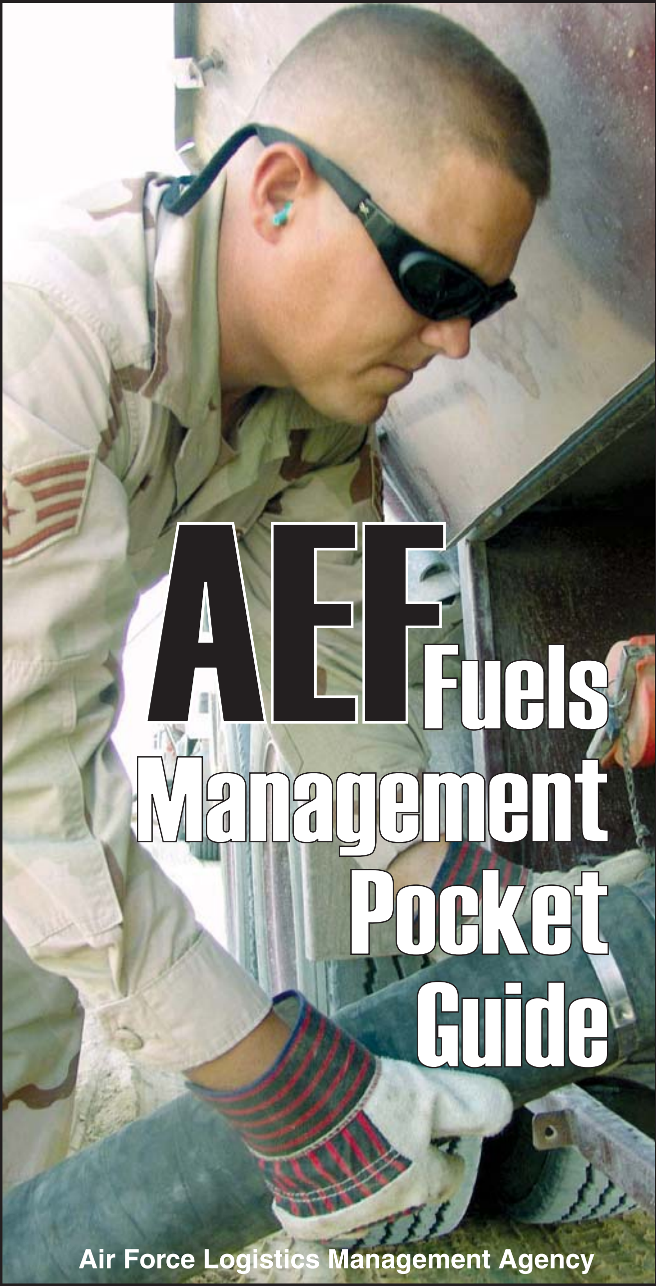

AEF Fuels Management Pocket Guide

Air Force Logistics Management Agency

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Foreword

This guide is designed to assist fuels personnel in understanding fuels issues as they relate to aerospace expeditionary force (AEF) and contingency fuels operations at bare bases. As AEFs and operations at bare bases continue to evolve, implementation and execution also will change. This book should be used as a reference only—Department of Defense (DoD) and Air Force directives will take precedence always.

Special thanks to the major commands and Air Staff fuels staff for providing valuable inputs to this pocket guide and CENTAF fuels staff and the Fuels Technical Training School for submission of photographs.

All questions concerning this guide should be directed to:

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Third Edition

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In the Beginning

When we think of war, many times, we envision large armies moving across the field, inspired by a clash of political ideologies. The intriguing twists and intricate strategy and battlefield tactics hold our attention above all other aspects of war. Yet, the bulk of a commander's considerations involve the logistical limitations that drive changes in strategy and tactics in order to keep forces supplied

