

SAFETY INFORMATION PROFILE

Liquid Transfer Operations - Petroleum Products

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16. Abstract (Limit: 200 words) A safety information profile is presented for the liquid petroleum products transfer industry. Several different Standard Industrial Classification (SIC) codes included in these operations are listed, and a table of employment information in those industries is provided. The liquid petroleum transfer process is described. Safety hazards, primarily fire and explosion, are reviewed along with health and biological hazards. Existing controls for handling flammable and combustible products are discussed. Accident and illness statistics are presented and tabulated data are included for several specific SIC codes. The availability of related studies is mentioned. Industry trends of growth and regulation are described, and current federal safety standards are outlined. A listing of names and addresses of industry associations and other interested parties is provided. It is noted that a tightening of environmental and safety regulations is occurring in this industry. Data are inadequate to determine the causes of accident and illness, thus, no specific safety recommendations are made but further study is suggested.					
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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.

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EXECUTIVE SUMMARY

This profile contains information describing the various transfer operations involved with liquid petroleum products. A number of SIC code industries are involved with the production, refining, transportation and distribution of liquid petroleum products. These industries all have some involvement with liquid transfer operations. The profile identifies a number of SIC code industries, however, estimates of the exposed employee population are not included. A variety of information concerning the potential hazards associated with the transfer of liquid petroleum products and the various situations which involve these transfers is discussed. Only very generalized information was discovered which would help to define the accident and illness experience associated with liquid petroleum product transfer operations. Several additional sources of information are discussed which could be examined to improve existing data concerning injury and illness statistics. The industries involved with liquid petroleum product transfer are not undergoing major change but are modifying their operations in view of increasing environmental protection and safety regulation. The liquid natural gas industry is growing and several additional terminals for the importation of liquid natural gas are anticipated.

LIQUID TRANSFER OPERATIONS - PETROLEUM PRODUCTS

A. Standard Industrial Classifications Included

This information profile covers petroleum product liquid transfer operations which occur at: (1) field petroleum extraction/production operations, (2) petroleum refineries, (3) terminals, (4) bulk plants, (5) oil jobbers, and (6) gasoline service stations. Liquid petroleum products, for the purposes of this profile, are defined to include: (1) crude oil, (2) refined petroleum liquids (e.g., gasoline), (3) liquefied petroleum gas, (LP-gas), and (4) liquefied natural gas (LNG). Transfers considered include flow of liquid petroleum products between the following containers and/or transportation systems: (1) pipelines, (2) storage tanks, (3) ships, (4) barges, (5) rail tankcars, (6) tank trucks, and (7) drums or other small containers. Transfer of petroleum liquids to fuel tanks of trucks, cars, ships, equipment, etc. is not included. Also not included is transfer within or from place to place using pipelines, railcars, trucks, ships, barges, etc.

This broad range of operations spans establishments which fall under many SIC codes. Among the industries included in coverage are the following (listed in numerical order):

(1) SIC Code 13 - Oil and Gas Extraction

131 Crude petroleum and natural gas

1311 Crude petroleum and natural gas

132 Natural gas liquids

1321 Natural gas liquids

(2) SIC Code 29 - Petroleum Refining and Related Industries

291 Petroleum refining

2911 Petroleum refining

295 Paving and roofing materials

2951 Paving mixtures and blocks

299 Miscellaneous products of petroleum and coal

2992 Lubricating oils and greases

(3) SIC Code 40 - Railroad Transportation

401 Railroads

4011 Railroads, line-haul operating

(4) SIC Code 42 - Motor Freight Transportation and Warehousing

421 Trucking, local and long distance

422 Public Warehousing

4226 Special warehousing and storage, N.E.C.

(NOTE: Includes petroleum and chemical bulk stations
and terminals for hire)

- (5) SIC Code 44 - Water Transportation
 - 441 Deep sea foreign transportation
 - 442 Deep sea domestic transportation
 - 443 Great Lakes - St. Lawrence Seaway transportation
 - 444 Transportation on rivers and canals
 - 445 Local water transportation
 - 446 Services incidental to water transportation
 - 4463 Marine cargo handling

(NOTE: Includes waterfront terminal operation)
- (6) SIC Code 46 - Pipelines, Except Natural Gas
 - 461 Pipelines, except natural gas
 - 4612 Crude petroleum pipelines
 - 4613 Refined petroleum pipelines
- (7) SIC Code 49 - Electric, Gas and Sanitary Services
 - 492 Gas production and distribution
 - 4925 Mixed, manufactured or liquefied petroleum gas production and/or distribution
- (8) SIC Code 51 - Wholesale Trade - Non Durable Goods
 - 517 Petroleum and petroleum products
 - 5171 Petroleum bulk stations and terminals

(9) SIC Code 55 - Automotive Dealers and Gasoline Service Stations

554 Gasoline service stations

5541 Gasoline service stations

(10) SIC Code 59 - Miscellaneous Retail

598 Fuel and ice dealers

5983 Fuel oil dealers

5984 Liquefied petroleum gas (bottled gas) dealers

All of these industries and possibly others are involved with petroleum liquid transfer operations. The industries of most concern to this profile are those which produce, refine, store and distribute petroleum liquids. Industries involved in transportation of petroleum liquids must obviously be considered but the emphasis here is on transfer between containers and/or transportation systems rather than on in transit petroleum liquid transportation.

The population of establishments and employees exposed to the potential hazards of liquid petroleum transfer operations is exceedingly difficult to define. In most situations, only a relatively small percentage of the persons employed within the listed SIC code industries would be involved with these operations. Table 1 provides some information concerning employment in SIC code industries which are involved with liquid petroleum transfer operations but not merely transportation of liquid petroleum products.

Table 1

United States—Establishments, Employees, and Payroll by Industry by Employment-Size Class: 1976

(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 alphabets indicate employment-size class—see footnote.)

SIC code	Industry, establishments, employees, and payroll	Employment-size class									
		Total	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
131	Crude petroleum and natural gas										
	Number of establishments.....	5 966	3 714	930	587	429	153	91	38	14	10
	Number of employees.....	96 956	(D)	6 357	8 171	13 405	10 932	14 110	13 195	(D)	14 841
	Payroll, first quarter (\$1000).....	364 675	(D)	17 514	25 292	47 915	42 118	59 445	53 993	(D)	61 062
	Payroll, annual (\$1000).....	1 531 105	(D)	72 953	105 440	201 601	172 392	250 503	218 209	(D)	254 264
132	Natural gas liquids										
	Number of establishments.....	616	121	125	166	154	41	8	-	1	-
	Number of employees.....	12 783	(D)	835	2 314	4 719	2 598	1 207	-	(D)	-
	Payroll, first quarter (\$1000).....	51 548	(D)	3 328	9 008	18 459	10 466	5 217	-	(D)	-
	Payroll, annual (\$1000).....	207 294	(D)	13 467	36 408	77 886	41 246	20 856	-	(D)	-
291	Petroleum refining										
	Number of establishments.....	413	67	25	28	70	44	66	55	36	22
	Number of employees.....	104 350	(D)	186	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)
295	Paving and roofing materials										
	Number of establishments.....	1 145	433	264	187	141	48	59	9	3	1
	Number of employees.....	28 727	(D)	1 779	2 630	4 589	3 777	8 956	(D)	2 364	(D)
	Payroll, first quarter (\$1000).....	86 616	(D)	5 600	7 868	12 855	10 586	26 904	(D)	7 914	(D)
	Payroll, annual (\$1000).....	429 496	(D)	32 453	43 126	69 337	56 044	122 373	(D)	33 249	(D)
2951	Paving mixtures and blocks										
	Number of establishments.....	900	390	245	151	83	21	10	-	-	-
	Number of employees.....	10 907	(D)	(D)	2 087	2 680	1 546	1 441	-	(D)	-
	Payroll, first quarter (\$1000).....	32 861	(D)	(D)	6 468	8 331	4 365	4 248	-	(D)	-
	Payroll, annual (\$1000).....	202 356	(D)	(D)	36 953	49 996	30 066	27 555	-	(D)	-
4226	Special warehousing and storage, nec										
	Number of establishments.....	507	226	108	78	58	29	10	-	-	-
	Number of employees.....	7 683	480	730	1 120	1 877	1 965	1 511	-	-	-
	Payroll, first quarter (\$1000).....	20 347	1 018	1 761	3 107	5 020	5 834	3 606	-	-	-
	Payroll, annual (\$1000).....	87 974	8 255	7 961	13 365	21 128	24 627	14 641	-	-	-
446	Water transportation services										
	Number of establishments.....	3 752	2 172	639	390	258	111	102	45	23	19
	Number of employees.....	107 655	3 828	4 507	5 380	8 179	8 036	16 808	16 131	15 648	29 140
	Payroll, first quarter (\$1000).....	273 959	8 709	10 218	14 822	24 475	22 213	41 648	47 497	30 245	74 128
	Payroll, annual (\$1000).....	1 151 264	55 968	48 264	65 638	110 143	96 222	173 330	196 147	134 558	270 996
5171	Petroleum bulk stations & terminals										
	Number of establishments.....	14 377	7 455	3 300	2 208	1 112	238	58	5	-	1
	Number of employees.....	132 599	18 422	22 866	30 236	32 496	16 674	8 730	(D)	-	(D)
	Payroll, first quarter (\$1000).....	400 889	59 790	59 842	84 575	100 181	57 835	29 536	(D)	-	(D)
	Payroll, annual (\$1000).....	1 611 393	235 591	244 305	343 245	406 865	230 569	114 377	(D)	-	(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.

