SAFETY INFORMATION PROFILE

Petroleum Refinery Turnaround

Robert Vandervort
Radian Corporation
Occupational Safety and Health Division
1864 South State Street, #200
Salt Lake City, Utah 84115

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Safety Research
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PREFACE

The information in this profile was prepared in accordance with the provisions of NIOSH Contract #210-78-0130-0000 and is only one of twenty-seven Industry Profiles prepared under the contract. The reader should understand that this study is not intended to be an in-depth analysis, but rather, a limited overview of the industry. Each individual profile was prepared by a Profile Manager utilizing approximately 45 hours of professional time. Each profile is a reflection of the available literature, and other information obtained from industry, government, and labor contacts. Information Profiles are primarily intended for use in determining future study needs, priorities and directions. From this preliminary study may come various in-depth studies such as criteria documents, technology assessments, epidemiological studies, etc.

Radian gratefully acknowledges the guidance and direction of Mr. Ted Pettit, Project Officer, and Ms. Pat Gussey, Assistant Project Officer. Radian also thanks the many industry labor and government officials who provided information and assistance on short notice.

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EXECUTIVE SUMMARY

This profile contains information describing turnaround work performed in petroleum refineries (SIC Code 291). There are in excess of 200 establishments in the United States which are currently engaged in petroleum refining. These establishments employ in excess of 90,000 persons. Refinery turnaround work involves a much smaller number of persons who are employed by the refining companies and outside contract service firms.

Turnaround work involves major maintenance of refinery units and equipment. Some turnaround work resembles construction activity. A wide variety of potential hazards are associated with turnaround work. At present, these hazards are being addressed through application of established work planning and performance procedures.

Very little information is available which describes employee injury and illness experience associated with refinery turnaround work. No studies are underway which will develop this type of information.

A. Standard industrial classifications and/or occupations included in coverage

291 Petroleum Refining

2911 Petroleum Refining

This profile covers the turnaround operations performed at petroleum refineries. By definition, petroleum refineries are "establishments engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants and other products from crude petroleum and its fractionation products, through straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes."(1)

Table 1 presents a list of petroleum refineries by company. Refinery locations are given together with refinery capacity and recent production of four categories of petroleum products. As can be seen from the table, several existing refineries are not operating and many others are primarily engaged in asphalt production.

A more recent tabulation of U.S. petroleum refineries can be found in the 1978-79 Worldwide Refining and Gas Processing Directory, 36th Edition, the Petroleum Publishing Company, 1421 South Sheridan, Tulsa, Oklahoma, 1978 pp. 12-24. This tabulation includes information

concerning the charge capacity of refinery unit operations and the production capacity with respect to classes of petroleum products.

The U.S. Bureau of the Census has tabulated information concerning employment and payroll amounts at petroleum refineries. This information is presented in Table 2. The relatively large number of total establishments and the inclusion of facilities with small total employment indicates that many of these establishments are not true petroleum refineries.

As part of an industrial hygiene characterization of petroleum refineries currently being conducted by NIOSH, an effort has been made to better estimate the number of persons employed in operating petroleum refineries. Employment estimates ranging from 90,000 to 135,000 persons working in approximately 210 operating refineries have been made.(3) The number of refinery production workers would be substantially less than these totals.

In many situations refinery turnaround operations will involve not only refinery personnel but contract personnel as well. These employees may work for contractors whose business activities fall under many different SIC codes. For example, construction companies often participate in turnaround activities and may involve a variety of subcontracted work such as vessel cleaning, electrical service, catalyst removal, refractory replacement, etc. No reasonable estimates of the numbers of contractor employees who become involved in petroleum refinery turnaround operations could be made.

Table 1
COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES (2)

	COMPANY	LOCATION	REFINERY CAPACITY (1) (m^3/day)	PRODUCTION CAPACITY			
				LUBES (1) (m^3/day)	ASPHALT (1) (m^3/day)	COKE (1) (metric tpd)	OPERATING GASOLINE OUTPUT (2) (m^3/day)
1.	Adobe Refining Co.	LaBlanca, Tex.	676	---	---	---	---
2.	Allied Materials Corp	Stroud, Okla.	875	143	192	---	---
3.	Amerada-Hess	Fort Reading, N.J.	11100	---	---	---	5090
4.		Purvis, Miss.	4530	---	---	291	2850
5.	American Petrofina	Eldorado, Kan.	3980	---	318	---	1690
6.		Mt. Pleasant, Tex.	4130	---	1270	---	1510
7.		Port Arthur, Tex.	13400	---	---	---	4170
8.	Amoco Oil	Savannah, Ga.	1910	---	1270	---	---
9.		Wood River, Ill.	17000	---	1720	---	5470
10.		Whiting, Ind.	50100	1380	4930	663	20000
11.		Baltimore, Md.	1590	---	1270	---	---
12.		Sugar Creek, Mo.	16700	---	1030	409	5950
13.		Mandan, N. Dakota	7630	---	---	---	3180
14.		Texas City, Tex.	52900	---	843	726	39400
15.		Salt Lake City, Utah	6200	---	398	---	2770
16.		Yorktown, Va.	8430	---	---	645	3820
17.		Casper, Wyoming	6840	204	246	---	1570
18.	APCO Oil Corp.	Arkansas City, Kan.	3980	---	223	---	2540
19.		Cyril, Okla.	1910	---	207	---	763
20.	Arizona Fuels Corp.	Fredonia, Ariz.	1590	---	---	---	---
21.		Roosevelt, Utah	1750	---	---	---	---
22.	Ashland Petroleum	Calettsburg, Ky.	21000	---	1590	---	8080
23.		Louisville, Ky.	3980	---	557	---	1370
24.		Tonawanda, N.Y.	10300	---	1590	---	3500
25.		Canton, Ohio	9540	---	1590	---	4370
26.		Findlay, Ohio (Seasonally)	1590	---	954	---	---
27.	Atlantic Richfield Co.	North Slope, Alaska	763	---	---	---	---
28.		Carson, Calif.	26200	---	---	1630	13700
29		East Chicago, Ind.	20000	---	1650	---	7600
30.		Philadephia, Penn.	29400	---	3100	---	12600
31.		Houston, Tex.	33900	1030	---	1180	20100
32.		Ferndale, Wash.	15300	---	---	1360	9740
33.	Atlas Processing	Shreveport, La.	4510	---	---	---	1270
34.	Bay Refining - Dow Chem.	Bay City, Mich.	2700	---	---	---	525
35.	Bayou State Oil Corp.	Hosston, La.	557	200	80	---	---
36.	Beacon Oil Co.	Hanford, Ca.	1910	---	---	---	411
37.	Berry Petroleum Co.	Stephens, Ark.	477	---	160	---	---
38.	Big West Oil Co.	Kevin, Mon.	815	---	52	---	216
39.	B. P. Oil Corp.	Marcus Hook, Penn.	15600	---	---	---	7710
40.	Bradford Petroleum	Bradford, Penn.	1110	493	---	---	286
41.	British Petroleum Co.	North Slope, Alaska	200	---	---	---	---
42.	Calumet Refining Co.	Princeton, La.	382	270	76	---	---
43.	Canal Refining Co.	Church Point, La.	398	---	---	---	200
44.	Caribou Four Corners, Inc.	Kirtland, N. Mex.	350	---	---	---	---
45.		Woods Cross, Utah	668	---	---	---	477

Table 1 Cont.

COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES (2)

