

APPENDIX B

EVALUATION OF REFINERY UPSET/BREAKDOWNS, CITIZEN COMPLAINTS AND NOTICES OF VIOLATION AT SELECTED CALIFORNIA REFINERIES

Appendix B provides additional information on staff's evaluation of upset/breakdowns, complaints, and Notices of Violation (NOVs) issued at selected refineries in the South Coast Air Quality Management District and the Bay Area Air Quality Management District.

A. Introduction

In evaluating the enforcement activities of local air quality management districts (districts) at refineries, Air Resources Board (ARB) staff also collected information on refinery operating activities. In particular, staff was interested in determining if requirements to produce reformulated fuels have had any impact on the ability of refineries to comply with district-adopted rules and regulations. Specifically, staff was interested in the impacts of the California Phase 2 reformulated gasoline (CaRFG2) regulations. These regulations, implemented in the spring of 1996, required refineries in the state to produce gasoline that meets eight key specifications, and when used, significantly reduces smog-forming emissions from gasoline-powered motor vehicles. To produce gasoline that meets these eight specifications, refineries in the state installed new equipment, and performed significant modification and modernization to various existing process units. These additions, modifications and modernizations made the California refineries more complex than they already were.

B. Methodology

To perform this evaluation, ARB staff worked with the enforcement staffs of the South Coast (SCAQMD) and Bay Area Air Quality Management Districts (BAAQMD) to collect information on four refineries in the state. Two of these refineries were located within the SCAQMD and two were located within the BAAQMD. The refineries selected represent both large and small facilities with different levels of modernization. Additional refineries were not selected for evaluation due to limited ARB staff resources. However, it is staff's expectation that analysis of additional refineries would provide little additional insight and would not significantly change the results of the staff's evaluation.

Since staff was interested in the observing any changes in the ability of California refineries to comply with district air quality rules and regulations as a result of the CaRFG2 regulations, staff evaluated historical information on upset/breakdowns, complaints, and NOVs issued at these refineries. Staff's goal was to determine if over time, the frequency of incidents at refineries has changed as a result of the modifications necessary to comply with the CaRFG2 regulations.

Since the focus of staff's evaluation was to determine if the CaRFG2 regulations had any impact on the frequency of incidents at refineries, staff evaluated upset/breakdown

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data retained by the SCAQMD and the BAAQMD for these four refineries. To perform staff's evaluation, the period of time from about mid-1989 to mid-2000 was selected for analysis. This provided about five years of data both before and after the introduction of CaRFG2. The pre-CaRFG2 years of 1989 to 1993 provide a baseline for establishing historical upset/breakdown frequency at these refineries prior to the CaRFG2 modifications. The years 1994 through 1997 represent the period of time major modifications at the refineries were occurring, and the equipment was undergoing start-up and optimization during CaRFG2 implementation in 1996. Finally, the period 1998 through 2000 represents a stable period of time at the refineries where major modifications were not occurring, and refiners had additional time to fine tune and optimize their refining operations.

Another important aspect of refinery operations was to evaluate the frequency of complaints by local citizens to the districts regarding refinery operations. To quantify this impact, staff also collected information on the number of complaints received by the districts for these four refineries over approximately the same period. Finally, staff were interested in the compliance records of these refineries, so NOV information was collected for these facilities over approximately the same period.

Due to constraints on time and resources, a refinery in the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) was not included in this analysis. However, in the near future, staff intend to perform a similar analysis for a refinery in the SJVUAPCD, and will report the findings from that analysis when they are complete.

C. Data Collection

In performing staff's evaluation, available data was collected from a number of sources within the district. Information regarding upset/breakdowns was collected from district staff within the enforcement programs, and included upset/breakdown reports filed by the individual refiners, inspector investigations, interviews with district inspectors, and annual compliance reports prepared by the district.

Information on the number of citizen complaints received, and the disposition of those complaints, was obtained from the districts' complaint logs, as well as annual compliance reports prepared by the districts. Finally, ARB staff worked with the staffs of both the enforcement and legal divisions within the districts to collect information on the numbers and types of NOVs issued.

ARB staff worked very closely with district staff to collect all of this information. District staff also helped compile and evaluate the information collected, and provided critical review of the findings. District staff were also very helpful in providing follow up

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information and answering any questions ARB staff had. ARB staff sincerely appreciate the resources and efforts provided by the districts in this evaluation.

In addition to reviewing the data and findings with the districts, ARB staff also shared their findings with the four refineries selected for this evaluation. These refineries were helpful in providing insight into particular trends that were evident in the data, and in a number of cases, provided staff with additional information to supplement the data provided by the districts.

To provide another measure of the performance of refinery operations, ARB staff compared California refineries to refineries in the rest of the nation in terms of worker safety. Staff collected data from the United States Occupational Health and Safety Administration regarding worker illness and injury for petroleum refineries in California and in the other 49 states. It was felt that this would serve as another indicator of problems occurring in refineries and are California refineries experiencing a higher rate of worker injuries than other refineries in the rest of the country.