Table 1 (cont)

United States—Establishments, Employees, and Payroll by Industry by Employment-Size Class: 1976

(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 alphabets indicate employment-size class—see footnote.)

SIC code	Industry, establishments, employees, and payroll	Employment-size class									
		Total	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
554	Gasoline service stations										
	Number of establishments.....	142 025	97 832	33 435	8 736	1 724	249	46	2		1
	Number of employees.....	661 395	231 945	233 145	118 536	51 747	17 462	6 919	(D)		(D)
	Payroll, first quarter (\$1000).....	879 950	313 281	305 987	156 380	69 220	23 845	8 756	(D)		(D)
	Payroll, annual (\$1000).....	3 705 463	1 396 542	1 250 533	633 788	277 005	100 340	36 392	(D)		(D)
5983	Fuel oil dealers										
	Number of establishments.....	6 825	3 538	1 713	1 082	419	57	15	1		
	Number of employees.....	52 691	7 309	12 074	14 698	12 112	4 140	(D)	(D)		
	Payroll, first quarter (\$1000).....	145 426	14 731	28 284	42 217	38 857	13 611	(D)	(D)		
	Payroll, annual (\$1000).....	556 768	65 480	108 766	161 406	145 019	48 284	(D)	(D)		
5984	Liquefied petroleum gas dealers										
	Number of establishments.....	6 065	2 895	2 141	843	176	8	2			
	Number of employees.....	38 438	7 344	14 413	10 962	4 832	(D)	(D)			
	Payroll, first quarter (\$1000).....	85 457	14 364	31 074	25 878	12 012	(D)	(D)			
	Payroll, annual (\$1000).....	344 536	60 926	123 665	103 231	47 645	(D)	(D)			

A: 0-19; B: 20-49; 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

As defined for the purposes of this profile, liquid petroleum transfer operations cover those activities from oil and gas production fields through to the delivery of bulk petroleum products to service stations. Petroleum products included in coverage originate from and include crude oil and extend through all of the refined petroleum products (e.g., gasoline, kerosene, fuel oil, etc.). Also included are liquefied petroleum gas (LP-gas) and liquefied natural gas (LNG).

(1) Field Transfer Operations

The initial transfer of petroleum products occurs in the production/extraction field. Oil and gas are extracted from wells and either directly routed to a transportation system or more commonly put into temporary storage. Depending on the size, production, and location of the field, crude petroleum oil may be transferred to a pipeline, to ships, to tank trucks, or to rail tank cars. Transfer of crude oil to these transportation systems may be accomplished by pumping, gravity flow or other means. At this stage, the crude oil contains all of its native constituents including some highly flammable and combustible components.

Natural gas and light petroleum gases which are extracted from wells with crude oil or from gas wells are usually routed to a gas processing plant

located in the field near the site of production. These processing plants remove heavier petroleum gases like propane, butane and light petroleum liquids from natural gas. The handling and transportation of natural gas is not covered by this profile. The handling of liquefied petroleum gas (LP-gas) including components like propane and butane is covered. Approximately 70% of the nations LP-gas comes from natural gas production.(2)

From the field gas processing plant, LP-gas is usually transported to large LP-gas terminals. The transportation of LP-gas to the large terminals may be accomplished by pipeline, tank truck, rail tank car and in some cases by barge and ship. The transfer of LP-gas from the field processing plant or field storage to the transportation system used to convey the material to the large LP-gas terminals is one of the liquid transfer operations considered in this profile.(2)

(2) Terminals

In most instances, crude petroleum which is transported from field production areas is received at a terminal facility. The terminal facility may belong to a major petroleum company or to an independent terminal operator.(3) As indicated earlier, the petroleum may be transported to the terminal via pipeline, ship, barge, tank truck, rail car, etc. The terminal will normally engage in both loading and unloading of liquid petroleum products from these various transportation systems. In the case of the Alaska oil pipeline terminal at Valdez, Alaska, crude oil is received by pipeline, stored temporarily and

then transferred to tankers which bring the crude petroleum to other terminals located in the United States. Crude petroleum received by ship from Alaska and foreign countries is off loaded at marine terminals. The liquid transfer operations associated with shore-to-ship/ship-to-shore transfer, and pipeline-to-terminal/terminal-to-pipeline transfer are covered by this profile.

Terminal operations are not confined to the receipt and handling of unrefined crude oil. Terminals are also actively involved in the transfer of finished petroleum products such as gasoline, fuel oil, etc. These terminals may be directly associated with refining operations or may be remotely located from refinery capacity. Terminals may transfer bulk quantities of refined petroleum products to ships, barges, tank trucks, and rail tank cars.(3)

Terminals also are involved with the transfer of liquefied petroleum gas products and liquid natural gas. Approximately 10% of the liquefied petroleum gas consumed in this country is received from overseas sources by ship transportation.(2) Liquefied natural gas is being received from overseas production fields in increasing amounts. Several terminals are now equipped to receive liquid natural gas and many more are planned.(2, 4)

Transportation of liquid petroleum products away from terminals may be accomplished by pipeline, tank truck, rail car, etc. The mode of transportation will depend on the quantities to be transferred, the type of product, and the market to be served.. Several companies operating large LP-gas terminals with massive underground storage capacity transfer LP-gas long distances via pipeline to relatively smaller LP-gas terminals. From these smaller terminals local shipments are made.(2)

(3) Refineries

Crude petroleum is received by refineries primarily through short or long distance pipeline. However, in the case of small refineries, crude petroleum may also be received by tank truck or rail tank car. In most situations, some piping of the crude from storage facilities is involved. This piping may extend from storage at terminals to the refinery complex or from tank farms on the refinery complex to the refining equipment. The receipt of crude petroleum and the shipping of refined petroleum liquids from refinery facilities are also included in the coverage of this profile. Refineries commonly transfer refined products to marine terminals. Bulk shipment of refined products is also commonly accomplished through loading racks which are used to fill railroad tank cars and trucks.

Approximately 20-30% of the LP-gas produced in the United States comes from refineries.(2) Therefore, this material is involved in liquid petroleum transfer operations at refineries.

(4) Bulk Plants

Petroleum product bulk plants serve as distribution centers for petroleum products. Petroleum liquids may be delivered to these plants via pipeline, tank truck, rail tank car or barge. The transfer of petroleum liquids from these transportation systems to temporary storage is included in this profile. Similarly, the transfer from storage to distribution equipment such as rail tank car and tank truck is also covered. The operation of petroleum bulk plants has been somewhat described in a NIOSH publication entitled "Health and Safety Guide For Bulk Petroleum Plants".(5)

(5) Oil Jobbers, Fuel Oil Dealers and Miscellaneous Distributors

A variety of facilities and transportation equipment is involved in the distribution of petroleum products below the bulk plant level. Fuel oil dealers may receive quantities of fuel oil from bulk plants, marine terminals independent terminals or directly from refineries. These products are usually transferred to customer storage facilities by tank truck. There are a number of oil jobbers who may own storage facilities of their own but are heavily engaged in the transport of materials from bulk plants or other storage facilities to retail gasoline and fuel oil dealers. The transfer of these liquid petroleum products from storage to transportation vehicle and from transportation vehicle to customer storage is covered under this profile.(6)

(6) Industry Descriptors

No attempt was made during the profile development to gather information on quantities of materials involved in the various segments of the petroleum industry. This sort of information is available from industry associations and trade journals and could be assembled with regard to individual petroleum products such as gasoline, LP-gas, LNG, etc.