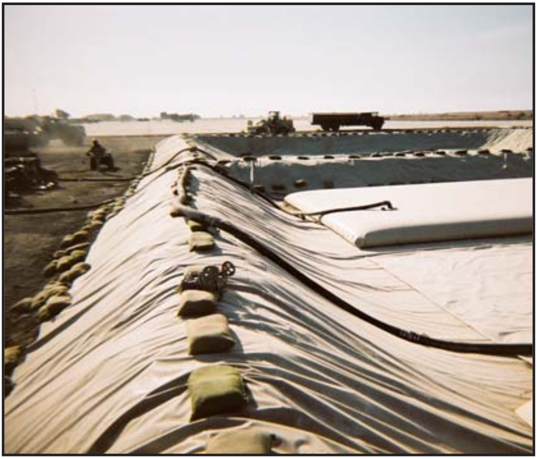
and moving. The provision of supplies always has been essential for military operations. Even in the earliest days of war, transportation of supplies and materiel relied on some form of pack animal, principally horses, for resupply. The horse's need for fodder (fuel) dictated to the commander the terrain and season of year through which he could campaign. However, fodder for horses proved to be a difficult challenge in sustaining forces. A

premechanized army could contain as many as 40,000 animals, requiring 800 acres of fodder per day. Horses were imperative in a campaign, yet their subsistence greatly strained an army's resources. The need to keep moving in search of fodder tended to cause an army to move too fast. After World War I, new modes of warfare made the use of pack animals obsolete, and technology manifested in aircraft and mechanized vehicles created a requirement for a new type of fodder: petroleum, oil, and lubricants (POL). Commanders still had to consider logistics; however, POL dominated their strategy and tactics. Further, POL products accounted for the majority of supplies shipped into a theater during the war. Regardless of its modern connotation, POL's intrinsic equivalent throughout history has been fodder. Since World War II, POL has become increasingly important in keeping armed forces going in the field. The last 50 years of technological advances only have optimized modes of transportation, not lessened the impact of fuel on strategy, tactics, and operations. While technological advances may reduce lift requirements in the amount of support equipment or munitions required for operations, a similar advance seems unlikely for fuel. Arguably, fuel will remain the dominant logistics factor that limits strategic and tactical planning, as well as actual operations for the foreseeable future.

Fuels Planning

The criticality and importance of fuels planning and support cannot be overemphasized. The success of any campaign hinges on a well-constructed and carefully thought-out plan. The role of fuels logistics in an AEF is no different. If we are well-prepared going into a contingency, it is less likely that we will experience problems during operations. Today's war-planning tactics have evolved considerably from those of the past. However, the ultimate objective remains unchanged: successfully accomplishing the mission. As with all logistics functions, planning for fuels support must be calculated carefully and planned deliberately. A typical fuels-planning cycle has four phases:

- Preplanning phase: determine requirements and draft initial support proposal.



Planning Results

- Site survey phase: verify the feasibility to support the proposal.
- Actual plan execution.
- After-action planning: analyze operation for lessons learned.

Many tasks go into planning a contingency operation, and fuel is one item that must not be underestimated. Fuels management personnel

MDS	Burn Rate (GPH)	Average Load (gal)
A-10	615	1,644
B-1B	3,544	30,842
B-2	2,687	25,373
B-52H	3,266	46,630
C-5	3,500	53,083
C-17	2,260	27,042
C-130	800	6,662
F-15	1,580	2,400
F-16	800	1,072
F-117	923	1,158
KC-10	2,650	52,000
KC-135	2,070	31,200
U-2	290	2,775

Sample Aircraft Burn Rates

	DF-2	DFM	MGX*
Density (lb/gal)	6.9	7.0	6.2
Flash Point °F	125	140	-30
Freeze Point °F	34	30	-75
API Gravity	33-42	-	47-71
NATO Symbol	F-54	F-76	F-46/49/50
* Represents all grades of gasoline (unleaded or premium)			

Diesel and Gasoline Planning Information

R-14 Filling an R-9

generally are trained in all aspects of fuels operations. Those involved in exercise or contingency planning also should have a working knowledge of tactical and mobile fuel systems. Fuels planning should focus on providing standardized refueling support in a nonstandard

	JP-8/ JET A-1	JP-5	JET B	TS-1
Density (lb/gal)	6.7	6.8	6.4	6.7
Flash Point ˚F	100	140	-20	82
Freeze Point ˚F	-53	-51	-58	-76
API Gravity	37-51	36-48	45-57	50.3 Max
NATO Symbol	F-34	F-44	F-18	

Aviation Fuel Planning Information

environment, while understanding that some aspects of the job will require work outside the normal chain of operations. Many times, a short-notice deployment will require the senior fuels person to arrange fuel support with host-nation military or civilian authorities to meet operational needs. This makes it essential that a fuels planner be involved in all aspects of contingency planning.

A common oversight to planning a deployment is the placement of the fuels personnel in the later chocks. Remember, aircraft without fuels support are just static displays! Ensure the fuels personnel are on the earliest chock.