	COMPANY	LOCATION	REFINERY[1] CAPACITY (m^3/day)	PRODUCTION CAPACITY			OPERATING[2] GASOLINE OUTPUT (m^3/day)
				LUBES[1] (m^3/day)	ASPHALT[1] (m^3/day)	COKE[1] (metric tpd)	
46.	Cenex	Laurel, Mon.	6680	---	---	---	3070
47.	Champlin Petroleum Co.	Corpus Christi, Tex.	9860	---	---	---	5100
48.		Wilmington, Calif.	4610	---	---	522	398
49.		Enid, Okla.	7870	175	223	150	5380
50.	Charter International Oil Co.	Houston, Texas	11100	---	636	---	4450
51.	Chevron Asphalt Co.	Baltimore Md.	2150	---	1750	---	---
52.	Chevron Oil Co.	Perth Amboy, N.J.	14000	---	3980	---	3420
53.		El Paso, Tex.	11300	---	795	---	5450
54.		Salt Lake City, Utah	7160	---	---	---	2850
55.	Cities Service Oil Co.	Lake Charles, La.	42600	1110	---	908	17300
56.	Clark Oil & Refining Corp.	Blue Island, Ill.	10800	---	716	---	7600
57.		Hartford, Ill.	5720	---	---	409	6480
58.	Coastal States Petrochemical Co	Corpus Christi, Tex.	21500	---	80	454	7080
59.	Continental Oil Co.	Billings, Mon.	8350	---	557	---	3380
60.		Commerce City, Colo.	4770	---	525	---	1700
61.		Ponca City, Okla.	18600	366	477	454	9410
62.		Westlake, La.	13200	---	---	454	5600
63.		Wrenshall, Minn.	3740	---	---	---	1060
64.	Cosden Oil & Chemical Co.	Big Spring, Tex.	10300	---	1270	---	8740
65.	Cotton Valley Solvents Co.	Cotton Valley, La.	1230	---	---	---	---
66.	CRA Inc.	Coffeyville, Kan.	5570	239	---	272	2860
67.		Phillipsburg, Kan.	3180	---	318	---	1510
68.		Scottsbluff, Neb.	795	---	---	---	350
69.	Cross Oil & Refining Co.	Smackover, Ark.	771	207	223	---	---
70.	Crown Central Petroleum Corp.	Houston, Texas	15900	---	---	272	8045
71.	Crystal Refining Co.	Carson City, Mich.	986	---	---	---	---
72.	Delta Refining Co.	Memphis, Tenn.	4610	---	477	---	2230
73.	Derby Refining Co.	Wichita, Kan.	4110	---	---	145	2020
74.	Diamond Shamrock Oil & Gas Co.	Sunray, Texas	7470	---	398	---	4130
75.	Douglas Oil Co. of Calif.	Paramount, Calif.	5570	---	2230	---	986
76.		Santa Monica, Calif.	1300	---	922	---	---
77.	Eddy Refining Co.	Houston, Texas	517	---	---	---	---
78.	Edgington Oil Co.	Long Beach, Calif.	4610	---	1190	---	---
79.	Edgington Oxnard Refinery	Oxnard, Calif.	398	---	---	---	---
80.	Evangeline Refining Co., Inc.	Jenings, La.	684	---	---	---	95
81.	Exxon Oil Co.	Benica, Calif.	13800	---	---	817	12000
82.		Baytown, Tex.	63600	3980	1910	---	26500
83.		Baton Rouge, La.	70800	2390	4600	1960	33000
84.		Billings, Mon.	7160	---	2070	227	3700
85.		Lindon, N.J.	43700	---	7310	---	18400
86.	Famariss Oil Corp.	Monument, N. Mex.	795	---	---	---	95
87.	Fletcher Oil & Refining Co.	Carson, Calif.	2510	---	---	---	557
88.	Flint Chem. Co.	San Antonio, Tex.	191	---	---	---	---
89.	Gary Western Co.	Grand Junction, Colo.	1320	---	---	363	---
90.	Getty Oil Co., Inc.	Delaware City, Del.	22300	---	---	1630	11700

Table 1 Cont.

COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES (2)

	COMPANY	LOCATION	REFINERY[1] CAPACITY (m^3/day)	PRODUCTION CAPACITY			
				LUBES[1] (m^3/day)	ASPHALT[1] (m^3/day)	COKE[1] (metric tpd)	OPERATING[2] GASOLINE OUTPUT (m^3/day)
91.	Gladieux Refinery	Fort Wayne, Inc.	1590	---	---	---	40
92.	Golden Bear, Div.	Oildale, Calif.	1670	636	509	---	---
93.	Golden Eagle Refining	Carson, Calif.	2070	---	---	---	---
94.	Good Hope Refineries	Good Hope, La.	4680	---	---	---	557
95.	Gulf Oil Co.	Sante Fe Springs, Calif.	8190	---	636	---	4530
96.		Belle Chasse, La.	28700	---	---	763	16900
97.		Venice, La.	4560	---	---	---	3550
98.		Cleves, Ohio	6690	---	461	---	3820
99.		Toledo, Ohio	8000	---	318	---	3790
100.		Philadelphia, Penn.	26800	---	---	---	15300
101.		Port Arthur, Tex.	49600	2010	---	1260	26500
102.	Hawaiian Indep. Ref.	Barber's Point, Hawaii	4770	---	---	---	---
103.	Howell Hydrocarbons	San Antonio, Texas	493	---	---	---	159
104.	Hunt Oil	Tuscaloosa, Ala.	2390	---	827	---	191
105.	Husky Oil	North Salt Lake, Utah	1830	---	---	---	652
106.		Cheyenne, Wy.	3750	---	477	---	2040
107.		Cody, Wy.	1700	---	636	---	763
108.	Ind. Farm Bur. Coop.	Mt. Vernon, Ind.	2390	---	---	---	906
109.	Jet Fuel Refinery	Mosby, Mon.	159	---	---	---	---
110.	Kern County Refining Co.	Bakersfield, Calif.	2050	---	---	---	509
111.	Kerr McGee Corp.	Cotton Valley, La.	1190	---	---	---	553
112.		Wynnewood, Okla.	5090	---	557	---	3930
113.	Koch Refining Co.	Pine Bend, Minn.	17000	---	3180	1180	6730
114.	LaGloria Oil & Gas Co.	Tyler, Texas	4450	---	---	73	2730
115.	LaJet Inc.	St. James, La.	1750	---	---	---	---
116.	Lakeside Refining Co.	Kalamazoo, Mich.	954	---	---	---	191
117.	Laketon Asphalt Refining, Inc.	Laketon, Ind.	1350	---	413	---	---
118.	Lion Oil Co.	El Dorado, Ark.	7000	127	954	---	2660
119.	Little America Refining Co.	Casper, Wy.	3500	---	318	---	1700
120.	Longview Refining Co.	Longview, Tex.	1050	---	---	---	239
121.	Lunday-Thagard Oil Co.	South Gate, Calif.	795	---	254	---	---
122.	MacMillan Ring - Free Oil Co, Inc.	Norphlet, Ark.	716	---	199	---	---
123.		Signal Hill, Calif.	1510	---	---	---	---
124.	Marathon Oil Co.	Robinson, Ill.	31000	---	---	817	11100
125.		Detroit, Mich.	9220	---	1380	---	4640
126.		Texas City, Texas	9700	---	---	---	3130
127.	Marion Corp.	Mobile, Ala.	2390	---	---	---	---
128.	Mid America Refinery Co., Inc.	Chanute, Kan.	493	---	---	---	---
129.	Midland Cooperatives, Inc.	Cushing, Okla.	3020	---	---	73	1540
130.	Mobil Oil Corp.	Ferndale, Wash.	11400	---	---	---	4320
131.		Beaumont, Texas	51700	1400	16	1090	25600
132.		Buffalo, N.Y.	6770	---	1190	---	3200
133.		Paulsboro, N.J.	15600	1020	---	885	5660
134.		Augusta, Kan.	7950	---	1270	---	3690
135.		Torrance, Calif.	19600	---	---	2540	14100

Table 1 Cont.

COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES(2)

	COMPANY	LOCATION	REFINERY CAPACITY (1) (m³/day)	PRODUCTION CAPACITY			
				LUBES (1) (m³/day)	ASPHALT (1) (m³/day)	COKE (1) (metric tpd)	OPERATING (2) GASOLINE OUTPUT (m³/day)
136.	Mobile Oil Corp., Inc.	Joliet, Ill.	27800	---	---	1540	14500
137.		East Chicago, Ind.	7470	---	---	---	3670
138.	Mohawk Petroleum Corp., Inc.	Bakersfield, Calif.	3510	---	---	---	350
139.	Mountaineer Refining Co., Inc.	LaBarge, Wy.	80	---	---	---	---
140.	Murphy Oil Corp.	Meraux, La.	14700	---	---	---	3690
141.		Superior, Wisc.	5880	---	1910	---	2240
142.	National Cooperative Ref. Assoc	McPherson, Kan.	8610	---	---	318	3350
143.	Navajo Refining Co.	Artesia, N. Mex.	3330	---	223	---	914
144.	Newhall Refining Co., Inc.	Newhall, Calif.	1190	---	477	---	---
145.	North American Petroleum Corp	Shallow Water, Kan.	795	---	---	---	---
146.	Northwestern Refining Co.	St. Paul Park, Minn.	9540	---	3500	---	3330
147.	OKC Refining Inc.	Okmulgee, Okla.	3420	---	223	---	1990
148.	Osceola Refining Co.	West Branch, Mich.	1510	---	---	---	---
149.	Pasco, Inc.	Sinclair, Wy.	6360	---	366	---	2630
150.	Pennzoil Co.	Rouseville, Penn.	1590	561	---	---	448
151.		Falling Rock, W. Va.	795	207	---	---	318
152.	Phillips Petroleum Co.	Borger, Tex.	15100	---	---	---	10600
153.		Kansas City, Kan.	13500	398	477	---	6121
154.		Great Falls, Mon.	906	---	127	---	262
155.		Woods Cross, Utah	3660	---	350	---	1750
156.		Sweeney, Texas	13500	---	---	---	9060
157.		Avon, Calif.	17500	266	---	1090	13600
158.	Plateau, Inc.	Bloomfield, N.Mex.	811	---	---	---	350
159.	Powerline Oil Co.	Santa Fe Springs, Calif.	4530	---	795	---	2130
160.	Pride Refining Inc.	Abilene, Tex.	2240	---	---	---	---
161.	Quaker State Oil Ref. Corp.	Emlenton, Penn.	528	270	---	---	169
162.		Farmers Valley, Penn.	1030	398	---	---	366
163.		Newell, W. Va.	1540	572	---	---	398
164.		St. Mary's, W. Va.	771	270	---	---	183
165.	Quintana-Howell	Corpus Christi, Tex.	1590	---	---	---	---
166.	Rock Island Refining Corp.	Indianapolis, Ind.	4690	---	477	---	2500
167.	Sage Creek Refining	Cowley, Wy.	159	---	---	---	---
168.	San Joaquin Refining	Oildale, Calif.	2700	---	534	---	---
169.	Sequoia Refining Corp.	Hercules, Calif.	4290	---	---	---	2660
170.	Seminole Asphalt Ref.	St. Marks, Fla.	795	---	398	---	---
171.	Shell Oil Co.	Martinez, Calif.	15900	716	1650	---	7880
172.		Wilmington, Calif.	15300	---	---	1630	7360
173.		Wood River, Ill.	41300	890	3580	---	24800
174.		Norco, La.	38200	---	954	817	20200
175.		Ciniza, N.Mex.	3180	---	134	---	1830
176.		Deer Park, Tex.	45800	954	604	---	19100
177.		Odessa, Tex.	5090	---	---	---	2420
178.		Anacortes, Wash.	14500	---	---	---	7710
179.	Skelly Oil Co.	El Dorado, Kan.	11700	---	---	454	6150
180.	Somerset Refinery	Somerset, Ky.	445	---	---	---	---
181.	Sound Refining Inc.	Tacoma, Wash.	718	302	413	---	---
182.	Southland Oil Co.	Crupp, Miss.	668	---	229	---	---

