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16 April 1979
SUPERSEDING
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14 July 1964

MILITARY STANDARDIZATION HANDBOOK

CONVERSION FACTORS AND LOGISTICS DATA FOR PETROLEUM PLANNING

FSC 9130, 9140, 9150, 9160

DEPARTMENT OF DEFENSE
WASHINGTON, DC 20301

MIL-HDBK-210A
Conversion Factors and Logistics Data for Petroleum Planning

1. This standardization handbook was developed by the Department of the Navy, Naval Facilities Engineering Command, in accordance with established procedures.

2. This publication was approved on 16 April 1979 for printing and inclusion in the military standardization handbook series.

3. This document provides a compilation of commonly used conversion factors, and data on characteristics of petroleum products. It will provide valuable information and guidance to personnel concerned with petroleum planning. The handbook is not intended to be referenced in purchase specifications except for informational purposes, nor shall it supersede any specification requirements.

4. Every effort has been made to reflect the latest information on conversion factors and logistics data for petroleum planning. The handbook will be reviewed periodically to insure its completeness and accuracy. Users of this document are encouraged to report any errors discovered and any recommendations for changes or inclusions to the Commanding Officer, Code 156, Naval Construction Battalion Center, Port Hueneme, CA 93043.

FOREWORD

1. This compilation of commonly used data on petroleum characteristics was prepared to facilitate the work of individuals requiring such information for purposes of overall general planning.

2. There has been no intent to supplant publications of a detailed technical or scientific nature such as used in a laboratory or engineering office, but rather to consolidate in one pamphlet those items frequently found scattered throughout technical literature.

3. This handbook supersedes Military Standardization Handbook 210, dated 14 July 1964.

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Capacity of vertical cylinders (Volume per foot).

Diameter			Diameter			Diameter		
ft	in.	U.S. gallons	ft	in.	U.S. gallons	ft	in.	U.S. gallons
1	0	5.87	3	8	79	14	0	1,151
1	1	6.89	4	0	94	14	6	1,235
1	2	8.00	4	6	119	15	0	1,322
1	3	9.18	5	0	147	20	0	2,350
1	4	10.44	5	6	177	25	0	3,672
1	5	11.79	6	0	212	30	0	5,288
1	6	13.22	6	6	248	35	0	7,197
1	7	14.73	7	0	288	40	0	9,400
1	8	16.32	7	6	330	45	0	11,897
1	9	17.99	8	0	376	50	0	14,688
1	10	19.75	8	6	424	55	0	17,772
1	11	21.58	9	0	476	60	0	21,151
2	0	23.50	9	6	530	70	0	28,788
2	2	27.58	10	0	588	80	0	37,601
2	4	31.99	10	6	641	90	0	47,589
2	6	36.72	11	0	711	100	0	58,752
2	8	41.78	11	6	777	110	0	71,095
3	0	52.88	12	0	846	120	0	84,600
3	2	58.92	12	6	918	130	0	99,298
3	4	65.28	13	0	992	140	0	115,150
3	6	71.97	13	6	1,070	150	0	132,201

Capacity of vertical storage tanks

Dimensions		Capacity		Dimensions		Capacity		Dimensions		Capacity	
D (ft)	H (ft)	BBL	1,000 Gal	D (ft)	H (ft)	BBL	1,000 Gal	D (ft)	H (ft)	BBL	1,000 Gal
15	12	378	16	50	12	4,200	176	120	18	36,288	1,524
	18	567	24		18	6,300	265		24	48,384	2,032
	24	756	32		24	8,400	353		30	60,480	2,540
	30	945	40		30	10,500	441		36	72,576	3,048
	36	1,134	48		36	12,600	529		42	84,672	3,556
					42	14,700	617		48	96,768	4,064
					48	16,800	706				
20	12	672	28	60	12	6,048	254	130	18	42,588	1,789
	18	1,008	42		18	9,072	381		24	56,784	2,385
	24	1,344	56		24	12,096	508		30	70,980	2,981
	30	1,680	71		30	15,120	635		36	85,176	3,577
	36	2,016	85		36	18,144	762		42	99,372	4,174
	42	2,352	99		42	21,168	889		48	113,568	4,770
					48	24,192	1,016				
25	12	1,050	44	70	12	8,232	346	140	18	49,392	2,074
	18	1,575	66		18	12,348	519		24	65,856	2,766
	24	2,100	88		24	16,464	691		30	82,320	3,457
	30	2,625	110		30	20,580	864		36	98,784	4,149
	36	3,150	132		36	24,696	1,037		42	115,248	4,840
	42	3,675	154		42	28,812	1,210		48	131,712	5,532
	48	4,200	176		48	32,926	1,382				
30	12	1,512	64	80	12	10,752	452	150	24	75,600	3,175
	18	2,268	95		18	16,128	677		30	94,500	3,969
	24	3,024	127		24	21,504	903		36	113,400	4,763
	30	3,780	159		30	26,880	1,129		42	132,300	5,557
	36	4,536	191		36	32,256	1,355		48	151,200	6,350
	42	5,292	222		42	37,632	1,581		54	170,100	7,144
	48	6,048	254		48	43,008	1,806				
35	12	2,058	86	90	12	13,608	572	160	30	107,520	4,516
	18	3,087	130		18	20,412	857		36	129,024	5,419
	24	4,116	173		24	27,216	1,143		42	150,528	6,322
	30	5,145	216		30	34,020	1,428		48	172,032	7,225
	36	6,174	259		36	40,824	1,715		54	193,536	8,129
	42	7,203	303		42	47,628	2,000				
	48	8,232	346		48	54,432	2,286				

Capacity of vertical storage tanks - Continued.

Dimensions		Capacity		Dimensions		Capacity		Dimensions		Capacity	
D (ft)	H (ft)	BBL	1,000 Gal	D (ft)	H (ft)	BBL	1,000 Gal	D (ft)	H (ft)	BBL	1,000 Gal
40	12	2,688	113	100	18	25,200	1,058	180	30	139,080	5,841
	18	4,032	169		24	33,600	1,411		36	166,896	7,010
	24	5,376	226		30	42,000	1,764		42	194,712	8,178
	30	6,720	282		36	50,400	2,117		48	222,528	9,346
	36	8,064	339		42	58,800	2,470		54	250,344	10,514
	42	9,408	395		48	67,200	2,822				
	48	10,752	452								
45	12	3,402	143	110	18	30,492	1,281	200	30	168,000	7,056
	18	5,103	214		24	40,656	1,708		36	201,600	8,467
	24	6,804	286		30	50,820	2,134		42	235,200	9,878
	30	8,505	357		36	60,894	2,561		48	268,800	11,290
	36	10,206	429		42	71,148	2,988		54	302,400	12,701
	42	11,907	500		48	81,312	3,415				
	48	13,608	572								

Capacity (barrels) = $0.14\ D^2H$ 1 barrel = 42 gallons

Capacity of vertical cylinders (metric)
(Volume per meter)

Diameter millimeter	Liters	Diameter millimeter	Liters	Diameter millimeter	Liters
100	7.854	550	238	3,500	9.621
110	9.503	600	283	3,750	11,045
120	11.31	700	385	4,000	12,566
130	13.27	800	503	4,500	15,904
140	15.40	900	636	5,000	19,635
150	17.67	1,000	785	5,500	23,758
160	20.11	1,100	950	6,000	28,274
170	22.70	1,200	1,131	7,000	38,485
180	25.45	1,300	1,327	8,000	50,266
190	28.25	1,400	1,540	9,000	63,617
200	31.42	1,500	1,767	10,000	78,540
225	39.76	1,600	2,011	11,000	95,033
250	49.08	1,700	2,270	12,000	113,098
275	59.39	1,800	2,545	13,000	132,733
300	70.69	1,900	2,835	14,000	153,938
325	82.96	2,000	3,142	15,000	176,715
350	96.21	2,250	3,976	16,000	201,062
375	110	2,500	4,908	18,000	254,470
400	126	2,750	5,939	20,000	314,160
450	159	3,000	7,069	22,500	397,609
500	196	3,250	8,296	25,000	490,875

Capacity of vertical storage tanks (metric)

Dimensions			Dimensions			Dimensions		
D (m)	H (m)	Capacity kiloliter	D (m)	H (m)	Capacity kiloliter	D (m)	H (m)	Capacity kiloliter
4	4	50	10	4	314	16	4	804
	6	75		6	471		6	1,206
	8	101		8	628		8	1,608
	10	126		10	785		10	2,011
	12	151		12	942		12	2,412
				14	1,100		14	2,814
6	4	113		16	1,257		16	3,217
	6	170						
	8	226	12	4	452	18	4	1,018
	10	283		6	679		6	1,527
	12	339		8	905		8	2,036
	14	396		10	1,131		10	2,545
				12	1,357		12	3,054
8	4	201		14	1,583		14	3,563
	6	301		16	1,810		16	4,072
	8	402						
	10	503	14	4	616	20	4	1,257
	12	603		6	924		6	1,885
	14	704		8	1,232		8	2,513
	16	804		10	1,539		10	3,142
				12	1,847		12	3,770
				14	2,155		14	4,398
				16	2,463		16	5,027
25	4	1,963	40	6	7,540	55	10	23,758
	6	2,945		8	10,053		12	28,510
	8	3,927		10	12,566		14	33,261
	10	4,909		12	15,080		16	38,013
	12	5,890		14	17,593		18	42,765
	14	6,872		16	20,106			
	16	7,854				60	10	28,274
			45	8	12,723		12	33,929
30	6	4,241		10	15,904		14	39,584
	8	5,655		12	19,085		16	45,239
	10	7,069		14	22,266		18	50,894
	12	8,482		16	25,447			
	14	9,896		18	28,628			
	16	11,310						
			50	10	19,635			
35	6	5,773		12	23,562			
	8	7,697		14	27,489			
	10	9,621		16	31,416			
	12	11,545		18	35,343			
	14	13,470						
	16	15,394						

Crude oil and petroleum product factors (at 60°F).

