

Aboveground Storage Tank Survey

HEALTH AND ENVIRONMENTAL AFFAIRS
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EXECUTIVE SUMMARY

This technical report describes the results of the Aboveground Storage Tank Survey conducted for the American Petroleum Institute by Entropy Limited. The survey covers all segments of the petroleum industry, namely marketing, refining, transportation and production. A total of 76,708 tanks were counted, including 75,369 tanks in the API field survey plus 1339 additional tanks in the marketing area from data supplied by the Petroleum Marketing Association of America (PMAA). This survey does not include what is believed to be a small part of the total tank population such as tanks at user locations (e.g., utility fuel storage). Based upon statistical analysis of these surveyed tanks into stratification groups, the total number of tanks nationally is estimated at approximately 700,000. This includes approximately 89,000 in marketing, 30,000 in refining, 9,000 in transportation and 572,000 in production. Table S-1 shows the number of tanks and their total shell capacity by industry sector.

Table S-1. National estimates by industry sector, number of tanks and total shell capacity.

	<u>Number Tanks</u>	<u>Total Shell Capacity (MBbls)</u>
Marketing	88,529	486,925
Refining	29,727	945,092
Transportation	9,197	556,183
Production	572,620	280,595
	<u>700,073</u>	<u>2,268,795</u>

Tank sizes, ages and other characteristics are covered in the survey. Table S-2 shows the estimated distribution of tanks nationally by industry sector and size. The largest portion (82.8%) comprises the smallest size category, 26 to 500 Bbls. The next largest portion (6.4%) is the 500 to 1000 Bbls size range. Only 0.6% of the tanks are over 100,000 Bbls.

Table S-2. National estimates by industry sector, numbers of tanks by shell capacity (bbls).

	26 to 500	+500 to 1 M	+1 M to 10 M	+10 M to 100 M	+100 M
Marketing	64,793	4,417	7,434	11,469	416
Refining	3,913	2,460	9,665	11,629	2,060
Transportation	694	307	1,468	5,048	1,680
Production	510,045	37,628	23,946	974	27
	<u>579,445</u>	<u>44,812</u>	<u>42,513</u>	<u>29,120</u>	<u>4,183</u>

For tanks of known ages, the largest portion (32.1%) comprises the 0-10 year age range. The next largest (26.6%) is the 11-20 year range. Table S-3 gives the age distributions by industry sector as well as the national total age distribution.

Table S-3. National estimates by industry sector, numbers of tanks by age (years).

	0-10	11-20	21-30	31-40	41+	Unkn
Marketing	9,583	13,465	21,167	15,578	21,149	7,587
Refining	2,066	3,446	4,814	6,877	11,129	1,395
Transportation	876	1,376	1,831	2,096	2,666	352
Production	212,440	167,863	112,131	28,865	13,109	38,212
	224,965	186,150	139,943	53,416	48,053	47,546

The survey also covers type of material contained in the tanks and type of tank construction. Detailed breakouts by material and construction types for each industry sector are given in the corresponding sections of this report.

The figures for distance from navigable waters were also surveyed. Totalling the numbers of facilities in marketing, refining and transportation, 48.8% are over 5 miles, 20.1% are 1 to 5 miles, 7.8% are 1/2 to 1 mile, 7.4% are 1/4 to 1/2 mile, and 15.9% are less than 1/4 mile from navigable waters. For production, 23.9% of the tanks are over 5 miles, 21.0% are 1 to 5 miles, 14.5% are 1/2 to 1 mile, 15.0% are 1/4 to 1/2 mile, and 25.6% are less than 1/4 mile from navigable waters.

In the estimated national totals, the percentage of facilities covered by SPCC regulation (40CFR112) is 91.6% for marketing, 100% for refining, and 37.3% for transportation. The percentage with written spill contingency plans is 96.0% for marketing, 97.6% for refining and 79.7% for transportation. In production, these figures were tabulated on a tank basis, with 58.2% of the tanks covered by SPCC plans, and 47.6% covered by written spill contingency plans. The bulk of transportation facilities are not covered by SPCC regulations, but are covered by DOT oil spill contingency regulations.