Table 1 Cont.

COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES (2)

	COMPANY	LOCATION	REFINERY[1] CAPACITY (m^3/day)	PRODUCTION CAPACITY			
				LUBES[1] (m^3/day)	ASPHALT[1] (m^3/day)	COKE[1] (metric tpd)	OPERATING[2] GASOLINE OUTPUT (m^3/day)
183.	Southland Oil Co.	Lumberton, Miss.	954	---	372	---	---
184.		Sandersville, Miss.	1750	---	554	---	---
185.	Southwestern Oil & Ref. Co.	Corpus Christi, Tex.	15900	---	---	---	3720
186.	Southwestern Ref. Co.	LaBarge, Wy.	52	---	---	---	---
187.	Standard Oil of Calif.	Kenai, Alaska	3500	---	48	---	---
188.		Bakersfield, Calif.	4130	---	175	---	1160
189.		El Segundo, Calif.	36600	---	1320	2000	21400
190.		Richmond, Calif.	30200	1590	1750	---	20300
191.		Barber's Point, Hawaii	6360	---	207	---	1860
192.		Portland, Oregon	2230	---	1370	---	---
193.		Richmond Beach, Wash.	716	---	636	---	---
194.	Standard Oil of Ky.	Pascagoula, Miss.	38200	---	---	---	22800
195.	Standard Oil of Ohio	Lima, Ohio	26200	334	---	554	8700
196.		Toledo, Ohio	19100	---	1110	590	8700
197.	Sun Oil Co.	Toledo, Ohio	19900	---	---	---	13800
198.		Duncan, Okla	7710	---	---	363	4390
199.		Tulsa, Okla.	14100	---	668	272	6420
200.		Marcus Hook, Penn.	26200	2700	1910	---	13500
201.	Sunland Ref. Co.	Bakersfield, Calif.	1400	---	---	---	151
202.	Suntide Refining	Corpus Christi, Tex.	9060	---	---	213	4710
203.	Temeco Oil Co.	Bakersfield, Calif.	191	---	---	---	---
204.		Chalmette, La.	15400	---	---	318	9810
205.	Tesoro-Alaskan Petr.	Kenai, Alaska	6040	---	---	---	---
206.	Tesoro Petroleum	Wolf Point, Mon.	398	---	---	---	---
207.		Carrizo Springs, Tex.	2070	---	---	---	---
208.		Newcastle, Wy.	1670	---	---	---	477
209.	Texaco, Inc.	Wilmington, Calif.	11900	---	---	1500	11800
210.		Lawrenceville, Ill.	13400	---	429	---	7080
211.		Lockport, Ill.	11400	---	---	272	5990
212.		Convent, La.	22300	---	---	---	1230
213.		Westville, N.J.	14000	---	---	---	5250
214.		Anacortes, Wash.	10000	---	---	---	3550
215.		Casper, Wy.	3340	---	239	114	1500
216.		Port Arthur, Tex.	64600	3180	---	---	26200
217.		Amarillo, Tex.	3180	---	---	91	1620
218.		El Paso, Tex.	2700	---	---	91	1510
219.		West Tulsa, Okla.	7950	---	---	---	3580
220.		Port Neches, Tex.	7470	---	1430	---	---
221.	Texas Asphalt & Ref. Co.	Fort Worth, Tex.	477	---	---	---	---
222.	Texas City Refining	Texas City, Tex.	9540	---	---	---	3550
223.	The Refinery Corp.	Commerce City, Colo.	2780	---	---	---	2590
224.	Three Rivers Refinery	Three Rivers, Tex.	238	127	19	---	---
225.	Thriftway Co.	Bloomfield, N. Mex.	338	---	---	---	---
226.	Tonkawa Refining	Tonkawa, Okla.	954	---	---	---	---
227.	Toscopetro Corp.	Bakersfield, Calif.	4220	---	---	191	4300
228.	Total Leonard, Inc.	Alma, Mich.	6500	---	477	---	3530
229.	U.S. Oil & Refining	Tacoma, Wash.	2540	---	477	---	398

Table 1 Cont.

COMPLETE LIST OF UNITED STATES REFINERIES BY COMPANIES(2)

	COMPANY	LOCATION	REFINERY CAPACITY (m³/day)[1]	PRODUCTION CAPACITY			
				LUBES[1] (m³/day)	ASPHALT[1] (m³/day)	COKE[1] (metric tpd)	OPERATING GASOLINE OUTPUT[2] (m³/day)
230.	Union Oil Co. of Calif.	Los Angeles, Calif.	17200	---	1590	---	8780
231.		San Francisco, Calif.	17600	572	978	1680	11100
232.		Lemont, Ill.	24200	---	318	908	11300
233.		Nederland, Tex.	18400	557	859	---	8060
234.	Union Texas Petroleum	Winnie, Tex.	1510	---	---	---	1256
235.	United Refining Co.	Warren, Penn.	6040	---	636	---	2290
236.	Valvoline Oil Co.	Freedom, Penn.	986	207	---	---	---
237.	Vickers Petroleum	Ardmore, Okla.	5000	---	795	---	2610
238.	Vulcan Asphalt Ref.	Cordova, Ala.	477	---	---	---	---
239.	Warrior Asphalt Co.	Holt, Ala.	385	---	274	---	---
240.	West Coast Oil Co.	Bakersfield, Calif.	2540	---	636	---	318
241.	Westco Refining Co.	Cut Bank, Mon.	741	---	---	---	242
242.	Westland Oil Co.	Williston, N.D.	741	---	---	---	318
243.	Winston Refining	Fort Worth, Tex.	2390	---	---	---	405
244.	Wireback Oil Co.	Plymouth, Ill.	238	---	---	---	---
245.	Wolf's Head Oil Ref.	Reno, Penn.	334	80	---	---	---
246.	Yetter Oil Co.	Colmar, Ill.	159	---	---	---	---
247.	Young Refining Corp.	Douglasville, Ga.	398	---	207	---	---
	TOTAL		2262854	32531	107073	39628	1052858

Source: (1) "Annual Refining Survey," Oil & Gas J. 1 April 1974.

(2) National Petroleum News, Fact Book, Mid-May 1974, N.Y., McGraw-Hill, 1974.

UNITED STATES - ESTABLISHMENTS, EMPLOYEES, AND PAYROLL BY INDUSTRY BY EMPLOYMENT - SIZE CLASS: 1976

TABLE 2

(Excludes government employees, railroad employees, self-employed persons, etc. - see "General Explanation" for definitions and statement on reliability of data. Size class 1 to 4 includes establishments having payroll but no employees during mid-March pay period. "D" denotes figures withheld to avoid disclosure of operations of individual establishments, the other alphabetics indicate employment-size class - see footnote.)