D. Limitations

Very early in the data collection process, staff recognized that inherent differences between districts created challenges in comparing the data between districts. For instance, while both the SCAQMD's and the BAAQMD's enforcement programs have many similar components, differences in the individual practices of the districts in implementing their enforcement programs, and internal changes in enforcement programs themselves over time, result in difficulties in making a direct comparisons of the data between districts. Also, while the two districts' rules and regulations applicable to refineries are often comparable, there are often sufficient differences in the stringency of similar rules between the districts to limit staff's ability to perform a direct comparison of compliance records between districts.

Because of these limitations, staff have not attempted to directly compare the enforcement programs of the two districts, nor have staff attempted to compare the compliance performance of refineries in different districts. ARB staff have limited their analysis to only a comparison of compliance trends within a particular district for each of the refineries selected.

E. Results

This section discusses the results of staff's data analysis of upset/breakdowns, complaints, and NOVs issued for the four refineries evaluated. It also includes the

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results of staff's evaluation of refinery worker injury and illness rates for California refineries compared to refineries in other parts of the country.

1. Upset/Breakdown Data

As stated previously, staff evaluated upset/breakdown data retained by the SCAQMD and the BAAQMD for four refineries over the period of time from about mid-1989 to mid-2000. This provided about five years of data both before and after the introduction of CaRFG2. The pre-CaRFG2 years of 1989 to 1993 provide a baseline for establishing historical upset/breakdown frequency at these refineries prior to the CaRFG2 modifications. The years 1994 through 1997 represent the period of time major modifications at the refineries were occurring, and when the new or modified equipment was undergoing start-up and optimization. Finally, the period 1998 through 2000 represents a stable period of time at the refineries where major modifications were not occurring, and refiners had sufficient time to fine tune and optimize their refining operations

The data is segregated by district, and presented by the number of upset/breakdowns per year. Each district is represented by two graphs: the first graph shows all reported upset/breakdowns for the two refineries selected, and the second graph shows upset/breakdowns of major refining units for the same two refineries. For this evaluation, major refinery process units are considered to be refinery process units that are critical to the production of finished refinery products, such as crude distillation units, fluid catalytic crackers, alkylation plants, etc. Ancillary equipment such as storage tanks, boilers, cogeneration units and monitoring equipment were not considered major refinery process units and are not included in the second graphs.

SCAQMD. The results of staff's analysis of the upset/breakdowns reported in the SCAQMD for the two refineries selected are shown in Figures B-1 and B-2. Figure B1 includes all reported upset/breakdowns that were reported from 1989 to 2000. Figure B2 includes only those upset/breakdowns for major refinery process units. The years 1989 and 2000 are likely only partially complete due to the unavailability of records from early 1989, and the fact that all of the 2000 records had not been completely compiled by the district when staff began their data collection.

As can be seen from Figure B-1, the total number of upset/breakdowns for all equipment at the two refineries evaluated in the SCAQMD is highly variable, with distinct peaks occurring in 1991, and again in 1997-1998. However, the data from 1999 and 2000 suggests that the current level of upset/breakdowns has returned to a level that is representative of minimum levels seen over the entire period evaluated.

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**Figure B-1:
Total Reported Breakdowns for All Units in
The South Coast Air Quality Management District
(1989 – 2000)**

