An Introduction to Petroleum Fuel Facilities:
General Design Information

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CONTENTS

1. OPERATIONAL CAPABILITIES. Design fuel facilities for continued operation using emergency or temporary expedients despite the loss of one or more components of the fuel receiving and/or dispensing system by enemy action or other factors. For tactical or mission-related fuel facilities, provide an alternative source of fuel supply to the fuel facility to ensure emergency operation under the most adverse conditions, including back-up power (emergency generators). Maintain consistency with prescribed criteria in appropriate directives, instructions, and standard designs (including NATO Standards).

2 FUEL SPECIFICATIONS. The following specifications apply to the various petroleum fuels that may be addressed:

a) MIL-DTL-5624, Turbine Fuel, Aviation, Grades JP-4 and JP-5.
b) MIL-DTL-38219, Turbine Fuel, Low Volatility, JP-7.
c) MIL-DTL-83133, Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), and NATO F-35, and JP-8+100 (NATO F-37).
d) MIL-DTL-25524, Turbine Fuel, Aviation, Thermally Stable.
e) ASTM D1655, Standard Specification for Aviation Turbine Fuels.
f) CID A-A-52557, Fuel Oil, Diesel; for Posts, Camps and Stations.
g) CID A-A-59693, Diesel Fuel, Biodiesel Blend (B20).
h) MIL-DTL-16884, Fuel, Naval Distillate.
i) ASTM D3699, Standard Specification for Kerosene.
j) ASTM D4814, Standard Specification for Automotive Spark-Ignition Engine Fuel.
k) ASTM D910, Standard Specification for Aviation Gasoline (Avgas)
l) ASTM D975, Standard Specification for Diesel Fuel Oils.
m) MIL-DTL-87107, Propellant, High Density Synthetic Hydrocarbon Type, Grade JP-10.
n) ASTM D5798, Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines.
o) ASTM D6751, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels.
p) ASTM D7467, Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)

3. FUEL PROPERTIES AND ADDITIVES. In addition to the fuel specifications, refer to Coordinating Research Council, Inc., CRC Report No. 635, Handbook of Aviation Fuel Properties, for additional fuel properties. The following paragraphs list typical physical properties of various grades of fuel and additives which would affect the design of a petroleum fuel facility. The NATO designation is shown in brackets.

3.1 MOTOR GASOLINE (MOGAS) [F-46] [ASTM D4814]

3.1.1 SPECIAL PRECAUTIONS FOR MOGAS. Because of its high volatility, gasoline produces large amounts of vapor at ordinary temperatures. When confined in a tank or container at liquid temperatures above 20 degrees F (-7 degrees C), the vapor space is normally too rich to be explosive. At temperatures 20 degrees F (-7 degrees C) or less, vapor spaces above gasoline may be in the explosive range. One gallon (3.785 L) of liquid gasoline when vaporized will occupy about 25 cubic feet (700 L) of space, and if permitted to escape and become diluted with air, it is highly flammable. Provide a design that precludes disposing of Mogas into storm or sanitary sewers.

3.2 AVIATION GASOLINE (AVGAS) [F-18] [ASTM D910]

3.2.1 DESCRIPTION OF AVIATION GASOLINE. Aviation gasoline is a high-octane aviation fuel used for piston or Wankel engine powered aircraft. It is distinguished from motor gasoline, which is the everyday gasoline used in ground vehicles.

3.2.2 AVGAS GRADES. 100LL, spoken as "100 low lead", is the most common grade used in many applications. It is dyed blue, and contains a maximum of 2 grams of lead per US gallon (0.56 grams/liter) and is the most commonly available and used aviation gasoline. Other grades that are theoretically available include Grade 80, Grade 91, Grade 100, and Grade 82UL. The differences between all 80, 91, 100, and 100LL are lead content and color. Grade 82UL is unleaded.

3.2.3 SPECIAL PRECAUTIONS FOR AVGAS. Using the wrong grade of gasoline will cause engine problems. Virtually all grades of avgas available contain tetra-ethyl lead (TEL) as a lead based anti-knock compound. See Mogas for flammability issues.

3.3 AVIATION TURBINE FUELS.

Grade Number	Property					
	Relative density	Specific Gravity	Reid Vapor Pressure at 100°F(38°C) psia (kPa)	Minimum Flash Point, °F (°C)	Average (kin.) Viscosity at 100°F (38°C), $ft^2/s \times 10^{-5}$ (cSt)	Freezing Point, °F (°C)
JP-4 [F-40]	57° to 45° API	0.751 to 0.802	2 to 3 (13.8 to 20.7)	-20 (-29)	0.9×10^{-5} (0.8)	-72 (-58)
JP-5 [F-44]	48° to 36° API	0.788 to 0.845	0.04 (0.3)	140 (60)	1.6×10^{-5} (1.5)	-61 (-52)
JP-8 [F-34, F-37]	51° to 37° API	0.775 to 0.840	0.05 (0.3)	100 (38)	1.9×10^{-5} (1.8)	-53 (-47)
JP-10	20° to 18.5° API	0.935 to 0.943	0.11 (0.8)	67 (19)	3.4×10^{-5} (3.2)	-110 (-79)
JPTS	53° to 46° API	0.767 to 0.797	0.11 (0.8)	110 (43)	1.3×10^{-5} (1.2)	-64 (-53)
Jet A	51° to 37° API	0.775 to 0.840	0.029 (0.2)	100 (38)	1.6×10^{-5} (1.5)	-40 (-40)
Jet A-1 [F-35]	51° to 37° API	0.775 to 0.840	0.05 (0.3)	100 (38)	1.6×10^{-5} (1.5)	-53 (-47)
Hydrazine	9° API	1.007	NA	126 (52)	NA	NA

Table 1

Properties of aviation fuels

3.3.1 SPECIAL PRECAUTIONS FOR AVIATION TURBINE FUELS. Because of the serious consequences of a turbine engine failure and the nature of the fuel systems in turbine engines, provide designs which include means to prevent contamination of aviation turbine fuels by dirt, water, or other types of fuels. Solid contaminants are generally those which are insoluble in fuel. Most common are iron rust, scale, sand, and dirt. Iron rust contaminates aviation turbine fuel. Special filtration is required for receiving aviation turbine fuel into bulk storage and operating storage to remove contaminants before the fuel is delivered to aircraft. To preserve fuel quality, limit materials in contact with the fuel to stainless steel, non-ferrous, or coated carbon steel for aircraft fueling systems. Do not use zinc, copper, and zinc- or copper-bearing alloys in contact with aviation turbine fuels, including pipe, valves, equipment, and accessories. The maximum allowable aircraft servicing use limits of solids is 2.0 mg/L and the maximum allowable aircraft servicing use limits of free water is 5 ppm. The maximum allowable Air Force aircraft servicing use limits for solids is 0.5 mg/L and maximum allowable servicing use limits of free water is 10 ppm. Provide a design that precludes disposing of aviation turbine fuels into storm or sanitary sewers.

3.4 KEROSENE [ASTM D3699]

3.4.1 PHYSICAL PROPERTIES OF KEROSENE

a) Relative density
b) API Gravity 51 degrees to 37 degrees API
c) Specific Gravity 0.775 to 0.840
d) Reid Vapor Pressure 0.5 psia (3.5 kPa) (maximum at 100 degrees F (38 degrees C))
e) Flash Point (minimum) 100 degrees F (38 degrees C)
f) Viscosity at 104 degrees F (40 degrees C) 1 to 2 x 10-5 ft2/s (0.9 to 1.9 cSt.)
g) Freezing Point -22 degrees F (-30 degrees C) (maximum)

3.4.2 SPECIAL PRECAUTIONS FOR KEROSENE. Design separate systems for kerosene to avoid discoloration caused by contamination. Provide a design that precludes disposing of kerosene into storm or sanitary sewers.