Under the warm, fixed-base concept of an AEF, much of the infrastructure should be in place and the planning completed. As such, many of the capabilities will be known and have been taken into account. However, mission configuration changes of AEFs and air expeditionary wings will alter fuel and equipment requirements. In some cases, changes in host-nation agreements or changes in suppliers will alter the ability to provide fuel support significantly.

The support for any operation with limited or no fuels infrastructure in place will necessitate using the Fuels Maintenance Support Equipment (FMSE) force modules to establish a wartime fuels capability. There are three FMSE force modules that are incrementally sized to open, establish, and operate the base. A complete AEF FMSE capability can issue 1 million gallons per day. The newest generation of FMSE, referred to as fuels operational readiness capability equipment (FORCE), has a throughput rate of 900 gallons per minute and will provide 400,000 gallons per day. The new FORCE is modular and scalable to fit mission needs of specific beddown locations.

What's Required

Once the deployment location has been identified, the next step is to determine how much fuel will be required and what capability for fuel support exists at the deployment location. Normally, flying requirements are stated in numbers of sorties flown each day or as a sortie rate. For deployment planning, combatant command (COCOM) fuels planners will use the FMSE/FORCE calculator to determine the type and amount of FMSE or FORCE equipment needed to support the deployment flying operation. The new FMSE/FORCE calculator automatically will determine the amount of bladders, refueling vehicles, and hydrant facilities needed to support operational flying, as well as the strategic and theater airlift that will rotate in and out of the deployed site. In the event the COCOM's air component major command (MAJCOM) fuels planner does not have access to the FMSE/FORCE calculator or you are required to perform a site survey with no preplanning data,

Setting Up to Support the Warfighter

use the manual method to determine your fuel support requirements. To calculate the number of sorties manually in a single day, multiply the number of aircraft available times the sortie rate. Add the number of sorties to be flown each day to the fuel onload quantity. Occasionally, planners will provide the fuel onload per aircraft. If this is the case, the daily fuels requirement can be computed by multiplying the number of sorties times the onload per sortie. If operations planners provide only the planned average duration of a sortie, then a reasonably accurate onload requirement forecast is obtained by using average consumption rates, multiplied by the sortie duration in hours. Limitations in capabilities at the deployment location can severely restrict the number of sorties. Knowing your capabilities up front will allow more accurate mission planning. It is recommended that each advanced echelon (ADVON) or site survey team member who is conducting a fuels assessment deploy with a laptop computer with the FMSE/FORCE calculator loaded for accurate planning. Your point of contact for the FMSE/FORCE calculator is the Headquarters Air Force Petroleum Agency.

What's Available

It is essential that you determine what infrastructure, if any, exists at the deployment location and what modifications and equipment are required to meet requirements. In determining what support or infrastructure is already in place, there are several sources of information.

MAJCOM

The responsible MAJCOM should be the first source for fuels information. Many MAJCOM fuels offices have unpublished trip reports, site surveys, and lessons-learned databases that contain helpful information from previous visits. Many provide detailed information on sources of supply and infrastructure locations within their theater.

Logistics Plans

The logistics readiness squadron's readiness flight is an excellent source for deployment planning and site information. They have access to base-support plans and expeditionary site plans that contain information on fuels for each location your base is normally tasked to support. In most cases, the readiness flight will have access to classified site information at bare bases as identified in the supported command operational plans.

Automated Air Facilities Information Files

The Defense Mapping Agency prepares these files, which are available on the Global Command and Control System or on the Secret Internet Protocol Router Network linked to the command intel page. Automated Air Facilities Information Files (AAFIF) provide the best available information on non-Air Force, especially non-DoD, installations worldwide. Information currently is not available for continental United States (CONUS) airfields. This information should be used with caution because it is not always accurate or current.

The Defense Logistics Agency Defense Energy Support Center

The Defense Energy Support Center (DESC) has an abundance of information, with offices all over the world. DESC prepares the World Wide Storage Plan annually and provides a database for analyzing fuel storage capabilities worldwide in support of peacetime and contingency missions. The 506 report lists fuel tank information (type, capacity, status) for locations where US military fuel storage exists. The report contains information on receiving rates and modes. DESC also develops emergency distribution plans to support contingency requirements. Emergency distribution plans are designed to provide a source of logistics support in supplying fuel to bases during crises.

