a similar value), then the per use cost of starting the charcoal would be between $0.0624 and $0.100 assuming that the waste paper used in the burning process has no commercial value. This is somewhat cheaper than the use of a liquid starter. However, since it requires a higher initial outlay of cash and is a little more difficult to store it is easy to see how owners might default to liquid starters.

As an inducement to purchase chimney starters, producers argue that the chimney starters produce hot coals faster than liquid starters do. One producer indicated a charcoal ready to cook time of about 5 minutes (www.kountrylife.com). This, of course, would save time and thus produce time cost savings as well for users of chimney starters if it is true. It is also possible that the reduction in cost might have happened due to the change in the location of manufacturing. Manufacturers of the chimneys might have moved to lower cost areas. But no analysis has been made in this study.

Electric Starters

Electric starters were available at the time of the adoption of Rule 1174 and were defined as complying with the rule. During the liquid fuel survey discussed above, electric starters were found to be available at only one of the retail outlets surveyed. They are available through the internet, however. Table IV-4 indicates the cost of electric barbeque starters found on the web.

Table IV-4: Cost of Electric Starters

Brand	**Cost**
Electric Lighter by Big Green Egg	$23.99
Electric Starter by ME Heuck	$14.99
Electric Starter by BBQ Guys	$24.95
Electric Starter by Char-Broil	$9.85
Electric Starter by Colorado Aggregate	$8.99
Electric Starter by Grilling Depot	$20.00
Average	$17.13

The SCAQMD originally indicated a cost of $16.05 for the cost of an electric starter. This is well within the range of values found today and very close to the average. The difference in cost is likely due to inflationary increases. The fact that the prices did not drop as was the case for chimney starters is likely due to the fact that the technology used to produce electric starters is essentially the same as that for electric stove tops, which was well developed by 1990 when the rule analysis was being made. Only one source of electric starters indicated the wattage of the starter, which is 500 watts. This is a reasonable energy consumption rate and will be used for the analysis. As with the chimney starter, electric starters have no moving parts and should be expected to last 20 years if properly cared for. No estimates were provided for the time it takes an electric starter to properly light a typical grill. It will be assumed that it requires the same as the liquid starter. Electricity costs in California averages $0.123 per kilowatt-hour at the time of this analysis. An electric starter running for 30 minutes will require 0.25 kilowatt-hours of power, which will cost $0.0308 per start. The cost of the grill using 8 uses per year over 20 years as for the case of chimney starters will range from $0.0562 to $0.156 per start. With electricity cost considered, the *per* start cost for an electric starter is between $0.087 to $0.194. Thus, the electric starter is also cheaper on a per use basis than the liquid starter. As is the case with the chimney, the electric starter does require an initial cash outlay and must be stored over multiple years. The electric starter must also be plugged in, which may indicate why they are not more popular.

Gas and Electric Grills

Gas and electric grills were defined as compliant with Rule 1174 at the time of rule adoption. The sale of gas and electric grills has surpassed charcoal grills in recent years as shown in Figure IV-1 (http://hpba.org). Beginning in 1985 and before Rule 1174 was adopted, the annual number of gas and electric grills sold increased while the annual number of charcoal grills sold decreased. Since 1995, the number of gas and electric grills sold exceeded the number of charcoal grills sold. Since this trend was already in progress at the time of adoption of Rule 1174, it is doubtful that the rule caused this trend. As noted earlier, Rule 1174 did not directly impact consumer costs associated with use charcoal grills.

The Southern California Gas Company indicates that 59% of barbeque grill owners use gas grills. The typical energy consumption of a smaller sized gas grill is about 25,000 BTU. Natural gas cost varies but residential gas costs are about $10 per million BTU (www.eia.doe.gov). Operation of a gas grill for 45 minutes will thus cost about $0.19. An equivalent charcoal grill will use about 2 pounds of charcoal. The cost of 2 pounds of charcoal plus the cost to start the charcoal burning will run about $1.20. Thus operational cost of a gas grill is much lower than those of a charcoal grill. The annualized cost of the gas grill itself will be about $1.87 per use. The annualized cost of the charcoal grill itself will be about $0.43. Both calculations assume 160 uses over the life of the grills. Thus, the use of a natural gas grill will run about $2.06 while a charcoal grill will cost about $1.63 with all costs included. Thus, the use of a charcoal grill overall will be cheaper but more time consuming due to the need to light the charcoal briquettes.

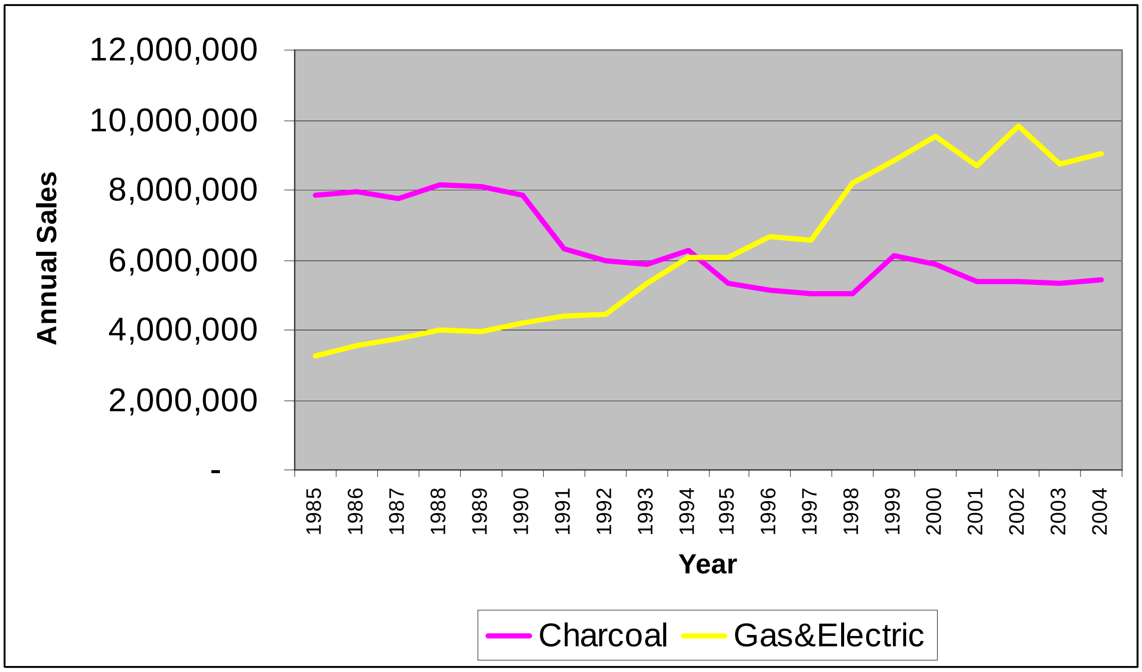

Figure IV-1. Annual Sales of Charcoal and Gas/Electric Grills (1985-2004)

IV.C.7 Conclusions

Rule 1174, adopted in 1990, applies to manufacturers, distributors and/or retailers of materials and/or methods used to ignite barbecue charcoal. The rule allows for several control options for the ignition of barbecue charcoal, based on baseline of 0.02 pound per start or less of VOC emissions. The exempt methods and materials used to ignite barbecue charcoal were electric starters, chimney with paper tinders, propane, and natural gas. From the ex ante analysis, barbecuing with natural gas was determined the least expensive of three alternatives and less time consuming than with charcoal briquettes. Table IV-5 compares the ex-ante evaluation with the ex-post evaluation.

Chimney and electric starters have the lower cost per use when compared to ready-to-light charcoal briquettes, lighter fluid, and solid and gel starters. The cost estimates by the SCAQMD at the time of rule adoption are consistent with the costs found today for the Chimney Starter and Electric Starter methods. However, consumers appear to be choosing the highest cost option, gas grills, over time. This is likely due to the ease of use of the gas grills.

Implementation of rule 1174 was expected to result in an average daily VOC reduction of 2 to 2.5 tons per average day and as high as 4 tons per day during the peak barbecue season. The increasing use of gas grills is likely resulting in a greater emission reduction than originally anticipated. In spite of the fact that chimney and electric starters are cheaper and likely faster than liquid starters, most persons using charcoal continue to opt for the liquid starter. Presumably, the cost of starting charcoal is so low regardless of the method used that consumers make no effort to evaluate cost effectiveness and simply choose the easiest approach at the time. The only lasting trend that is observable is the increasing use of propane and natural gas fired grills, which in effect are displacing the use of liquid starter.

Based on information collected and assembled for the ex post cost estimation, the original SCAQMD cost projections of the impact of Rule 1174 have proved to be reasonably accurate, if not slightly too high.

Table IV-5. Comparison of Ex-Ante With Ex-Post Cost Estimates

Starter Type	Original SCAQMD Estimate (per start)	Study Estimate (per start)
Liquid Starter		\$0.134 - \$0.340
Chimney Starter	\$0.94	\$0.062 - \$0.100
Electric Starter	\$0.87	\$0.087 - \$0.194
Liquid Starter + Charcoal	\$1.02	\$1.63
Gas Grill + Gas	\$0.62	\$2.06

IV.D. CASE 4 - SCAQMD RULE 1138

CONTROL OF VOC AND PARTICULATE MATTER (PM) EMISSIONS FROM RESTAURANT OPERATIONS

IV.D.1 Background

Rule 1138 applies to the operators and owners of commercial restaurants. Food preparation emits volatile organic compound (VOC) and particulate matter (PM) that contribute to ozone formation. Charbroilers, griddles and deep fat fryers contribute to the emissions of VOC and PM. In the South Coast Air Basin, daily VOC emissions from restaurants are approximately 1.6 tons and PM about 11.6 tons, according to a South Coast Air Quality Management District (SCAQMD) report. The Rule was adopted in 1997.

Charbroilers are classified as “chain-driven” and “under-fired”. Installations of flameless catalytic oxidizers, the “Best Available Control Technology” (BACT) for chain-driven charbroilers, could eliminate 0.2 tons/day of VOC and 0.5 tons/day of PM emissions. This technology was considered easy to install and maintain. Use of a catalyst could reduce natural gas usage by 3 to 7% and decrease the amount of grease buildup in exhaust ducts. In 1991, approximately twenty flameless catalytic oxidizers were operating in the Basin.

Rule 1138 partially implemented control measure PRC-03 from the 1197 Air Quality Management Plan and tried to make progress towards attainment of Federal and State particulate matter (PM) and ozone standards. In addition, Rule 1138 was the first rule adopted to address the National Ambient Air Quality Standard for $PM_{2.5}$. Implementation of the rule was expected to decrease of the number of visible emission violators from the restaurant industry in the Basin.

AQMD has jurisdiction over four counties: Los Angeles, San Bernardino, Orange and Riverside. Levels of pollutants vary within these areas. Some portions of the Basin have been designated by the EPA as extreme non-attainment areas for ozone.

IV.D.2 General Description of the Rule

Rule requirements initially targeted chain-driven charbroilers used to cook meat since they were the only restaurant emissions that were thought to be amenable to cost-effective control with proven, available control technology. SCAQMD had specifically identified catalytic oxidizers as BACT which could effectively control PM and VOC emissions. The majority of emissions from charbroilers are PM emissions.

The 1997 Air Quality Management Plan (AQMP) outlined standards to achieve emission reductions and air quality goals through the implementation of control measures. Rule 1138 partially implemented PRC-03 – Emission Reductions from Restaurant Operations (VOC, PM_{10}), a control measure listed in the AQMP under “Fugitive Dust and

Miscellaneous Source Categories." This measure projected emission reductions of 1.2 tons/day for VOC and 8.2 tons/day for PM_{10}. The first rule development based on control measures started in 1991. Until 1997, AQMD worked with industry to develop the rule and possible best available control technologies. During the rule action period, a survey was conducted in cooperation with the California Restaurant Association. There were approximately 31,000 restaurants in the jurisdictional boundaries of AQMD. Results from the survey suggested that commercial restaurants produce emissions from several types of cooking equipment.

The Rule requires existing chain-driven broilers with an average life of 10 years to be operated with certified pollution control equipment within twenty-four months of the rule adoption. A certification and/or registration program was developed for equipment manufacturers. They could obtain pre-approval of equipment certification after it had been shown to meet all of AQMD's requirements.

Rule 1138 allowed existing chain-driven charbroilers with control equipment to continue operation until the end of their functional life, but not more than ten years after the adoption of the Rule. AQMD typically applies a 10-year life to any piece of standard control equipment fitted with BACT. At the end of this period operators should install or replace a catalyst or other certified control equipment. There are some exemptions to the rule and record-keeping requirements are minimal.

IV.D.3 Air Quality and Best Available Technologies for the Rule

Restaurants emit particulate matter (PM) and volatile organic compounds (VOC), which contribute to ozone formation. PM less than 2.5 microns in diameter are referred to as "fine" particles. Those larger than 2.5 microns are termed "coarse". The federal standard, and most of the focus on controls and the impact of particulate emissions, has been on PM measured at 10 microns or less, termed PM_{10}. The maximum 24 hour PM_{10} concentration recorded in the Basin in 1995 was 45% larger than the federal standard and 429% of the State standard. The Antelope Valley and Coachella Valley Planning Areas, Mojave Desert, Ventura and San Diego County are impacted by transport of pollutants from the Basin.[6] In 1993, EPA reclassified the Basin and Coachella Valley as a serious non-attainment zone for PM_{10}. Rule 1138 focuses on reducing both PM_{10} and a subset, $PM_{2.5}$.

PM and VOC reductions are accomplished with a catalytic oxidizer, self-cleaning ceramic filters, fiber-bed filters, and incineration (catalytic and thermal). A staff technical report determined the BACT to be the flameless catalytic oxidizer. In this process, the exhaust stream containing PM and VOC is mixed with air before entering a flameless reactor vessel. The air mixture is evenly distributed into a bed of inert ceramic material coated with a special metal catalyst. This bed provides complete mixing of PM, VOC and oxygen. PM and VOC oxidize into carbon dioxide and water vapor once the mixture reaches the combustion temperature. Temperature control is very important for

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[6] South Coast Air Quality Management District, Air Quality Management Plan, 1997, Appendix Chapter 2-Air Quality and Health Effects.

effective oxidation of VOC and PM. For restaurant applications, exhaust gas entering the reactor needs to be at least 600°F. A removal efficiency approaching 85% can be achieved using this process. The cost estimates used by the agency and industry assume an 83% effectiveness.

Several companies have developed and were producing certified catalytic reactors that were operating successfully at about 15 restaurant locations in the South Coast Air Basin at the time of the rule making.

IV.D.4 Emissions and Emissions Reductions

During the rule action period, significant testing had been done with emissions from restaurant operation. Important findings were that the food type and appliance used were important to the level of emissions observed. The largest amount of emissions came from under-fired charbroilers. PM size distribution in cooking appliance exhaust was below PM_{10}, and even mostly below $PM_{2.5}$. Installation of catalytic oxidizers was responsible for significantly reducing both VOC and PM.

Testing during the rule action period was aimed at developing suitable VOC test methods and emission factors for different types of foods and appliances. Four types of cooking appliances were tested: under-fired charbroilers, chain-driven charbroilers (with and without catalytic oxidizer), deep-fat fryers, and flat griddles. Five types of food were tested: hamburger patties, steaks, chicken, fish and potatoes.

Chain-driven charbroilers accounted for 12% of the VOC restaurant emission inventory and 4% of PM restaurant emission inventory. Under-fired charbroiling was the cooking method which resulted in the largest amount of PM and VOC emissions. Emission levels were deemed to depend on the type of food cooked. For instance, hamburger meat produced the most PM emissions, while deep-fat fryers had PM emissions below detectable levels regardless of the food cooked. VOC emissions ranged from 0 to 0.042 lb per 1000 lb of food. Flat griddles gave PM emissions below detectable levels when cooking fish and chicken, and their VOC emissions ranged from 0.02 lb VOC/1000 lb to 0.56 lb VOC/1000 lb. With hamburgers on the flat griddle, emissions increased significantly to an average of 5.08 lb PM/1000 lb and 0.12 lb VOC/1000 lb, respectively.

In summary, test data showed that the type of food and appliance used had a large impact on emission levels. Installation of catalytic oxidizers to chain-driven charbroilers was expected to significantly reduced both PM and VOC emissions.

IV.D.5 Cost Effectiveness for Ex-Ante Evaluation

Owners of restaurants with chain driven charbroilers were expected to incur additional costs when installing catalytic oxidizers. SCAQMD calculated the average cost effectiveness for catalytic oxidizers based on two sources of data (Dabirian 1997).[7] First, the equipment manufacturers submitted cost information. Capital equipment costs were

[7] Addendum to Staff Report, Socio Economic Assessment of Proposed Rule 1138 prepared by S. Dabirian, November 1997.

estimated to be $4,366, with installation and retrofit costs of $1,180. Annual O&M costs were estimated to be $590. Savings from less cleaning of the exhaust stack was estimated at $885 annually. Assuming a 5-year catalyst life, a 4% interest rate, and an 83% PM and VOC emissions reduction, the cost per ton of emissions reduced was estimated to be $1,980 from the equipment manufacturers.

Restaurant operators also provided information related to the ex ante costs of meeting this regulation. Their per ton cost estimates ranged from $1,180 to $8,730 per ton depending on the extent of the retrofit. While annual O&M were not listed in any of the documentation viewed, it was noted that the affected restaurants assumed no cost savings from fewer stack cleaning events.

Based on the information the District received from the potentially affected restaurants and equipment manufacturers, the District assumed the average cost estimate was approximately $3,300/ton of PM and VOC reduced. Finally, cost estimates indicated that catalytic oxidizers were a cost-effective control option. It was determined that other control technologies, such as ceramic filters, fiber-bed filters, and wet scrubbers did not appear technologically or economically feasible.

The total gross sales of an average large volume quick service franchise ranged from $590,000 to $1,180,000, according to the Directory of High Volume Independent Restaurants and American Business Information Inc. Total annual costs of complying with Rule 1138 to individual restaurants were estimated between $950 and $1,500. The total annual compliance cost for a restaurant was 0.13-0.16 % of its total gross annual sales. Since affected restaurants are local businesses, they were expected to pass the cost of compliance to customers.

Rule 1138 was estimated to result in an average annual loss of 28 jobs in the four-county area. The facilities generally affected were large volume fast food restaurants, such as Burger King, Carl's Jr., and some restaurants located in amusement parks. During the rule action period, business impacts were not calculated due to lack of information. However, comments were submitted by several impacted industries in the South Coast Air Basin. None of these comments were about the economical feasibility of the rule; rather, they focused on cost effectiveness calculations involving maintenance or labor.

IV.D.6 Cost Effectiveness for Ex-Post Evaluation

Initial contact with the SCAQMD to request an updated list of restaurants indicated that for Rule 1138, the SCAQMD only maintained restaurant registration numbers. Additional contact information was not available. Initial contact with four of the major companies affected by the rule - Burger King Corp., Carl Karcher Enterprises, Inc., Knott's Berry Farm, and McDonald's Corporation – was also unproductive due to company representatives being unresponsive to data requests.

A follow up campaign to gather ex post information on the restaurant rule was conducted in 2005, and useful contacts at the South Coast Air Quality Management District, as well as Engelhard Catalyst Company and Carl Karcher Enterprises were obtained[8]. The information on the costs and implementation of the required catalysts for this rule below are based on these contacts.

Carl Karcher Enterprises, owner of Carl's Junior restaurants, represents approximately half of the 800 affected restaurants in the District. Burger King represents the other major restaurant chain affected, although efforts to obtain information from Burger King during this time period were unsuccessful. However, because of the large percentage of affected restaurants, the information received from Carl Karcher Enterprises is expected to be representative of all restaurants where the rule applied. At the time of the rulemaking there were three companies identified as having acceptable products for meeting this rule's requirements. The vast majority of restaurants chose Engelhard's CharCat Series 900 to meet their needs.

According to Carl Karcher Enterprises, the implementation of the catalysts was straightforward and consistent with the anticipated costs of implementation, in a large part due to industry's active participation in the rule making process. As part of the rule, the companies are required to keep records on the installation of these units and their maintenance, and be provided to District on request. Although the district could not provide an updated list of affected restaurants and has not ever requested this information from the restaurants, it appears that there are some records being maintained by the restaurants. For Carl's Junior restaurants, this responsibility was transferred from the headquarters to the individual franchisees several years ago. Due to time constraints as well as the difficulties associated with collecting information from franchisees directly, this information was not collected. However, general information from the headquarters, which has the responsibility of training the franchisees on where to buy the equipment and how to maintain the equipment, was provided and considered useful for this analysis.

Capital Cost and Maintenance

The current capital cost of a CharCat ranges from $1507 to $3000 depending on the size of the charbroiler[9]. The estimated cost from both the affected restaurants and the equipment manufactures during the rulemaking was $3700.

Engelhard has recently reported that the CharCat has very low maintenance and lowers operating costs by decreasing their gas usage and reducing the frequency of duct and roof cleaning, enabling capital and installation costs to be paid back in less than a year.[10] Carl's Junior representatives reported similar findings of lowered gas usage and less duct cleaning. The reason for the decreased gas usage is that the catalyst actually increases the operating temperature, so less gas is used in the heating process than if the same

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[8] Mike Kissell, Carl Karcher Enterprises 714-778-7150, conversations on February 14th, 2005; Pamela Periman SCAQMD, 909 396 3103, conversations on February 11th,2005; Ed Pupka, SCAQMD, conversations on February 11th and 12th, 2005

[9] Information obtained from Golden West Equipment, 714-879-3850, February 16, 2005

[10] Restaurant Chains Clear the Air With Engelhard Technology, Iselin, NJ November 24, 2004. http://www.engelhard.com/Lang1/xDocIDBC755A528F4D45AAA7BE71371B34FDBA/xDocTable_News/Tab_Overview/TechnologyClassID0/MarketID0/TechnologyID0/ApplicationID563CDEACDEAD4F15AEAA62BE1FCDD7F5/ProductID0/up1/SubSiteID0

charbroiler was operating without the catalyst. The reason for the decreased duct cleaning is that approximately 85% of the particulates are removed using the catalyst. The particulates are what cause clogged ducts because they condense as they cool and attach themselves to the walls of the duct, requiring periodic cleaning. The only maintenance recommended and performed by Carl's restaurants is when weekly cleaning on the charbroiler is performed, which is soaking the catalyst for a few minutes. This results in virtually no increase in routine maintenance as these weekly cleanings need to be performed anyway. Hence, the $590 that was part of the ex ante costs for operation and maintenance was a clear overestimate.