3.5 DIESEL FUELS.

3.5.1 SULFUR CONTENT OF DIESEL FUELS. Diesel fuel that is available for motive fuel in the United States is Low Sulfur Diesel (LSD) which has a maximum sulfur content of 500 ppm and Ultra Low Sulfur Diesel (ULSD) which has a maximum sulfur content of 15 ppm, both meeting ASTM D975.

3.5.2 PHYSICAL PROPERTIES OF DIESEL FUELS.

	Automotive DF-2 [F-54]	Diesel Fuel Marine [F-76]	Ultra Low Sulfur Diesel [ASTM D975]
(a) Relative density API Gravity, °API (Specific Gravity)	40 to 34 (0.825 to 0.855)	39 to 33 (0.830 to 0.860)	30 (0.876)
(b) Reid Vapor Pressure at 100 °F (38 °C), psia (kPa)	0 (0)	0 (0)	0 (0)
(c) Flash Point, °F (°C)	131 (55)	140 (60)	150 (66)
(d) Viscosity at 104°F (40°C) ft^2/s (cSt)	2.0 to 4.4 x 10-5 (1.9 to 4.1)	1.8 to 4.6 x 10-5 (1.7 to 4.3)	2.7 x 10-5 (2.5)
(e) Pour Point, °F (°C)	10 (-12)	20 (-7)	0 (-18)

Notes: JP-8 is currently used as arctic grade diesel fuel (DFA) in the Arctic and Antarctic for heating fuel. The gross heating value of JP-8 is 18,400 Btu/lb (42 800 kJ/kg).

DF-1, winter grade diesel fuel, has a flash point of 100 degrees F (38 degrees C) and a viscosity of 1.4 to 2.6 x 10^{-5} ft^2/s (1.3 to 2.4 cSt) at 104 degrees F (40 degrees C).

Table 2

Physical properties of diesel fuels

3.5.3 SPECIAL PRECAUTIONS FOR LOW SULFUR DIESEL FUELS.

While not as critical as with aviation turbine fuels, diesel fuel systems are subject to damage by dirt and water in the fuel. Avoid contamination by dirt and water or dilution by lighter fuels. In cold climates, provide designs that will prevent “gelling.” Provide a design that precludes disposing of diesel fuels into storm or sanitary sewers.

3.5.4 SPECIAL PRECAUTIONS FOR ULTRA LOW SULFUR DIESEL. With the reduction in sulfur content comes a reduction in overall lubricity and conductivity of the fuel. A lower lubricity level can cause premature wear and damage to metal parts in typical compression ignition engines. Lubricity additives are added in accordance with ASTM D975. Lower conductivity can cause a potential for an increased risk in fire or explosion caused by static electricity. Even though a conductivity additive is added it is recommended that flow rates are limited and bonding and grounding equipment be utilized to minimize static electricity during loading operations.

3.6 Burner Fuel Oils.

3.6.1 PHYSICAL PROPERTIES OF BURNER FUEL OILS.

	Grade Number					
	1	2	4	5 Light	5 Heavy	6
Relative Density °API	48 to 36	40 to 28	30 to 15	22 to 14	23 to 8	22 to 7
Specific Gravity	0.786 to 0.843	0.825 to 0.877	0.876 to 0.966	0.922 to 0.972	0.913 to 1.017	0.922 to 1.022
Reid Vapor Pressure at 100°F (38°C), psia (kPa)	< 0.1 (< 0.7)	< 0.1 (< 0.7)	< 0.1 (< 0.7)	< 0.1 (< 0.7)	< 0.1 (< 0.7)	< 0.1 (< 0.7)
Minimum Flash Point, °F (°C)	100 (38)	100 (38)	130 (54)	130 (54)	130 (54)	150 (66)
Average viscosity at 100°F (38°C), $ft^2/s \times 10^{-5}$ (cSt)	1.5 to 2.4 (1.4 to 2.2)	2 to 3.3 (1.9 to 3.1)	11.3 to 70 (10.5 to 65)	70 to 215 (65 to 200)	323 to 969 (300 to 900)	208 to 807 (193 to 750)
Pour Point, °F (°C)	-10 (-23)	-5 (-21)	21 (-6)	20 to 30 (-7 to -1)	20 to 30 (-7 to -1)	30 to 70 (-1 to 21)
Gross Heat Value, Btu/lb (kJ/kg)	19,765 (45 973)	19,460 (45 264)	18,840 (43 820)	18,560 (43 171)	18,825 (43 787)	18,200 (42 333)

Table 3

Physical Properties of Burner Fuel Oils

3.6.2 SPECIAL PRECAUTIONS FOR BURNER FUEL OILS. When the ambient temperature of the burner fuel oil is less than 20 degrees F (11 degrees C) above the pour point temperature, the burner fuel oil needs to be heated. At the burner fuel oil's pour point temperature, the fuel oil has reached a gel-like state and would be difficult to pump. In nearly all cases, No. 6 fuel oil requires heating to be pumped. In some cases, No. 4 and No. 5 burner fuel oils will require heating. Provide a design that precludes disposing of burner fuel oils into storm or sanitary sewers.

3.7 ALTERNATIVE FUEL (E85) [ASTM D5798]

3.7.1 PHYSICAL PROPERTIES OF E85.

a) Specific Gravity 0.760 to 0.780

b) Reid Vapor Pressure 6-12 psia (42 to 83 kPa)

c) Flash Point (minimum) -20 degrees F (-30 degrees C)

d) Viscosity is 6.1x10-6 to 3.4x10-5 ft2/s (0.57 to 3.19 cSt)

e) Pour Point -212 degrees F (-100 degrees C)

3.7.2 SPECIAL PRECAUTIONS FOR E85. Due to the corrosiveness of E85, many common materials used with gasoline systems are not compatible with the handling and storage of alcohols (E85, or ethanol, is 85 percent ethyl alcohol). Zinc, brass, lead, aluminum, and lead based solder are several metals that become degraded by ethanol exposure. Other metals, including unplated steel, stainless steel, black iron and bronze seem to have acceptable resistance to ethanol corrosion. Certain nonmetallic materials that have been successfully used with ethanol include: Buna-N, Neoprene rubber, polyethylene, nylon, polypropylene, nitrile, Viton, and Teflon. Common nonmetallic materials degraded by ethanol are natural rubber, polyurethane, cork gasket material, leather, polyester-bonded fiberglass laminate, polyvinyl chloride (PVC), polyamides, and methyl-methacrylate plastics. Proper cleaning of existing tanks that are being converted for E85 storage is required, because E85's solvent properties loosen tank deposits. In ethanol dispensing a one-micron in-line filter is recommended for impurity/particle removal. The shelf life of E85 is approximately 60-90 days in some cases. At normal temperatures E85 is less explosive than gasoline, but E85 is more explosive at lower temperatures. Ethanol vapors have similar behavior to gasoline, but a lower vapor pressure. E85 is an electrical conductor, and is potentially carcinogenic. Provide a design that precludes disposing of E85 into storm or sanitary sewers.