SIC code	Industry, establishments, employees, and payroll	Total	Employment-size class								
			1 to 4	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250 to 499	500 to 999	1000 or more
291	Petroleum Refining										
	Number of Establishments	413	67	25	28	70	44	66	55	36	22
	Number of Employees	104,350	(D)	166	386	2,427	3,448	11,318	18,954	25,340	(D)
	Payroll, first quarter ($1000)	467,969	(D)	532	1,327	8,865	13,163	46,954	85,618	115,744	(D)
	Payroll, annual ($1000)	1,914,861	(D)	2,396	5,329	37,805	55,896	192,769	352,405	455,821	(D)

A: 0-19; B: 20-99; C: 100-249; E: 250-499; F: 500-999; G: 1,000-2,499; H: 2,500-4,999; I: 5,000-9,999; J: 10,000-24,999; K: 25,000-49,999: L: 50,000-99,999; M: 100,000 or more.

U.S. Bureau of the Census, County Business Patterns, 1976, Table 1B.

B. Process Descriptions

Petroleum refinery turnaround is the general title given to a range of activities and operations periodically performed at petroleum refining establishments. These activities are generally related to maintenance of the refinery but may involve new construction, redesign of existing equipment, etc.

All refineries must devote substantial attention to maintenance activities. Large portions of refinery workforces are assigned to routine and emergency maintenance operations. Emergency maintenance would normally be associated with an unforeseen event such as a ruptured line, fire, etc. Routine maintenance may involve relatively minor day-to-day activities or major maintenance activities involving the shutdown and repair of processing units or the entire refinery. These latter major maintenance activities are commonly referred to as refinery turnaround.(4)

Refinery turnarounds usually involve segments, units, or portions of a refinery while the remainder of the refinery continues to operate. Small refineries may entirely shutdown during turnaround.(5)

Refinery turnarounds are performed for a variety of reasons:(5)

(1) To maintain the integrity of a unit by performing repairs on equipment which cannot be accomplished while the unit is in operation.
(2) To perform periodic tasks such as catalyst change.
(3) To modify or expand the process in response to market changes, relief of process bottlenecks or changes in product specification.
(4) To inspect and repair relief and flare systems.

Turnaround operations consist of frequently performed work tasks which are conducted in a relatively small work area, in a relatively short time by a relatively large number of people. Completion of individual tasks usually involves adherence to established permitting policies and work procedures.(5) Turnaround activities can be performed in total or in part by outside contractors. Procedures vary from refinery to refinery depending on the individual refiner's practices.(4)

Unit shutdown and startup procedures are involved in refinery turnaround. The ILO (6) suggests that shutdown procedures should include:

(1) Advance preparation at the unit.
(2) Preparation by other departments whose operations will be affected.
(3) Written procedures to be strictly followed.
(4) Check-off lists to show the sequence of events and ensure continuity of work between shifts.

The ILO (6) further states that shutdown procedures should include the following consecutive phases: "cutting out the feed; cooling and de-pressuring; pumping out; removal of residual hydrocarbons; removal of corrosive or poisonous materials; disposal of water; 'blinding' (sealing-off of a flanged joint by insertion of a solid plate; also known as 'blanking-off') and opening; removal of pyrophoric iron sulfide; in-spection for entering."

Similarly the ILO(6) states that startup procedures should include the following consecutive phases: "preliminary preparations; preparation of auxilliary equipment and services; elimination of air; tightness testing; backing in fuel gas; elimination of water; bringing unit on stream."

The point at which normal shutdown procedures terminate and turnaround procedures take over is debatable. Obviously, there are circumstances which require units to be shutdown which do not involve their turnaround in terms of major maintenance. These circumstances are considered to be a part of normal refinery operation by some refiners and are addressed in standard operating procedures.(5)

There are a number of tasks and activities encountered refinery turnaround which are outlined in the paragraphs to follow:(5)

(1) General preparation.

(a) Unit shutdown

- o Take unit off line. (May take hours to a week following established shutdown procedures).

(b) "Plot limit blinding"

- o Disconnect utilities
- o Blind off process flows
- o Pump liquid materials out of lines
- o Send vapors to flare
- o Remove heavy materials according to waste management plan.

(c) Decontamination

- o Nitrogen purging
- o Washing of system with solvent or water
- o Special methods to clean variety of units
- o Strive to terminate decontamination procedures with nitrogen purge or water wash.
- o Decontamination may take a shift to a week, typically several shifts.

(2) Equipment preparation

(a) The following general categories of equipment must be prepared for work to be performed during turnaround

- o Heat exchangers - clean, inspect, repair
- o Columns and vessels - clean, inspect, repair
- o Rotating equipment (pumps, compressors, mixers, agitators, conveyors, turbines).

- o Relief valves - remove, overhaul, reset, test, reinstall.
- o Shutdown systems - checkout and repair
- o Relief system and flare-inspect and repair (sometimes one flare will serve several units requiring multi-unit shutdown to properly service the flare system)
- o Catalyst change - hydro-treating catalyst, reforming catalyst, catalytic crackers (unique catalyst handling problems)
- o Unit modification - improvements predicated by economic, energy, environmental, or market considerations.
- o Utility systems - inspection and repair

Instrumentation can be routinely maintained throughout normal operation. Alarm systems are part of the shutdown system which can be tested routinely.

C. Potential Hazards

Refinery turnaround activities involve a wide variety of potential safety and health hazards. Although confined space entry is involved in turnaround activities, not all turnaround work is conducted in confined spaces.

Hazard potential is somewhat increased by the fact that turnaround operations involve relatively large numbers of employees working in relatively small areas of the refinery. Materials handling equipment (cranes, etc.) may in some cases further reduce the available workspace.

It is not within the scope of this profile to delineate all of the potential hazards associated with turnaround operations. Some general information is available in relatively well known published sources.(2,6,7,8)

The outline of activities encountered in refinery turnaround which was presented in the preceding section of this profile helps to define situations where employees may be exposed to safety and health hazards.

Table 3 presents a list of unit operations which are common to many refineries. Table 4 presents a list of substances or classes of substances which may be emitted from the component process modules delineated in Table 3. Turnaround operations could expose employees to these and other substances emitted during decontamination, welding, etc.

Table 5 shows a list of trace elements commonly found in crude oil. These elements can accumulate in various portions of refinery equipment and can cause special problems during refinery turnaround activities such as welding and cutting.

Safety hazards associated with refinery turnaround are extremely diverse. The following list is provided to give examples of common turnaround safety hazards. No attempt has been made to order these hazards in terms of relative importance.

(1) Fire and explosion (hydrocarbons, etc.)
(2) Work in confined spaces (tanks, vessels, etc.)
(3) Walking and working surfaces (ladders, scaffolds, etc.)
(4) Means of egress (manholes, etc.)
(5) Powered work platforms (aerial lifts, etc.)
(6) Hazardous materials (flammable and combustible liquids, compressed gases, etc.)
(7) Compressed air equipment
(8) High pressure water equipment
(9) Materials handling (cranes, hoists, lift trucks, etc.)
(10) Hand and portable powered tools and other hand-held equipment
(11) Welding, cutting, brazing
(12) Sandblasting and abrasive blasting
(13) Electrical hazards
(14) Hazards associated with utilities (water, steam, gas, etc.)
(15) Inert gases
(16) Corrosives

TABLE 3: Component Process Modules Common to Petroleum Refining(2)

Crude Separation

- Process No. 1 - Crude Storage
- Process No. 2 - Desalting
- Process No. 3 - Atmospheric Distillation
- Process No. 4 - H_2S Removal
- Process No. 5 - Sulfur Recovery
- Process No. 6 - Gas Processing
- Process No. 7 - Vacuum Distillation
- process No. 8 - Hydrogen Production

Light Hydrocarbon Processing

- Process No. 9 - Naptha Hydrodesulfurization
- Process No. 10 - Catalytic Reforming
- Process No. 11 - Isomerization
- Process No. 12 - Alkylation
- Process No. 13 - Polymerization
- Process No. 14 - Light Hydrocarbon Storage and Blending

Middle and Heavy Distillate Processing

- Process No. 15 - Chemical Sweetening
- Process No. 16 - Hydrodesulfurization
- Process No. 17 - Fluid Bed Catalytic Cracker
- Process No. 18 - Moving Bed Catalytic Cracker
- Process No. 19 - Hydrocracking
- Process No. 20 - Lube Oil Processing
- Process No. 21 - Lube and Wax Hydrotreating
- Process No. 22 - Middle and Heavy Distillate Storage and Blending

TABLE 3 (continued)

Residual Hydrocarbon Processing

- Process No. 23 - Deasphalting
- Process No. 24 - Asphalt Blowing
- Process No. 25 - Residual Oil Hydrodesulfurization
- Process No. 26 - Visbreaking
- Process No. 27 - Coking
- Process No. 28 - Residual Hydrocarbon Storage and Blending

Auxilliary Processes

- Process No. 29 - Wastewater Treating
- Process No. 30 - Steam Production
- Process No. 31 - Process Heaters
- Process No. 32 - Pressure Relief and Flare Systems