Other identified costs for the affected restaurants included retrofitting the charbroiler to allow enough room for the catalyst to fit. In actuality, the retrofit was a very minor modification and cost and only affected approximately 1% of Carl's existing charbroilers. The other potential up-front cost of complying with the rule was that the use of the catalyst recommended having a liquid fire suppressant installed at the restaurant. Carl's was in the process already of converting from powder to liquid fire suppressants but this rule accelerated the process in a few restaurants. Both of these costs were included in the ex-ante analysis provided by the restaurants, and the actual costs realized are probably slightly less than the projected costs. Furthermore, neither of these costs applies to a new restaurant.

The ex ante cost analysis estimated a savings for less duct cleaning of between $0 and $885 per year, operational costs estimated at $590 per year with no estimate of savings from reduced gas usage. Although no specific numbers on operational savings and installation were provided from Engelhard or Carl's, the ex-ante numbers are probably an overestimate of the costs, since no gas usage savings were factored in and Engelhard's recent reports of operational savings in excess of $3000 per year.

Performance

Although the district has not performed any field emissions testing since the rule has been implemented, it is believed that the performance of the catalyst is maintaining at least the originally estimated removal efficiencies of 85% in the field. This assumption, in part, is due to the minimal maintenance requirements for proper functioning of the catalysts. Furthermore, Engelhard reports the efficiency to be over 95% for gases and 90% for particulates for its CharCat technology[11].

Per Unit Cost Comparison

Indeed, if we overlook gas savings, the per ton costs of compliance using the updated capital costs, assuming no retrofit costs nor operation and maintenance costs, and, finally, assuming an 85% efficiency is $1,250/ton, a 90% efficiency is $1,150/ton, and a 95% efficiency of $1,085/ton. This is a very conservative estimate (i.e., the costs are likely to be considerably less if fuel savings is included), and is significantly less than the

[11] Charbroiler catalysts, Product information on Engelhard website, Accessed February 16th, 2005. http://www.engelhard.com/Lang1/xDocIDAB366D76201F471EA789C6D03D0D7F03/xDocTable_Technology/Tab_Overview/TechnologyClassID0/MarketID0/TechnologyIDAB366D76201F471EA789C6D03D0D7F03/up1/SubSiteID0

$1,980/ton and $3,300/ton based on ex ante estimates provided by the equipment manufacturers and affected restaurants in 1997.

IV.D.7 Conclusions

Restaurant operators using existing or new chain-driven charbroilers that cook more than 875 pounds of meat per week (that is 500 quarter pounders a day) were required to install a catalytic converter by 1999. Records were to be kept for a minimum of 5 years. It was estimated that approximately 800 restaurants within the basin were affected by this rule.

The various cooking equipment contributing to the emissions of PM_{10} and VOCs includes deep-fat fryers, griddles, and charbroilers. Rule 1138 applies only to chain-driven charbroilers used to cook meat. During the rule action, there were approximately 1,000 chain-driven charbroilers being used in 800 restaurants located in the Basin, contributing approximately 0.5 tons per day of PM_{10} and 0.2 tons per day of VOC. Rule 1138 requires the installation of a catalytic oxidizer control device on new and existing chain-driven charbroilers. The record-keeping requirement is for the installation dates of catalytic oxidizer, cleaning, maintenance and replacement of the catalyst for a period of five years.

The restaurants with chain driven charbroilers will incur additional costs as a result of installing catalytic oxidizers. The SCAQMD calculated the average cost effectiveness value for catalytic oxidizer to be $3,300 per ton of emissions reduced based on data submitted by affected restaurants and equipment manufacturers. The average cost calculated from equipment manufacturers was $1,980 per ton of PM and VOC emissions reduced, and the industry estimates ranged from $1,180 to $8,730 per ton reduced emissions. The actual annual cost of complying with Rule 1138 for each restaurant was estimated to be between $1,085 and $1,250. The actual annual compliance cost for each restaurant ranged between 0.13-0.16 percent of total gross annual sales. At the time of the rule making, information from the affected industries suggested that due to the economic impact of Rule 1138 on industries, it could result in an average annual loss of 28 jobs in the four-county area. The ex post cost estimates are considerably smaller than either parties ex ante estimates. Most likely the rule did not result in significant job losses.

The discrepancies in the ex ante and ex post cost analysis can be attributed to a combination of the following misassumptions made during the ex ante analysis:

- An overestimate of operating and maintenance costs of the catalyst
- An underestimate of operational savings (less duct cleanings) from the catalyst
- An underestimate of the capital cost of the equipment
- An overestimate of the number of retrofits required for compliance in the industry
- An underestimate of the catalyst efficiency improvements over time for new units

Some of these assumptions could not have been improved upon before the rulemaking, such as forecasting technological improvements of the catalyst efficiency. A more detailed look at the operational and maintenance costs by the AQMD and the fraction of required retrofits, though, might have improved the ex ante analysis considerably.

IV.E. CASE 5 – CARB RULE 90-5-1

AIRBORNE TOXIC CONTROL MEASURE FOR ETHYLENE OXIDE EMISSIONS FROM STERILIZERS AND AERATORS

IV.E.1 Background

Ethylene oxide (EtO), a registered pesticide, is widely used as a biocide to sterilize medical products and fumigate foodstuffs. EtO is classified as a "probable human carcinogen" by the International Agency for Research on Cancer (IARC) and the California Department of Health Services (DHS). The California Air Resources Board (ARB) identified EtO as a toxic air contaminant on November 12, 1987. California's Health and Safety Code Section 39665 requires ARB to establish Best Available Control Technology (BACT) limits for toxic air contaminants identified by their board. Only the Department of Food and Agriculture has the authority at the state level to regulate the pesticide use of EtO. By agreement between the two agencies, ARB would regulate the routine discharge of "waste" EtO from sterilization and, thus, not require changes in EtO usage. On May 10, 1990, the California Air Resources Board approved an Air Toxic Control Measure (ATCM) 90-5-1 governing the control of EtO emissions from sterilizers and aerators. The ARB executive officer subsequently adopted the regulation through Executive Order G-586 on November 16, 1990. By state law, local air districts had 120 days to propose, and six months to adopt, a regulation at least as stringent as the ATCM.

IV.E.2. Air Quality and Best Available Control Technology

The control measure required that any EtO be vented to a control device, with none lost due to leaks or discharge in wastewater streams. Chlorofluorocarbon-12 (CFC-12) is the most common gas used as a diluent in EtO sterilization mixtures. In 1987, the United States signed the Montreal Protocol, an international agreement to reduce the production and consumption of ozone-depleting compounds over a 10-year period. In 1989 a national tax was imposed on CFC production to reduce its consumption.

The concentration of EtO in exhaust streams strongly influences the applicability and efficiency of the various control technologies. Source tests of catalytic oxidation and acid-catalyzed scrubbing technologies showed that EtO in sterilizer exhaust had been reduced by more than 99.9% with these technologies. In a technical report by ARB, these levels of emissions are possible for sterilizer exhaust through thermal oxidation. Reclamation systems can recover 60-80% of the sterilant gas exhausted from a sterilizer and it might be more effective for using them in conjunction with other technologies to reduce emissions further.

At the time of their proposal, ARB staff believed there were 650 facilities statewide that would be affected by the control measure. EtO emissions were estimated at 796,000 lbs/year representing a cancer burden of 360-510 over a seventy-year period. Hospitals and veterinary clinics were stated to represent over eighty-five percent of the number of sources in the state, but less than twenty percent of the EtO emissions. Commercial facilities, including medical/food products manufacturers and contract sterilizers, were stated to represent less than ten percent of the sources, but accounted for more than eighty percent of the EtO emissions.

In establishing the BACT levels for EtO, ARB evaluated five types of add-on controls: catalytic oxidation, thermal oxidation, acid-scrubbing, solid reactant bed, and reclamation. While there were no known “drop-in substitutes” for EtO, gamma radiation and electron beam irradiation did have limited application as alternate sterilization techniques.

Instead of specifying control technologies, ARB chose to define BACT as levels of control. This approach allows a facility to select the control technology that is most appropriate to their situation. The ATCM established different levels of control efficiency based upon the facility’s level of EtO usage as follows: < 25 lbs of EtO/year – no control required; > 25 lbs/year and < 600 lbs/year – 99% control on the sterilizer; > 600 lbs/year and < 5000 lbs/year – 99.9% control on the sterilizer and 95% control on the aerator; > 5000 lbs/year – 99.9% control on the sterilizer and 99% control on the aerator. Aeration-only facilities were required to control their emissions by 95%. Compliance timeframes ranged from 12 to 24 months depending on the level of EtO usage with the highest users having the shortest timeframe.

IV.E.3. Cost Effectiveness for Ex-Ante Evaluation

ARB staff included the following considerations in their calculations of projected compliance costs:

- Capital equipment costs – including taxes and freight
- Installation costs – including minor building modifications
- Indirect costs – including site engineering, source testing and district fees
- Contingency and retrofit costs – including other site-specific expenses
- Office of Statewide Health Planning and Development (OSHPD) fees – for modification of health care facilities

While small (< 25lbs/year) users were exempt from the control measure, they were still required to obtain permits and thus some administrative costs at the local air district existed.

ARB staff also annualized the cost of compliance over ten years at ten percent interest and added operation and maintenance costs to estimate an annual cost for typical facilities. Table IV-6 provides information on the projected costs developed by ARB staff. ARB staff estimated the total statewide initial cost of compliance for all facilities, excluding operation and maintenance, to be $87,000,000. The annualized statewide cost of compliance was estimated to be $21,750,000.

Table IV-6. Projected Costs by CARB Staff (2004 dollars)

Control Category	Initial Cost per Facility (excluding O&M)	Annualized Cost per Facility (including O&M)
Exempt	$ 435	$ 290
Small	$152,000	$ 33,350
Medium	$188,500	$ 50,750
Large	$674,250	$188,500
Aeration-only	$174,000	$ 50,750

Specifically, ARB had determined that the regulation would create a cost burden to the State, local government, and customers. According to the rule action files, the costs associated with this control measure would result from the purchase, installation, operation, and testing of emission control equipment. A breakdown of the initial cost of compliance to different levels of government is provided.

Costs to State Government
The affected state agencies operate ethylene oxide sterilizers in hospitals, laboratories, veterinary care facilities, and museums. These agencies include the University of California, California State University, the California Department of Developmental Services, and the California Department of Mental Health. For facilities within these agencies that use less than 25 pounds EtO per year, the cost associated with this regulation would be for record keeping and demonstrating to the applicable air pollution control and air quality management districts that these levels are not exceeded.

For facilities using more than 25 pounds of EtO per year, the expenses associated with this regulation would be for purchasing, installing, operating, and testing EtO emission control equipment. The total annual estimated cost to these agencies was $420,500.

Costs to Local Governments
Costs to Districts for implementing this regulation were expected to be $1.0 million the first year and $246,500 annually thereafter. The regulation would create costs to, and impose a mandate upon, some local public agencies, specifically counties and local hospital districts. Thirty-one local agencies owning or operating hospitals were expected to incur costs totaling $1.1 million annually. Costs to individual agencies were expected to range from $290 to $50,750 annually.

Costs to Hospital Patients
Cost burdens to hospital patients were expected from $0.58 to $1.74 per bed per day (an increase of 0.1% to 0.2%). The costs to customers of commercial sources were estimated at $0.23 per cubic foot of material (an increase of 3% to10%).

ATCM 90-5-1 control technologies included catalytic oxidation, thermal oxidation, catalyzed scrubbing, and solid reactant. The capital cost of the largest device, excluding installation and any necessary instrumentation, was between $116,000 and $290,000 for thermal oxidation.

Annualized costs to various sources were also estimated by CARB. The highest annualized costs were to the large EtO users, which numbered 25 in California. The largest numbers resulted from small facilities, and their annualized cost was $33,350. The highest installation and annualized costs for both control technologies were to facilities using more than 5,000 pounds of EtO per year. These facilities incurred additional permitting costs. Based on the SCAQMD permit fee schedule, permitting costs were a $232 to $479 one time fee and a $218 annual renewal fee.

It should be noted that in 1988 EPA produced a technical report on EtO control measures. EPA and CARB estimates for capital and annual costs were generally in agreement. In some instances ARB used EPA data in its report.

Comments from industry representatives reflect a higher estimation of costs than those projected by ARB. Presco Food Products Inc. claimed they would have to pay approximately $116,000 for a scrubber in order to comply with the regulation and that such a cost would shut down their operation because they could not bear that cost. Griffith Micro Science Inc. reported the cost to implement the control technology proposed by CARB at their two Vernon facilities (including extensive modification of aeration room and warehouse areas to comply with both CARB and OSHA regulations, purchase and install equipment, non-process related facilities upgrades that would be required by the City of Vernon, and production down time) would be $2.18 to over $3.6 million. They also reported annual operating costs of this technology to be in excess of $435,000. The Health Industry Manufacturer's Association (HIMA) claimed that the costs associated with aeration room emissions controls were understated by ARB, especially for large EtO users.

IV.E.4. Cost Effectiveness for Ex-Post Evaluation

In the CARB Rule Action files, there were 58 hospital names, but no addresses or telephone numbers. A contact list was developed; however, stakeholders were non-responsive to subsequent telephone requests for cost information.

In February, 2005, the Director of Hospital Operations at the University of California at Irvine, was contacted by telephone. She had been a Deputy Executive Officer at the South Coast Air Quality Management District. While in that position, she was responsible for developing the AQMD regulation for EtO Emissions from Sterilizers and Aerators. She subsequently left the SCAQMD in 1998 to become the Director of Hospital Operations at the Children's Hospital in San Diego (CHSD). During the telephone interview, the Director indicated that virtually all of the hospitals in Los Angeles and Orange counties had moved away from in-house EtO sterilization. She further reported that EtO continues to be a critical sterilization technique, especially in pediatric care. She stated that CHSD was engaged in a physical change in its sterilization processes and may or may not still have an on-site EtO sterilizer. She recommended our team contact the director of the Peri-Operative Department at CHSD. We subsequently contacted the director of Peri-Operative Department at CHSD. She confirmed that EtO continues to be a critical sterilization technique, especially in light of the direction that endoscopic surgery has taken in recent years. She recommended we contact a particular staff employee who would have access to the technical and cost information related to their sterilization program. Ultimately, that staff person reported that CHSD owns and operates two AMSCO 100% EtO sterilizers. Each unit is connected to a "catalytic converter" that scrubs the residual EtO from the chamber. No by-products, such as ethylene glycol, are produced. Approximately, 10% of the total sterilization is performed using EtO. CHSD never used EtO exclusively. It is now the primary method of sterilization for heat sensitive items. CHSD also conducts sterilization using steam (autoclave) and "paracetic acid." The staff person reported that he had no readily available cost information and would provide after researching the hospital records. To date, no further information has been forthcoming although subsequent contact attempts have been made.

The website for the "Medical Device Link's North American Suppliers' Directory – Sterilization Services" was used to develop a contact list. Subsequently, telephone contact was made with a representative of Sterilization Validation Services. Telephone contact was made with an employee at this company. The representative reported that at the time of the rule adoption, he worked for Pfizer at a facility located in the Basin. Prior to the rule, Pfizer operated an EtO sterilization process equipped with a control system that was 97% efficient and produced ethylene glycol as a by-product. The ethylene glycol was then sold to manufacturers of anti-freeze. He further recalled that compliance with this rule would have required catalytic or flame oxidation and,at that time, the cost was on the order of $2,000,000 (or $2.9 million in 2004). He reported that Pfizer made the decision to shut the EtO operation down and to outsource their sterilizations.

According to this source, there are now only two contract sterilizers: Steris (plants in Otai Mesa and Temecula) and Sterigenics (plants in Ontario and downtown L.A., which has recently been purchased by IBA, a Belgian company. When asked whether outsourcing was actually more economical than maintaining an onsite sterilization system, his reply was that there may have been an initial saving but related that, as the field of contract sterilizers has narrowed, the costs per chamber run have risen dramatically (perhaps less competition and supply). He cited a cost increase from $500 to $1800 per chamber run over a 10 year period.[12] He noted that validations are required on a more frequent basis for radiation sterilization than for EtO, which has cost implications. This contact also indicated a continuing need for EtO sterilization for items that can't be radiated (electronics), subjected to steam or dry heat, or to hydrogen peroxide.

[12] He is willing to be contacted if further information is needed. He is a microbiologist and now performs validations of sterilization systems. He noted that validations are required on a more frequent basis for radiation sterilization than for EtO. Mr. Davis indicated a continuing need for EtO sterilization for items that can't be radiated (electronics), subjected to steam or dry heat, or to hydrogen peroxide.

Additionally, two medical equipment providers, BC Technology Inc. and Special Team Medical Services Inc. were contacted (by phone). BC Technology Inc. reported they outsource their sterilization. The contact at Special Team Medical Services Inc., reported they use gamma radiation and have never used EtO. Yet, it was noted, they do send out items from intermittently for EtO sterilization, mostly to IBA in the Los Angeles area and Steris in Ontario.

Following up, telephone contact was made with the plant manager at the Steris facility in Ontario. He stated he did not have the needed information but would identify the correct person(s) to contact in order to obtain that information. Subsequently, he provided the address for the Vice President for Operations, in Illinois and suggested a letter be sent that describes the purpose of the study and identifies the information being requested. A letter was sent on 2/21/05. To date, no response has been received.

IV.E.5. Conclusion

The ATCM, and subsequent local air district rules on EtO Sterilizers/Aerators, appear to have catalyzed a substantial movement toward the outsourcing of EtO sterilization. It would seem illogical such a movement would have occurred if the outsourced costs of sterilization were higher than the costs for compliant in-house sterilization. Having said that, it is unclear what role external influences, such as the CFC phaseout, CalOSHA EtO worker exposure requirements, and Proposition 65 notification requirements, may have had in outsourcing decisions. As a result, the vast majority of EtO sterilization in California is now performed by contract sterilizers, such as Steris and Sterigenics (IBA).

While it is anecdotal, the information provided above indicates that consolidation of the contract sterilization industry may have resulted in a more rapid increase in EtO sterilization costs than originally projected by ARB. Regardless, there is nothing in the ex-ante cost estimates that forecasts the significant move toward contract sterilization and away from the smaller individual EtO sterilization units that were in existence prior to rule adoption. Consolidation of the industry, such as observed in this case, can result in greater cost effectiveness in terms of cost per pound of pollutant removed. At the same time, the law of supply and demand can result in a greater cost to the ultimate consumer (in this case hospitals and hospital patients) as the numbers of locations available to provide the needed service are decreased.

EtO sterilization continues to be a valuable tool in the sterilization arsenal, although other sterilization processes such as steam, high heat, irradiation, and hydrogen peroxide vapor have grown in their usage.

IV.F. CASE 6 – CARB RULE 89-10-2

EXHAUST EMISSION STANDARDS, TEST PROCEDURES, AND DURABILITY REQUIREMENTS APPLICABLE TO PASSENGER CARS AND LIGHT-DUTY TRUCKS FOR THE CONTROL OF HYDROCARBON, CARBON MONOXIDE AND BENZENE EMISSIONS

IV.F.1. Background

With Rule 89-10-2, several standards were amended. These standards were the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", "Guidelines for Certification of 1983 and Subsequent Model-Year Federally Certified Light-Duty Motor Vehicles for Sale in California", and "California In-Use Vehicle Emissions-Related Recall Procedures for 1982 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles, Heavy-Duty Vehicles and Engines, and Motorcycles." In the new standard, the ARB, by Resolution 89-61, approved adoption of regulations for the implementation of more stringent emission standards and durability requirements for hydrocarbon (HC) and carbon monoxide (CO) exhaust emissions from passenger cars and light-duty trucks. The Board also approved adoption of regulations related to the sale of federally certified vehicles in California.

The Rule was phased-in over a three-year period with 40, 80 and 100 percent of a manufacturer's vehicles in 1993, 1994, and 1995, respectively. Manufacturers were permitted to use alternative, less stringent standards to determine the compliance status of vehicles in customer use. In addition, ARB amended the procedures for certifying federal vehicles, such as motor vehicles certified by EPA as meeting federal standards for sale in California.

In the Staff report, it was determined that the proposed regulations would not create either costs or savings. It was also determined that these regulations would not have a significant adverse economic impact on small businesses, and that there would not be a significant, potential cost impact on private persons or businesses directly affected by the proposed action. The Board further determined that no alternative considered by the agency would be more effective in carrying out the purpose for which the regulations were proposed or would be as effective as and less burdensome to affected private persons than the adopted regulations.

IV.F.2. General Description of the Rule

With Rule 89-10-2, the following sections were amended:

1. "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty

Vehicles." The standard is adopted on May 20, 1987, and amended in 1989 and 1990. In this rule, there are amendments related to exhaust emission standards in the years 1988, 1989, and 1993, 1995. The California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, Section 1960.1 would require manufacturers to meet more stringent HC and CO exhaust emission standards for passenger cars and light-duty trucks. The proposal would also extend the current durability demonstration requirement to 100,000 miles".

2. "Guidelines for Certification of 1983 and Subsequent Model-Year Federally Certified Light-Duty Motor Vehicles for Sale in California." The Guideline is adopted in July, 1982, amended twice at 1983, and again in 1985, 1987, and 1989. These guidelines are not applicable to medium-duty trucks, motorcycles, heavy-duty engines, heavy-duty vehicles, emergency vehicles, or vehicles with engine having a displacement less than 50 cubic inches. In this section, which includes guidelines from Section 1960.5 and 2061, the criteria are specified for manufacturers to sell federally certified vehicles in California and for those vehicles that have emission levels that are higher than the California standards. The proposed amendments would reduce by 50% the percentage of available credits manufacturers may use in the AB 965 program. Adoption of the proposed HC exhaust emission standards would permit a HC offset procedure for the first time because the California standards would be lower than the corresponding federal standards."

3. "California In-Use Vehicle Emissions-Related Recall Procedures for 1982 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles, Heavy-Duty Vehicles and Engines, and Motorcycles." This section, Section 2112, requires manufacturers to submit warranty failure and defects reports and to recall and correct nonconforming vehicles. The staff proposes to amend the procedures to specify that "useful life" for passenger cars and light duty trucks subject to the proposed 100,000 miles HC and CO standards is ten years or 100,000 miles, whichever first occurs."

According to a technical report prepared by CARB in 1989, the regulation was technologically feasible and cost-effective. Vehicle manufacturers would be required to comply with the emission standards and durability requirements beginning in the 1993 model year. During the first two years under the new standard, manufacturers would be permitted to comply with less stringent in-use standards, and in-use compliance would be waived after 50,000 miles.

During the 45-day comment period, CARB received comments from the following companies, government agencies, and individuals: the American Gas Association (AGA), Austin Rover (Austin), Automobile Club of Southern California (AAA), Chrysler Motors Corporation (Chrysler), Ford Motor Company (Ford), Bert Growald, Manufacturers of Emission Controls Association (MECA), Nissan Research and Development (Nissan), Rolls Royce Motor Cars (RRMC), SCAQMD, Toyota Technical Center, U.S.A. (Toyota), Robert Presley and Byron D. Chairs of the California Legislature.

