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This report was prepared by Arvind Shah under the supervision of Alan Ingham.

REPORT OVERVIEW

The petroleum industry is composed of refineries and oil exploration companies. The petroleum refineries generally produce gasoline, jet fuels, petroleum coke, sulfuric acid, liquified petroleum gas and a variety of petroleum products through crude oil distillation. The oil exploration companies operate to locate and drill oil and natural gas.

In 1990, the largest hazardous waste streams generated by the distillation, drilling, and other processes within the petroleum industry were the following:

1) oil/water separator sludge
2) alkaline solutions without metals
3) waste oil and mixed oil
4) tank bottom waste
5) other inorganic solid waste
6) unspecified oil-containing waste
7) aqueous solution with metals

The Department reviewed fifteen petroleum refineries and three oil exploration companies' SB 14 plans. This resulted in some encouraging information regarding the petroleum industry's source reduction efforts. Prior to the SB 14 program, the petroleum refineries and oil exploration companies generated more than 265,000 tons and 7,900 tons of hazardous waste respectively, during 1990. After performing the SB 14 evaluation of its operations, the refineries and oil exploration companies selected 67 and 16, implementable source reduction measures, which could result in the reduction of nearly 52,500 tons and 2,200 tons of hazardous waste per year. The petroleum industry as a whole can reduce at least 20 percent of its hazardous waste due to source reduction.

"Operational improvement" was the most preferred source reduction approach used by the petroleum industry. More than half of the proposed source reduction measures were operational improvements. The most common method was paving areas near process drains and other refinery locations. The paving can reduce the amount of soil and dust entering the refinery waste water treatment system during washdown operations and storms. Reducing the amount of soil and dust in the wastewater treatment system decreases oil/water/solid emulsions and sludge formation.

The use of administrative source reduction measures is another popular approach selected by the industry. This frequently involved setting up programs within the organization, such as employee participation and reward, hazardous waste awareness, and personnel training.

The Department projects that by implementing all the 83 selected measures, the petroleum industry can eliminate up to 73,000 tons annually of its hazardous waste requiring disposal. With the current hazardous waste disposal cost of petroleum waste ranging from $100 to $230 per ton, these reductions could save the petroleum industry $7.3 million to $16.8 million in annual disposal costs.

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1. INTRODUCTION

In accordance with the provisions of the Hazardous Waste Source Reduction and Management Review Act of 1989 (Act, SB 14), the Department of Toxic Substances Control (Department) selected, among other industries, the petroleum industry (SIC codes 2911, 1311 and 1381) SB 14 documents call-in and review. These documents include the Source Reduction Review and Plan (Plan), a Plan Summary, Hazardous Waste Management Performance Report (Report), and a Report Summary. The data collected from review of these Plans and Reports provide the basis for the findings presented in this report.

The Department selected the petroleum industry for review due to this industry's significance as a large quantity hazardous waste generator. The petroleum industry source reduction documents were reviewed to:

- determine completeness, and
- identify successful source reduction measures for dissemination to the rest of the industry.

The Department initially requested 27 refinery (SIC 2911) and oil exploration company (SIC 1311 or 1381) sites to submit their source reduction documents. Of the initial sites contacted, 67% (representing 10 corporations) submitted their documents for Department review. These documents were prepared by 15 refineries and 3 oil exploration companies. The three oil exploration companies prepared plans covering 14 oil exploration sites. The balance filed Declarations of Exclusion certifying that the total quantity of hazardous waste generated at their facilities was below the threshold amounts captured by SB 14.

2. BACKGROUND

The Act required generators who produced over 12,000 kilograms of hazardous waste or 12 kilograms of extremely hazardous waste in 1990, to prepare two documents by September 1991 and every four years thereafter. The first document, the Plan, identifies all major hazardous waste streams at the generator's site and evaluates potential options for reducing the waste at the source. The second, the report, assesses the effectiveness of hazardous waste management procedures previously implemented by the generator, including recycling and treatment activities.

The Department is charged with meeting certain statutory requirements under the Act. These requirements include the compilation and review of selected Plans and Reports from at least two categories of generators by SIC (Standard Industrial Classification) Codes every two years. The selected Plans and Reports are evaluated for completeness. Successful approaches to source reduction and hazardous waste management practices are gleaned from the documents, put into fact sheets or reports, and disseminated back to targeted generators and others with similar operations.

For the first two years of the program, the petroleum industry was one of the industries selected as the targeted category of generators to meet the statutory requirements of the Act. The petroleum industry was picked, in part, because of the typically high volume of hazardous wastes generated and the broad spectrum of wastes produced. This industry is made up of three four-digit SIC Codes--2911, 1311 and 1381.

3. APPROACH

A Special Directed Work Team (SDWT) within the Department was formed and assigned the task of identifying, compiling, and reviewing selected petroleum refinery Plans and Reports. The data collected from these Plans and Reports provide the basis for the findings presented in this report. The SDWT was made up of staff from several headquarters units. The units provided staff resources to the SDWT if they had an interest in the petroleum refinery Plan and Report reviews. Members of the SDWT brought with them special expertise from their different programs and reviewed the data found in the Plans and Reports in a distinct manner from the others depending on their interest.

Selected generators were initially sent letters requesting that they submit their Plans and Reports to the Department. In order to track and document the Plan and Report review process, the Department was initially concerned with making sure that the targeted facilities received the Plan and Report call in request letters. For this reason, each letter was sent out certified mail requiring a return receipt for letters delivered. These letters asked generators that they either submit the Plan and Report or return an attached Declaration of Exclusion (DOE). Of the original 27 selected generators, 9 sent back DOEs.

To assist in evaluating the plans, the Department created a number of review forms (Appendix A). The forms were completed by staff while reviewing the documents. The completeness checklist followed a similar format as found in the checklists in Appendix L of the Appendices to the Guidance Manual for the Hazardous Waste Source Reduction and Management Review Act of 1989. Another form was designed for gathering more specific information from the review documents, such as the type of waste streams generated, the source reduction measures considered, and the waste management practices used during the reporting year.

4. FINDINGS

The following sections highlight major findings based on the SB 14 Plan and Report review.

I PETROLEUM INDUSTRY PROCESSES AND WASTE STREAMS

The petroleum industry is composed of oil exploration companies, refineries and marketing (retail outlets). The latter are typically small quantity generators and are not captured by SB 14. The following discussion is divided into three main topics: 1) petroleum refinery processes and waste streams; 2) oil exploration company processes and waste streams; and 3) data analysis - which contains waste generation and analyses for both refineries and oil exploration companies.

A. PETROLEUM REFINERY (SIC 2911) PROCESSES AND WASTE STREAMS

Petroleum refinery operations are complex. Appendix B contains a detailed description of some of the major operations. The description was taken from one of the refinery source reduction documents. The refinery operations can be divided into four general categories:

1) Fuel Production
2) By-product Processing
3) Ancillary Operations
4) Waste Management

1) Fuel Production encompasses those operations which manufacture petroleum products such as gasoline, jet fuel, diesel fuels, sulfuric acid and petroleum coke. The following key processes are generally used to produce saleable petroleum products: i) distillation, ii) hydrotreating, iii) catalytic reforming and iv) hydrocarbon cracking.

2) By-product processing covers refinery operations that convert used materials and/or undesirable petroleum constituents into saleable or reusable end products. The following main processes are used for by-product processing: i) sour water/gas processing, ii) acid production and iii) caustic production.

3) Ancillary operations are those activities which support refinery functions and recovery such as i) cogeneration of electricity and steam and ii) water treatment to demineralize and soften municipal water before use in refinery operations.

4) Waste management activities include: i) wastewater treatment, ii) oil recovery and iii) solid and hazardous waste disposal.

The following discussion presents the eight most common wastes generated in the refinery industry that are produced by one or more of the four refinery operation category(ies) noted above.

Oil/water separation sludge (CWC 222):

The wastewater treatment activities (category #4) generated the largest quantity of hazardous waste (see Appendix C, Table C-1). These wastes are actually generated by upstream processes but appear in wastewater treatment units in the form of sludges, containing oil, water and solids. This waste category is comprised mostly of API separator sludge, dissolved air flotation sludge, slop oil emulsion solids and other miscellaneous sludges. The processes contributing to the generation of the above listed sludges are: cooling towers, boilers, rainwater runoff, process unit washing, steam traps, and crude desalter effluent. Water contacts oil in many petroleum refining processes. This water is typically routed to the oily sewer. In addition, water is used either to clean equipment or to hose process areas, solids are washed into the oily sewer along with the water and oil. The major sources accounting for the solids washed into the oily sewer are: fluid catalytic cracker fines from the fluid catalytic cracking (FCC) unit, coke fines from the coker, and dirt and silt washed in from unpaved areas.

Alkaline solution without metals (pH > 12.5), (CWC 122):

The main waste under CWC 122 category is spent caustic. It is generated in fuel production and by-product processing operations (category 1 & 2). According to one refinery, caustic is used throughout the refinery for several purposes, including sulfur compound conversion, entrained catalyst removal, and low pH wastewater neutralization. Fresh or recycled caustic is used in the refinery's crude distillation section, the alkylation unit, the dimersol unit and the fluidized catalytic cracking unit.

Waste oil and mixed oil (CWC 221):

Waste oil can be hazardous due to its low flash point and benzene content. This waste is generated from category #1. All waste oil in the refinery including slop oil, lube oil, and spilled oil are routed through the oily water sewer and the API separator. Upon generation from the API separator, the API sludge (water, oil and solids) can be recycled into the coker. The oil portion is sent to the recovered oil tanks and later sent to the crude or coker units. Recovered oil is also generated due to flushing of sampling lines and routine maintenance lines.

Tank bottom waste (CWC 241):

Fuel production and by-product processing (categories #1 and #2) generate this wastestream, which is a result of a storage of intermediate and final products. Over time, solids contained in the stocks associated with these tanks settle to the bottom. The settled solids are removed from each tank as tank bottom sludge every few years. The amount of tank bottom sludge generation depends on many factors, including crude oil quality, catalyst fines, corrosion by-products, and chemical side reactions, which can frequently produce ammonium chloride salts. These materials generally settle in tanks. The primary contributor to tank bottom sludge is crude oil quality. California crude is well known to generate higher amounts of tank bottom sludge.

