“Without fuel aircraft don’t fly”
Aviation Fueling Operations
Planning an aviation fueling system requires careful consideration of the many factors affecting the fueling process, as well as airport airside operations. Whether creating a fueling facility for a major international airport, a regional airport, or a military aviation installation, each presents a unique set of conditions that must be evaluated and addressed in planning, design, and implementation of the project. Factors to be considered include the type(s) of aircraft to be serviced (hence, the type of fuel that will be dispensed), the volume of air traffic, and the associated costs. While cost may be a major decision driver, it must be balanced with due attention to safety, environmental issues, and the airport’s requirements for on-going airside functions and the efficiency of the fueling process.

Types of Fuel
Different categories of fuel are required depending on the type of aircraft that may be present or planned at any given airport. These categories include commercial and military jet fuels, and aviation gasoline. Commercial jet fuel is available in three grades:
- Jet A – standard jet fuel used in the United States
- Jet A-1 – produced to international specifications and used at commercial airports throughout Canada and the rest of the world
- Jet B – used primarily in areas where its cold-weather performance characteristics are necessary
Jet fuels for military applications come in a variety of grades, primarily dependent on the type of aircraft, the military department they serve (i.e. Army, Navy, Air Force), and whether the aircraft are land-based or ship-based. Military jet fuels are very similar to commercial jet fuels, the significant difference being performance additives.
Avgas, also known as aviation gasoline, commonly available in Avgas 100LL grade, is used by small aircraft with piston engines. The two other grades of Avgas are seldom used, and their availability is limited.

Fueling System
Whether planning a new aviation fueling system or tackling a major expansion or upgrade of an existing one, several important factors affecting the planning and design must be considered:
- **Fueling Process** that covers the receipt of the fuel on site by various modes, storage of this fuel, and final delivery to the aircraft
- **Facilities** that incorporate all the infrastructure, pipelines, and distribution systems that are required to support the fueling operation
- **Key considerations** that deal with safety, environmental protection, fire protection, airport location planning, and airport operations
Systems and Processes

An airport aircraft fueling facility is comprised of three key systems:

• **Receipt**: the process of receiving fuel at the airport, determining fuel quality, filtering, and metering the fuel

• **Storage**: the system where received fuel is kept, inventoried, tested, and made available for distribution

• **Distribution**: the system that pumps, filters, meters, and distributes the fuel to the aircraft

Fuel receipt, storage, and much of the equipment associated with distribution facilities are all situated in an airport fuel tank farm complex. This is typically located groundside, some distance from passenger terminals, aircraft parking aprons, taxiways, runways, and flight lines.

**Fuel Receipt**

Normally, receipt of fuel at airports is accomplished by either pipeline or transport tanker trucks. At some airports, fuel is received directly from railroad tank cars or marine vessels. Even when fuel is received by pipeline, offloading capability from transport tankers is an emergency second means of fuel receipt. Medium to large airports generally have two or more methods of fuel receipt to increase reliability and avoid jeopardizing airport operations. Regardless of the method, it is imperative that proper receiving procedures are followed to maintain fuel quality and safety. The procedures include:

• Delivery of correct fuel grade, type, and quantity, and certification that the product meets the required specifications

• Preparation of receiving storage tank(s) by proper valve positioning and adequate tank capacity

• Standard tests of product samples at the beginning, mid-point, and near the end of the receiving process to ensure quality

Major equipment in fuel receiving systems usually consists of offloading pumps, air eliminators, metering devices, pre-filters, and filters/separators.

Fuel Storage

Most airports have fuel storage facilities configured for tanks to supply the product either directly to refueler trucks or to an underground hydrant fueling system. For jet fuel storage, most airports have at least two tanks, one in the receiving mode, and the other(s) in the distribution mode. This segregation of the incoming fuel allows the operator to perform standard quality checks on one batch of fuel, with adequate time for any water suspended in the product to settle to the bottom of the tank. This is necessary to avoid distributing fuel that does not comply with specifications, or has water contamination. Avgas storage facilities may consist of only a single tank, since Avgas is not adversely affected by trace amounts of water in the product.