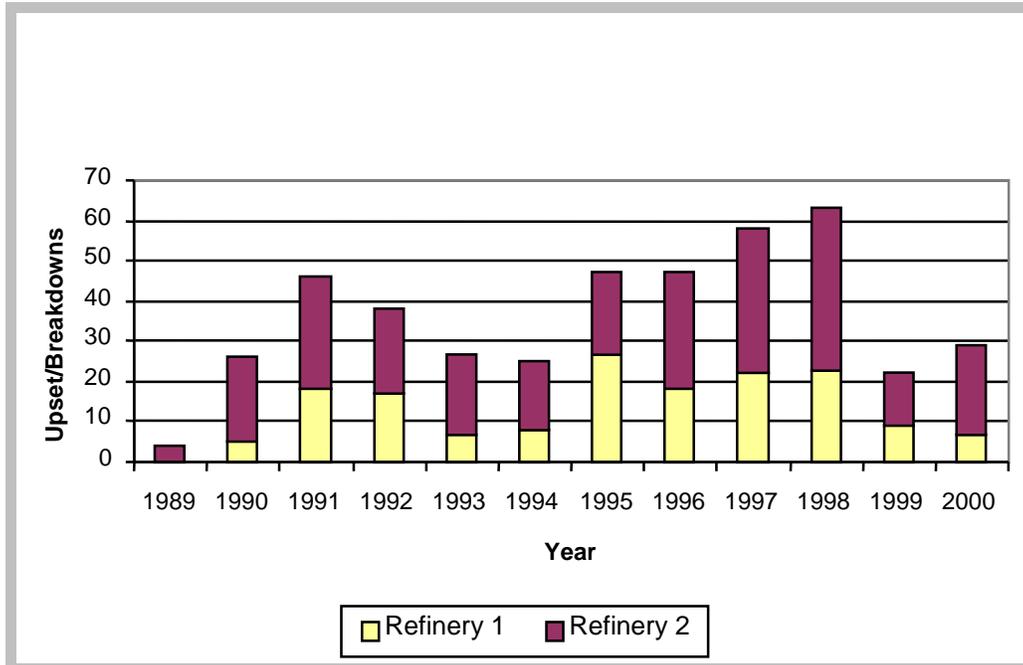
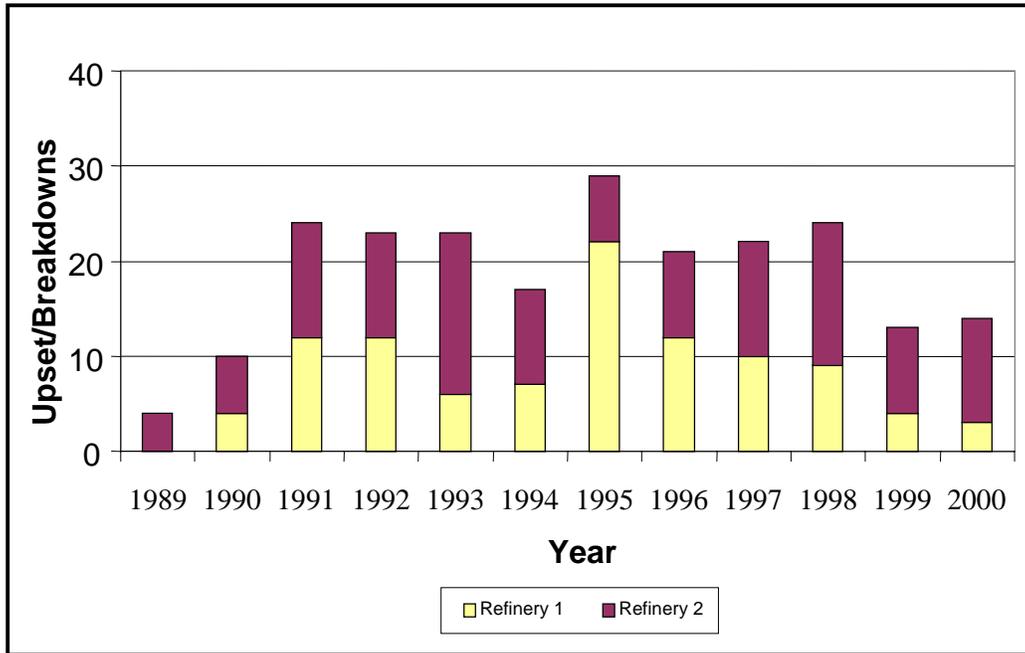


Figure B-2 shows similar data for the major process units at these same two refineries. It is interesting to note that for the major process units, the data shows significantly less variability from year to year, and that during most years, there are significantly more upset/breakdown conditions associated with the ancillary refinery equipment than with the major process units. With the exception of a small spike evident in 1995, the data shows a very consistent pattern of upset/breakdowns during the CaRFG2 modification and implementation period, and appears to have returned to a level that is lower than that observed in the early 1990's.

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**Figure B-2:
Total Reported Breakdowns for Major Process Units in
The South Coast Air Quality Management District
(1989 – 2000)**



By comparing Figures B-1 and B-2, it is evident that the equipment that is more likely to experience upset/breakdown conditions is usually not a major refinery process unit. Because of this fact, staff believes that as refineries have modernized, older refinery process equipment has been replaced with newer, more reliable units. Based on the data presented in Figures B-1 and B-2, these units appear to be less likely to experience upset/breakdown conditions than the ancillary refinery equipment.

BAAQMD. The results of staff’s analysis of the upset/breakdowns reported in the BAAQMD for the two refineries selected are shown in Figures B-3 and B-4. Figure B-3 includes all reported upset/breakdowns that were reported from 1989 to 2000. Figure B-4 includes only those upset/breakdowns of major refinery process units. The years 1989 and 2000 are likely only partially complete due to the unavailability of records from early 1989, and all the fact that all of the 2000 records had not been completely compiled by the district when staff began their data collection.

As can be seen from Figure B-3, unlike in the SCAQMD, the total number of upset/breakdowns for all equipment at the two refineries evaluated is fairly consistent

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with the exception of the years 1994 through 1996. This higher than usual level of upset/breakdowns may be due to the installation and startup of new equipment associated with the production of CaRFG2. However, the data shows that for the years 1997 and 1998, the frequency of upset/breakdowns returned to a level consistent with the pre-CaRFG2 period, and has subsequently been further reduced to a level that is even lower than that observed during the pre-CaRFG2 period.