Unspecified oil-containing waste (CWC 223):

This wastestream consists of the following wastes generated from any of the three categories of fuel production, by-product processing or ancillary operations.

a) Miscellaneous wash-out solids, which constitute the majority of waste. Wash-out solids consist of cooling tower sludge, water softener sludge, coker sewer sludge, yard sewer sludge and other miscellaneous sources.

b) Vacuum residuum and other oil is generated during clean-out of process equipment. This stream is highly viscous and sometimes contains dirt.

c) Waste carbon. A small quantity of carbon is occasionally contaminated with hydrocarbons in the acid gas removal system. Aqueous diethanolamine (DEA) is used to remove acid gases from process streams. Oil-contaminated DEA carbon can not be recycled and must be disposed of as a CWC 223 waste.

d) Oily production trash is generated during cleanup of equipment and spills in addition to any containers, rags, absorbent, paper, wood, plastic and other debris contaminated with hydrocarbons.

e) Used cartridge filters are generated when polishing filters in the wastewater system are changed due to solid accumulation. The purpose of the filters is to remove suspended oil and solid particles which pass through processing equipment.

f) Filter cake is the residue remaining from the processing of oil emulsion in a filter press.

g) Hydrocarbon solids are generally generated during cleaning of hydrocarbon tanks.

h) Waste solvents are generated from routine cleaning of instruments and small mechanical parts during maintenance operations.

Other inorganic solid waste category (CWC 181):

This wastestream is generated from the by-product processing category and is comprised of more than fourteen types of waste, with significant waste producers associated with the Stretford tailgas unit and sand blasting grit. At one refinery, spent Stretford solution, off-specification Stretford sulfur, and Glauber salts make up more than 85 percent of the waste quantities listed as CWC 181 wastes. These waste groups are discussed below:

a) Spent Stretford solution. The Stretford process is used for removal of hydrogen sulfide from refinery tailgas. During the removal of hydrogen sulfide, several unfavorable oxidation side reactions occur, resulting in an undesirable production of sodium thiosulfate, which at higher concentrations tends to cause operating problems, including solids deposition and plugged equipment. A few refineries identified this waste as CWC 132.

b) Stretford sulfur. Stretford sulfur is generated when the absorbed hydrogen sulfide is reacted with sodium carbonate and oxidized with air in an open-top tank.

c) Glauber Salt. One refinery uses a desalting process which regenerates spent Stretford solution. The process uses hot sulfuric acid to convert sodium thiosulfate to sodium sulfate. The resulting solution is chilled to form Glauber salts ($Na_2SO_4:10H_2O$).

d) Spent Blasting Media. Sand blasting operations are conducted to remove mill scale from new equipment prior to painting and to remove paint from old equipment.

Other spent catalyst (CWC 162):

Spent catalysts typically contain large concentrations of metals such as nickel, vanadium, cobalt and molybdenum. Generally, hydrocracking and hydrotreating units in the fuel production (#1) category generate this waste. While processing hydrocarbon streams, catalysts become contaminated with sulfur and nitrogen and other contaminants. As the catalysts become contaminated

they lose their reactivity and fail to perform as designed. As a result, these catalysts are periodically removed from the reactors and replaced with fresh catalysts.

FCC waste (CWC 161):

FCC catalyst fines are considered a California hazardous waste due to the metal content, which include silica, alumina, and rare earth compounds. The FCC converts straight run and coker distillates from the hydrotreater unit into high octane gasoline and hydrocracker charge stock. These wastes are generated during fuel production (category #1).

Extremely Hazardous Waste: Only 13% of the reporting generators addressed this waste, the entire volume for all reporters amounted to a total of only 4.6 tons, which included four waste streams (see Appendix - C, Table C-2). The most common waste cited was empty containers (CWC 512).

B. OIL EXPLORATION COMPANY (SIC 1311/1381) OPERATIONS AND WASTE STREAMS

The processes and operations of oil exploration companies involve finding, producing, or selling crude oil and natural gas. As one company stated in its SB 14 Plan, the following are the overall activities:

1) Drilling to find oil and natural gas;
2) Lifting production fluids from subsurface reservoirs to the surface and collecting the production fluids at central collection facilities;
3) Cleaning and separating the crude oil and natural gas from water, formation solids and other contaminants; and
4) Selling the crude oil and natural gas to a purchaser.

The Oil exploration industry generates more than ten types of hazardous waste (see Appendix C, Table C-3); the three common waste streams are: 1) Other inorganic solid waste (CWC 181) 2) Fly ash, bottom ash and retort ash (CWC 571), and 3) Tank bottom waste (CWC 241). These are discussed below:

Other inorganic solid waste (CWC 181):

This waste which includes refractory waste, sand blast grit, stack wash filter cake, and oily contaminated debris, is generated from activity #2. Refractory waste is generated during the combustion of crude oil in the steam generators or furnaces. This waste can be hazardous if it is contaminated with vanadium and/or nickel. This waste is mainly generated when small sections of damaged steam generators or furnace refractory are repaired during routine maintenance; it is also generated when the fire brick lining is replaced every few years. Sand blast grit is generated during sand blasting of equipment, platforms and storage tanks. This grit is potentially a hazardous waste due to metal-containing paints and primers used on the equipment. Stack wash filter cake is generated from the removal of fly ash from steam generator tubes when fired with crude oil. The fly ash is removed by washing the tubes with water.

Fly ash (CWC 571):

This waste is generated from activities #2 and #3. Fly ash, also known as scrubber waste, produced by this industry is one of the common waste in this category. This waste is generated by the combustion of crude oil in the steam generators as fuel to provide heat, which in turn produces steam to enhance oil recovery. This waste is accumulated in settling basin and tanks. The fly ash, which contains vanadium and nickel, is captured by the water used to scrub effluent gases to reduce air emissions.

Tank bottom waste (CWC 241):

This wastestream is generated from activity #2 and it is a result of solids such as dirt and sand dropping out of fluid stream into the bottom of a settling or storage tank. According to one generator, crude tank bottoms have been determined to be a hazardous waste because of their toxicity.

Extremely Hazardous Waste: This category of waste was not reported/generated by oil exploration companies.

C. DATA ANALYSIS

Twenty seven California refineries (SIC 2911) and oil exploration companies (SIC 1311 or 1381) were requested to submit their Plans, Reports and summaries during September 1991. Of these, documents were actually received from 18 generators, representing 10 corporations. A few generators addressed multiple sites in their plans; therefore, the 18 plans that the Department received covered 15 refinery and 14 exploration sites. Nine generators filed Notices of Exclusion. A tremendous amount of data was reviewed, interpreted and organized from the eighteen documents. Tables C-1 to C-7 in Appendix C summarize the hazardous waste generated by the petroleum industry during 1990, prior to California's source reduction program. Following are some of the key observations derived from the data provided in Tables C-1 through C-7.

* The California refineries generated thirty five types of hazardous waste by California Waste Code (Table C-1). A total of more than 265,000 tons of hazardous waste, with individual generation ranging from 1,325 to 49,000 tons, was generated by reporting California refineries (Table C-5). The most common waste generated by California refineries is Oil/Water separator sludge (CWC 222), (Table C-1 and C-4). Ninety three percent of reporting refineries considered this waste to be their major waste stream. Individual refinery generation of oil/water separator sludge ranged from 176 tons to more than 32,000 tons, accounting for a total of more than 100,000 tons (39%) of the total refinery hazardous waste. There are fifteen wastes identified as major hazardous wastes (Table C-4).

* Only 4.6 tons of extremely hazardous waste, comprising only four waste streams, were generated by refineries(Table C-2).

* Oil exploration companies reported a total generation of nearly 8,000 tons of hazardous waste, with each site producing between 250 tons to 3,150 tons annually. Four sets of documents were submitted by three oil exploration companies, which covered fourteen sites. Inorganic solid waste (CWC 181) was the most common wastestream, with more than 3,000 tons generated annually (Table C-3).

* Three of the most common hazardous waste streams, based on both quantity generated and number of oil exploration generators, are: 1) refractory waste (CWC 181); 2) Stack/scrubber waste and fly ash (CWC 571); and 3) crude tank bottom (CWC 241). (Table C-3 & C-6).

* Extremely hazardous waste was not reported being generated by exploration companies.

II. FEASIBLE SOURCE REDUCTION MEASURES

Source reduction measures can be grouped and analyzed in a number of different ways. For instance, they can be categorized by the types of source reduction measures identified in the plans for various categories of hazardous wastes; or, more specifically, by implementable source reduction measures to address specific waste streams identified by the California Waste Codes (CWCs). In addition, source reduction measures can be grouped as whether or not they are transferable (useful to other facilities with similar operations). By placing the source reduction measures into various groupings, it is possible to draw several conclusions. The following sections highlight these findings.

A. IMPLEMENTABLE SOURCE REDUCTION MEASURES

Tables 1 and 2 provide refinery and oil exploration company listings of general categories of source reduction measures identified by source reduction approach. For each approach, the number of implementable source reduction measures found in the SB 14 Plans are listed. The tables indicate that both refineries and oil exploration companies commonly find that they could implement source reduction using operational improvements, followed by production process changes and implementing administrative procedures.

The relatively high number of selected measures under operational improvement and production process change indicates that these approaches frequently presented a combination of the low cost and ease of implementation, combined with the economical benefit of reduced waste management costs. On the other hand, the number of measures selected under product reformulation or input changes were either zero or very low. This is attributed to the nature of the petroleum industry, where the type of crude purchased and the complex processes used could not be changed due to technical and/or economic constraints.

Examining the number of measures selected for implementation, one notices that a total of 22 and 46 measures under production process changes and operational improvements were identified by both refineries and oil exploration companies.