Fuel storage tanks come in many shapes and sizes, but are usually classified as **aboveground, underground, or cut and cover**:

• Aboveground tanks are made of steel, and are either vertical/cylindrical in shape, with large capacity tanks being field-erected, or horizontal/cylindrical, usually prefabricated and thus of lower capacity.

• Underground tanks are horizontal/cylindrical in shape and can be of single or double wall design to provide integral secondary containment. Usually these tanks are prefabricated with steel or fiberglass and have lower capacity than the aboveground vertical storage tanks.

• Cut and cover tanks are constructed of concrete and/or steel, and are of large volume and vertical design. These tanks are located mostly underground with a very small portion above the surrounding grade, and mounded over by earth. Cut and cover tanks are usually found at military air bases and wherever security against terrorism or sabotage is necessary.

In all cases, storage tanks must be provided with suitable secondary containment to capture any spills, leaks, or other unwanted product discharges. Storage tanks are equipped with ancillary devices such as overfill level alarms, low level alarms, automatic product level gauging, manual gauge ports, sampling ports, floating suction, access man-ways, and vents.

*Above Left:* Jet Fuel Rail Car Being Offloaded on Concrete Spill Containment Pad  
*Left:* Additional Storage and Supply Facility  
*Above Right:* Aviation Fuel Storage Tanks
Fuel Distribution

Fuel distribution is accomplished through a system of supply pumps, filters, meters, pressure and flow control valves, and other equipment. These systems draw fuel from the storage tanks and are usually located adjacent to the tanks in the tank farm area. From there, jet fuel is usually distributed to the aircraft by way of a refueler truck or an underground hydrant piping system.

Fuel is distributed to vehicle loading stations where it is transferred to the refueler truck. Use of refueler trucks is a common practice in small and medium airports and on many military air bases. Although it is a much slower process than a hydrant system, as the amount delivered is limited to the truck capacity, requiring several trips, it is usually the only means of fuel delivery at these airports. It is, nonetheless, the most economical means of fuel delivery in terms of capital expenditure, and at many airports, sufficient to meet operational needs.

A hydrant fueling system entails a network of underground piping that delivers fuel from the tank farm complex to aircraft positions at passenger terminals, hardstands, and aircraft parking aprons. Hydrant systems are usually found at busy, medium to large airports. They are the primary means of fuel delivery where rapid fueling is necessary for a quick turnaround to meet airline flight schedules or military mission requirements. The underground piping network includes individual fueling hydrant pits situated in the apron area adjacent to the parked aircraft. At the hydrant pit, a hose is connected from the truck or cart to the control valve located in the pit, and another hose from the same vehicle is connected directly to the aircraft. Upon activation, fuel flows through the truck or cart filters, meter, and flow and pressure controls, and then directly into the aircraft. This method is considerably more efficient than truck fueling because the larger hydrant system pumps at the fuel farm can supply product to the aircraft continuously. In addition, hydrant systems are designed to serve numerous aircraft simultaneously. In some busy airports, the hydrant systems are quite complex and far reaching, and are capable of serving over one hundred aircraft simultaneously.
Avgas is usually distributed by a much smaller system than what is used for other types of fuel. One delivery method involves taking the fuel from the storage tank(s) directly to adjacent fuel dispensers or cabinets, similar to a gas station. From these dispensers, Avgas is supplied directly to small aircraft, which maneuver close to the dispenser hoses. Fuel is delivered to larger aircraft via a refueler truck.

Above: Delivering Fuel to Aircraft by Hydrant System
Left: Delivering Fuel to Aircraft by Tanker Truck
Key Considerations

There are three key considerations when designing an aviation fueling system: Safety, Environmental Protection, and maintenance of Airport Operations. Numerous systems and procedures are required to address these concerns.