In Public Hearings, oral comments were received from American Honda (Honda), American Importers Association (AIA), Champion Spark Plugs (Champion), Chrysler, Ford, General Motors Corporation (GM), MECA, California Air Pollution Control Officers Association (CAPCOA), Sierra Club, SCAQMD, Toyota, Volkswagen.

IV.F.3. Air Quality and Best Available Control Technologies for the Rule

During the Rule Action period the most significant air pollution problem in California was ozone. Ambient ozone concentrations in parts of the South Coast Air Basin had been recorded at more than three times the national standard.[13] The Rule "Exhaust Emission Standards, Test Procedures, And Durability Requirements Applicable To Passenger Cars And Light-Duty Trucks For The Control Of Hydrocarbon, Carbon Monoxide And Benzene Emissions" applied to the manufacturers to certify all passenger cars and light duty trucks to new 50,000 miles and 100,000 miles hydrocarbon and carbon monoxide emission standards.

The Staff predicted that the following emission control technologies would be necessary:

- Fuel injection
- Platinum-tipped spark plugs
- Dual oxygen sensors
- Increased catalyst loading-80%; warm-up converters
- Bypass converter

IV.F.4. Emissions and Emissions Reductions

Hydrocarbon (HC) emissions, which are a major precursor in the photochemical formation of ozone, have been classified as a toxic air contaminant. HC emissions also contain Benzene, which is a known carcinogen chemical and has no minimum threshold level below which its effects are not of concern. Carbon monoxide (CO) is not as severe as ozone, but it is a significant health concern. During Rule Action the CO levels in California reached levels exceeding twice the national standard. In 1989, the certification and in-use compliance period for most passenger cars and light duty trucks was 50,000 miles. Only a few manufacturers were chosen to certify diesel vehicles to an optional 100,000 miles standard. In addition, over 60% of the in-use vehicles in California had accumulated more than 50,000 miles. These vehicles accounted for 55% of California's total vehicle travel fraction and nearly 70% of California's passenger car emissions.

The adoption and implementation of Rule 89-10-2 to govern vehicles up to 100,000 miles was necessary to combat the deterioration of emission control system occurring beyond the 50,000 miles period. Manufacturers would also improve the in-use durability of their vehicles. In the Staff report, by the year 2010 emission reductions would be 70 tons/day HC, 1000 tons per day for CO and 3.6 tons per day for benzene.

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[13] The Technical Support Document prepared by California Air Resource Board, Sacramento, CA 1989.

The Rule required all manufacturers to meet non-methane hydrocarbon (NMHC) standards because NMHC emissions are more indicative of the pollution effects of motor vehicles. More specifically, the 50,000 miles emission standards were 0.25 g/mi NMHC and 3.4 g/mi carbon monoxide (CO) for passenger cars and light-duty trucks from 0-3,750 lbs, loaded vehicle weight. The 100,000 miles emission standards were 0.31 g/mi NMHC and 4.2 g/mi CO. The emission standards for light-duty trucks from 3,751-5,750 lbs loaded vehicle weight were 0.32 g/mi NMHC and 4.4 g/mi CO at 50,000 miles and 0.40 g/mi NMHC and 5.5 g/mi CO at 100,000 miles.

Thereafter, in-use compliance would be limited to 75,000 miles. According to test data the lowest NMHC and NOx emissions were achieved by the 1986 Model Isuzu I-Mark, and the lowest CO emission by the 1986 Model Volkswagen Jetta. Under Rule 89-10-2, possible emission reductions were estimated by assuming that in-use emission would be reduced by the same percentage as the proposed 50,000 miles standard when compared to current standards. The percentage reduction was 36% for NMHC and 51% for CO. CARB estimated emission benefits in year 2010 of the proposed standards based upon an average implementation date of 1995.

IV.F.5. Cost Effectiveness for Ex-Ante Evaluation

The cost effectiveness of Rule 89-10-2 is the incremental cost per vehicle divided by the expected reduction in emissions over the lifetime of the vehicle. The incremental cost of the Rule was estimated at $65 per vehicle. The cost effectiveness of the proposed regulations was estimated as $1.20 per pound of NMHC and $0.10 per pound of CO reduced. In-use emission benefits from an ARB technical report were estimated at 56 pounds of NMHC and 580 pounds of CO per vehicle. The cost effectiveness of benzene reduction, attributing the entire cost to the benzene benefit, was from $4.0 to $31 million per cancer case reduced.

In 2010, emission reductions would be 70 tons per day for HC, 1,000 tons per day for CO, and 3.6 tons per day for Benzene.

General responses to the Rule were about the emission standards and the adoption of more stringent motor vehicle emissions standards. There were also issues regarding cost estimates:

1. There were concerns from companies about the durability data for vehicles. Current protocol allows manufacturers to certify in California using federal durability data even if the engine calibration and catalyst loading and location are significantly different. These factors can affect emissions and deterioration, and therefore it is appropriate to require a California durability test. Volkswagen claimed that the cost of running durability tests is approximately $250,000 per 50,000 miles. Nissan said that durability requires large expenditures of cost and time. The comments from Ford were that durability tests would cost $20.0 million to run for 17 durability families in order to generate deterioration lines under the 1993 to 1995 California certification standards.

2. The original staff proposal required manufacturers to demonstrate compliance with the Inspection and Maintenance (I/M) standards between 35 and 50 degrees Fahrenheit in order to improve the effectiveness of the I/M program. But some companies said that the estimated cost is $400,000 for building new facilities in order to test each 4K certification vehicle. The Board revised the staff proposal to eliminate the need for cold temperature testing and the need to build additional cold testing facilities.

3. The most likely emission control technology that would be employed on passenger cars and light duty trucks to meet the proposed standards were sequential fuel injection, increased catalyst loading and volume, distributor-less ignition systems, and aspirator with shut off system. The estimated cost of these systems was $200-$300 to the consumer (Chrysler). The response of CARB was that "the emission control measures listed by Chrysler are likely to be necessary for only worst-case vehicles and it was not appropriate to associate the cost of these control measures with the entire fleet."

4. Ford disagreed with the technical report prepared by CARB which would restrict the efficient use of shared durability vehicles for Federal and California certification. They estimated that disallowance of this practice could cost Ford about $20 million in the 1993 to 1995 period. This was about $20 per California vehicle. The Board revised the Staff proposal.

IV.F.6. Cost Effectiveness for Ex-Post Evaluation

This rule affected the automobile manufacturers. In the CARB Rule Action files, there were only a few automobile manufacturers' names and phone numbers and three related trade association's names: Manufacturers of Emission Controls Association (MECA) (Washington DC), Automobile Importers of America (Arlington), Motor and Equipment Manufacturers Association (MEMA).

The study team was unable to get representative name and phone numbers from trade associations. When the team tried to contact manufacturers and trade association representatives, some of the manufacturers (American Honda, Aston Martin, Jaguar, Mercedes, BMW and Ford) indicated a willingness to participate in a limited manner. After several follow-up attempts the team did not manage to obtain any meaningful data. MECA at first indicated that they would supply cost information but later declined.

This rule did not lend itself well to ex post cost estimation for a number of reasons. First, there is a high degree of competitiveness in the automobile industry and thus unless the industry sees some tangible benefits from providing this information (i.e., costs, emissions, technologies), they do not want to share any information with any outside sources. This is clearly a strategic, and understandable, decision on their part. Second, there were many amendments to the Rule afterwards, as well as this Rule was in essence an amendment (or an additional requirement) to other earlier rules. Hence, there is likely to be an aggregation issue in terms of how to parcel out any cost increases to which rules, or expected rules for that matter. That is, any cost increases today could be a result of other rules or the anticipation of other rules that came afterwards.

Appendix D contained a detailed description of efforts to collect ex post cost data. Appendix E provides information on efforts to collect data for Rule 91-11-1, Reformulated Gasoline-Phase II and the Wintertime Oxygen Content of Gasoline.

IV.F.7. Conclusions

Rule 89-10-2 required manufacturers to certify all passenger cars and light duty trucks to a new 50,000 miles and 100,000 miles hydrocarbon and carbon monoxide emission standards. Major requirements were lower exhaust emission standards and extended durability. In 1989, the current durability period was 50,000 miles, and nearly 70% of vehicle emissions would occur after 50,000 miles. In addition to the durability period, other extended durability requirements were increased warranty periods: cars for 7 years/70,000 miles, federal light-duty trucks for 120,000 miles, and optional California diesel standards for 100,000 miles.

In 1989, the available control technologies were electronic fuel-injection, close-coupled catalysts, dual oxygen sensors, increased catalyst loading, platinum-tipped spark plugs, and on-board diagnostics (OBD). For the Rule, future control technologies included bypass catalysts, electrically-heated catalysts, on-board diagnostics (OBD), and other measures.

The Rule was to be phased-in over a three year period with 40, 80 and 100 percent of a manufacturer's vehicles in 1993, 1994, and 1995, respectively. Manufacturers would be permitted to use alternative, less stringent standards to determine the compliance status of vehicles in costumer use.

Incremental costs of the Rule were estimated at $65 per vehicle and the cost effectiveness of the regulation was estimated as $1.20 per pound of NMHC and $0.10 per pound of CO reduced. In-use emission benefits from an ARB technical report were estimated at 56 pounds of NMHC and 580 pounds of CO per vehicle. The cost effectiveness of benzene reduction, attributing the entire cost to the benzene benefit, was from $4.0 to $31 million per cancer case reduced. In 2010, emission reductions would be 70 tons per day for HC, 1,000 tons per day for CO; and 3.6 tons per day for Benzene.

During the Rule Action period, some automobile manufacturers prepared written and oral testimonies. Most of the comments addressed the technical feasibility of the regulation and others its economical feasibility. However, the Board worked closely with industry in several phases of rule preparation and in several instances revised the regulations after receiving the stakeholders' comments.

During ex-post evaluation, the study team tried to contact manufacturers and trade association representatives. Some of the manufacturers (American Honda, Aston Martin, Jaguar, Mercedes, BMW and Ford) were willing to participate in a limited manner at the beginning of the contacts. After several follow-up attempts, the team has did not manage to acquire any meaningful data.

IV.G. CASE 7- CARB RULE 88-2-2

AIRBORNE TOXIC CONTROL MEASURE (ATCM) FOR EMISSIONS OF HEXAVALENT CHROMIUM FROM CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS

IV.G.1. Background

Chrome plating, chromic acid anodizing facilities and chromate-treated cooling towers cause up to 98% of the total emissions of hexavalent chromium. According to a report prepared by ARB, potential statewide cancer cases by hexavalent chromium over a 70 year period could reach 400 to 4,900.[14] However, with implementation of Rule 88-2-2, cancer cases attributable to chrome plating and anodizing facilities were estimated to be reduced to between 220 and 2,700 over a 70 year period.

Rule 88-2-2 would affect decorative chrome plating shops, hard chrome plating shops, and chromic acid anodizing shops which generally meet the definition of a small business (manufacturers with fewer than 250 employees).

IV.G.2. General Description of the Rule

Hexavalent Chromium was identified by the Board as a toxic air contaminant on January 23, 1986. ARB approved the control plan as an appropriate overall course of action for the Staff to follow when developing hexavalent chromium control measures. Chrome plating, chromic acid anodizing shops, and chromate-treated cooling towers were believed to be responsible for 98% of hexavalent chromium emissions in the State. Hexavalent chromium emissions from chrome plating results in a greater potential adverse impact on public health than do emissions from chrome-treated cooling towers because of the localized exposure associated with chrome plating operations. A measure given high priority in the plan was the control of hexavalent chromium emissions from chrome plating and chromic acid anodizing facilities. At the time of rule enactment, CARB identified a total of 416 chrome plating and anodizing shops in the State, located in 18 different air districts to meet the following targets:

- 95% control efficiency: 242 decorative chrome shops and 74 small hard chrome shops
- 99% control efficiency: 87 medium size shops
- 99.8% control efficiency: 13 large shops.

CARB performed a survey to gather information on hexavalent chromium facilities in the State. The survey analysis emphasized hard chrome firms in California over the chrome

[14] State of California Air Resource Board, Proposed Hexavalent Chromium Control Plan Staff Report, prepared by Toxic Air Contaminant Control Branch Stationary Source Division with the Participation of the Technical Review Group, January 1988, pp: 1-40.

plating industry as a whole. It indicated that small and large firms could generate the profits needed to finance the annualized cost of the regulation. However, results suggested that a typical medium-sized firm may not generate enough profits to finance the regulation.

Exposure to an air pollutant is determined by the concentration of the pollutant in the air, the number of the people breathing that air, and the amount of time the pollutant is breathed (concentration x population x duration). The potential cancer risk due to exposure to carcinogenic pollutants such as hexavalent chromium can be computed from estimated exposure using carcinogenic potency factors. Based on an analysis of exposure to hexavalent chromium prepared by CARB, approximately 21 million Californians were thought to be exposed to chromium emissions. Most of this exposure would come from chrome plating operations and chrome-treated cooling towers. The 21 million people are exposed to a population-weighted annual average concentration of 1.59 ng/m^3. Cooling towers contribute 45%, and plating facilities contribute 55%.

IV.G.3. Air Quality and Best Available Control Technologies for the Rule

The control of hexavalent chromium emissions would cause a significant positive effect on air quality and human health. Implementing Rule 88-2-2 would avert a very large number of potential cancer cases.

Control measures were thought capable of controlling 97% of emissions of hexavalent chromium. The emissions from chromate-treated cooling towers were twice as large as the ones from chrome plating and anodizing facilities. However, emissions from cooling towers were estimated to cause only 80% of the number of potential cancer cases caused by chrome plating and anodizing facilities due to the location and emission characteristics of the sources.

Depending on the type of facilities, and objectives of reducing emissions, the Best Available Control Technology (BACT) would vary. Regardless of measure, a 97% control efficiency of hexavalent chromium was expected. Control measures are summarized in table IV-7.

CARB analyses have determined that the cost per cancer case reduced is from $176,000 to $2.24 million for chrome plating and anodizing facilities. The reduction in cancer cases over 70 years would be between 220 and 2,700 for chrome plating and anodizing facilities. Table IV-8 summarizes the potential control measures ranked by cost-effectiveness, reduction in cancer cases, and development time.

Table IV-7 Summary of Potential Hexavalent Chromium Control Measures

Source Category	Emissions (TPY)		Control Reduction		Cost/lb Reduced	Average Cost/Cancer Reduced	Cum. Annual Cost[2]	% Contribution to Total Emission	Control Measure to Board	Priority[3]
	Current	Proposed Controls	Approaches[1]	# Cancer Cases	($*10[6])					
Chrome Plating and Anodizing	6.0	0.19	ADD-ON	260-3,300	0.00034	0.087-1.1	3	31	Feb-88	H
Fuel Combustion (Oil and Coal)	0.4							2.2	Jun-88	M
		>0.04	ADD-ON	1 _ 12	0.011-0.035	35-2,500	70			
		0	MOD.&SUB.	1 _ 12	0.26-1.5	910-120,000	276			
Other[4]	0.1	0.05		1_14	n/a	n/a	n/a	0.3	Sep-89	L
Totals	**19.5**	**1.4**		**463-6,138**		**0.045-0.60**	**276**	**100**		

1 control technology approaches: sub.=substitution, add-on= add-on controls, mod.=fuel modification (e.g., metals removal from fuel oil)

2 cumulative control cost

3 H: high, M: medium, L: low

4 includes chromate pigment usage, motor vehicle emissions, sewage sludge incineration, and refractory production

Source: The California Air Resource Board’s rule action files.

Table IV-8 Potential Hexavalent Chromium Control Measures Ranked by Cost-Effectiveness and Reduction in Cancer Cases. Development Time (1988$)

Measure		Cost per Pound Reduced (dollars)	Cost per Cancer Case Reduced	Reduction in Cancer Cases	Control Measure to Board
Chrome Plating and Anodizing		340	110,000-1.4 mil.	220-2,700	Feb-88
Fuel Combustion					
	A. Add-on Controls	11,000-39,000	160 mil.-2 bil.	0.8-9	*
	B. Fuel Modification and Sunstitution	260,000-2.4 mil.	2.7 bil.-33 bil.	0.8-9	*

* not determined

mil.= million, bil.=billion

Source: The California Air Resource Board's rule action files.

IV.G.4 Emissions and Emissions Reductions

Most hexavalent chromium emissions result from two industrial processes that use hexavalent chromium compounds: chrome plating and chromic acid anodizing, and cooling towers treated with chromate corrosion inhibitors. These two categories account for 98% of the emissions. As presented in table IV-9, chromate-treated cooling towers were estimated to emit 68% of all statewide hexavalent chromium emissions while chrome plating and anodizing operations were estimated to emit 30%. All other sources account for the remaining 2% of emissions.

Future qualitative changes in hexavalent chromium emissions are important for establishing control plans. In the Board's projections, during the period 1985 and 2000, chromate-treated cooling towers were projected to decrease due to the increased use of nonchromate corrosion-inhibiting water treatments. Emissions from the second largest emitting category, chrome plating and chromic acid anodizing facilities, were expected to increase because of growth in hard chrome plating activity. These estimates of future emissions were based on projections of trends in industrial activity or vehicle population growth.

Table IV-9 Estimated Statewide Emissions of Hexavalent Chromium in California According to Source Category (1985)

Source Category		Emission, tons/year	Number of source	Percentage of Emissions
Stationary Source				
	Chromate-Treated Cooling Towers	13.7	3,200	68
	Chrome Plating and Chromic Acid Anodizing	6	416	30
	Combustion	<0.4	510	<2
	Refractory Production	<0.01	1	<0.05
	Sewage Sludge Incineration	<0.02	14	<0.1
	Pigment Usage	0.02	114	0.1
Mobile Sources				
	Motor Vehicles	0.06	22 million	0.3
Total		20.2		100

Source. The California Air Resource Board's rule action files.

IV.G.5 Cost Effectiveness for Ex-Ante Evaluation

CARB performed a financial analysis of the small businesses (less than 250 employees) representing California's chrome plating industry. The analysis was intended to assess the financial ability of these small businesses to comply with the Rule. These firms are classified as small, medium and large "small business" according to their annual sales. The expected costs to decorative chrome platers would include district permit fees, the costs of purchasing anti-mist additive or control equipment, and the costs of routine testing of the additive in the plating bath.

CARB estimated that the total statewide non-discretionary cost imposed on the affected local agencies should not exceed $992,000 as an initial program cost and $133,000 annually thereafter. Total compliance cost (per year) would average $1,220 ($640 to $4,160). The capital cost for a wet scrubber would be $19,200 to $488,000 (median cost $78,400) and the annualized cost for wet scrubber would be between $6,400 and $176,000. For reference the average cost for a square foot of hard plating was $320. The overall cost effectiveness per pound controlled, in decorative plating shops, hard plating and anodizing shops was expected to be $528 to $560. These estimates, in terms of their nominal dollar values at the time of the rule adoption, are presented in table IV-10.

In ARB cost estimates, the annualized costs of capital and operations were based on annual after-tax net cash flow discounted at six percent per year for ten years. Depreciation was calculated over 10 years by the double declining balance method. Total state plus federal income tax rate were 43.6%. The median capital costs, including source test costs and permits, ranged from $28,000 to $768,000. The median annual revenue requirements ranged from $7,200 to $240,000. Table IV-11 shows these costs for the median (by tank area) shop in each of the three control categories.

Table IV-10. **The Overall Cost-Effectiveness Estimations, Prepared by CARB (1988$)**

Overall cost effectiveness (per pound controlled at decorative plating shops)	$330
Overall cost effectiveness (per pound controlled at hard plating and anodizing shops)	$350
Cost to individual facilities for lowest emitting (per year)	$400
Cost to individual facilities for highest-emitting one (per year)	$340,000
Cost attributable to hard plating and anodizing operations (per cancer prevented)	$110,000-$1,3 million
Cost attributable to decorative plating (per cancer prevented)	$100,000-$1.2 million

Source. The California Air Resource Board's rule action files.

Table IV-11. **The Costs of Compliance (median values) According to Control Requirements**

	Control Requirement		
	95%[a]	95 to 99%[b]	99%[c]
Capital cost (initial investment)	$17,500	$61,000	$480,000
Operation &maintenance (annual)	$2,400	$11,000	$94,000
Annualized cost (revenue required)	$4,500	$18,000	$150,000

[a] de-mister; [b] packed bed scrubber; [c] high-efficiency de-mister;

Source. The California Air Resource Board's rule action files.

Hexavalent chromium facilities were located mostly in the South Coast Air Quality Management District. The highest initial permit cost for complying with Rule 88-2-2 was $656,000 and the annual permit cost was $88,000. The highest hourly labor rate between Districts was in the Ventura Air Pollution Control District ($98.60). In the same District, the initial fiscal cost to hexavalent chromium facilities was $4,355, and the annual fiscal cost was $581.

IV.G.6. Cost Effectiveness for Ex-Post Evaluation

Rule 88-2-2 applied to decorative chrome plating shops, hard chrome plating shops, and chromic acid anodizing shops. Most of these firms were considered small business given they had fewer than 250 employees.

In the CARB Rule Action files, 88 hard plating facilities, 21 anodizing facilities, and 129 decorative plating facilities' were identified by facility type. Some of these facilities have since gone out of business and/or phone numbers and addresses have changed. Upon notifying CARB and the SCAQMD of this situation, the team was able to compile a contact list of 44 facilities (with contact names and telephone numbers) of which 13 facilities were from the San Diego Air Pollution Control District (APCD), 1 facility from the Ventura County APCD, 11 facilities from the Sacramento Metro AQMD, and 19 facilities from the San Joaquin Valley APCD. The Shasta County AQMD was unable to help due to their lack of data. Subsequent research by CARB has lead to an updated list of facilities as of 2003 (Appendix F).

Numerous attempts were made to contact some Hexavalent Chromium facilities to gather information on compliance costs and emission reductions. At first, progress was not gained in obtaining any data due to the facilities' unwillingness to share such data.

In January of 2005, though, we were able to contact over 30 facilities, several from the SCAQMD, and request relevant cost and emissions information. After numerous discussions, 6 different business owners agreed to participate in this survey. Although this is not a large enough sample size to make an accurate judgment on cost estimates, the data collected do give some indication of such. In order to keep a certain degree of confidentiality, individual company names are not mentioned anywhere in this report.