3.8 ALTERNATIVE FUEL BIO-DIESEL (B20).

3.8.1 PHYSICAL PROPERTIES OF BIO-DIESEL. Biodiesel fuel B20 is a blend of petroleum diesel fuel meeting ASTM D975 and 100 percent (neat) biodiesel fuel meeting either ASTM D6751 or EN 14214, where the biodiesel content of the blended fuel is no more than 20 percent biodiesel by volume (B20). Biodiesel has physical properties very similar to conventional diesel.

a) Specific Gravity 0.870 to 0.890

b) Reid Vapor Pressure 0.0 psia (0.0 kPa) (maximum at 100 degrees F (38 degrees C))

c) Flash Point (minimum) 100 degrees F (38 degrees C) for D1, 126 degrees F (52 degrees C)

d) Viscosity at 104 degrees F (40 degrees C) 1.2 to 4.4 x 10-5 ft2/s (1.3 to 4.1 cSt.)

e) Pour Point 10 degrees F (-12 degrees C)

3.8.2 SPECIAL PRECAUTIONS FOR BIO-DIESEL. In dispensing Bio-Diesel, it is recommended that a 30-micron and a 10-micron in-line filter be used, in succession, as a primary and secondary means for impurity/particle removal. Bio-Diesel (B100) has good solvent qualities and will remove deposits from fuel systems. As a result, it may require more filter changes initially. One of the most commonly used blends of Bio-Diesel is B20. B20 has not been approved for use in combat or tactical vehicles or equipment. The usage of bio-diesel in other engines/vehicles has been reviewed by vehicle manufacturers and copies can be obtained at http://www.biodiesel.org/. B20 should be used within six months of manufacturer, because of the fuels shelf life. Users should be aware that a B20 blend will have increased viscosity requirements. Provide a design that precludes disposing of bio-diesel fuels into storm or sanitary sewers. For Air Force projects see ETL 03-04.

3.9 LIQUEFIED PETROLEUM GAS (LPG).

3.9.1 PHYSICAL PROPERTIES OF LPG. LPG is composed predominantly of propane and propylene with minor amounts of butane, isobutane, and butylene. It is odorless, colorless, and non-toxic. To reduce the danger of an explosion from undetected leaks, commercial LPG usually contains an odorizing agent which gives it a distinctive pungent odor. LPG is a vapor at atmospheric conditions. It is normally stored as a liquid at a storage pressure of 200 psia (1400 kPa). LPG has the following properties:

a) Freezing Point, degrees F (degrees C) -305 (-187)

b) Relative Density (Specific Gravity) 147 degrees API (0.588)

c) Vapor Pressure at 100 degrees F (38 degrees C), 175.8 (1212) psi (kPa)

d) Heat Content, Btu/lb (kJ/kg) 21,591 (50 221)

3.9.2 SPECIAL PRECAUTIONS FOR LPG.

a) Store LPG under pressure in appropriate pressure-rated tanks.

b) The potential for fire and explosion presents extreme hazards to life and property. Provide adequate relief venting and additional fire protection in accordance with NFPA 58

c) Provide tank spacing in accordance with the requirements of Chapter 10 of this UFC.

3.10 COMPRESSED NATURAL GAS (CNG).

3.10.1 PHYSICAL PROPERTIES OF CNG. Appendix A to NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems, defines certain CNG properties. Natural gas is a flammable gas. It is colorless, tasteless, and non-toxic. It is a light gas, weighing about two thirds as much as air. It tends to rise and diffuse rapidly in air when it escapes from the system. Natural gas burns in air with a luminous flame. At atmospheric pressure, the ignition temperature of natural gas mixtures has been reported to be as low as 900 degrees F (482 degrees C). The flammable limits of natural gas-air mixtures at atmospheric pressure are about 5 percent to 15 percent by volume of natural gas. While natural gas consists principally of methane, it also contains ethane, small amounts of propane, butane, and higher Hydrocarbons and may contain small amounts of nitrogen, carbon dioxide, hydrogen sulfide, and helium which will vary from zero to a few percent depending upon the source and seasonal effects. As distributed in the United States and Canada, natural gas also contains water vapor. This “pipeline quality” gas can contain 7 pounds or more of water per million cubic feet of gas (112 kg/106 m3). Some constituents of natural gas, especially carbon dioxide and hydrogen sulfide in the presence of liquid water, can be corrosive to carbon steel, and the corrosive effect is increased by pressure. The pressures used in CNG systems covered by NFPA 52 are substantial and well above those used in transmission and distribution piping and in other natural gas consuming equipment. As excessive corrosion can lead to sudden explosive rupture of a container, this hazard must be controlled. Pressures in CNG fueling stations are typically less than 5,000 psi (35 000 kPa).

3.10.2 SPECIAL PRECAUTIONS FOR CNG.

a) Provide venting for safety relief in areas where CNG is to be stored.

(1) CNG is a highly flammable substance. Therefore, in design of facilities, use the following precautions to prevent fires from becoming uncontrollable:

(2) Do not directly extinguish fires with water.

(3) Do not extinguish large fires.

(4) Allow large fires to burn while cooling adjacent equipment with water spray.

(5) Shut-off CNG source, if possible.

(6) Extinguish small fires with dry chemicals.

b) CNG is non-toxic but can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in a confined area without adequate ventilation.

c) Because of corrosion problems, water in Department of Transportation (DOT) certified tanks is limited to 0.5 pounds per million cubic feet (8 kg/10 6 m3).

3.11 OTTO FUELS. Information on OTTO fuels is not part of this discussion.

3.12 LUBRICATING OILS.

3.12.1 STEAM TURBINE LUBRICATING OILS [0-250] [MIL-PRF-17331]

a) For use in main turbines and gears, auxiliary turbine installations, certain hydraulic equipment, general mechanical lubrication, and air compressors.

b) Physical Properties:

(1) Flash Point: 400 degrees F (204 degrees C) minimum.

(2) Pour Point: 20 degrees F (-6 degrees C) maximum.

(3) Viscosity at 104 degrees F (40 degrees C), 80 to 104 x 10-5 ft2/s (74 to 97 x 10-6 m2/s).

3.12.2 LUBRICATING OILS [0-278], [MIL-PRF-9000]. For use in advanced design high-output shipboard main propulsion and auxiliary diesel engines using fuel conforming to MIL-DTL-16884.

3.12.3 SPECIAL PRECAUTIONS FOR LUBRICATING OILS. To pump the oil when the ambient temperature of the lubricating oil is less than 20 degrees F (11 degrees C) above the pour point temperature, heat the lubricating oil. At the pour point temperature, the oil becomes gel-like and is difficult to pump. Ensure the design does not allow the discharge of lubricating oil into storm or sanitary sewers.

3.13 HYDRAZINE - WATER (H-70) [MIL-PRF-26536].

3.13.1 PHYSICAL PROPERTIES OF H-70. This fuel is a mixture of 70 percent hydrazine and 30 percent water. It is a clear, oily, water-like liquid with a fishy, ammonia-like odor. It is stable under extremes of heat and cold; however, it will react with carbon dioxide and oxygen in the air. It may ignite spontaneously when in contact with metallic oxides such as rust.

3.13.2 SPECIAL PRECAUTIONS FOR H-70. Keep working and storage areas clean and free of materials that may react with hydrazine. Provide only stainless steel in areas where extended contact is possible. Areas where incidental contact is possible should be kept free of rust. Ensure the design does not allow the discharge of H-70 into storm or sanitary sewers.

3.14 FUEL ADDITIVES.

3.14.1 FUEL SYSTEM ICING INHIBITOR (FSII), HIGH FLASH, [MIL-DTL-85470] (DIETHYLENE GLYCOL MONOMETHYL ETHER (DIEGME))

a) Used in aviation turbine fuels to prevent the formation of ice crystals from entrapped water in the fuel at freezing temperatures. In addition, it has good biocidal properties, preventing growth of microorganisms in the fuel.

b) Avoid water entry/bottoms in storage tanks because the additive will dissolve in the water, reducing the concentration of additives left in the fuel.

c) Refer to fuel specification for more information.

d) Consult federal, state, and local regulations for appropriate disposal methods.

3.14.2 CORROSION INHIBITOR/LUBRICITY IMPROVER (CI), [MIL-PRF-25017]. A combination lubricity improver and corrosion inhibitor additive, procured under MIL-PRF-25017, is injected in all many aviation turbine fuels at the refinery in order to improve the lubricating characteristics of the fuel.

