410 LIQUID STORAGE - FUEL AND NONPROPELLANTS

Liquid storage utilizes bulk tanks and associated stationary equipment for:

1. Liquid fuel storage
2. Liquid storage other than water, fuel and propellants

411 LIQUID FUEL STORAGE - BULK

1. General Storage Requirements. The types and sizes of storage tanks required for depot storage facilities will be determined by safety considerations, the availability of commercial facilities, and intended services. Depot fuel storage facilities must be of sufficient capacity to provide an adequate operating and reserve supply of fuel for the activities served. The different types of fuel in storage will be segregated, and in the larger installations, the tanks will be separated into two or more subgroups.

2. Site Planning. Fuel storage facilities should be located on gently rolling terrain. A site with an elevation slightly above that of the facilities to be served, is preferred for both the aboveground and underground storage. Where military or safety considerations govern, tanks should be placed underground. Aboveground tank spacing will be staggered as much as possible to minimize alignment, to aid concealment, and to provide maximum protection from enemy attack.

3. Quantities. The quantities of petroleum products to be stored are based on the total requirements of the activities served. Bulk storage may be as much as 1,000,000 barrels in a large fuel depot or facility designed for a reserve supply.

For planning purposes the capacities of individual tanks should be approximately 25 percent of the ultimate storage for each type of fuel, subject to the following:

1. The minimum capacity of a tank for fuel depot bulk storage shall not be less than:
   (a) Diesel oil -- 13,500 barrels
   (b) Fuel oil -- 27,000 barrels
2. The maximum capacity of an individual tank for bulk storage shall normally be limited to 100,000 barrels. (The barrel is the standard 42 U.S. gallon capacity.)
3. A minimum of two tanks will be provided for each type of fuel. One will serve as the working tank and the other the receiving tank for new deliveries.
4. The time necessary for impurities in MoGas, AvGas and jet fuels to settle prior to the use of these fuels will be a factor in determining the size and number of tanks required for bulk storage. Allow a minimum settling time of two hours.

The planning information contained in Basic Category 411 pertains to the bulk storage of fuel oils and lubricants in the following codes:

Code 411 10 Ship Fuel Storage
Code 411 20 Aviation Gasoline Storage
Code 411 30 Diesel Fuel Storage
Code 411 40 Motor Gasoline Storage
Code 411 50 Jet Engine Fuel Storage
Code 411 60 Liquefied Petroleum Fuel Gas Storage
Code 411 70 Vapor Collection/Recovery System
Code 411 82 Contaminated Fuel Storage
Code 411 84 Bulk (Depot) Heating Fuel Storage

Codes 411 10 through 411 50 (BL). The fuel products in these codes may be stored in bulk quantities and will be protected as indicated in Basic Category 411, Liquid Fuel Storage--Bulk. Plans for the bulk storage will include only those fuel products required by an activity to perform its assigned mission, plus a specified reserve supply.

The maximum capacities for the aboveground storage tanks and the safety spacing distances for both the aboveground and the underground storage tanks for these fuel products are shown in Basic Category 124, herein. The capacities and uses for the underground storage tanks for these fuel products are shown in Tables 411-l and 411-2.

Codes 411 60 through 411 84 (BL). Planning information pertinent to the storage and handling of liquefied petroleum gases, contaminated, and heating fuel is as follows:

411 60 LIQUEFIED PETROLEUM FUEL GAS STORAGE (BL)

The Navy uses liquefied petroleum gas, commonly known as LPG, for heating, metal cutting, brazing, in dental laboratories, aboard ships, and in similar installations. LPG consists predominantly of propane, propylene, with minor amounts of butane, isobutane, and butylene. LPG is normally supplied in 100-pound cylinders or may be procured by tank car or tank truck for bulk storage. The bulk storage capacity requirements for LPG depends on activity requirements, frequency of deliveries, and dependability of supply. A multi-tank system should be considered because it provides for a more dependable supply. For aboveground storage of up to 30,000 gallons of LPG tank capacity, or at locations where underground storage is required or is economically desirable, use horizontal steel tanks. For bulk storage requiring over 30,000 gallons tank capacity, use spherical or spheroidal steel tanks. For design information pertaining to storage tanks, see Mechanical Engineering, NAVFAC DM-3; for berms and accessory piping, see Liquid Fueling and Dispensing Facilities, NAVFAC DM-22; and for fire protection and fire fighting, see Fire Protection Engineering, NAVFAC DM-8.