C. Potential Hazards

(1) Safety Hazards

The primary safety hazard associated with the transfer of liquid petroleum products is fire and explosion. Existing standards, work practices and procedures recognize the fire and explosion potential. The relative fire and explosion hazard depends to a great extent on: (1) the quantity of material on hand and its flammability rating, (2) the probability of leakage or spills, (3) whether the liquid or vapor can become exposed to air or oxygen, (4) whether the material is handled in closed containers or within a piping system, (5) the location of the transfer operation in relationship to buildings or sources of ignition and (6) the fire protection provided at the site.(5)

The relative safety hazard associated with petroleum products is a function of the physical properties or characteristics of the substance. Flash point has been recognized as possibly the most important hazard characteristic when rating flammable and combustible liquids.(7) This property along with others has been used to rate flammable and combustible liquids (NFPA 30). NFPA 325A contains flash point index information for many trade name liquids.

Flammable and combustible liquids are not in themselves a cause of fire and explosions.(7) When these materials or their vapors are combined with oxygen and come in contact with an ignition source or in contact with a catalytic substance

which can lower their auto ignition temperature a fire or explosion may occur.

Petroleum products will emit vapors to the atmosphere if exposed. These vapors may be ignited and propagate flame over a range of concentrations in air. This flammable or explosive range can vary considerably from one petroleum product to another.

Other factors which relate to the relative safety hazard associated with petroleum products are the density of the vapor emitted by the product and its susceptibility to ignition by static electricity. The vapor density will affect the rate of diffusion associated with a release of the vapor and also the general character of diffusion (e.g., settling into low places or rising into the atmosphere).

(2) Health Hazard

Health hazards associated with petroleum liquid transfer operations usually result from inhalation of hydrocarbon vapors or direct contact with the material. All petroleum products display some toxic potential even if it is only simple asphyxiation. The relative toxicity of many refined petroleum products is discussed in a recent NIOSH Criteria Document entitled "Refined Petroleum Solvents".(8)

Each of the individual hydrocarbons which makes up a petroleum product or which is contained in crude petroleum oil has distinct toxicologic properties. The straight chain aliphatic hydrocarbons are widely known to be narcotic in their action. Some of the aromatic hydrocarbons like benzene have more serious potential health effects. Benzene and some polynuclear aromatic hydrocarbons have been associated with causing various forms of cancer.

Inhalation of vapors from petroleum products can occur during spills or releases, as well as, during normal transfer operations. Many liquid petroleum product transfer operations include vapor balance systems, which greatly limit escape of hydrocarbons to the work environment. An example of this type of transfer would be the transfer of LP-gas. On the other hand, many bulk transfer operations currently make no real effort to control relatively large quantities of vapor emission. An example would be the filling of tankers or barges with petroleum products and the displacement of large volumes of vapor laden air from the cargo holds of these transportation vessels.(2, 9)

Direct contact with many petroleum products can cause defatting of the skin and dermatitis if not properly controlled. Additionally some of the heavier polynuclear aromatic hydrocarbons have the potential to produce skin photosensitivity. Liquefied natural gas and LP-gas handling has the potential to expose employees to cold equipment and other problems associated with liquefied and cryogenic materials. (Refer to profile entitled "Production, Storage and Handling of Cryogenic Materials")

Tetraethyl lead and other petroleum product additives can also pose significant hazard to health in specific circumstances.

(3) Biological Hazards

Although petroleum products do not contain biological agents, the transportation of crude petroleum by ship and barge does involve potential employee contact with products of biological action on petroleum. The ballast water which is carried in sea-going vessels must be off-loaded before petroleum products can be loaded aboard these vessels. Bacteria grow in the ballast water during travel from unloading to loading terminals. These bacteria create hydrogen sulfide which can expose employees during the onshore treatment of ballast waters. Relatively small quantities of hydrogen sulfide contained in ballast water can result high concentrations of airborne hydrogen sulfide in ballast water treatment facilities.

D. Existing Hazard Controls

Control of the hazards associated with flammable transfer of liquid petroleum products has traditionally followed basic techniques or principles. These principles have been based on the individual properties of flammable and combustible products. The National Fire Protection Association in NFPA 30 established hazard rating systems and recommended practices for flammable and combustible materials. This rating system has been adopted by many federal, state and local agencies and serves as a common foundation on which many regulations have been developed. Similarly, standard classifications for hazardous locations associated with exposure to flammable and combustible materials have been established under NFPA 70, the National Electric Code.

In most situations the control of fire or explosion hazards associated with flammable and combustible liquids is dependent on one or more of the following techniques or principles: "(1) exclusion of sources of emissions, (2) exclusion of air, (3) keeping the liquids in closed containers or systems, (4) ventilation to prevent the accumulation of vapor within the flammable range, and (5) use of an atmosphere of inert gas instead of air."(7) In practically all situations additional hazard control measures are provided. They include fire protection equipment, excess flow valves, flame arresters, combustible gas indicators, drip catch containers, etc.

It is essential that the identity of the petroleum product being handled be known at the time of transfer. For example, the precautions used in transferring lubricating oil when compared to those required for transferring gasoline are quite different. Normally, it would be difficult to confuse lubricating oil and gasoline products since they are readily distinguishable by sight and smell. However, there are many situations where possible mixing of petroleum products can occur resulting in altered hazard potential. Therefore, it is essential to properly identify the product contained in tanks, pipelines, etc. and to prevent the unintentional mixing of various petroleum products. It is possible to make materials like fuel oil unsafe in normal use and handling by contaminating them with lighter hydrocarbon mixtures like gasoline. In many cases, separate pumps, manifolds and piping systems are required for distinct petroleum products.(7)

Excluding sources of ignition from petroleum transfer operations involves more than simply prohibiting smoking, and the carrying of matches and other ignition sources. Static electricity can cause fire and explosions involving petroleum products. Grounding to neutralize potential differences between objects and ground, and bonding to neutralize potential differences between objects is widely required in petroleum transfer operations.

Another problem in dealing with flammable and combustible materials is the prevention of vapor air mixtures and contact with catalytic substances which can lower auto ignition temperature. This problem is mainly addressed by the specification of suitable materials of construction and isolation of processes.

Other control measures involving petroleum products are designed to limit the consequences of accidental fire and explosion. The quantity of specific substances stored in containers, tanks, etc. is regulated. The proximity of buildings and other facilities to storage areas, transfer areas, etc. is specified to minimize exposure. Diking of storage containers is often necessary. Electrical systems meeting requirements as specified in the National Electric Code are utilized in recognition of hazardous locations caused by the potential presence of flammable vapors. Consideration for vapors which are heavier than air and which may concentrate in low places is indicated.(10)

Where contact with flammable and combustible liquid materials is likely, personal protective equipment can be utilized. In most situations involving petroleum product transfer, the transfer occurs outdoors where maximum opportunity for natural dilution ventilation is present. Outside installation not only helps to reduce potential breathing zone concentrations of hydrocarbon vapor but also helps to eliminate accumulation of flammable concentrations of hydrocarbon vapor.

Vapor recovery systems are available for some petroleum liquid transfer operations which can help reduce employee exposures.(9)

E. Accident and Illness Statistics

Specific information concerning injuries and illnesses which have been associated with liquid petroleum product transfer operations was not uncovered during developemnt of this profile. The physical transfer of liquid petroleum products between containers and/or transportation systems is only one element in the operations conducted at terminals, bulk plants, etc. The operations at these facilities are in many cases a small subset of the activities which are performed at establishments with the same 4 digit SIC Code. Tables 2, 3, and 4 present available general injury and illness statistics for 3 and 4 digit SIC Code industries which most closely relate to the various liquid petroleum transfer operations considered. Due to the very general nature of these statistics no meaningful conclusions can be drawn. An outline indicating which liquid petroleum transfer facilities are included in the general SIC Code industries contained in these tables is presented in Section (A) of this profile.

Somewhat more specific injury and illness information from the State of California is contained in Tables 5, 6, and 7.(11) These data also reflect injury and illness experience which is associated with much more than strictly liquid petroleum transfer operations. Similar information is available from other states.