**Figure B-3:
Total Reported Breakdowns for All Units in
The Bay Area Air Quality Management District
(1989 – 2000)**

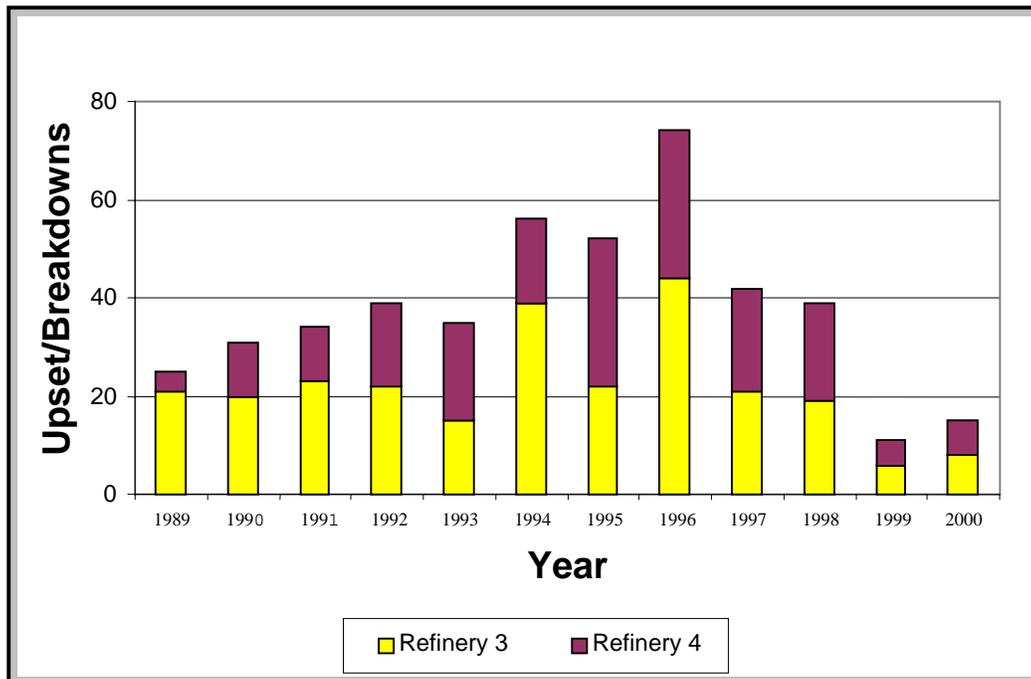


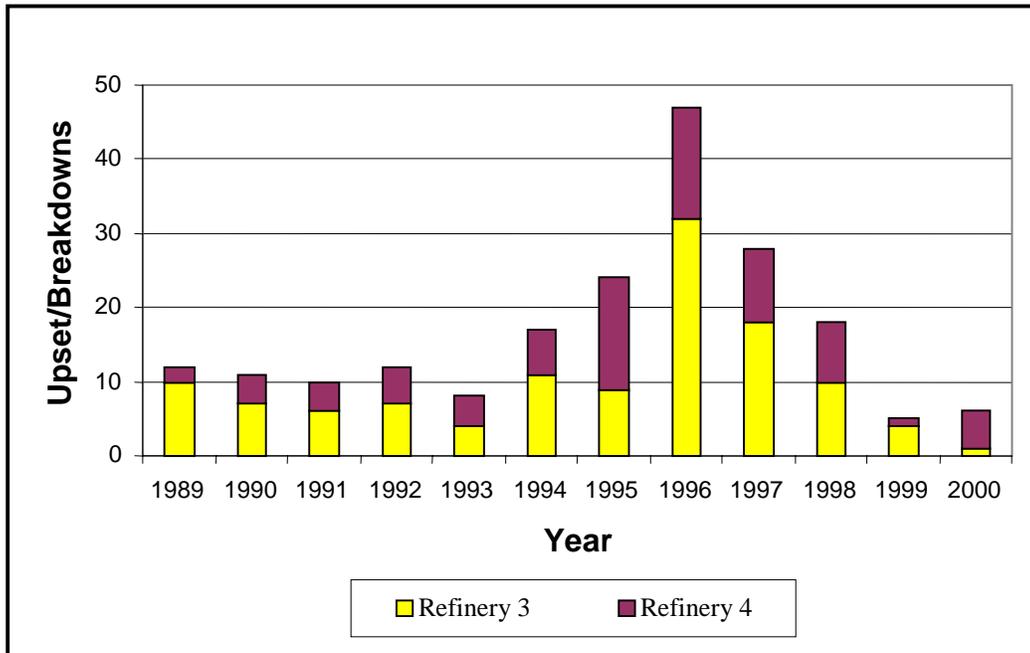
Figure B-4 shows similar data for the major process units at these same two refineries. Similar to the results seen in Figure B-3, the frequency of upset/breakdowns for major refinery process units is fairly consistent over the period evaluated. The exception to this is from the years 1995 through 1997. However, it is likely that, as observed in Figure B-3, this higher than usual level of upset/breakdowns may be due to the installation and startup of new equipment associated with the production of CaRFG2, and that when the refineries optimized the operation of these units, these upset/breakdown conditions were minimized. This conclusion is supported by the fact

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that the frequency of upset/breakdowns in 1999 and 2000 was less than that observed for any other period evaluated.