Item	Degrees API Gravity Range From	To	Average	Average Specific Gravity	Pounds U.S. Gallon	Imperial Gallon	Metric Tons Per Cubic Meter
TYPICAL CRUDE OILS:							
From:							
United States	10.0	48.0	35.0	0.8499	7.076	8.499	0.847
Canada	5.0	48.0	35.0	0.8499	7.076	8.499	0.047
Mexico	12.0	42.0	28.6	0.8838	7.360	8.838	0.882
Colombia	21.1	46.8	25.7	0.9001	7.495	9.001	0.898
Venezuela	10.3	48.0	26.1	0.8978	7.426	8.978	0.889
Saudi Arabia	27.7	38.2	36.2	0.8438	7.026	8.438	0.842
Kuwait	31.9	31.9	31.9	0.8660	7.211	8.660	0.864
Iran	31.0	38.0	37.2	0.8388	6.984	8.388	0.836
Iraq	32.1	41.7	35.0	0.8499	7.076	8.499	0.847
Egypt	17.0	41.0	24.0	0.9100	7.578	9.101	0.908
British Borneo	19.0	38.0	36.4	0.8428	7.017	8.428	0.840
Indonesia	17.2	38.5	34.5	0.8524	7.098	8.524	0.850
PETROLEUM PRODUCTS:							
Aviation Gasolines:							
Grade:							
115/145	67.0	73.0	69.5	0.7040	5.860	7.038	0.702
100/130	66.0	70.0	68.0	0.7093	5.904	7.091	0.707
100LL	64.0	69.0	66.0	0.7165	5.964	7.163	0.715
Motor Gasoline:							
Combat grade	55.1	61.4	58.4	0.7451	6.203	7.330	0.743
Jet Fuels:							
JP-4	48.1	56.5	53.5	0.7657	6.375	7.650	0.763
JP-5	36.0	48.0	41.0	0.8203	6.830	8.203	0.818
JP-8	37.0	51.0	44.0	0.8073	6.713	8.062	0.804
Thermally Stable	46.7	48.0	47.3	0.7914	6.589	7.907	0.789
Naphthas:							
Cleaning Solvent	45.0	55.0	48.0	0.7883	6.563	7.882	0.786
Other Naphthas	50.0	74.0	62.0	0.7313	6.087	7.310	0.729
Kerosene	39.0	46.0	42.0	0.8156	6.790	8.155	0.813

Crude oil oil and petroleum product factors (at 60°F) - Continued.

Item	Degrees API Gravity Range From	To	Average	Average Specific Gravity	Pounds U.S. Gallon	Pounds Imperial Gallon	Metric Tons Per Cubic Meter
DIESEL FUELS:							
DFA	36.0	50.0	43.0	0.8109	6.751	8.109	0.809
DF-2	34.0	40.0	37.0	0.8398	6.992	8.397	0.838
DFM	33.0	39.0	36.0	0.8448	7.034	8.448	0.843
BURNER FUEL OILS:							
Grade No. 1	36.3	48.3	42.5	0.8132	6.771	8.132	0.811
Grade No. 2	30.0	45.1	35.5	0.8473	7.055	8.473	0.845
Grade No. 4	12.1	34.6	23.2	0.9147	7.617	9.148	0.913
Grade No. 5 (light)	11.7	26.0	16.7	0.9548	7.951	9.549	0.953
Grade No. 5 (heavy)	7.5	23.4	15.7	0.9613	8.005	9.614	0.959
Grade No. 6	1.6	26.9	13.3	0.9772	8.138	9.773	0.975
Navy Special	12.1	21.4	18.0	0.9465	7.882	9.466	0.944
LUBRICATING OILS:							
Aviation (Recip)	26.6	28.4	27.7	0.8888	7.401	8.888	0.886
Aviation (Jet-Petroleum)...	29.6	29.6	29.6	0.8783	7.314	8.784	0.876
Aviation (Jet-Synthetic)...	8.6	25.7	22.0	0.9218	7.676	9.219	0.919
Diesel Engine	24.3	27.4	26.3	0.8967	7.467	8.968	0.894
Other Heavy Duty	23.0	31.0	27.0	0.8927	7.434	8.928	0.890
All Others	26.0	29.0	27.0	0.8927	7.434	8.928	0.890
Insulating and Transformer Oils	29.5	31.5	30.0	0.8762	7.296	8.762	0.874
Fog Oil	34.0	37.0	36.0	0.8448	7.034	8.448	0.842
Liquified Petroleum Gases ...	----	----	----	------	4.450	5.344	0.533
Greases	----	----	----	1.0002	8.330	10.004	0.998
Asphalt and Road Oils	----	----	----	1.0326	8.601	10.329	1.030
Petroleum Coke	----	----	----	------	-----	------	-----

Crude oil and petroleum factors (at 60°F) - Continued.

Item	Pounds per barrel	Barrels per: Long ton	Barrels per: Metric ton	Barrels per: Short ton	Barrels per day required to equal: One Metric ton per year	Barrels per day required to equal: One Long ton per year
TYPICAL CRUDE OILS:						
From:						
United States	297.19	7.537	7.418	6.729	0.0203	0.0206
Canada	297.19	7-537	7.418	6.729	0.0203	0.0206
Mexico	309.12	7.247	7.133	6.470	0.0195	0.0199
Colombia	314.79	7.115	7.003	6.353	0.0192	0.0195
Venezuela	313.99	7.134	7.021	6.369	0.0192	0.0195
Saudi Arabia	295.09	7.591	7.470	6.770	0.0205	0.0208
Kuwait	302.86	7.396	7.280	6.604	0.0199	0.0203
Iran	299.33	7.637	7.516	6.818	0.0206	0.0209
Iraq	297.19	7.537	7.418	6.729	0.0203	0.0206
Egypt	318.28	7.038	6.927	6.284	0.0190	0.0193
British Borneo	294.73	7.600	7.480	6.786	0.0205	0.0208
Indonesia	298.12	7.514	7.395	6.709	0.0203	0.0206
PETROLEUM PRODUCTS:						
Aviation Gasolines:						
Grade:						
115/145	246.10	9.102	8.958	8.127	0.0245	0.0249
100/130	247.97	9.033	8.891	8.065	0.0244	0.0247
100LL	250.49	8.943	8.801	7.984	0.0241	0.0245
Motor Gasoline:						
Combat grade	260.74	8.599	9.410	7.678	0.0258	0.0236
Jet Fuels:						
JP-4	267.58	8.366	8.234	7.469	0.0225	0.0229
JP-5	286.86	7.809	7.686	7.686	0.0211	0.0214
JP-8	281.95	7.945	7.818	7.094	0.0214	0.0218
Thermally Stable	276.75	8.094	7.966	7.227	0.0218	0.0222
Naphthas:						
Cleaning Solvent	275.65	8.126	7.998	7.256	0.0219	0.0223
Other Naphthas	255.65	8.761	8.623	7.822	0.0236	0.0240
Kerosene	285.18	7.854	7.730	7.013	0.0212	0.0215

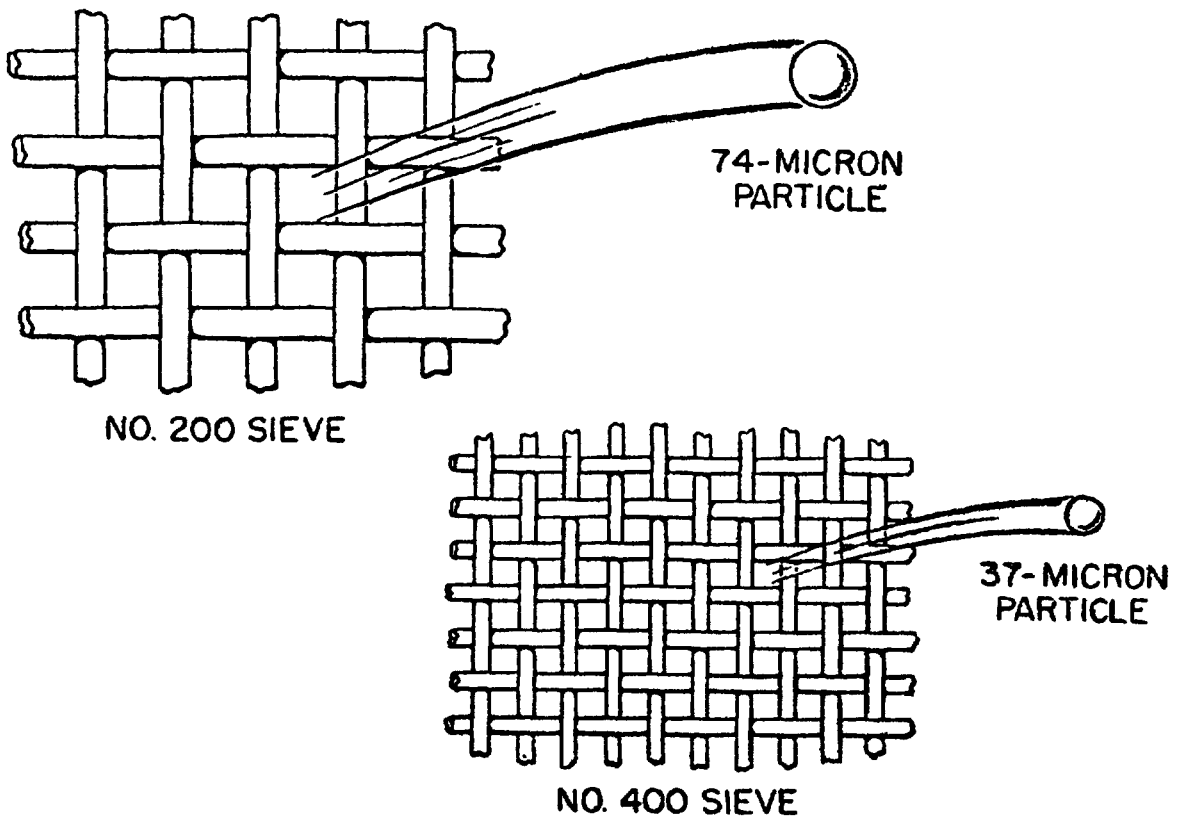
Crude oil and petroleum factors (at 60°F) - continued.