Special Fuels Storage

Automated Air Facilities Information Files

The National Geospatial-Intelligence Agency prepares the automated air facilities information files (AAFIF), which are available on the Worldwide Military Command and Control System Intercomputer Network (WIN). The WIN is normally found only at MAJCOM fuels or logistics planning offices. AAFIF files provide the best available information on non-Air Force and especially non-DOD installations worldwide. Information is not currently available for CONUS airfields. Because of sources used and the frequency of updating information files, information should be used with caution because it is not always accurate or current.

Fuel Grades Available

Aviation Fuel

No fuels planning is complete without determining what grades of fuel are available at a deployed location. Where aviation fuel is concerned, many locations do not have the Air Force-preferred grade of JP-8, so alternate fuels must be used. Alternate fuels include JP-4, JP-5, Jet A, Jet A-1, Jet B and TS-1.

Primary, alternate, and emergency fuel for all turbojet and turboprop engines installed in Air Force aircraft will be listed in the aircraft -1 flight manual. In order of decreasing precedence, fuel use for Air Force aviation applications (excepting the U-2) is as follows.

1. **JP-8/JP-5**
2. **Jet A/Jet A-1 (with SDA, FSII, and CI)**
3. **TS-1 (with SDA, FSII, and CT)**
4. **Jet A/Jet A-1 (neat)**
5. **TS-1 (neat)**

TS-1 must meet the Russian GOST 10227-86 specification if used on US military aircraft. Use of the Russian additive package is not allowed without approval from the aircraft manager.

Special caution must be taken when working with JP-4 and Jet B as these are highly volatile fuels. Alternate fuels are those authorized for continuous use without impacting aircraft performance. However, alternate fuels, particularly commercial grades, may not contain additives. Long-term operation of some aircraft without additives may decrease engine life by increasing component wear. The Air Force has the capability to inject additives to minimize this impact. Many times, DESC is successful in getting the supplier to inject the additives prior to shipment, making it ready for use when it arrives on site. If the supplier does not inject additives, the fuel must be inoculated by Air Force fuels personnel on location. The Air Force developed fuel injectors specifically designed for use in forward operating locations or locations where no commercial injection system is in place. The injector is powered by the fuel flow through the injector turbine and requires no outside power source. If the injector is not available, additives must be blended into the fuel manually.

Ground Fuels

Ground products (mogas [motor gasoline], diesel) are every bit as important to a campaign as aviation fuel. In most cases, ground fuels will be required to support communications and ground power equipment before aircraft arrival. Obtaining a suitable grade (lead or octane content) of ground fuel may be a problem; if DESC has not contracted for it—or will not—a local purchase will be required. Ground fuel may be more readily available—but is in greater demand—in the commercial sector. This increased competition for ground fuels with host-nation needs can limit product availability. When calculating ground fuels requirements, an experienced fuels planner can provide a very accurate figure. Requirements are determined by contacting using agencies, such as civil engineers, transportation, communications, and aircraft maintenance. Receipt, storage, and issue procedures are basically the same as for aviation fuels, except that smaller dispensing systems normally are required. Most fuels organizations maintain kits containing smaller adapters for ground fuels operations, but special attention should be given to ensure there are small nozzles for use with vehicles that use unleaded fuel.

Cryogenics

Future AEF operations will see nearly all cryogenics products purchased locally because of their availability. Mobile cryogenics production plants are driven by a diesel engine and are transportable via air, land, or sea. Where smaller quantities are required, cryogenics products can be shipped in 400-gallon, skid-mounted containers. These containers are equipped with an overboard vent to

LOX Servicing

	Liquid Oxygen	Liquid Nitrogen
Boiling Point	-297°F	-320°F
Freezing Point	-361°F	-346°F
Liquid Density	9.52lb/gl	6.74 lb/gl
Purity (by vol)	99.5% min	99.% min

Cryogenic Characteristics

allow shipment by air. Important considerations when planning for cryogenics support are product requirements, tankage required to support the requirement, and sufficient product availability via local purchase. DoD specifications for cryogenics are more stringent than most commercial specifications. Commercial products must meet the required specifications. An unlimited supply of a product is of little use if it does not meet Air Force specifications.