TABLE 1

REFINERY SOURCE REDUCTION

APPROACHES vs. NUMBER OF SELECTED MEASURES

Approach	Number of Source Reduction Measures Selected
Input change	0
Operational Improvement	39
Production Process Change	20
Product Reformulation	0
Administrative Steps	8
Total	67

TABLE 2

OIL EXPLORATION COMPANY SOURCE REDUCTION

APPROACHES vs. NUMBER OF SELECTED MEASURES

Approach	Number of Source Reduction Measures Selected
Input Change	1
Operational Improvement	7
Production Process Change	2
Product Reformulation	0
Administrative Steps	6
TOTAL	16

B. SOURCE REDUCTION MEASURES BY WASTE CODES

Table 3 lists selected source reduction measures for hazardous waste identified by the California Waste Codes for refineries, and Appendix D contains list of selected source reduction measures for petroleum industry. As discussed previously, wastewater treatment and fuel production within the petroleum industry generate significant amounts of hazardous waste. Those waste streams include oil/water separation sludge (CWC 222), alkaline solution without metals (CWC 122), waste oils & mixed oils (CWC 221), and tank bottom waste (CWC 241), among other categories.

The most common hazardous waste in the petroleum refineries is oil/water separator sludge (CWC 222). Ninety-three percent of California reporting refineries considered this waste to be their major waste stream. Individual refinery generation of oil/water separator sludge ranged from 176 tons to 32,000 tons, accounting for a total of 103,500 tons (39% of the total refinery hazardous waste generated in California during 1990). A reduction of approximately 9% (9,250 tons) of this waste has been estimated by the refineries.

For CWC 222 (oil/water separation sludge), the total number of selected measures for implementation by various generators had the highest entry (33) (see Table 3). One of the commonly selected source reduction measures which can result in reduction of CWC 222 is the paving of areas near process drains and other refinery locations.

Table 4 lists selected source reduction measures for hazardous waste identified by CWC for oil exploration companies. A total of 18 measures covering 8 waste streams are identified by the three exploration companies. Tables 5 and 6 delineate the estimated reduction of the refineries and oil exploration companies major waste streams.

TABLE 3

NUMBER OF SOURCE REDUCTION MEASURES SELECTED BY WASTE STREAMS FOR REFINERIES

CWC	WASTE	MEASURES
222	Oil/water separation sludge	33
181	Other inorganic solid waste	10
223	Unspecified oil-containing waste	9
221	Waste oil and mixed oil	3
132	Aqueous solutions with metals	3
135	Unspecified aqueous solution	2
162	Other spent catalyst	2
122	Alkaline solutions without metals (pH > 12.5)	1
341	Organic liquids (nonsolvents with halogens)	1
---	All types of waste(*)	3
	TOTAL	67

(*) These three measures represent administrative source reduction measures, which apply generally to the reduction of all types of waste

TABLE 4

NUMBER OF SOURCE REDUCTION MEASURES SELECTED BY WASTE STREAMS FOR OIL EXPLORATION COMPANIES

CWC	WASTE	MEASURES
181	Refractory Waste	4
223	Oily Contaminated Debris	3
571	Stack Wash/Scrubber solids	2
352	Industrial Filters	2
135	Laboratory Waste	2
441	Sulfur Sludge/Spent Stretford	1
581	Stretford Sulfur Cake	1
241	Crude Tank Bottoms	1
	Total	16

TABLE 5

PROJECTED WASTE REDUCTION BY REFINERIES

CWC	WASTE	WASTE REDUCTION (TONS)
221	Waste oil and mixed oil	20,400
122	Alkaline soln. without metals (pH > 12.5)	10,000
222	Oil water/separation sludge	9,885
181	Other inorganic solid waste	3,660
132	Aqueous solutions with metals	2,788
441	Sulfur sludge/Spent stretford	2,150
135	Unspecified aqueous solution	1,901
223	Unspecified oil-containing waste	1,121
162	Other spent catalyst	415
343	Unspecified org. liq. mixture	160
	Total	52,480

TABLE 6

PROJECTED WASTE REDUCTION BY OIL EXPLORATION COMPANIES

CWC	WASTE	1990 WASTE GENERATION (TONS)	WASTE REDUCTION (TONS)	PERCENT REDUCTION
181	Other inorganic solids waste	3,198	921	28.8
571	Fly ash	2,520	948	37.6
441	Sulfur sludge	330	330	100.0

C. TRANSFERABLE SOURCE REDUCTION MEASURES

Transferable source reduction measures are those measures which broadly apply across the industry and could be easily adapted and implemented by other facilities with similar operations. Several transferable measures were listed in the Plans, resulting in waste reductions ranging from 5 to 100%. A fact sheet contained in Appendix E, discusses key transferable source reduction measures. This fact sheet was prepared and distributed primarily to the petroleum industry in October of 1992.

D. SUMMARY OF PROJECTED SOURCE REDUCTION

A total of 83 implementable source reduction measures were selected by the California petroleum industry in 1991. Out of these 83 measures, a total of 67 implementable source reduction measures were selected by refineries and 16 were selected by oil exploration companies. The following discussion presents notable findings that were derived from fifteen refineries' (SIC 2911; 15 sites) and three oil exploration companies' (SIC 1311,1381; 14 sites) source reduction plans.

* Refineries projected quantifiable levels of hazardous waste reduction for 72 percent of these selected measures. Table 1 summarizes the implementable measures according to SB 14's five source reduction approaches. According to estimates by the generators, more than 52,000 tons of hazardous waste can be reduced by measures targeted for implementation between 1991 and 1994. Implementing these measures alone would reduce the total hazardous waste generated by the reporting petroleum refineries by nearly 20 percent.

* Only one extremely hazardous waste source reduction measure was identified by a generator as implementable. No quantity was estimated for this source reduction measure.

* Oil exploration company generators projected quantifiable levels of hazardous waste reduction for 25 percent of their selected source reduction measures. No hazardous waste source reduction was projected for the remaining 75 percent. Nearly 2200 tons of hazardous waste can be reduced by source reduction measures targeted for implementation between 1991 to 1994, as estimated by the generators.

* The petroleum industry (refineries and oil exploration companies), prior to the SB 14 program, generated more than 270,000 tons of hazardous waste during 1990. The industry selected eighty-three implementable source reduction measures. For sixty-three percent of these measures (that percentage for which generators estimated source reduction), generators projected that implementation will result in nearly 55,000 tons of waste reduction. This translates to nearly 20 percent of hazardous waste source reduction identified for the 1991-1994 period.

The remaining thirty-seven percent of the selected measures were not quantifiable due to several reasons, such as employee training, establishing source reduction program at the site, complex processes involved etc. However, the Department projects that by implementing all eighty-three selected measures, the petroleum industry can reduce nearly 30 percent of California's petroleum industry's hazardous waste generation. This reduction is equivalent to 73,000 tons of hazardous waste not requiring

disposal. With the current hazardous waste disposal costs for petroleum waste ranging from $100 to $230 per ton, these reductions could save the industries 7.3 to 16.8 million dollars in annual disposal costs.

* Data normalization is an important consideration whenever determining the level of waste reduction occurring at a facility. Annual variations in waste type and quantity can result from changes in the production output, scheduled maintenance and variations in the sources of crude oil. It is extremely difficult to determine if waste reductions achieved by facilities are truly a result of implemented source reduction measures or simply variation in production and the business economy. None of the eighteen reviewed plans normalized their data.

E. REJECTED SOURCE REDUCTION MEASURES

The SB 14 Plans identified source reduction measures which were later rejected upon further evaluation. Measures were rejected based on the following:

Economic Feasibility:

Several petroleum industries rejected measures due to a lack of sufficient funding to implement them. Measures in this category usually required high initial capital cost for implementation, had extended payback periods and provided low cost/benefit ratios.

The following are some examples:

1) One refinery considered replacing its current Claus/Beavon-Stretford sulfur plant with new Unisulf sulfur plant, because the new process does not generate as much spent Stretford solution as the current sulfur plant. However, the refinery rejected the measure due to the large capital expenditure required, which made the measure economically infeasible. The refinery selected other measures, which can reduce the generation of spent Stretford solution more cost-effectively, for implementation.

2) Another refinery evaluated a measure to change the type of crude oil that is currently being processed at their site. The intent was to reduce the quantity of Dissolved Air Flotation (DAF) sludge (CWC 222) generated. The refinery processes 100 percent Alaskan North Slope Crude (ANSC). Processing units have been alloyed specifically for ANSC. If the crude is changed, the refinery may reduce DAF sludge but it would need realloying the processing units. The refinery's economic evaluation attests that the processing units realloying cannot be justified at this time.

Technical Feasibility:

Source reduction measures were rejected if they were found to be technically infeasible. Very few innovative measures were mentioned in the SB 14 Plans reviewed. For several identified innovative measures, the industry concluded that further study is necessary prior to implementation.

The following are two examples:

1) A refinery wants to further investigate possible opportunities for reclaiming spent catalysts currently being landfilled. 10

percent spent catalysts generated by the refinery are not being reclaimed. Although the refinery staff continually reviews opportunities for reclaiming these catalysts, metals reclamation is a market-driven business, and it is likely that new reclaiming opportunities may develop in the future. The refinery intends to take advantage of any new opportunities to reclaim additional spent catalysts as they develop.

2) A refinery wants to further study the installation of inserts in sewer catch basins for collection of solids entering the sewer. These solids eventually produce oil/water separator sludge (CWC 222). During unit washdown and precipitation events, dust, which has accumulated either on the pavement or on the above-grade structure and equipment, will generally enter the sewer. Metal inserts fitted into the sewer catch basins could be installed, which would catch the majority of solids reaching the sewer opening. These inserts would then be cleaned out periodically to recover the accumulated solids. The refinery has no experience with these devices. This measure will be studied further to determine the effectiveness of the inserts in collecting solids and to assess the effort necessary to remove accumulated solids.

Refineries identified 160 viable measures for source reduction; 58% of these measures were rejected, while the rest were selected for implementation. Table F-1 in Appendix F contains a listing of rejected measures. The oil exploration industry considered 18 measures for source reduction; only 2 of these measures were rejected, while the rest were selected for implementation.

III. PLAN/REPORT COMPLETENESS

The Department determined source reduction document completion as a first step following SB 14 plan and report call-in. Completeness was determined by referencing the Completeness Checklist provided in Appendix L of the Appendices to the Guidance Manual. The checklist ensures that the Plan meets all of the content requirements codified in regulation. Of the 18 Plans and Reports reviewed by the Department, only one Plan was found incomplete.