MARKETING

There are an estimated 88,529 aboveground storage tanks at marketing sites in the U.S. representing the total demand for petroleum products, including motor gasoline, jet fuel, distillates, residuals and other. To achieve this estimate, API survey data has been supplemented with marketing facility surveys from the PMAA. The data supplied by PMAA members (Table M-4b) are incomplete in some respects, so that they have not been combined with the API marketing totals (Table M-4a). Valid surveys from API companies were received for 395 facilities while results from an additional 169 facilities were obtained through the PMAA.

In order to obtain a reliable estimate of total U.S. tankage, it is necessary to stratify the sample. Unstratified extrapolation based on sales figures, which are 116,659 MBbl/Month for the 395 API survey respondents and 17,131 MBbl/Day nationally as of the end of 1986*, would produce an underestimate because of the distribution of survey respondents by sales. Unstratified extrapolation based on number of facilities, which is 395 for the API survey and 12,424 for the nation as a whole (the 1982 Census of Wholesale Trade estimates the number of bulk plants and terminals at 10,131 and 2,293 respectively--LP gas facilities excluded), would produce an overestimate because the API survey has a disproportionate number of large terminals, which tend to have a high number of tanks per facility (see Table M-2).

Stratification of the components of the tankage by type of material is not possible because of differences between the portions categorized as heavy oils in national data definitions and the portions so categorized in the survey responses. Of course, it would be necessary to separate aboveground from underground storage capacity, and this generally precludes using this factor for the stratification.

Stratified estimation is possible by keying against total facility storage capacity. Storage capacity in the national census technically includes both AST and UST storage. However, virtually all storage at terminals and roughly 90% of bulk plant storage is above ground. Stratification is based on five facility storage capacity groups: below 2,500 Bbl, 2,500 - 24,999 Bbl, 25,000 - 149,999 Bbl, 150,000 - 499,999 Bbl, and 500,000 Bbl and above.

* "1987 Energy Statistics Sourcebook," p. 239.

Table M-1 gives the estimation of AST's based on these groupings. API and PMAA survey responses are combined to achieve better coverage in all five groups.

Table M-1

Extrapolation of survey tanks to U.S. totals (API and PMAA data)

Facility Group Total Facility Storage	Survey Storage Capacity (MBbl)	National Storage Capacity* (MBbl)	Survey Tanks	Estimated National Tanks* (AST and UST)	Estimated National Tanks (AST only)
(1) below 2.5 MBbl	168.1	7,865	637	29,804	26,824
(2) 2.5 - 24.9 MBbl	646.5	39,041	780	47,103	42,393
(3) 25 - 149.9 MBbl	12,770	95,654	1,034	7,745	7,745
(4) 150 - 499.9 MBbl	43,984	141,803	1,649	5,316	5,316
(5) 500 MBbl and above	<u>57,305</u>	<u>206,951</u>	<u>1,731</u>	<u>6,251</u>	<u>6,251</u>
Totals	114,874	491,314	5,831	96,219	88,529

*National storage capacity and national tank estimates include underground storage tanks (UST's) as well as AST's. Removal of the UST population is discussed below.

The representativeness of the current survey is given in Table M-2 in terms of percent of facilities and percent of storage capacity.

Table M-2

Representativeness of current survey (API and PMAA data)

Facility Group	National number of facilities	Surveyed number of facilities	Surveyed facilities (% of U.S.)	Surveyed capacity (% of U.S.)
(1)	5,317	121	2.3 %	2.1 %
(2)	4,917	81	1.6	1.7
(3)	1,480	145	9.8	13.4
(4)	525	160	30.5	31.0
(5)	<u>185</u>	<u>57</u>	<u>30.8</u>	<u>27.7</u>
Totals	12,424	564	4.5	23.4

Table M-3 characterizes the groups in terms of per tank thruput and capacity for the survey data.