TABLE 2
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
Crude Petroleum and Natural Gas	131	157.7	7.2	5.0	2.6	2.3	4.6	2.7	49.8	50.5
Petroleum Refining	291	157.5	7.1	5.8	2.5	2.5	4.6	3.2	54.7	47.8
Paving Mixtures & Blocks	2951	12.2	12.6	12.8	4.0	4.7	8.6	8.1	95.4	114.1
Lube Oils & Greases	2992	8.8	12.8	12.8	5.4	4.8	7.3	8.0	75.0	72.9
Water Transportation Services	446	24.1	24.9	22.9	13.2	11.9	11.6	11.0	500.2	457.5
Pipelines, Except Natural Gas	46	37.8	4.7	3.9	1.6	1.3	3.0	2.6	79.3	24.6
Petroleum and Petroleum Products	517	229.5	5.6	5.8	2.3	2.9	3.3	2.9	38.9	44.8
Gasoline Service Stations	554	627.2	4.8	3.8	2.0	1.6	2.8	2.2	38.6	37.7
Fuel and Ice Dealers	598	102.5	7.4	7.3	3.3	3.7	4.1	3.6	50.7	70.3

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 is 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 exclude 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: $(N/EH) \times 200,000$ 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 non-metal 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 3

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
Crude Petroleum and Natural Gas	131	7.0	4.9	2.5	2.2	4.5	2.7	47.2	49.8
Petroleum Refining	291	6.7	5.5	2.4	2.5	4.2	3.0	53.6	46.6
Paving Mixtures & Blocks	2951	11.9	12.6	3.7	4.6	8.1	8.0	91.5	113.2
Lube Oils & Greases	2992	12.3	12.4	5.3	4.7	7.0	7.7	74.1	71.0
Water Transportation Services	446	24.2	22.5	13.0	11.7	11.1	10.8	496.1	452.6
Pipelines, Except Natural Gas	46	4.6	3.8	1.5	1.3	2.9	2.6	79.3	24.4
Petroleum and Petroleum Products	517	5.5	5.7	2.3	2.9	3.2	2.8	37.8	43.6
Gasoline Service Stations	554	4.7	3.7	1.9	1.5	2.7	2.1	38.3	36.8
Fuel and Ice Dealers	598	7.3	7.1	3.2	3.6	4.1	3.5	50.0	67.5

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/ The incidence rates represent the number of injuries or lost workdays per 100 full-time workers and were calculated as: $(N/EH) \times 200,000$, 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.

**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
Crude petroleum and natural gas-----	131				
All sizes-----		6.6	0.0	0.0	13.8
1 to 19-----		12.3	0.0	0.0	19.7
20 to 49-----		7.4	9.2	0.0	12.9
50 to 99-----		8.2	5.9	2.1	10.6
100 to 249-----		7.4	4.3	1.1	11.1
250 to 499-----		5.0	3.0	1.1	6.2
500 to 999-----		4.2	(*)	(*)	(*)
1,000 to 2,499-----		1.1	(*)	(*)	(*)
Petroleum refining-----	291				
All sizes-----		7.0	9.3	1.5	21.6
1 to 19-----		10.7	(*)	(*)	(*)
20 to 49-----		12.4	(*)	(*)	(*)
50 to 99-----		12.8	12.0	4.5	16.4
100 to 249-----		8.1	7.1	3.6	11.3
250 to 499-----		7.1	4.5	2.3	8.4
500 to 999-----		4.5	3.4	1.8	4.9
1,000 to 2,499-----		4.4	(*)	(*)	(*)
Paving and roofing materials-----	295				
All sizes-----		16.8	9.4	0.0	24.3
1 to 19-----		18.4	0.0	0.0	21.7
20 to 49-----		16.2	11.0	5.4	25.3
50 to 99-----		19.2	22.2	6.2	28.2
100 to 249-----		16.2	14.8	10.3	22.5
250 to 499-----		17.9	(*)	(*)	(*)
Services incidental to water transportation---	446				
All sizes-----		25.7	0.0	0.0	16.0
1 to 19-----		7.3	0.0	0.0	0.0
20 to 49-----		20.2	13.8	2.6	28.9
50 to 99-----		26.9	22.5	10.5	37.9
100 to 249-----		29.9	32.5	17.1	52.9
250 to 499-----		31.0	31.2	13.3	46.6
500 to 999-----		34.4	(*)	(*)	(*)
1,000 to 2,499-----		39.3	(*)	(*)	(*)

^{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.

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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.

Table 4 (cont)

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
Pipeline transportation-----	40				
All sizes-----		4.7	0.0	0.0	5.2
1 to 19-----		4.5	0.0	0.0	0.0
20 to 49-----		6.2	4.0	0.0	9.1
50 to 99-----		3.6	(*)	(*)	(*)
100 to 249-----		4.0	(*)	(*)	(*)
250 to 499-----		.9	(*)	(*)	(*)
Gasoline service stations-----	554				
All sizes-----		4.9	0.0	0.0	0.0
1 to 19-----		3.9	0.0	0.0	0.0
20 to 49-----		5.9	0.0	0.0	10.0
50 to 99-----		9.0	8.6	2.1	16.3
100 to 249-----		8.7	6.4	.2	14.3
250 to 499-----		9.4	(*)	(*)	(*)
500 to 999-----		5.6	(*)	(*)	(*)
Fuel and ice dealers-----	598				
All sizes-----		7.6	0.0	0.0	0.0
1 to 19-----		4.9	0.0	0.0	0.0
20 to 49-----		11.6	8.6	.8	17.8
50 to 99-----		13.2	12.4	4.9	21.0
100 to 249-----		12.0	(*)	(*)	(*)

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 $(N/EH) \times 200,000$, 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.

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best available copy.



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.

Table 5

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

INDUSTRY	TOTAL	AMPU- TATIONS, LOSS OF USE OF	BURNS AND SCALDS	CUTS, LACER- ATIONS, PUNCTURES, ABRASIONS	STRAINS, SPRAINS, DISLO- CATIONS, HERNIAS	CRUSHING INJURIES	FRACTURES	OCCU- PATIONAL DISEASES	BRUISES, CONTUSIONS	EYE INJURIES, N.E.C.	OTHER	NATURE OF INJURY NOT STATED
TOTAL	259,652	776	8,240	40,067	107,910	3,758	16,833	10,164	33,532	12,287	4,325	21,760
OIL AND GAS EXTRACTION	424	1	18	52	142	28	37	12	79	17	3	35
DRILLING	83	-	1	8	19	11	10	-	16	6	-	12
WELL PULLING AND SERVICING	205	1	9	28	78	12	12	5	42	5	-	13
OIL FIELD CONSTRUCTION	13	-	1	-	5	-	3	-	4	-	-	-
OIL FIELD EXPLORATION	12	-	-	1	7	-	1	1	2	-	-	4
PRODUCING AND MAINTENANCE	111	-	7	15	37	5	11	6	15	6	3	6
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
OTHER PETROLEUM INDUSTRIES	149	2	14	10	60	4	9	-	31	5	1	13
PIPE LINE TRANSPORTATION (EXCEPT NATURAL GAS)	6	-	2	3	-	-	-	-	1	-	-	-
PETROLEUM DISTRIBUTION (INCLUDING RULK TANK STATIONS)	482	1	25	47	221	4	28	11	66	23	13	43
GASOLINE SERVICE STATIONS	1,710	3	201	280	462	37	121	29	181	139	35	222

* 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.

**INJURIES TO EMPLOYEES OF PUBLICLY OPERATED UTILITIES INCLUDED IN THE TRANSPORTATION, COMMUNICATION, AND UTILITIES DIVISION.

Table 6

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 TEMPER- ATURE 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
TOTAL	259,652	68,460	16,677	54,071	11,850	73,628	6,022	8,361	585	595	11,859	4,811	2,733
OIL AND GAS EXTRACTION	424	145	46	79	10	93	9	18	1	2	17	4	-
DRILLING	83	32	13	18	-	13	-	1	-	-	6	-	-
WELL PULLING AND SERVICING	205	70	24	41	5	44	5	8	-	2	5	1	-
OIL FIELD CONSTRUCTION	13	4	1	3	-	4	-	1	-	-	-	-	-
OIL FIELD EXPLORATION	12	4	1	2	-	4	-	1	-	-	-	-	-
PRODUCING AND MAINTENANCE	111	35	7	15	5	28	4	7	1	-	6	3	-
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
OTHER PETROLEUM INDUSTRIES	149	37	16	28	7	37	10	3	-	1	5	-	5
PIPE LINE TRANSPORTATION (EXCEPT NATURAL GAS)	6	4	-	-	-	-	1	1	-	-	-	-	-
PETROLEUM DISTRIBUTION (INCLUDING BULK TANK STATIONS)	482	94	18	134	40	127	12	15	3	3	22	9	5
GASOLINE SERVICE STATIONS	1,710	488	97	308	112	283	182	27	1	21	135	26	30

* 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.

**INJURIES TO EMPLOYEES OF PUBLICLY OPERATED UTILITIES INCLUDED IN THE TRANSPORTATION, COMMUNICATION, AND UTILITIES DIVISION.