IV. HAZARDOUS WASTEWATER

SB 14 required generators to identify and perform a source reduction review and plan for "all routinely-generated hazardous waste streams which result from ongoing processes or operations and that have a yearly volume exceeding 5% of the total yearly volume of hazardous waste generated at the site, or, for extremely hazardous waste, 5% of the total yearly volume of extremely hazardous waste generated at the site." In setting these limits, the Legislature overlooked the fact that, at many facilities, hazardous wastewater generation represents the largest percentage of total waste generated. Therefore, when generators apply the above-mentioned 5% rule, only the wastewater will amount to greater than 5% and thus generators will address only the wastewater and will not be required to address other hazardous waste streams for which SB 14 was originally intended.

This problem was later rectified by the enaction of SB 1133 which required generators to determine if the total quantity of wastewater generated exceeds 5%, then conduct additional calculation without counting the wastewater to address the remaining hazardous wastes separately.

SB 1133 did not pass until September 5, 1991. As the initial SB 14 Plans/Reports were due on September 1, 1991, generators with large quantities of hazardous wastewaters had the option to address only the wastewater. None of the petroleum industry Plans and Reports reviewed by the Department elected to address only wastewater. Therefore, the review team was able to evaluate source reduction options for various wastestreams and compile the information to be used by other facilities with similar operations.

5. CONCLUSIONS

The Department review of petroleum industry SB 14 Plans and Reports resulted in several conclusions and recommendations. A brief outline of the major findings follows:

- The petroleum industry (refineries and oil exploration companies) selected 83 implementable source reduction measures. The Department projects that by implementing 100 percent of the selected measures, the petroleum industry can reduce nearly 30 percent of its hazardous waste generation. This reduction is equivalent to 73,000 tons of hazardous waste not requiring disposal.

- A few Plans and Reports were in error as to whether a selected measure is considered source reduction, recycling, or treatment. Some generators were confused regarding the definition of "source reduction" and confused it with source control (i.e., onsite treatment and/or recycling).

- Paving drainage areas to avoid eroding soil and silt into stormwater runoff was the most popular source reduction measure selected. This measure was frequently found to require minimal expenditure and offered the best cost/benefit ratio.

- Most facilities elected to use 1990 as their baseline year, since few companies had source reduction programs in place prior to that time. Therefore, most of the SB 14 data did not reflect historical source reduction trends. Only 4 of the 18 reports reviewed provided a baseline year different from the reporting year. The next Reports (due September 1, 1995) will provide more revealing data by comparing waste management practices and waste reductions obtained between 1990 and 1994

APPENDICES

A. Review Forms

B. Refinery Operation Description

C. Table C-1 to C-7

D. List of Selected Source Reduction Measures

E. Fact Sheet

F. List of Rejected Source Reduction Measures

APPENDIX -A

REVIEW FORMS

Source Reduction Evaluation Review & Plan Checklist

The following checklist may be helpful in determining completeness of a Hazardous Waste Source Reduction Evaluation Review and Plan. The Department of Health Services will be using a similar approach to determine whether or not a review and plan has met the minimum requirements necessary to comply with of the Hazardous Waste Source Reduction and Management Review Act of 1989.

1. Is your (the generator's) name and address given in the plan? (CCR Section 67100.5(a)) ☐ Yes ☐ No

2. Is the address the same location where waste is generated? ☐ Yes ☐ No
   If no, is there a given address where waste is generated? ☐ Yes ☐ No

3. Is the four digit SIC code(s) for the site given? (CCR Section 67100.5(b)) ☐ Yes ☐ No

4. Are you a small business? (CCR Section 67100.2(g)) ☐ Yes ☐ No
   If yes, is a DHS Waste Audit Study Checklist being used? (If yes, see Checklist for content requirements.) ☐ Yes ☐ No

5. Is the plan addressing a multi-site operation? ☐ Yes ☐ No
   If yes, are all the sites' addresses listed in the plan? (If no, this plan is incomplete.) ☐ Yes ☐ No

6. Is there a description of your business and waste generating activities in the plan? (CCR Section 67100.5(c)) ☐ Yes ☐ No

7. Is the length of time your company has been in operations at the present site provided in the plan? (CCR Section 67100.5(d)) ☐ Yes ☐ No

8. Are the major manufactured products and services you provide described in the plan? (CCR Section 67100.5(e)) ☐ Yes ☐ No

9. Are the number of employees working for you given in the plan? (CCR Section 67100.5(f)) ☐ Yes ☐ No

10. Is there a general description of your operations in the plan? (CCR Section 67100.5(g)) ☐ Yes ☐ No

11. Does the plan identify all routinely generated hazardous waste streams which result from ongoing processes or operations having a yearly volume that exceeds five percent of the total yearly volume of hazardous waste at the site? (CCR Section 67100.5(h)) ☐ Yes ☐ No

12. Does the plan provide an estimate of the weight, in pounds, of waste generated at the site? (CCR Section 67100.5(i)(1)) ☐ Yes ☐ No

13. Have you listed the applicable California waste code(s) for each waste stream? (CCR Section 67100.5(i)(2)) ☐ Yes ☐ No

14. Are the waste generating processes, operations and activities (along with corresponding diagrams) described in the plan? (CCR Section 67100.5(i)(3)) ☐ Yes ☐ No

15. Do the processes, operations and activities described include a listing of all input materials contributing to the generation of waste? (CCR Section 67100.5(i)(3)) ☐ Yes ☐ No

16. Is there an evaluation of available source reduction approaches? (CCR Section 67100.5(j)) ❑ Yes ❑ No

17. Do the evaluations for source reduction approaches consider input changes, operational improvements, production process changes, product reformation, etc.? (CCR Section 67100.5(j)) ❑ Yes ❑ No

18. Do the evaluations consider the following: (CCR Section 67100.5(k))

Expected change in the amount of hazardous waste generated?	❑ Yes	❑ No	❑ N/A
Technical feasibility?	❑ Yes	❑ No	❑ N/A
Economic evaluation?	❑ Yes	❑ No	❑ N/A
System capacity?	❑ Yes	❑ No	❑ N/A
System efficiency?	❑ Yes	❑ No	❑ N/A
Effects on product quality?	❑ Yes	❑ No	❑ N/A
Employee health and safety implications?	❑ Yes	❑ No	❑ N/A
Permits, variances, compliance schedules of applicable State, local and federal agencies?	❑ Yes	❑ No	❑ N/A
Releases and discharges?	❑ Yes	❑ No	❑ N/A

19. Does the plan provide information, such as waste stream constituents and concentrations, pertinent to the evaluation of the source reduction approaches? (CCR Section 67100.5(l)) ❑ Yes ❑ No

20. Is there a specification of, and a rationale for, each technically feasible and economically practicable source reduction measure(s) being proposed in the plan for implementation? (CCR Section 67100.5(m)) ❑ Yes ❑ No

21. Is there an evaluation and, to the extent practicable, a quantification of the effects of the chosen source reduction measure(s) on emissions and discharges to air, water, or land? (CCR Section 67100.5(n)) ❑ Yes ❑ No

22. Is there a list of alternatives considered but not selected for a detailed evaluation as a potentially viable source reduction approach? (CCR Section 67100.5(o)) ❑ Yes ❑ No

23. For each alternative rejected, is there a rationale for rejection? (CCR Section 67100.5(o)) ❑ Yes ❑ No

24. Is there a timetable/schedule for making reasonable and measurable progress towards implementing and completing the selected source reduction measures? (CCR Section 67100.5(p)) ❑ Yes ❑ No

25. Does the timetable/schedule prioritize processes and wastes for future research, development and source reduction analysis? (CCR Section 67100.5(p)) ❑ Yes ❑ No

26. Is the plan properly certified? (CCR Section 67100.10) ❑ Yes ❑ No

Management Performance Report Checklist

The following checklist may be helpful in determining completeness of a Hazardous Waste Management Performance Report. The Department of Health Services will be using a similar approach to determine whether or not a performance report has met the minimum requirements necessary to comply with of the Hazardous Waste Source Reduction and Management Review Act of 1989.

1. Is your (the generator's) name and address given in the report? (CCR Section 67100.8(a)(1)) ☐ Yes ☐ No

2. Is the address the same location where the waste is generated? ☐ Yes ☐ No
   If no, is there a given address where waste is generated? ☐ Yes ☐ No

3. Is the four digit SIC code(s) for the site given? (CCR Section 67100.8(a)(2)) ☐ Yes ☐ No

4. Are you a small business? (CCR Section 67100.2(g)) ☐ Yes ☐ No
   If yes, did you know that you can use your most recent biennial report instead of writing a performance report? ☐ Yes ☐ No

5. Is the report addressing a multi-site operation? ☐ Yes ☐ No
   If yes, are all the sites' addresses listed the report? (If no, the report is incomplete.) ☐ Yes ☐ No

6. Is the baseline year clearly stated in the report? ☐ Yes ☐ No

7. Is the reporting year clearly stated in the report? ☐ Yes ☐ No

8. Is the reporting year the same as the baseline year and so stated in the report? ☐ Yes ☐ No
   (If no years are given, the report is incomplete.)

9. Does the report list and describe all routinely generated hazardous waste streams identified in the review and plan? (CCR Section 67100.8(a)(3)) ☐ Yes ☐ No

10. Does the report provide an estimate of the quantity, in pounds, of waste generated and managed, both onsite and offsite, during the current reporting year and the baseline year? (CCR Section 67100.8(a)(3)(A)) ☐ Yes ☐ No

11. Is there a listing and description of current hazardous waste management approaches implemented since the baseline year? (CCR Section 67100.8(a)(3)(B)) ☐ Yes ☐ No

12. Is there an assessment of the effectiveness of each hazardous waste management approach implemented since the baseline year? (CCR Section 67100.8(a)(3)(C)) ☐ Yes ☐ No

13. Does the assessment of implemented waste management approaches consider the following: (CCR Section 67100.8(a)(3)(C))

    Source Reduction? ☐ Yes ☐ No
    Onsite or offsite recycling? ☐ Yes ☐ No
    Onsite of offsite treatment? ☐ Yes ☐ No

14. If applicable, describe factors that, during the period between the baseline year and the current reporting year, have affected hazardous waste generation and onsite and offsite hazardous waste management practices? (CCR Section 67100.8(a)(3)(D)) ☐ Yes ☐ No

15. When describing factors affecting hazardous waste management practices at the site, did you consider:

Changes in business activity	❒ Yes ❒ No
Changes in waste classification	❒ Yes ❒ No
Natural phenomena	❒ Yes ❒ No

16. Is the report properly certified? (CCR Section 67100.10) ❒ Yes ❒ No

Source Reduction Evaluation Review and Plan Summary Checklist

The following checklist may be helpful in determining completeness of a Source Reduction Evaluation Review and Plan Summary. The Department of Health Services will be using a similar approach to determine whether or not a performance report has met the minimum requirements necessary to comply with of the Hazardous Waste Source Reduction and Management Review Act of 1989.

