



AEROSPACE RECOMMENDED PRACTICE

ARP5789™

REV. A

Issued 2006-01
Reaffirmed 2011-11
Revised 2022-01

Superseding ARP5789

Aviation Fuel Facilities

RATIONALE

This SAE Aerospace Recommended Practice contains general criteria for the planning, design, and construction of military and commercial ground based aviation fueling facilities that receive, store, distribute, and dispense liquid aviation turbine fuels at airports. Its purpose is to provide a description of practices that are commonly recognized throughout the industry as proving beneficial in the planning, design, and construction of aviation fuel systems at airports.

FOREWORD

The purpose of any aviation fueling system is to safely deliver clean, dry, on specification fuel to an aircraft. As is true for any type of system, there are peculiarities inherent to handling aviation fuels that are not readily apparent to anyone who does not design, build, or use these systems regularly. Aviation fueling systems represent a barely measurable percentage of the overall construction industry; there are therefore very few companies or individuals who are aware of these peculiarities. With both the commercial airlines and the military going through a protracted cycle of downsizing and outsourcing, the portion of the industry that pays for and is ultimately responsible for these systems is losing many of its most experienced personnel. The purpose of this guide is to provide key individuals who are responsible for aviation fuel facilities an overview of general practices which have proven beneficial in planning, design, and construction.

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1. SCOPE

This document contains general criteria for the planning, design, and construction of military and commercial ground based aviation fueling facilities that receive, store, distribute, and dispense liquid aviation turbine fuels at airports to both fixed and rotary wing aircraft.

1.1 Purpose

The purpose of this document is to provide a description of practices that are commonly recognized throughout the industry as proving beneficial in the planning, design, and construction of aviation fuel systems at airports.

1.2 Field of Application

This document is intended for use with airport facilities that handle common aviation turbine fuels including Jet A, Jet A-1, F-24, Jet B, JP-5, and JP-8. It is not intended for:

- a. Portable or temporary systems such as military tactical systems
- b. Mobile equipment such as hydrant carts or tank trucks
- c. Retail or consumer aviation fueling facilities
- d. Any facility with gasoline whether aviation or motor vehicle type
- e. Military aircraft facilities with special or uncommon fuels such as JP-4, JP-7, JP-10, and JPTS

1.3 Selecting Design Engineers, Project Managers, and Contractors

The selection process should include qualification criteria that include, at a minimum, the following:

- a. Firms should have experience in fuel facilities equal to the current project in value and complexity.
- b. Firms should have experience in the same types of facilities being designed and constructed.
- c. The project personnel assigned to the project should be the individuals with the actual experience described above.
- d. Other unique experience factors as determined by the Owner.

1.4 Limitations

- 1.4.1 This document is not mandatory and does not replace regulatory requirements. It is meant to be complementary to other approved codes and regulations applicable to fuel system planning, design, and construction, whether statutory or in general use. It does, however, identify practices that are commonly recognized throughout the industry as proving beneficial in use within the aviation fueling industry.
- 1.4.2 This document is intended to apply to new facilities and retrofitting existing facilities.
- 1.4.3 This document presents a basic outline of the essential elements of an aircraft fuel handling system. It will not give complete details of any systems or equipment.
- 1.4.4 This document is not intended to suggest or treat any property, equipment, or technology in a preferential manner.
- 1.4.5 Numerical setpoints given in this document are typical and are presented for demonstration purposes only. They are not prescriptive. The actual setpoints shall be prescribed by the Engineer.

1.5 Military Fueling Systems

1.5.1 Purpose built military aircraft fueling systems differ from commercial systems even though military aircraft will use a commercial system when necessary. Military systems typically follow standard designs. Major factors which cause the differences between military and commercial systems include:

1.5.1.1 Additives and Filtration

Military fuels always contain additives. Jet A, JP-5, and JP-8 fuel are usually received at the military installation with an additive package consisting of fuel system icing inhibitor (FSII) and a corrosion inhibitor/lubricity improver (CI). JP-8 also includes a static dissipater additive (SDA). In some systems, the fuel arrives as un-additized Jet-A or Jet A-1 and is additized at the site either during or after it is received. Jet-A plus additives is F-24. Receipt filtration is normally by filter/separators conforming to EI SPEC 1581. A variety of receipt pre-filtration options are available depending on contaminants such as water or particulate that may be in the fuel. Clay filtration is not used because it strips the fuel of the additives.

1.5.1.2 Fuel Thermal Stability

Fuel thermal stability is critical to military aircraft since they use fuel as a coolant and heat sink for avionics, air conditioning, and other functions that may drive the fuel temperature to the point that it begins to break down. Since fuel received may be at the minimum allowable thermal stability, military systems are designed to prevent further degradation. Military systems use coatings, plating, aluminum, and stainless steel to minimize contact with ferrous materials from receipt to issue.