Table 7

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

INDUSTRY	FATAL	TOTAL	MA- CHINES	HOISTING APPARATUS, CONVEYORS, ELEVATORS	VEHICLES	HAND TOOLS	CHEMICALS, HOT, INJURIOUS SUBSTANCES	WORKING SURFACES	LADDERS	CON- TAINERS (FILLED OR UNFILLED)	LUMBER, LOGS, TREES	OTHER AGENCIES	AGENCY NOT STATED
TOTAL	662	259,652	20,407	4,241	26,150	22,418	13,725	51,643	1,696	29,133	5,020	81,841	3,378
OIL AND GAS EXTRACTION	4	424	7	103	20	53	32	81	2	20	1	104	1
DRILLING	1	83	3	37	-	3	4	20	-	2	-	14	-
WELL PULLING AND SERVICING	-	205	1	50	12	29	13	40	2	11	-	46	1
OIL FIELD CONSTRUCTION	-	13	-	1	-	-	1	3	-	1	1	6	-
OIL FIELD EXPLORATION	-	12	-	2	-	2	1	2	-	2	-	3	-
PRODUCING AND MAINTENANCE	3	111	3	13	8	19	13	16	-	4	-	35	-
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
OTHER PETROLEUM INDUSTRIES	1	149	22	6	13	17	13	23	1	21	1	26	6
PIPE LINE TRANSPORTATION (EXCEPT NATURAL GAS)	-	6	-	-	-	4	1	-	-	-	-	1	-
PETROLEUM DISTRIBUTION (INCLUDING BULK TANK STATIONS)	4	482	12	3	85	42	24	125	4	59	2	120	6
GASOLINE SERVICE STATIONS	12	1,710	60	31	416	170	127	299	11	72	-	495	29

* 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.

**INJURIES TO EMPLOYEES OF PUBLICLY OPERATED UTILITIES INCLUDED IN THE TRANSPORTATION, COMMUNICATION, AND UTILITIES DIVISION.

A number of federal regulatory agencies require that spills and other releases of petroleum products and hazardous materials be reported. Reports usually take the form of telephone communication followed by incident investigation and written reporting. Depending on the nature of the incident, it may or may not also be reported to the U.S. Department of Labor. The following paragraphs describe incident reporting mechanisms and indicate sources of additional statistics which may be useful in describing the injury and illness experience associated with liquid petroleum transfer operations. It was not within the scope of this profile development to secure and evaluate statistics from these various sources.

The U.S. Department of Transportation requires the reporting of incidents involving railroad, highway and pipeline transportation of hazardous materials. Railroad and highway hazardous materials incidents are reported in accordance with 49 CFR 171.15 and 16. These reports cover incidents which occur in transit and during loading, unloading and temporary storage. Incident reports (DOT Form F 5800.1) are sent by the carrier to the Secretary, Hazardous Materials Regulations Board, Department of Transportation, Washington, D.C. 20590. Pipeline accidents involving transportation of liquids are to be reported in accordance with 49 CFR 195 Subpart B. These reports are submitted on DOT Form 7000-1 to the Director, Office of Pipeline Safety, Department of Transportation, Washington, D.C. The Department of Transportation periodically prepares summaries of these and other incident reports. Tables 8 and 9 are included to illustrate some of the information which is available from these reports.(12)

Table 8

SUMMARY -BY COMMODITY INVOLVED

Commodity Operation Accidents	Accidents		Loss		Property Damage				Deaths		Injuries	
	Number	% of Total	Barrels	% of Total	Carrier	Other	Total	% of Total	Carrier Employees	Non Employees	Carrier Employees	Non Employ
Crude Oil	138	58.0	107,443 ¹	47.0	541,859,348 ⁵	980,265 ⁸	42,839,606	97.6	1	0	3	4
Gasoline	35	14.7	27,163 ²	11.9	520,310	27,600 ⁹	547,910	1.2	0	0	0	2
N.G.L.	14	5.9	17,301	7.6	71,312	45,220 ¹⁰	116,532	0.3	0	0	4	0
Fuel Oil	17	7.1	7,725	3.4	4,608	93,700	98,308	0.2	0	0	0	0
L.P.G.	18	7.5	59,823 ³	26.1	15,482	261,157 ¹²	276,639	1.6	0	2	0	6
Jet Fuel	3	1.3	1,230	0.5	1,350	0	1,350	0.0	0	0	0	0
Diesel Fuel	7	2.9	4,196	1.8	11,450	5,500	16,950	0.0	0	0	0	0
Anhydrous Ammonia	1	0.4	1,093	0.5	50	500	550	0.0	0	0	0	0
Kerosene	1	0.4	200	0.1	500	0	500	0.0	0	0	0	0
Turbine Fuel	3	1.3	1,595	0.7	1,437	1,200	2,637	0.0	0	0	0	0
Oil and Gasoline	1	0.4	660	0.3	1,750	200	1,950	0.0	0	0	0	0
TOTAL	238	99.9 ⁴	228,429	99.9 ⁴	42,487,590	1,415,342	43,902,932	99.9 ⁴	1	2	7	12

(1) Includes accidents with losses of 10,500; 9,401; 5,190; 4,398; and 10,000 barrels.

(2) Includes accident with loss of 5,158 barrels.

(3) Includes accidents with losses of 18,606; 13,789; 7,563; and 6,026 barrels.

(4) 0.1 percent discrepancy due to rounding of percentages.

(5) Includes accidents of \$40,000,000; \$750,000; \$530,000; \$225,000; and \$200,000.

(6) Includes accidents of \$450,000; \$31,750; and \$20,000.

(7) Includes accident of \$57,817.

(8) Includes accidents of \$500,000; \$330,000; and \$96,000.

(9) Includes accident of \$15,000.

(10) Includes accident of \$45,000.

(11) Includes accidents of \$80,000 and \$10,000.

(12) Includes two accidents of \$100,000 and one of \$50,000.

Table 9

LIQUID PIPELINE ACCIDENT SUMMARY - JANUARY 1, 1977 Through DECEMBER 31, 1977

Cause of Accident	No. of Accidents Number % of Total		Deaths		Injuries		Property Damage			Loss of Commod. (Barrels)	Number of Accidents by Year of Installation							
			Carrier Employees	Non- Employees	Carrier Employees	Non- Employees	Carrier	Other	Total		Before 1920	1920 1929	1930 1939	1940 1949	1950 1959	1960 1969	1970 1977	Not Reported
Equipment Rupturing Line	79	33.2	0	0	0	7	\$ 832,223 ³	\$1,145,737 ⁴	\$ 1,977,960	99,209 ¹⁴	5	2	13	15	13	20	10	1
Corrosion - External	48	20.2	0	0	0	0	49,388 ⁵	17,050	66,438	20,517 ¹⁵	7	3	9	10	10	7	2	0
Incorrect Operation by Carrier Personnel	19	8.0	1	0	3 ²	3	40,033,113 ⁶	97,275 ⁷	40,130,388	10,318	0	2	0	1	4	7	4	1
Defective Pipe Seam	15	6.3	0	0	0	2 ²	8,513	15,170	23,683	38,816 ¹⁶	0	0	5	2	6	2	0	0
Corrosion - Internal	12	5.0	0	0	0	0	1,792	1,200	2,992	10,612 ¹⁷	1	1	2	2	5	1	0	0
Failure of Previously Damaged Pipe	4	1.7	0	0	0	0	680	4,800 ⁸	5,480	4,109	0	0	1	0	2	1	0	0
Malfunction of Control or Relief Equipment	4	1.7	0	0	0	0	8,505	1,710	10,215	1,600	0	0	0	0	2	1	1	0
Defective Girth Weld	1	0.4	0	0	0	0	1,500 ⁸	0	1,500	100	0	1	0	0	0	0	0	0
Vandalism	2	0.8	0	0	0	0	1,050	500 ⁸	1,550	254	0	0	0	0	0	1	1	0
Malfunction of Valve	5	2.1	0	0	0	0	2,000	300 ⁸	2,300	1,960	0	0	0	2	0	0	3	0
Threads Stripped or Broken	2	0.8	0	0	0	0	535 ⁸	3,500	4,035	3,085	0	2	0	0	0	0	0	0
Cold Weather	2	0.8	0	0	0	0	0	0	0	157	0	1	0	0	1	0	0	0
Pump or Appurtenance Facilities	19	8.0	0	0	0	0	713,492 ⁹	16,600 ¹⁰	730,092	5,172	0	0	2	1	0	6	10	0
Natural Events	6	2.5	0	2 ¹	4 ²	0	787,837 ¹¹	105,000 ¹²	892,837	24,211 ¹⁸	0	0	1	2	1	1	1	0
Tank or Appurtenance Facilities	5	2.1	0	0	0	0	500 ⁸	0	500	2,968	0	1	0	0	1	2	1	0
Miscellaneous	15	6.3	0	0	0	0	46,462 ¹³	6,500	52,962	5,341	0	1	1	1	1	5	6	0
TOTAL	238	99.9 ¹⁹	1	2	7	12	42,487,590	1,415,342	43,902,932	228,429	13	14	34	36	46	54	39	2

(1) Deaths caused by same accident.