1. Is the generator's name and address given? ☐ Yes ☐ No

2. Is the address the same location where the waste is generated? ☐ Yes ☐ No
   If no, is there a given address where waste is generated? ☐ Yes ☐ No
   (CCR Section 67100.6(a))

3. Is the E.P.A. I.D. number given? (CCR Section 67100.6(a)) ☐ Yes ☐ No

4. Is the four digit SIC code(s) applicable to activities at the site given? ☐ Yes ☐ No
   (CCR Section 67100.6(a))

5. Is there a brief overview of the plan? (CCR Section 67100.6(b)) ☐ Yes ☐ No

6. Is there a summary of the information used for evaluation of each source reduction measure? (CCR Section 67100.6(c)) ☐ Yes ☐ No

7. Is there a summary of the specification of, and rationale for, each technically feasible and economically practicable source reduction measure? (CCR Section 67100.6(d)) ☐ Yes ☐ No

8. Is there a brief abstract for each source reduction measure to be implemented or has been implemented in the reporting year? (CCR Section 67100.6(f)) ☐ Yes ☐ No

9. Do the abstracts include:

   Quantity of waste ☐ Yes ☐ No
   Process or activity generating the waste ☐ Yes ☐ No
   Source reduction approach ☐ Yes ☐ No
   Brief description of source reduction measure ☐ Yes ☐ No
   Brief economic overview ☐ Yes ☐ No
   Estimated source reduction in terms of weight or properties which cause the waste to be classified as hazardous ☐ Yes ☐ No
   Barriers/obstacles, including any federal, state, or local government requirements ☐ Yes ☐ No
   Identification of discharge impacts to air, water, and/or land ☐ Yes ☐ No
   (CCR Section 67100.6(f))

10. Is the Plan Summary properly certified? (CCR Section 67100.10) ☐ Yes ☐ No

Management Performance Report Summary Checklist

The following checklist may be helpful in determining completeness of a Hazardous Waste Management Performance Report Summary. The Department of Health Services will be using a similar approach to determine whether or not a performance report has met the minimum requirements necessary to comply with of the Hazardous Waste Source Reduction and Management Review Act of 1989.

1. Is the generator's name and address given? (CCR Section 67100.9(a)) ❒ Yes ❒ No

2. Is the digit SIC code(s) for the site given? (CCR Section 67100.9(b)) ❒ Yes ❒ No

3. Is the baseline year clearly stated? ❒ Yes ❒ No

4. Is the reporting year clearly stated? ❒ Yes ❒ No

5. Is the baseline year same as the reporting year and so stated in the summary? (If no years are given, the Report Summary is incomplete.) ❒ Yes ❒ No

6. Is there a summary of the following:

   Quantity of waste generated and managed, both onsite and offsite, during the current reporting year and baseline year ❒ Yes ❒ No

   Hazardous waste management approaches implemented since baseline year ❒ Yes ❒ No

   Assessment of implemented waste management approaches ❒ Yes ❒ No

   Factors, during the period between baseline and current year, which have affected hazardous waste generation (CCR Section 67100.9(c)) ❒ Yes ❒ No

7. Does the Report Summary include abstracts for each source reduction, recycling or treatment technology implemented from baseline year through current reporting year, if reporting year is different? (CCR Section 67100.9(d)) ❒ Yes ❒ No

8. Is there a narrative description of changes in business activities significantly affecting waste generation at the site? (CCR Section 67100.9(e)) ❒ Yes ❒ No

9. Is there a brief assessment of the effect? (CCR Section 67100.9(e)) ❒ Yes ❒ No

10. Does the Report Summary include net waste reduction achieved by site if reporting year is different from baseline year? (CCR Section 67100.9(f)) ❒ Yes ❒ No

11. Is the Report Summary properly certified? (CCR Section 67100.10) ❒ Yes ❒ No

REVIEW ABSTRACT

NAME: _____
ADDRESS: _____

PLAN___
PLAN SUMMARY___
REPORT___
REPORT SUMMARY___

CONTACT: _____ TEL: _____

SIC CODE _____ _____

DESCRIPTION OF BUSINESS ACTIVITY:

CALIFORNIA WASTE CODES AND WEIGHT OF MAJOR WASTE STREAMS:

	CWC	WEIGHT	% REDUCED	METHOD	TIME
1.					
2.					
3.					
4.					
5.					
6.					

COMMENTS:

REVIWER'S NAME_____ DATE COMPLETED_____

Company Name _____

CWC	PROCESS DESCRIPTION	SOURCE REDUCTION						
		ADMINISTRATIVE STEPS	PRODUCT REFORMULATION	PROCESS CHANGE	OPERATIONAL IMPROVEMENT	INPUT CHANGE	TREATMENT	RECYCLING

APPENDIX - B

REFINERY OPERATION DESCRIPTION

REFINERY OPERATIONS

For the purpose of simplifying the refinery, operations have been divided into four basic categories: Fuel Production; By-product Processing; Ancillary Operations and Waste Management. Fuel Production encompasses those operations which manufacture petroleum products such as gasoline, polymers, and coke. By-product Processing covers refinery operations that convert used materials and/or undesirable petroleum constituents into saleable or reusable end products. Ancillary Operations are those activities which support refinery functions and recover energy. Finally, Waste Management deals with the recovery of useable materials from refinery waste streams, the disposal of solid and hazardous wastes, and the treatment of wastewaters generated by refinery operations.

FUEL PRODUCTION

There are three basic raw materials used in the crude oil refining process: crude oil; catalysts; and process chemicals. Heat, the final component in this process, is used to accelerate reactions, separate components, and reduce viscosity. Crude oil arrives at the El Segundo Refinery by ship or pipeline and is stored in tankage prior to processing. Initial separation of crude components occurs in distillation columns. Subsequently materials recovered from distillation are used as a fuel source in the refinery, or sent to other processes to generate useful products. The processes used to produce saleable petroleum products are discussed in further detail in the following sections.

Distillation

Distillation is the first process a barrel of crude oil encounters after it leaves the crude oil storage tanks in the refinery. Crude oil consists of many miscible substances all with different boiling points. While it is virtually impossible to separate each compound in crude oil individually, the distillation process uses temperature and pressure control to effectively separate groups of compounds with similar boiling points into mixtures.

Crude oil is initially heated and salts are removed prior to distillation. The first material to separate out from the crude oil mixture during distillation is the sour (hydrogen sulfide containing) gases. Sour gases are routed to refinery plants so that hydrogen sulfide can be separated from fuel gases. Hydrogen sulfide does not have value as a fuel source but is an important source of sulfur which can be recovered from it for use in the refinery

or resale to other industries. The next fraction removed during distillation are propane and butane. These materials can be processed further and sold as liquified petroleum gas (LPG), used as an in-plant fuel source or used to produce hydrogen.

Continued fractionation in the distillation columns yields gasoline, jet and diesel fuels. The lower boiling materials, gas oil and reduced crude, are the last materials to separate and require additional processing to reach desired endpoints. Reduced crude is used as feed material in vacuum distillation columns (distillation under vacuum lowers the boiling point of the materials and eases separation).

Hydrotreating

Hydrotreating is a catalytic process which uses hydrogen to improve the stability of and remove impurities from distillation products. Impurities in crude oil such as sulfur, nitrogen and metals must be removed to meet product specifications and to prevent poisoning of catalysts used in some down stream processes. A potential negative side effect of hydrotreating is hydrocracking. During hydrocracking desirable hydrocarbons are broken up into potentially unusable by-products.

Catalytic Reforming

Catalytic reforming is a process which employes catalysts to mediate reactions that boost the octane level of distillation products at the refinery. During the process of catalytic reforming hydrogen is produced for use in hydrotreating. Catalytic reforming encompasses four types of reactions:

1) Dehydrogenation of naphthene to produce aromatics
2) Dehydrocyclization of paraffins to naphthenes and aromatics
3) Isomerization of naphthenes and paraffins to more highly branched isomers
4) Cracking of naphthenes and paraffins to shorter hydrocarbon chains

The fourth reaction listed above is undesirable because it reduces yields, lowers hydrogen purity and consumes hydrogen.

Hydrocarbon Cracking

Hydrocarbon cracking is a process in which large molecules are cleaved into smaller ones. This process of cracking hydrocarbons can be accomplished either thermally or catalytically resulting in maximization of saleable products from crude oil.

During catalytic cracking of hydrocarbons, the catalysts act to increase the yield of desirable products and minimize the production of less useful materials, or allow cracking to occur at more favorable temperatures and pressures.

Thermal cracking, which occurs in the Coker, is a process that is typically used to crack the heaviest hydrocarbons, the residuum. Coke, a hydrogen poor by-product of thermal cracking left over after heating, is also sold as a fuel source.

BY-PRODUCT PROCESSING

During the refining of petroleum products, by-products are produced that have resale value or that can be reused in refinery processes thus displacing normal feed stocks. Some of these by-products, such as hydrogen sulfide which is used in sulfur production, are constituents in crude oil, while others, spent sulfuric acid for example, are process chemicals which can be recovered and reused. By-product processing at the El Segundo Refinery is discussed in more detail below.

Sour Water/Gas Processing

One of the principal by-products of petroleum refining is sour off-gases. Sour gases contain hydrogen sulfide, a noxious volatile compound, that is easily stripped from crude oil or partially refined products and transported to refinery hydrogen sulfide (H_2S) plants. The H_2S plants effectively separate sour off-gases into "sweet" and "sour" fractions. "Sweet" or H_2S poor gases are then transported to the refinery fuel gas system while sour gases are routed to Claus sulfur units for sulfur recovery. The Claus units produce elemental sulfur.