1.5.1.3 Low Daily Throughput with High Peak Demand Requirements

Military systems are typically designed for a maximum flow rate of 2400 to 3000 gpm (151 to 189 L/s). Normally, this rate is experienced during military peak demand operations. During normal operations, flow rates may be much lower causing conflicts between the need to maintain a minimum velocity of 7 ft/s (2.1 m/s) while preventing pressure surges during high flow rates. To minimize surges, systems are designed in a loop that circulates fuel from the storage tank through the loop and back to the storage tank. By controlling pumps, a minimum amount of fuel is returned to the tanks. All systems require a surge analysis and on occasion surge arrestors. Where higher flow rates are required, multiple systems are installed.

1.5.1.4 Defuel Capability

To maximize the cargo carrying capacity of military aircraft, fuel is often removed so more cargo can be added. Additionally, fuel must be removed for certain maintenance functions to be performed. Defueling at commercial facilities can be into a fuels maintenance dock or into a truck. At many military facilities, due to the large fuel loads in certain military aircraft, hydrant fueling systems are designed to both fuel and defuel aircraft through the hydrant. Normally this requires a diaphragm operated hydrant control valve in the pit that is larger than the valves used in commercial systems and requires a larger hydrant pit.

1.5.1.5 Standardization

Military systems are designed for minimum maintenance due to manning limitations and are standardized to minimize the learning curve for replacement technicians and augmentees deployed during contingencies.

1.5.1.6 Tank Fire Protection

Because of the high cost of maintaining Aqueous Film Forming Foam (AFFF) fire protection systems over the life of a tank, and because AFFF product release is generally treated as hazardous, military fire experts have stopped requiring such systems for fire protection except where directed otherwise by the Owner or Authority Having Jurisdiction. Instead they require a honeycomb type floating pan that limits fire exposure to the rim area. The internal pans are equipped with rim seals to also minimize vapor loss and preclude debris from entering the fuel.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-00001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org

AS5877 Detailed Specification for Aircraft Pressure Refueling Nozzle

2.1.2 ANSI and ASME Publications

ANSI Accredited Publications are available online at <http://webstore.ansi.org/> ASME publications are available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org

ANSI B16.104 Control Valve Seat Leakage

ANSI/ASME B31.3 Chemical Plant and Petroleum Refinery Piping

ASME Boiler and Pressure Vessel Code

2.1.3 API and IP Publications

Available from API, 1220 L Street, NW, Washington, DC 20005-4070, Tel: 202-682-8000, www.api.org

2003 MPMS Manual of Petroleum Measurement Standards

SPEC 5L Specification for Line Pipe

SPEC 6D Specification for Pipeline Valves, End Closures, Connectors and Swivels

STD 607 Fire Tests for Soft-Seated Quarter-Turn Valves

STD 609 Dimensional Standard for Butterfly Valves

STD 610 Centrifugal Pumps for Refinery Service

STD 650 Welded Steel Tanks for Oil Storage

STD 653 Tank Inspection, Repair, Alteration, and Reconstruction

STD 2000 Venting Atmospheric and Low-Pressure Storage Tanks (Methods for calculating vent sizes on tanks)

2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

A105 Forgings, Carbon Steel, for Piping Components

A106	Seamless Carbon Steel Pipe for High-Temperature Service
A234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
A333	Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service
D1655	Standard Specification for Aviation Turbine Fuels
D6615	Standard Specification for Jet-B Wide Cut Aviation Fuel
D4021	Glass Fiber-Reinforced Polyester Underground Protection Storage Tanks

2.1.5 Airlines for America (A4A) Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

ATA SPEC 103	Standards for Jet Fuel Quality Control at Airports
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2.1.6 CRC Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org

CRC 663	Handbook of Aviation Fuel Properties
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2.1.7 EI Publications

Available from the Energy Institute, 61 New Cavendish St, Marylebone, London W1G 7LP, United Kingdom, Tel: +44 (0)207 467 7100, www.energyinst.org.

1529	Aviation Fueling Hose and Hose Assemblies
SPEC 1581	Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators
1583	Specifications and Qualification Procedures for Aviation Jet Fuel Monitors
1584	Four-inch Aviation Hydrant System Components and Arrangements
1588	Laboratory Tests and Minimum Performance Levels for Aviation Fuel Water Barrier Filters
1590	Specifications and Qualification Procedures for Aviation Fuel Microfilters

2.1.8 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov www.faa.gov.

Advisory Circular 150/5230-4	Aircraft Fuel Storage, Handling and Dispensing at Airports
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2.1.9 ICC Publications

Available from ICC, 5203 Leesburg Pike, Suite 600; Falls Church, VA 22041, Tel: 888-422-7233, www.iccsafe.org

UBC	Uniform Building Code
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2.1.10 NEMA Publications

Available from National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, VA 22209, Tel: 703-841-3200, www.nema.org.