**Figure B-4:
Total Reported Breakdowns for Major Process Units in
The Bay Area Air Quality Management District
(1989 – 2000)**



By comparing Figures B-3 and B-4, it is evident that in the BAAQMD, the trends in the frequency of upset/breakdowns are consistent for both major refinery process units and ancillary equipment. However, as seen in the SCAQMD, the equipment that is more likely to experience upset/breakdown conditions is usually not a major refinery process unit. Staff believes that this is predominantly due to the fact that as refineries have modernized, older refinery process equipment has been replaced with newer, more reliable units.

2. Complaints

As stated previously, staff collected information on the number of citizen complaints received from about mid-1989 to mid-2000 for the four refineries evaluated. This provided about five years of data both before and after the introduction of CaRFG2 into

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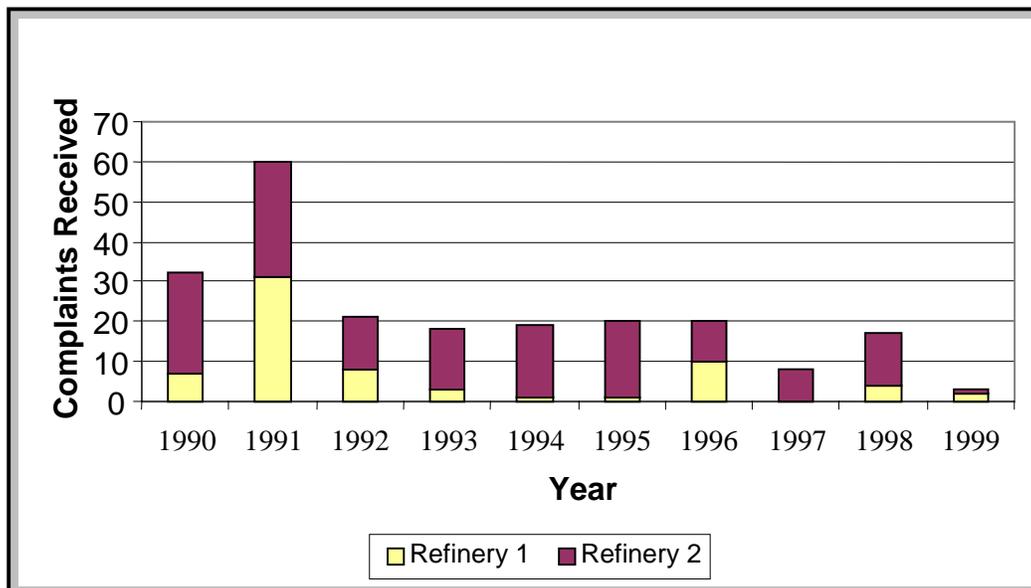
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the state. In general, the complaints received from citizens identifying the refineries evaluated usually were associated with unusual odors or visible emissions.

The data is segregated by district, and presented by the number of citizen complaints received per year. For the BAAQMD, staff had access to additional data, which identified the disposition of each complaint. Either the complaint was unverifiable as to the source or verified to have originated at the suspected refinery. Also, staff was able to determine whether a NOV was issued to the refinery as a result of the complaint.

SCAQMD. As can be seen from Figure B-5, with the exception of 1991, the number of complaints received by the SCAQMD regarding the two refineries selected for staff's evaluation has been fairly consistent with time. In general, less than 20 complaints per year have been received since 1992, and since 1997, the number of complaints has been further reduced. Since most complaints are associated with odors and visible emissions (excessive flaring, excessive steam releases, etc), this trend is correlated with the implementation of new refinery rules in the SCAQMD. These rules have been effective in reducing the frequency of flaring and other visible emission events (such as excess particulate emissions from petroleum coke handling), and have imposed new standards on refinery equipment that tends to release odorous compounds (such as wastewater separators, sulfur recovery plants, etc.).