In discussions with business owners, it is apparent that the chromium plating industry has undergone considerable consolidation during the past few years. Many of the more inefficient and more expensive shops to operate have gone out of business, or moved their business to neighboring states or countries. There has also been considerable pressure from local activist groups to shut down some of the worst polluters, especially in areas near schools. Almost all of the affected companies are small businesses with fewer than 250 employees, most with considerably less than that.

Of the 6 companies participating in this study, 2 are decorative chrome shops, 2 are anodizing shops and 2 are hard chrome plating shops. The decorative shops fall into the 95% reduction category, the 2 anodizing facilities fall into the 99% reduction category, and both of the hard chrome plating shops fall into the 99.8% reduction category.

Decorative shops
The 2 participating decorative shops indicated that they are able to comply with Rule 88-2-2, simply by using suppressant in the plating tanks. Shop A has annual operating costs to comply of about $7400, and Shop B complied with a cost of about $4000 annually.

Anodizing facilities
The 2 anodizing facilities that participated each had to install a wet scrubber with an anti-mist section. The capital cost to install the required equipment was stated to be $22,800 for one of the facilities and $67,500 for the other (in 2004$). The difference in cost can be primarily attributed to the cost to retrofit the scrubber onto existing equipment. In one case the retrofit was very simple, and in the other case it was very complex due to space constraints and other issues. The annual operating costs for the scrubber and associated compliance costs (not including depreciation costs) were similar for each facility, $2,000 compared to $1,500. Annual amortized costs assuming a 15-year life expectancy and a 4% interest rate was $4,050 and $7,568.

One of the anodizing facilities provided emissions data, and the cost per pound of Chromium reduced for that facility was approximately $100. This is considerably lower than the $330 to $350 per pound controlled that was estimated. It should be pointed out that the emissions data is somewhat suspect as the business owner was uncertain of its accuracy but indicated it was the best number he had.

Hard Plating Facilities
As mentioned, the 2 hard plating facilities were classified as large emitters and needed to reduce emissions by 99.8% to comply with Rule 88-2-2. Again, both facilities had to install wet scrubbers and associated equipment, and the capital cost / scrubber was $381,000 for one facility and $347,500 for the other. The second facility had to install 2 scrubbers for a total cost of $695,000. Operating costs (not including depreciation) ranged from $7,000 / year to $16,000 / year. Together, the amortized yearly costs for these control strategies were $50,000 and $69,000.

One of the hard plating facilities provided emission data, and the cost / pound of Chromium reduced was about $50. Again, this is considerably lower than the ex ante costs. Likewise, this emissions data could be suspect for this facility too, however, it probably represents a minimum of Chromium reduction, and thus a maximum cost / pound of Chromium reduced. The business owner indicated he had to meet the 99.8% reduction by the narrowest of margins. If you assume the 99% controlled emissions were greater than 10 lbs / yr, then the uncontrolled emissions had to be greater than 1000 lbs / yr. This yields a minimum cost / lb of Chromium reduced of about $50, which correlates exactly with the emissions data supplied by the business owner.

IV.G.7. Conclusions
The chrome plating industry in California is a rather large group of highly competitive, owner operated small businesses. Considerable consolidation has taken place over the past several years due to regulatory pressures, consumer group activities and the business climate. Although many business owners will say regulation has created this consolidation, the evidence is only anecdotal. However, regardless of the cause, consolidation certainly can have an impact on the ex-ante and ex-post cost differences. As mentioned in a previous rule (Bakeries), consolidation can result in a number of different scenarios that might affect the overall costs of production. While an evaluation of the impacts of consolidation would require additional assumptions and a more general equilibrium approach to analyzing this problem which go well beyond the scope of the present report, consideration of these potential impacts may want to be considered in future ex-ante cost projections by CARB.

Rule 88-2-2 impacted 3 classes of chrome plating shops in California, the decorative shops, the anodizing shops and the hard chrome plating shops. These facilities fell into three categories of emissions, small, medium or large, with required reductions of Chromium emissions of 95%, 99%, and 99.8% respectively. There were 6 facilities that agreed to share their data with this study team, 2 decorative shops, 2 anodizing shops, and 2 hard plating shops.

The small emitters were able to comply with simply using a chemical suppressant that controls the surface tension in the Chromium bath tanks. Both decorative shops had similar chemical costs, and minimal capital costs.

The medium emitters both had to install wet scrubbers, and the capital costs were significant, ranging from approximately \$23,000 to \$68,000. The difficulty in retrofitting the scrubber into an existing facility drove the cost of one of the scrubbers up significantly. The capital cost of the scrubbers was in line with CARB estimates of \$19,200 to \$488,000. The one piece of emissions data that was supplied indicates that the cost of reducing Chromium levels was about \$100 / pound of Chromium reduced.

Both of the large emitters also had to install wet scrubbers and associated equipment to comply with the 99.8% reduction levels. The capital costs to the facilities were \$381,000 and \$695,000, as the second facility installed 2 scrubbers, each costing \$347,000. Annual operating costs for each facility not including depreciation costs average around \$7,000 and \$16,000. The emissions data supplied indicate that the cost of reducing Chromium levels for a large emitter is about \$50 / pound of Chromium reduced.

In summary, it appears that for the small emitters, the cost estimates were fairly accurate. The ability of the facilities to comply with little or no capital cost, while using a chemical suppressant was realized. For the larger emitters that required the installation of wet scrubbers, it appears the estimates may have been low. The cost to retrofit a scrubber onto an existing facility where space constraints are an issue can significantly increase the capital expenditure. The capital costs of the installed scrubbers fell into the high end of the estimates. Based on the two sources that provided emissions data, the cost per pound of Chromium removed ranged between \$100 and \$50, considerably lower than the approximately \$550 ex ante estimate from CARB.

It should be noted that on May 21st of 1996, the United States Environmental Protection Agency approved a Air Resources Board request to substitute the 1988 Chrome Plating ATCM for the National Emissions Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks (referred to as NESHAP). From a federal perspective, the substitution became effective June 20th, 1996. The main difference between these two rules (CARB 1998, p. 4-2), is that California’s 1988 Chrome Plating ATCM does not allow research and laboratory operations to be exempt from emissions control, contrary to the federal NESHAP. An additional benefit of the 1988 Chrome Plating ATCM, based on source testing information, is greater emission reductions than observed under the hard chrome standard in the federal NESHAP rule. The revised Chrome Plating ATCM, as a substitute for the federal NESHAP, was approved by the Office of Administrative Law on June 26th, 1998. This additional revision of the 1988 Chrome Plating ATCM does not affect any of the ex ante or ex post cost estimates presented above given that the California standards were both broader than the federal standards and observably more stringent. Hence comparisons of ex ante cost estimates, and subsequently with ex post cost estimates, would consistently use the 1988 standards throughout.

IV.H. CASE 8 – CARB RULE 93-12-2 (Section 93109, Title 17 CCR)

ATCM FOR PERCHLOROETHYLENE EMISSIONS FROM DRY CLEANING OPERATIONS & REGULATION FOR ENVIRONMENTAL TRAINING

IV.H.1. Background

The CARB Board-approved Airborne Toxic Control Measure (ATCM) for Perchloroethylene emissions from Dry Cleaning Operations was designed to reduce statewide emissions of perchloroethylene from dry cleaning operations by about 75%. Perchloroethylene (Perc) is a substance listed as a toxic air contaminant (TAC) with no identified exposure threshold level. For a TAC with no identifiable threshold level, Health and Safety Codes require that a regulation be designed to obtain the lowest achievable emission rate through application of a Best Available Control Technology (BACT) in consideration of cost and risk. Based upon prior research performed by CARB, Perc emissions from dry cleaning operations were not adequately regulated to protect public health statewide.

Perc emissions from dry cleaning facilities result in public exposure. It was estimated that a lifetime exposure (70 years) to Perc emitted from dry cleaning facilities would contribute an additional 250 potential cancer cases statewide. The facilities' potential cancer risk was assessed at 50-500 cases per million.

Perchloroethylene is widely used in California in a variety of processes and products including dry cleaning, degreasing, paints and coatings, adhesives, aerosols, specialty chemical production, printing inks, silicones, rug shampoos, and laboratory solvents. In 1987, an estimated 17,000 tons of emissions resulted from these uses as well as from the production, distribution, recycling, and disposal of Perc.

According to a report prepared by CARB, adoption of the proposed rule would not have a significant adverse economic impact on most small businesses. At the time of rule adoption, more than half of the dry cleaners already had machines complying with the ATCM.

IV.H.2. General Description of the Rule

Rule 93-12-2 required dry cleaning facilities to reduce their Perc emissions to the lowest level achievable through the application of a BACT. The regulation also required dry cleaning facilities to have trained operators who have successfully attended a CARB approved environmental training course. The Dry Cleaning ATCM specified equipment, recordkeeping and reporting, good operating practices, training, and other requirements for these facilities.

The dry cleaning regulation ensured that every dry cleaner had the three essential elements it needed to minimize Perc emissions. These elements were the BACT, the knowledge to reduce emissions, and a periodic measurement of their performance. The total statewide Perc emissions from dry cleaning were about 742,000 gallons per year. This represented about three-fourths of the total Perc used by dry cleaners in the State. After use, the remaining Perc was shipped off-site as hazardous waste and recycling. A typical commercial dry cleaner emitted about 100 to 300 gallons of Perc per year depending on the machine type and operating practices.

Prior to developing the regulation, the Board visited over 70 dry cleaning plants, participated in 80 industry meetings and conferences, and mailed out notices and documents to approximately 6,000 people. Based on the 1991 survey data provided by nearly 2,100 Perc dry cleaners, ARB characterized Perc dry cleaning operations in California prior to the regulations as follows:

- 4,800 Perc dry cleaning facilities;
- 5,300 Perc dry cleaning machines;
- 247 million pounds of materials dry cleaned annually;
- One million gallons of Perc used annually.

Rule 93-12-2 provided significant benefits such as reduced emissions and risk by 75%, reduced worker exposure, and reduced hazardous wastes. Finally, it was estimated that 88% of California dry cleaners are independently owned commercial operations.

IV.H.3. Emissions and Emissions Reductions

Perc is a volatile organic hydrocarbon with a chloroform-like odor used as a solvent in dry cleaning operations. Most emissions from dry cleaning operations are from dryers and solvent recovery residues. During the drying portion of the dry cleaning process, Perc is either vented to the atmosphere or recovered in a carbon absorber or refrigerated condenser. Carbon absorbers reduce vent emissions by about 95% while refrigerated condensers reduce vent emissions by about 70%.

When drying units are equipped with absorber and condensers, recovery residues become more significant as a source of Perc emissions. In solvent recovery, used Perc is purified by filtration and distillation so that it can be reused. Perc waste adsorbs on the filters and still-bottoms and then vaporizes into the atmosphere.

Additional emissions result from the disposal of waste, equipment leaks, and the transfer of clothes from washer to dryer. “Dry-to-dry” cleaning operations use and emit less Perc per pound of clothes cleaned than “transfer” operations. Most new dry cleaning operations are dry-to-dry operations in which clothes are washed and dried in the same unit. Transfer operations are those in which clothes are manually transferred from washer to dryer.

Apart from controlling Perc as a toxic air contaminant (TAC), about 25% of California’s air pollution control districts have adopted control measures specifying the installation of emission reduction devices (e.g., carbon absorbers or refrigerated condensers) at larger dry cleaning facilities.

In California, the second major source of Perc emissions was degreasing operations. Degreasing is an integral part of many manufacturing industries including automobile, electronic, furniture, appliance, textile, paper, plastic, and glass. Based on EPA and ARB estimates in 1985 and 1989, respectively, the use of 3,300 tons of Perc by degreasers in California in 1987 resulted in estimated emissions of about 3,000 tons.

The other Perc emission sources were paints and coatings (1,300 tons in 1987), adhesives (340 tons in 1987), and some other sources like aerosols, pharmaceuticals, textiles, printing inks, and dielectric fluid for power transformers (960 tons).

IV.H.4. Cost Effectiveness for Ex-Ante Evaluation

ARB based their ex ante cost estimates on the following characteristics. Perc dry cleaning operators would be required to replace all dry cleaning machines with either a new closed loop machine with primary control or convert their existing machines to a closed loop machine with a primary control system. As part of the rule, an extensive operator training program would be instituted and various record keeping and annual reporting requirements would be put in place. Finally, an extensive leak check, repair, and operation and maintenance program would be implemented. Records would be required to be maintained for a minimum of 2 years. This rule was estimated to affect about 4,800 Perc dry cleaning facilities in the State.

In the Staff report, adoption of the proposed rule was suggested to not have a significant adverse economic impact on most small businesses. More than half of the dry cleaners already had machines that met the requirements specified in the ATCM.

The annualized cost of the Rule 93-12-2 to most dry cleaners was estimated to range from $417 to $4,170 per year, with the typical dry cleaner, which produced $333,600 in annual revenues, incurring an annual cost of around $1,700. Annual costs included operation and maintenance, record keeping and reporting, training, and miscellaneous equipment. The annualized cost was based on a 15-year equipment lifetime and represented an incremental cost over what the dry cleaners would incur without regulation. ARB extrapolated this estimate statewide, assuming the industry produced $1 billion in annual revenues, the sum being under $7 million per year. About 40% of existing dry cleaners would need to either purchase new equipment or convert existing equipment. A one time cost to replace a machine was estimated to cost between $55,000 and $83,000.

In addition to developing one time and amortized cost estimates, ARB evaluated the performance of dry cleaning machines with a BACT over time, including the influence of operating practices. In the dry cleaners 1991 survey performed by CARB, three cost categories were developed that differed based on size of facility - small, medium, and large. Size of a facility was a function of pounds of clothes cleaned per year, machine capacity, number of machines, and annual Perc usage.

The estimated gross income for a total of 4,830 facilities in California in 1991 was $1,435 million per year. The initial total out-of-pocket cost of the regulation was $29 million per year. Total initial Perc emission reduction was 578,000 gallons per year, and the initial cost-effectiveness was $3.60 per pound reduced. The long-term regulation cost was $6.8 million per year. The total long-term emission reduction was 310,000 gallons per year. For small facilities, then, the cost-effectiveness of the regulation was $22 per gallon reduced. Total cancer burden reduction was 195 cases for 70 years.

IV.H.5. Cost Effectiveness for Ex-Post Evaluation

Based on a 1991 survey performed by CARB during the Rule Action period, approximately 4,800 Perc dry cleaning operations in California were identified. In 2005, the study team contacted the CARB representatives to obtain telephone numbers and contact person's names. A CARB representative familiar with this rule informed the team that CARB was considering reevaluating dry cleaning operations in California, and had performed a survey to do so. The representative also advised the team that they do not have any post-implementation emission testing from operations impacted by the Rule. The representative provided the team with the survey sheet prepared when reevaluating the dry cleaner industry. After reviewing the survey the team identified data relevant to the study and made a request to CARB. Three months later they sent an address list containing more than 5,000 dry cleaning operations in California.

The CARB representative also sent information on two trade associations: the California Cleaners Associations and the Korean Dry Cleaners Association. The California Cleaners Association refused to participate because of the confidentially of their membership addresses and telephone numbers. The Korean Dry Cleaners Association sent their complete membership database, but emphasized that since many of their members speak primarily Korean, communication would be a problem. Efforts to contact individual members of the Korean Dry Cleaners Association did confirm this problem. Hence, these initial efforts did not lead to much information on the ex post costs.

Subsequent efforts were considerably more successful. Several contacts were made with individual dry cleaner owners, South Coast Air Quality Management District (SCAQMD) personnel, and 2 trade organizations; The Greater Los Angeles Area Dry Cleaners Association (GLADCA) and The International Fabricare Institute (IFI). Information obtained during this process was said to be confidential, and therefore individual businesses are not identified here.[15]

It appears that the replacement costs for a new closed loop machine were in line with CARB estimates of $55,000 to $83,000, although on the high end. Most owners who had to replace their machines reported that they paid in between $76,000 to $83,000. However, as indicated, most of the industry already had closed loop machines installed before this rule was implemented, and those who did not have closed loop machines

[15] However, the author would like to thank Mr. Bobby Smerling, owner Royal Cleaners, and past president GLADCA for his contributions to this study.

needed to replace their machines regardless. The actual cost to the industry was, therefore, probably overstated.

The objective of this rule of reducing statewide emissions of Perc from dry cleaning operations by 75% is still being evaluated by the CARB. IFI, however, has estimated that Perc usage in the United States has dropped about 70% over the past several years. With California's stricter regulations, it appears this goal has been attained. One owner stated his Perc usage dropped from almost 8,000 gallons per year to about 200 gallons per year with the new closed loop machine, a reduction of over 97%. A corollary benefit of the closed loop machine is the reduced operating costs to the owners due to the reduction in solvent (Perc) costs. Although this example is perhaps extreme, this would provide a savings of some $7,800 per year based costs seven or eight years ago when Perc was priced at about $1 per gallon or a savings of between $54,600 to $132,600 per year with today's Perc prices ranging from $7 to $17 per gallon.

Likewise, water quality regulations are putting additional pressure on owners to switch to other solvents and away from the toxic issues related to Perc. Other solvents and technologies like Hydrocarbon, Green Jet, Silicon, and even carbon dioxide (CO2) are being used as an alternative. It is estimated that Perc is used in only about 50 to 60% of the machines in the South Coast Basin today. While there is a noticeable switch away from Perc, there is concern within the industry that some of the other solvents will also eventually come under regulatory scrutiny. The Hydrocarbon alternative is a petroleum based product that requires special handling. In fact one owner has anticipated the imposition of future regulations on these other chemicals and, approximately one year ago, installed a new CO2 machine at a cost of about $200,000. This may be the future of the dry cleaning industry, but presently there are only a few machines in the United States and only two in the Los Angeles basin.

IV.H.6. Conclusions

The objective of CARB Rule 93-12-2 was to reduce statewide emissions of Perc from dry cleaning operations by about 75 percent. Although this objective is still being evaluated by the CARB, it appears that considerable progress has been made, and has been accomplished by not only forcing the industry to replace their old vented machines with new or converted closed loop machines, but also by the industry switching to various alternative solvents. There are some in the industry that believe that the rest of the state will phase out Perc in the next several years just as is being done in the South Coast Basin where regulations require alternative solvents.

From conversations with various owners, it appears the cost to replace their old vented machines with closed loop machines was $76,000 to $83,000, in line with, but on the high side of the CARB estimates. It should be noted however, that almost all of the older vented type machines were at the end of their useful life, and the owners needed to replace them anyway. There are exceptions to this, but overall the industry was converting to the closed loop machines before the implementation of this rule. In fact, as stated, about 60 pecent of the industry did not need to upgrade their equipment at all. For those owners who did have to purchase new machinery, some significant savings in Perc usage were realized. This correlated into monetary savings to help offset the added cost of the new machines. It does not appear that this savings was included in the ex-ante projections.

In summary, it appears that CARB Rule 93-12-2 was implemented at a cost about equal to the preliminary estimates. Perhaps there was a bit of an overstatement of actual costs because most of the open vented machines that were replaced with the new closed loop machines were near the end of their useful life, and the capital expenditures were mostly needed anyway. Likewise, a substantial savings of operating costs was realized due to significant reductions in Perc usage. Although the goal of reducing Perc usage by 75 percent is still being assessed, significant progress appears to have been made towards that goal. Although this study did not quantify the actual Perc reduction statewide, the efficiency of the closed loop machines has been demonstrated and actual reductions have been substantial, some approaching 98 percent.

V. ANALYSIS OF INFORMATION GATHERING PROCCESS

In general, while there were positive returns from the efforts to compile and summarize the ex ante cost estimates, the returns from nearly two years of effort to collect data on the ex post costs were disappointing. Three separate approaches were employed to gather ex post cost information during this study. This effort was limited by an impending deadline for completing the project as well as remaining funding; however, the final effort yielded enough information to allow for a useful analysis for 6 of the 8 rules. In addition to what is described above in each case study, a description of some of the problems encounter during this process is described in Section V.A below, followed by a summary of lessons learned in Section V.B.

V.A. Attempts to Obtain Ex Post Data

It should not be surprising that many, if not most, of the stakeholders, trade associations, or industry representatives contacted initially were either unable or unwilling to provide cost and/or emissions data to the study team. The difficulty in collecting information from stakeholders has been made apparent in many prior studies. For instance, as pointed out in a very comprehensive report by the BBC Consulting and Research Group (BBC 2002,: page 2-4), prior efforts by CARB and the United States General Accounting Office (GAO) have been relatively unsuccessful with this approach. Of the 51 companies contacted in the GAO study in 1996, only 17 agreed to participate, 15 provided data, and none provided complete data. Alternatively, CARB was only able to get an 11.8% response rate to its survey despite a "very time-consuming and intensive effort at survey completion."[16] From an objective standpoint, there are logical reasons why stakeholders would be reluctant to provide this type of information. As the BBC (2002) report points out, there is very little incentive for the firm to share such information and often the information is not easily separated from other costs the firm incurs. For smaller businesses, expending resources to provide this data may pose a significant burden with no reward. Finally, some businesses view this data as confidential information and don't want to share it for competitive purposes.

V.A.1. Approach One: Industry Contact lists

The first approach to collect ex post cost information initially consisted of contacting affected industries. Contact lists were difficult to appropriate, and the ones that were finally obtained were mostly outdated and/or inaccurate. As mentioned above, when firms were finally reached, very little if any relevant information related to their cost changes could be gleaned. In total, more than 500 phone calls were made in conjunction with a similar amount of emails in an effort to contact some 400 of the companies that were impacted by these regulations. Unfortunately, these efforts were, for the most part, unproductive. It has been observed that many interviewed businesses were reluctant or unwilling to share any information related to compliance costs, emissions, or

[16] Significance of *California Air Pollution Control Regulation for Business Location Decision*. *California* Environmental Protection Agency, Air Resources Board, Research Division. May, 1995.

technologies. Several firm representatives stated that such cost data is confidential and considered sensitive due to the high degree of competitiveness in their industry (this was especially true of the automobile industry and refineries - Rules 95-6-3, 91-11-1, 89-10-2, and 1173). They responded that sharing cost, emission, and technology data is not considered a very prudent strategy for a firm trying to compete in the fluid and fast-paced industry such as automobile industry. On the other hand, many of the smaller scale facilities stated, understandably so, that record-keeping is very expensive and their limited budgets impinge up their efforts -both then and now- to organize and compile the data in a manner amenable to analysis.[17]

The appendix shows contact lists for many of the rules analyzed. Most of these companies' lists were outdated; hence, considerable effort was expended trying to get up to date lists and contact information. Explanations are often provided in these appendices related to why we were not able to obtain information from a particular firm. It should be noted that not all efforts are documented since after some time, it became an unproductive time sink given the scarcity of resources and time that were initially budgeted into this component of the project.