NEMA	Classifications
MG1	Motors and Generators

2.1.11 National Fire Protection Agency Publications

Available from NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

11	Standard for Low, Medium, and High Expansion Foam
24	Installation of Private Fire Service Mains and Their Appurtenances
30	Flammable and Combustible Liquids Code
70	National Electrical Code
77	Static Electricity
407	Aircraft Fuel Servicing (Includes EFSO station requirements)
415	Aircraft Fueling Ramp Drainage
418	Standard for Heliports
780	Installation of Lightning Protection Systems

2.1.12 Steel Tank Institute Publications

Available from Steel Tank Institute, 944 Donata Ct., Lake Zurich, IL 60047, Tel: 847-438-8265, www.steeltank.com.

ACT 100	Steel/FRP Composite Tank
ACT 100U	Steel/Urethane Coated Tank
STI P3	Cathodically Protected Steel Tank

2.1.13 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

58	Steel Underground Tanks for Flammable and Combustible Liquids
142	Steel Aboveground Tanks for Flammable and Combustible Liquids
1316	Glass Fiber Reinforced Plastic Underground Storage Tanks
1746	External Corrosion Protection Systems for Steel Underground Storage Tanks
2085	Protected Aboveground Tanks for Flammable and Combustible Liquids

2.1.14 U.S. Government Publications

Copies of these documents are available online at <http://quicksearch.dla.mil>.

40 CFR 112 Oil Pollution Prevention

MIL-DTL-5624 Turbine Fuels, Aviation, JP-4, JP-5, and JP-5/JP-8 ST

MIL-PRF-25017 Inhibitor, Corrosion, Fuel Soluble

MIL-DTL-83133 Turbine Fuels, Aviation, Kerosene Types, NATO F-34 (JP-8), and NATO F-35

2.2 Related Documents

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 CSA Publications

Available from CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3, Tel: 416-747-4000, www.csa-international.org.

B836-00 Storage, Handling, and Dispensing of Aviation Fuels at Aerodromes

2.2.2 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

UFC 3-460-1 Petroleum Fuel Facilities

2.3 Definitions, Symbols, and Terminology

ADDITIVE: Chemical added in minor proportions to fuels or lubricants to create, enhance, or inhibit selected properties; example, fuel system icing inhibitor (FSII).

AFFF: Aqueous film forming foam.

AIRCRAFT PARKING AREA: Location designated for aircraft parking or staging.

AMBIENT: Encompassing on all sides, as temperature.

ANODE: The positively charged electrode of an electrolytic cell.

ANSI: American National Standards Institute.

ANSI CLASS: The pressure-temperature rating of a flange, flanged fitting, or flanged valve. For the purposes of this document, an ANSI Class 150 flange has a pressure rating of 275 psig at 100 °F (1896 kPa at 37.7 °C); an ANSI Class 300 flange has a pressure rating of 740 psig at 100 °F (5102 kPa at 37.7 °C).

AOA: Airport Operations Area.

API: American Petroleum Institute.

APRON OR RAMP: A defined area on an airport or heliport intended to accommodate aircraft for the purposes of parking, loading and unloading passengers or cargo, refueling, or maintenance.

ASME: American Society of Mechanical Engineers.

ASTM: American Society for Testing and Materials.

AST: Aboveground Storage Tank.

ATA: Air Transport Association of America

ATG: Automatic tank gauge or gauging.

AUTHORITY HAVING JURISDICTION: Entity responsible for determining the required engineering, construction, and operating standards.

AUTO-IGNITION TEMPERATURE: The temperature at which a substance will ignite without the further addition of energy from an outside source.

BARREL (BBL): Measure of volume as used in the petroleum industry, equivalent of 42 U.S. gallons (0.16 m³).

BIOCIDE: Additive to jet fuels to prevent microbiological growths in jet fuels.

BLIND FLANGE: Piping flange with no passage through the center.

BONDING: Providing an electrical connection between two objects to equalize their electrical potential.

BOTTOM LOADING: Method of filling tank trucks or tank cars through a tight connection at the bottom.

BREATHING: The movement of vapors into or out of a container because of natural cyclical heating and cooling.

BUNA-N (NITRILE): A copolymer of butadiene and acrylonitrile used as general purpose elastomers in contact with jet fuels.

CALIBRATION: Adjustment of the scale of a graduated device to meet an established standard, especially applicable to the adjustment of meter registers to indicate true volume as determined by a standard measure.

CATHODIC PROTECTION: A technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

CENTISTOKES: A unit of kinematic viscosity. A centistoke (cSt) is equal to 1 millimeter squared per second.

CENTRIFUGAL PUMP: A rotating device which moves liquids and develops liquid pressure by imparting centrifugal force.

CFR: Code of Federal Regulations.

CI: Corrosion inhibitor.

COALESCER: A filter designed to cause very small drops of water to form larger drops (coalesce) which will separate from fuel by gravity. Coalescer elements form one stage in a typical filter/separator.

COMBUSTIBLE LIQUID: Any liquid having a flash point at or above 100 °F (38 °C).

CONDUCTOR: A substance which permits the flow of electric currents without permanent physical or chemical change such as copper or aluminum.