Item	Pounds per barrel	Barrels per Long ton	Barrels per Metric ton	Barrels per Short ton	Barrels per day required to equal One Metric ton per year	Barrels per day required to equal One Long ton per year
Diesel Fuels:						
DFA	283.58	7.900	7.774	7.053	0.0213	0.0216
DF-2	293.66	7.628	7.508	6.811	0.0206	0.0209
DFM	295.43	7.582	7.462	6.770	0.0204	0.0208
BURNER FUEL OILS:						
Grade No. 1	284.38	7.877	7.752	7.033	0.0212	0.0216
Grade No. 2	296.31	7.560	7.440	6.750	0.0204	0.0207
Grade No. 4	319.91	7.002	6.891	6.252	0.0189	0.0192
Grade No. 5 (light)	333.94	6.708	6.602	5.999	0.0181	0.0184
Grade No. 5 (heavy)	336.21	6.663	6.557	5.949	0.0180	0.0183
Grade No. 6	341.80	6.554	6.450	5.851	0.0177	0.0180
Navy Special	331.04	6.766	6.660	6.041	0.0182	0.0185
Lubricating oils:						
Aviation (Recip)	310.84	7.206	7.092	6.434	0.0194	0.0197
Aviation (Jet-Petroleum)	307.19	7.292	7.177	6.511	0.0197	0.0200
Aviation (Jet-Synthetic)	322.39	6.948	6.838	6.204	0.0187	0.0190
Diesel Engine	313.61	7.143	7.030	6.377	0.0193	0.0196
Other Heavy Duty	312.23	7.174	7.061	6.406	0.0193	0.0197
All Others	312.23	7.174	7.061	6.406	0.0193	0.0197
Insulating and Transformer Oils	306.43	7.310	7.194	6.527	0.0197	0.0200
Fog Oil	295.43	7.582	7.462	6.770	0.0204	0.0208
Liquefied Petroleum Gases	186.90	11.989	11.799	10.704	0.0323	0.0328
Greases	349.86	6.402	6.301	5.716	0.0173	0.0175
Asphalt and Road Oils	361.24	6.201	6.103	5.537	0.0167	0.0170
Petroleum Coke	401.00	5.589	5.500	4.990	0.0151	0.0153

Filtration data.

Meshes per inch	U.S. Sieve No.	Opening in inches	Opening in microns
52.36	50	0.0117	297
72.45	70	0.0083	210
101.01	100	0.0059	149
142.86	140	0.0041	105
200.00	200	0.0029	74
270.26	270	0.0021	53
323.00	325	0.0017	44
	400	0.00144	37
		0.00039	10
		0.000351	9
		0.000312	8
		0.000245	7
		0.000234	6
		0.00019	5
		0.000156	4
		0.000117	3
		0.000078	2
		0.000039	1

SCHEMATIC COMPARISON OF MESH AND MICRON SIZES



GRAVITY CONVERSION:

$$\text{Degrees API Gravity} = \frac{141.5}{\text{specific gravity (60/60°F)}} - 131.5$$

$$\text{Specific Gravity (60/60°F)} = \frac{141.5}{131.5 + \text{degrees API}}$$

Group numbers for API gravity ranges.

Group No.	Range of group API gravity 60°F	Coefficient of Expansion per °F at 60°F	Corresponding API Gravity 60°F
0	0 - 14.9	0.00035	6.0
1	15.0 - 34.9	0.00040	22.0
2	35.0 - 50.9	0.00050	44.0
3	51.0 - 63.9	0.00060	58.00
4	64.0 - 78.9	0.00070	72.00
5	79.0 - 88.9	0.00080	86.00
6	89.0 - 93.9	0.00085	91.00
7	94.0 - 100.0	0.00090	97.00

Heating value of solid fuels.

Fuel	Usual range-BTU's per Pound	Short ton	Kilojoule per kilogram
Anthracite	12,000 to 13,500	24,000,000 to 27,000,000	28,000 to 31,000
Bituminous	12,000 to 14,500	24,000,000 to 29,000,000	28,000 to 34,000
Sub-bituminous	9,000 to 11,500	18,000,000 to 23,000,000	21,000 to 27,000
Lignite	6,000 to 8,500	12,000,000 to 17,000,000	14,000 to 20,000

Heating value of liquid fuels.

Fuel	Average API Gravity	Specific gravity	Gross BTU's per pound	Gross BTU's per gallon	net BTU's per pound	net BTU's per gallon	Kilojoule per kilogram gross	Kilojoule per kilogram net
Aviation Gasolines								
115/145	69.5	0.7040	20,450	120,000	19,040	111,750	47,567	44,299
100/130	68.0	0.7093	20,420	120,700	19,020	112,500	47,497	44,241
100LL	66.0	0.7165	20,380	121,700	18,990	113,400	47,404	44,171
Automotive gasolines								
Winter:								
Premium	63.2	0.7268	20,324	123,100	18,952	114,800	47,274	44,082
Regular	62.5	0.7294	20,310	123,450	18,940	115,150	47,241	44,054
Unleaded	61.8	0.7320	20,296	123,820	18,928	115,500	47,208	44,027
Summer:								
Premium	61.6	0.7328	20,292	123,940	18,926	115,600	47,199	44,022
Regular	60.4	0.7374	20,268	124,600	18,908	116,200	47,143	43,980
Unleaded	60.1	0.7385	20,262	124,750	18,902	116,350	47,129	43,966
Combat motor gasolines								
Type I	58.4	0.7451	20,215	125,600	18,874	117,260	47,020	42,202
Type II	62.0	0.7313	20,300	123,700	18,930	115,400	47,218	44,031
Aviation turbine fuels								
JP-4	53.5	0.7649	20,110	128,250	18,790	119,800	46,776	43,706
JP-5	41.0	0.8203	19,780	135,200	18,530	126,700	46,008	43,101
JP-7	47.0	0.7927	19,940	131,900	18,660	123,300	46,380	43,403
JP-8	44.0	0.8063	19,860	133,500	18,600	125,000	46,194	43,264
JPTS	49.0	0.7839	20,000	130,700	18,700	122,200	46,520	43,496
Kerosene	42.0	0.8156	19,810	134,700	18,560	126,200	46,078	43,171
Diesel fuel oils								
DFA	43.0	0.8109	19,830	134,100	18,580	125,600	46,125	43,217
DF-1	41.2	0.8193	19,792	135,000	18,536	126,600	46,036	43,115
DF-2	37.0	0.8398	19,650	137,600	18,430	129,100	45,706	42,868
DFM	36.0	0.8448	19,620	138,200	18,410	129,700	45,636	42,822

Heating value of liquid fuels - Continued

Fuel	Average API gravity	Specific gravity	Gross BTU's per pound	Gross BTU's per gallon	Net BTU's per pound	Net BTU's per gallon	Kilojoule per kilogram gross	Kilojoule per kilogram net
Burner fuel oils								
Grade No. 1	42.5	0.8132	19,820	134,400	18,570	125,900	46,101	32,194
Grade No. 2	35.5	0.8473	19,605	138,500	18,400	130,000	45,601	42,798
Grade No. 4	23.2	0.9147	19,158	146,080	18,038	137,580	44,562	41,956
Grade No. 5 (light) .	16.7	0.9548	18,875	150,210	17,811	141,810	43,903	41,428
Grade No. 5 (heavy) .	15.7	0.9613	18,825	150,880	17,778	142,480	43,787	41,352
Grade No. 6.	13.3	0.9772	18,705	152,420	17,682	144,020	43,508	41,128

Packaging containers.

Item	Dimensions				Weight Empty (lb)
	Length (in.)	Width (in.)	Height (in.)	Cubic feet	
55-U.S. Gallon Drums:					
16-gage		23-7/16	35	12	70
18-gage		23-7/16	35	12	50
5-U.S. Gallon Can, Gasoline	13-3/4	6-3/4	18-1/2	1	10.5
Cases:					
6-5-Qt. Cans, Oil	22	14	10	1.9	8.43
24-1-Qt. Cans, Oil	16-3/8	12-3/16	11-5/8	1.50	7.5
48-1-lb. Cans, Grease	20-5/8	13-3/4	9-1/2	1.8	
12-5-lb. Cans, Grease	20	13-5/8	12-3/8	2.1	
35-lb. Pails, Grease:					
Tight Head, 24-gage		11-1/2	13-9/16	1.1	5
Tight Head, 22-gage					5-1/4
Lug Cover, 24-gage					5-1/4
Lug Cover, 22-gage		11-7/8	13-1/4	1.1	5-3/4
Lug Cover, 24-gage w/20-gage Cover					6-1/2
120-lb. Drum, Grease, Lug Cover, 20-gage		14-7/8	26-3/4	3.4	16

To calculate weight of a filled container: Weight of empty container + (Weight per gallon of product X No. gallons).

Packaged products.

Product	Packaging	Packaged per Short Ton	Packaged per Long Ton	Measurement Ton**	Capacity of Vehicles for Carrying Filled Containers* 1-Ton Tlr	1-1/2 Ton Trk	2-1/2 Ton Trk
Aviation Gasoline	55 gal. drums	5.57	6.24	3.33	6	9	14
	5 gal. cans	48.7	54.5	40.0	50	75	120
Motor Gasoline	55 gal. drums	5.29	5.93	3.33	6	8	14
	5 gal. cans	47.7	53.5	40.0	50	75	120
Jet Fuel	55 gal. drums	5.12	5.71	3.33	6	8	13
	5 gal. cans	45.7	51.5	40.0	45	70	115
Kerosene	55 gal. drums	4.91	5.50	3.33	5	7	12
	5 gal. drums	44.2	49.6	40.0	45	70	110
Diesel Fuel	55 gal. drums	4.73	5.30	3.33	....	....	
	5 gal. drums	43.3	48.5	40.0	45	70	110
Lubricating Oils	55 gal. drums	4.40	4.92	3.33	4	7	11
	5 gal. drums	40.7	45.5	40.0	40	60	100
	1 qt. cans, 24 per case .	33.4	37.3	20.0	35	60	90
	5 qt. cans, 6 per case ..	26.0	29.1	20.0	25	40	65
Greases	35 lb. pails	49.6	55.5	40.0	50	75	125
	5 lb. cans, 12 per case .	26.3	29.4	40.0	26	40	66

*Based upon authorized loads in short tons. When overloads are authorized, these quantities may be increased to the cubic capacity of the vehicles or to 100 percent overload, whichever limit is reached first.

**Measurement ton or ship ton = 40 cubic feet.

Table of API gravity equivalents at 60°F.