Sour waters are also generated by many processes at the El Segundo refinery. In addition to the H_2S, ammonia is also present in sour waters. Sour water is first

concentrated in stripping towers and subsequently delivered to facilities capable of recovering the ammonia. During ammonia recovery, H_2S is separated out and returned to the sulfur recovery process.

Acid Production

Sulfuric acid is an essential chemical used in the production of gasoline. Spent acids and acid sludges generated at the refinery are routed to the Sulfuric Acid Plant where the spent materials are mixed with sour and fuel gases and burned. The combustion products are cooled, scrubbed and catalytically converted to produce sulfuric acid. Some of the acid produced from this plant is reused in the refinery while the remainder is sold as a product.

Caustic Production

Another critical chemical used in the oil refining process is caustic soda. After being used in the production of jet fuel and light gasolines, caustic soda with entrained cresols or naphthenes is sold as a product. after leaving the refinery, these materials are processed to create fresh caustic soda and to recover cresols and naphthene which are contained in them.

ANCILLARY OPERATIONS

Ancillary operations at the El Segundo refinery include power production and process water purification. These operations do not directly result in a saleable product however they are desirable operations because they reduce costs, recover energy (power production), and provide softened water for refinery processes.

Cogeneration

In the Cogeneration (Cogen) Plant refinery fuel gas, natural gas, and LPG are used to generate electricity in turbines located on-site and to fire boilers that produce steam. Steam is a critical ingredient in many refining processes.

Water Treatment

The water treater consists of a system for demineralizing and softening municipal drinking water prior to use in refinery operations. Inorganic ions such as sodium, calcium and chloride are removed from drinking water using exchange resins. The purified water created in this process extends the life or refinery equipment by reducing scale and eliminating compounds which interfere with the refinery processes.

WASTE MANAGEMENT

Waste management activities have been divided into three categories: wastewater treatment: oil recovery; and solid and hazardous waste disposal. Wastewater treatment includes the physical and biological purification of aqueous wastes. Part of the process of wastewater treatment is oil/water separation. This leads directly to the recovery of oil and oil products from the refinery effluent system. The final step in waste management is the proper disposal of materials which cannot be recycled further. Each of these activities is discussed in greater detail below.

Wastewater Treatment

Wastewater treatment facilities at the El Segundo Refinery consist of passive and active oil/solids separation, biological wastewater treatment, and sludge digestion. The collection of wastewater is accomplished using a parallel system of pipes designed to carry different wastewater materials. This two tiered wastewater collection system is referred to as the segregated and unsegregated drain system.

The segregated drainage system collects discharges from refinery operations producing process wastewaters. The unsegregated system is used to convey non-process wastewaters, such as cooling tower blowdown, and rainwater runoff. The parallel systems join after passing through their respective treatment facilities and ultimately discharge into Santa Monica Bay under the National Pollutant Discharge Elimination System permit program.

Passive oil/solids separation is a process common to both the segregated and unsegregated systems. Separation is accomplished by transmitting wastewaters through an

oil/solids separator where materials are removed from the water based on their differing densities. Oils, which float on water, are recovered from this process and the settleable solids are periodically removed from the separator bottom.

Active oil separation processes are also employed on both the segregated and unsegregated systems. These processes include dissolved and induced air flotation (DAF and IAF respectively) units. IAF units operate upstream from passive oil separation in the segregated system and downstream from passive oil separation on the unsegregated system. An emergency IAF system also is available for use when required on the unsegregated system or on the downstream side of the biological treatment plant. Oil removal by the DAF unit occurs down stream of passive oil separation in the segregated system.

The biological wastewater treatment plant takes all wastewater flow from the segregated drainage system. This facility consists of an activated sludge process for the removal of dissolved organic materials from wastewater. Subsequent to biological processing, solids generated during biological treatment are removed by settling in clarifiers. The majority of the settled material, which consists of biological matter, is recirculated to the process. The remaining solid material is processed in the sludge digester.

Sludge digestion is a process that reduces the mass of biological solids generated during wastewater treatment. Settled sludge from the clarifier is processed aerobically (in the presence of oxygen) and ultimately disposed of to the sanitary sewer or sent for dewatering and disposal by other means.

Oil Recovery

Oil recovery processes are designed to extract usable crude oil and refined or partially refined petroleum products from liquid and solid materials. Using a two-tiered approach, liquid materials are transported to tanks and allowed to passively separate. Recoverable oil is removed after passive separation and returned to the refining process. Solid and semi-solid secondary materials generated at the refinery then may be processed either mechanically or mechanically and thermally to recover trapped oil.

Solid and Hazardous Waste Disposal

After refinery materials have been recycled and/or recovered to the greatest extent possible, they are sent off the refinery for disposal in accordance with federal, state and local regulations. When hazardous wastes are generated, they are appropriately manifested and transported to a licensed hazardous waste disposal site. For non-hazardous waste, disposal occurs at appropriate facilities.

APPENDIX - C

TABLES C-1 TO C-7

TABLE C-1

TOTAL REFINERY 1990 HAZARDOUS WASTE GENERATION

CWC	Waste	Amount (*) (Tons)
222	Oil/water separator sludge	103,347.0
122	Alkaline soln. without metals	48,377.5
221	Waste oils & mixed oils	31,343.7
241	Tank bottom waste	22,723.6
223	Unspecified oily waste	9,732.1
181	Other org. solids waste	9,612.8
132	Aqueous soln. with metals	8,480.9
162	Other spent catalyst	6,704.0
161	FCC waste	6,207.6
352	Other organic solids	4,318.5
441	Sulfur sludge	3,360.2
242(**)	Tank bottom waste	3,301.0
135	Unspecified aqueous solution	2,378.4
611	Contaminated soil from site clean-ups	2,231.7
512/513	Empty containers	979.4
343	Unspecified org. liq. mixture	888.1
491	Unspecified sludge waste	291.9
551	Laboratory waste chemicals	254.2
331	Off-spec., aged, or surplus organics	196.8
121	Alkaline solution (pH>12.5)	68.8
723	Liq. with chromium	50.0
571	Fly ash	38.2
141	Off-spec., aged, or surplus inorg.	33.0
726	Liq. with nickel >134 Mg/L	32.3
213	Hydrocarbon solvents	21.6
322	Biological waste	18.1
411	Alum and gyp. sludge	12.3
741	Liq. with halo. org. comp. > 1000 Mg/L	7.3
171	Metal sludge	6.0
581	Gas scrubber waste	5.9
792	Liq. with pH < 2 with metals	5.4
133	Aqu. soln. with total org. residue > 10%	4.8
461	Paint sludge	4.5
521	Drilling mud	1.7
281	Adhesives	1.5
791	Liq. with pH < 2	1.0
	TOTAL	265,045.0

(*) These quantities are total California refinery hazardous waste generation. Smaller wastestreams are not included in the SB 14 planning activity.

(**) Refinery assigned this CWC code to the specified waste stream. However, no such code exists.

TABLE C-2

TOTAL REFINERY 1990 EXTREMELY HAZARDOUS WASTE GENERATION

CWC	WASTE	AMOUNT (TONS)
512	Empty containers > 30 gallons	2.9
481	Tetraethyl lead sludge	1.0
725	Liquid with mercury > 20 Mg/L	0.6
551	Laboratory waste chemicals	0.1
	TOTAL	4.6

TABLE C-3

TOTAL OIL EXPLORATION COMPANY 1990 HAZARDOUS WASTE GENERATION

CWC	Waste	Amount (Tons)
181	Other inorg. solids waste	3198.4
571	Fly ash, bottom ash, and retort ash	2519.6
241	Tank bottom waste	881.5
581	Gas scrubber waste	382.7
223	Unspecified oil-containing waste	347.3
441	Sulfur sludge	330.0
726	Liquids with Nickel > 134 Mg/L	163.4
352	Other organic solids	56.0
135	Unspecified aqueous soln.	6.7
221	Waste oil and mixed oil	5.1
551	Laboratory waste chemicals	3.4
	TOTAL	7894.1

TABLE C-4

REFINERY 1990 MAJOR WASTE GENERATION

CWC	Waste	Quantity(*) (Tons)	% of Total Waste (**)
222	Oil/water separator sludge	102,837	38.8
122	Alkaline soln. without metals	48,196	18.2
221	Waste oils & mixed oils	31,300	11.8
241	Tank bottom waste	19,875	7.5
223	Unspecified oily waste	8,959	3.4
132	Aqueous. soln. with metals	8,481	3.2
181	Other org. solids waste	5,061	1.9
161	FCC waste	3,422	1.3
441	sulfur sludge	3,302	1.3
242(#)	Tank bottom sludge	3,301	1.3
162	Other spent catalyst	2,576	1.0
352	Other organic solids	1,394	0.5
343	Unspec. org.liq.mixture	712	0.3
512/513	Empty container	540	0.2
213	Hydrocarbon solvents	3	0.001

(*) These quantities were identified by refineries as major wastestream totals and therefore they do not include minor refinery generated wastestreams included in Table C-1.

(**) Table reports only major wastes; therefore total of percentage column is not 100.

(#) Refinery assigned this CWC code to the specified waste stream. However, no such code exists.

TABLE C-4 (CONT.)