Table M-3
Characteristics of stratification groups

Facility Group	Tanks/ facility	Thruput** (MBbl/D)		Capacity (MBbl)		Thruput** per Capacity (Bbl/Bbl-D)	
		per tank	per facility	per tank	per facility	Survey	U.S.
(1)	5.2	1.6*	9*	0.3		1.4	1.5
(2)	9.6	7.3*	33*	0.8		8.0	7.9
(3)	7.1	23.7	163	12.3		88.1	64.6
(4)	10.3	32.8	346	26.7		274.9	270.1
(5)	30.4	24.7	763	33.1		1005.4	1118.7
		(API only)	(API only)				(API only)

*Throughput data for some of the facilities in the groups (1) and (2) have been estimated.

**All throughput data and throughput per capacity ratios are derived from API survey respondents only.

The capacity per facility ratio for the survey closely matches Census Bureau data for the U.S. Group (2) exhibits an anomalously high value for tanks per facility. In this respect, the API and PMAA samples differ, PMAA data exhibiting a higher ratio.

An estimated adjustment to exclude UST's from the extrapolation can be achieved by reducing the U.S. tank totals by 10% for the bulk plant subpopulation. This subpopulation approximately coincides with groups (1) and (2), which jointly consist of 10,234 U.S. facilities. From Table M-1, 10% of the group (1) and (2) tanks equals 7667.3. Reducing the overall U.S. totals by this amount gives an adjusted total of 88,318 above ground storage tanks.

Table M-4 contains the survey totals for (a) API and (b) PMAA marketing facilities, respectively. Note that PMAA data were surveyed for only the two tank size ranges 25-1000 Bbl and over 1000 Bbl. National estimates for marketing tank populations are presented in Table M-5.