A second part to this first approach included perusing published records on industry cost estimates, by SIC code for example, with the idea of identifying cost changes. This is data that exists typically because of prior studies or for other entities. The benefit of this data, referred to as secondary data, is that it requires fewer resources to collect and is not subject to the strategic responses/biases inherent in conducting original studies. One major source of secondary data on environmental compliance costs is the Pollution Abatement Costs and Expenditures (PACE dataset) compiled by the U.S. Department of Commerce, Bureau of the Census. The dates on this data are from 1989 to 1994, and then again from 1999 to the present. Unfortunately, the PACE is designed to be statistically representative at the 3-digit SIC level on a national basis and may not be a representative sample of smaller geographic regions (BBC 2002). This certainly limits its usefulness in this study. Furthermore, the data is published at the 2-digit SIC level of detail by state, whereas the types of information required for this study is more micro-level data to enable analysis at the geographic level and industry specificity required. Additionally, PACE includes manufacturing establishments with 20 or more employees (our rules affect many establishments with firms in other sectors and with smaller businesses) and the costs are broken down by pollutant, not by specific rule or regulation.

This avenue was also unfruitful given the reasons listed above and also that expenditures are typically listed as total expenditures and at a unit of analysis larger or different than what would be required for this analysis. Rules that are narrowly tailored, such as many of the rules in this analysis, do not lend themselves well to being analyzed using the PACE data set. As an example, BBC (2002, page 4) states that "…it would be more

[17] Whether the firms from which we did finally gather cost information from – either directly or indirectly – are characteristically different from those that we did was not analyzed. Given the difficulties associated with not only getting firms to participate, but even with getting contact information, we attempted to contact any and all firms possible – in effect, we attempted to perform a census rather than extract a representative sample of the affected firms.

feasible to perform a PRA of economic effects for a rule involving the wood furniture industry (which comprises most of a 2-digit SIC code) than for a rule involving the dry cleaning industry (which is a 4-digit SIC code). A PRA on the economic impacts of rules which pertain to only a subset of firms within a 4-digit SIC code (such as restaurants using charcoal broiling processes) will be most difficult of all."

In our efforts to obtain cost and emissions information from secondary data, we evaluated the following well-known sources of secondary data: PACE (Survey of Pollution Abatement Cost and Expenditures Data), SBO (Survey of Business Owners), BES (Business Expenses Survey), LRD (Longitudinal Research Database), Annual Survey of Manufacturers, Facility Search Engine from CARB Database. However, as listed in Appendix G, table G1, all of these databases present some difficulties to perform the ex-post analysis on a regional base, and for small-scale industries. For informational purposes, the SIC codes are listed for each rule in table G2.

V.A.2. Approach Two: Equipment manufacturers

With the assistance of Dr. Reza Mahdavi of the CARB, a second approach was undertaken to gather cost information from air pollution control (APC) equipment manufacturers. If current cost estimates were obtained from the APC list, it should be acknowledged that backing out a comparison of ex ante vs. ex post cost estimates based on the price of capital equipment, pollution expenditures today is a tenuous task given it would require accounting for the many factors that would cause the cost to change over time, especially over 5 to 10 years. These include: changes in input prices or technological efficiency, and changes in market conditions that affect market prices. It is noted, however, such information could be useful in understanding what technologies are currently being used, or perhaps have been used in the past. Coupling this with best estimates of the capital and operations and maintenance costs would provide some information for comparison with ex ante estimates. Yet, as indicated in Rule 90-5-1, it is important to contact APC manufacturers that are very specific to the rule at hand (such as the two medical equipment providers, BC Technology Inc. and Special Team Medical Services Inc. we contacted). Else, efforts using much more aggregated data (such as from the PACE website) or obtaining information from manufacturers not really familiar with the industry will likely to lead to poor estimates at best, and no estimates at worst.

V.A.3. Approach Three: Technical Contacts

Because of the lack of progress from approaches one and two, a third approach was undertaken in January of 2005. In this instance, engineers and specialists with expertise in air quality management from UCR and NN Environmental Consulting developed contact lists for stakeholders of six of the ten rules and attempted to collect cost data. The contact lists were developed in a number of ways including internet searches, ex-coworkers, and information provided by ARB and SCAQMD personnel. This effort was limited by an impending deadline for completing the project as well as remaining funding; however, it did provide limited success in obtaining some ex post cost and technology data. It also provided some insight into how greater success in obtaining ex post cost information might be achieved in the future, as described in the next section.

V.A.4. Difficulties Encountered on Individual Rules

Below are some suggestions or comments related to a few of the rules that proved to be difficult to obtain ex post costs and implementation data from:

(i) Rules 89-10-2 and 95-6-3

These rules involve modifications to engine, fuel and exhaust systems from on-road vehicles. These rules are inherently more difficult to identify and analyze since emission controls are incremental. The data needed for the study is mostly confidential for competitive reasons, and are extremely difficult to obtain though voluntary cooperation with the industry.

(ii) Rules 91-11-1 and 1173

These rules require engineering and process changes specific to affected fuel refineries. The data needed to estimate ex post costs include rule impact on design, retrofit work, and operations modified as a result of the rule. Active cooperation of the local refinery, as well as its parent company is needed on a voluntary basis to obtain this data for this study. Because there is no incentive for the refineries to participate in this study and with much of the information deemed confidential, it is difficult to obtain meaningful information from the affected industries. Personal contacts were used to obtain the small amount of information obtained for Rule 1173.

(iii) Rule 1138

This rule applies mostly to fast food (hamburger) facilities. Headquarter representatives from each affected facility participated or followed along with the rulemaking process, and trained franchise owners on how to comply with the rule. The most helpful information was obtained from the industry headquarters and persons initially involved in the rule-making process. Although the franchise owners are required to maintain the records individually, they were not as receptive to providing this type of information on a voluntary basis.

(iv) Rule 1153

This rule applies to bakeries in the South Coast Basin. Although about half of the baking capacity is represented in the responses to this study, some companies declined to participate due to competitive purposes. However, the cost data is generally thought to be quite accurate. There is not as much confidence in the emissions data that was collected. Most companies either wouldn’t say what their VOC reductions were, or they didn’t know.

(v) Rules 93-12-2 and 88-2-2

These rules apply to the dry cleaning and Chrome plating industries. These industries are both represented by a rather large group of highly competitive, owner operated small businesses, and it is difficult to obtain a representative sample of the industry due to the number of businesses in operation. Over 400 Chrome plating businesses and almost 5,000 dry cleaning businesses are affected by these rules. The costs associated with the dry cleaners are probably quite accurate. It is likely that the costs did not vary significantly from business to business. The same probably cannot be said for the

Chrome plating industry. As evidenced by the limited data obtained during this study, the installation costs can vary significantly from business to business.

It was the observation of team members that plating shops seem unlikely to have the financial resources to install expensive APC. They either operate in margin of the law or are in the process of disappearing in California. It was learned that much of the plating done for bathroom fixtures is outside the U.S. where environmental laws are more lenient.

V.B. Lessons Learned

As described in the previous section, an extensive campaign to collect data on ex post costs was conducted over two years, with few successes and many difficulties. In total, over 1000 attempts were made to contact entities affected by the rules via telephone, email, and hardcopy mail.[18] Specifically, using telephone surveys as a method of gathering data often produces a low information yield because:

- Accurate and up-to-date phone lists are difficult to produce
- The right person to talk to is seldom answering the phone
- Any request done in the name of the ARB or SCAQMD will raise suspicion
- The person making the call should "speak the language" of the industry contacted
- If the entity is willing to share some data there is little assurance that the data will be complete, accurate or up to date

In the instance that industry representatives were successfully contacted, many were either unable or unwilling to provide the necessary cost and emissions data to the study team. The main reasons that industries *did not provide information include*:

- Lack of resources (particularly for the smaller firms) for allocation to record keeping as well as extracting and reducing relevant data when requested.
- Length of time between rule implementation and request for data (due primarily to changing personnel/companies or loss of data files over time).
- Strategic behavior (reluctance from the firm's perspective) to provide information contradicting original industry estimates
- Rule contained no provisions to require record keeping, therefore no records were ever made
- Confidentiality concerns
- Lack of financial or other incentive to cooperate (information was being requested on a voluntary basis by a non-enforcement entity)

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[18] As mentioned previously, given the expected difficulties of getting even a reasonably sized sample, we made an effort to contact all firms and industries affected - i.e., a census rather than a sample. If we had a list containing a large number of contacts (e.g., > 1000), we would choose every 10th contact. In the end, we used the data from any firm that would agree to participate. Whether these estimates are from a representative sample is not a luxury we were afforded.

In contrast, there were some very helpful firms and industries that were able to provide some useful information. The main reasons these specific individuals could and *did provide information include*:

- The rule contained specific provisions requiring record keeping of cost and maintenance data
- Industry representatives had a true interest in the outcome of the study and believed it was in their best interest to cooperate and have a chance to share their experience with no repercussions or contact with a regulatory agency
- Industry representatives had cooperated in the initial rulemaking and had first hand knowledge and easy access to information.

VI. RECOMMENDATIONS AND CONCLUSIONS

VI.A. Recommendations for Process Improvement

Several recommendations for improving the approach and information gathering process on ex ante and ex post data were developed during this study. Existing recommendations for selecting appropriate rules for conducting ex ante and ex post costs analysis have been documented by the BBC. While these recommendations were found to be useful in determining good candidate rules for a successful analysis, additional guidelines gleaned from this study include the following:

- **Encourage strong industry participation throughout the entire rulemaking process.** It should be emphasized that more reliable estimations are obtained when there is effective communication with the regulator and affected industries from theory to post implementation phase of the regulation.

- **Require each affected industry to report their contact information** to the rulemaking agency on who is responsible for implementing the controls and maintaining any records. The rulemaking agency should maintain this list electronically and update as needed. This would immensely improve the ability to gather ex post data while requiring minimal time effort on the part of industry and enforcers.

- As part of the rule, **require record keeping** and reporting to the agency cost, maintenance, and emissions data as deemed cost effective and reasonable.

- **Collaboration between the regulatory agency and industry stakeholders via** the setting of a **working group** is important during and after the rulemaking process in generating ex ante and ex post cost estimates.

- **Surveys** and focus groups of industry stakeholders should be **conducted with the participation of actual data users t**o strengthen quality of data.

- Use of **third party technical experts** to collect information on cost and emission reductions for control equipment **may be considered**. In some instances, third party technical experts can have greater knowledge in specific areas. Third party experts may also have better access to industry stakeholders (under the condition of anonymity).

- As part of the FBA and rule selection process, **choose rules that have recently been adopted or amended (~1-2 years)** to maximize the availability of knowledgeable personnel, correct contact information, and access to data files.

In summary, the approach upon which this study was based is not an optimum approach to achieve the desired goal. For all the reasons noted previously in this report, it is difficult to obtain the desired ex post information and, if obtained, may be of questionable value due to a variety of potential biases. We certainly support and encourage the idea of the use of more frequent post rule analysis, especially for the more controversial rules. Additionally, more accurate audits would be possible if the rulemaking authority also included, and followed up on, a cost reporting requirement in the rule. In this way, regulated entities would be required to report their capital and installation costs upon achieving compliance with the rule and annual operating costs for each of the first three years of operation. This would greatly improve the opportunity to make ex ante to ex post comparisons with sufficient validity to base changes in the methodologies for ex ante determinations.

VI.B. Conclusions of Analysis

Based on the analysis of the eight rules in this study, the following summary statements and conclusions were drawn:

- The rulemaking agency considerably overestimated the actual costs for three rules, underestimated the costs for one rule, and estimated very similar to actual costs for two rules. The ex post cost information obtained for one rule was insufficient to allow a conclusion to be reached.

- In the instances where ex ante costs between the agency and industry were similar, significant stakeholder involvement beginning early in the rule formulation was observed. Additionally, the ex ante costs were generally closer to actual costs than if industry was not involved in the process. The collaboration between industry and the rule makers appear to have very useful benefits in aiding CARB and the District to develop more accurate ex ante cost estimates.

- In all cases where both industry and CARB or the SCAQMD provided ex ante costs, the industry's predicted costs were higher.

- In developing predicted costs, it is not an uncommon practice for the regulatory agency to generate a range of estimates. This would lead to an expectation that if the ex ante costs are accurate, the typical actual costs would occur within the midpoint of that range. In 5 of the 7 cases, actual capital costs were within the range of the agency estimates, however, they fell into the upper 50% of the range and, for 4 of the rules (Rules 1153,1174, 88-2-2, and 93-12-2), were in the very upper range of the estimated capital costs. It must be mentioned, however, that the overestimation of predicting capital costs does not necessarily result in an overestimation of the overall cost per ton emission reduced. In fact, there are several instances where the capital costs were in the high range, and the actual ex post cost in dollars / ton reduced was lower than that predicted by both industry and the agency.

- Regulations can have a significant effect on the direction of growth within an industry. The evidence is mostly anecdotal, but several of the industries, most notably the contract sterilization industry, which were part of this study, have undergone considerable consolidation in the past several years. This has been, at least in part, due to the regulations impacting their businesses.

- In some instances, size-related exemptions may result in unwanted effects. In the case of the bread bakeries, the small oven exemption appears to have catalyzed a movement toward decentralization of the industry. A proliferation of small specialty operations, primarily in large chain grocery stores has occurred since the time of the initial rule adoption. Some grocery store centralized bakeries were sold, or shut down, and smaller, non-regulated ovens were started up in individual grocery stores to make specialty products (fresh baked bread on premises). Decentralization and the proliferation of exempt ovens were not envisioned during the rulemaking and, as a result, the full reduction potential of the adopted rule was probably not realized.

Although there is a fairly good correlation between ex ante and ex post capital costs for most cases, the correlation breaks down for cost per pound of pollutant reduced. In general, most of the participants were comfortable giving the actual costs to install the pollution control equipment when those costs were readily available. An understanding of emissions requires a higher degree of technical knowledge than an understanding of the cost of a control device and is generally not germane to the operation of most businesses. As a result, the emissions data obtained from stakeholders may not be sufficiently accurate to support some of the conclusions regarding the cost per unit mass of pollutant reduced. Additionally, there was a general reluctance to share emissions data. This is probably due to concern of reprisal if the data is used in the wrong manner or can somehow show non-compliance. This attitude can be attributed in part to a failure of small business owners to fully understand the regulations they are under and, perhaps, an inherent concern on their part of making an error or mistake in reporting.

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GLOSSARY

APC: Air pollution control

ARB: California Air Resources Board

ATCM: Airborne toxic control measure

AQMP: Air quality management plan

BACT: Best available control technology

CARB: California Air Resources Board

CO: Carbon monoxide

District: Air quality management district

EtO: Ethylene oxide

Ex Ante: Beforehand

Ex Post: After the fact

FBA: Facility-based assessment

HC: Hydrocarbon

O&M: Operations and maintenance

Perc: Perchloroethylene

PM: Particulate matter

PRA: Post-rule assessment

ROC: Reactive organic compounds

SCAQMD: South Coast Air Quality Management District

VOC: Volatile organic compound

Appendices:

Data Related to Contact Information and Efforts to Collect Cost Information

Appendix A: Rule 1153

Table A1. Commercial Bakeries' List (original list)

	Company' Name	Calling Process	Number		Provided Ex Post information	Miscellaneous
1	Western Bagel Corp.	Disconnected				
2	Vons. Comp. Inc.	Disconnected				
3	Foix French Baking Co.	Disconnected				
4	Van de Kamp's Holland Dutch Bakery	Disconnected				
5	Pacific Multigrain Foods and Fornaca Family Bakery	Disconnected				
6	Alpha Beta Co.	Disconnected				
7	Freund Baking Co.	(818) 502 1400	(323) 724 3000	Plant Manager's Assistant	Yes	They were willing to participate for preparing the data (emission and actual cost data). After a few weeks, they informed us it that it might be difficult to gather data since it was nearly 10 years ago.
8	Albertson's Central Bakery	Disconnected				
9	Galasso's Bakery	Disconnected				
10	Certiified Grocers of California	Disconnected				
11	Martino's Bakery Inc.	Disconnected				

Table A1. Commercial Bakeries' List (continued)

12	Interstate Brands Corp.	(818) 846 3671	(323) 660 4455 ext. 119	David Gravys	Yes	They talked with their law division about our request. Two months later they sent annual operations cost for BACT, not emission data. This is current costs, not costs after ruling. Many variables have changed.
13	Peter Pan of Hollywood	change of business				
14	Fornaca Family Bakery	change of business				
15	Best Food Baking Group	(714) 996 7910				Several times called and left a message. No response for months. Have responded but no data available.
16	Bridgford Foods Group	(714) 526 5533	(714) 992 9321 faks	Bill Bridgford (714) 526 5533 ext. 5200		They requested detailed info with fax for contact person's name. Left messages with manager. Manager finally responded, advised us that they have since changed production area and are not subject to Rule 1153.
17	Ralphs Grocery Co Bakery	Disconnected			Yes	
18	Entenmann's/Oroweat Bakery	Disconnected			Yes	
19	Pioneer French Baking	Disconnected				
20	International Baking Co. Inc.	Disconnected				
21	Fresh Start Bakeries	Disconnected			Yes	
22	Harvest Day Bakery	Disconnected				

Table A1. Commercial Bakeries' List (continued)

23	Division of American Bakeries	Disconnected				
24	Bell Brand Foods	Disconnected				
25	Bob's Big Boy, Inc.	Disconnected				
26	CAL French Inc.	Disconnected				
27	Chippers Not Hut	Disconnected				
28	Four-S Bakeries	Disconnected				
29	French Americanm Bakery	Disconnected				
30	Frisco Baking Co.	Disconnected				
31	Frito-Lay Inc.	Disconnected				
32	ITT Continental Baking Co.	Disconnected				

Appendix B: Rule 1173

Table B1. The Permitted Petroleum Facilities under Rule 1173

Facility ID	Facility Name	City	State	Zip	Rep. Name	Phone	Updated Contact	Updated Phone	Response
162	Continental Airlines Unit No.02	Los Angeles	CA	90045	Thomas Braun	310-258-3300	Anna Schmitt	713 324 6942	Left messages, no responses.
4945	Chevron Products Company	El Segundo	CA	90245	Neal Truong	310-615-5889	left messages		
8439	Exxon Mobil Corp	Long Beach	CA	90803	Laura Johnson	714-431-1213	wrong number		
10805	Chevron U.S.A. Inc Unit No. 88	El Segundo	CA	90245	Neal Truong	310-615-5889	left messages		
11076	Shell Oil Co Unit No. 63	Carson	CA	90745	R. Kawczynski	310-816-2340	Tom Jackson	310 816 2046	Left messages. They said they would be willing to participate. No data or effort to date.
11922	Union Oil Co Of Cal Unit No. 46	Wilmington	CA	90744	D N Price	213-513-7600	wrong number		
12066	Chevron Products Company	El Segundo	CA	90245	Neal Truong	310-615-5889	left messages		
13189	Unocal Corp #47	Wilmington	CA	90744	M. Marrinan	310-952-6116	left messages		
13990	Us Govt, Veterans Affairs Medical Center	Long Beach	CA	90822	Al Greenrock	562-494-2611			
14066	Chevron Products Company	El Segundo	CA	90245	Neal Truong	310-615-5889	left messages		

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

18609	Exxonmobil Oil Corporation	Torrance	CA	90504	Sharon Cristino	310-212-3763	left messages		Returned out calls. Requested we send email to tiffany.l.mensing@exxonmobile.com. Sent email and several reminder phone calls. To date, no response or data.
21537	Chevron Products Company	El Segundo	CA	90245	Neal Truong	310-615-5889	left messages		
32272	Union Pacific Resources	Wilmington	CA	90744	Davis Scharff				
40552	Golden West Ref Co	Santa Fe Springs	CA	90670	David J. Dragt	310-921-3581	disconnected		
40563	Golden West Ref Co Unit No. 22	Santa Fe Springs	CA	90670	David J. Dragt	310-921-3581	disconnected		
40583	Golden West Ref Co	Santa Fe Springs	CA	90670	Douglas B. Ayer	213-921-3581	disconnected		
40898	Trans World Airlines Inc, Unit No.02	Los Angeles	CA	90009					
40951	Dominguez Energy Co	Carson	CA	90746	Jaimie J Clark	714-981-0459	disconnected		
44586	Rohrig Petr Co	Signal Hill	CA	90806	John Rohrig	714-842-6338	left messages		
46875	Scott Oil Co	Huntington Beach	CA	92646	William J. Scott	714-662-5718	Tom Scott (son of owner) and Daryl Scott (562) 843 6903	714- 535-1011/714-432-9255	After several phone conversations with Daryl Scott, they were willing to participate but to date no data provided.
46992	Brindle & Thomas	Huntington Beach	CA	92648	John Thomas	714-556-1834	they didn't want to talk		Refused to participate.