CONTAMINATED FUEL: Petroleum fuel containing suspended or emulsified water, cleaning chemicals, or other foreign matter such as iron scale, dust, or other solid particles; or containing an unacceptable percentage of noncompatible fuel or other liquids; or containing more than one, or all of these classes of contaminants.

CONTAMINATION: The accidental addition to a petroleum fuel of some foreign material (contaminant) such as dirt, rust, water, or accidental mixing with another grade of petroleum.

CONTRACTOR: A person or entity responsible for constructing or operating a fuel project.

CORROSION: The process of dissolving, especially of metals due to exposure to electrolytes.

CORROSION INHIBITOR: Additive labeled CI that minimizes rusting in pipelines and tanks. Also acts as a dirt dispersant and lubricity improver.

CRC: Coordinating Research Council, Inc.

CROSS CONTAMINATION: Accidentally mixing two product streams that are intended to be separate.

CRUDE OIL: Petroleum in its natural state prior to refining.

CSA: Canadian Standards Association.

CUT AND COVER: A style of petroleum storage tank used principally by the military, made by field erecting a steel or concrete/steel tank that is partially or fully below ground.

DEAD-MAN CONTROL: A control device, such as a switch or valve, designed to interrupt flow if the operator leaves his station. Ensures that flow stops when the operator manually releases a control.

DEFUELER: Tank vehicle used to remove fuel from aircraft.

DENSITY: The mass per unit volume of a substance.

DIEGME: Diethylene glycol monomethyl ether.

DIKE: An embankment or wall, usually of earth or concrete, surrounding a storage tank to impound the contents in case of a release.

DIRECT FUELING SYSTEM: Method used to refuel aircraft; also known as a hydrant system.

DISPENSE OR ISSUE: To transfer fuel from a storage system to a truck or aircraft.

DISSOLVED WATER: Water which is in solution with fuel as opposed to undissolved water.

DIVERSITY FACTOR: Fuel system design usage factor, normally less than 1.0, to account for unknown non-simultaneous fueling system operations.

DOUBLE BLOCK AND BLEED: A method of proving that two closed piping segments are isolated from each other using two closed valves and an open drain between them. The two seals and the drain may be incorporated into one valve.

DOWNGRADE: To reclassify a petroleum product to a lesser grade than originally specified, due to the changing of properties resulting from contamination.

EFFLUENT: Stream flowing; discharge.

EFSO: Emergency fuel shut-off. (Also called ESO for military fueling facilities.)

EGME: Ethylene Glycol Monomethyl Ether.

ELASTOMERS: Materials with elastic properties.

ELECTRICAL ISOLATION: The condition of being electrically separated from other metallic structures or the environment.

EMULSION: A suspension of small globules of one liquid in a second liquid with which the first will not mix.

ENGINEER: Licensed professional engineer responsible for defining the technical requirements for the design, modification, and construction of fuel system facilities.

EPDM: Ethylene-propylene terpolymer. Not recommended for use in jet fuel systems. Used on AST dikes.

EPOXY COATING: A coating of thermosetting resins having strong adhesion to the parent structure, toughness, and high

corrosion and chemical resistance, also used as an adhesive.

EXPLOSION-PROOF: Classification of electrical enclosures for use in hazardous areas designed to prevent the passage of internal arcs, sparks, or flames.

FAA: Federal Aviation Administration.

FAR: Federal Acquisition Regulation.

FIBERGLASS: Composite material consisting of glass fibers in a matrix of resin such as epoxy.

FILLSTAND: Facilities specifically designed for loading aircraft refueler trucks.

FILTER: A porous substance through which a liquid is passed to remove unwanted particles of solid matter. Also a name for a vessel, usually equipped with paper elements, designed to remove particulate matter from a fuel stream.

FILTER/SEPARATOR: A filter or combination of filters designed to remove particulate matter and to remove entrained water by coalescing it.

FLAMMABLE LIQUID: Any liquid having a flash point below 100 °F (38 °C) and a vapor pressure not exceeding 40 psia (275 kPa) at 100 °F (38 °C).

FLASH POINT: The temperature at which a combustible or flammable liquid produces enough vapor to support combustion.

FLOATING PAN: See the definition for INTERNAL FLOATING ROOF TANK.

FREE WATER: Undissolved water content in fuel.

FSII: Fuel System Icing Inhibitor.

FUEL QUALITY MONITOR: A special type of filter designed to prevent the passage of dirt or water.

GALVANIC ANODE: A metal which, because of its relative position in the galvanic series, provides protection to metal or metals that are more noble in the series, when coupled in an electrolyte.

GALVANIZING: Rust resistant zinc coating applied to iron and steel.

GROUNDING: Providing an electrical connection to earth.

GSE: Ground Service Equipment. All conveyances, except aircraft, used on the ground to transport persons, cargo, fuel or equipment.

HAYPACK FILTER: A filter which uses hay, straw, or excelsior as a filtering medium.

HAZARDOUS AREA: Electrical classification for areas where flammable or combustible liquids or vapors may be present.

HOT REFUELING: Refueling of aircraft which have one or more engines running.