**Figure B-5:
Total Reported Complaints in
The South Coast Air Quality Management District
(1990-1999)**

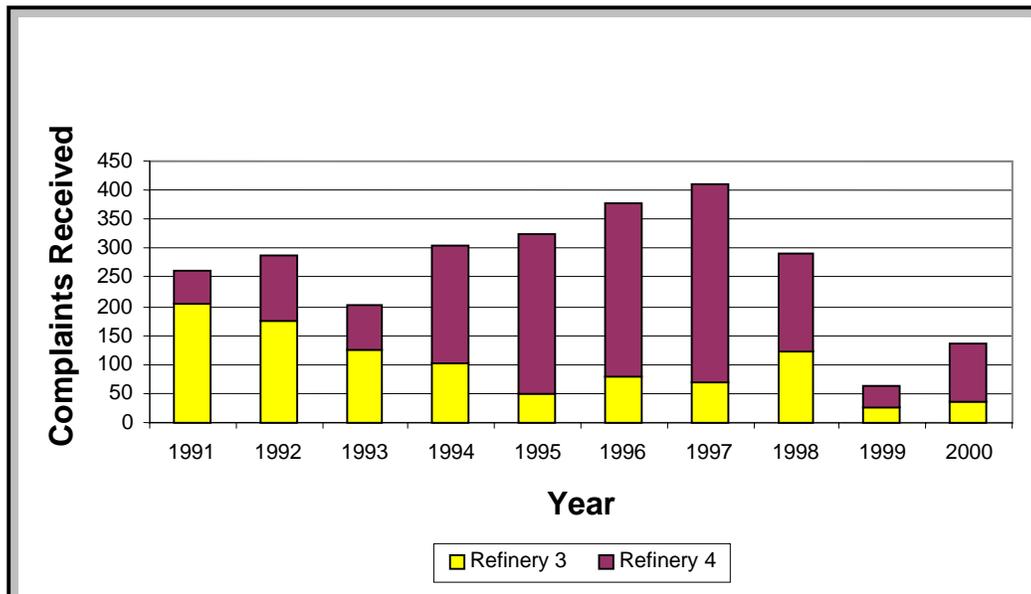


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BAAQMD. As can be seen from Figure B-6, significantly more complaints are received within the BAAQMD than the SCAQMD. Although, the range in the number of complaints is highly variable, with slightly more than 50 complaints received in 1999, and over 400 received in 1997. However, when evaluating this particular set of data, it is important to note the disposition of these complaints, as shown in Figure B-7. Based upon investigation by BAAQMD inspectors, each complaint received was either verified or not verified as having originated from the suspected refinery. As can be seen from Figure B-7, the vast majority of complaints received by the district are not verified as originating from either refinery. In fact, in most cases, over 75 percent of the complaints received these refineries were not verifiable.

**Figure B-6:
Total Reported Complaints in
The Bay Area Air Quality Management District
(1991-2000)**

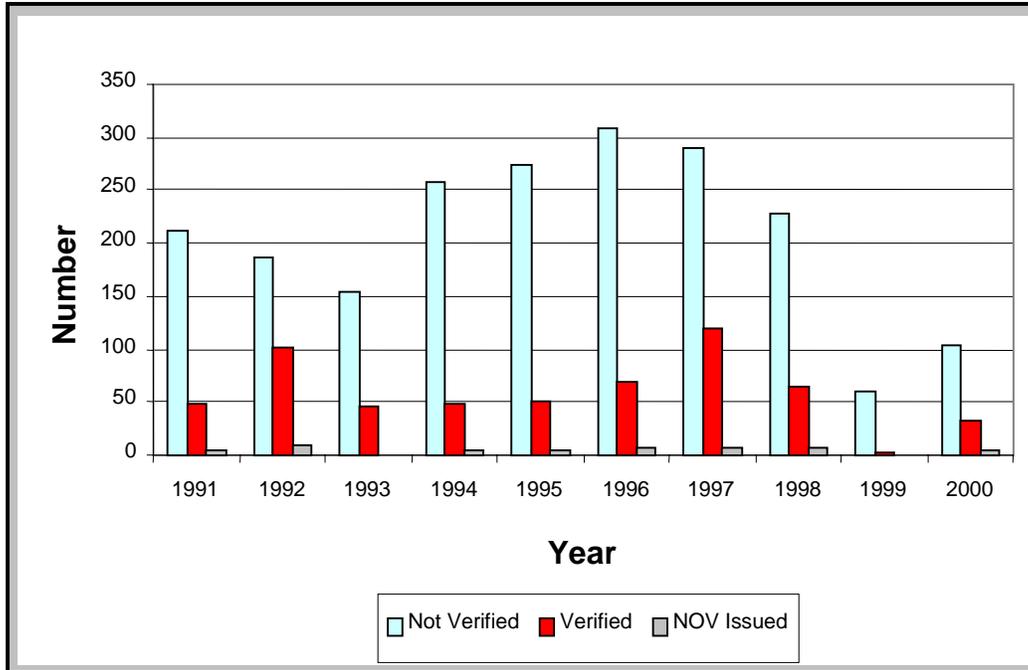


As shown in Figure B-7, the number of verified complaints has been fairly consistent over the period evaluated, with slight increases being observed in 1991 and 1997. Also, it is important to note that even for most verified complaints, the cause of the complaint was not a violation of any district regulations, and no NOVs were issued. In addition, both the total number of complaints and the number of verified complaints received since 1998 have declined dramatically below historic levels.

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**Figure B-7:
Disposition of Reported Complaints in
The Bay Area Air Quality Management District
(1991-2000)**



When staff compared the verified complaints in the BAAQMD with the complaints received in the SCAQMD over the same period, similar trends in the number of complaints were apparent. Staff believes that for both districts, as new refinery rules and regulations have been implemented, the frequency of flaring and excessive emissions from other visible emission events (such as petroleum coke handling) has been reduced, as has release of odorous compounds (such as mercaptans and hydrogen sulfide).