(2) All injuries caused by one accident.

(3) Includes accidents of \$750,000 and \$15,000.

(4) Includes accidents of \$500,000; \$330,000; and \$100,000.

(5) Includes accident of \$31,750.

(6) Includes accident of \$40,000,000.

(7) Includes accident of \$96,000.

(8) One accident.

(9) Includes accidents of \$450,000 and \$225,000.

(10) Includes accident of \$15,000.

(11) Includes accidents of \$530,000, and \$200,000.

(12) Includes accident of \$100,000.

(13) Includes accident of \$40,000.

(14) Includes accidents with losses of 18,606; 13,789; and 7,563 barrels.

(15) Includes accident with loss of 6,026 barrels.

(16) Includes accidents with losses of 10,500; 5,158; and 4,398 barrels.

(17) Includes accident with loss of 5,190 barrels.

(18) Includes accidents with losses of 10,000 and 9,401 barrels.

(19) 0.1 percent discrepancy due to rounding of percentages.



Releases or spills of liquid petroleum products which occur near water or may enter water are required to be reported to the National Response Center operated by the U.S. Coast Guard. Incidents of this sort may result from liquid petroleum transfer operations conducted at refineries, terminals, etc. Investigation of these incidents is performed by officials of the U.S. Coast Guard or the Environmental Protection Agency. Both the Coast Guard and the EPA have responsibilities to investigate these incidents under the Federal Water Pollution Control Act as amended by the Clean Water Act of 1977. In general, the official who investigates the incident "predesignated onscene coordinator" is supplied by EPA when inland waters are involved and by the Coast Guard when coastal waters are involved. The National Oil and Hazardous Substance Contingency Plan (40 CFR 1510) generally outlines the inland water versus coastal water jurisdictional boundaries between EPA and the Coast Guard. Specific boundaries within geographic areas of the country are worked out at the local level between EPA and the Coast Guard. Regardless of which agency provides the "predesignated onscene coordinator" the report of the spill or release is forwarded to the National Response Center.(13) These reports are to include all significant facts regarding the spill or release and may be valuable in assessing the safety of liquid petroleum transfer operations.

F. Exposure Levels

Information describing exposures of employees to health and safety hazards associated with liquid petroleum transfer operations was not discovered during the development of this profile. Conversations with several safety and health professionals within the involved industries indicated that information of this type is not available in the open literature. If any information does exist, it is probably contained within the safety and health departments of individual companies.

G. Related Studies

During the development of this profile a variety of sources were contacted or searched to obtain information. In general, key words like "safety" and "health" were used to guide the search. Use of these words did help to insure that information with safety and/or health significance was retrieved. This practice also limited the number of articles and other references to a level which could be reasonably managed in the course of this profile development. It should be recognized that many more references could be accessed if less restrictive matrices of key words were used. Should this profile topic or portions thereof be selected for further development, a wider, more intensive literature review is recommended which would uncover articles of related importance but not necessarily devoted to safety and/or health objectives. For example, it is suspected that an expanded number of useful trade association journal articles would be retrieved if a wider search were employed.

The American Petroleum Institute and other capable industry associations are continually involved in the development of information of importance to their member companies. Most of these associations publish catalogs or other lists of studies they have sponsored. These lists should be periodically reviewed to detect the availability of new information.

Several studies relating to specific portions of this profile were uncovered and they are briefly discussed in the following paragraphs.

A number of articles relating to electrical safety near liquid petroleum transfer operations were found. They are as follows:

Edmonds-Brown, H. Safety Aspects of Electrical Engineering Practice in the Petroleum Industry, Mining Technology 55(629), 88-91 (1973).

Brown, A.S. and Wadhwa, K.B. Electrical Safety at Docks for Ships Transferring Hazardous Cargos. Record of Conference Papers, 23rd Annual Petroleum Chemistry Industrial Conference, Philadelphia, PA, August/September 1976. IEEE, 1976, pp. 288-294.

Verhiel, A.L., Review of Bonding Practices of Ship-to-Shore Facilities Handling Petroleum Products. IEEE Transactions on Industry and General Applications, Volume I6A-5, No. 5, September/October 1969, pp. 624-632

An extensive source of information developed by the Institute of Petroleum, London, England was discovered. It is described as follows:

Special Publication Series No. 1, Gas Evolution: Tanker and Terminal Safety. Proceedings of a symposium organized by the Institute of Petroleum and held at the Mount Royal Hotel, London, W.1, on 5 March 1971, Edited by Peter Hepple. Institute of Petroleum, 61 New Cavendish Street, London, 1971.

This document contains the following components:

Opening address

Classification of Petroleum Products

The Dispersion of Hydrocarbon Gas During the Loading of Tankers

Classification of Hazardous Areas

Electrical Equipment for Hazardous Areas

Flow Rate Limitations Imposed by Static Electricity on Tankers

Application of IOTTSG Guide to Loading and Discharging Operations

Studies found related to LNG are as follows:

Hazards Associated with the Importation of Liquefied Natural Gas. R-1845-RC, June 1976. Published by the Rand Corporation, Santa Monica, CA 90406.

Kobayashi, A. et al., Experimental Study of LNG Underground Tank. ASME Paper 76-WA-PID-5 for the meeting of December 5, 1976.

A general study related to energy related accidents was found:

Accidents and Unscheduled Events Associated with Non-Nuclear
Energy Resources and Technology, MITRE Corp., McLean, VA METREK
Division. EPA, Washington, D.C., Office of Energy, Minerals
and Industry. EPA Contract: EPA-68-01-3188

H. Industry Trends

Some information was discovered during the development of this profile which indicated trends in the industries involved with transfer of liquid petroleum products.

In general, the total volume of liquid petroleum products which are transferred during a space of time is relatable to their consumption. Therefore, increased consumption of gasoline by automobiles and heating fuel by homes and businesses would be expected to cause an increase in transfer of liquid petroleum products.

For the last several years, large petroleum producing and refining firms have been divesting themselves of bulk plant, bulk liquid terminal and service station operations.(3,6,9) This may have been caused in part by the increasing pressure to equip these kind of facilities with improved vapor recovery equipment to meet local oxidant air pollution standards.

Increasing concerns for the environment and public safety have caused many petroleum transportation systems to be carefully examined in hopes of minimizing pollution and potential for disaster. Oil spills have received much attention and have caused development of improved methods to cope with these types of incidents. This same type of concern has

caused more careful selection of sites for new refineries, terminals, etc. The growing LNG industry is feeling the pressure of concern for public safety in its drive to build and operate more LNG terminals(4,14). Similar pressure is being felt by public utilities which are depending more and more on LNG systems to serve as peakshaving supplies.(4,15)

I. Existing Standards

From the material presented in the preceding sections of this information profile, it is readily apparent that many existing standards are applicable to petroleum liquid transfer operations. The fire and explosion hazards associated with these products long ago necessitated the development of procedures and requirements to safeguard life and property. A number of standards organizations have developed provide information relating to the storage, handling, and transportation of liquid petroleum products. These standards have been adopted in whole or in part by many regulatory agencies at the federal, state and local levels.

Among the OSHA standards which have important application to liquid petroleum product transfer operations are those contained in 29 CFR 1910.106. This detailed section of the OSHA General Industry Standards is devoted to flammable and combustible liquids. An outline of this section is included here to highlight the applicable requirements.

29 CFR 1910.106 - Flammable and Combustible Liquids

- (1) Definitions
- (2) Tank Storage
- (3) Piping, valves, and fittings

- (4) Container and portable tank storage
- (5) Industrial plants
- (6) Bulk plants
 - (a) Storage (i-iii)
 - (b) Buildings (i-iii)
 - (c) Loading and unloading facilities (i-vi)
 - (d) Wharves (i-x)
 - (e) Electrical equipment (i-iii)
 - (f) Sources of ignition
 - (g) Drainage and waste disposal
 - (h) Fire control
- (7) Service stations
 - (a) Storage and handling (i-v)
 - (b) Private stations
 - (c) Dispensing systems (i-vii)
 - (d) Marine service stations (i-iii)
 - (e) Electrical equipment (i-iv)
 - (f) Heating equipment (i-v)
 - (g) Drainage and waste disposal
 - (h) Sources of ignition
 - (i) Fire control

(8) Processing plants

- (a) Scope
- (b) Location (i-ii)
- (c) Processing building (i-iv)
- (d) Liquid handling (i-iv)
- (e) Tank vehicle and tank car loading and unloading
- (f) Fire control (i-iv)
- (g) Sources of ignition (i-iii)
- (h) Housekeeping (i-iv)

(9) Refineries, chemical plants and distilleries

- (a) Storage tanks
- (b) Wharves
- (c) Fired and unfired pressure vessels (i-ii)
- (d) Location of process units
- (e) Fire control (i-iii)

(10) Scope

The following outline indicates the type of regulatory coverage which some states provide for petroleum liquid transfer operations. This example is taken from State of California, Division of Industrial Safety, Petroleum Safety Orders.