Table 4: HAZARDOUS CHEMICALS POTENTIALLY EMITTED FROM PROCESS MODULES (2)

Chemical	Potential Emission Source Process Module Numbers
Maleic Acid	1,2,3,4,7,16,17,18,19,20,22,23,24,25,26,27,28,30
Benzoic Acid	1,2,30
Cresylic Acid	3,7,16,17,18,19,20,22,23,24,25,26,27,28,30
Acetic Acid	4,30
Formic Acid	4,30
Sulfuric Acid	27,30
Diethylamine	4,5,30
Methylethylamine	4,5,30
Aromatic Amines	18,19,26,30
Ammonia	3,5,7,16,17,18,19,20,22,23,24,25,26,27,30
Chlorides	1,2,30
Sulfates	27,30
Chromates	30
Ketones	1,2,3,7,16,17,18,19,20,22,23,24,25,26,27,30
Aldehydes	1,2,3,7,16,17,18,19,20,22,23,24,25,26,27,30,32
Formaldehyde	18,19,26
Acetaldehyde	18,19,26
Carbon Monoxide	5,9,10,12,13,16,17,18,19,20,22,24,25,26,27,32
Sulfur Oxides	5,10,13,16,17,18,19,20,22,24,25,26,27,32
Nitrogen Oxides	31,32
Pyridines	1,2,3,7,16,17,18,19,20,22,23,24,25,26,27,28,30
Pyrroles	1,2,3,7,16,17,18,19,20,22,23,24,25,26,27,28,30
Quinolines	28,30
Indoles	18,19,26,30
Furans	28,27,30
Benzene	1,2,3,7,10,13,14,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30
Toluene	1,2,3,7,10,13,14,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30
Xylene	1,2,3,7,10,13,14,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30
Phenol	1,2,7,18,19,25,26,28,30
Dimethylphenol	1,2,27
Cresols	1,2,7,18,19,25,27,28,30
Xylenols	7,18,19,25,26,27,28,30
Thiophenols	26,30
Carbazoles	1,2,28,30
Anthracenes	1,2,18,19,26,28,30
Benzo(a)pyrene	18,19,25,28,32
Pyrene	18,19,26,30
Benzo(e)pyrene	18,19,26
Perylene	18,19,26,30
Benzo(ghi)perylene	18,19
Coronene	18,19,26
Phenanthrene	18,19,26
Fluoranthrene	18,19,26
Metalloporphrins	1,2,30
Nickel Carbonyl	10,16,17,20,22,24,27
Cobalt Carbonyl	10,16,17,20,22,24,27
Tetraethyl Lead	14,21
Sulfides	3,7,15,16,17,18,19,20,22,23,24,25,26,27,28,29,30
Sulfates	30
Sulfonates	3,7,16,17,18,19,20,22,23,24,25,26,27,28,29,30
Sulfones	30
Mercaptans	1,10,15,26,30
Thiophenes	1,2,3,7,16,17,18,19,20,22,23,25,25,26,27,28,30
Hydrogen Sulfide	1,3,5,7,10,13,15,16,17,18,19,20,22,23,24,25,26,27
Methylmercaptan	3,4,7,16,17,18,19,20,22,23,24,25,26,27
Carbon Dilsulfide	4,5,10,16,17,18,19,20,22,24,27
Carbonyl Sulfide	4,5,10,13,16,17,18,19,20,22,24,27
Thiosulfide	4
Dibenzothiophene	28
Alkyl Sulfide	28
Vanadium	1,2,10,16,17,18,19,20,22,24,25,26,27,28,30,32
Nickel	1,2,10,16,17,18,19,20,22,24,25,26,27,28,30,32
Lead	1,2,32
Zinc	1,2,18,19,25,26,28,30
Cobalt	10,16,17,20,22,24,27
Molybdenum	10,16,17,20,22,24,27
Copper	18,19,25,26,28,30,28
Strontium	28
Barium	28
Sulfur Particulates	5
Catalyst Fines	9,10,12,16,17,18,19,20,22,24,27
Coke Fines	10,16,17,20,22,24,25,26,27,32
Cyanides	4,5,18,19,26,30

Source: Cavanaugh, G., et al, Potentially Hazardous Emissions From the Extraction and Processing of Coal and Oil, EPA-650/2-75-038, Austin, Texas, Radian Corporation, and Columbus, Ohio, Battelle - Columbus Labs. (April 1975).

TABLE 5: Trace Elements Commonly Found in Crude Oil(2)

Iron
Calcium
Magnesium
Silicon
Aluminum
Vanadium
Nickel
Copper
Manganese
Strontium
Barium
Boron
Cobalt
Zinc
Molybdenum
Lead
Tin
Sodium
Potassium
Phosphorus
Lithium

NOTE: Elements are presented in decreasing order with regard to their presence in crude oil.

D. Existing Hazard Control

Control of hazards associated with refinery turnaround activities usually involves the application of routine refinery health and safety practices which are followed during less major maintenance activities. Safe work practices for the petroleum refinery industry have been emphasized by safety and health organizations and by industry associations.

Conversations with several health and safety professionals in the petroleum refinery industry indicated that almost all routine maintenance is covered in refinery manuals which spell out checklists, procedures, etc. These manuals have been developed through application of safety and health hazard control principles to specific work tasks. The ILO (6) discusses some of these basic principles which include: written work plans; blinding or blanking off; electrical lockouts; gas tests; hot work permits; protective clothing and equipment; ventilation; etc.

The American Petroleum Institute (API) has published a variety of materials to assist refining companies in development of comprehensive safe work practices and procedures. The ultimate effectiveness of these procedures is, of course, dependent on the degree of their implementation and updating as circumstances change.

Publications available from API are listed in their Publications and Materials 1978 which is a catalog which provides brief abstracts and ordering information. The following publications would appear to be applicable to controlling hazards associated with refinery turnaround.

Refining

Guide for Inspection of Refinery Equipment (20 Chapters)

- Chapter I - Introduction
- Chapter II - Conditions Causing Deterioration or Failures
- Chapter III - General Preliminary and Preparatory Work
- Chapter IV - Inspection Tools
- Chapter V - Preparation of Equipment for Safe Entry and Work
- Chapter VI - Pressure Vessels (Towers, Drums, and Reactors)
- Chapter VII - Heat Exchangers, Condensers, and Cooler Boxes
- Chapter VIII - Direct-Fired Boilers and Auxiliary Equipment
- Chapter IX - Fired Heaters and Stacks
- Chapter X - Pumps, Compressors, and Blowers, and Their Drivers
- Chapter XI - Pipe, Valves, and Fittings
- Chapter XII - Foundations, Structures, and Buildings
- Chapter XIII - Atmospheric and Low-Pressure Storage Tanks
- Chapter XIV - Electrical Systems
- Chapter XV - Instruments and Control Equipment
- Chapter XVI - Pressure-Relieving Devices
- Chapter XVII - Auxiliary and Miscellaneous Equipment
- Chapter XVIII - Protection of Idle Equipment
- Chapter XIX - Inspection for Accident Prevention
- Chapter XX - Inspection for Fire Protection
- Appendix - Inspection of Welding

Std. 615, Sound Control of Mechanical Equipment for Refinery Services, 1973

RP 500A, Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries, Third Edition, 1966. (Intended to serve as supplement to the National Electrical Code).

RP 2001, Fire Protection in Refineries, Fifth Edition, 1974

RP 2003, Protection Against Ignitions Arising Out of Static, Lighting, and Stray Currents, Third Edition, 1974

Publ 2009, Safe Practices in Gas and Electric Cutting and Welding in Refineries, Gasoline Plants, Cycling Plants and Petrochemical Plants, Fourth Edition, 1976

Publ 2015, Cleaning Petroleum Storage Tanks, Second Edition, 1976

Publ 2015A, A Guide for Controlling the Lead Hazard Associated with Tank Entry and Cleaning, 1975

Publ 2023, Guide for Safe Storage and Handling of Heated Petroleum - Derived Aspnalt Products and Crude Oil Residual, 1977

Publ 926, Digest of State Inspection Laws Relating to Petroleum Products

Publ 928, Hydrocarbon Emissions from Refineries, 1973

Bull 2511, Precautionary Labels, Fourth Edition

EA 7103, Health Aspects of Petroleum Asphalt

EA 7301, Guidelines on Noise

EA 7501, Industrial Hygiene Monitoring Manual for Petroleum Refineries and Selected Petrochemical Operation

Bull 2007, Safe Maintenance Practices in Refineries, 1962

Several health and safety professionals employed by refining companies stated that control of contractor activities associated with refinery turnaround was much more difficult than surveillance of operations performed by refinery personnel. Various reasons were stated for this reported difficulty. Among them were:

(1) Many refinery turnaround contractors do not have strong or rigorous safety and health programs.