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

46992	Brindle & Thomas	Huntington Beach	CA	92648	John Thomas	714-556-1834	they didn't want to talk		Refused to participate.
47005	Brindle & Thomas	Huntington Beach	CA	92648	John Thomas	714-556-1834	they didn't want to talk		Refused to participate.
47006	Brindle & Thomas, Talbert Lease	Huntington Beach	CA	92648	John Thomas	714-556-1834	they didn't want to talk		Refused to participate.
47009	Brindle & Thomas	Huntington Beach	CA	92648	John Thomas	714-556-1834	they didn't want to talk		Refused to participate.
47022	Weir Oil Co	Huntington Beach	CA	92648	Don Weir	714-960-3744	he doesn't want to talk		Refused to participate.
47385	Capro Oil Co	Huntington Beach	CA	92648					
47397	Cather Production C0, Tenycke Lease	Long Beach	CA	90807	Kurt Elliott		left messages		
47399	Cather Production Co, James Lease	Long Beach	CA	90807	Kurt Elliott	714-534-2048	left messages		
47402	Cather Production Co, Green Lease	Long Beach	CA	90807	K Elliott	714-534-2048	left messages		
47403	Cather Production Co, Lamb Lease	Long Beach	CA	90807	K Elliott	714-534-2048	left messages		
47445	Herley-Kelly Co (Fee Lease)	Long Beach	CA	90807	David Herley				
47651	Us Govt Naval Air Station North Island	San Diego	CA	92135	David Nicholls	619-545-1125	Disconnected		
47708	Hellman Properties Llc	Seal Beach	CA	90740	Mike Hannah	213-431-6022	Disconnected		
49475	H & L Operators, Hannah/Laney Dba	Signal Hill	CA	90806	John Rohring	714-842-6338	left messages		
49966	Texaco Ref & Marketing Inc, Unit No. 20	Wilmington	CA	90744	Martin Arteaga	310-522-6411	Disconnected		
49993	Texaco Ref & Marketing Inc Unit No.54	Wilmington	CA	90744	Gregory Brandt	310-522-6380	Disconnected		
49994	Texaco Ref & Marketing Inc Unit No. 57	Wilmington	CA	90744	Doug Thompson	310-522-6130	Disconnected		

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

54615	Fletcher Oil & Refining Co Gnrl	Carson	CA	90745	William Thorpe	562-531-2060	Left messages to Jim Cresman from the Division of Env.	I have positive response	Initially suggested they were willing to participate. Nothing to date.
54940	Laxfuel Corp Unit No.04	Los Angeles	CA	90045	Andrew K Grant	213-646-2990	Disconnected		
57756	Texaco Refining & Marketing Inc Gnrl	Wilmington	CA	90744	William H Freedman	213-680-6400	wrong number		
62146	Chemoil Ref Corp Unit 02	Signal Hill	CA	90806	Ted Chrestensen	213-424-8515	wrong number		
62165	Chemoil Refining Corp	Signal Hill	CA	90806	Ken Ezoe	562-427-6611	Left messages		
63013	Cooper And Brain Inc	Los Angeles	CA	90044	Don King	213-834-4411	Disconnected		
63401	Ultramar Refining Unit No.21	Wilmington	CA	90744	Steven O. Epperson				
63731	Ultramar Inc, Unit No.15	Wilmington	CA	90744	James Hatchell	310-491-6631	Disconnected		
63742	Ultramar Inc	Wilmington	CA	90744	Leslie E Norton	310-491-6677	left messages		
63746	Ultramar Inc, Unit No.13	Wilmington	CA	90744	Jason R. Lee	562-491-6608	left messages		
65358	Trans World Airlines Inc, Unit No.03	Los Angeles	CA	90045	Charles A. Soules	213-646-5907	Disconnected		
65380	Sfpp, L.P. Unit No.01	Orange	CA	92867	Jack Freeman	714-538-0207	fax number	Sent a fax	No response.
66816	Lbth Inc.	Castaic	CA	91310	W.J. Lovingfoss	805-642-6881	They wanted a detail fax about our request, Fax: (805) 654 8557	I sent the faks on Friday 19th December	Said willing to participate. No effort or data to date though.
67434	Laxfuel Corp Unit No.05	Los Angeles	CA	90045	J. Eric Boling	213-646-5915	Disconnected		
67852	Brindle & Thomas	Huntington Beach	CA	92648	John Thomas	714-556-1834	Refused to talk		

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

68846	Laxfuel Corp Unit No.08	Los Angeles	CA	90009	Andrew Grant	213-646-5915	Disconnected		
68954	E.D. Mitchell, An Individual	Santa Fe Springs	CA	90670	E.D. Mitchell	213-595-5775			
69537	Herley Petroleum (Dell Lease)	Long Beach	CA	90807	David Herley	213-424-2523	Disconnected		
70105	Dominguez Energy, L.P.,Carson Estate Co.	Torrance	CA	90503	C A Champion	213-638-7791	Disconnected		
70206	Harbor Investment Co	Wilmington	CA	90744	Richard Young				
71189	Old-Field Assoc./M, Bair, T. Cacek Etal	Signal Hill	CA	90807	Mike Bair	310-595-4475	Disconnected		
73752	Delta Air Lines, Inc.	Los Angeles	CA	90045	Dave Wallace	213-646-6925	Disconnected		
77259	Lbth, Inc./Sepulveda Lease	Saugus	CA	90631	R W Bowman	805-642-6881	left messages		There is not any response.
78148	Laxfuel Corp Unit No.12	Los Angeles	CA	90045	James Moses	213-646-1334	Disconnected		
78212	Dentino Oil Co	Yorba Linda	CA	92868	Mauro Dentino	714-528-2347	They are changing the business for some personal reasons		
84135	Golden West Refining Unit #41	Santa Fe Springs	CA	90670					
101299	Tidelands Oil Production Co	Wilmington	CA	90744	Mark Shemaria	310-436-9918	wrong number		
104013	Aera Energy Llc	Brea	CA	92821	Milan Steube	714-969-3234	Left messages	They called back and will try to compile some cost data for the project and send.	No data sent.
113160	Hilton Costa Mesa	Costa Mesa	CA	92626	Patrick Serge	714-540-7000			
124589	Breitburn Energy Company Llc	Brea	CA	92823	Pat Gorski	213-225-5900	They will compile cost and emission data and send.		After several reminder phone calls, still no data.

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

125905	GE Energy & Environmental Research Corp	Irvine	CA	92618	Peter Maly	949-552-1803	They haven't done anything for Rule 1173, but they gave a Lab name (Quantum Analytical Lab. 310 830 2226)	Lab said they have some emission and cost data but person who worked on Rule, Dr. Andrew Requito, gone til February. Left messages.	To date, no response.
136475	Lomita Rail Terminal, Llc	Carson	CA	90810	Gary Lawrence	281-648-1111	Left messages		No data.
800030	Chevron Products Co.	El Segundo	CA	90245	Neal Truong	310-651-5669	Disconnected		
800193	La City, Dwp Valley Generating Station	Sun Valley	CA	91352	Tim Conkin	213-367-0443	Left message, they returned my call and they said they sold the facilities to the ULTRAMAR (Jason Lee, (562) 491 6608).	ULTRAMAR called and said there is not any facility under Rule 1173.	
					June Christman	562-748-4704	jchristman@ppcla.com, Contact suggest she will try to gather data.		

Table B1. The Permitted Petroleum Facilities under Rule 1173 (continued)

	Shell Oil Products-Us				Chris Rathbun	310-522-6451	ctrathbun@shellopus.com, called me back and wanted to send email about our request (Chris: ctrathbun@shellopus.com I sent the email and he will gather the info		After several phone conversations and emails, they were willing to help, but after a couple weeks later they informed that they cannot to participate because of the lack of data and time

Appendix C: Rule 1174

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California

Product Mfgr.	Address	Product Name	Web Browsing		Response
Classic Fuels	2506 Zurich Dr., Ste. 5, Fort Collins, CO 80524	CRL's Ultra-Lite			
Garrut Mfg. Corp.	15775 N. Hillcrest, Ste. 108, Dallas, TX 75248	Fire-Up Charcoal			
AOK Products	7984 Stagecoach Rd., Cross Plaines, WI 54615	AOK Fireliters			
EZ-Lite	P.O. Box 33942, San Antonio, TX 78265	EZ-Lite Fire Starter	(800) 707-EASY	Called several times.	Contacted - they will call back. Subsequently, advised us that they do not sell in the area.
Tyson Consumer Products	15237 Sunset Blvd., Pacific Palisdes, CA 90272	Lightnin' Rods			
Gelron Corp.	1616 Ogden Ave., Lisle, IL 60532	Enviro-Fuel w/Hawaiian			
Lovoc, Inc.	12932 Victory Church Rd., Raleigh, NC 27613	Bon Fire			
Happy Jack Corp.	P.O. Box 711, Pacific Palisades, CA 90272	Happy Jack's Bag Light			
Two Trees Products	P.O. Box 4527, Carson, CA 90749	East Start Charcoal	1-888 505-WEST (9378)	left messages	Peter Wyckoff, (818) 353 1189, fax:(818) 353 5578. Send them fax and the summaries of rule. No data yet.
NU-TECH	8001 SE King Rd., Milwaukie, OR 97222	NU-TECH Start-UP			
Hexacorp, Inc.	P.O. Box 370, Bass Lake, CA 93604	Hexaflame Master Start			
Charcoal Master, Int'l.	10165 Valley Blvd., El Monte, CA 01731	Charcoal Master	415-647-2088,	wrong number	
P.C. Campana, Inc.	2115 W. Park Dr., Lorain, OH 44053	Camp's Fire BBQ Box			
EEB, Inc.	567 35th St., Manhattan Beach, CA 90266	Navajo Charcoal Lighter			
Griffo Products, Inc.	1400 N. 30th St., Quincy, IL 62301	Cob Lites			
Alkohol Handelskontor	101 E. Key Capri, Treasure Island, FL 33796	Grilly Willy			
Safelite, Inc.	4245 SE International Way, Ste. A, Milwaukie, OR 97222	Safelite	614-210-9000	left messages	

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California… (continued)

Coldiron Wood Products	136 E. Hill St., Oklahoma City, OK 74145	Mesquite Light-A-Bag	405-525-5541	left messages	
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	Re-packaged Charcoal Lighter	678-461-3200	left messages	
Clorox	P.O. Box 493, Pleasanton, CA 94566	Kingsford BBQ Bag	510-271-7000	(510) 271 7000 R&D	Talked with Ryan Williams (925) 425 4338 and sent an email about our project (as requested). They advise will talk in their group meeting and inform me. No response or data to date.
Clorox	P.O. Box 493, Pleasanton, CA 94566	Kingsford Match Light			
Clorox	P.O. Box 493, Pleasanton, CA 94566	Kingsford Char. Lighter			
Seymour Mfg. Co.	500 N. Broadway, P.O. Box 248, Seymour, IN 42274	Seymour Fire Blox	812-522-2900	Left phone and fax messages. They replied. Sent fax about Rule1174, fax: (812) 522 6109	No subsequent response to date.
Forest Technology Corp.	299 N. Arlington St., Akron, OH 44305	Starterlogg™ Brand			
Reckitt & Colman	1655 Valley Rd., Wayne, NJ 07474	Wizard Char. Ltr./Gulf Lite Char. Str.			
Reckitt & Colman	1655 Valley Rd., Wayne, NJ 07474	Wizard Char. Lighter Blocks			

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California… (continued)

Diamond Brands, Inc.	1820 Orangewood Ave., Ste. 101, Orange, CA 92668	Supermatch	800-777-7942	Christopher Schaefer Quality Assurance Manager/Plant Chemist Alltrista Consumer Products Company 1800 Cloquet Avenue Cloquet, Minnesota 55720	At the first phone conversations they were willing to participate, but there is no any data to date. Phone: (218) 878-2755 Fax: (218) 879-6369 cschaefer@alltrista.com
Bortz Distributing Co., Inc.	6043 Tampa Ave., Ste 205, Tarzana, CA 91356	Klear-Lite Char. Lighter Gel	818-342-8922	Talked with the owner. Company sold division related to charcoal. Horizon Environmental Lab. might have cost and emission data	
Pine Mountain Corp.	1375 Grand Ave., Piedmont, CA 92610	Fire Flakes			
Weber-Stephen Products	200 E. Daniels Rd., Palatine, IL 60067	Flamgo 17 g	800-446-1071, 866-249-3237, 847-202-2773.	847-934-5700 Env. safety Division, Chris	Left messages. No response.
Weber-Stephen Products	200 E. Daniels Rd., Palatine, IL 60067	Flamgo 12.5 g			
Pacer Technology	9420 Santa Anita Ave., Rancho Cucamonga, CA 90670	Bar-B-Bric Zap Light	800-538-3091 909-987-0550.		

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California… (continued)

Angeles Chemical Co.	8915 Sorenson Ave., Santa Fe Springs, CA 90607	Klear-Lite Fluid			
Phillips 66	337 Phillips Bldg. Annex, Bartlesville, OK 74004	Soltrol 100	281-293-1000	left messages (environmental safety division, Mary)	No response.
Phillips 66	337 Phillips Bldg. Annex, Bartlesville, OK 74004	Soltrol 130			
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	One-Time Instant Lighting	678-461-3200	Division Manager Bob Gossip.	Left messages, no response.
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	Multi-Use Instant Lighting			
Imperial Products	P.O. Box 549, Salem, MO 65560	Instant Lighting Char.	800-537-7285, 765-966-0322	They do not sell any product under Rule 1174	
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	2lb. Wax-coated Lump Char.			
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	Brix Instant Lighting Char.			
Unocal Chemicals & Minerals Div.	14445 Alondra Blvd., La Mirada, CA 90638	Napthol Spirits 66/3	310-726-7600		
Arrow Industries	845 Crossover Lane, Ste. 124. Memphis, TN 38117	Just Light 4.0lb.	800-242-7769	headquarter: (317) 888 9800). Indiana	Left messages, no response.
Arrow Industries	845 Crossover Lane, Ste. 124. Memphis, TN 38117	Just Light 2.5lb.			
Trans America Chemical	9511 E. 54th St., Tulsa, OK 74145	Dragon Light Instant Briquets			
Royal Oak Enterprises	900 Ashwood Pkwy., Ste 800, Atlanta, GA 30338	R.O. Char. Ignition Product			
Ashland Chemical	8600 Enterprise Dr., Newark, CA 94560	Kwik-Dri	614-790-3475	left message	No response

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California… (continued)

Exxon Chemical Co.	P.O. Box 5200, Baytown, TX 77522	Char. Lighter 105	281-834-1000, 248-350-6500, 732-321-6000		
Rutland, Inc.	801 N. Church St., Jacksonville, IL 62650	Safe Light Fire Lighters	800-438-5134, 704-553-0046	left messages	No response
Exxon Chemical Co.	P.O. Box 5200, Baytown, TX 77522	Char. Lighter 105 LO			
Exxon Chemical Co.	P.O. Box 5200, Baytown, TX 77522	Char. Lighter 142 CA			
Exxon Chemical Co.	P.O. Box 5200, Baytown, TX 77522	Char. Lighter 125			
Trans America Chemical	9511 E. 54th St., Tulsa, OK 74145	Red Hot Char. Briquets			
Shell DevelopmentCenter	P.O. Box 1380, Houston, TX 77251	Envirolite Fluid	713-348-4614	left messages	No response
Reckitt & Colman	1655 Valley Rd., Wayne, NJ 07474	Wizard/Gulf Lite Product			
Safeway, Inc.	1100 7th Ave., Oakland, CA 94621	Ozark Just Light The Bag	877-723-3929	left messages	No response
West Plains Charcoal	P.O. Box 850, West Plains, MO 65775	Just Light The Bag			
West Plains Charcoal	P.O. Box 850, West Plains, MO 65775	Instant Char. Briquets			
H.O.F. Enterprises, Inc.	200 N. Harvey, Ste. 1415, Oklahoma City, OK 73102	Hot Light			
EES	1725 Business Center Dr., Duarte, CA 91010	Might Lites			
Gulf Lite & Wizard, Inc.	2605 Nonconnah Blvd., Ste. 100, Memphis, TN 38132	Gulf Lite One Match			
Gulf Lite & Wizard, Inc.	2605 Nonconnah Blvd., Ste. 100, Memphis, TN 38132	Wizard One Match			
Arrow Industries	P.O. Box 81049, Dallas, TX 75381	Re-packaged under various names			
Forest Tech. Corp.	299 N. Arlington St., Akron, OH	Starterlogg			
Packaging Services Co.	P.O. Box 875, Pearland, TX 77581	Re-packaged under various names			
Hickory Specialities, Inc.	P.O. Box 1669, Brentwood, TN 37024	Instant Lighting Char.			
Forest Tech. Corp.	299 N. Arlington St., Akron, OH	Starterlogg 7oz.			
Phillips 66	337 Phillips Bldg. Annex, Bartlesville, OK 74004	Char. Lighter Distillate			
Nature's Fire	P.O. Box 773, Anoka, MN 55303	Instant Char. Starter			

Table C1. The Approved Manufacturers' List for Charcoal Ignition Products in Southern California… (continued)

Clorox	P.O. Box 493, Pleasanton, CA 94566	Match Light w/Mesquite			
Young's Choice Supertech	2975 Wilshire Blvd., Ste. 500, Los Angeles, CA 90010	Coconut Coal	213-380-1188	left messages	No response
Kwik Organic Products, Inc.	46 E. 70th St., New York, NY 10021	Greenheat Fire Lighter 6oz.			
Tradco Chemical Corp., Inc.	1081 Rosemary Blvd., Akron, OH 44306	Hearth & Grill Char. Lighter			
Duraflame	P.O. Box 1230, Stockton, CA 95201	Quick Start Fire Lighter	209-461-6600, 800-342-2896	left messages	No response
Calumet Lubricants Co.	2780 Waterfront Parkway E. Dr., Ste. 200, Indianapolis, IN 46214	Cal-Lite Lighter Fluid	317-328-5660, 800-437-3188	left messages	No response
General Produce Co., Ltd.	1330 North B St., Sacramento, CA 95814	Blue Flower			
H.O.C. Industries, Inc.	3511 N. Ohio, Wichita, KS 67201	Re-packaged under various names			
Stephanos Associates	1255 Juanita Dr., Walnut Creek, CA 94595	Sure Light Fluid			
Twinco Romax Wisconsin, Inc.	4635 Willow Dr., Medina, MN 55340	Char. Starting Fluid	414-247-8770	left messages	No response
Chevron Phillips Chemical Co.	1301 McKinney St., Ste. 2137, Houston, TX 77010	Char. Lighter Distillate High Flash			
Packaging Services Co.	P.O Box 875, Pearland, TX 77508	Instant Char. Briquets			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	CRKDFP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	OCSHFP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	SASHFP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	BRSHFP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	WPSH2.5FP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	BR2.5BBSHFP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	SASH2.5FP			
Royal Oak Enterprises	One Royal Oak Ave., Boswell, GA 30076	ELBRFP			
General Produce Co., Ltd.	1330 North B St., Sacramento, CA 95814	Miracle Blaze			
Greenheat South Africa Ltd.	5 Sneezewood Ln., Glen Anil, 4051 South Africa	Gel Pack Char. Starter			

Sunfire Trading Co.	10019 S. Pioneer Blvd., Santa Fe Springs, CA 90670	Magic Lite Char.			
Sunfire Trading Co.	10019 S. Pioneer Blvd., Santa Fe Springs, CA 90670	Sunfire Instant Light II Char. Briquets			
Char Sales	549 Mercury Lane, Brea, CA 92821	Quik Glow Bag Light			

Appendix D: Rule 89-10-2, 91-11-1, and 95-6-3

Table D1. The Updated Automobile Manufacturers' Name and Addresses for Rule 89-10-2 (Exhaust Emissions), Rule 91-11-1 (Reformulated Gasoline Phase-II), Rule 95-6-3 (Onboard Refueling Vapor Recovery)

Company	Contact	Address	Company Name
Aston Martin	**Randal K. Busick** (313) 668-7300 (313) 668-0001 FAX (313) 600-5959 MOBILE	Vehicle Science Corporation 740 Woodland Drive No. 2 Saline, MI 48176-1620	They requested an email about our project. Sent to them. No response since.
Audi Lamborghini Rolls-Royce Volkswagen	**Wolfgang Groth** Manager-Emissions Regulations (248) 754-4701 (248) 754-4707 FAX **Richard E. Thomas** Certification Analyst (248) 754-4713 (248) 754-4707 FAX **Dennis E. Reineke** Certification Analyst (248) 754-4715 (248) 754-4707 FAX	Volkswagen of America, Inc. 3800 Hamlin Road EEO, Auburn Hills, MI 48326	Left messages
BMW	**Wilhelm Hall** Manager (201) 573-2177 (201) 782-0764 FAX	Emission Control Engineering BMW of North America, Inc. BMW Plaza Montvale, New Jersey 07645	They requested an email about our project and an email sent to them. No response since.
Chrysler	**LeeAnn Doherty** (Cars) (248) 576-5454 **Chuch Paterka** (Trucks) (248) 576-5465 (248) 576-7922 FAX	DaimlerChrysler Corporation 800 Chrysler Drive, Auburn Hills, MI 48326-2757	Left messages
Daewoo	**Kenneth J. Boshart** (909) 946-0491 (909) 946-0494 FAX	Automotive Testing Services 222 N. Mountain Ave., #203 Upland, CA 91786	Disconnected
Ferrari	**Frank Maloziec** (248) 488-5600 (248) -488-5820 FAX	Fiat Auto R&D USA 39300 Country Club Drive Farmington Hills, MI 48331	Number no further exists.