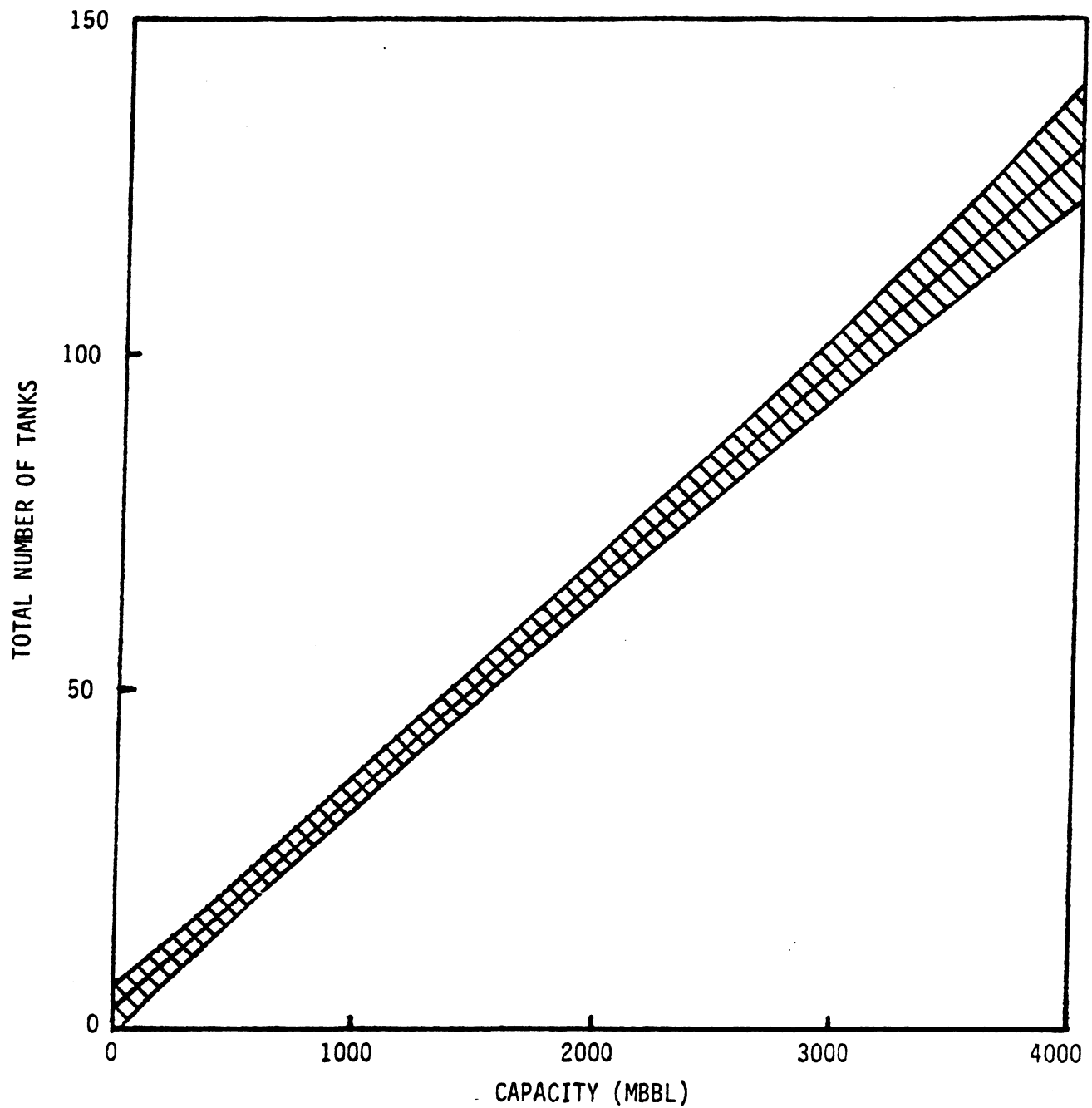


Figure M-1. Linear trend line and its uncertainty in fitting the number of aboveground storage tanks versus facility storage capacity for 395 marketing facilities.

Table M-4a

Form completed by _____ Survey totals for MARKETING (API only) Title _____
 Company _____ Phone _____
 Mail address _____ City _____ State _____ Zip _____
 Facility name & address _____ City _____ State _____ Zip _____
 Total monthly thruput (thousands of barrels out of facility) 116,659

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing 395 Petroleum transportation _____
 Petroleum refining _____ Utilities _____
 Petroleum production _____ Chemical manufacturing _____
 Other (specify): _____

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material	Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (# tanks)	Total Capacity (MBbls)
148	Viscous heavy oils		35	25	40	48	0	0	1,913
47	Fluid heavy oils		9	3	21	12	2	0	1,039
347	Lube oils (not viscous)		157	80	79	31	0	0	99
1242	Distillates		143	28	222	805	44	0	37,485
1896	Gasolines		227	27	278	1299	65	0	57,646
48	Non-potable water		9	3	23	13	0	0	403
287	Non-operational tanks		116	23	81	65	2	0	2,847
477	Other:		189	30	94	163	1	0	5,780
4492	Total		885	219	838	2436	114	0	108,109

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction	Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
30	Elevated		6	1	13	2	5	3
34	Reconstructed		4	11	9	2	8	0
135	Shop fabricated		61	16	27	17	6	8
907	Riveted/bolted (in field)		10	3	9	41	692	152
3167	Welded (in field)		163	405	788	1058	569	184
4273	Total		244	436	846	1120	1280	347

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment: R S Distance to navigable waters:
 Pipe line _____ 283 69 less than 1/4 mile 132
 Rail car _____ 13 9 +1/4 to 1/2 mile 32
 Marine vessel _____ 75 29 +1/2 to 1 mile 35
 Truck transport _____ 91 337 +1 to 5 miles 62
 Other (specify): _____ 1 1 over 5 miles 100