API Gravity	Specific Gravity	Pounds per U.S. Gallon	Pounds per Imperial Gallon	Pounds per Barrel	Barrels per Long ton	Barrels per Metric ton	Barrels per Short ton	BTU per pound Gross	BTU per pound Net	Kilojoule per kilogram Gross	Kilojoule per kilogram Net
1	1.0679	8.895	10.683	273.59	5.996	5.901	5.353	18,220	17,110	42,380	39,800
2	1.0599	8.828	10.602	370.78	6.041	5.946	5.394	18,280	17,160	42,520	39,910
3	1.0520	8.762	10.523	368.00	6.087	5.991	5.435	18,340	17,210	42,660	40,030
4	1.0443	8.697	10.446	365.32	6.132	6.035	5.475	18,400	17,260	42,800	40,150
5	1.0366	8.634	10.369	362.63	6.177	6.080	5.516	18,460	17,310	42,940	40,260
6	1.0291	8.571	10.294	359.98	6.223	6.124	5.556	18,310	17,350	42,590	40,360
7	1.0217	8.509	10.219	357.38	6.268	6.169	5.596	18,370	17,400	42,730	40,470
8	1.0143	8.448	10.146	354.82	6.313	6.213	5.637	18,430	17,450	42,870	40,590
9	1.0071	8.388	10.074	352.30	6.359	6.258	5.677	18,480	17,490	42,980	40,680
10* ...	1.0000	8.328	10.002	349.78	6.404	6.303	5.718	18,540	17,540	43,120	40,800
11	0.9930	8.270	9.932	347.34	6.449	6.347	5.758	18,590	17,580	43,240	40,890
12	0.9861	8.212	9.863	344.90	6.495	6.392	5.799	18,640	17,620	43,360	40,980
13	0.9792	8.155	9.794	342.51	6.540	6.437	5.839	18,690	17,670	43,470	41,100
14	0.9725	8.099	9.727	340.16	6.585	6.481	5.880	18,740	17,710	43,590	41,190
15	0.9659	8.044	9.661	337.85	6.630	6.525	5.920	18,790	17,750	43,710	41,290
16	0.9593	7.989	9.595	335.54	6.676	6.570	5.961	18,840	17,790	43,820	41,380
17	0.9529	7.935	9.530	333.27	6.721	6.615	6.001	18,890	17,820	43,940	41,450
18	0.9465	7.882	9.466	331.04	6.766	6.660	6.042	18,930	17,860	44,030	41,540
19	0.9402	7.830	9.404	328.86	6.812	6.704	6.082	18,980	17,900	44,150	41,640
20	0.9340	7.778	9.341	326.68	6.857	6.749	6.122	19,020	17,930	44,240	41,710
21	0.9279	7.727	9.280	324.53	6.902	6.793	6.163	19,060	17,960	44,330	41,770
22	0.9218	7.676	9.219	322.39	6.948	6.838	6.204	19,110	18,000	44,450	41,870
23	0.9159	7.627	9.160	320.33	6.993	6.882	6.244	19,150	18,030	44,540	41,940
24	0.9100	7.578	9.101	318.28	7.038	6.927	6.284	19,190	18,070	44,640	42,030
25	0.9042	7.529	9.042	316.22	7.084	6.972	6.325	19,230	18,100	44,730	42,100
26	0.8984	7.481	8.985	314.20	7.129	7.017	6.365	19,270	18,130	44,820	42,170
27	0.8927	7.434	8.928	312.23	7.174	7.061	6.406	19,310	18,160	44,920	42,240
28	0.8871	7.387	8.872	310.25	7.220	7.106	6.446	19,350	18,190	45,010	42,310
29	0.8816	7.341	8.817	308.32	7.265	7.150	6.487	19,380	18,220	45,080	42,380
30	0.8762	7.296	8.762	306.43	7.310	7.194	6.527	19,420	18,250	45,170	42,450

*Water (H_2O at 60°F)

Table of API gravity equivalents at 60°F - Continued

API Gravity	Specific Gravity	Pounds per U.S. Gallon	Pounds per Imperial Gallon	Pounds per Barrel	Barrels per Long ton	Barrels per Metric ton	Barrels per Short ton	BTU per pound Gross	BTU per pound Net	Kilojoule per kilogram Gross	Kilojoule per kilogram Net
31	0.8708	7.251	8.708	304.54	7.356	7.239	6.568	19,450	18,280	45,240	42,520
32	0.8654	7.206	8.654	302.65	7.401	7.284	6.608	19,490	18,310	45,330	42,590
33	0.8602	7.162	8.603	300.85	7.446	7.328	6.648	19,520	18,330	45,400	42,640
34	0.8550	7.119	8.550	299.00	7.492	7.373	6.689	19,560	18,360	45,500	42,710
35	0.8499	7.076	8.498	297.19	7.537	7.418	6.730	19,590	18,390	45,570	42,780
36	0.8448	7.034	8.448	295.43	7.582	7.462	6.770	19,620	18,410	45,640	42,820
37	0.8398	6.992	8.399	293.71	7.628	7.506	6.810	19,650	18,430	45,710	42,870
38	0.8348	6.951	8.348	291.94	7.673	7.552	6.851	19,680	18,460	45,780	42,940
39	0.8299	6.910	8.299	290.22	7.718	7.597	6.891	19,720	18,480	45,870	42,980
40	0.8251	6.870	8.251	288.54	7.764	7.641	6.931	19,750	18,510	45,940	43,050
41	0.8203	6.830	8.203	286.86	7.809	7.686	6.972	19,780	18,530	46,010	43,100
42	0.8156	6.790	8.155	285.18	7.854	7.731	7.013	19,810	18,560	46,080	43,170
43	0.8109	6.751	8.109	283.58	7.900	7.774	7.053	19,930	18,580	46,120	43,220
44	0.8063	6.713	8.062	281.95	7.945	7.819	7.093	19,860	18,600	46,190	43,260
45	0.8017	6.675	8.017	280.35	7.990	7.864	7.134	19,890	18,620	46,260	43,310
46	0.7972	6.637	7.971	278.75	8.036	7.909	7.175	19,920	18,640	46,330	43,360
47	0.7927	6.600	7.927	277.20	8.081	7.953	7.215	19,940	18,660	46,380	43,400
48	0.7883	6.563	7.882	275.65	8.126	7.998	7.256	19,970	18,680	46,450	43,450
49	0.7839	6.527	7.838	274.09	8.172	8.043	7.297	20,000	18,700	46,520	43,500
50	0.7796	6.491	7.794	272.58	8.217	8.088	7.337	20,020	18,720	46,570	43,540
51	0.7753	6.455	7.752	271.11	8.262	8.132	7.377	20,050	18,740	46,640	43,590
52	0.7711	6.420	7.710	269.64	8.308	8.176	7.417	20,070	18,760	46,680	43,640
53	0.7669	6.385	7.668	268.17	8.353	8.221	7.458	20,100	18,780	46,750	43,680
54	0.7628	6.350	7.626	266.70	8.398	8.266	7.499	20,120	18,800	46,800	43,730
55	0.7587	6.316	7.586	265.27	8.444	8.310	7.539	20,140	18,810	46,850	43,750
56	0.7547	6.283	7.546	263.89	8.489	8.354	7.579	20,170	18,830	46,920	43,800
57	0.7507	6.249	7.505	262.46	8.534	8.400	7.620	20,190	18,850	46,960	43,850
58	0.7467	6.216	7.465	261.07	8.580	8.444	7.661	20,210	18,870	47,010	43,890
59	0.7428	6.183	7.427	259.73	8.625	8.488	7.700	20,230	18,880	47,050	43,910
60	0.7389	6.151	7.387	258.34	8.670	8.534	7.742	20,260	18,900	47,120	43,960