(2) Significant numbers of contractor personnel may be new hires who have had little or no experience in refinery turnaround work.

The effectiveness of existing hazard control measures can not be determined at this time since meaningful statistics covering turnaround work are unavailable.

E. Accident and Illness Statistics

Specific injury and illness statistics for refinery turnaround activities are unavailable from published sources. Due to OSHA's interest in development of refinery turnaround standards, individual refining companies may begin to keep records of injuries and illnesses associated with turnarounds.(9) Several health and safety professionals within the refining industry indicated that the health and safety programs for refinery personnel were generally much better than those for contractor personnel. However, it was indicated that some of the larger contract firms with established safety and health programs may be keeping statistics on refinery turnaround activities.

Table 6 presents some general information concerning disabling occupational injuries and illnesses which were incurred by workers employed in petroleum refineries within the state of California. These general statistics would include cases related to turnarounds and are broken out by agency, accident type, nature of injury and part of body.

Table 7 presents injury and illness information for SIC Code 291 (petroleum refining) and SIC Code 29 (petroleum and coal products). The statistics for SIC Code 291 include injury and illness experience for all refinery employees and operations.

Table 8 presents injury information for SIC Codes 291 and 29. Some general improvement in injury and illness experience is indicated to have occurred from 1975 to 1977 provided that reporting practices were consistent during this period.

Comparison of the information contained in Table 7 to that in Table 8 indicates that injuries appear to be more significant in terms of incidence rates than illnesses.

Table 9 presents injury and illness incidence rates by plant employment size for SIC Code 291. The data presented in this table indicate that larger refineries are experiencing better incidence rates than relatively smaller refineries.

TABLE 6

DISABLING OCCUPATIONAL INJURIES AND ILLNESSES* UNDER WORKERS' COMPENSATION, INDUSTRY BY AGENCY
CALIFORNIA, 1975

INDUSTRY	FATAL	TOTAL	MACHINES	HOISTING APPARATUS, CONVEYORS, ELEVATORS	VEHICLES	HAND TOOLS	CHEMICALS, HOT, INJURIOUS SUBSTANCES	WORKING SURFACES	LADDERS	CONTAINERS (FILLED OR UNFILLED)	LUMBER, LOGS, TREES	OTHER AGENCIES	AGENCY NOT STATED
PETROLEUM REFINING AND RELATED INDUSTRIES	2	511	32	14	32	58	59	121	8	46	5	125	11
PETROLEUM REFINING	1	362	10	8	19	41	46	98	7	25	4	99	5

DISABLING OCCUPATIONAL INJURIES AND ILLNESSES* UNDER WORKERS' COMPENSATION, INDUSTRY BY ACCIDENT TYPE
CALIFORNIA, 1975

INDUSTRY	TOTAL	STRUCK BY OR STRIKING AGAINST	CAUGHT IN OR BETWEEN	FALL OR SLIP	ACCIDENT INVOLVING MOVING MOTOR VEHICLE	STRAIN OR OVER-EXERTION	CONTACT WITH TEMPERATURE EXTREME	CONTACT WITH RADIATION, CAUSTIC, TOXIC OR NOXIOUS SUBSTANCE	CONTACT WITH ELECTRIC CURRENT	EXPLOSION, FLAREBACK, ETC.	FOREIGN SUBSTANCE IN EYE	OTHER	ACCIDENT TYPE NOT STATED
PETROLEUM REFINING AND RELATED INDUSTRIES	511	104	29	135	13	135	35	22	2	4	19	4	9
PETROLEUM REFINING	362	67	13	107	6	98	25	19	2	3	14	4	4

DISABLING OCCUPATIONAL INJURIES AND ILLNESSES* UNDER WORKERS' COMPENSATION, INDUSTRY BY NATURE OF INJURY
CALIFORNIA, 1975

INDUSTRY	TOTAL	AMPUTATIONS, LOSS OF, LOSS OF USE OF	BURNS AND SCALDS	CUTS, LACERATIONS, PUNCTURES, ABRASIONS	STRAINS, SPRAINS, DISLOCATIONS, HERNIAS	CRUSHING INJURIES	FRACTURES	OCCUPATIONAL DISEASES	BRUISES, CONTUSIONS	EYE INJURIES, N.E.C.	OTHER	NATURE OF INJURY NOT STATED
PETROLEUM REFINING AND RELATED INDUSTRIES	511	2	54	42	220	11	41	14	77	20	6	24
PETROLEUM REFINING	362	-	40	32	160	7	32	14	46	15	5	11

DISABLING OCCUPATIONAL INJURIES AND ILLNESSES* UNDER WORKERS' COMPENSATION, INDUSTRY BY PART OF BODY
CALIFORNIA, 1975

INDUSTRY	FATAL	TOTAL	EYES	HEAD, FACE, NECK	BACK AND SPINE	TRUNK	UPPER EXTREMITIES	LOWER EXTREMITIES	BODY, N.E.C.	PART NOT STATED
PETROLEUM REFINING AND RELATED INDUSTRIES	2	511	25	47	132	48	111	126	15	7
PETROLEUM REFINING	1	362	18	39	99	34	72	85	12	3

* DISABILITY CAUSING ABSENCE FROM WORK FOR A FULL DAY OR SHIFT BEYOND THE DAY OF THE INJURY. EXCLUDES INJURIES TO EMPLOYEES NOT COVERED BY THE CALIFORNIA WORKERS' COMPENSATION ACT SUCH AS MARITIME WORKERS, FEDERAL EMPLOYEES, AND RAILROAD EMPLOYEES IN INTERSTATE COMMERCE.

California Work Injuries and Illnesses 1975. State of California, Agriculture and Services Agency, Department of Industrial Relations, Department of Labor Statistics and Research, San Francisco, CA, August, 1977. Tables 8 to 11.

OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES, PRIVATE SECTOR, BY INDUSTRY, UNITED STATES, 1975 AND 1976

Industry 1/	SIC code 2/	1976 annual average employment (in thousands) 3/	Incidence rates per 100 full-time workers 4/							
			Total cases 5/		Lost workday cases		Nonfatal cases without lost workdays		Lost workdays	
			1975	1976	1975	1976	1975	1976	1975	1976
Petroleum Refining	291	157.5	7.1	5.8	2.5	2.5	4.6	3.2	54.7	47.8
Petroleum and Coal Products	29	199.3	9.0	7.9	3.1	3.2	5.8	4.7	65.3	62.5

1/ Totals for divisions and 2- and 3-digit SIC codes include data for industries not shown separately.

2/ Standard Industrial Classification Manual SIC, 1972 Edition.

3/ Annual average employment for nonagricultural industries is based primarily on employment covered by State unemployment insurance program. For those industries in which the unemployment insurance program does not have complete coverage and there is no change in the content of the industry classification between the 1967 and 1972 SIC manuals, estimates from the U.S. Department of Labor's Employment and Earnings Survey, which are based on the 1967 manual, are used. Annual average employment for the agriculture, forestry and fishing division in a composite of data from the unemployment insurance program, and estimates of hired-farm workers engaged in agricultural production (SIC 01 and 02) provided by the Statistical Reporting Service, U.S. Department of Agriculture. The agricultural production estimates are adjusted to excluse employment on farms with fewer than 11 employees.

4/ The incidence rates represent the number of injuries and illnesses or lost workdays per 100 full-time workers and were calculated as: (N/EH) x 200,000 where

N = number of injuries and illnesses or lost workdays
EH = total hours worked by all employees during calendar year
200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

5/ Includes fatalities. Because of rounding, the difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays does not reflect the fatality rate.

6/ Excludes farms with fewer than 11 employees.

7/ Data conforming to the OSHA definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetal mining (SIC 10 and 14), and for railroad transportation (SIC 40) were provided by the Mining Enforcement and Safety Administration, U.S. Department of the Interior, and by the Federal Railroad Administration, U. S. Department of Transportation.

NOTE: Dashes indicate no data reported, or data that do not meet publication guidelines.

n.e.c. = not elsewhere classified.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

Chartbook on Occupational Injuries and Illnesses in 1976. U.S. Department of Labor, Bureau of Labor Statistics, 1978, Report 535, Table 1.

OCCUPATIONAL INJURY INCIDENCE RATES, PRIVATE SECTOR, BY INDUSTRY
UNITED STATES, 1975 AND 1976

TABLE 8

Industry 1/	SIC code 2/	Incidence rates per 100 full-time workers 3/							
		Total cases 4/		Lost workday cases		Nonfatal cases without lost workdays		Lost workdays	
		1975	1976	1975	1976	1975	1976	1975	1976
Petroleum Refining	291	6.7	5.5	2.4	2.5	4.2	3.0	53.6	46.6
Petroleum and Coal Products	29	8.5	7.6	3.0	3.1	5.5	4.5	63.8	61.3
		1976	1977	1976	1977	1976	1977	1976	1977
Petroleum and Coal Products*	29	7.6	7.8	3.1	3.2	4.5	4.6	61.3	57.9

*BLS Reports on Occupational Injuries and Illnesses for 1977. U.S. Department of Labor, Bureau of Labor Statistics, Nov. 21, 1978. USDL-78-951, Table 2.