Safety

Aviation fuel is a highly flammable product requiring rigid adherence to all applicable industry and regulatory safety standards, which include:

• National Fire Protection Association (NFPA) 407 “Standard for Aircraft Fuel Servicing”
• Air Transport Association of America (ATA) Specification No. 103 “Standard for Jet Fuel Quality Control at Airports”
• American Petroleum Institute (API), Petroleum Equipment Institute (PEI), Steel Tank Institute (STI), and Association for Composite Tanks (ACT) for storage tanks, piping, valves, filter separators, and other equipment, inspections, testing methods, and procedures

Each category and grade of fuel requires its own unique procedure for receipt, storage, and distribution. Intermingling of fuels can result in a highly dangerous situation for the receiving aircraft. A crucial requirement of the fueling operation, therefore, is the delivery of the correct type and grade of fuel, free of contaminants, in the safest manner possible. Special filtration processes ensure contaminants such as water and solids (rust, scale, sand, and dirt) are kept within acceptable levels. Such filtration is usually required at three stages: when receiving fuel prior to storage, when withdrawing from storage prior to distribution, and prior to delivery to the aircraft. Standard procedures for daily fuel quality checks are required prior to distribution.

Dangerous static electricity can result in electrical arcing when connections to fueling equipment are made. To avoid ignition during fueling, procedures and equipment must be in place to allow the equipment (vehicles, aircraft, piping, and valves) to be brought to the same electrical potential by bonding prior to hook-up of the equipment and before commencing fueling, and remain connected until fueling is completed. One of the safety controls used for fuel transfer to tanker trucks or the aircraft is a “deadman” switch connected to a flow control valve in the transfer equipment or on the truck itself. The flow starts when the switch is squeezed and stops when it is released, preventing release of fuel into the environment, and keeping the fuel transfer process in the hands of an alert operator.

Environmental Protection

Containment of spills and other unintentional releases of fuel to prevent endangering the environment are of primary importance to airport authorities. Federal, state, and local regulations generally dictate the type of facilities required to comply with such regulations. Such facilities include:

• Concrete pavement and containment curbing and other spill control infrastructure at truck loading and offloading stations
• Double-walled tanks, where the outer wall serves as secondary containment, or containment dikes around single-walled tanks
• Cathodic protection and special coatings applied to tanks and pipelines to inhibit corrosion
• Double-walled underground piping systems with state-of-the-art leak detection systems
• Independent high and high-high level alarms to avoid overfilling of storage tanks
• High-level shutoff systems at truck loading stations to prohibit overfilling of trucks
• Oil-water separators incorporated in industrial areas, such as tank farms, to separate oil from any storm runoff
• Vapor recovery systems for Avgas facilities

Airport Operations

Timely delivery of the correct, clean, and dry fuel to the aircraft is one of the most important aspects of aircraft operations. To the typical airline passenger it is an unheralded part of airport operations, but to the many people that run a commercial airport or a military base, it is the lifeblood of that facility – without fuel aircraft don’t fly. Accordingly, to plan and design an aviation fueling system properly, it is vital that specific, day-to-day operations of that airport are addressed. Often, redundancy is built into the subsystems and equipment that make up the entire aviation fueling system so that failure of one part will not adversely impact continued airport operations. Once integrated into the airport operations, the aviation fueling system becomes one of the most valuable assets to an airport, especially if it is designed to accommodate future growth.
how can hatch mott macdonald help?
HMM has superior capability and experience in the planning, design, and construction of any airport fueling project. Recognizing that every fueling project is unique, we apply top-notch professional skills honed over 30 years of practice to bring innovative, high-quality services to every aviation client. Our truly integrated design approach is proven to save capital, operating and maintenance costs, and our optimal engineering solutions lead to lower life-cycle costs and sustainable results. Our goal is to give you confidence that your fueling project will proceed smoothly, and that all expectations will be met. These are the hallmarks of our services and how Hatch Mott MacDonald can make a difference for your next aviation fueling project.