Resupply

The fastest and most economical method of obtaining refueling support is from the host-nation airfield. Host-nation support is especially critical during contingencies when logistics support from US units or equipment may not be readily available. Many times, the host can provide some support and will allow limited use of its facilities. Arranging for fuel support, particularly with a foreign government, may require a memorandum of agreement or memorandum of understanding between the government and the host. However, only certain agencies have the authority to enter into such agreements. DESC, the primary agent that performs this function for fuel support, can delegate this authority. In situations where Air Force personnel perform fuels operations and it becomes necessary to obtain fuel from a bulk source, the simplest and most expedient method of resupply is to use the same source of supply as the host airfield through arrangements with the supplier or

Receipt Line

host-nation personnel. This method is the most common, and usually, deliveries are made using tank trucks. In some situations where there is an established US presence, a pipeline may be the method of resupply. However, there are situations where resupply is unavailable or is inadequate. In these situations, there are several other sources of resupply.

Ocean Tanker

If there is a port available, DESC's Commodity Business Unit (CBU) can arrange for tanker shipments of fuel if given enough lead time. Tankers also may be diverted, depending on location, timing, and urgency of the requirement. Contracts for ocean tankers are accomplished through the Military Traffic Management Command, which has transportation contracting authority. Military Sealift Command ocean tankers also provide the capability to ship about 10 million gallons of fuel at a time, making them highly desirable where large quantities are required.

Tanker Design	Draft (Loaded)	Capacity (bbl)	Offloaded (bbl/hr)
AO-22 USN	32'-0"	138,000	8,000
AOE-1 USN	38'-0"	166,000	42,700
T5S-RM2a	36'-1"	180,000	24,800
Victory Class	39'-10"	372,000	21,130
T10S-101b	70'-2"	1,655,000	102,400

Ocean Tanker Information

Ocean Tanker

DESC successfully shipped about 46.6 million barrels of fuel by tanker in 2005.

Aerial Bulk Fuel Delivery System

The Aerial Bulk Fuel Delivery System (ABFDS) is designed for aerial delivery of fuel to locations where other methods of transportation are impractical. It has been particularly successful delivering fuel to forward locations under austere conditions. The system has been qualified for bulk transport of all types of liquid fuel, including special fuels, such as JPTS (thermally stable jet fuel). The system can carry from 3,000 to 24,000 gallons per sortie, but it is not cost-effective or an efficient means of providing fuel resupply, especially in support of large flying operations. Depending on the contingency location and its distance from a fuel source, the aircraft may consume more fuel than actually delivered by the system. Limited availability of airlift during contingencies further complicates resupply by

ABFDS

ABFDS. Use of aircraft as the primary mode of fuel resupply is permitted only after all other possible means of support have been exhausted.

Tanker Aircraft

All AMC aircraft can be used for onground defueling or wet-wing defueling and plane-to-plane refueling using the aircraft's transfer pumps, an adequate length of discharge (collapsible) hose, and a single-point nozzle. Normally, the receiver will provide the nozzle and hose. These cargo aircraft are interoperable with most rotary-wing aircraft (except Army and Marine Corps UH-1 and OH-68), Marine Corps and Navy ground systems, and Army HEMMT M970 aviation road tankers. This method should not be considered a standard method of resupply; however, it can be used to provide small quantities of fuel under emergency conditions.

Fuel Storage

In any fuels operation, mission success cannot be achieved if adequate storage is not available. Established locations may have permanently installed storage systems that provide sufficient capacity to carry out any operation within the airfield's capability. However, where fuel infrastructure is inadequate or when operating in forward or austere locations, bladder systems, railroad tank cars, or any container that meets operational, safety, and environmental needs can meet storage requirements. It is important to maximize use of host storage facilities and minimize the construction of berms or use of bladders. The most common sizes of fuel bladders

	50K	210K
Inside Area (Ft)	80 x 80	80 x 80
Dike Height (Ft)	4	6

Bladder Size Information

Bladder Fuel Farm

are 10,000, 50,000, and 210,000 gallons. Bladders provide an expedient short-term storage capability, but because of their limited service life (1-3 years) and propensity to weep, leak, or rupture, long-term solutions are being sought, such as steel-bolted tanks, where extended operations are expected. Use the AFTO Form 95, Significant Historical Data, to document all inspections, maintenance, and operational actions including the use life start date and any periods of extensions.

Computing Requirements

In accordance with AFPAM 23-221, *Materiel Management Fuels Logistics Planning*, the following procedures will help in identifying fuel requirements.