Table of API gravity equivalents at 60°F - Continued

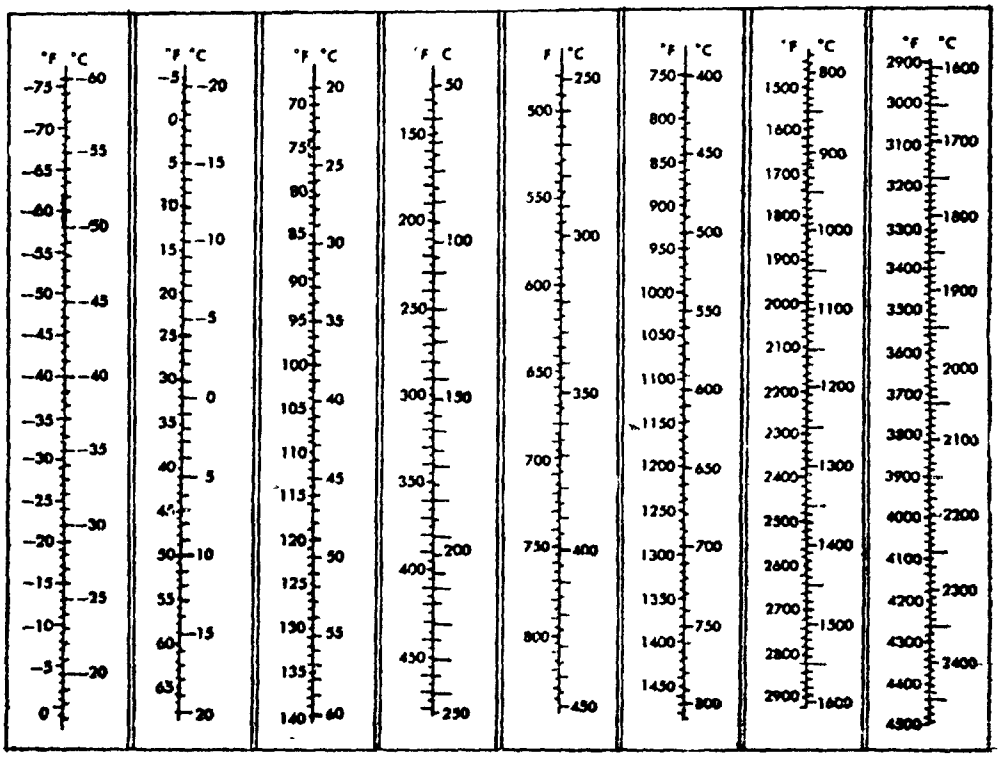
API Gravity	Specific Gravity	Pounds per U.S. Gallon	Pounds per Imperial Gallon	Barrels per Barrel	Barrels per Long ton	Barrels per Metric ton	Barrels per Short ton	BTU per pound Gross	BTU per pound Net	Kilojoule per kilogram Gross	Kilojoule per kilogram Net
61	0.7351	6.119	7.349	257.00	8.716	8.578	7.782	20,280	18,920	47,170	44,010
62	0.7313	6.087	7.310	255.65	8.761	8.623	7.823	20,300	18,930	47,220	44,030
63	0.7275	6.056	7.273	254.35	8.807	8.668	7.863	20,320	18,950	47,260	44,080
64	0.7238	6.025	7.236	253.05	8.852	8.712	7.904	20,340	18,960	47,310	44,100
65	0.7201	5.994	7.199	251.75	8.897	8.757	7.944	20,360	18,980	47,360	44,150
66	0.7165	5.964	7.163	250.49	8.943	8.801	7.984	20,380	18,990	47,400	44,170
67	0.7128	5.934	7.127	249.23	8.988	8.846	8.025	20,400	19,010	47,450	44,220
68	0.7093	5.904	7.091	247.97	9.033	8.891	8.065	20,420	19,020	47,500	44,240
69	0.7057	5.875	7.055	246.71	9.079	8.936	8.107	20,440	19,040	47,540	44,290
70	0.7022	5.845	7.020	245.49	9.125	8.980	8.147	20,460	19,050	47,590	44,310
71	0.6988	5.816	6.986	244.31	9.169	9.024	8.187	20,480	19,070	47,640	44,360
72	0.6953	5.788	6.951	243.10	9.215	9.069	8.227	20,490	19,080	47,660	44,380
73	0.6919	5.759	6.917	241.88	9.260	9.114	8.269	20,510	19,090	47,710	44,400
74	0.6886	5.731	6.883	240.70	9.305	9.159	8.309	20,530	19,100	47,750	44,430
75	0.6852	5.704	6.849	239.53	9.351	9.204	8.350	20,550	19,120	47,800	44,470
76	0.6819	5.676	6.817	238.39	9.396	9.248	8.390	20,560	19,130	47,820	44,500
77	0.6787	5.649	6.784	237.26	9.442	9.292	8.430	20,580	19,140	47,870	44,520
78	0.6754	5.622	6.752	236.12	9.487	9.337	8.470	20,600	19,150	47,920	44,540
79	0.6722	5.595	6.720	234.99	9.532	9.382	8.511	20,620	19,170	47,960	44,590
80	0.6690	5.569	6.687	238.86	9.578	9.427	8.552	20,630	19,180	47,990	44,610
81	0.6659	5.542	6.656	232.76	9.623	9.472	8.593	20,650	19,190	48,030	44,640
82	0.6628	5.516	6.624	231.67	9.668	9.516	8.633	20,660	19,200	48,060	44,660
83	0.6597	5.490	6.595	230.62	9.714	9.559	8.672	20,680	19,210	48,100	44,680
84	0.6566	5.465	6.563	229.53	9.759	9.605	8.713	20,690	19,220	48,120	44,710
85	0.6536	5.440	6.533	228.48	9.805	9.649	8.754	20,710	19,230	48,170	44,730
86	0.6506	5.415	6.503	227.43	9.850	9.694	8.794	20,720	19,240	48,190	44,750
87	0.6476	5.390	6.473	226.38	9.895	9.738	8.835	20,740	19,250	48,240	44,780
88	0.6446	5.365	6.443	225.33	9.941	9.784	8.876	20,750	19,260	48,260	44,800
89	0.6417	5.341	6.415	224.32	9.986	9.828	8.916	20,770	19,270	48,310	44,820
90	0.6388	5.317	6.385	223.27	10.031	9.874	8.957	20,780	19,280	48,330	44,850
91	0.6360	5.293	6.357	222.31	10.077	9.917	8.996	20,800	19,290	48,380	44,870
92	0.6331	5.269	6.328	221.30	10.122	9.962	9.038	20,810	19,300	48,400	44,890
93	0.6303	5.245	6.300	220.33	10.168	10.006	9.077	20,820	19,310	48,430	44,920
94	0.6275	5.222	6.273	219.37	10.213	10.050	9.117	20,830	19,320	48,450	44,940

TEMPERATURE CONVERSION CHART

TEMPERATURE CONVERSION

$C = 5/9 (F - 32)$, $0^{\circ} C = 273.16\ ^{\circ}K$

$F = 9/5 (C + 32)$, $0^{\circ} F = 459.688\ ^{\circ}R$



Temperature correction table (rough calculations).

Products	Change in volume per degree over/under 60°F. Volume/ volume °F.
Heavy Crudes (up to 15° API), Residuals and Asphalts	0.00035
Medium Crudes (15° to 35° API), Navy Special and Lube Oils	0.00040
Light Crudes (above 35° API), Jet Fuels, Cleaning Solvents, Kerosene, Distillate Fuel Oils and Fog Oil	0.00050
Motor Gasolines and Naphthas (other than cleaning Solvents)	0.00060
Aviation Gasolines	0.00070

For more exact volume changes, refer to ASTM D1250 of the American Society for Testing and Materials and IP-200 of the Institute of Petroleum.

Transportation pipeline dimensions and data.

Plain end pipe.

Diameter in Inches			Wall Thickness	Weight-lbs	Volume in barrels	
Nominal	Outside	Inside	Inches	Per Foot	Per Mile	Per M Feet
4	4.500	4.026	0.237	10.79	83.14	15.75
5	5.563	5.047	.258	14.62	130.65	24.74
6	6.625	6.065	.280	18.97	188.67	35.73
6	6.625	5.761	.432	28.57	170.23	32.24
7	7.625	7.000	.312	24.41	251.33	47.60
8	8.625	7.625	.500	43.39	298.21	56.48
8	8.625	7.981	.322	28.55	326.71	61.88
8	8.625	8.125	.250	22.36	338.60	64.13
10	10.750	9.750	.500	54.74	487.59	92.35
10	10.750	10.020	.365	40.48	514.97	97.53
10	10.750	10.250	.250	28.04	538.88	102.06
12	12.750	11.750	.500	65.42	708.14	134.12
12	12.750	12.000	.375	49.56	738.59	139.88
12	12.750	12.250	.250	33.38	769.69	145.78
14	14.000	13.250	.375	54.57	900.48	170.55
14	14.000	13.500	.250	36.71	934.78	177.04
16	16.000	15.250	.375	62.58	1,192.84	225.92
16	16.000	15.500	.250	42.05	1,232.27	233.38
18	18.000	17.250	.375	70.59	1,526.24	289.06
20	20.000	19.250	.375	78.60	1,900.66	359.97
22	22.000	21.250	.375	86.61	2,316.12	438.66
24	24.000	23.250	.375	94.62	2,772.62	525.12

Capacities of standard military lightweight steel pipelines.

Nominal Size (inch)	Normal		Emergency	Working Pressures	
	Bbl/hr	Ft/sec	Bbl/hr	Safe (psi)	Maximum (psi)
4	355	5.5	393	600	750
6	785	5.4	1,000	600	750
8	1,355	5.6	1,730	500	600
12	7,150	12.5	11,400	400	530

Transportation tankers.

Units of volume and weight (used in tanker shipping):

Barrel = 42 gallons = 5.615 cubic feet = 0.159 cubic meters

Long ton = 2,240 pounds = 1016 kilograms

Deadweight tons = total carrying capacity of a tanker expressed in tons of 2,240 pounds.

Cargo Deadweight tons = total deadweight tons minus the weight of fuel, water, stores, crew, and other items necessary for the voyage.

Measurement tons = cargo capacity expressed in bale units of 40 cubic feet per ton.

Weight factors (used by MSC for billing purposes):

	All lube	Navy special	Diesel	Jet fuel		Ker-	Gasoline	
Unit of Measure	oils	fuel oil	fuel	JP-4	JP-5	osene	Motor	Aviation
Barrel/long ton	6.8	6.8	7.6	8.4	7.9	8.0	8.7	9.0
Barrel/metric ton	6.66	6.66	7.25	8.2	7.77	7.75	8.5	8.6

Voyage turn-around time: The period of time required by a tanker to make one complete round trip between its load port(s) and its discharge port(s).

Tanker requirements: To determine the number of T2-SE-A1 tanker equivalents required for a given task, use the following formula:

$$X = \frac{TQ}{C}$$

Where: X = number of T2-SE-A1 equivalents required.

T (Peace time) = Time required for one complete round trip at 14 knots, plus 2 days for loading and 2 days for unloading, plus 13 percent cycle time.

T (War Time) = Time required for one complete round trip of 14 knots plus 2 days for loading and 4 days for unloading and delays in port, plus 13 percent cycle time.

Q = Quantity required per day in long tons.

C = 15,500 tons (estimated cargo deadweight tons of a T2=SE-A1 tanker).

USMC tanker data.

Type	Speed (knots)	Deadweight tons	T2-SE-A1 Tanker equivalents*	Freeboard Draft (loaded)	Payload cargo in barrels at designed draft		
					Motor	Diesel	Jet
TI-M-BT2	10.0	3,933	0.2	19' 6"	29,000	25,100	28,000
T2-SE-AI	14.0	17,200	1.0	31' 0"	135,000	118,000	132,000
T5-S-12A	18.0	26,900	2.0	33' 8"	196,000	185,000	196,000
T5-S-RM2a	20.0	24,298	2.0	36' 1"	180,000	157,000	165,000
Sealift class	16.0	27,200	1.8	34' 7"	218.000	190,000	212,000
Columbia class	16.0	37,276	2.5	36' 4"	301,000	265,000	295,000

*T2-SE-A1 Tanker equivalents = $\frac{\text{deadweight tons X speed (knots)}}{17,200 \text{ X } 14.0}$

Tanker data.

Design of tanker	Dead-weight tons (1000 tons)	Draft fully loaded(1)	Cargo capacity (bbls)(2)	Number of cargo ranks	Number of cargo pumps	Cargo pumps hourly capacity per pump (bbls)	hourly capacity all pumps (bbls)	Size of hose connection (inches)	Dis-charge pressure (psi)(3)
AO-22(4)	16.5	32'-0"	138,000	9	4	2,000	8,000	8	125
AO-51(4)	21.0	36'-0"	151,000	33	10	3,680	36,800	7	100
AO-143(4)	22.2	35'-0"	187,100	9	4	4,285	17,000	8	125
AOR-1(4)	25.0	36'-0"	170,000	20	11	3,725	41,000	7	150
AOE-1(4)	26.8	38'-0"	166,000	27	11	3,880	42,700	7	150
T2-M-BT2	4.0	19'-3"	31,000	7	3	1,430	4,290	8	80
T2-SE-A1	17.2	31'-0"	138,335	9	3	3,025	9,075	8 to 10	125
T5-S-12a	26.9	33'-8"	196,000	9	4	6,200	24,800	12 to 14	125
T5-S-RM2a	24.3	36'-1"	180,000	9	4	6,200	24,800	12 to 14	125
SEALIFT CLASS	27.2	34'-7"	225,846	7	4	6,000	24,000	12 to 14	125
COLOMBIA CLASS	37.3	36'-4"	303,315	10	5	7,140	35,700	10 to 14	125
MONTICELLO VICTORY CLASS	49.5	39'-10"	372,000	11	4	5,280	21,120	10 to 14	125
SOHIO INTREPID CLASS	80.7	43'-6"	598,000	8	2	26,227	52,454	10+	125
ARCO ANCHORAGE CLASS	120.6	51'-8"	924,000	12	4	22,867	91,468	10+	125
T10-S-10lb	228.9	70'-2"	1,655,000	10	4	25,600	102,400	10+	125

(1) The values indicated for "DRAFT" in the tabulation are summer load line drafts.
(2) U.S. Navy tankers 95 percent loaded to provide for expansion. All others 98 percent loaded
(3) Use 100 psi for planning purposes.
(4) U.S. Navy design.
(5) Tankers over 75 DWT are used primarily for movement of crude oil.