HYDRANT SYSTEM: Distribution and dispensing system for aviation turbine fuels directly to an aircraft from the tank farm without first transferring the fuel to a refueler tank vehicle.

HYDRANT SERVICING VEHICLE: A hydrant servicing vehicle (either self-propelled truck or towed cart) or a pantograph (fixed or towed) is used to complete the link between distribution piping and the aircraft. Pressurization is supplied by the pumps at the fuel storage facility. The hydrant servicing vehicle is equipped with a meter to measure fuel quantity, a filter/separator or fuel monitor to maintain fuel quality, and a primary and secondary pressure control valve.

HYDROCARBON: A compound made up exclusively of hydrogen and carbon in various ratios and molecular arrangements.

HYDROSTATIC TEST: A test for structural integrity and leaks in tanks and piping systems using liquid as the test medium.

IMPERVIOUS: Not easily penetrated. The property of a material that does not allow, or allows only with great difficulty, the movement or passage of a fluid. Also referred to as impermeable.

ICC: International Codes Council.

ISSUE OR DISPENSE: To transfer fuel from a storage system to a truck or aircraft.

JP FUEL: Military designation applied to aviation turbine fuels (e.g., JP-4, JP-5, and JP-8).

KEROSENE: A general term covering the class of refined petroleum which boils between 370 °F and 515 °F (188 °C and 268 °C). Mostly used in oil lamps and cooking stoves.

LITER (L): Equivalent to 0.001 cubic meters or 0.264 U.S. gallons.

MICRONIC FILTER: Commonly used name for a pre-filter.

NACE: National Association of Corrosion Engineers.

NEC: National Electrical Code. Another name for NFPA 70.

NEMA: National Electrical Manufacturers Association.

NFPA: National Fire Protection Association.

NIOSH: National Institute for Occupational Safety and Health.

NIPPLE: Short length of pipe, usually used to make side branch connections.

NOZZLE: A spout or connection, usually with a control valve through which fuel is discharged into a receiving container.

NPDES: National Pollutant Discharge Elimination System.

OIL/WATER SEPARATOR: A device used to separate oil from water.

OPA: Oil Pollution Act.

OPERATING STORAGE TANK: Storage tank from which fuel is issued directly to the aircraft, sometimes called day tanks or ready-issue tanks.

OPERATOR: Entity designated by the Owner or Owner's representative to have responsibility for fuel system operation and maintenance.

OSHA: Occupational Safety and Health Act of 1970.

OWNER: Entity having ultimate control of the fuel system.

PANTOGRAPH: A series of pipes, joined by rotating joints, used to connect fueling equipment to aircraft or refueler trucks.

PARTICULATE MATTER: Solid particles such as dirt, grit, and rust, which contaminate fuel.

PIGGING: The act of propelling special devices called pigs through a pipeline with liquid or air for the purpose of internal pipe cleaning.

PIPELINES: Piping systems that are not subject to regulation by the Department of Transportation.

PLC: Programmable Logic Controller.

PREFILTER: A filter, usually equipped with paper elements, designed to remove particulate matter from a fuel stream. It is the term usually reserved for a filter located ahead of additional, more sophisticated, filter vessels such as filter/separators.

or clay treaters.

PRODUCT SAVER: Small process device for separating dirt and water from fuel by gravity. Also called a sump separator.

PSI: Pounds per square inch, the unit of pressure measurement.

PSIG: Pounds per square inch gauge; pressure above atmospheric.

PSIA: Pounds per square inch absolute; pressure above an absolute vacuum.

RADIOGRAPH: An image produced on radiosensitive film by invisible radiation such as X-ray, specifically the image produced by radiographic inspection of welds and plates.

READY-ISSUE TANK: Storage tank from which fuel is issued directly to the aircraft, sometimes called day tank or operating storage tank.

RECEIPT: To receive fuel into a storage system, normally from a third party provider. Fuel delivery may be by truck, pipeline, barge or other transporting method.

REFUELER TRUCKS OR REFUELERS: Tank truck vehicles used to resupply aircraft with fuel.

RELAXATION CHAMBER: Small tank in a fuel dispensing piping system downstream of high pressure drop components such as filter/separators or fuel quality monitors designed to remove static electricity from the liquid stream before discharge into a receiving tank. The principle is reduced velocity and time, allowing the electrons in the fuel to recombine and the static charge to dissipate.

RUST: Ferric oxide, a reddish-brown scaly or powdery deposit found on the surface of steel and iron as a result of oxidation of the iron.

SLUDGE: Heavy viscous oily mass found in the bottom of storage tanks and treatment vessels, often contains rust, scale, dirt, lead additives, wax, gum, or asphalt.

SPCC: Spill prevention control and countermeasure.

SPECIFIC GRAVITY: The ratio of the weight in air of a given volume of a substance to the weight in air of an equal volume of distilled water (62.4 lb/ft^3) (1000 kg/m^3), both taken at the same temperature, usually 60°F (16°C).