SUBCHAPTER 14. PETROLEUM SAFETY ORDERS—DRILLING AND PRODUCTION

Originally Printed April 20, 1945. Repealer and New Subchapter 14 Filed May 14, 1952.

Article

1. Purpose, Application, Scope and Permits for Variation
2. Definitions
3. Accident Prevention Program
4. First Aid
5. Dangerous Exposure
6. Fires and Explosions
7. Enclosed and Confined Spaces
8. Gas and Vapor Testing
9. Pipe Lines, Fittings, and Valves
10. Opening and Blinding Pipe Lines and Equipment
11. Drainage, Housekeeping, and Leakage Control
12. Hazardous Substances
13. Agitation and Heating of Liquids in Tanks
14. Stationary Tanks and Reservoirs
15. Vessels: Pressure-Relieving Safety Devices
16. Gas Compressors and Engines
17. Identification of Wells and Equipment
18. Standard Type Derricks
19. All Derricks and Masts
20. Cellars and Shafts
21. Access and Exits, Derrick and Mast Floors
22. Safety Belts and Life Lines
23. Safety Provisions in Erection of Masts
24. Guying Masts
25. Crown Platforms and Railings
26. Pipe and Sucker Rod Platforms for all Masts
27. Pipe-Racking Supports for Masts
28. Ladders and Ladderway Openings for Masts
29. Tools, Equipment, and Materials in Derricks or Masts

Article

30. Back-Up Posts, Kelly Pull-back Posts, Back-Up and Safety Lines for Pipe Tongs
31. Handling Heavy Tools at Drilling Wells
32. Rotary and Circulating Hose and Standpipe
33. Rotary Drilling Machinery
34. Standard Tool Drilling Machinery
35. Well-Servicing Machinery
36. Machinery Common to All Drilling and Well Servicing
37. Oil Well Pumping Machinery
38. Pumps and Pump Pressure-Relieving Safety Devices
39. Guarding Sheaves for Telescoping, Jackknife, Gin Pole and Cantilever Masts
40. Traveling Blocks and Hooks or Similar Devices
41. Wire Rope Hoisting Lines
42. Cathheads for Well Drilling and Well Servicing Machinery
43. Lines Used on Cathheads
44. Miscellaneous Tools and Equipment
45. Pipe Handling and Storage Racks
46. Liquid Loading and Unloading Facilities and Operations
47. General Safety Provisions and Precautions
48. Illumination
49. Wharves and Piers
50. Shafts at Oil Wells
51. Rig-Building Equipment and Operations
52. Prime Movers
53. Line Spoolers and Deadline Stabilizers
54. Weight Indicators
55. Blowout Prevention
56. Attractive Nuisance Guards

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

Article

1. Application, Scope and Variations from These Orders
2. Definitions
3. Accident Prevention Program
4. First Aid
5. Fires and Explosions
6. Dangerous Exposure
7. Enclosed and Confined Spaces
8. Escape Exits
9. Tanks and Reservoirs
10. Gas and Vapor Testing
11. Opening and Blinding Pipe Lines and Equipment
12. Hazardous Commodities
13. Drainage

Article

14. Agitation and Heating of Liquids in Tanks
15. Process Equipment Maintenance
16. Pumps, Pipe Lines and Valves
17. Equipment Leakage and Breakage
18. Vessels: Pressure-Relieving Safety Devices
19. Equipment Identification
20. High Pressure Hydrocarbons
21. Gas Compressors and Engines
22. Loading and Unloading Facilities and Operations
23. Laboratories and Pilot Plants
24. Wharves
25. Bulk Distributing Plants



The National Fire Protection Association has developed many standards which relate to this profile subject. Among the applicable NFPA standards are:

Volume 1 - Flammable Liquids, Boiler-Furnaces, Ovens

- NFPA 30 - Flammable and Combustible Liquids Code
- NFPA 321 - Classification of Flammable Liquids
- NFPA 327 - Cleaning Small Tanks
- NFPA 329 - Underground Leakage of Flammable and Combustible Liquids
- NFPA 385 - Tank Vehicles for Flammable and Combustible Liquids
- NFPA 386 - Portable Shipping Tanks
- NFPA 704M - Fire Hazards of Materials, Identification Systems for

Volume 2 - Gases

- NFPA 58 - Liquefied Petroleum Gases, Storage and Handling
- NFPA 59A - Liquefied Natural Gas, Storage and Handling

Volume 5 - Electrical

- NFPA 70 - Electrical Code

Volume 10 - Transportation

- NFPA 307 - Marine Terminals Operation
- NFPA 512 - Truck Fire Protection

The American National Standards Institute has developed a number of applicable standards which relate to liquid petroleum products. Some of these standards share identification with NFPA standards but are included to indicate the ANSI reference number. Among the applicable standards are:

- Z288.1 - Flammable and Combustible Liquids Code ANSI/NFPA 30-1976
- Z225.1 - Fuel Storage and Handling - Production, Storage, and Handling of Liquefied Natural Gas (LNG) ANSI/NFPA 59A-1975
- Z222.1 - Flame Arresters for Use on Vents of Storage Tanks for Petroleum Oil and Gasoline. ANSI/UL 525 - September 1973.
- Z106.1 - Liquefied Petroleum Gases, ANSI/NFPA 58-1977.
- Z216.1 - Power Operated Dispensing Devices for Petroleum Products. ANSI/UL 87 - September 1975.
- Z217.1 - Pressure Regulators for LP-Gas, ANSI/UL 144 - March 1971.
- B148.1 - Piping Hazardous Materials - Pipe Connectors for Flammable Liquids and LP-Gas, ANSI/UL 567 - August 1972.
- MH22.1 - Tank Trucks - Flammable and Combustible Liquid Tank Vehicles, ANSI/NFPA 385 - 1974
- MH 9.1 - Marine Terminal Operations - 1972
- C1 - Electrical Safety - National Electrical Code, ANSI/NFPA 70 - 1978

The American Petroleum Institute has developed several bulletins and recommended practices which have application to this profile topic. Several of these publications are listed in the profile developed on "Petroleum Refinery Turnaround". A complete list of API publications and materials can be found

in their Publications and Materials 1978 Catalog available from the American Petroleum Institute, 2101 L Street, N.W., Washington, D.C. 20037.

Other industry associations and professional organizations have also developed materials which form the basis for good operating and work practices in petroleum liquid transfer operations. Among these materials are the LP-Gas Safety Handbook developed by the National LP-Gas Association and a loading practices manual for truck drivers developed by the Gas Processors Association.

Several other federal agencies have or are contemplating regulations which have or will have varying impact in the work environment associated with petroleum liquid transfer operations. It should be stated at the outset that many jurisdictional problems still exist with regard to which agency has regulatory authority over petroleum liquid transfer operations. Many of these jurisdictional problems are associated with the interface between production, processing, storage and one form or another of transportation. It is at this interface where petroleum liquid transfer takes place.

The Department of Transportation has promulgated regulations which govern the transportation of liquid petroleum products by rail, highway, and pipeline. These regulations are codified as follows:

49 CFR 174 Carriage by Rail

49 CFR 177 Carriage by Public Highway

Both of these sets of regulations include requirements which govern loading and unloading of product carriers (i.e., rail tankcars and tank trucks).

Other Department of Transportation Regulations govern pipeline transportation of liquids. These regulations are codified as:

49 CFR 195 Transportation of Liquids by Pipeline

The Department of Transportation, Materials Transportation Bureau is developing some new rules for the U.S. LNG industry. These rules will be codified under 49 CFR 113. Other recent legislative action H.R. 11622, the Fuels, Transportation and Safety Amendments Act of 1978 if passed would authorize DOT to set new minimum standards for existing, as well as, new LNG facilities. Both of these potential rulemaking actions are being viewed as potential inhibitors to the growth of the LNG industry according to one trade journal.(15)

The U.S. Coast Guard under the Department of Transportation has promulgated regulations which govern the bulk carriage of hazardous materials (including petroleum liquids) by water. These regulations are codified as:

46 CFR Subchapters D, I, O, and N

The U.S. Coast Guard also has promulgated regulations which govern waterfront operations. They are codified as 33 CFR 126. The Coast Guard is currently preparing new "Waterfront Facility" regulations. An advance notice of these

regulations was published in the Federal Register on April 10, 1978. The Coast Guard expects to publish draft waterfront facility regulations in the summer of 1979 with final regulations in place by the summer of 1980.(13)

The Department of Labor is also currently developing regulations which would apply to waterfront facilities. Reportedly the U.S. Coast Guard and OSHA are coordinating their regulatory development projects to avoid potential overlap and ambiguities.(13,16) A discussion draft of the OSHA "Marine Terminal Facilities" regulations is now being reviewed. Draft regulations are expected to be published in the Federal Register during the late summer or fall of 1979. These regulations will become Subparts M to S of 29 CFR 1918 Maritime Standards. These standards will include a specific section on "Bulk Liquid Cargo Terminals" but no specific detailed coverage of LP-Gas or LNG.(16)

The reporting of significant accidents to OSHA, DOT, the U.S. Coast Guard and to EPA has been discussed earlier in this profile in Section (E).