Units of measurement
Area

To convert	To	Multiply by
Acres	Square Feet	43,560
"	Square Yards	4,840
"	Square Miles	0.0015625
"	Square Meters	4,046.873
"	Hectares	0.4046873
Hectares	Square Yards	11,959.85
"	Acres	2.47104
"	Square Miles	0.003861
"	Square Meters	10,000
"	Square Kilometers	0.01
"	Square Feet	107,600
Square Centimeters	Square Feet	0.001076
" "	Square Inches	0.1550
" "	Square Meters	0.0001
" "	Square Miles	3.861×10^{-11}
" "	Square Millimeters	100
" "	Square Yards	0.000196
Square Feet	Acres	0.0000296
" "	Square Centimeters	929.0
" "	Square Meters	0.09290
" "	Square Inches	144.0
" "	Square Yards	0.11111
" "	Square Miles	3.587×10^{-8}
" "	Square Millimeters	9.29×10^{4}
Square Inches	Square Centimeters	6.452
" "	Square Feet	0.6944
" "	Square Millimeters	645.2
" "	Square Yards	0.000716
Square Kilometers	Acres	247.1
" "	Square Centimeters	10^{10}
" "	Square Feet	10.76×10^{6}
" "	Square Inches	1.550×10^{9}
" "	Square Meters	10^{6}
" "	Square Miles	0.3861
" "	Square Yards	1.196×10^{6}
Square Meters	Acres	0.0002471
" "	Square Centimeters	10,000
" "	Square Feet	10.76
" "	Square Inches	1,550
" "	Square Miles	3.861×10^{-7}
" "	Square Millimeters	10^{6}
" "	Square Yards	1.196

Units of measurement. - Continued

Area

To convert	To	Multiply by
Square Miles	Acres	640.00
" "	Square Feet	27.88×10^6
" "	Square Kilometers	2.590
" "	Square Meters	2.590×10^6
" "	Square Yards	3.098×10^6
Square Yards	Acres	0.0002066
" "	Square Centimeters	8,361
" "	Square Feet	9.0
" "	Square Inches	1,296
" "	Square Meters	0.8361
" "	Square Miles	3.228×10^{-7}
" "	Square Millimeters	8.361×10^5

Flow

Bbl/day	gal/hr	1.75
" "	gal/min	0.0292
Bbl/hr.	cu ft/min	0.0936
" "	gal/min	0.7
Gal/hr	cu ft/hr	0.1337
" "	cu ft/min	0.002228
" "	gal/min	0.016667
Gal/min	bbl/day	34.2857
"	bbl/hr	1.4286
"	bbl/min	0.02381
"	cu ft/day	192.50
"	cu ft/min	0.1337
"	gal/day	1,440.0
"	liters/sec	0.6308
"	cu ft/sec	0.002228
Cu ft/min	gal/sec	0.1247
"	liters/sec	0.4720
"	cubic centimeters/sec	472.0
Cu ft/sec	million gals/day	0.646317
"	gals/min	448.831
Cu yards/min	cu ft/sec	0.45
"	gals/sec	3.367
"	liters/sec	12.74

Units of measurement. - Continued

Flow

To convert	To	Multiply by
Liters/min	cu ft/sec	0.0005886
" "	gals/sec	0.004403

Length

Centimeters	feet	0.03281
"	inches	0.3937
"	kilometers	1×10^{-5}
"	meters	0.01
"	miles	6.214×10^{-6}
"	millimeters	10.0
"	mils	393.7
"	yards	0.01094
"	microns	10,000
Feet	centimeters	30.48
"	kilometers	0.0003048
"	meters	0.3048
"	miles (naut.)	0.0001645
"	miles (stat.)	0.0001894
"	millimeters	304.8
"	mils	12,000
"	microns	30,480.0
Kilometers	centimeters	1×10^{5}
"	feet	3,281
"	inches	39,370.0
"	meters	1,000.0
"	miles	0.6214
"	millimeters	10^{6}
"	yards	1,094
League	miles	3
Meters	centimeters	100
"	feet	3.281
"	inches	39.37
"	kilometers	0.001
"	miles (naut.)	0.0005396
"	miles (stat.)	0.0006214
"	millimeters	1,000.0
"	yards	1.094
"	microns	1×10^{6}

Units of measurement. - Continued

Length

To convert	To	Multiply by
Miles (Naut.)	Feet	6,080.27
" "	Kilometers	1.853
" "	Meters	1,853.0
" "	Miles (Stat.)	1.1516
" "	Yards	2,027
Miles (Statute)	Centimeters	1.609×10^{5}
" "	Feet	5,280
" "	Inches	63,360.0
" "	Kilometers	1.609
" "	Meters	1,609.0
" "	Miles (Naut.)	0.8684
" "	Yards	1,760
Millimeters	Centimeters	0.1
"	Feet	0.003281
"	Inches	0.03937
"	Kilometers	10^{-6}
"	Meters	0.001
"	Miles	6.214×10^{-7}
"	Mils	39.37
"	Yards	0.001094
"	Microns	1,000
Microns	Centimeters	1×10^{-4}
"	Inches	3.937×10^{-5}
"	Meters	1×10^{-6}
Yards (U.S.)	Centimeters	91.4402
"	Fathoms	0.03
"	Feet	3
"	Inches	36
"	Meters	0.9144
"	Miles	5.68182×10^{-4}

Volume

Barrels (U.S.)	U.S. gallons	42
"	Cubic inches	9,702
"	Cubic Feet	5.6146
"	Imperial Gallons	34.9726
"	Liters	158.984
"	Cubic Meters	0.15899

Units of measurement. - Continued
Volume

To convert	To	Multiply by
Cubic Centimeters	Cubic feet	3.531×10^{-5}
" "	Cubic inches	0.06102
" "	Cubic meters	10^{-6}
" "	Cubic yards	1.308×10^{-6}
" "	Gallons (U.S. liquid)	0.0002642
" "	Liters	0.001
" "	Pints (U.S. liquid)	0.002113
" "	Quarts (U.S. liquid)	0.001057
Cubic Feet	Cubic centimeters	28,320.00
" "	Cubic inches	1,728.00
" "	Cubic meters	0.02832
" "	Cubic yards	0.03704
" "	Gallons (U.S. liquid)	7.48052
" "	Liters	28.32
" "	Pints (U.S. liquid)	59.84
" "	Quarts (U.S. liquid)	29.92
Cubic Inches	Cubic centimeters	16.39
" "	Cubic feet	5.787×10^{-4}
" "	Cubic meters	1.639×10^{-5}
" "	Cubic yards	2.143×10^{-5}
" "	Cubic gallons	0.004329
" "	Liters	0.01639
" "	Mil feet	1.061×10^{5}
" "	Pints (U.S. liquid)	0.03463
" "	Quarts (U.S. liquid)	0.01732
Cubic Meters	Bushels (dry)	28.38
" "	Cubic centimeters	1×10^{6}
" "	Cubic feet	35.31
" "	Cubic inches	61.023
" "	Cubic yards	1.308
" "	Gallons (U.S. liquid)	264.2
" "	Liters	1,000
" "	Pints (U.S. liquid)	2,113.0
" "	Quarts (U.S. liquid)	1,057.0
Cubic Yards	Cubic centimeters	7.646×10^{5}
" "	Cubic feet	27.0
" "	Cubic inches	46,656
" "	Cubic meters	0.7646
" "	Cubic gallons	202.0
" "	Liters	764.6
" "	Pints (U.S. liquid)	1,615.9
" "	Quarts (U.S. liquid)	807.9

Units of measurement. - Continued
Volume

To convert	To	Multiply by
Gallons (Imperial)	Cubic inches	277.42
" "	Cubic feet	0.160544
" "	U.S. gallons	1.20094
" "	U.S. barrels	0.028594
" "	Liters	4.54596
" "	Cubic meters	0.004546
Gallons (U.S.)	Cubic centimeters	3,785.0
" "	Cubic feet	0.1337
" "	Cubic inches	231.0
" "	Cubic meters	0.003785
" "	Cubic yards	0.004951
" "	Liters	3.785
" "	Pints	8.0
" "	Quarts	4.0
Gills	Liters	0.1183
"	Pints (liquid)	0.25
Liters	Bushels (U.S. dry)	0.02838
"	Cubic centimeters	1,000.0
"	Cubic feet	0.03531
"	Cubic inches	61.02
"	Cubic meters	0.001
"	Cubic yards	0.001308
"	Gallons (U.S. liquid)	0.2642
"	Pints (U.S. liquid)	2.113
"	Quarts (U.S. liquid)	1.057
	Weights	
Kilograms	Pounds	2.20462
"	Short tons	0.0011023
"	Metric tons	0.001
"	Long tons	9.842×10^{-4}
Long Tons	Kilogram	1,016.05
" "	Metric tons	1.01605
" "	Pounds	2,240
" "	Short tons	1.12
Metric Tons	Kilogram	1,000
" "	Long tons	0.98421
" "	Pounds	2,204.6
" "	Short tons	1.10231

Units of measurement. - Continued

Weights

To convert	To	Multiply by
Pounds (avoirdupois)	Grams	453.59
" "	Kilogram	.45359
" "	Ounces (avoirdupois)	16
" "	Ounces (troy)	14.5833
" "	Long tons	4.4643×10^{-4}
" "	Short tons	5×10^{-4}
Short Tons	Kilograms	907.185
" "	Long tons	.892857
" "	Metric tons	.907185
" "	Pounds	2,000.00

Pressure

Pounds per square inch	Kilograms per sq. m.	703.06687
" " " "	Inch of Mercury	2.036009
" " " "	Feet of water	2.306009
" " " "	Atmospheres	.0680457
" " " "	Kilogram per sq. cm.	.07036
" " " "	Pascal	6894.757
Kilograms per sq. m.	Pounds per sq. inch	.00142234
" " " "	Pounds per sq. foot	.2048169
" " " "	Inches of Mercury	.0028959
" " " "	Feet of water	.003280833
" " " "	Pascal	9.806650

Mass per unit length

Pounds per foot	Kilograms per meter	1.488
Pounds per inch	Kilograms per meter	17.86

Density

Pounds per cubic foot	Kilograms per cubic meter	16.018
Pounds per cubic inch	Kilograms per cubic meter	0.02768
Pounds per gallon (U.S.)	Kilograms per liter	0.11983

Power

Btu	Watts	0.2931
Horsepower	Watts	745.7

Thermal conductivity

Btu per hour-foot-°F	Watt per meter-Kelvin	1.729

Viscosity conversion table.