411 70 VAPOR COLLECTION/RECOVERY SYSTEM (EA)

The vapor collection and recovery system is used to eliminate continued vapor emissions to the atmosphere during AVGAS and MOGAS storage and transfer operations. This facility is usually constructed in order to comply with local county air pollution control requirements. No criteria is currently available.

TABLE 411-1
Underground Fuel Storage Tanks, Vertical, Steel
(Sizes and Uses)

Capacity (bbl)	Diameter (ft)	Height (ft)	Normal Use
5,000	53-1/2	13	Aviation gas
7,500	65	13	Aviation gas
13,500	88	13	Fuel oil
13,500	88	13	Diesel
13,500	88	13	Aviation gas
13,500	88	13	Jet
27,000	100	20	Fuel Oil
27,000	100	20	Diesel
27,000	100	20	Jet
27,000	100	20	Ship fuel
50,000	122	24	Ship & Jet fuel

TABLE 411-2
Underground Fuel Storage Tanks, Vertical, Concrete
(Sizes and Uses)

Circular Tanks				
Capacity	Type	Diameter (ft. in.)	Height (ft. in.)	Normal Use
Gallon				
25,000	N	24	8	Fuel oil or gas
25,000	P	24	8	Aviation gas
50,000	N	33	8	Aviation gas
100,000	P	42	10	Aviation gas
250,000	P	56	13-6	Aviation gas
Barrel				
13,500	P	88	13	Fuel oil
13,500	P	88	13	Diesel
13,500	P	88	13	Aviation gas
13,500	P	88	13	Motor gas
27,000	P	99-6	20-2	Fuel oil
27,000	P	99-6	20-2	Diesel
27,000	P	99-6	20-2	Jet
27,000	P	99-6	20-2	Ship fuel
50,000	P	134-8	20	Fuel oil
50,000	P	134-8	20	Diesel
50,000	P	134-8	20	Jet fuel
50,000	P	134-8	20	Ship fuel

Table continued on next page

TABLE 411-2 (Continued)
Underground Fuel Storage Tanks, Vertical, Concrete
(Sizes and Uses)

Rectangular Tanks					
Capacity (gal)	Type	Length (ft.)	Width (ft.)	Height (ft.)	Normal Use
5,000	N	14	7	7	Fuel oil and diesel
10,000	N	20	10	7	Fuel oil and diesel

Note: Dimensions are internal.
P = Prestressed
N = Non prestressed

411 82 CONTAMINATED FUEL STORAGE (BL)

A fuel storage facility requires temporary storage for off-specification (contaminated fuel). Separate installations may be required for each major type of fuel. For details of renovation tanks and equipment see Liquid Fueling and Dispensing Facilities, NAVFAC DM-22.

411 84 BULK (DEPOT) HEATING FUEL STORAGE (BL)

Heating fuel oil storage may include storage tanks for kerosene and several different grades of diesel oil. The quantity of any type of heating fuel oil stored will be determined by the station requirements and mission. See Structural Engineering, NAVFAC DM-2 and Liquid Fueling and Dispensing Facilities. NAVFAC DM-22.

TABLE 411-3
ABOVEGROUND VERTICAL STEEL
STORAGE TANKS (SIZES)

COLUMN A Capacity in Barrels	(U.S. Standard) Tank Dimensions In Feet		COLUMN B Capacity in Cubic Meters	(Metric Standard) Tank Dimensions (Meters)	
	Diameter	Height		Diameter	Height
5,020	33.6	32	799	10.21	9.75
5,040	30.0	40	801	9.14	12.19
5,480	35.0	32	872	10.67	9.75
6,020	36.8	32	957	11.18	9.75
6,040	30.0	48	961	9.14	14.63
6,860	35.0	40	1,090	10.67	12.19
7,160	40.0	32	1,139	12.19	9.75
7,520	36.8	40	1,196	11.18	12.19
8,950	40.0	40	1,423	12.19	12.19
10,110	42.6	40	1,607	12.95	12.19
10,310	48.0	32	1,640	14.63	9.75
11,330	45.0	40	1,801	13.72	12.19
12,110	52.0	32	1,928	12.95	14.63
12,130	42.6	48	1,924	15.85	9.75
12,890	48.0	40	2,050	14.63	12.19
13,600	45.0	48	2,162	13.72	14.63
13,990	50.0	40	2,224	15.24	12.19
15,060	58.0	32	2,394	17.68	9.75
15,130	52.0	40	2,405	15.85	12.19
15,470	48.0	48	2,460	14.63	14.63
16,790	50.0	48	2,669	15.24	14.63
20,150	60.0	40	3,203	18.29	12.19
24,170	60.0	48	3,843	18.29	14.63
25,120	67.0	40	3,993	20.42	12.19
27,420	70.0	40	4,359	21.34	12.19
30,090	73.4	40	4,784	22.35	12.19
30,140	67.0	48	4,792	20.42	14.63
32,900	70.0	48	5,231	21.34	14.63
35,810	80.0	40	5,693	24.38	12.19
40,430	85.0	40	6,427	25.91	12.19