STATIC ELECTRICITY: Accumulation of electric charge on an insulated body; also the electrical discharge resulting from such accumulation.

STATIC DISSIPATER: Additive labeled CU that raises the electrical conductivity of fuels and allows static electrical charges to dissipate more quickly. Also has mild surfactant properties.

STORAGE TANK: A vessel that is intended for fixed installations and is not used for processing.

STRAPPING: The process of determining the volume of a storage tank or cargo hold by measuring its linear dimensions and performing calculations to determine its volume per foot of tank height.

STRAY CURRENT: Current through paths other than the intended circuit.

STRIPPER PUMP: A pump used to strip or remove the last bit of liquid from a tank or pipe.

SUMP: A low area or depression which collects drainage.

SUMP SEPARATOR: A small process device for separating dirt and water from fuel by gravity. Also called a product saver.

SURFACTANTS: Short for Surface Acting Agents; also called emulsifiers or wetting agents. They are detergent or soap-like compounds that if in sufficient quantities will disarm (render inoperative) the water removing capabilities of filter/separators.

SURGE: Sudden increase in fluid pressure caused by sudden stopping of a moving stream as by a quick closing valve; hydraulic shock.

SURGE SUPPRESSOR: Device designed to control or reduce hydraulic pressure surges; hydraulic shock absorber.

TANK: A vessel for storing liquids or gases.

TANK CAPACITY: The quantity of aviation turbine fuel that can be stored in a tank. The nominal capacity is usually defined as the volume of the shell of a vertical aboveground storage tank between the floor to shell joint and the roof to shell joint. The nominal capacity of an underground storage tank is usually defined as the volume of the cylinder from end weld to end weld. The usable capacity of a tank is the amount of fuel in a particular tank that is designated as accessible under normal conditions. It is typically defined as the volume contained between the high and low level alarms.

TEFLON: A family of polymerized fluoroethylenes used as general purpose elastomers in contact with jet fuels.

TOP LOADING: Method of filling tank cars and trucks through an opening in the top.

UBC: Uniform Building Code.

UL: Underwriters Laboratories, Inc.

USER: Entity that receives, purchases, and or issues fuel through the fuel delivery system, such as an airline, fixed base operator, division of the military, etc.

UST: Underground Storage Tank.

VAPOR PRESSURE: Internal pressure of vapor in a liquid usually in pounds per square inch; an indication of volatility.

VITON: A family of fluoroelastomer dipolymers used as general purpose elastomers in contact with jet fuels.

VOLATILITY: Measure of the tendency of a liquid to vaporize; vapor pressure.

WASTE OIL: Oil or fuel which has become contaminated with foreign substances causing a level of non-conformance of its original properties sufficient to make it unusable for its original purpose.

WATER DRAW-OFF: A valve or similar device used to remove water from the bottom of a tank.

WATER SLUG SHUTOFF: A valve in the discharge piping from a filter/separator which closes automatically when the water in the unit rises above a set level.

WITHDRAW: To remove product from storage.

3. DESCRIPTION OF JET FUELS

3.1 Turbine Fuels

Turbine fuels are refined from crude oils and are made up of hundreds of different hydrocarbon compounds. They are specified by chemical composition and general properties. The exact composition of any particular turbine fuel will therefore vary with the type of crude oils from which they are manufactured as well as the refining process.

3.2 Commercial Jet Fuels

3.2.1 Jet A

A commercial aviation turbine fuel used primarily in the continental United States. The fuel is a refined, kerosene type, hydrocarbon product defined by ASTM D1655. Its primary distinguishing characteristics are a -40 °F (-40 °C) freezing point and a minimum flashpoint of 100 °F (37.8 °C). It is typically delivered to the aircraft without additives. When Jet A is additized for military purposes, it is called F-24.

3.2.2 Jet A-1

A commercial and military aviation turbine fuel used outside the continental United States and in most northern U.S. airports. It is similar to Jet A but with a freezing point of -53 °F (-47 °C). It is similar to JP-8 without the additives. It is also defined by ASTM D1655 and is typically delivered to the aircraft without antistatic additive.

3.2.3 Jet B

A seldom-used commercial aviation turbine fuel used primarily where a lower freezing point is required. The fuel is a refined, wide cut type (kerosene and naphtha mixture), hydrocarbon product defined by ASTM D6615. It is similar to JP-4 but typically contains no additives. Its primary distinguishing characteristics are a -58 °F (-50 °C) freezing point and a vapor pressure of 2 to 3 psi (14 to 21 kPa).

3.3 Military Jet Fuels

3.3.1 JP-4

Once widely used in the military, it has been phased out and is used only at a limited number of extremely cold weather locations. The fuel is a refined, wide cut type (kerosene and naphtha mixture), hydrocarbon product defined by MIL-DTL-5624. It contains anti-icing, antioxidant, corrosion inhibitor, and antistatic additives with metal deactivator as an option. Its primary distinguishing characteristics are a -72 °F (-58 °C) freezing point and a vapor pressure of 2 to 3 psi (14 to 21 kPa).