REFINERY 1990 MAJOR WASTE GENERATION

CWC	No. of refineries claim major waste stream
222	13
122	3
221	1
241	3
223	3
132	3
181	5
161	2
441	2
242	1
162	5
352	3
343	2
512/513	1
213	1

TABLE C-5

INDIVIDUAL 1990 TOTAL REFINERY WASTE GENERATION
REPORTED UNDER SB 14

	Refinery	Waste Generation (Tons)
1.	Exxon, Benicia	49,171
2.	Shell, Martinez	48,462
3.	Shell, Carson, Wilmington	46,860
4.	Mobil Oil, Torrance	38,689
5.	Texaco, Los Angeles	28,015
6.	Arco, Los angeles	12,110
7.	Chevron, El Segundo	7,467
8.	Chevron, Richmond	7,301
9.	Texaco, Bakersfield	7,006
10.	Unocal, San Francisco	5,800
11.	Unocal, Los Angeles	4,625
12.	Ultramar, Wilmington	4,322
13.	Tosco, Martinez	2,539
14.	Golden West, Santa Fe Spring	1,354
15.	Unocal Santa Maria	1,325
	TOTAL	265,046

TABLE C-6

OIL EXPLORATION COMPANY 1990 MAJOR WASTE GENERATION

CWC	WASTE	QUANTITY(*) (TONS)	%(**) TOTAL
181	Other Inorganic Solid Waste	3198.4	40.5
571	Fly Ash, Bottom Ash	2519.4	32.9
241	Tank Bottom Waste	881.5	11.2
581	Gas Scrubber Waste	382.7	4.9

(*) These quantities were identified by refineries as major wastestreams totals and therefore they do not include minor refinery generated wastestreams included in Table C-1.

(**) Table reports only major wastes; therefore total of percentage column is not 100.

TABLE C-7

INDIVIDUAL 1990 TOTAL OIL EXPLORATION COMPANY WASTE GENERATION REPORTED UNDER SB 14

	Company	Waste Generation (Tons)
1.	Shell Western E & P	
	Multisite (6 sites)	4,155.8
	Huntington Beach	333.2
2.	Chevron U.S.A. (7 sites)	3,152.2
3.	Mobil, San Ardo	252.7
	TOTAL	7,893.9

APPENDIX - D

LIST OF SELECTED SOURCE REDUCTION MEASURES
CALIFORNIA PETROLEUM INDUSTRY

TABLE D-1

SELECTED MEASURE DESCRIPTION
REFINERIES

CWC	MEASURE	TYPE (*) APPROACH
222		
1.	"Stamp Out Waste" employee incentive program	AS
2.	Install new pumps for DAF flocculent injection	PC
3.	Dedicate area for maintenance and waste recovery	AS
4.	Asphalt ground cover for unpaved plant areas	OI
5.	Increase sludge coking injection rate	OI
6.	Increase thermal dryer capacity	OI
7.	Minimize use of soaps etc. that increase sludge	IC
8.	Use detector to reduce oil drainage during tank draws	OI
9.	Replace bauxite filters in finish process (study)	OI
10.	Install separate drainage system for stormwater	OI
11.	Improve FCC fines handling, reduce API load (study)	OI
12.	Reduce carbon load to API; install upstream settler	PC
13.	Modify sewer openings to reduce solids	IC
14.	Modify sewer near coker silo to remove solids	IC
15.	Use powered sweeper on refinery street (study)	IC
16.	Use auto. water draws on product & crude tanks	OI
17.	Improve flexicoker clarifier	OI
18.	Coat bare surface areas with gunite (study)	OI
19.	Reduce oil discharges to sewer (study)	OI
20.	Control hardness in cooling water (study)	OI
21.	Improve housekeeping, pave areas around sewers	IC
22.	Use adsorbent instead of sand to control spills	IC
23.	Use lead blanket to cover sewers during maintenance	IC
24.	Inject oily wastes into onsite coker	PC
25.	Install sewer inserts to catch solids (study)	IC
26.	Pave areas near sewer catch basins	IC
27.	Conduct sweeping prior to forecasted storms	OI
28.	Minimize soap use in process areas	AS
29.	Minimize precoat material in filter press	IC
30.	Pave areas near process and sewer drains	IC
31.	Use low temp. dryer to dry filter cake	PC
32.	Erosion control pipe trenches; install catch basins	OI
33.	Develop vacuuming pgm. to remove solids	OI
34.	Do not screen spent catalyst before shipping	OI
35.	Construct Mobil Oil Sludge Coking (MOSC) unit	PC
122		35
1.	Internally evaluate caustic treatment/handling	

		2
221		
1.	Improve Mobil oil sludge coking operation	OI
2.	Improve oil/water separation for coker blowdown	PC
3.	Reduce crude desalter oil undercarry	PC
		3
223		
1.	"Stamp Out Waste" pgm. with employee incentives	AS
2.	Dedicate area for resource recovery	OI
3.	Employee training for haz. waste reduction	AS
4.	Redefine components to reduce haz. waste	AS
5.	Pave roads within process area	OI
6.	Install filter cake thermal dryer	PC
7.	Install delayed coking unit oil emulsion injection	PC
8.	Install Howe-Baker desalter unit	PC
9.	Install oil emulsion breaking system	PC
10.	Utilize self-cleaning reusable filters	PC
11.	Replace ATS tail gas treatment unit with Claus-SCOT	PC
		11
132		
1.	Use global sulfur systems TTU to regenerate stretford	PC
2.	Install door sheets on 3 oxidizer tanks	OI
3.	Use global sulfur system to remove thiosulfates	OI
		3
181		
1.	"Stamp Out Waste" program with employee incentives	AS
2.	Change from Apache Blast to Kleen blast media	IC
3.	Segregate toxic sand blast media (study)	OI
4.	Recycle sludge as slagging substitute (study)	OI
5.	Stop adding quicklime, lower pH below 12.5	IC
6.	Segregate sand by paint type	OI
7.	Replace material with nonhazardous recyclable material	IC
8.	Self-certify Glauber salt as non-hazardous	AS
9.	Improve regeneration of stretford solution	IC
10.	Improve water washing of stretford filer cake	PC
11.	Use nonhazardous blasting media	IC
		11
161		
1.	Recycle FCC catalyst fines to Portland cement	OI
		1
441		
1.	Reuse sulfur at H_2SO_4 manufacturer	OI
		1
162		
1.	Extend catalyst life by feed quality monitoring	PC
2.	Evaluate segregation practices (study)	IC
3.	Recycle FCC waste to produce new catalyst (study)	OI
		3

352			
	1. Replace bauxite filters in finish process (study)	OI	
	2. Install separate drainage system for stormwater	OI	
	3. Improve FCC fines handling and reduce API load (study)	OI	
	4. Reduce carbon load to sumps (upstream settler)	PC	
	5. Phase out use of tetraethyl lead as octane enhancer	PR	
			5
343			
	1. Use crystallization unit to recover DEA	OI	
			1
135			
	1. Reduce frequency of washdowns	OI	
	2. Install new alkanolamine unit to reduce load	PC	
			2
725			
	1. Minimize mercury containing equipment purchases	AS	
			1
All			
	1. Implement site-wide minimization awareness pgm.	AS	
	2. Implement corporate "Wipe Out Waste" pgm	AS	
			2
		TOTAL(**)	81

(*) IC = Input Change, OI = Operational Improvement, PC = Production process change, PR = Product Reformulation, AS = Administrative steps. The approaches in this column are taken as they were described in generators' plans. They were not corrected; therefore this may not correlate with approaches shown in Tables 1 and 2.

(**) The total selected measures do not match with the total in Tables 3 and 4 because this table includes several "study" measures.

APPENDIX - E

FACT SHEET

FACT SHEET

PETROLEUM INDUSTRY

BACKGROUND

Hazardous waste generated by the petroleum industry comprises a significant portion of the hazardous wastes disposed of to land in California. These wastes consist of both federal and state only regulated hazardous waste. The more common hazardous wastes generated by petroleum industry include:

- wastewater treatment wastes (e.g. API separator sludge, dissolved air flotation sludge, slop oil emulsion solids and other sludges)
- Stretford and Unisulf solutions
- spent catalysts
- tank bottom waste
- shot and sand blasting aggregate
- filter media waste oils
- fly ash
- contaminated soils

SELECTED SOURCE REDUCTION MEASURES

The source reduction measures presented in this fact sheet were drawn from a review of eighteen California petroleum industry Source Reduction Evaluation Plans and Hazardous Waste Management Performance Reports. They represent the most significant of those reviewed in terms of reducing generated wastestreams. The selected source reduction measures are grouped and presented by the five approaches listed in the Hazardous Waste Source Reduction and Management Review Act of 1989 and regulations: product reformulations, input changes, operational improvements, production process changes, and administrative steps. The industry did not develop any source reduction measure in the category of product reformulation.

Product Reformulation

"Product reformulation" is defined as the changes in design, composition, or specifications of end products, including product substitution, so as to reduce, avoid, or eliminate the generation of hazardous waste.

Input Changes

"Input Changes" are defined as changes in raw materials or feedstocks used in a production process or operation so as to reduce, avoid, or eliminate the hazardous materials that enter the production process, thereby avoiding the generation of hazardous wastes within the production process.

Example:

Lime Removal-- A refinery's Additive Super Detergent plant (ASD) generates hazardous ASD filter cake. The filter cake is generated from solids removed from the product filtrate in a rotary drum filter and cake dryer. The solids are hazardous due to high pH from the presence of quicklime used to neutralize organic amine in the manufacture of ASD.

The filter cake may be rendered nonhazardous by eliminating the quicklime from the process. By removing quicklime from the process, the filter cake pH is lowered to less than 12.5 and is therefore nonhazardous. The refinery considers this to be a technically feasible measure without affecting product quality. This measure would be expected to reduce the amount of hazardous waste generation by 775 tons per year. The annual savings associated with this measure is about $200,000 per year, which is mainly due to avoiding waste disposal costs. There is no cost associated with implementation of this measure. No permits approvals or variances from state, local or federal agencies are required.

Operational Improvement

"Operational improvements" is defined as improved site management so as to reduce , avoid, or eliminate the generation of hazardous waste.

Examples:

Separate Drainage System Installation-- API separator sludge is a listed hazardous waste (K051). The hazardous constituents in this stream are hexavalent chromium and lead. API separator sludge is generated during the gravitational separation of waste solids from refinery process wastewater in the API separators. This waste stream is made up of tank water draw solids, rust, scale and other process equipment contaminants and soil runoff.

An intensive source reduction effort has been proposed by a refinery for the API separator sludge. The refinery will conduct sampling to determine sources of solids. One of the refinery's solids-control programs is a segregated stormwater system. This major project will prevent most of the rainfall which falls on the refinery grounds from being contaminated with process waste water by providing a seperate storm water collection system. This will reduce the amount of water that needs to be treated in

the refinery effluent system. It will also greatly reduce the amount of solids (dirt) that wash into the API separators and therefore reduce the amount of sludge formed. It is estimated that in some cases process sumps and API separator sludge volumes can be reduced by more than seven percent.