3. NOVs

As stated previously, staff collected information on the number of NOVs issued by district refinery inspectors to the four refineries evaluated. NOV data provides insight into the level of enforcement activities at refineries, and indicates the level of compliance achieved at these facilities.

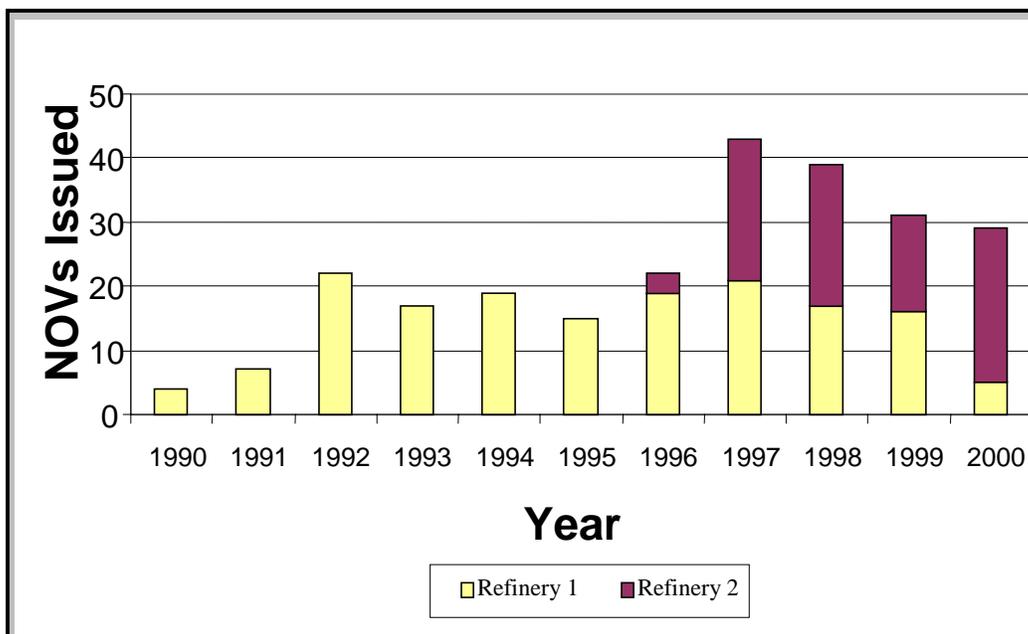
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The data in the SCAQMD covered the period of 1990 through 2000 for one refinery, and 1997 to 2000 for the other (data was incomplete for this refinery prior to 1997). The BAAQMD data collected only covered the period 1994 through 2000 because data prior to 1994 was not readily accessible to ARB staff (the district changed their file storage protocol in 1994). The 1989 data from the SCAQMD and the 1994 data from the BAAQMD are likely only partially complete due to the unavailability records from these years, and the 2000 records had not been completely compiled by the district when staff began their data collection. The data is segregated by district, and presented by the number of NOVs issued per year.

SCAQMD. The results of staff's analysis of the NOVs issued by the SCAQMD enforcement staff to the two refineries selected is shown in Figure B-8. As can be seen in Figure B-8, for Refinery 1, the number of NOVs issued has been fairly consistent since 1992, averaging less than 20 per year. Since 1997, the number issued has steadily declined. For Refiner 2, while historical data was generally not available prior to 1997, this facility has also seen a decline in the number of NOVs issued. These declines in the number of NOVs issued has occurred during a time when the SCAQMD has increased its level of enforcement at refineries significantly since the mid-1990's, with district inspectors now visiting each refinery nearly three times a week. This is indicative of an increasing rate of compliance of these facilities with district rules.