3.14.3 STATIC DISSIPATER ADDITIVE. Static dissipater additive (SDA) enhances safety during handling and flight by reducing static discharge potential in the vapor space above the fuel. SDA increases the conductivity of the fuel, thus decreasing the electrostatic charge relaxation time (the rate of which a charge dissipates or travels through the fuel) which decreases the potential for ignition from static charges. The actual proportion is in accordance with the specific fuel specification. For fuel system design purposes, assume a lower limit of 50 picosiemens per meter in the determination of relaxation requirements. SDA is added to all JP-8 (F-34; F-35; F-37). SDA is not added to JP-5 and F-76 or to Jet A/A-1 that is stored at some installations.

3.14.4 THERMAL STABILITY IMPROVER ADDITIVE (+100 ADDITIVE). Thermal stability additive (TSIA) enhances safety during handling and flight by increasing fuel tolerance to elevated temperatures. JP-8+100 (NATO F-37) is the aviation turbine fuel that utilizes TSIA.

4. PRODUCT SEGREGATION.

4.1 PRODUCT GRADES. Except as otherwise approved by the Owner, provide separate receiving, storage, and distribution systems for each product. Except as otherwise approved by the Owner, prevent misfueling (transferring a type of fuel other than the type intended) by using different size piping, valves, adaptors, nozzles, etc. The products to be segregated include:

a) Mogas.
b) Diesel fuel, including ultra-low sulfur diesel and distillate type burner fuels (No. 1, No. 2, and kerosene).
c) Aviation turbine fuel, separate systems for each grade.
d) Residual type burner fuels (No. 4, No. 5, and No. 6).
e) LPG.
f) CNG.
g) OTTO fuels.
h) E85.
i) Bio-diesel.

4.2 EXCEPTIONS. Designs for different products using the same piping may be approved for long receiving lines such as from a tanker or barge pier or a cross-country pipeline to a storage facility. Where such common use occurs, make provisions for receiving and segregating the interface between two products. Consider the use of pigs or break-out tanks to separate batches. Exceptions will not be approved for common systems to carry both clean and residual type fuels.

5. TRANSFER FLOW RATES. Table 4 shows the recommended range of design flow rates. In some cases, greater rates may be needed to meet the operational requirements of a particular facility.

Service[1]	Aviation Turbine Fuel	Diesel Fuel	Burner Fuel Oils	Mogas
Between storage tanks, gpm (m^3/hr)	600 to 1,200 (136 to 272)	600 to 1,200 (136 to 272)	600 to 1,200 (136 to 272)	600 to 1,200 (136 to 272)
Tank car unloading to storage (per car), gpm (m^3/hr)	300 to 600 (68 to 136)	300 to 600 (68 to 136)	300 to 600 (68 to 136)	300 (68)
Tank truck unloading to storage (per truck), gpm (m^3/hr)	300 to 600 (68 to 136)	300 to 600 (68 to 136)	300 to 600 (68 to 136)	300 to 600 (68 to 136)
Gravity receipt tank to storage gpm (m^3/hr)	600 (136)	600 (136)	600 (136)	600 (136)
Storage to tank truck/refueler loading (per truck), gpm (m^3/hr)	300 or 600 (68 or 136)	300 or 600 (68 or 136)	300 or 600 (68 or 136)	300 or 600 (68 or 136)
Delivery from direct fueling stations to aircraft, gpm (m^3/hr)	Varies[2]	N/A	N/A	N/A
Delivery from direct fueling stations to helicopters, gpm (m^3/hr)	Varies[2]	N/A	N/A	N/A
Between super tanker and storage, gpm (m^3/hr)	16,800 (3815)	16,800 (3815)	16,800 (3815)	16,800 (3815)
Between regular tanker and storage, gpm (m^3/hr)	7,000 (1590)	7,000 (1590)	7,000 (1590)	7,000 (1590)
Between barge and storage, gpm (m^3/hr)	2,800 (636)	2,800 (636)	2,800 (636)	2,800 (636)
To fleet oilers, gpm (m^3/hr)	3,500 (795)	3,500 (795)	N/A	N/A
To AOEs, gpm (m^3/hr)	7,000 (1590)	7,000 (1590)	N/A	N/A
To carriers, gpm (m^3/hr)	2,450 (556)	2,450 (556)	N/A	N/A
To average cruisers, gpm (m^3/hr)	700 (159)	1,400 (318)	N/A	N/A
To average destroyers, gpm (m^3/hr)	700 (159)	1,400 (318)	N/A	N/A
Storage to tank car loading (per car), gpm (m^3/hr)	300 or 600 (68 or 136)	300 or 600 (68 or 136)	300 or 600 (68 or 136)	300 or 600 (68 or 136)

[1] At dockside, deliveries from tankers should be assumed to be at a pressure of 80 to 100 psig (600 to 700 kPa), and deliveries to tankers to be at 60 psig (400 kPa). Rates to other ships are maximums based on fueling at sea capacities. Lesser rates for fueling at piers can be used if more practical. Loading rates are based on 40 psig (300 kPa) maximum per hose at ship connections.

Table 4

Design flow rates.

6. PHYSICAL SECURITY. Plan and design fuel facilities with the goal of protecting the fuels, storage, and transfer capability from enemy attack, terrorists, sabotage, fire, seismic activity, and other damaging influences. In high threat areas, more extensive protection may be required.

6.1 ANTITERRORISM AND PHYSICAL SECURITY.

6.1.1 PHYSICAL SECURITY PROGRAM. At a minimum, fuel support points, pipeline, pumping stations, and piers shall be designated and posted as Controlled Areas. Areas containing critical assets may be designated as a restricted area. Controlled and restricted areas are defined areas in which there are special restrictive measures employed to prevent unauthorized entry. Restricted areas may be of different types depending on the nature and varying degree of importance of the protected asset. Restricted areas must be authorized, properly posted, and shall employ physical security measures.

6.2 SECURITY FENCING. Unless otherwise directed by the Owner, provide security fencing around all petroleum facilities to ensure safety and inhibit sabotage, theft, vandalism, or entry by unauthorized persons. Install a 7-foot (2.1 m) fabric height fence of chain-link type with three-strand barbed wire outriggers on top or its equivalent.

7. MAINTAINABILITY CAPABILITIES. Provide adequate maintenance space around all equipment including:

a) Filter/separator and other filtration device maintenance access, particularly element removal. For vertical filtration devices provide stair and platform access to at least one side of each unit.
b) Manual valves, especially replacement of slips in double block and bleed tapered lift plug valves.
c) Adequate room and locations for the use of an intelligent pig launcher/receiver in all section of piping.

d) Meter reading and maintenance.

e) Control valves.

f) Pumps, including removal.

g) Instruments, especially those mounted on tank shells.

8. VOICE COMMUNICATIONS. Provide voice communications between separated areas such as receiving, dispensing, pump stations, and fuel storage areas to coordinate operations involved in fuel transfer.

9. OTHER COMMUNICATIONS.

9.1 DATA COMMUNICATIONS. Data communications systems shall be designed and accredited by designated accrediting authority or authorizing official in accordance with the applicable Telecommunications Industry Association (TIA) and Electronic Industries Association (EIA) documents. Coordinate with local Base Communications squadron where applicable.

9.2 FIRE ALARM COMMUNICATION. Fire alarm communications systems shall be coordinated with the Fire Department.

10. VAPOR RECOVERY. Provide vapor recovery where required by federal, state, and local regulations (40 CFR Part 60 Subpart XX).

11. WORKER SAFETY. Design facilities to comply with the most stringent of the Occupational Safety and Health Administration (OSHA) standards. Also, ensure that design complies with service-specific occupational safety and health criteria.

11.1 SAFETY SHOWERS AND EYEWASH FOUNTAINS. Safety showers and eyewash facilities are required in workshops, laboratories, pumphouses, fueling piers and other similar facilities. Fixed safety showers and eyewash facilities, or portable eyewash units, shall be installed at other locations where fuel is transferred to/from trucks, rail cars, and aircraft.