The following table will give a comparison of various viscosity ratings so that if the viscosity is given in terms other than Saybolt Universal, it can be translated quickly by following horizontally to the Saybolt Universal column.

		Approx. Seconds Mac	Approx. Gardner Holt	Seconds Zahn					Seconds Demnler		Approx. Seconds Stormer	Seconds Pratt and
SSU*	CS**	Michael	Bubble	Cup #1	Cup #2	Cup #3	Cup #4	Cup #5	Cup #1	Cup #10	100 gm LOAD	Lambert "F"
31	1.00	-	-	-	-	-	-	-	-	-	-	-
35	2.56	-	-	-	-	-	-	-	-	-	-	-
40	4.30	-	-	-	-	-	-	-	1.3	-	-	-
50	7.40	-	-	-	-	-	-	-	2.3	-	2.6	-
60	10.3	-	-	-	-	-	-	-	3.2	-	3.6	-
70	13.1	-	-	-	-	-	-	-	4.1	-	4.6	-
80	15.7	-	-	-	-	-	-	-	4.9	-	5.5	-
90	18.2	-	-	-	-	-	-	-	5.7	-	6.4	-
100	20.6	125	-	38	18	-	-	-	6.5	-	7.3	-
150	32.1	145	-	47	20	-	-	-	10.0	1.0	11.3	-
200	43.2	165	A	54	23	-	-	-	13.5	1.4	15.2	-
250	54.0	198	A	62	26	-	-	-	16.9	1.7	19	-
300	65.0	225	B	73	29	-	-	-	20.4	2.0	23	-
400	87.0	270	C	90	37	-	-	-	27.4	2.7	31	7
500	110.0	320	D	-	46	-	-	-	34.5	3.5	39	8
600	132	370	F	-	55	-	-	-	41	4.1	46	9
700	154	420	G	-	63	22.5	-	-	48	4.8	54	9.5
800	176	470	-	-	72	24.5	-	-	55	5.5	62	10.8
900	198	515	H	-	80	27	18	-	62	6.2	70	11.9
1000	220	570	I	-	88	29	20	13	69	6.9	77	12.4
1500	330	805	M	-	-	40	28	18	103	10.3	116	16.8
2000	440	1070	Q	-	-	51	34	24	137	13.7	154	22
2500	550	1325	T	-	-	63	41	29	172	17.2	193	27.6
3000	660	1690	U	-	-	75	48	33	206	20.6	232	33.7

Viscosity conversion table. - Continued

SSU*	CS**	Approx. Seconds Mac Michael	Approx. Gardner Holt Bubble	Seconds Zahn Cup #1	Cup #2	Cup #3	Cup #4	Cup #5	Seconds Demnler Cup #1	Cup #10	Approx. Seconds Stormer 100 gm Load	Seconds Pratt and Lambert "F"
4000	880	2110	V	-	-	-	63	43	275	27.5	308	45
5000	1100	2635	W	-	-	-	77	50	344	34.4	385	55.8
6000	1320	3145	X	-	-	-	-	65	413	41.3	462	65.5
7000	1540	3670	-	-	-	-	-	75	481	48	540	77
8000	1760	4170	Y	-	-	-	-	86	550	55	618	89
9000	1980	4700	-	-	-	-	-	96	620	62	695	102
10000	2200	5220	Z	-	-	-	-	-	690	69	770	113
15000	3300	7720	Z2	-	-	-	-	-	1030	103	1160	172
20000	4400	10500	Z3	-	-	-	-	-	1370	137	1540	234

*Seconds Saybolt Universal

**Kinematic Viscosity (in centistokes) = $\frac{\text{Absolute viscosity (in centipoises)}}{\text{Specific Gravity}}$

Above 250 SSU, use the following approximate conversion: SSU = Centistokes (CS) x 4.62.

Above the range of this table and within the range of the viscosimeter, multiply their rating by the following factors to convert to SSU.

Viscosimeter	Factor
Mac Michael	1.92 (approx.)
Demnler #1	14.6

Viscosimeter	Factor
Demnler #10	146
Stormer	13. (approx.)

PIPELINES

PRESSURE REQUIRED TO PUMP PETROLEUM PRODUCTS THROUGH PIPELINES OVER LEVEL GROUND

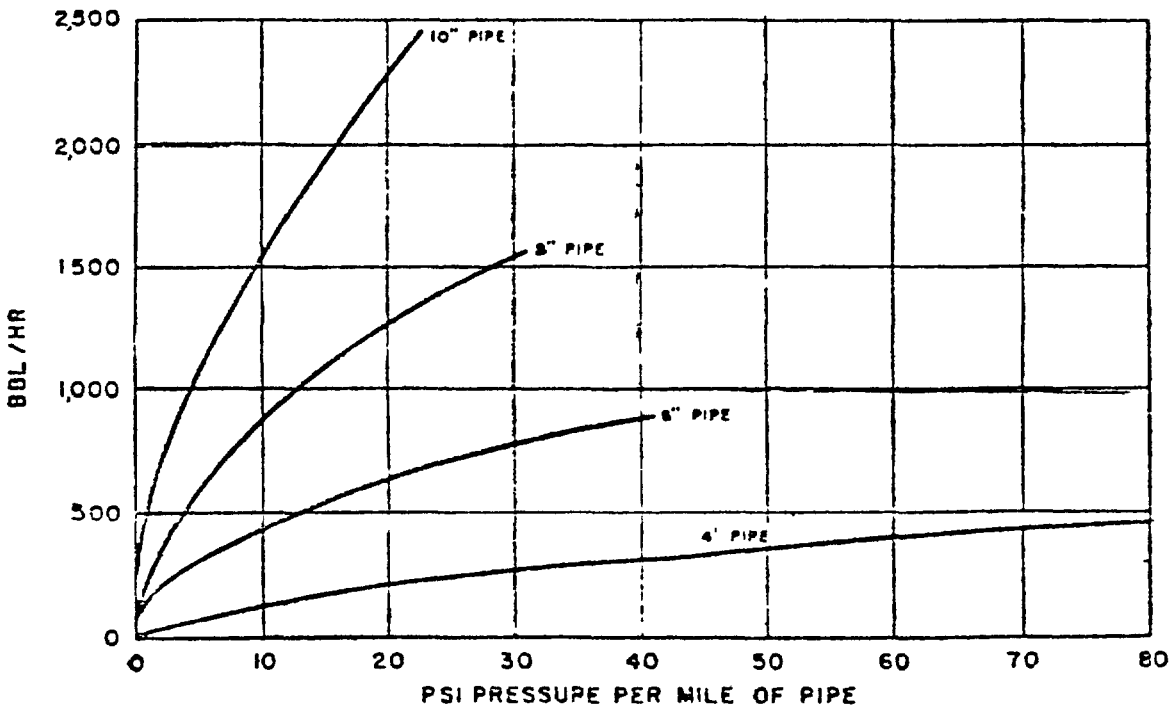
CORRECTION FACTOR FOR FRICTION LOSSES = 140

CURVES PLOTTED TO 7 FT./SEC. VELOCITY

SOURCE:
ENGINEER RESEARCH AND DEVELOPMENT LABORATORY.
CAMERON HANDBOOK, HYDRAULIC DATA.