5. Is this facility covered by SPCC regulations (40CFR112)? yes 372 no 19

6. Does this facility have a written spill contingency plan? yes 391 no 2

Form 05/13/88

Survey totals for MARKETING (PMAA members)

Form completed by _____ Title _____
 Company _____ Phone _____
 Mail address _____ City _____ State _____ Zip _____
 Facility name & address _____ City _____ State _____ Zip _____
 Total monthly thruput (thousands of barrels out of facility) _____ Insufficient Data _____

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing 169 (PMAA only) Petroleum transportation _____
 Petroleum refining _____ Utilities _____
 Petroleum production _____ Chemical manufacturing _____
 Other (specify): _____

2. Record the number of above ground tanks (excluding elevated tanks) at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material	Capacity in bbls	26 to 1000 (# tanks)	+800 to 1M (# tanks)	over 1000 (# tanks)	+10M to 100M (# tanks)	+100M to 800M (# tanks)	+800M (# tanks)	Total Capacity (MBbls)
12	Viscous heavy oils		3		9				36.7
24	Fluid heavy oils		10		14				58.1
226	Lube oils (not viscous)		211		15				90.9
575	Distillates		480		95				3,506
405	Gasolines		359		46				1,362
0	Non-potable water		0		0				0
83	Non-operational tanks		75		8				42
14	Other:		14		0				5
1339	Total		1152		187				6,772

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction	Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
346	Elevated		31	74	63	54	111	13
50	Reconstructed		8	0	11	12	13	6
564	Shop fabricated		86	86	172	71	71	78
79	Riveted/bolted (in field)		0	1	15	4	56	3
260	Welded (in field)		26	45	65	64	29	31
1299	Total		151	206	326	205	280	131

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waters.

Mode of receipt/shipment: R S Distance to navigable waters:
 Pipe line _____ 15 3 Less than 1/4 mile 23
 Rail car _____ 1 0 +1/4 to 1/2 mile 11
 Marine vessel _____ 7 0 +1/2 to 1 mile 10
 Truck transport _____ 142 144 +1 to 5 miles 30
 Other (specify): _____ 1 5 over 5 miles 70

5. Is this facility covered by SPCC regulations (40CFR112)? yes 139 no 18

6. Does this facility have a written spill contingency plan? yes 156 no 10

Form 05/13/88

Table M-5. Estimated U.S. AST's for MARKETING

1. Indicate with an "X" the industry function that best describes the facility (mark only one).

Petroleum marketing	<u>11305</u>	Petroleum transportation	_____
Petroleum refining	_____	Utilities	_____
Petroleum production	_____	Chemical manufacturing	_____
Other (specify):	_____		

2. Record the number of above ground tanks at this facility according to each type of material being stored by the tank capacity range indicated (within one M=thousand barrels). "Total Capacity" equals the summed shell storage capacities of all tanks with the specified material.

Total	Type of Material	Capacity in bbls	26 to 500 (# tanks)	+500 to 1M (# tanks)	+1M to 10M (# tanks)	+10M to 100M (# tanks)	+100M to 500M (# tanks)	+500M (# tanks)	Total Capacity (MBbls)
1068	Viscous heavy oils		281	144	399	243	1	0	9868
896	Fluid heavy oils		460	25	267	135	9	0	7092
10732	Lube oils (not viscous)		9300	834	393	202	3	0	11007
35287	Distillates		26683	1680	2880	3884	160	0	176143
32003	Gasolines		22250	1328	2159	6034	232	0	246415
287	Non-potable waste water		43	10	184	50	0	0	1771
5776	Non-operational tanks		4403	251	782	333	7	0	13531
2480	Other:		1373	145	370	588	4	0	21098
88529	Total		64793	4417	7434	11469	416	0	486925

3. Record the number of above ground tanks at this facility according to each type of tank construction by the age range indicated. Some tanks may fit more than one of the categories. In such cases, enter them only in the first applicable category appearing in the list below. For example, a reconstructed field-welded tank should be listed as "reconstructed" and not as "welded."