3.3.2 JP-5

A military aviation turbine fuel used exclusively by the United States Navy. It is the only fuel allowed on naval vessels for aviation use due to its relatively high flashpoint. The fuel is a refined, kerosene type, hydrocarbon product defined by MIL-DTL-5624. It contains anti-icing, antioxidant and corrosion inhibitor additives with metal deactivator as an option. Its primary distinguishing characteristics are a -51 °F (-46 °C) freezing point and a minimum flashpoint of 140 °F (60 °C).

3.3.3 JP-8

A military turbine fuel used by the United States Air Force and Army. The fuel is a refined, kerosene type, hydrocarbon product defined by MIL-DTL-83133. It is similar to Jet A-1 with additives including anti-icing, antioxidant, corrosion inhibitor, and antistatic. Metal deactivator and thermal stability enhancer additives are options. When the thermal stability enhancer is used the fuel is referred to as "JP-8 + 100" where "100" refers to the rise in degrees F of the thermal stability point of the fuel. Its primary distinguishing characteristics are a -53 °F (-47 °C) freezing point and a minimum flashpoint of 100 °F (37.8 °C). JP-8 + 100 should never be mixed with, or downgraded to, JP-8 without following the most stringent fuel quality controls.

3.3.4 F-24

A military turbine fuel produced from adding the additives listed for JP-8 to Jet A fuel. It has all the properties of JP-8 except for the slightly higher freezing point.

3.4 Fuel Properties

For properties of commercial and military jet fuels, refer to ASTM D1655 and the Handbook of Aviation Fuel Properties as prepared by the Coordinating Research Council, Inc.

3.5 Description of Additives

Additives are components added to a fuel to improve certain properties or to overcome a particular problem. Refer to Owner's fuel specifications for additive quantities.

3.5.1 Fuel System Icing Inhibitor (FSII)

These additives prevent the formation of ice in fuel. The principal chemical used is diethylene glycol monomethyl ether (DIEGME); however ethylene glycol monomethyl ether (EGME) is also used. They also act as a potential biocide to reduce the potential for microbiological growth at the fuel/water interface.

3.5.2 Corrosion Inhibitor (CI)

These additives are intended to minimize rusting in pipelines and tanks. Their composition is controlled by MIL-PRF-25017. The principal chemical used is DCI-4A. It also acts as a dirt dispersant and lubricity improver.

3.5.3 Static Dissipater (CU)

These additives raise the electrical conductivity of fuels and allow static electrical charges to dissipate more quickly. The principal chemical used is Dow Stadis 450 which has mild surfactant properties.

3.5.4 Biocide Additives

These are sometimes added to jet fuels to prevent microbiological growths in jet fuels.

3.5.5 Other Additives

Anti-oxidants may have been added to prevent formation of gums and peroxides. Metal deactivators react with soluble copper and other metal compounds to prevent undesirable reactions leading to filter-blockage troubles.

3.6 Fuel Contamination

Jet fuel contamination occurs as a result of poor design, construction, handling, storage, maintenance, and/or operational practices. Contaminants include the following:

3.6.1 Water

Water causes icing of the fuel system, malfunctioning of fuel measurement devices, and corrosion of fuel system components. Water also promotes other types of contamination such as particulate matter and biological growth. Water can also mix with additives to cause many types of fuel quality and contamination issues as well as disarming several common types of filtration and water removal equipment. The primary sources of contamination are rain and atmospheric condensation in storage tanks and free, entrained and/or dissolved water from the refinery or transport (pipeline, barge, truck, etc.).

3.6.2 Particulate Matter

Particulate matter is deleterious to fuel measurement devices and can clog fuel filters and foul valves. Its primary sources are rust from wetted metal surfaces, dust from air vents, and materials left in the fuel system from the construction period.

3.6.3 Biological Growth

Living organisms grow at the fuel and water interface. The presence of organisms may lead to problems with measurement devices, sight glasses, etc. Certain types of biological growth can damage steel piping, tanks, vessels, etc.

3.6.4 Metal Ions

Contact between jet fuels and certain types of metals release ions into the fuel, which may lead to a decrease in fuel thermal stability.

3.6.5 Disapproved Additives or Additives Mixed Improperly

Refer to the Owner's specifications for the proper fuel additives, additive mixing procedures, and additive quantities.

3.6.6 Cross Contamination with Other Fuels

Mixing different products intended to be separate can cause both products to be downgraded or rendered unfit for service. This is not only costly but has safety (flashpoint) and aircraft engine operation issues.

3.7 Design Considerations Regarding Contaminants

3.7.1 Jet fuel handling, storage, and distribution system designs shall be designed to both prevent the introduction of contaminants and to remove them after they are introduced.

3.7.2 Water

Design piping systems with adequate slope and velocity to move water to the low points and provide drains to remove the water. Provide water removal filter/separators and monitors to remove water from the fuel before it enters controlled areas such as an aircraft, a refueling vehicle or storage tank. Design storage tanks to minimize rainfall introduction and condensation within the tank.