The Environmental Protection Agency and state and local air pollution control agencies will also affect work environments associated with petroleum liquid transfer operations. EPA has prepared "Control Technique Guideline Documents" for bulk plants, bulk terminals, stage 1 - service stations and fixed roof storage tanks. The information contained in these documents will be used by

some air pollution control agencies in their Implementation Plans to meet EPA oxidant pollutant standards. In areas when vapor recovery systems, etc. are required at bulk plants, etc., significant changes in potential exposure of employees to petroleum product vapors would be expected.(9)

The EPA does not anticipate that a Control Technique Guideline Document will be prepared for vapor recovery at Marine terminal operations. It is possible that new source performance standards will be developed for marine terminals. The EPA does anticipate that additional regulations governing barge loading of benzene will be developed in the future.(9)

J. Names and Addresses of Industry Associations and Other Interested Parties

Due to the broad range of industrial classifications covered by this profile many associations and organizations could be listed. These groups would have interests related to petroleum products and various transportation considerations. In the interest of keeping this list to a manageable length, only those groups which have been identified with the petroleum industry are presented.(17) An expanded list could be developed by searching the following topics: trucking, railroads, shipping, labor unions, transportation, etc.

(1) Industry Associations

American Petroleum Institute
2101 L. Street, N.W.
Washington, D. C. 20037
202-457-7000

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

Association of Oil Pipe Lines
1725 K Street, N. W.
Washington, D. C. 20006
202-331-8228

Independent Liquid Terminals Association

Suite 509

1001 15th Street, N.W.

Washington, D. C. 20005

202-659-2301

Independent Petroleum Association of America

1101 16th Street, N.W.

Washington, D. C. 20036

202-466-8240

Independent Refiners Association of America

Suite 403

1220 19th Street, N.W.

Washington, D. C. 20036

202-466-2340

Independent Terminal Operators Association

1523 L Street, N.W.

Washington, D. C. 20005

202-393-8535

National LP-Gas Association

1301 W. 22nd Street

Oak Brook, Ill. 60521

312-986-4800

National Oil Jobbers Council, Inc.

1707 H Street, N.W.

Washington, D.C. 20006

202-331-1198

National Petroleum Council

1625 K Street, N.W.

Washington, D. C. 20006

202-393-6100

National Petroleum Refiners Association

Suite 1000

1899 L Street, N.W.

Washington, D. C. 20036

200-638-3722

Oilfield Haulers Association, Inc.

Box 488, 700 East 11th Street

Austin, Texas 78767

512-476-5326

Shippers Oil Field Traffic Association

616 South Beacon Street

Tulsa, Oklahoma 74119

918-585-1201

(2) Labor Unions

International Union of Petroleum and Industrial Workers

335 California Avenue

Bakersfield, Calif. 93304

805-327-1614

Oil Chemical and Atomic Workers International Union

Box 2812

Denver, Colorado 80201

303-893-0811

(3) Professional Organizations

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

345 East 47th Street

New York, N. Y. 10017

212-644-7695

K. Names and Addresses of Companies

(1) Oil Production and Refining

Exxon Company, U.S.A.

Box 2180

Room 491

Houston, Texas 77001

713-656-3636

Atlantic Richfield Company

260 South Broad

Philadelphia, PA 19101

215-735-2345

Texaco, Inc.

135 East 42nd

New York, NY 10017

212-953-6000

(2) Companies Operating LP-Gas Pipelines and Terminals(2)

Mapco (Mid America Pipeline Company)

1437 South Boulder

Tulsa, Oklahoma 74119

918-584-4471

(3) Companies Operating LNG Terminals (2, 4)

El Paso Natural Gas Company

P. O. Box 1492

El Paso, Texas 79978

915-543-2671

Columbia LNG Corporation

Subsidiary of Columbia Gas Systems, Inc.

20 Montchanin Road

Wilmington, Delaware 19807

302-429-5000

Southern Energy Company

Subsidiary of Southern Union Gas Company

Fidelity Union Tower

Dallas, Texas 75201

214-748-8511

(4) Independent Terminal Operators(3)

GATX Terminals Corporation

120 South Riverside Plaza

Chicago, Illinois 60606

312-621-6200

South Coast Terminals, Inc.

7401 Wallaceville

Houston, Texas

713-672-2401

(5) Oil Jobbers(6)

Gibbs Oil Company

5315 Washington

West Roxbury, Mass.

617-323-9693

Mid-Missouri Oil Company

8th and Maple

Eldo, Missouri

314-392-5231

L. Summary Analysis of Data

The information assembled for this profile indicates that the general area of liquid petroleum product transfer falls at the interface between production, transportation, and use of these products. Many regulatory authorities presently have what appears to be overlapping responsibilities in covering these operations. There is a lack of detailed information describing the injury and illness experience of employees exposed to the safety and health hazards associated with liquid petroleum transfer operations. From the data sources consulted, it is surmised that a substantial body of information exists concerning relatively serious accidents or incidents which have occurred in recent years involving transfer of liquid petroleum products. However, it does not appear that this body of data has been carefully examined to discover causative injury and illness factors. No current studies were discovered which will clarify the understanding of safety and health problems associated with these operations. There are rulemaking procedures in process which will further regulate liquid petroleum transfer operations. It is not clear at this time whether these pending regulations will aide in the discovery of accident causes allowing the development of approved control measures.

The industries involved with transferring liquid petroleum products are undergoing change related to tightening environmental and safety regulations. Growth of liquid natural gas importation and handling is being experienced. It is assumed from the regulatory actions being contemplated that additional control of vapors from all types of liquid petroleum product transfer operations will be required. Emphasis will continue to be applied to spills that occur on land and in or near water.

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, pp. 37, 127, 128, 220, 224, 225, 228, 229, 230, 232, 237, 256, 265 and 275.
2. Telephone communication with: National LP-Gas Association 1/31/79.
3. Telephone communication with: Independent Liquid Terminals Association 1/30/79.
4. Telephone communication with: American Gas Association 2/1/79.
5. Health and Safety Guide for Bulk Petroleum Plant. U.S. DHEW, PHS, CDC, NIOSH, Division of Technical Services, Cincinnati, Ohio, September, 1974.
6. Telephone communication with: National Oil Jobbers Council, Inc. 1/30/79.
7. Fire Protection Handbook, 14th Ed., National Fire Protection Association, Boston, Mass. 1976, pp. 3-18 to 3-38.
8. Criteria for a Recommended Standard ... Occupational Exposure to Refined Petroleum Solvents, DHEW (NIOSH) Publication No. 77-192.

9. Telephone communication with: Chemical and Petroleum Branch, Emission Standards and Engineering Division, Office of Air Quality Planning and Standards, Environmental Protection Agency, 1/31/79.
10. 29 CFR 1910.106
11. California Work Injuries and Illnesses, 1975. Department of Industrial Relation, Division of Labor Statistics and Research, State of California, P. O. Box 603, San Francisco, CA 94101, August, 1977.
12. Summary of Liquid Pipeline Accidents Reported on DOT Form 7000-1 from January 1, 1977, through December 31, 1977. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau. Compiled by the Office of Program Support, August 1, 1978.
13. Telephone communication with: Chief, Port Safety Branch, Port Safety Law Enforcement Division, Office of Marine Environment and Systems, U.S. Coast Guard, Washington, D.C. 1/30/79.
14. Handling Cryogenics - A Developing Technology. Cargo Systems International. 4(6), 71-73 (1977).
15. Hale, D. Peakshaving Supplies Reach All-Time High For '78-'79 Winter. Pipeline Oil and Gas Journal, November, 1978, pp. 20-25.

16. Telephone communication with: Office of Maritime Safety Standards,
Occupational Safety and Health Administration, Department of Labor, 1/31/79.
17. National Trade and Professional Associations of the United States and
Canada and Labor Unions. 14th Annual Edition, 1979. Columbia Books,
Inc., Publishers Washington, D.C. 20005.