12. ELECTRICAL DESIGN.

12.1 AREA CLASSIFICATIONS. Classify all fuel facilities, except as modified herein, in accordance with API RP 500, NFPA 30, NFPA 70, and ANSI/IEEE C2. These practices may be modified where unusual conditions occur, where locations contain hazardous atmospheres classified other than Group D (as defined by NFPA 70), or where equipment malfunction may cause hazardous situations. Use sound judgment in applying these requirements. Specify a higher classification wherever necessary to maintain safety and continuity of service. Treat combustible liquids under pressure as flammable liquids. All piping and equipment including that connected to an atmospheric storage tank shall be considered pressurized. Ensure design is in accordance with the requirements designated in NFPA 70 for the specific division and class. Ensure equipment temperature class or operating temperature is in accordance with NFPA 70. Ensure that project drawings include hazardous area plans indicating extent and classification of areas. Drawings should provide dimensions indicating extent of classified areas and should include sections/elevations when required to fully convey the extent of the areas.

12.1.1 CLASS I, DIVISION 1. Class I, Division 1 locations include:

a) Outdoor locations and those indoor locations having positive mechanical ventilation that is within 3 feet (0.9 m) of the fill openings or vents on individual containers to which flammable liquids are being transferred. Provide alarm devices on all ventilation systems.
b) Outdoor locations within 5 feet (1.5 m) of open end of vents and openings on liquid fuel storage tanks extending in all directions.
c) Entire pit, sump, open trench, or other depression, any part of which is within a Division 1 or 2 location and is without mechanical ventilation.
d) Locations within and on exterior walls of open top spill containment structures including oil/water separators and spill containment boxes.

e) Locations at fuel dispensers.

f) Locations within 3 feet (0.9 m) of vent, extending in all directions, when loading a truck through the bottom connection.

g) All pump/filter houses handling liquid fuels.

h) Any area containing electrical equipment that is or may be exposed to atomized fuel and where the ambient temperature can at any time be above the flash point of the fuel.

12.1.2 CLASS I, DIVISION 2. Class I, Division 2 locations include:

a) Outdoor locations between 5 feet (1.5 m) and 10 feet (3 m) of the Division 1 zones at vents and openings, on liquid fuel storage tanks extending in all directions.

b) Entire pit, sump, open trench, or other depression, any part of which is within a Division 1 or 2 location and is provided with mechanical ventilation.

c) Outdoor locations within 3 feet (0.9 m) of the exterior surface of pumps, air relief valves, withdrawal fittings, meters, and similar devices that are located in pipelines handling liquid fuels under pressure. Class I, Division 2 locations extend upward 18 inches (450 mm) above grade level and within 10 feet (3 m) horizontally from any surface of the device.

d) Locations within and extending upward to the top of the dikes that surround aboveground tanks containing liquid fuels and within 10 feet (3 m), extending in all directions of the tank shell, ends, or roof.

e) Locations extending upward 18 inches (450 mm) above grade level within 15 feet (4.6 m) horizontally from any surface of open top spill containment structures including oil/water separators and spill containment boxes, whether installed indoors or outdoors.

f) Locations 25 feet (7.6 m) horizontally in all directions on pier side from portion of hull containing cargo and from water level to 25 feet (7.6 m) above cargo tank at highest point.

g) Area between 3 feet (0.9 m) and 10 feet (3 m) extending in all directions from vent when loading a truck. Also upward 18 inches (450 mm) above grade and within 10 feet (3 m) horizontally from the truck load connection.

12.1.3 NON-CLASSIFIED LOCATIONS. Non-classified locations include:

a) Outdoor locations having closed piping systems handling flammable or combustible liquids that have no pumps, air relief valves, withdrawal fittings, valves, screwed fittings, flanges, meters, or similar devices which create joints in piping.
b) Office buildings, boiler rooms, control rooms, and similar locations that are outside the limits of hazardous locations, as defined above, and are not used for transferring flammable or combustible liquids or containers for such liquids.
c) Areas in which flammable and combustible liquids are stored in accordance with NFPA 30, outside the limits of a classified location, and the liquids are not transferred.

12.2 ILLUMINATION. Illuminate all working areas for night operations to the minimum intensity recommended in Table 4 of API RP 540. Lighting design should also provide for road access on tall light posts to allow for lamp replacement. For facilities within the jurisdiction of the U.S. Coast Guard under 33 CFR Part 154, illuminate to the minimum intensity required by that regulation. Provide security lighting in accordance with UFC 3-530-01. If local or state regulations exist, follow the most stringent requirements.

12.3 GROUNDING AND BONDING. The following references apply to grounding and bonding systems:

a) ANSI/IEEE 142
b) NFPA 70
c) NFPA 77
d) NFPA 780
e) API RP 540
f) API RP 2003
g) ANSI/IEEE 1100
h) NFPA 407
i) UFC 3-575-01

12.3.1 GROUNDING REQUIREMENTS. Ground the following items in accordance with Article 250 of NFPA 70:

a) Motor, generator, and transformer frames.
b) Non-current-carrying metallic parts of electrical equipment and installations, such as enclosures for panelboards, switchgear, and motor control centers.
c) Metallic messengers of self-supporting cables.
d) Exposed conductive materials enclosing electrical conductors, such as metallic conduit, metallic tubing, metallic armoring, sheaths and shields, cable troughs, trays and racks, wireways, and busways.
e) Filter/separators and other filtration equipment.

12.3.2 CURRENT AND LIGHTNING PROTECTION. Provide lightning protection in accordance with NFPA 780 and local requirements. For fault current protection and lightning protection, ground the following items through ground rods or beds or bond to a grounded network. Provide ground for these items as required by the above references.

a) Fences.
b) Lightning arrestors and lightning shield conductors.
c) Operating mechanisms of overhead airbreak switches.
d) Canopies.
e) Aboveground storage tanks.

12.3.3 STATIC ELECTRICITY PREVENTION. To prevent the buildup static electricity, ground the following items directly through ground rods or beds or bond to a grounded network. Do not exceed 10,000 ohms of resistance to ground, unless otherwise stated. Do not bond dissimilar metals together.

a) Aboveground tanks, vessels, stacks, heat exchangers, and similar equipment not directly supported or bolted to a grounded supporting network.

b) Pipe and pipe support columns in accordance with the more stringent of NFPA 77 or below.

- Provide (minimum) 1 ground rod on pipe runs 100 feet (30 m) long or less unless the pipe is connected to a grounded source within the 100 feet (30 m).
- Provide (minimum) 2 ground rods on runs of pipe that exceed 100 feet (30 m), but are less than 300 feet (90 m) in length.
- Provide (minimum) 1 ground rod at intervals not exceeding 300 feet (90 m) on runs of pipe that are greater than 300 feet (90 m) in length.
- Parallel pipes may be bonded and common ground rods used, spaced in accordance with (1) through (3) above.

c) Aircraft direct fueling stations.

d) Hydrant pits.

e) Internal floating pans bonded to the storage tank shell.

f) Aboveground portions of electrically isolated piping at truck, rail, and marine loading and unloading stations.

12.3.4 INSTALLATION.

Isolate grounding systems for instrumentation, instrument control boards, and electronic equipment from all other ground systems. Additional grounding is not required for overhead electrical equipment bolted directly to grounded metallic structures. Where feasible, separate the conductor connecting a lightning rod to the grounding electrode from other grounding conductors. Route with a minimum of sharp bends and in the most direct manner to the grounding electrode. Do not use this electrode in lieu of grounding electrodes which may be required for other systems. This provision does not prohibit the required bonding together for grounding electrodes of different systems.