Paving-- Paving areas near process drains can reduce the amount of soil and dust which enters the refinery wastewater treatment system during washdown operations and storm events. Reducing the amount of soil and dust entering the process drains results in less oil/water/solid emulsions and sludge being formed. Past experiences with refinery sewer systems have indicated that one pound of solids results in the formation of five to ten pounds of sludge. It is estimated that up to ten percent of oil/water separation sludge can be reduced by implementing this measure.

Steam Generator Fuel System-- Scrubber waste (fly ash) is generated by the combustion of crude oil in the steam generators. The fly ash, is captured by the water used to scrub the effluent gases to reduce particulate air emissions. The fly ash settles out of the scrubber water in the waste water settling basins and in the waste water storage tanks (tank bottoms). Solids which settle out of scrubber effluent in the tanks and settling basins contain nickel and vanadium in quantities high enough to cause the stream to be classified as hazardous. At one petroleum company's oil field facility, steam generator fuel system conversion from crude oil to natural gas will eliminate the generation of fly ash and refractory waste by seven and twenty five percent respectively. This can result in waste disposal cost savings of up to $600,000 per year.

Production Process Changes

"Production Process Change" is defined as a change in a process, method, or technique which is used to produce a product or desired result, including the return of materials or their components for reuse within the existing processes or operations, so as to reduce, avoid, or eliminate the generation of hazardous waste.

Examples:

Recovery of Diethanolamiine (DEA) through Crystallization -- Spent DEA is a dilute solution of Diethanolamine which is generated in the refinery's hydrogen sulfide plant. This solution with an excess of 10% Diethanolamine is toxic per acute bioassay toxicity test. This waste stream may also contain benzene and exhibit the characteristic of reactivity. DEA is used by some refineries to remove hydrogen sulfide from refinery fuel gas and liquified petroleum gas streams. DEA is circulated until it becomes saturated with heat stable amine salts and is then drawn off as spent DEA. The crystallization unit can successfully

recover DEA, thereby reducing the amount of spent DEA, generated while separating contaminants. It is estimated that using crystallization process, one refinery can reduce spent DEA volume nearly 25 percent. Local air quality air permits may be required to conduct the DEA crystallization process.

Mobil Oil Sludge Coking (MOSC)-- Oil/water separator sludge contains significant levels of oil and solids. The presence of aromatic organic compounds in the oil and the concentration of heavy metals in these solids cause this waste stream to be hazardous. Refinery wastewater from various processes enters the wastewater treatment system via refinery sewer. These wastewaters contain oil and solids. The oily solids settle in the sewer sump, wastewater storage tank, API separator, and Dissolved Air Flotation units (DAF). These pieces of equipment are designed to provide sufficient residence time to gravity settle wastewater. These accumulating solids are routinely removed from the process equipment. Use of the patented MOSC process can enable reuse of oil/water separator sludges generated in the refinery. This process injects sludges into the coke drums during quench cycle used to produce petroleum coke. Here the water will be evaporated and eventually treated in the refinery wastewater treatment facilities. The separated oil is either coked or recovered for further refining, and the remaining solids become part of the coke product. This measure will both physically reduce the quantity of oily wastes treated by the wastewater system, and the amount of hazardous waste shipped offsite. The implementation of this measure can reduce the generation of oil/water sludges by up to 100 percent. Since these wastes are recycled onsite, the refinery may not require either federal or state hazardous waste treatment permit in this situation. However it is recommended that generator must meet the conditions required under California Health and Safety Code 25143.2. of the hazardous waste control law recycling exemptions. Construction of MOSC facilities will require an "Authority to Construct" from local Area Air Quality Management District.

Removal of Thiosulfates-- A program was developed at several refineries to routinely remove thiosulfates from Stretford solution using the Global Sulfur System (GSS). GSS' oxidation process is operated as a transportable treatment unit. The system can process approximately 6000 gallons per day of Stertford solution. The process uses sulfuric acid to oxidize sodium thiosulfate to sodium sulfate. The conversion of sodium thiosulfate to sodium sulfate is greater than 90% efficient. The resulting sodium sulfate is crystallized and filtered for removal. The Stretford solution can then be recycled for reuse. The removal of thiosulfates using the GSS will greatly reduce the need to purge Stretford solution to control the thiosulfate concentration, thereby greatly reducing the spent Stretford solution volume and saving the cost of purchasing new solution. Implementation of this measure can typically reduce the generation of spent Stretford solution by more than 50 percent.

Administrative Steps

"Administrative steps" is defined as regular operational practices, such as inventory controls and employee training programs, that apply to the operation of the facility and initiate, maintain and develop employee actions which avoid, reduce, or eliminate the generation of hazardous waste.

Example:

Revise Training Plans-- Petroleum refinery trash - frequently consists of hydrocarbon contaminated gloves, rags, wood, contaminated protective clothing etc. - which is generated inside the facility during routine operation. This stream is potentially toxic as determine by the bioassay test. An existing program at one refinery trains employees to recognize hazardous wastes and avoid discarding hazardous wastes with routine non hazardous trash. The separation of hazardous wastes from non-hazardous avoids the need to manage contaminated trash as hazardous. Revising training plans to recognize hazardous wastes for seperate management can decrease hazardous waste generation by more than 5 percent.

CONCLUSION

The source reduction measures described above illustrate ways in which the Petroleum Industry in California is reducing hazardous waste. The various reduction strategies discussed have resulted in reductions of hazardous waste generation from 5 to 100 percent. With current hazardous waste disposal costs for petroleum waste ranging from $100 to $230 per ton, these reductions could save a refinery $370,000 to $850,000 in disposal cost per year.

The mention of commercial products, patented processes, their source, or their use in connection with the material or equipment reported in this fact sheet are not to be construed as either an actual or applied endorsement of such products, processes or equipment.

APPENDIX - F

LIST OF REJECTED SOURCE REDUCTION MEASURES
CALIFORNIA REFINERIES

TABLE F-1

REJECTED SOURCE REDUCTION MEASURES BY CWC REFINERIES

CWC	MEASURE DESCRIPTION	No. Rejected
222	. Change crude oil type processed . Perform pH adjustment of segregated drainage flow . Addition of phosphonates to segregated drainage system flow . Clean, inspect, and repair segregated drainage system . Install automatic shutoff valves on crude oil draw tank and storage tanks . Install above ground coalescing plate separators . Replace separator centrifugal pumps with low shear pumps . Upgrade segregated drainage system separator . Use street sweepers around drainage area . Route sour water & ammonia/H2S effluent to refinery cooling towers . Modify jet clay washing procedures/equipment . Buy crude oil with lower solids content . Enclose bauxite conveyor belts . Reduce runoff by preparing ground cover on open area to retain water . Design catch basins to prevent solids from heat exchanger bundle to W.W. Treatment system . Asphalt paving of open areas to prevent dust . Plant groundcover in bare areas . Segregate sanitary sewer waste . Reduce cooling tower blowdown . Reduce boiler blowdown . Soften cooling water make-up . Demineralize boiler feed water . Paving of refinery pipeways . Tighten BS&W specs. for incoming crude . Develop refinery weed abatement pgm.	

	. Develop procedures to capture sand blast grit . Shut down delayed coking process unit . Enclose coke pits with curtains to reduce fines . Build pipeline to carry slurried coke to calciner . Replace existing delayed coker with Flexi-coker . Bring on-line new emulsion treating facilities . Investigate new MOSC II process . Install pumparound system on KOH regeneration tank	33
122	. Install MEA scrubber system . Merox process instead of REGEN process for caustic regeneration	2
221	. Change design or specif. of final or intermediate products . Change raw material or feedstock . Initiate admin. steps such as inventory control	3
241	. Limit crude rate . Buy crude with lower B S & W . Install rakes in crude tanks to remove solids . Change to lighter crude slate . Use desalter instead of chemical treatment in tankage . Improve sediments/contaminants removal at oil fields	6
223	. Waste segregation haz. vs. non hazardous . Water wash clay to remove hydrocarbons and recycle nonhaz. washed clay	2
132	. Combine acid wash and neutralization steps . Buy crude with lower solids content . Purtec system . Flexorb process . Superclaus modifications . Convert H2S to sulfur in Claus plant . Replace Claus/Beavon-Stretford with Unisulf plant	

	. Install washout facilities for vacuum trucks . Ship spent Stretford solution to Cri-Met . Regenerate spent soln. on-site using Dow Stretford . Use computer to optimize sulfur plant conversion	11
181	. Use ultra-high pressure hydroblasting . Use nonhazardous grit . Use longer lasting paints and coatings . Add dry acid to ASD filter cake . Recycle used sand . Install methyldiethanolamine (MDEA) tailgas treatment unit . Install molecular sieve dryer to feed alkylation unit	7
161	. Reuse spent catalyst in less critical processes within refinery . Explore more effective catalyst! . Recycle FCC catalyst fines to original . manufacturer . Research and develop more effective catalyst . Initiate admin. steps to reduce FCC waste . Modify process to reduce FCC fines formation	7
441	. Superclaus modifications . Flexsorb SE process . Sulfur filtration	3
162	. Use of alternative catalyst . Recycle spent catalyst at phosphorous manufacturer . Process non-metal catalyst through thermal oil recovery equipment . Regenerate spent catalyst through catalyst suppliers . Neutralize spent catalyst on site . Maximize process unit run lengths . Develop durable catalyst . Construct on-site catalyst regeneration facility	8
352	. Modify jet clay washing procedures/equipment . Buy crude with lower solids content . Enclose bauxite conveyor belts	

	. Initiate: a) operational improvement b) production process change and c) admin. steps	4
343	. Use reverse osmosis to remove contaminants from spent DEA . Carbon filtration to remove hydrocarbons promoting contaminant formation	2
512/513	. Recycle empty drums to reconditioner or metal reclaimer . Eliminate need for sodium arsenite by switching from MEA to MDEA	2
213	. Replace safety-kleen with reclaimable solvent	1
135	. Recycle spent Stretford solution . Replace Stretford melter with mechanical separator	2
	TOTAL	93