**Figure B-8:
Notices of Violation Issued in
The South Coast Air Quality Management District
(1990-2000)**



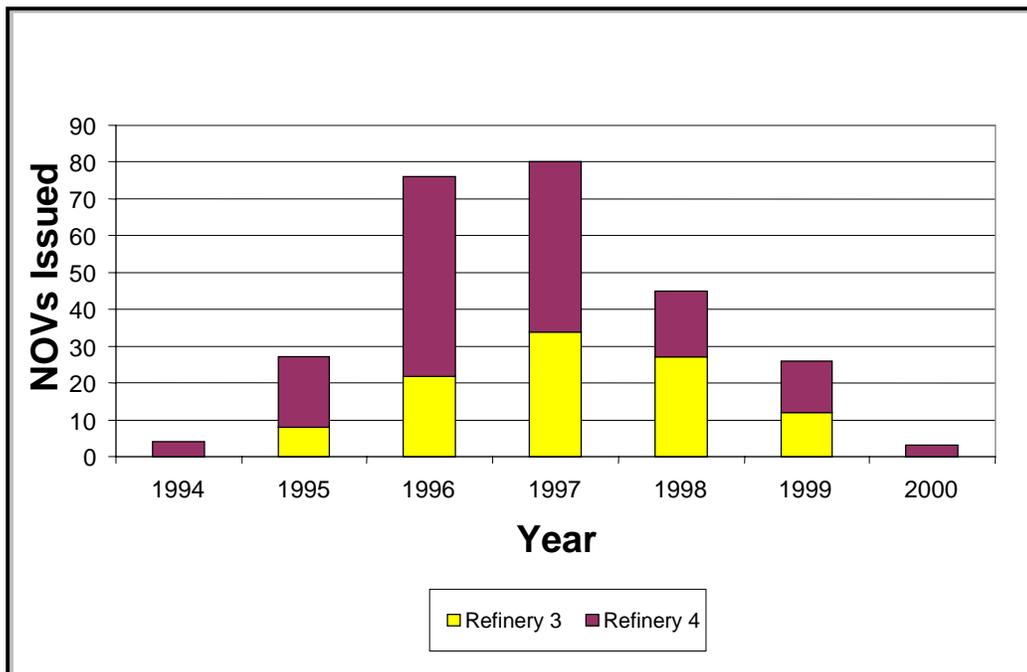
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BAAQMD. The results of staff's analysis of the NOVs issued by the BAAQMD enforcement staff to the two refineries selected are shown in Figure B-9. As can be seen in Figure B-9, there is a sharp increase in the number of NOVs issued to the two refineries evaluated in 1996 and 1997. This increase is likely due to more rigorous and frequent inspections by the BAAQMD enforcement staff during this period, when enforcement staff began visiting each refinery at least once per week.

However, similar to the trend observed in the SCAQMD, the number of NOVs issued to these facilities has steadily declined since 1997, while the enforcement practices of the district have not decreased. The decline in the number of NOVs issued, occurring during a time of aggressive enforcement by the district, is indicative of an increasing rate of compliance of these facilities with district regulations.

**Figure B-9:
Notices of Violation Issued in
The Bay Area Air Quality Management District
(1994-2000)**



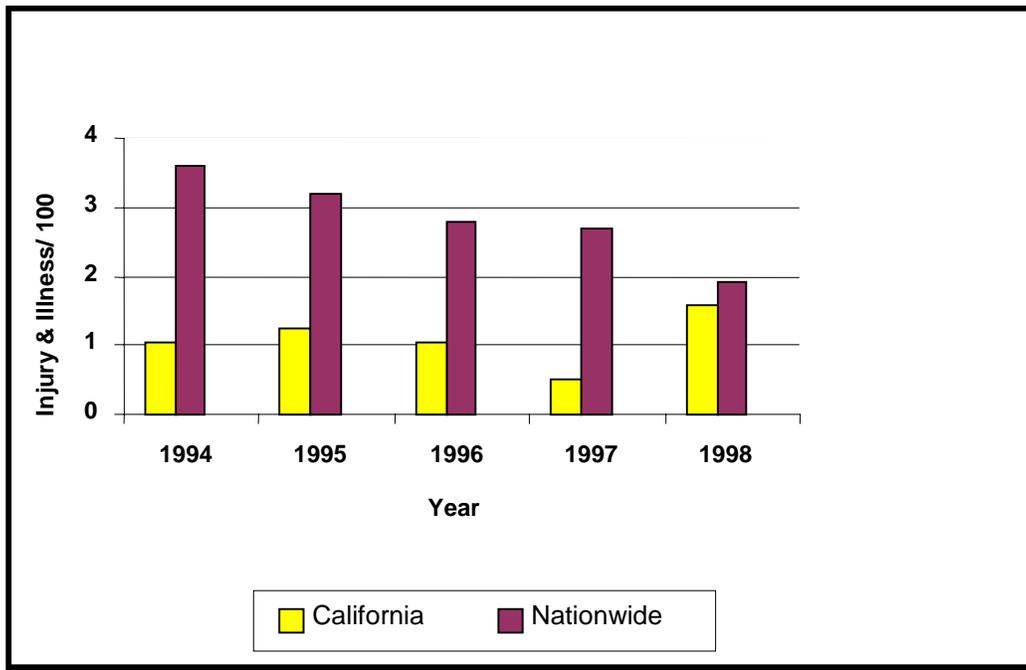
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4. OSHA Reported Injuries and Illness

Staff also evaluated data collected from the United States Occupational Health and Safety Administration regarding worker illness and injury at petroleum refineries. This data was collected for California refineries, as well as for refineries nationally. As shown in Figure B-10, this data clearly shows that while illness and injuries among refinery workers has declined nationally over the last decade, California refineries consistently have a lower rate of worker injuries than refineries nationwide. This consistently lower rate of worker illness and injury in California refineries has occurred during a period when refineries in California have undergone significant modification and modernization to produce clean fuels. In turn, this modernization has necessarily increased the complexity of these refineries. Yet, consistent with staff's findings earlier in this section, this modernization not adversely impacted the frequency of breakdowns at California refineries, and it has also not increased the rate at which refinery workers are injured.

**Figure B-10:
Comparison of Refinery Illness and Injuries
California vs. National
(1994-1998)**



Source: United States Occupational Safety and Health Administration