1/ Totals for divisions and 2- and 3-digit SIC codes include data for industries not shown separately.

2/ Standard Industrial Classification Manual SIC, 1972 Edition.

3/ The incidence rates represent the number of injuries or lost workdays per 100 full-time workers and were calculated as: (N/EH) X 200,000, where
N = number of injuries or lost workdays
EH = total hours worked by all employees during calendar year
200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

4/ Includes fatalities. Because of rounding, the difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays do not reflect the fatality rate.

5/ Excludes farms with fewer than 11 employees.

6/ Data conforming to the OSHA definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetal mining (SIC 10 and 14), and for railroad transportation (SIC 40) were provided by the Mining Enforcement and Safety Administration, U.S. Department of the Interior, and by the Federal Railroad Administration, U.S. Department of Transportation.

NOTE: Dashes indicate no data reported, or data that do not meet publication guidelines.

n.e.c. = not elsewhere classified.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

Chartbook on Occupational Injuries and Illnesses in 1976, U.S. Department of Labor, Bureau of Labor Statistics, 1978, Report 535, Table 5.

TABLE 9

Occupational injury and illness incidence rates, private sector, by industry and employment size, United States, 1975

Industry and employment size 1/	SIC code 2/	Incidence rates per 100 full-time workers 3/			
		Mean 4/	Median 4/	Middle range 4/	
				First quartile	Third quartile
Petroleum Refining	291				
All sizes		7.0	9.5	1.5	21.6
20-49		10.7	(*)	(*)	(*)
50 to 99		12.4	(*)	(*)	(*)
100 to 249		12.8	12.0	4.5	16.4
250 to 499		8.1	7.1	3.6	11.3
500 to 999		7.1	4.5	2.3	8.4
1,000 to 2,499		4.5	3.4	1.8	4.9
2,500 and over		4.4	(*)	(*)	(*)

1/ Totals for divisions and 2- and 3-digit SIC codes include data for industries not shown separately.

2/ Standard Industrial Classification Manual, 1967 Edition.

3/ The incidence rates represent the number of injuries and illnesses per 100 full-time workers.

4/ The mean incidence rate is calculated as (N/EH) X 200,000, where

N = number of injuries and illnesses
EH = total hours worked by all employees during calendar year
200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

The median incidence rate is the middle measure in the distribution; half of the establishments have an incidence rate lower than or equal to the median and half have a rate higher than or equal to the median rate.

The middle range (interquartile) is defined by 2 measures; one-fourth of the establishments have a rate higher than or equal to the first quartile rate and one-fourth of the establishments have a rate lower than or equal to the third quartile.

5/ Data conforming to the OSHA definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetal mining (SIC 10 and 14), and for railroad transportation (SIC 40) were provided by the Mining Enforcement and Safety Administration, U.S. Department of the Interior, and by the Federal Railroad Administration, U.S. Department of Transportation.

NOTE: Asterisk (*) indicates incidence rate of less than 0.05 per 100 full-time workers.

n.e.c. = not elsewhere classified.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor.

Occupational Injuries and Illnesses in the United States by Industry, 1975. U.S. Department of Labor, Bureau of Labor Statistics, 1978, Bulletin 1981, Table 2.

F. Exposure Levels

Information describing exposures of employees to health and safety hazards associated with refinery turnaround activities was not discovered during the development of this information profile. Conversations with several safety and health professionals within the refining industry indicated that information of this sort is not available in the open literature. If any information does exist, it is probably contained within the safety and health departments of individual refining companies or contractors who routinely perform turnaround activities.

G. Related Studies

During the development of this profile a variety of sources were contacted or searched to obtain information. This effort did not uncover safety or health studies of refinery turnaround activities. The following related studies were located which may produce some information which will be helpful in characterizing refinery turnaround activities.

The American Petroleum Institute sponsored a mortality study of petroleum refinery workers which was conducted by Tabershaw-Cooper Associates. This study is available from API using the following identification: 847-74020 EA 7402 "A Mortality Study of Petroleum Refinery Workers." A cohort of approximately 20,000 active refinery workers from 17 refineries with at least one year of refinery work experience between 1962 and 1971 was studied.(9)

The API is currently sponsoring a five year update to the above mentioned mortality study. The update is being performed by the Stanford Research Institute and a final report is anticipated in early 1979.(9)

The API is also sponsoring a prospective mortality-morbidity study of refinery and petro-chemical workers which was initiated in 1977. A cohort of approximately 72,000 active workers and 12,000 annuitants is being studied. The study is being performed by the Epidemiology and Preventive Medical Services group of the Memorial Sloan Kettering Cancer Center. Preliminary, general results from this study are expected to be available in 1979.(9)

NIOSH is currently conducting an industrial hygiene characterization of petroleum refineries.(3) Nine refineries will be studied. Preliminary visits have begun and the results of a literature survey should be available in early 1979.

OSHA has announced that it intends to explore development of a safety standard covering refinery turnaround operations.(10) OSHA personnel have been in contact with refining companies industry associations, and have visited a refinery where turnaround was in progress. OSHA plans to continue its data gathering efforts over the next several months.

H. Industry Trends

The U.S. petroleum refining industry has experienced steady growth in refining capacity as is evidenced by the data contained in Table 10. Refinery capacity is projected to continue to steadily increase to the year 1990 when U.S. refinery capacity is expected to reach 21.5 million barrels/day.(11) As of the spring of 1978, 694,530 barrels/day of additional capacity was underway with planned projects totaling 945,300 barrels/day.(11)

As of October, 1978, plans to construct 10 new refineries with total capacity in excess of 780,000 barrels/day were known.(12) Expansion of existing refineries is ongoing but no estimates of total added capacity were found.

New construction and expanded capacity of existing facilities will involve updating of facilities and incorporation of state-of-the-art process control. There are indications that new and updated facilities will require less frequent turnaround with heavier reliance on routine maintenance to keep refinery units on stream for longer periods.

Refining companies are trying to minimize turnaround work. Maintenance work can be performed more safely and more efficiently outside turnaround. Some refineries are investing actively in parallel equipment (pumps, exchangers, catalyst beds, etc.) which will permit maintenance without unit shutdown.(5)

Table 10: CRUDE CAPACITY OF U.S. REFINERIES

YEAR*	CAPACITY PER CALENDAR DAY	
	hm^3	Thousands of Barrels
1967	1.662	10452
1968	1.771	11142
1969	1.832	11523
1970	1.932	12155
1971	2.016	12681
1972	2.081	13087
1973	2.128	13383
1974	2.260	14216
1975	2.360	14845
1976	2.397	15075

* as of January 1 of the year indicated

Source: Oil and Gas Journal, Annual Refining Issues

Contractors are expected to continue in their performance of certain turnaround activities. Many existing contract firms have performed turnaround work at specific refineries for several consecutive years.(9) It is anticipated that the health and safety programs of contract firms will improve as more and more attention is devoted to occupational safety and health.

It is anticipated that expanded use of high-pressure water for cleaning and decontamination of equipment will occur.(13) Several industry representatives indicated their acceptance of this technology.

I. Existing Standards

From the material presented in the preceding sections of this information profile it is readily apparent that refinery turnaround involves activities which are covered by many existing standards. Section (D) of this profile included a list of standards, recommended practices and other publications developed by API which apply to some turnaround activities. In many cases these materials were developed to supplement OSHA, ANSI, NFPA, MCA, CGA, etc. standards or to facilitate the application of the intent of these standards to refinery work.

Many turnaround operations are construction-like in nature and thus many sections of 29 CFR 1926 (OSHA - construction standards) would be applicable. In other situations portions of 29 CFR 1910 (OSHA - general industry standards) would apply.

Many ANSI standards have been adopted by OSHA and also incorporated in API guidelines, standards, etc. Among the ANSI standards of particular importance to turnaround operations is ANSI Z117.1 - Working in Confined Spaces. This standard is important because OSHA regulations do not completely cover this work and guidelines from agencies like NIOSH are not yet available.