Table D1. The Updated Automobile Manufacturers… (continued)

Ford	**Bill Kostin**	Vehicle Environmental Engineering	They sent a CD about their post implementation emission testing, but there is not any cost data.
	Passenger Cars	Certification Engineering Department	
	(313) 594-1206	Ford Motor Company	
	E-mail: wkostin@ford.com	1500 Enterprise Drive, Allen Park, MI 48101	
	Todd Fagerman		
	LDT/MDV		
	(313) 594-0680		
	E-mail: tfagerma@ford.com		
GM	**Randall C. Harvey**	General Motors Proving Ground	Left messages
	Manager, Compliance & Certification	M/C 483-331-500	
	(248) 685-6976	3300 GM Rd, Milford, MI 48380-3726	
Honda	**Brian Gill**	American Honda Motor Co., Inc.	Brian Tinkler from Certification Center brian_tinkler@ahm.honda.com They requested project info and stressed that the cost info is very sensitive data - unlikely to give out.
	(310) 783-3414	1919 Torrance Blvd.	
	retired	Torrance, CA 90501-2746	
Hyundai	**Alfred Gloddeck**	Hyundai American Technical Center, Inc.	
	(909) 627-3525	12610 East End Avenue	
	(909) 628-7682 FAX	Chino, CA 91710	
Jaguar	**Diane Black-Nixon**	Legislation & Compliance	They advised might have cost and emissions data but must request from England
	Manager	Jaguar Cars Inc.	
	(201) 818-8171	555 MacArthur Boulevard	
	(201) 818-8490 FAX	Mahwah, NJ 07430-2327	
	E-mail: dblack3@ford.com		
Mazda	**Hisao Nishitani**	Mazda North American Operations	Left messages
	Senior Engineer	1421 Reynolds Avenue	
	(949) 852-7292	Irvine, CA 92614	
	(949) 261-8071		
	E-mail: hnishita@mazdausa.com		
Mercedes	**Bernd Herrbrich**	Mercedes-Benz Service Corporation	They requested detail info about project. We obliged. No response to date.
	Manager	4035 Via Oro Avenue	
	(310) 549-7600	Long Beach, CA 90810	

Table D1. The Updated Automobile Manufacturers'

Porsche	**Walter J. Lewis** Senior Compliance Engineer (770) 290-3627 (770) 290-3711 FAX E-mail:wlewis@pcnaidcs.com	Porsche Cars North America 980 Hammond Drive, Ste 1000 Atlanta, GA 30328	
Rover Group	**Dennis T. Johnston** Manager (301) 731-6583 (301) 731-5408 FAX E-mail: djohnston@landrover.com	Land Rover North America 4731 Parliament Place Lanham, MD20706	
Saab	**Randall C. Harvey** Manager, Compliance & Certification (248) 685-6976	General Motors Proving Ground M/C 483-331-500 3300 GM Rd. Milford, MI 48380-3726	
Subaru	**James Murphy** (734) 623-0075 (734) 623-0076 FAX E-mail: jmurphy@izzy.net	Subaru Research and Development, Inc. 3995 Research Park Drive Ann Arbor, MI 48108	Left messages
Suzuki	**Jeffrey L. Link** Certification Manager (714) 996-7040, ext.2201-07	Government Relations Dept American Suzuki Motor Corporation (ASMC) 3251 East Imperial Highway Brea, CA 92621	
Toyota	**Mike Lord** (310) 538-2570 (310) 787-5655 (LAPT) FAX (310) 787-5675 (Certification & Regulatory Affairs) FAX E-mail: lord@ttc-usa.com	Toyota Technical Center, USA 1630 West 186th Street Gardena, CA 90248	
Volvo	**Gregory Buffalino** Manager Emissions/Fuel Economy Certification Regulations & Compliance (201) 768-7300 Ext. 7125 (201) 768-8695	Volvo Cars of North America Volvo Drive Rockleigh, NJ 07647-0913	

Appendix E: Gasoline Specifications Phase II-Stakeholders List

Table E.1. Stakeholders List and Contact Efforts

Company's Name	Person's Name	Phone No	Updated phones	Response I	Response II	Response III
Unocal (LA, CA)	Laurence Popofsky	213-977-5974	Barry Lane Manager, Public Relations 310-726-7731	Did not want to talk since no facility in California	William Almas Government Affairs Manager 805-784-0494	Left messages
Exxon Mobil Corp. (Houston, TX)	Michael F. Smith, Lauren Bird	713-656-3554, 707-745 7878 310-212-1874	Left message	972-444-1000	They called back, Richi (310) 212 4002 provided two other names: Tom Kiliany 310-212-1727, Jeff Joyce 310-212-4787	Left message to Tom. Tom called back and provided another name, name: Chris Armstrong, 713-656-1722, Called and left a message but to no avail.
Shell Oil Products (Martinez, CA)	Bruce Irion	510-313-3000, 510-313-3198		Tony Paul, operations manager 925-313-3000,		
Shell Western E&P Inc.	W. P. Harper	805-326-5545				
Martinez Manufacturing	Tom Wickiser	713-241-7035	Wrong no (not in web)	It retired		
Texaco Refining and Marketing Inc. (Universal City, CA) (ARCO)	Charles Walz	818-505-2641	Wrong no	John E. Bethancourt technology and service 925-842-1000, 513-880-0362	Left message	
Ultramar	D. Green	310-491-7126, 310-495-5300	Disconnected			

Table E.1. Stakeholders List and Contact Efforts… (continued)

	Steven Epperson	310-495-5466 310-495-5426	Disconnected			
Paramount Petroleum	Glenn Lingle	310-531-2060	Wrong no	562-531-2060	Talked with Engineering Division. They do not have any gasoline products, nor records for five and ten years ago.	
Kern Oil and Refining	Thomas Eveland	805-845-0761		661-845-0761	Left Messages	
Southern California Edison Comp.		818-302-9459	Disconnected	626-302-1212, 800-333-4766	Left Messages	
Southern California Gas		213-689-2410	Wrong no	877-866-2066		
California Council for Environmental and Economic Balance		415-512-7890		415-512-7890		
General Motor	S.A. Leonard, G.J. Barnes, Automotive Emission Control	313-947-1894	Disconnected			
Fletcher Oil and Refining Comp.	Byron P.Gee, Technical and Environmental Services	213-518-4270 213-775-3731	Disconnected			
Powerine Oil Comp.	A. L. Gualtieri	310-944-9861, 310-944-6111	Disconnected			
Motor Vehicle Manufacturers Association	Gerald Esper (technical Affairs)	313-872-4311	Disconnected			
Ford Motor Company	Richard L. Dugally, Governmental Affairs	916-442-0111	Left messages, they called me back, Walter Kreucher (wkreuche@ford.com) (313) 845 8247, they w/ collect and send.		They responded. Sent CD.	They sent the data CD. No cost data. Useful emissions and technology data.
Arco	Timothy J. Clossey	714-491-6866		800-322-2726, 202-879-9260		
American Independent Refiners Association (West Coast Office)	Craig A. Meyer, Counsel	213-488-1748				

Table E.1. Stakeholders List and Contact Efforts… (continued)

American Independent Refiners Association (DC Office)		202-625-3850				
Tosco Refining Corp.	Duane B. Bordvick, Environmental External Affairs	415-602-4120		310-952-6000, 510-235-7600	Left messages	
Chevron USA inc.		925-842-1000	I talked with Sheri Huber from Environmental Division. hubc@chevrontexaco.com	Left messages	No information.	
TESORO	Tara Ford Payne	210-283-2676	Left messages			
Western States Petroluem Association	Gina Grey	480-595-7131	Left messages for several times			
Chevron-Texaco Fuels Regulations and Emissions Group	John	925-842-5825	Left messages			
MathPro inc.		301-951-9006				
Wayne Miller CE-CERT	wayne@cert.ucr.edu	909-781-5579	Left messages			
Alliance of Automobile Manufacturers	Ellen Shapiro	202-326-5533				

Appendix F: Rule 88-2-2 List of plating (decorative, hard, trivalent) and chromic acid anodizing facilities (2003)

FACILITY	ADDRESS	CITY	STATE	ZIP
EXCELLO PLATING CO INC	4057 GOODWIN AVE	LOS ANGELES	CA	90039
VELING PLATING COMPANY	763 N SEWARD	HOLLYWOOD	CA	90038
HIGHLAND PLATING CO	1001 N ORANGE DR	LOS ANGELES	CA	90038
MULTICHROME CO INC	11165 TENNESSEE AVE	WEST LOS ANGELES	CA	90064
CHROMPLATE COMPANY	1127 W HILLCREST BLVD	INGLEWOOD	CA	90301
HAWKER PACIFIC INC	11310 SHERMAN WAY	SUN VALLEY	CA	91352
EL MONTE PLATING CO, DARREL JENSEN	11409 STEWART ST	EL MONTE	CA	91731
ACCU CROME PLATING CO INC	115 W 154TH ST	GARDENA	CA	90248
D & S Custom Plating	11552 Anabel	Garden Grove	CA	92843
COASTAL MULTICHROME	1160 Mercantile Street	OXNARD	CA	93030
NATIONAL O-RINGS	11634 PATTON RD	DOWNEY	CA	90241
DIXON HARD CHROME INC	11645 PENDLETON ST	SUN VALLEY	CA	91352
OMNI METAL FINISHING	11665 COLEY RIVER CIR	FOUNTAIN VALLEY	CA	92708
BABBITT BEARING	1170 N 5th St	San Jose	CA	95112
QUAKER CITY PLATING	11729 E WASHINGTON BLVD	WHITTIER	CA	90606
Sanchez Polishing and Plating	1175 Industrial Ave #W	Escondido	CA	92029
UNITED CUSTOM POLISHING, A MARTINEZ ETC	1179 N FOUNTAIN WAY	ANAHEIM	CA	92806
VALLEY CHROME PLATING	1000 HOBLITT AVE	CLOVIS	CA	93612
SPENCE ELECTRO PLATING	1001 CHESTNUT ST	BURBANK	CA	91506
HIGHLAND PLATING CO	1001 N ORANGE DR	LOS ANGELES	CA	90038
LOCKHEED ADVANCED DEV CO-PLANT 10,B/608	1011 LOCKHEED WAY	PALMDALE	CA	93599
MULTICHROME CO INC / MICROPLATE	1013 W. HILLCREST BLVD	INGLEWOOD	CA	90301
WHITING ENTERPRISES	10140 ROMANDEL AVE	SANTA FE SPRINGS	CA	90670
KP METAL FINISHING INC	1022 PETROLIA AVE	COMPTON	CA	90221
PREMIUM PLATING	1026 N. 10th St	San Jose	CA	95112
SIGMA PLATING CO INC	1040 OTTERBEIN	LA PUENTE	CA	91748
KENNETH JEFFERS CHROME PLATING	1044 E 2 ND ST	POMONA	CA	91767
ANADITE INC	10647 GARFIELD AVE	SOUTH GATE	CA	90280
CENTRAL PLATING SERV	10930 SCHMIDT RD	EL MONTE	CA	91733
CYCLE SHACK	1104 San Mateo Ave	South San Francisco	CA	94080
CAL-TRON PLATING INC	11919 RIVERA RD	SANTA FE SPRINGS	CA	90670

FACILITY	ADDRESS	CITY	STATE	ZIP
K & L ANODIZING CORP	1200 S VICTORY BLVD	BURBANK	CA	91502
KRYLER CORP	1217 E ASH AVE	FULLERTON	CA	92631
PLATECORP	1223 N BATAVIA ST	ORANGE	CA	92867
AIRCRAFT PLATING CO INC	12233-12 S PRAIRIE AVE	HAWTHORNE	CA	90250
WRE/COLORTECH	1225 6th St	Berkeley	CA	94710
INDUSTRIAL METAL PLATING	12300 BRANFORD ST	SUN VALLEY	CA	91352
VALLEY PLATING	1236 N FILBERT	STOCKTON	CA	95205
BRICO METAL FINISHING	12416 BENEDICT AVE	DOWNEY	CA	90242
AMERICAN ELECTRO PLATING CO	1245-47 E FLORENCE AVE	LOS ANGELES	CA	90001
COAST PLATING INC	128 150 W 154TH ST	GARDENA	CA	90248
VALLEY-TODECO, INC	12975 BRADLEY AVE	SYLMAR	CA	91342
ELECTRO FORMING	130 Nevin Ave	Richmond	CA	94801
BRITE PLATING CO INC	1313 MIRASOL ST	LOS ANGELES	CA	90023
SIZE CONTROL PLATING CO INC	13349 E TEMPLE AVE	LA PUENTE	CA	91746
SW PLATING CO	1344 W SLAUSON AVE	LOS ANGELES	CA	90044
J & R PLATING / RAFAEL ALFREDO LEAL	1353 W 134 ST	GARDENA	CA	90247
GRANT PISTON RING CO	1360 JEFFERSON ST	ANAHEIM	CA	92807
AERODYNAMICS PLATING CO. INC.	13620 S ST ANDREWS PL	GARDENA	CA	90815
CLOVIS SPECIALTY PLATING	1366 N SIERRA VISTA	FRESNO	CA	93703
WEST COAST CYLINDER WORKS	13907 MARQUARDT AVE	SANTA FE SPRINGS	CA	90670
Lemon Grove Plating Inc	1400 Cleveland Ave	National City	CA	91950
ALCO CAD-NICKEL PLATING CORP	1400 LONG BEACH AVE	LOS ANGELES	CA	90021
METAL FINISHING MARKETERS INC	1401 MIRASOL ST	LOS ANGELES	CA	90023
V & M PLATING CO	14024 S AVALON BLVD	LOS ANGELES	CA	90061
VISALIA CHROME	1414 SWITZER	VISALIA	CA	93291
CYTEC INDUSTRIES INC	1440 N KRAEMER BLVD	ANAHEIM	CA	92806
CROWN CHROME PLATING INC	14660 ARMINTA ST	VAN NUYS	CA	91402
U.S. CHROME CORP OF CALIFORNIA	1480 CANAL AVE	LONG BEACH	CA	90813
S & S POLISHING & PLATING INC	1503 N MILLER ST	ANAHEIM	CA	92806
CALIFORNIA POLISHING & PLATING, INC.	15125 S ILLINOIS AVE	PARAMOUNT	CA	90723
Allfast Fastening System Inc	15200 Don Julian Rd	CITY OF INDUSTRY	CA	91745

FACILITY	ADDRESS	CITY	STATE	ZIP
ASTRO CHROME & POLISHING CORP	15236 ERWIN ST	VAN NUYS	CA	91411
UNIVERSAL METAL PLATING & POLISHING	1526 W 1ST ST	AZUSA	CA	91702
A & Z GRINDING, INC.	1543 NADEAU ST	LOS ANGELES	CA	90001
UNITED STATES MINT	155 Hermann Street	San Francisco	CA	91402
CUSTOM METAL FINISHING	1550 SHAW ROAD	STOCKTON	CA	95215
ANAPLEX CORP	15547 GARFIELD AVE	PARAMOUNT	CA	90723
CAL BUMPER CO INC	1555 W ANAHEIM ST	LONG BEACH	CA	90813
VERNE'S CHROME PLATING INC	1559 W EL SEGUNDO BLVD	GARDENA	CA	90249
DNR INDUSTRIES, INC.	1562 S. Anaheim Blvd.	ANAHEIM	CA	92805
TECHPLATE ENGINEERING CO	1571-H S SUNKIST ST	ANAHEIM	CA	92806
GARDENA SPECIALIZED PROCESSING INC	16520 S FIGUEROA ST	GARDENA	CA	90248
AMERICAN RACING EQUIP INC	17006 S FIGUEROA ST	GARDENA	CA	90248
CONTROL PLATING CO INC	17014 GRAMERCY PL	GARDENA	CA	90247
ANGELUS PLATING WKS	1713 W 134TH ST	GARDENA	CA	90249
ALTA PLATING & CHEMICAL, CORP.	1733 'S' STREET	SACRAMENTO	CA	95814
CHROMAL PLATING CO	1748 N WORKMAN ST	LOS ANGELES	CA	90031
PCA INDUSTRIES, LLC	1818 E ROSSLYNN AVE	FULLERTON	CA	92831
CHROME CRAFT	5950 88TH STREET	SACRAMENTO	CA	95828
A-H PLATING INC	1837 VICTORY PL	BURBANK	CA	91504
DOLPHIN ENGINEERING	1842 E 41ST PL	LOS ANGELES	CA	90058
CARTER PLATING INC	1842 N KEYSTONE ST	BURBANK	CA	91504
SERV PLATING CO INC	1855 E 62ND ST	LOS ANGELES	CA	90001
PLATO PROD INC/techspray	P.O. BOX 949	AMARILLO	TX	79105
COMMERCIAL ELECTRO PLATING	1937 S CHERRY ST	FRESNO	CA	93721
ELECTROLIZING INC	1947 HOOPER AVE PO BOX 11900	LOS ANGELES	CA	90011
MECLEC PLATING	5945 E HARVARD	FRESNO	CA	93702
Vanier Mfg In	200 Motor Ave	AZUSA	CA	91702
MOOG, INC (HARD &ANODIZING)	20263 S WESTERN AVE	TORRANCE	CA	90501
SOUTH BAY CHROME	2041 S GRAND AVE	SANTA ANA	CA	92705
AAA PLATING	2081 RENE AVE. BLDG. C	SACRAMENTO	CA	95838
HIGHTOWER PLATING COMPANY	2090 N GLASSELL BLVD	ORANGE	CA	92665
GARY'S GRINDING & HARD CHROME INC	2124 S GROVE AVE UNIT A	ONTARIO	CA	91761

FACILITY	ADDRESS	CITY	STATE	ZIP
PEMACO METAL PROCESSING CORP	2125 LEMON ST	ALHAMBRA	CA	91803
MIL-SPEC PLATING CORP	2134 SEAMAN AVE	SOUTH EL MONTE	CA	91733
SHERMS CUSTOM PLATING	2140 Acoma Street	SACRAMENTO	CA	95815
Carlson & Beauloye Machine Shop Inc	2141 Newton Ave	San Diego	CA	92112
NEWAGE METAL FINISHING	2142 N PLEASANT	FRESNO	CA	93705
Walkers Custom Chrome	2145 Grand Coulee Blvd	Shasta Lake	CA	96019
ALL AMERICAN MANUFACTURING CO	2201 E 51ST ST	LOS ANGELES	CA	90058
BARRY AVE PLATING CO INC	2210 BARRY AVE	LOS ANGELES	CA	90064
ANODYNE INC	2226-223 S SUSAN ST	SANTA ANA	CA	92704
RE-BILT METALIZING CO	2229 E 38TH ST	VERNON	CA	90058
WESTERN CHROME	2306 E MCKINLEY	FRESNO	CA	93703
CHROME TECH INC	2309 W 2ND ST	SANTA ANA	CA	92705
Artistic Silver Plating	2344 Orange Ave	Signal Hill	CA	90755
M J B CHROME PLATING & POLISHING	236 S RIVERSIDE AVE	RIALTO	CA	92376
BARKEN'S HARDCHROME, INC	239 E GREENLEAF BLVD	COMPTON	CA	90220
PRIME WHEEL CORPORATION	24000 S VERMONT	HARBOR CITY	CA	90710
CHRISTENSEN PLATING WKS INC	2455 E 52ND ST	VERNON	CA	90058
HIGH LUSTER METAL FINISHING	2466 American Way	Hayward	CA	94545
WHEEL SERVICES GROUP INC	2525 S BIRCH ST	SANTA ANA	CA	92707
JOHNSON PLATING	2526 Telegraph	Oakland	CA	94612
DV INDUSTRIES INC UNIT NO.01	2605 INDUSTRY WAY	LYNWOOD	CA	90262
West Coast Plating	2613 Temple Heights Dr #D	Oceanside	CA	92056
KOTOFF & CO INC	2620 N DURFEE AVE	EL MONTE	CA	91732
AIRCRAFT X-RAY LABS INC	2627 E 53RD & 5216 PACIFIC ST	HUNTINGTON PARK	CA	90255
BOWMAN PLATING CO INC	2631 E 126TH ST	COMPTON	CA	90222
WADE CLINE PLATING CO	2634 E 126TH ST	COMPTON	CA	90222
PRODUCT ENGINEERING CORPORATION	2645 MARICOPA ST	TORRANCE	CA	90503
RUTTER ARMEY	2684 S CHERRY	FRESNO	CA	93706
VALLEY PLATING WORKS, INC	2701 SAN FERNANDO RD	LOS ANGELES	CA	90065
S & K PLATING INC	2727 N COMPTON AVE	COMPTON	CA	90222
CA Plating	2802 Imperial Ave	San Diego	CA	92102

FACILITY	ADDRESS	CITY	STATE	ZIP
ARTISTIC PLATING & METAL FINISHING INC	2801 E MIRALOMA AVE	ANAHEIM	CA	92806
I W INDUSTRIES CORP	28238 AVENUE CROCKER	VALENCIA	CA	91355
ESPOSITO PLATING CORP	2904 Chapman St	Oakland	CA	94601
Andres Tech Plating Inc	2921 E Miraloma, SUITE 5	ANAHEIM	CA	92806
PHYLRICH INTERNATIONAL	2937 N. ONTARIO ST	BURBANK	CA	91504
CLASSIC PLATING INC	2985 E MIRALOMA AVE	ANAHEIM	CA	92806
NEUTRON PLATING INC	2993 E BLUE STAR ST	ANAHEIM	CA	92806
Avis Roto-Die Co, Inc	P O BOX 65617	LOS ANGELES	CA	90065
DECOR METAL FINISHING INC	3041 ORANGE AVE	SANTA ANA	CA	92707
REID METAL FINISHING	3110 W HARVARD 14	SANTA ANA	CA	92704
STEVE'S PLATING CORPORATION	3111 N SAN FERNANDO BLVD	BURBANK	CA	91504
TEIKURO AMERICA CO LTD	31499 Hayman St	Hayward	CA	94544
LODI CHROME	316 N MAIN STREET	LODI	CA	95240
A C PLATING	317 MT VERNON AVENUE	BAKERSFIELD	CA	93307
BRASSTECH INC	3230 S STANDARD AVE	SANTA ANA	CA	92705
SUPREME PLATING & COATING, L DE LA ROSA	330 E BEACH AVE	INGLEWOOD	CA	90302
BROS PLATING	334 S MOTOR AVE	AZUSA	CA	91702
TECHNICAL METAL FINISHING CO INC	3401 PACIFIC AVE	BURBANK	CA	91505
SAL'S PLATING	3419 UNION PACIFIC AVE	LOS ANGELES	CA	90023
GROVER PROD. CO, UNIT NO. 1	3424 E OLYMPIC BLVD	LOS ANGELES	CA	90023
BRONZEWAY PLATING CORP	3432 E 15TH ST	LOS ANGELES	CA	90023
PALM SPRINGS PLATING	345 DEL SOL	PALM SPRINGS	CA	92262
GENE'S PLATING WORKS	3498 e. 14TH STREET	LOS ANGELES	CA	90023
CAL ELECTROPLATING INC	3510 E PICO BLVD	LOS ANGELES	CA	90023
Gene's Plating Works	3656 E Naokes	LOS ANGELES	CA	90023
SUPERIOR PLATING CO	389 N EAST END	POMONA	CA	91767
CANYON PRECISION PLATING & GRINDING	3911 E MIRALOMA AVE	ANAHEIM	CA	92806
EXCELLO PLATING CO INC	4057 GOODWIN AVE	LOS ANGELES	CA	90039
SANTA ANA PLATING INC	411 E ALTON AVE	SANTA ANA	CA	92707
COAST PLATING INC	417 W 164 TH ST	CARSON	CA	90248
CONSOLIDATED FOUNDRIES	4200 W VALLEY BLVD	POMONA	CA	91766
AAA PLATING & INSPECTION INC	424 E. DIXON ST	COMPTON	CA	90222

FACILITY	ADDRESS	CITY	STATE	ZIP
E.M.E. INC/ELECTRO MACHINE & ENGINEERING	431 E OAKS ST	COMPTON	CA	90222
MORRELL'S ELECTRO PLATING INC	432 E EUCLID AVE	COMPTON	CA	90222
Decore Plating	434 W 164th St	GARDENA	CA	90248
CROWN CITY PLATING CO	4350 TEMPLE CITY BLVD	EL MONTE	CA	91731
MODESTO PLATING	436 MITCHELL ROAD STE D	MODESTO	CA	95354
WEST COAST CHROME	451 SONORA AVE, #J & D	MODESTO	CA	95356
S.J. VALLEY PLATING	491 Perry Court	Santa Clara	CA	95054
STUTZMAN PLATING INC	5045 EXPOSITION BLVD	LOS ANGELES	CA	90016
Taylor Made Plating	5110-A Caterpillar Rd	Redding	CA	95812
J & M ANODIZING, INC.	525 S FLOWER ST	BURBANK	CA	91502
DOMAR PRECISION INC	5250 E SOUTHERN AVE	SOUTH GATE	CA	90280
MCDONNELL DOUGLAS AEROSPACE	5301 BOLSA AVE	HUNTINGTON BEACH	CA	92647
MODERN PLATING CO	5400 W 104TH	LOS ANGELES	CA	90045
RMS SERVICES, INC/ AMERICAN EAGLE	5777 SOESTERN COURT	CHINO	CA	91710
Specialized Processing Co Inc	581 Marshall Ave. S	El Cajon	CA	92020
COLLINS TECHNOLOGIES	5875 OBISPO AVE	LONG BEACH	CA	90805
VALLEY PLATING WORKS INC	5900 E SHEILA ST	COMMERCE	CA	90040
STANISLAUS CHROME PLATING	610 7TH STREET	MODESTO	CA	95354
VAN NUYS PLATING INC	6109 VESPER AVE	VAN NUYS	CA	91411
ULTRA WHEEL CO	6300 VALLEY VIEW	BUENA PARK	CA	90620
BROWN INTL CORP	633 N BARRANCA	COVINA	CA	91723
Gorilla's Plating	654 E Young St	SANTA ANA	CA	92704
PONAM LTD, INC.	6618 SAN FERNANDO RD	GLENDALE	CA	91201
PENNOYER-DODGE CO	6634 SAN FERNANDO RD	GLENDALE	CA	91201
LUBECO INC	6859 DOWNEY AVE	LONG BEACH	CA	90805
Palace Plating	710 E 29th St	LOS ANGELES	CA	90011
ROTO-DIE COMPANY INC	712 N VALLEY ST	ANAHEIM	CA	92801
QUALITY CUSTOM CHROME / WESTERN PLATING/ quality custom chrome	714 Francisco Blvd-W	San Rafael	CA	94902
FAITH PLATING / JAN IV CORP	7141 SANTA MONICA BLVD	LOS ANGELES	CA	90046
JANKENS CO INC	715 E CYPRESS AVE	MONROVIA	CA	91016