13. CATHODIC PROTECTION. Obtain the services of a National Association of Corrosion Engineers (NACE)-certified Corrosion Specialist or Cathodic Protection Specialist or a registered professional Corrosion Engineer to perform all cathodic protection design and testing.

13.1 TANKS. For all underground steel tanks and tank bottoms of aboveground vertical tanks, provide cathodic protection in accordance with API RP 651, 40 CFR Part 280, and UL 1746. Current tank design configuration electrically isolates the tank bottom from surrounding earth. Therefore, install cathodic protection between the liner and the tank bottom.

13.2 PIPING. For all carbon steel and stainless steel underground and underwater piping, provide cathodic protection in accordance with 40 CFR Part 280 for piping associated with underground storage tanks. For additional information on cathodic protection, refer to NACE SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems, and 49 CFR Part 195. Buried stainless steel corrodes and, therefore, must be cathodically protected.

13.2.1 SURGE ARRESTORS. Provide surge arrestors across all aboveground insulated flanges connected to belowground cathodically protected piping. Require surge arrestors to be designed for use with insulated flanges and for use in Class I, Division 1 areas. Provide covers over flanges to preclude dirt from degrading surge arrestors.

13.3 STRUCTURES. Obtain the services of a (NACE)-certified Corrosion Specialist or Cathodic Protection Specialist or a registered professional Corrosion Engineer to evaluate the need for cathodic protection on steel portions of fueling support facilities.

14. ENVIRONMENTAL PROTECTION.

14.1 GENERAL POLICY. It is usually the Owner's policy to design and construct fueling facilities in a manner that will prevent damage to the environment by accidental discharge of fuels, their vapors or residues. Designs must comply with national, state, and local environmental protection regulations that are in effect at a particular facility.

14.2 REGULATIONS.

14.2.1 WITHIN U.S.A. Within the jurisdiction of the United States, adhere to the following environmental protection regulations:

a) National Environmental Policy Act (NEPA), 42 USC 4321.
b) U.S. Coast Guard Regulations, 33 CFR Part 154.
c) Environmental Protection Agency Regulations, 40 CFR Part 60.
d) Environmental Protection Agency Regulations, 40 CFR Part 112.
e) Environmental Protection Agency Regulations, 40 CFR Part 122.
f) Environmental Protection Agency Regulations, 40 CFR Part 280.
g) Environmental Protection Agency Regulations, 40 CFR Part 281.
h) Department of Transportation Regulations, 49 CFR Part 195

14.2.2 OUTSIDE U.S.A.. At facilities in other countries, consult appropriate environmental directives. If tank is to be installed in a locale or state with more stringent criteria, use the more stringent criteria. Follow the most stringent of local regulations.

14.3 TRANSFER OF FUEL AT PORTS.

14.3.1 BULK TRANSFER. Compliance with 33 CFR Part 154 is required for each fixed facility capable of transferring fuel in bulk to or from a vessel with a capacity of 10,500 gallons (39,700 L) or more. These facilities are required to have an operations manual approved by the Captain of the Port. In the operations manual, include the requirement for the following systems:

a) Hose assemblies
b) Loading arms
c) Closure devices
d) Monitoring devices
e) Small discharge containment
f) Discharge removal
g) Discharge containment equipment
h) Emergency shutdown
i) Communications
j) Lighting

14.3.2 VAPOR COLLECTION. For facilities that collect vapor from vessel cargo tanks, ensure that the requirements of 40 CFR Part 60 for the following items are met:

a) Vapor line connections
b) Vessel liquid overfill protection
c) Vessel vapor overpressure and vacuum protection
d) Fire, explosion, and detonation protection
e) Detonation arrestors, flame arrestors, and flame screens
f) Inerting, enriching, and diluting systems
g) Vapor compressors and blowers
h) Vapor recovery and vapor destruction units

14.4 AIR QUALITY CONTROL.

14.4.1 DESIGN REQUIREMENTS. Regulatory requirements pertaining to air quality control will vary according to locality and to type and size of the petroleum vapor source. Petroleum storage and dispensing facilities are common sources of air pollution. Their emissions are typically restricted through requirements in state and local regulations. Federal regulations (40 CFR Part 60 Subparts Kb and XX) may also apply depending on the product handled and size of the tank or facility being constructed.

14.4.2 ABOVEGROUND STORAGE TANKS. Federal regulation 40 CFR Part 60 Subpart Kb requires that tanks used for the storage of fuel with a design capacity greater than 19,000 gallons (72,000 L) having a true vapor pressure greater than 0.75 psia (5. kPa) at operating temperature must be equipped with either: 1) a fixed roof in combination with an internal floating pan; 2) an external floating roof equipped with a dual seal closure device between the wall of the tank and the roof edge; or 3) a closed vent system designed to collect all volatile organic compound (VOC) vapors and gases discharged from the tank and a control device designed to reduce VOC emissions by 95 percent or greater. It is the design intent that most vertical aboveground tanks will have internal floating pans and that vapor recovery will be used only if required by federal, state, or local regulations for the type of fuel and type of tank proposed, except as specifically required by other regulations.

14.4.3 TRUCK AND RAIL LOADING FACILITIES. Tank truck and tank car loading facilities constructed or modified after December 17, 1980 which load an annual average of more than 20,000 gallons (76,000 L) per day of fuel having a true vapor pressure (TVP) of 0.75 psia (5 kPa) or greater must discharge the vapors resulting from such operations into a closed system. Ensure this system leads to a vapor recovery or disposal system which is capable of removing 95 percent of the petroleum vapor before final discharge into the atmosphere. Equip bulk gasoline terminals (handling fuels with TVP > 4.003 psia or 27.60 kPa) with a vapor collection system designed to collect total organic compound (TOC) vapors displaced from tank trucks during loading. Emissions from the vapor control system due to loading must not exceed 35 mg of TOC per liter of gasoline loaded. For facilities with an existing vapor processing system, the TOC emissions must not exceed 80 mg of TOC per liter of gasoline loaded (40 CFR Part 60 Subpart XX).

14.4.4 PERMIT REQUIREMENTS. Air quality permits are typically required for the construction of petroleum storage and dispensing facilities. It is essential for designers to review regulatory requirements to ensure incorporation of proper environmental controls. State and local regulations are primary sources for air quality requirements, but for particularly large facilities, it is also beneficial to confer with the EPA regional office. The permit review and air quality controls will further depend on whether the construction site is located in an attainment or non-attainment area for ozone. Different permit programs apply in these areas, but they can both yield strict control requirements depending on the air quality of the area. An emissions offset analysis may be necessary before any construction permit can be granted. This analysis will require and demonstrate a reduction in VOC emissions from other sources in the locality where the new source construction is to take place. The offset can be obtained by providing new or better controls or otherwise decreasing emissions from an existing source.

14.5 WATER QUALITY CONTROL.

14.5.1 DESIGN REQUIREMENTS. Protection of the natural waters against pollution from discharge of petroleum is achieved by complying with federal, state, and local regulations.

14.5.2 STORMWATER DISCHARGE. A National Pollutant Discharge Elimination System (NPDES) Permit, 40 CFR Part 122, may be required for the discharge of stormwater. A review of federal, state, and local stormwater regulations is required prior to design and construction. Discharge of stormwater includes:

a) Controlled drainage from storage tank areas with impermeable diked enclosures or drainage systems leading to impoundments.
b) Drainage from treatment systems.
c) Drainage from facility transfer operations, pumping, and tank car and tank truck loading/off-loading areas.
d) Drainage from equipment/vehicle maintenance areas.

14.5.3 SPILL PREVENTION CONTROL AND COUNTERMEASURES (SPCC) PLAN. The minimum requirements for spill prevention in the United States are contained in 40 CFR Part 112. It requires the preparation of a SPCC Plan for facilities that may discharge fuel into navigable waters of the United States. Specific design features are necessary to meet the SPCC objectives at all facilities. The SPCC plan must demonstrate that the fuel facility will be designed and constructed in a manner that will prevent spillage, and should such a spillage occur, prevent the spill from leaving the property and entering a waterway. Review API Bulletin D16 to assist with conformance to regulations. Refer to 33 CFR Part 154 for small discharge containment.