(Continued)

TABLE 411-3 (Continued)
ABOVEGROUND VERTICAL STEEL
STORAGE TANKS (SIZES)

COLUMN A Capacity in Barrels	(U.S. Standard) Tank Dimensions In Feet		COLUMN B Capacity in Cubic Meters	(Metric Standard) Tank Dimensions (Meters)	
	Diameter	Height		Diameter	Height
42,970	80.0	48	6,832	24.38	14.63
44,760	100.0	32	7,117	30.48	9.75
45,320	90.0	40	7,206	27.43	12.19
50,130	80.0	56	7,971	24.38	17.07
54,390	90.0	48	8,647	27.43	14.63
54,160	110.0	32	8,611	33.53	9.75
55,950	100.0	40	8,896	30.48	12.19
67,140	100.0	48	10,675	30.48	14.63
67,700	110.0	40	10,764	33.53	12.19
78,340	100.0	56	12,454	30.48	17.07
80,570	120.0	40	12,810	36.58	12.19
81,250	110.0	48	12,917	33.53	14.63
96,690	120.0	48	15,372	36.58	14.63
100,470	134.0	40	15,974	40.84	12.19
109,670	140.0	40	17,436	42.67	12.19
112,800	120.0	56	17,934	36.58	17.07
120,570	134.0	48	19,168	40.84	14.63
125,900	150.0	40	20,016	45.72	12.19
131,600	140.0	48	20,923	42.67	14.63
143,240	160.0	40	22,774	48.77	12.19
151,080	150.0	48	24,019	45.72	14.63
153,540	140.0	56	24,411	42.67	17.07
171,890	160.0	48	27,329	48.77	14.63
181,290	180.0	40	28,823	54.86	12.19
200,540	160.0	56	31,883	48.77	17.08
217,550	180.0	48	34,588	54.86	14.63
223,820	200.0	40	35,584	60.96	12.19
253,810	180.00	56	40,352	54.86	17.07
268,580	200.0	48	42,701	60.96	14.63
313,340	200.0	56	49,818	60.96	17.07

(Continued)

TABLE 411-3 (Continued)
ABOVEGROUND VERTICAL STEEL
STORAGE TANKS (SIZES)

COLUMN A Capacity in Barrels	(U.S. Standard) Tank Dimensions In Feet		COLUMN B Capacity in Cubic Meters	(Metric Standard) Tank Dimensions (Meters)	
	Diameter	Height		Diameter	Height
324,980	220.0	48	51,668	67.06	14.63
379,140	220.0	56	60,279	67.06	17.07
386,750	240.0	48	61,489	73.15	14.63
451,210	240.0	56	71,737	73.15	17.07
453,900	260.0	48	72,164	79.25	14.63
526,420	280.0	48	83,694	85.34	14.63
529,550	260.0	56	84,192	79.25	17.07
604,300	300.0	48	96,077	91.44	14.63
614,150	280.0	56	97,642	85.34	17.07
672,500	293.0	56	106,920	89.31	17.07
687,560	320.0	48	109,314	97.54	14.63
750,020	300.0	56	112,090	91.44	17.07
776,190	340.0	48	123,405	103.63	14.63
789,950	343.0	48	125,593	104.55	14.63

412 LIQUID STORAGE OTHER THAN WATER, FUEL, AND PROPELLANTS

This group includes tank storage, accessories and piping for organic liquids such as cottonseed, linseed or soybean oils and other non-fuel liquids. The individual codes in this group are:

412 15 Road Oil Storage (GA)
412 25 Lubricant Storage (GA)
412 35 Ballast and Sludge Storage (GA)
412 40 Organic Oil Storage (GA)
412 45 Miscellaneous Liquid Storage (GA)
412 50 Industrial/POL Waste Storage Facility (GA)

No specific planning factors for these codes are currently available.