Total	Type of construction	Age (years)	0-10	11-20	21-30	31-40	41+	Unknown
19459	Elevated		1597	4533	3827	2915	5935	652
3037	Reconstructed		517	50	757	593	831	289
32364	Shop fabricated		5201	5068	9728	3929	4069	4369
8836	Riveted/bolted (in field)		506	78	644	413	6277	918
24833	Welded (in field)		1762	3736	6211	7728	4037	1359
88529	Total		9583	13465	21167	15578	21149	7587

4. Indicate the primary modes of material receipt (R) and/or shipment (S) at this facility. Place the appropriate letter(s) (R, S, or RS) beside each primary mode of transport. Also, indicate with an "X" the facility's distance to the nearest navigable waterway.

Mode of receipt/shipment:	R	S	Distance to navigable waters:
Pipe line	<u>1985</u>	<u>524</u>	less than 1/4 mile <u>1751</u>
Rail car	<u>111</u>	<u>44</u>	+1/4 to 1/2 mile <u>819</u>
Marine vessel	<u>470</u>	<u>119</u>	+1/2 to 1 mile <u>880</u>
Truck transport	<u>9070</u>	<u>10673</u>	+1 to 5 miles <u>2384</u>
Other (specify):	<u>48</u>	<u>263</u>	over 5 miles <u>5471</u>

5. Is this facility covered by SPCC regulations (40CFR112)? yes 10360 no 945

6. Does this facility have a written spill contingency plan? yes 10855 no 450

REFINING

There are an estimated 29,727 aboveground storage tanks at refineries in the U.S. Of these, 54.7% are at large refineries, 28.5% are at medium sized refineries, and 16.7% are at small refineries.*

These estimates were obtained by comparing the capacity and thruput figures for 63 facilities in the survey to those for the 207 facilities reported in "United States Refining Capacity," National Petroleum Refiners Association, Wash., D.C., Jan. 1, 1988, pp. 31-34. These 207 include 182 operating refineries and 25 refineries which were idle at that time. This agrees with the figures reported in the Oil and Gas Journal, (March 21, 1988). This means that about 10% of the refinery tanks are non-operational, in agreement with the non-operational tank figures from the current survey (see Table R-3).

Figure R-1 shows a plot of the number of tanks per facility versus charge capacity for the refineries surveyed. Here, charge capacity is defined as the input (feed) capacity of the refinery processing facilities. Large, medium and small refineries in the survey averaged about 294, 126 and 82 tanks per facility, respectively. As is evident from this plot, the average number of tanks per facility has two components: a base line of about 65 tanks, independent of size, plus a size dependent component which is about 120 tanks per 100,000 Bbl/D charge capacity.

*For purposes of aligning the data in this survey with categories used by the Nat. Petrol. Refiners Assoc., the points dividing large/medium and medium/small were defined as 100,000 B/CD and 30,000 B/CD charge capacity, respectively.

Table R-1

Extrapolation of survey tanks to U.S. totals

Refinery Size Group	Survey Sample			U.S. Total		
	Number Refineries	Charge Cap. Per Refinery (Bbl/D)	Total Tanks	Number Refineries	Charge Cap. Per Refinery (Bbl/D)	Estimated Total Number of Tanks
Small	8	16,750	654	82	12,388	4958
Medium	32	63,561	4015	74	58,047	8479
Large	23	191,643	6771	51	207,929	16,290
Total	63	-	11,440	207	-	29,727

Table R-1 gives the number of refineries, the average charge capacity per refinery and the total number of tanks. These figures are given both for the survey sample and for the U.S. as a whole. The survey respondents included 30.4% of the nation's refineries, accounting for 41.3% of the charge capacity and an estimated 38.5% of the storage tanks.