14.5.4 MEETING SPCC PLAN OBJECTIVES. 40 CFR Part 112 allows SPCC Plan objectives to be met by either spill containment or spill treatment. For facilities covered by this UFC only spill containment systems are acceptable. Spill treatment systems shall not be allowed to meet SPCC requirements unless required by regulations. Provide treatment systems (oil/water separators) to treat the discharge from spill containment systems only when required by federal, state, or local regulations, or by Service Headquarters. Typical facilities requiring a spill containment system are fuel storage tanks, tank truck loading/off-loading/parking areas, and tank car loading/off-loading areas.

14.5.5 SPILL CONTAINMENT SYSTEMS. The SPCC Plan objectives expressed in 40 CFR Part 112 shall be met with impermeable spill containment system designed to prevent a spill from leaving the property unless a spill treatment system is required by federal, state, or local regulations, or by Service Headquarters. See the individual chapters of this UFC for requirements.

14.5.6 SPILL TREATMENT SYSTEMS (OIL/WATER SEPARATORS). Treatment systems (oil/water separators) may not be used to meet the requirements of 40 CFR Part 112 unless required by federal, state, or local regulations, or as determined by the appropriate regulatory agency. Do not provide oil/water separator to treat the discharge from spill containment systems (e.g. secondary containment dikes, tank truck parking areas, loading/off-loading facilities), unless specifically required by regulations. Select either a conventional rectangular API type gravity oil/water separator or one with inclined parallel plates. Where possible, design the separator as a rectangular vessel with a fully open top with lid for ease of inspection and cleaning.

a) Design and construct the separator in accordance with the following:

- ACI 350.4R-04, Design Considerations for Environmental Engineering Concrete Structures.

b) Consider the following items in sizing the oil/water separator:

- Anticipated inlet flow rate of a 5-year, 1-hour duration storm event.
- Type of fuel.
- Specific gravity and viscosity of fuel.
- Specific ambient and product temperature ranges.
- Product storage capacity required.
- Possible contaminants present.
- Operating parameters are intermittent or continuous.

c) Require parallel plates to be constructed from non-oleophilic materials such as fiberglass. Arrange the plates in either a downflow or crossflow mode so that the oil collects in the high point of the corrugations and rises to the top without clogging from settleable solids.

d) Consider installing a retention basin upstream of the oil/water separator. This would allow solids to settle prior to reaching the oil/water separator and allow the option of either releasing the stormwater to the oil/water separator or to an appropriate stormwater collection system.

14.5.7 LEAK DETECTION. As required by federal, state, and local regulations install leak detection on aboveground tank bottoms, underground storage tanks, and underground piping.

14.5.8 WASTEWATER DISPOSAL. Provide a holding tank for wastewater. Wastewater is any water which has been in contact with significant quantities of fuel such as water collected from tank sumps, equipment drains, and equipment sumps. Ensure that tank construction conforms to federal, state, and local environmental requirements. Provide a means to remove wastewater for off-site disposal.

14.5.9 DEWATERING. Where dewatering for construction purposes is necessary and contamination is suspected, test the groundwater prior to construction to determine the extent of contamination. If the groundwater is, or has the potential to be, contaminated with petroleum products, review federal, state, and local regulations for acceptable treatment methods. Permits may be required for treatment and/or disposal of the water.

14.6 ABOVEGROUND STORAGE TANKS.

14.6.1 DESIGN REQUIREMENTS. Aboveground storage tanks may be single wall, double wall, horizontal, vertical, protected, or fire resistant as discussed in Chapter 8. There is not a single federal regulation that specifically addresses aboveground storage tanks similar to 40 CFR Part 280 that solely governs underground storage tanks. The majority of the federal environmental design requirements come from either 40 CFR Part 112 or 29 CFR Part 1910.106. These regulations include environmental related requirements for:

a) Diking and drainage.
b) Flooding.
c) Corrosion Protection.
d) Inspections, Tests, and Records.
e) Brittle Fracture Analysis.

The designer must consult the latest version of these regulations and comply with all federal, state, and local regulations.

14.6.2 OTHER REQUIREMENTS. If a tank is to be installed in a locale or state with more stringent criteria, use the more stringent criteria. If tank is to be installed in a foreign country, follow the most stringent of local regulations.

14.7 UNDERGROUND STORAGE TANKS.

14.7.1 DESIGN REQUIREMENTS. All underground and cut and cover storage tanks are to be double wall type. Single wall underground storage tanks are not allowed. For underground storage tanks larger than 110 gallons (416 L), the following are required by 40 CFR Part 280:

a) Corrosion protection for tanks and associated underground piping.
b) High level alarm.
c) Spill and overfill protection.
d) Release detection.

14.7.2 OTHER REQUIREMENTS. If a tank is to be installed in a locale or state with more stringent criteria, use the more stringent criteria. If tank is to be installed in a foreign country, follow the most stringent of local regulations.

15. FIRE PROTECTION.

15.1 GENERAL REQUIREMENTS. Design all petroleum fuel storage, handling, transportation, and distribution facilities with full consideration of the hazardous nature of the fuels to be handled and their vapors.

15.2 PROTECTION OF ABOVEGROUND STORAGE TANKS.

15.2.1 TANK EXTERIOR FIRE PROTECTION WATER SYSTEMS. Provide fire protection water mains, hydrants, valves, pumps, and application devices to permit control of brush and grass fires and cooling of storage tanks in the event of a fire exposure. Provide a minimum of two hydrants. Locate hydrants and valves outside of diked areas and accessible to fire department pumper vehicles. Locate hydrants so that protected exposures can be reached through hose runs not exceeding 300 feet (90 m).

15.2.2 TANK INTERIOR FIRE PROTECTION SYSTEMS. Tanks containing Class I flammable fuels or mission-critical Class II combustible fuels, such as JP-8, shall be equipped with a full contact, aluminum honeycomb floating pan. Other Class II fuels require a floating pan if the tank does not comply with the spacing and diking requirements of this UFC. Tanks storing mission-critical Class III fuels, such as JP-5 and diesel fuel marine (F-76), if located in hot (desert-like) climate, also require a floating pan to eliminate the fuel/air interface. A single slotted stilling well, that penetrates the floating pan, has a maximum diameter of 10 inches (250 mm) and is used for the automatic tank gauge system, is allowed to be provided without a vapor sleeve (bellow). The slotted well used for manual measurements shall be equipped with an approved floating plug. The 8 inch (200 mm) slotted stilling well for the automatic tank gauge system level sensing device and the 6-inch (150 mm) minimum nominal size slotted stilling well for the automatic tank gauge system water probe are allowed to be provided without floating plugs.

15.3 Fire Protection of Pumping Facilities. Fuel pump houses where over 50% of the fuel hydrant pumping capacity is in one fire area and that area is enclosed shall be protected with an automatic fire suppression system, such as a fire sprinkler system, foam water fire suppression system, etc. Fuel pump houses where over 50% of the transfer pumping is in one (enclosed) fire area shall be protected with an automatic fire suppression system, foam water fire suppression system, etc. Readily available mobile pumping equipment with 50% of the total pumping capacities can be used to eliminate need for a fire suppression system. Where mobile pumping option is selected, provide connection points in the fuel system for temporary mobile pumps in the event that a pump facility is lost. Pump pads and pump shelters do not need fire suppression systems.

15.3.1 PUMPHOUSES, PUMP SHELTERS, AND PUMP PADS. A pump pad has no roof or canopy. A pump shelter has a roof, at least one wall completely open with adequate fire department access, and a total open wall area of 50 percent or more. A pumphouse has a roof, and a total open wall area of less than 50 percent.