The state of California has adopted occupational safety and health regulations for refinery work. These regulations are found in Title 8 of the State of California, Division of Industrial Safety, Subchapter 15 -

Petroleum Safety Orders - Refining, Transportation, Handling (Register 55, No. 13-9-3-55). Other states may have adopted similar regulations but were not discovered during development of this profile. An outline of the State of California regulations follows:

SUBCHAPTER 15. PETROLEUM SAFETY ORDERS—REFINING, TRANSPORTATION AND HANDLING

DETAILED ANALYSIS

Article 1. Application, Scope and Variations

Section

6750. Application, Scope and Permits for Variations From Orders.

Article 2. Definitions

Section

6755. Definitions.

Article 3. Accident Prevention Program

Section

6760. Safety Training and Instruction.
6761. Reporting Unsafe Conditions.
6762. Contractors.

Article 4. First Aid

Section

6767. First Aid.

Article 5. Fire and Explosions

Section

6772. Smoking, Matches, Lighters.
6773. Fire Protection and Fire Fighting Equipment.
6774. Cleaning Oils.
6775. Static Electricity.
6776. Spontaneous Ignition.
6777. Fire Permits.
6778. Surge Tanks.
6779. Flammable Waste Gases or Vapors.
6780. Transfer of Light Oils by Air Displacement.
6781. Steam Hose.

Article 6. Dangerous Exposure

Section

6786. Clothing.
6787. Change Rooms.

Article 7. Enclosed and Confined Spaces

Section

6792. Ventilation.
6793. Confined Spaces.

J. Names of Industry Associations and Other Interested Parties (14)

(1) Industry Associations

Among the industry associations with petroleum refining company membership are:

American Petroleum Institute
2101 L Street, N.W.
Washington, D. C. 20037
200-457-7000

American Petroleum Refiners Association
1110 Ring Building
1200 18th Street, N.W.
Washington, D. C. 20036
202-331-7081

Independent Petroleum Association of America
1101 16th Street, N.W.
Washington, D. C. 20036
202-466-8240

Independent Refiners Association of America
1801 K Street, N.W.
Washington, D. C. 20006
202-466-2340

National Petroleum Refiners Association

1725 DeSales Street, N.W.

Suite 802

Washington, D. C. 20036

202-638-3722

(2) Labor Organizations

Refinery turnaround activities can involve members of many labor unions. Among the unions which represent these workers are:

International Union of Petroleum and Industrial Workers

335 California Avenue

Bakersfield, California 93304

213-630-6232

Oil, Chemical and Atomic Workers International Union

Box 2812

Denver, Colorado 80201

303-893-0811

(3) Professional Associations

American Institute of Mining, Metallurgical and Petroleum Engineers, Inc.

345 East 47th Street

New York, New York 10017

212-644-7695

K. Names and Addresses of Companies

(1) Large Firms

The following companies are among the largest petroleum refining firms in the United States. No attempt has been made to rank them in order of size.

Amoco Oil Company
200 E. Randolph Drive
Chicago, Illinois 60601
312-856-5111

Atlantic Richfield Company
260 South Broad
Philadelphia, Pennsylvania 19101
215-735-2345

Exxon Company, U.S.A.
Box 2180
Room 491
Houston, Texas 77001
713-656-3636

Gulf Oil Company, U.S.
P.O. Box 1519
Houston, Texas 77001
713-226-1011

Mobil Oil Corporation

150 East 42nd Street

New York, New York 10017

212-883-4242

Phillips Petroleum Company

Bartlesville, Oklahoma 74004

918-661-6600

Shell Oil Company

One Shell Plaza

Houston, Texas 77002

713-220-6161

Standard Oil Company of California

Western Operations, Inc.

575 Market Street

San Francisco, California 94105

415-894-7700

Texaco Inc.

135 East 42nd

New York, New York 10017

212-953-6000

Union Oil Company of California

Union Oil Center

Los Angeles, California 90017

213-486-7600

(2) Small Firms

The following companies are examples of relatively smaller petroleum refining firms.

Apco Oil Corporation
1700 Houston Natural Gas Building
Houston, Texas 77002
713-224-0610

Champlin Petroleum Company
P.O. Box 552
Enid, Oklahoma 73701
405-233-7600

Clark Oil and Refining Corp.
8530 West National Avenue
Milwaukee, Wisconsin 53201
414-321-5100

Douglas Oil Company of California
P.O. Box 2500
Costa Mesa, California 92626
714-540-1111

Getty Oil Company, Inc.
660 Madison Avenue
New York, New York 10021
212-832-7800

Husky Oil Company

P.O. Box 380

Cody, Wyoming 82414

307-587-4623

Marathon Oil Company

539 South Main

Findlay, Ohio 45840

419-422-2121

Pennzoil Company

900 Southwest Tower

Houston, Texas 77002

713-228-8741

Quaker State Oil Refining Corporation

Center Street

P.O. Box 989

Oil City, Pennsylvania 16301

814-676-1811

Skelly Oil Company

1437 South Boulder

Tulsa, Oklahoma 74119

918-584-2311

Tenneco Oil Company
Subsidiary of Tenneco, Inc.
Tenneco Building
1010 Milam Street
P.O. Box 2511
Houston, Texas 77001
713-229-2131

(3) Contract Firms

In many instances much of the work performed during refinery turnaround operations is contracted out to construction firms or specialty service firms. Among the firms which perform portions of turnaround work on a contract basis are:

Brown and Root Marine Operators
4100 Clinton Drive
Houston, Texas 77020
713-676-3011

Halliburton Services
Drawer 1431
Duncan, Oklahoma 73533
405-251-3760

Ethyl Corporation
330 South Fourth
Richmond, Virginia 23219
804-644-6081

Browning Ferris Industries

Chemical Services Inc.

1020 Holcombe Blvd.

Houston, Texas 77025

713-790-1611

L. Summary Analysis of Data

The information contained within this profile indicates that little is known regarding the injury and illness experience which accompanies petroleum refinery turnaround operations. Refining companies, industry associations, contractors, etc. acknowledge that turnaround activities are potentially hazardous. There appears to be a consensus that contractors experience more problems in turnaround situations than full-time refinery personnel due to their relative lack of experience with refinery work and less strict adherence to work practices and procedures.

Many interested parties maintain that most if not all turnaround work can be safely performed by carefully applying well established work practices. However, it is presently unknown to what extent all refining companies (small and large) employ rigorous attention to safety. Some data are available which indicate that small refineries experience relatively more injuries and possible illnesses among employees than larger establishments.

It would appear that there are many areas of refinery turnaround activity which should be studied to determine whether a "turnaround standard" is necessary or appropriate. Due to the diverse nature of work performed during turnarounds, it would be necessary to evaluate work on many of the process modules delineated in Section (C) of this profile. It appears that both safety and industrial hygiene evaluation would be appropriate.

REFERENCES AND SOURCES

(1) Standard Industrial Classification Manual 1972. Executive Office of the President - Office of Management and Budget, Statistical Policy Division, U.S. GPO: 1976-210-882/159, p. 194.

(2) Industrial Process Profiles for Environmental Use: Chapter 3. Petroleum Refining Industry. U.S. Environmental Protection Agency, Office of Research and Development, EPA-600/2-77-023c, January, 1977, pp. 12-24.

(3) Project Officer, Contract No. 210-78-0082-0000, Industrial Hygiene Section, Industrywide Studies Branch, DSHEFS, NIOSH, (1/2/79).

(4) Field Surveillance and Enforcement Guide for Petroleum Refineries. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Control Program Development Division, EPA-450/3-74-042.

(5) Telephone communication with: John Rivard, Manager Safety Services, Safety and Industrial Hygiene Department, Shell Oil Company, Houston, Texas 77001, (10/17/78).

(6) Encyclopedia of Occupational Health and Safety, International Labour Office, McGraw-Hill, New York, New York, 1976. Vol. II, pp. 1035-1038.

(7) Industrial Hygiene Monitoring Guide for Petroleum Refineries and Selected Petro-chemical Operations. American Petroleum Institute, Publications and Distribution Section, 1010 L Street, N.W., Washington, D.C. 20037. 847-75010, EA 7501.

(8) Occupational Diseases - a Guide to Their Recognition, Revised Edition June 1977, U.S. Department of Health, Education, and Welfare, PH$, CDC, NIOSH, DHEW(NIOSH) Publication No. 77-181.

(9) Telephone communication with: Mr. Wendall Ward, Staff Industrial Hygienist, Medical and Biological Sciences Department, American Petroleum Institute, Washington, D.C. (1/2/79 and 1/10/79).

(10) Bureau of National Affairs, Occupational Safety and Health Reporter, Volume 8, Number 18, Sept. 28, 1978, pp. 541-2.

(11) Refiners Adding Capacity in Global Building Surge. Oil and Gas Journal, April 24, 1978, Vol. 76, No. 17, pp. 47-8.

(12) Cantrell, Aileen. Refineries - World Wide Contruction. Oil and Gas Journal, October 2, 1978, Vol. 76, No. 4, pp. 128-135.

(13) High-Pressure Water Speeds Refinery Cleanups, Cuts Turnaround Costs. Oil and Gas Journal, August 2, 1976, Vol. 74, No. 31, pp. 134-136.

(14) National Trade and Professional Associations of the United States and Canada and Labor Unions, NTPA '78, 13th Annual Edition, 1978, Craig Colgate, Jr., Editor. Columbia Booles, Inc., Washington, D.C.