3.7.3 Particulate Matter

Prevent the corrosion of wetted metal surfaces that may corrode by using non-corrosive materials or coating them. Provide filters and strainers to remove contaminants from the fuel before it enters controlled areas such as an aircraft, a refueling vehicle or storage tank.

3.7.4 Biological Growth

Prevent the introduction of water into the fuel system and provide for its removal after its discovery.

3.7.5 Metal Ions

Limit contact between jet fuels and materials that affect thermal stability by eliminating to the extent practical zinc, zinc alloys, copper, copper alloys, or bare carbon steel. Use stainless steel, aluminum, or interior coated carbon steel instead.

3.7.6 Additives

Design additive injection systems as per manufacturer guidelines. Designing the system to handle water contamination will help mitigate most operational additive related contamination problems.

3.8 Construction Considerations Regarding Contaminants

To ensure fuel quality, the jet fuel handling, storage, and distribution system shall be constructed per the construction documents and per the recommendations of the equipment manufacturers. Keeping the interiors of the piping, tanks, and vessels free of particulate matter and water are of supreme importance.

3.9 Operational Practices

The Owner shall be responsible for ensuring that jet fuel quality control operator training and task evaluation programs are implemented per ATA SPEC 103, ATA SPEC 103, or other locally accepted/approved standard such as JIG 2.

4. SYSTEM PLANNING

4.1 General

4.1.1 Planning for aviation fueling facilities must comply with industry codes and standards and meet all applicable federal, state, and local laws and regulations. Further requirements should include Owner's specific objectives as well as insurance requirements.

4.1.2 Planning for facilities shall comply with FAA airspace and airfield clearance restrictions and local and FAA security requirements. Compliance with these requirements should also be considered when planning renovations of existing facilities.

4.1.3 The engineer should consider the Owner's need for system expansion based on future growth predictions to meet operational requirements.

- 4.1.4 Owner's scope and budget limitations are key issues that should be addressed as part of the planning phase of the project. The engineer should consider if the Owner's objective is to minimize long-term ownership costs or to minimize initial construction or operating costs or some combination thereof.
- 4.1.5 The facility design should be consistent with the airport master plan and must comply with project lease and land use restrictions imposed by adjacent jurisdictions. Changes to the master plan shall be thoroughly documented and coordinated with applicable agencies.
- 4.1.6 The Owner's policies concerning custody receipt requirements, inventory control procedures, handling of bonded fuel, and special handling needs to include additive injection equipment should be considered.
- 4.1.7 Determination of current and future fuel consumption needs is critical and requires thorough analysis of historical fuel use data from all users of the facility. Take into consideration average daily fuel consumption by grade, peak uplift data, simultaneous servicing requirements, and peak flow data as well as receipt and transfer capability. General planning information used in this analysis includes aircraft information including flight schedule, aircraft mix, load factors, flight duration, aircraft fuel consumption factors and aircraft characteristics including length, wingspan, and location and height of the fueling receptacles.
- 4.1.8 Verify availability of all necessary utilities such as electrical power, water, and communications to meet current and future facility requirements.
- 4.1.9 Planners shall consider building redundant capacity in critical system components such as pumps, filters, and emergency power to minimize and/or eliminate system down time.
- 4.1.10 Assure compliance with fuels quality requirements of ATA SPEC 103 or applicable military criteria. Coordinate with Owner to identify additional quality requirements exceeding industry standards.
- 4.1.11 Provide corrosion protection for piping, equipment and tanks consisting of coatings and cathodic protection.

4.2 Facility Siting Issues

- 4.2.1 Conduct a geotechnical survey and incorporate the resulting information into the planning process when available.
- 4.2.2 Coordinate the design concept review with responsible fire official and/or other Authority Having Jurisdiction.
- 4.2.3 Locate existing and site future utilities to minimize impact on current operations.
- 4.2.4 Evaluate emergency vehicle access/egress routes to provide adequate emergency response.
- 4.2.5 Evaluate existing airport industrial and commercial traffic to develop safe entry and exit routes for petroleum delivery vehicles.
- 4.2.6 Comply with necessary security requirements including fencing, surveillance equipment, and security communications equipment. Considerations should be given to the Owner's risk management program.

4.3 Fuel Receipt

- 4.3.1 The engineer should thoroughly analyze existing receipt capabilities to assure optimization of facilities in use and consider enhancements to increase existing fuel receiving and transfer rates. Obtain anticipated changes to the current demand rate to assess facilities' capability to meet future needs. New facilities should be designed to meet anticipated growth or to accommodate future expansion.
- 4.3.2 Consider the following for development of new or expanded receipt facilities: type of existing and possible future receipt mode(s); space to accommodate new equipment; existing and future fuel consumption; land use and airspace clearance constraints, Owner quality requirements, cost constraints, facility access, vehicle traffic flow, environmental issues, installation security, and specific insurance considerations of the Owners.
- 4.3.3 Incorporate Owner's specific accounting and automation requirements and custody transfer procedures.