15.3.2 FIRE DEPARTMENT ACCESS. Provide adequate fire department access for all pumping facilities. Provide fire department access to all open sides of a pumphouse or pump shelter. Provide fire department access to at least two sides of a pump pad.

15.4 FIRE PROTECTION OF UNDERGROUND VERTICAL STORAGE TANKS.

15.4.1 FIRE PROTECTION WATER SYSTEMS. Provide fire protection water mains, hydrants, valves, pumps, and application devices to permit control of brush and grass fires and for cooling of the aboveground piping and equipment associated with underground vertical storage tanks in the event of a fire exposure. Provide a minimum of two hydrants. Locate hydrants so that protected exposures can be reached through hose runs not exceeding 300 feet (90 m). Comply with all requirements for water supply except that the minimum fire flow rate and minimum duration per hydrant shall be calculated using the smallest diameter of aboveground POL tank.

15.5 PROTECTION OF TANK TRUCK AND TANK CAR FACILITIES. For facilities (such as loading stands) used for the transfer of flammable or combustible liquids to or from tank truck, refuelers, tank cars, drums, or other portable containers, provide portable dry chemical extinguishers of appropriate size, number, and location for the exposure.

15.6 PROTECTION OF AIRCRAFT FUELING FACILITIES. Provide fire fighting equipment in accordance with local requirements. Refer to NFPA 407.

15.7 PROTECTION OF FUEL TESTING LABORATORY. Laboratories shall comply with the general facility requirements of NFPA 45 Laboratories using Chemicals.

15.8 PROTECTION OF SUPPORT FACILITIES. Comply with local requirements for fire protection of support facilities.

15.9 PROTECTION OF FUEL PIERS. Provide protection for piers with fixed piping systems used for the transfer of flammable or combustible liquids in accordance with the following:

a) UFC 3-600-01
b) UFC 4-1501, UFC 4-150-02, and UFC 4-150-06

c) NFPA 30

d) NFPA 30A

e) NFPA 307 (If liquids are handled in bulk quantities across general purpose piers and wharves.)

15.9.1 FIRE PROTECTION WATER SYSTEMS. Use fire water systems with hydrants located so that vessels alongside can be reached through hose lines not longer than 300 feet (90 m). Determine total water demands for piers based on an extra hazard occupancy classification.

16. EMERGENCY SHUT-DOWN. Emergency fuel shutoff (EFSO) pushbuttons are required wherever there is a potential for an accidental release. EFSO pushbutton stations are required near tanks (outside of berm area), tank car and tank truck loading and off-loading, refueler truck fillstands, aircraft direct fueling stations, pumps, fuel piers, etc. All pumps shall shut down and all motor operated valves shall close when an EFSO pushbutton is pressed. An alarm shall be annunciated at the master alarm panel. Operation of all pumps and valves shall be discontinued until all EFSO pushbuttons are cleared and the alarm acknowledged. Off-base pipeline receipt and tanker receipt may be exceptions; contact Service Headquarters for direction.

17. ELECTROMAGNETIC RADIATION HAZARDS. Potential ignition hazards to petroleum storage, dispensing, or handling facilities may be created by emissions from electromagnetic devices such as radio and radar. Beam/signal strength has been known to cause ignition of flammable vapor-air mixtures from inductive electrical heating of solid materials or from electrical arcs or sparks from chance resonant connections. For additional information, refer to NFPA 407. Incorporate the following specific precautions and restrictions in the design of petroleum fuel facilities:

a) Locate the radio transmitting antennas as far as practically possible from fuel storage or transfer areas.

b) Do not locate the fuel storage or transfer facilities closer than 300 feet (90 m) from aircraft warning radar antennas.
c) Do not locate fuel storage or transfer facilities closer than 500 feet (150 m) from airport ground approach and control equipment.
d) Do not locate fuel storage or transfer facilities closer than 300 feet (90 m) from areas where airborne surveillance radar may be operated.
e) Do not locate fuel storage and transfer facilities closer than 100 feet (30 m) from airport surface detection radar equipment.

18. IDENTIFICATION. Identify all pipelines and tanks as to product service by color coding, banding, product names, local designation requirements, and directions of flow.

a) Mark valves, pumps, meters, and other items of equipment with easily discernible painted numbers or numbered corrosion-resistant metal or plastic tags attached with a suitable fastener. Ensure numbers correspond to those on the schematic flow diagrams and other drawings for the installation.
b) Mark tanks with easily discernible painted numbers and letters indicating the following in addition to the requirements stated in MIL-STD-161: Tank number, Facility number, “No Smoking” on class 1 tanks, and “Confined Space” on Roof Manhole/Ladder Hatch
c) Mark tanks in accordance with NFPA 704.

19. ANTISTATIC DESIGN. Consider static build-up in the design. Refer to CRC Report No. 346 and No. 355 and API RP 2003. Because of the many variables involved, such as properties of fuels and geometry of equipment layouts, no specific limits are established for design factors such as flow velocities.

19.1 PIPING INLET CONNECTIONS. Design connections to tanks for reduced velocity and to prevent splashing by use of diffusers. Fuel products are not permitted to free fall under any circumstances. Position inlet as close to the tank floor as possible to limit free fall.

19.2 ENCLOSED VAPOR SPACES. Spaces above flammable or combustible Hydrocarbons in tanks or other liquid containers must not have any pointed projection or probes which could be focal points for static electricity discharges.

19.3 FILTER/SEPARATORS. The heaviest electrostatic charges are usually developed in filtering elements of this equipment. The design should attempt to reduce such charges before fuel is transferred into storage tanks, vehicle tanks, or any equipment containing vapor spaces.

a) By means of residence time in piping or in a relaxation tank, provide a minimum of 30 seconds relaxation time between this equipment and discharging into a tank or vehicle. The only aviation turbine fuel currently in the inventory that requires this minimum relaxation time are JP-5, JPTS and other aviation turbine fuels that do not contain SDA.

b) Relaxation time is not required for projects handling only fuels containing a static dissipator additive that provides a conductivity level greater than 50 conductivity units at the fuel temperature of the operations. Examples of this are JP-4 and JP-8.

c) Provide a means for slow filling, to prevent static discharge when first filling empty filter-separator vessels.

19.4 AIRCRAFT DIRECT FUELING STATIONS. JP-5 requires a 30-second residence time in the piping or in a relaxation tank after flowing through filtration and before being discharged into the aircraft to allow separate charges generated by the filtering elements to recombine and neutralize themselves. Where possible, design the piping layout to provide the required 30-second relaxation time without use of a relaxation tank.

19.5 TRUCK BOTTOM LOADING. Provide facilities only capable of bottom loading of trucks. Facilities that routinely handle trucks that are not capable of bottom loading should obtain approval for the addition of top loading capability from the appropriate authority. Refer to NFPA 77 and API RP 2003 for additional information and requirements.

20. OPERATION AND MAINTENANCE DOCUMENTATION.

20.1 EQUIPMENT OPERATION AND MAINTENANCE DOCUMENTATION. In all construction and procurement contracts, require operation and maintenance data for pieces of equipment which require maintenance and/or which require setting, adjusting, starting, stopping, calibrating, and similar operational activities.

20.2 OPERATION AND MAINTENANCE SUPPORT INFORMATION (OMSI). An OMSI for all new facilities is required. The determination to include a requirement for a complete OMSI for new facilities or a major rehabilitation will be made by the appropriate authority.

21. PROTECTION AGAINST SEISMIC ACTIVITY. Design fuel facility buildings and structures for seismic requirements in accordance with appropriate codes and regulations. Design aboveground vertical storage tanks in accordance with API Std 650, Appendix E. Analyze flexible aboveground pipelines using techniques to account for harmonic response.