FACILITY	ADDRESS	CITY	STATE	ZIP
ACE PLATING CO INC	719 TOWNE ST	LOS ANGELES	CA	90021
VELING PLATING COMPANY	763 N SEWARD	HOLLYWOOD	CA	90038
TOOL & JIG PLATING COMPANY, A. WILLIAMS	7635 S BALDWIN PL	WHITTIER	CA	90602
HARD CHROME PLATING INCORPORATED	7635 S BALDWIN PL	WHITTIER	CA	90602
WALLY'S METAL POLISHING & PLATING	7810 JACKSON ST	PARAMOUNT	CA	90723
DUCOMMUN AEROTRUCTURES	801 ROYAL OAKS DR	MONROVIA	CA	91016
INDUSTRIAL PLATING CO	803 Amer. St	San Carlos	CA	94070
ALUMINUM ART PLATING INC	803 W STATE ST	ONTARIO	CA	91762
BUMPER SHOP INC.	808 - 828 E FLORENCE AVE	LOS ANGELES	CA	90001
FOSS PLATING CO INC.	8140 SECURA WAY	SANTA FE SPRINGS	CA	90670
EQUALITY PLAING CO	8172 Center St	La Mesa	CA	91942
HIXSON METAL FINISHING	817-853 PRODUCTION PL	NEWPORT BEACH	CA	92663
DELTA PLATING INC	818 S STANISLAUS ST	STOCKTON	CA	95206
ALL METALS PROCESSING OF ORANGE CO INC	8401 STANDUSTRIAL ST	STANTON	CA	90680
ESCONDIDO PLATING	860 Metcalf St	Escondido	CA	92025
ELECTR0 COATINGS - BRKLY	893 Carleton Street	Berkeley	CA	94710
USS-POSCO	900 Loveridge	Pittsburg	CA	94565
LA HABRA PLATING CO INC	900 S CYPRESS ST	LA HABRA	CA	90631
SUPERIOR PLATING	9001 GLENOAKS BLVD	SUN VALLEY	CA	91352
SAN JOAQUIN CHROMEWORKS	910 BLACK DIAMOND UNIT B	LODI	CA	95240
ELECTRONIC CHROME GRINDING CO INC	9128 DICE RD	SANTA FE SPRINGS	CA	90670
ANAHEIM PLATING INC	928 E SOUTH ST	ANAHEIM	CA	92805
INTERMETRO INDUSTRIES CORP	9393 ARROW ROUTE	RANCHO CUCAMONGA	CA	91730
C&M GOLD PLATING	948 INDUSTRIAL WAY	AZUSA	CA	91702
GENERAL PLATING CO	951 W VERNON AVE	LOS ANGELES	CA	90037
DYNAMIC PLATING	952 W 9TH ST	UPLAND	CA	91786
OR. CO. PLATING CO INC	960 N PARKER ST	ORANGE	CA	92667
Allen Insustrial & Machine	960 S Hathaway St	BANNING	CA	92220
NETWORKS ELECTRONIC CORP	9750 DE SOTO AVE	CHATSWORTH	CA	91311
HARTWELL CORP	9810 6TH ST	RANCHO CUCAMONGA	CA	91730
L & R METAL FINISHING CO	9912 1/2 RUSH ST	SOUTH EL MONTE	CA	91733
DOE-SANDIA LABS	7011 East Avenue	Livermore	CA	94550

FACILITY	ADDRESS	CITY	STATE	ZIP
USN Aviation Depot	NAS North Island	San Diego	CA	92135
EMBEE INC.	PO BOX 15705	SANTA ANA	CA	92735
HARD CHROME ENGINEERING	PO BOX 2447	Oakland	CA	94614
ROLL TECHNOLOGY WEST	PO Box 472	Pittsburg	CA	94565
PACIFIC HARD CHROME	3105 S 51ST STREET	Richmond	CA	94804
CUSTOM CHROME AND BUMPER	335 GARDEN HWY	YUBA CITY		95991
QUAKER CITY PLATING	11729 E WASHINGTON BLVD	WHITTIER	CA	90606
MARKLAND MANUFACTURING	1111 E McFadden Ave	SANTA ANA	CA	92705
McDonnell Douglas (Boeing C-13)	15400 Grahan St #101	HUNTINGTON BEACG	CA	92647
VALLEY PLATING WORKS INC	5900 E SHEILA ST	COMMERCE	CA	90040
A & A ENTERPRISES	1733 S STREET	SACRAMENTO	CA	95814
MOOG, INC (HARD &ANODIZING)	20263 S WESTERN AVE	TORRANCE		90501
VALLEY PLATING WORKS, INC	2701 SAN FERNANDO RD	LOS ANGELES	CA	90065
COASTAL MULTICHROME	1160 Mercantile Street	OXNARD	CA	93030
LEAVITTS METAL FINISHING	15131 S ILLINOIS AVE	PARAMOUNT	CA	90723
EMBEE INC.	PO BOX 15705	SANTA ANA		92735
SUPERIOR PLATING	9001 GLENOAKS BLVD	SUN VALLEY		91352
BRONZEWAY PLATING CORP	3432 E 15TH ST	LOS ANGELES		90023

Appendix G: Potential Secondary Sources of Data

Table G1. Secondary Sources of Data Considered

Secondary Sources	**Industries**	**Indicators**	**Years**	**Classification System**	**Explanation**
PACE (Survey of Pollution Abatement Cost and Expenditures Data)	All Industries (in 1999: manufacturing, mining and electric utility industries)	Capital expenditures and operating costs by type of media and percent that is attributed to hazardous materials. Types of pollutans; air, water and solid waste. Also disposal and recycling expenditures and costs, pollution prevention, site cleanup, habitat protection, environmental monitoring and testing, administrative environmental programs, permits, fees, penalties and fines (by major groups and states)	1973 through 1994, except 1987 (the survey was discontinued after 1994 and re-instated in 1999) 1994, 1999	In 1999: NAICS (North America Industry Classification System) and in 1994: SIC (Standard Industry Classification system)	No industries are shown where total abatement capital expenditures and total abatement operating costs are each less than $1,0 million and no plants with fewer than 20 employees (in 1999, there is a small representation of that)
SBO (Survey of Business Owners)	All nonfarm businesses with receipts of $1,000 or more	Gender, ethnicity, race for up to three persons owning the majority of rights, equity, or interest in the business, and some additional demographic and economic characteristics of the business owners and their businesses such as: owner's age, education level etc, types of costumers and workers, source of financing for expansion, capital improvements. According to state, counties, metro areas (all firms' numbers, and sales and receipts; and firms with paid employees with employees' number and payroll)	Every five years since 1972 (for years ending "2" and "7") 1992, 1997. In 1997, the survey was conducted as the 1997 Economic Census Surveys of Minority and Women-Owned Business Enterprises (SMOBE/SWOBE)	SIC	Mostly demographic data, might be usefull for state and selected areas

Table G1. Secondary Sources of Data Considered (continued)

BES (Business Expenses Survey)	Merchant Wholesale, Retail Trade, Service Industries, Communications, Trucking and Warehousing, Arrangement of Passenger Transportation, Manufacturing, Mining, Construction	General Operating Statistics Operating Expenses by Type and Kind of Business. Detail lease and rental payments and cost of repair services by kind of business. Detail purchase utilities by kind of business. Detail cost for data processing and other computer related services by kind of business Sales, annual payroll, employer costs for fringe benefits, and contract labor by kind of business. Sales, cost of goods sold, and measures of value produced by kind of business. Estimated relative standard errors by kind of business	Every five years since 1958 (for years ending "2" and "7") 1992, 1997	NAICS (North America Industry Classification System) and SIC (Standard Industry Classification system)	Not very detail as industries
Selected Air Pollution Control Equipment's Cost Data	Selected industrial air-pollution control equipment used in the seperation, removal, or collection of particulate and gaseous emissions	Companies number, net new orders (quanitity and value), shipments (quantity and value), backlog of orders- December 31- (quantity and value), particulate emissions collectors, gaseous emissions control devices	1996, 1997, 1998 (between 1990-1994 is in PACE survey)	Product Code	Not very detail control equipment devices and limited years
LRD (Longitudinal Research Database)	All manufacturing companies	Individual establishments, detail manufacturing inputs and manufactured products, industry codes, location, current status, legal status, employment, number of production workers, hours worked, labor costs, materials cost, materials consumed, services and energy used, inventory levels, depreciable assets, and capital expenditures. Product data include receipts (value of shipments, value added, value of resales); production details SIC codes, quantities of production, value and quantity of product shipped, value and quantity of interplant transfers, and internal consumptions) and exports.	Continuously since 1980, updated with annually	SIC	Looks very detail but in the web, need to contact with CES (Center for Economic Studies) one of its Research data Center and only for manufacturing

Table G1. Secondary Sources of Data Considered (continued)

Annual Survey of Manufacturers	All manufacturing companies with one or more paid employee	Statistics for employment, payroll, value added by manufacture, cost of materials consumed, value of shipments, detailed capital expenditures, supplemental labor costs, fuels and electric energy used, and inventories by fabrication stage.	1993-96, 98-2000	NAICS (North America Industry Classification System) and SIC (Standard Industry Classification system)	no data according to state and/or region
Facility Search Engine from CARB Database	All Industries	TOG, ROG, NOx, PM, PM10, PM2,5, CO, and SOx, according to District, facility name, air basin, county.	1990-2002	SIC and/or Facility ID	

Table G2. CARB Post Rule Assessment- SIC and NAICS Codes for Secondary Sources

Rule No	Rules	Affected Industries	SIC Codes (4 digit)	NAICS
Rule 88-2-2	ATCM for Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Facilities	Hexavalent Chromium Facilities, Hard Plating Facilities, Anodizing Facilities, Decorative Plating Facilities	3471 Electroplating, Plating, Polishing, Anodizing, and Coloring	332813 (Electroplating, plating, polishing, anodizing, and coloring)
Rule 90-5-1	ATCM for Ethylene Oxide Emissions from Sterilizers and Aerators	Own or operate EtO Sterilizers	* 3821 Sterilizers, laboratory * 3842 Sterilizers, hospital and surgical * 3843 Sterilizers, dental * 2869 Ethylene oxide	339111 (Laboratory apparatus and furniture manufacturing)
Rule 89-10-2	Exhaust Emission Standards, Test Procedures and Durability Requirements Applicable to Passenger Cars and Light-Duty Trucks for the Control of Hydrocarbon, Carbon Monoxide and Benzene Emissions	Automobile Manufacturers	3711 Motor Vehicles and Passenger Car Bodies	336111 (automobile manufacturing)
Rule 93-12-2	ATCM for Perchloroethylene Emissions from Dry Cleaning Operations and a Regulation for and Environmental Training Program for Perchloroethylene Dry Cleaning Operations	Dry Cleaning Operations/Dry Cleaners	7212 Garment Pressing, and Agents for Laundries and Drycleaners	812320 (Drycleaning and laundry services -except coin-operated-)
Rule 91-11-1	Reformulated Gasoline-Phase II and the Wintertime Oxygen Content of Gasoline	Petroluem Refineries, Automobile Manufacturers	2911 Petroleum Refineries, oil refineries	324110 (Petroluem refineries)

Table G2. CARB Post Rule Assessment- SIC and NAICS Codes for Secondary Sources (continued)

Rule 95-6-3	Onboard Refueling Vapor Recovery Standards and Test Procedures and Modifications to Evaporative Test Procedures Applicable to 1998 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles	Automobile Manufacturers	3711 Motor Vehicles and Passenger Car Bodies (Establishments primarily engaged in manufacturing or assembling complete passenger automobiles, trucks, commercial cars and buses, and special purpose motor vehicles which are for highway use. This industry also includes establishments primarily engaged in manufacturing chassis and passenger car bodies. Such establishments may also manufacture motor vehicle parts, but establishments primarily engaged in manufacturing motor vehicle parts except chassis and passenger car bodies are classified in Industry 3714, 2899 Fuel tank and engine cleaning chemicals, automotive and aircraft -not related to vapor recovery-, 3569 Vapor separators -machinery-)	336111 (automobile manufacturing, 336211 motor vehicle body manufacturing, 336112 light truck and utility vehicle manufacturing, 333999 all other miscellaneous general purpose machinery manufacturing (vapor))
Rule 1153	VOC Emissions from Commercial Bakeries	Commercial Bakeries	5461 Retail Bakeries (Bagel stores-retail, Bakeries-retail, Cookie stores-retail, Doughnut shops-retail, Pretzel stores and stands-retail)	311811 (Retail bakeries, 445291 baked goods stores)
Rule 1173	Control of VOC Leaks and Releases from Components at Petroleum Facilities and Chemical Plants	Petroleum Refineries, Chemical Plants, Oil and Gas Production Fields, Natural Gas Processing Plants,	2911 Petroleum Refineries, Oil refineries, Acid oil produced in petroleum refineries, Gas, refinery or still oil produced in petroleum refineries, Mineral oils, natural: produced in petroleum refineries, Road oils, produced in petroleum refineries	324110 (Petroleum refineries)

Table G2. CARB Post Rule Assessment- SIC and NAICS Codes for Secondary Sources (continued)

Rule 1174	Control of VOC Emissions from the Ignition of Barbecue Charcoal	Manufacturers, Distributors and/or Retailers of materials and/or methods used to Ignite Barbecue Charcoal	2861 Gum and Wood Chemicals (as charcoal and wood distillates), Tar and tar oils, products of wood distillation (2491 Wood products, creosoted, 2499 Bentwood (steam bent) products, -except furniture-, 2679 Pressed products from wood pulp-mfpm, 5031 Composite board products, wood-based-wholesale	325191 (Gum and Wood Chemical Manufacturing)
Rule 1138	Control of Emissions from Restaurant Operations	Restaurant Operations	5812 Eating Places	722110 (Full-service restaurants, 722310 food service contractors, 722320 caterers, 722212 cafeterias, 722211 limited service restaurants)

Appendix H: APC Manufacturer's Survey

Near the end of the study period the team decided to refocus its work away from rules 90-5-1, 89-10-2, 91-11-1, 95-6-3, 1173 and 1174. Instead, for the remaining rules, it would do a survey of the manufacturers and installers of APC equipment. They were expected to be more responsive since they should not have a defensive attitude, they should have more resources to generate the needed cost data, and they need that data to help generate future business. The following simple questions were asked:

1. Who are your clients?

2. Do you provide equipment and retrofit services to assist
    - Plating shops comply with ARB rule 88-2-2?
    - Dry Cleaners comply with ARB rule 93-12-2?
    - Bread bakeries comply with SCAQMD rule 1153?
    - Fast food restaurants comply with SCAQMD rule 1138?

3. If so could you please share with us your cost data on equipment, installation, operation and maintenance?

The issues encountered during our data collection were the following:

- The limited knowledge of the listed companies regarding the specified regulations;

- The lack of cooperation to describe their product in fear that we may be a regulatory agency;

- The APC manufacturer list did not contain current contact information.

Cost varied depending on equipment specifications, efficiency, and dimensions. The team did not get through the entire contact list due to time and budget constraints.

The results of the survey are summarizes in Table III-1 below.

Table H.1: APC Manufacturer's Survey

Company	Applicable to the Study?	Contact Name	Information Given
A.V.C. Specialists, Inc.	No		Business trade is not applicable to the study. They serve power plants.
Adwest Technologies	No	Joe Terry	Business trade is not applicable to the survey. They handle printing and pharmaceuticals.
Aerovironment	Pending	Mail box no.	Left a message on December 6, 2004.
Aeroject Propulsion Div.	Not willing to answer		
Aeroenvironment Inc.	Pending		Left a message on December 6, 2004.
Air Blast Inc	No		Business trade is not applicable to the survey. They handle labels for bottles (pre-manufacturer).
Air Chem Systems	Yes	Bob Lease-Sales manager	Example for a plating shop: Can only design original equipment. For a small system (exhaust system of 2,000 cf/min with a fan, scrubber, and duct) \$45,000 to \$50,000. For installing the equipment cost would be from \$15,000 to \$20,000.00.
Air Cleaning Specialists	Number is no longer in service		
Air Cleaning Systems	Number is no longer in service		
Air Cleaning Technology	Yes	Sergio	Example for a fast food restaurant: For an original exhaust system for a 10 foot long 4 foot deep collection hood: Equipment is \$20,000 (air cleaner) \$150 to \$160 (monthly maintenance) \$150 (duct cleaning)
Air Exchange Inc.	Number is no longer in service		
Air Factors-Lok	Number is no longer in service		
Air instruments & Measurements	Number is no longer in service		

Table H.1: APC Manufacturer's Survey (continued)

Company	**Applicable to the Study?**	**Contact Name**	**Information Given**
Air Pollution Control Co.	Number is no longer in service		
Aircorp	No	Dale Hickens	Business trade is not applicable to the survey. They only perform remediation and waste clean-up.
Airex Corp. Div. Of Adwest	No. Same contact as for Adwest Technologies.	Joe Terry	
Airfoil Management Company	No		Business trade is not applicable to the survey.
Airguard Industries of California	Yes. The business changed its name to "TFS" as of 2003.		The business specializes in filters. Example for a fast food restaurant: For a metal degreaser filter for flame hoods $20. Filter lasts 3 to 4 years.
Airtech	No		Business trade is not applicable to the survey.
Alita Industries Inc.	No		Specialize in air pumps. Business trade is not applicable to the survey.
Allied Environmental Technologies, Inc.	Pending		Left a message December 7, 2004. No reply as of December 9, 2004.
Alphagaz	Number is no longer in service		
Alzeta Corp.	Yes	Jim (Out of the country starting December 7, 2004).	For a catalytic oxidizer, depending on the size of the machine would run from a small amount to $50,000. Source gave me very generic information.
Aapplied Air Technology	Number is no longer in service		
Baghouse Services, Inc.	Number is no longer in service		
Baker Furnace Inc.	Yes		Faxed an information request regarding catalytic oxidizers December 7, 2004.
Banyan Industries	No		Business specializes in portable potties.
Bioscreen Testing Services	No		Business specializes only in sample testing, not manufacturing.

Table H.1: APC Manufacturer's Survey (continued)

Company	Applicable to the Study?	Contact Name	Information Given
Biosolve Western States	Pending		Left a message December 7, 2004.
California Analytical Instrument, Inc.	Not willing to help		
California Clean Air, Inc.	Number is no longer in service		
Caltest Instruments, Inc.	No		Business only manufactures machines that test diesel equipment for trucks.
CALVERT Environmental	Number is no longer in service		
Camfil Farr	Number is no longer in service		
Car Sound Exhaust Systems	No		Business handles catalytic converters, mufflers, ect. for vehicles only.
Catalytic Solutions	No		Business handles catalytic converters for vehicles only.
Catalytica	Pending		No message allowed as of December 7, 2004.
CJI Process Systems, Inc.	Pending		Faxed an information request regarding an exhaust system for a plating shop December 7, 2004.
Coen Company Inc.	Number is no longer on service		
Conserve Engineering Company, Llc	Number is no longer on service		
Crown Chrome	No		
Davy Environmental	Number is no longer in service		Business handles aircraft equipment only.
Delatech Incorporated	No number listed on the APC list		
Delta Circuits Tech, Inc.	No		
Du-All Safety	No		Specialize in window tinting only.
Dynamic Air Engineering Inc	No number listed on the APC list		Only provide safety training.

Table H.1: APC Manufacturer's Survey (continued)

Company	Applicable to The Study?	Contact Name	Information Given
Eco-Air Products, Inc.	No		
Eldridge Products Inc.	No		Sell heating and air filters.
Emcotek Corp.	Yes		Left a message December 7, 2004. Manufacture meters for natural gas. Not relevant for air pollution control.
Envir-Alert Inc	Number is no longer in service		
Envirocare International Inc	No number listed on the APC list		
Environmental Combustion Sys.	Number is no longer in service		
Environmental Engineering Concepts Inc.	No	Jim Murphy (sales representative)	Company makes misting products (makes fog).
Environmental Filter Corp	No answer. Could not leave a message December 7, 2004.		
Environmental Instruments	Number is no longer in service		
Environmental Silica Products	No number listed in the APC list		
Envirosupply and Service Inc.	Pending		Left a message for Shelly December 7, 2004.
ESA Engineering Corp.	Pending		Left a message. The number may be incorrect as of December 7, 2004.
ESS	No		Company manufactures supplies for water treatment and one air product (tetler bag).
Florence Filter Corporation	Yes		Company manufactures filters for food processors, plating, etc. A Hepa filter with 99.9% efficiency (used in hospital clean rooms) would run for $200 to $300 and would be changed every 3 to 4 years. For regular air filters, one would run for $5 to $6 that would need to be changed once per month.
Forney Corporation	No number listed		

Table H.1: APC Manufacturer's Survey (continued)

Company	Applicable to the Study?	Contact Name	Information Given
Gas Tech, Inc.	Number is no longer in service		
GC Industries Inc.	Pending		Left a message December 7, 2004.
Hal Murphree and Associates	Number is no longer in service		
Harel International, Ltd.	Number is no longer in service		

Appendix I: Consumer Price Index[19]

U.S. City Average
Base Period: 1992-84=100.

Year	Annual
1980	82.4
1981	90.9
1982	96.5
1983	99.6
1984	103.9
1985	107.6
1986	109.6
1987	113.6
1988	118.3
1989	124.0
1990	130.7
1991	136.2
1992	140.3
1993	144.5
1994	148.2
1995	152.4
1996	156.9
1997	160.5
1998	163.0
1999	166.6
2000	172.2
2001	177.1
2002	179.9
2003	184.0
2004	188.9

[19] http://www.bls.gov/data/home.htm