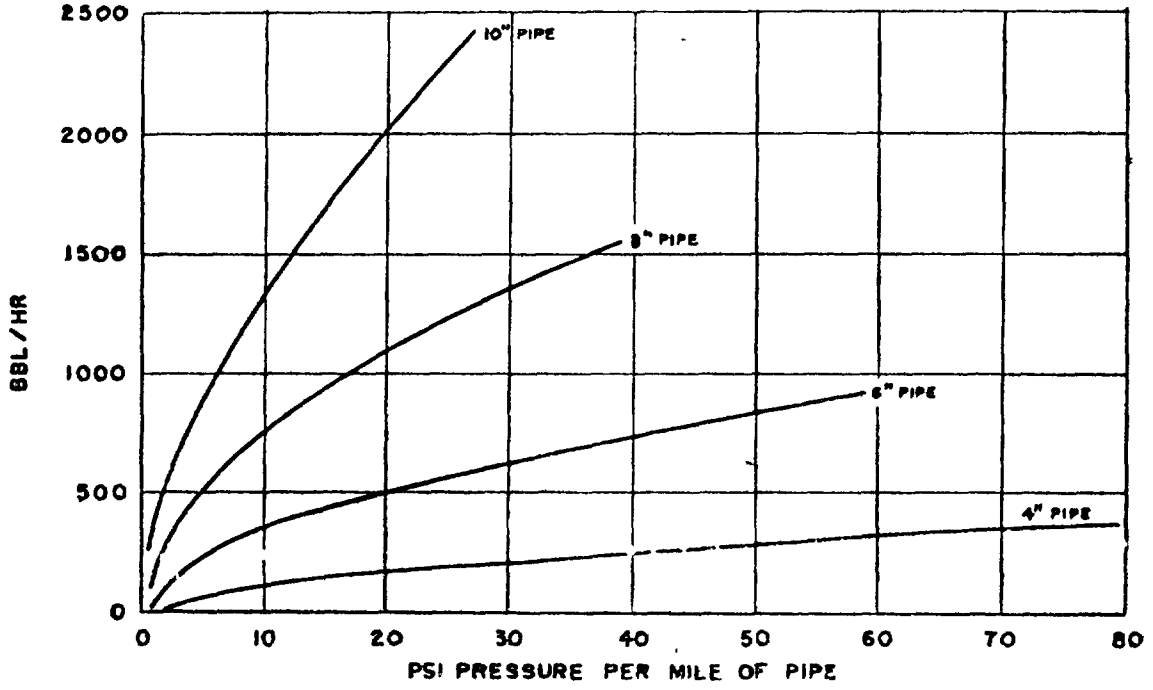
AVIATION GASOLINE

SPECIFIC GRAVITY: 0.70; API GRAVITY: 70.6°
0.60 KINEMATIC VISCOSITY CENTISTOKES



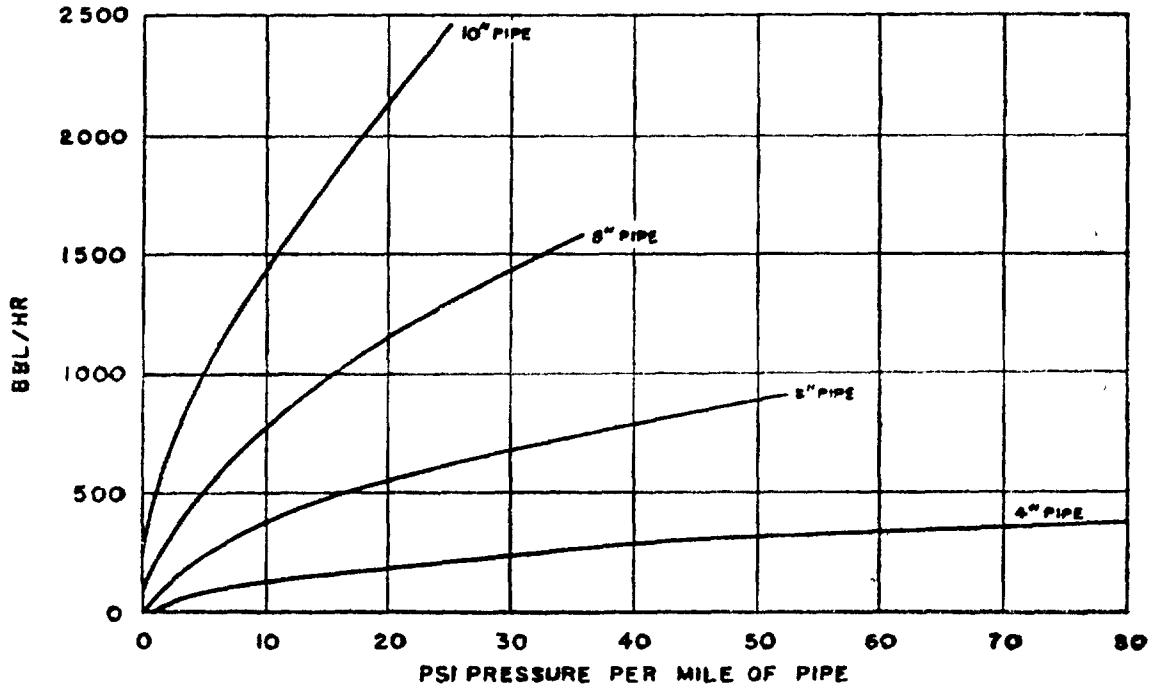
NAVY SPECIAL

SPECIFIC GRAVITY: 0.9465, API GRAVITY: 18°



DIESEL FUEL

SPECIFIC GRAVITY: 0.8498; API GRAVITY: 35°



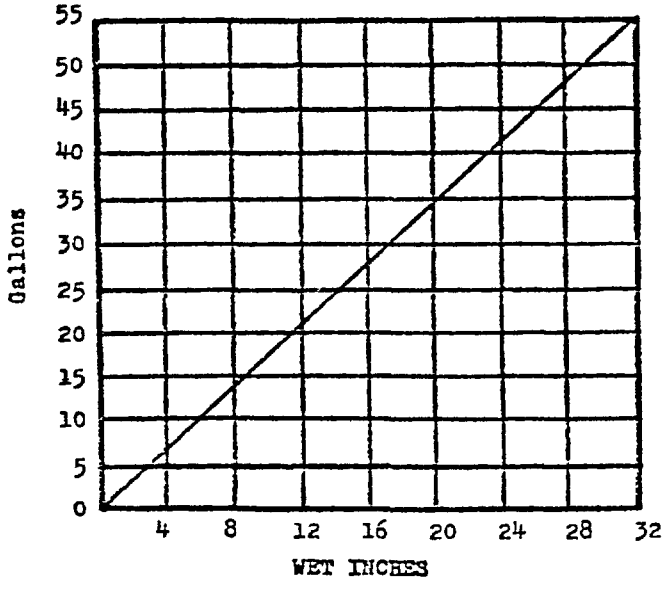
GAUGING 55 GALLON DRUMS
(APPROXIMATE)

PROCEDURE

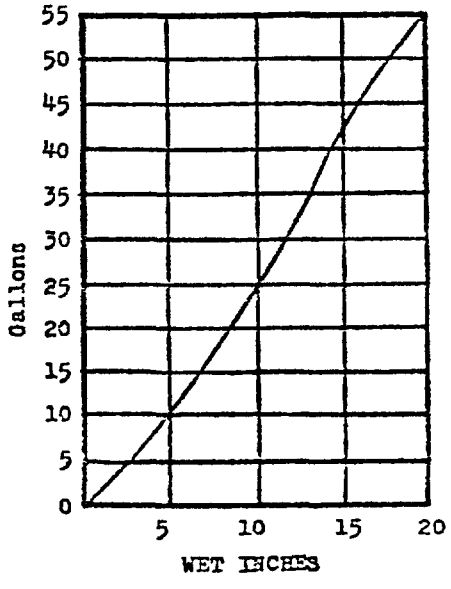
Dip an ordinary yardstick into the drum to get a wet inch reading. Apply this number to the horizontal axis of these charts and get your value in gallons from the vertical axis.

The values on these charts were obtained at 60° F. Correct for measurements at higher or lower temperatures by a factor of about 0.6 per cent increase or decrease in volume per degree.

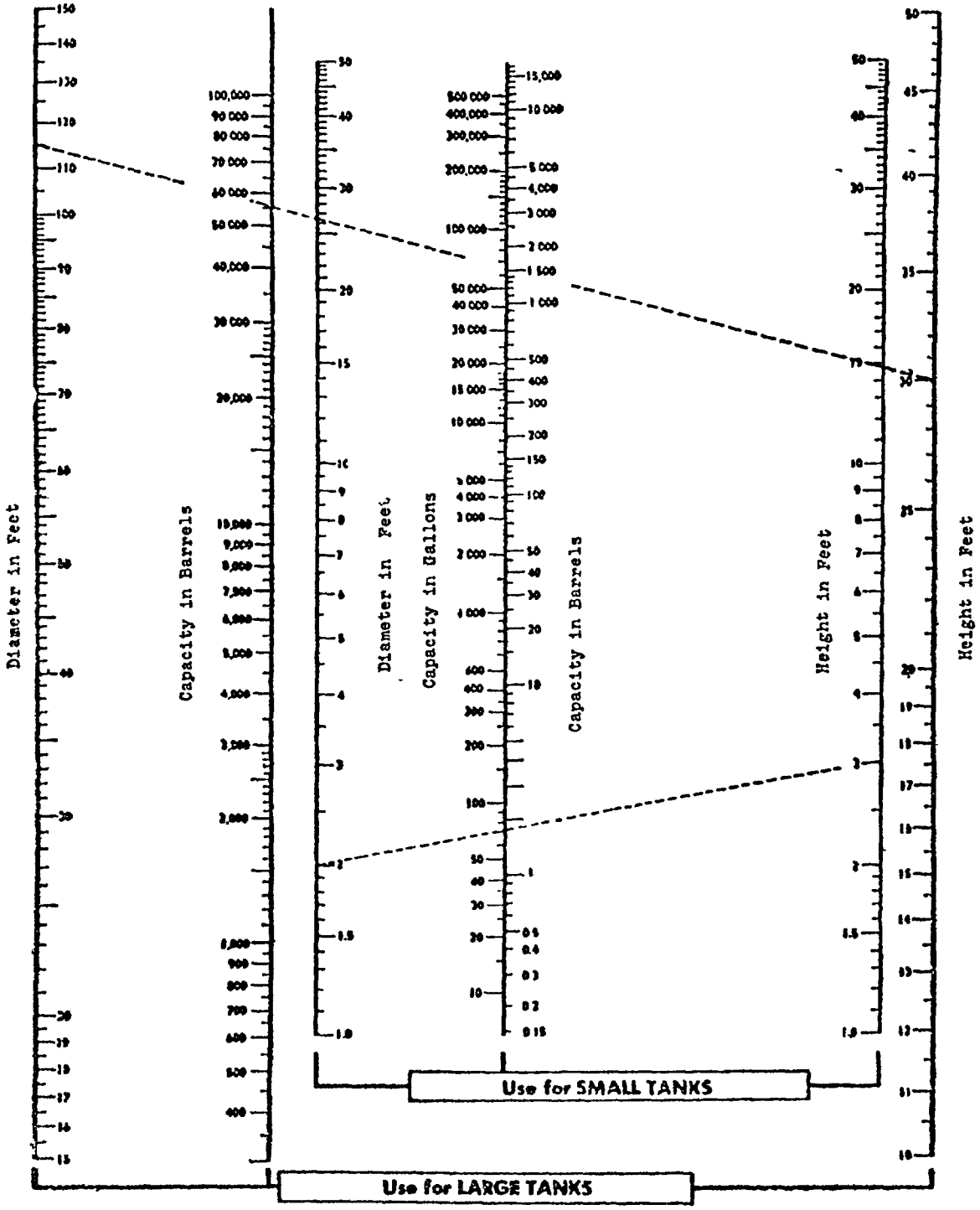
VERTICAL DRUM



HORIZONTAL DRUM



TANK CAPACITY DIAGRAM FOR APPROXIMATE VALUES



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Navy - YD
Air Force - 68

Review activities:

Army - ME, SM, EA
Navy - MC
DLA - PS

User activities:

Navy - SH, CG

Preparing activity:

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CONVERSION FACTORS AND LOGISTICS DATA FOR PETROLEUM PLANNING

MIL-HDBK-210A, dated 16 April 1979, has been reviewed and determined to be valid for use in acquisition.

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