Above: Fuel Tank Secondary Containment Structures

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<td>• Tank Farm Storage • Hydrant System Pipelines • Hydrant, Valve, HP &amp; LP Pits • Receipt &amp; Distribution Systems • Gasoline/Diesel, Deicing Fluid &amp; Waste Fuel Facilities • Fuels Testing Laboratory • Aircraft Apron Pavements</td>
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<td>Conceptual Planning, Budgeting, Preliminary/Final Design, PLC System Design, Environmental Permitting, Construction Support &amp; Commissioning</td>
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<td>• Phasing of Construction • Pipeline Leak Detection • Proximity to Taxiing Aircraft</td>
<td>Conceptual Planning, Budgeting, Preliminary/Final Design, Environmental Permitting, Construction Support &amp; Commissioning</td>
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<td>• Horizontal Storage Tanks • Truck Receipt/Loading Stations</td>
<td>• Tank Farm Storage • Receipt &amp; Distribution Systems • Surge Suppression Systems • Avgas Facilities • Fuel Vehicle Parking</td>
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<tr>
<td>Massachusetts</td>
<td>Boston: 400 Blue Hill Dr (Suite 100), North Latitude Westwood, MA 02089 781.455.3035</td>
<td>781.913.5940</td>
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<td>Hyannis: 56 Lower Wortham Road Hyannis, MA 02601 617.595.0190</td>
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<td>Mississippi</td>
<td>Hattiesburg: 222 Millbrook Rd (Suite 300) Hattiesburg, MS 39402 601.204.6030</td>
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<tr>
<td>New Jersey</td>
<td>Cape May: 450 4th St North Park Rd 375 Cape May Court House, NJ 08210 609.427.0077</td>
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<td>Clinton: 150 West Main St Clinton, NJ 08029 908.799.8880</td>
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<td>Southfield: 5 Paragon Way Southfield, NJ 07429 908.799.8880</td>
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<td>NY</td>
<td>Suffern: 670 Main St (Suite 700) Suffern, NY 10901 914.727.0000</td>
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<td>New York, NY 10013 212.332.6000</td>
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<tr>
<td>Ohio</td>
<td>Columbus: 3601 East Broad (Suite 290) Columbus, OH 43219 614.332.0000</td>
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<td>Oregon</td>
<td>Portland: 400 SE 5th Ave (Suite 190) Portland, OR 97204 503.245.3200</td>
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<tr>
<td>Pennsylvania</td>
<td>Pittsburgh Gateway View Plaza 1000 W. Carson St Pittsburgh, PA 15219 412.497.2900</td>
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<tr>
<td>Philadelphia</td>
<td>The Public Lodge Building (Suite 10th floor) 150 South Independence Mall West Philadelphia, PA 19106 215.427.2278</td>
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<tr>
<td>Texas</td>
<td>Houston: 2501 Austin Parkway (Suite 201) Houston, TX 77084 713.770.3100</td>
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<tr>
<td>Utah</td>
<td>Provo: 2000 South Minor Street (Suite 200) Draper, UT 84020 801.577.3222</td>
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<tr>
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<td>Washington: 300 Commerce St (Suite 110) Seattle, WA 98101 206.386.0000</td>
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<tr>
<td>West Virginia</td>
<td>Morgantown: 2001 Cranberry Square Morgantown, WV 26508 304.214.2500</td>
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For Current Office Locations Click Here.

for canadian offices, see reverse side
Areas of Expertise

- aircraft hydrant fueling systems
- helicopter fueling systems
- fuel tank farm complexes, fuel depots, and terminals
- aboveground and underground tanks
  - API inspection and repair
  - overfill protection systems
- pipelines
  - integrity inspection
  - life remaining analysis
- fuel offloading and loading facilities:
  - pipeline, truck, rail, and marine vessels
  - automated truck loading systems
- plc terminal automation
  - fuel flow control systems
- fuel transfer systems
- fuel filtration systems
- leak detection systems
- fuel system fire suppression/protection
- vapor recovery systems
- fueling process safety
- cathodic protection
  - system design
- annual survey and condition assessment
- special coatings and paints for corrosion protection
- airport fuel emergency shutdown systems
- oily wastewater treatment
  - spill containment infrastructure
  - oil-water separator systems
- fuel vehicle maintenance buildings
- fuel facility operational buildings and laboratories
- fueling vehicle parking areas
- alternative fuels receipt, storage, and distribution facilities
- liquid oxygen and liquid nitrogen storage facilities

Services

- ramp services design
- aircraft stand planning and design
- project management
- construction management
- feasibility studies
- master planning
- planning including growth projections
- programming
- conceptual design
- preliminary and detail design
- site planning and layout
- security solutions
- mechanical design
- electrical design
- instrumentation design
- piping design
- cost estimating
- material specifications
- permitting
- environmental compliance
- contract administration
- commissioning of systems
- procurement and contracting
- asset management
- asset life remaining and value estimating
- fuel system audits