- Obtain the appropriate command portion of the wartime aircraft activity (WAA) report from the parent MAJCOM or local logistics plans office for each operational plan (OPLAN).
- Separate the WAA activity per OPLAN. Each WAA contains activity including unit, sorties per day, gallons per sortie, and sortie generation factor.
- Use the FMSE calculator to record each line of activity. One line of activity equals one weapons system and estimated gallons per sortie. The FMSE Calculator will compute your total requirement per aircraft, per day and provide MAX 1-day. **NOTE: The F-Qty refers to the amount of fuel anticipated via in-flight refueling and must be subtracted from the gallons per sortie in the requirements calculations, except for tanker aircraft.**

Defense Energy Support Center

DESC is critical to linking bulk fuels with contingency and warfighter support. Its origin extends back to World War II where it was an entity of the Department of Interior as the Army-Navy Petroleum Board. Over the years, DESC has gone through many changes, both in mission and in name. Its mission today is to build an energy program aimed at managing energy products. DESC is a large organization with many different units. However, an overview is made of those areas that are of particular interest when deploying or preparing to deploy in an expeditionary environment.

Direct Delivery Fuels CBU

The Direct Delivery Fuels CBU is the worldwide acquisition and integrated materiel manager for motor gasoline, gasohol, diesel fuels, jet fuels, and kerosene delivered directly to using activities by contracted vendors to support the Services. It also oversees the post, amp, and station program (used primarily to procure commercial ground products). Its specialty fuels division handles commercial aviation fuels delivered in aircraft at commercial airports worldwide. It also directs implementation of Federal, DoD, and Defense Logistics Agencyenergy contracting regulations and programs, including contracting policies. It maintains the fuels procurement system and contract oversight plan.

It is also responsible for the Aviation Into-Plane Reimbursement (AIR) Card Program and DoD Fleet Credit Card. The AIR Card Program allows government aircrews to present their AIR cards at DESC into plane contract locations to obtain fuel. The AIR card simplifies billing and procedures for fuel purchases and is used to simplify payments for local purchases of ground services at contract locations. It also provides wing commanders visibility into their flying-hour program and helps DESC identify future contract locations to maintain possible program savings. The DoD Fleet Credit Card is new and is available for drivers of DoD vehicles (cars, trucks, tanks, and so forth) and allows drivers to purchase fuel with a swipe of their card. The process is electronic and paperless, with billing data being sent electronically to the Defense Finance Accounting Service.

The Bulk Fuels CBU

The bulk fuels CBU is responsible for the purchase, distribution, inventory management, and overall quality of bulk fuels and lubricants used by DoD worldwide. Bulk fuels are purchased in accordance with applicable military specifications. Products include aviation fuels, marine fuels, qualified lubricating oils, and fuel additives. Bulk fuels generally are purchased directly from the point of manufacture and transported by pipeline, ocean tanker, barge, truck, and rail. There is a fleet of six oceangoing tankers dedicated to delivering bulk fuels worldwide. DESC owns the product from the point of purchase and is responsible for managing the distribution and storage of these fuels until ultimate sale and consumption by the customers. The bulk fuels CBU writes annual contracts with 75-percent minimum-lift guarantees. It also writes 2- to 3-year requirements contracts.

The terms of providing fuel in support of operations depend on location. If the operation will be conducted at an overseas base, it normally is supported through bulk fuels. If there is no base- or government-controlled storage but a commercial airport is available for operations, DESC may or may not have an into-plane contract already available. If there is no contract available, the direct delivery CBU will write one with a valid requirement. The direct delivery team is very responsive and generally can get *something* in place within 48 hours.

The bulk fuels CBU has a core fleet of six 235,000-barrel (9.8M-gallon) ocean tankers for fuel distribution. It spot-charters tankers and is responsible for funding (about $32M annually) three afloat-prepositioned force (APF) tankers. These ships hold from 175,000 to 308,000 barrels of war reserve jet fuel (JP-5). Two of the three ships have offshore petroleum discharge systems. The APF tankers are essentially floating storage, and while DESC funds the vessels and owns the inventory, the Commander in Chief, Pacific Command controls their movements.

Unlike the APF tankers, the Marine Corps funds the 13-vehicle cargo ships under the Maritime Prepositioning Ship program. To support the onboard equipment, each ship holds 30,000 barrels of DESC-owned JP-5 war-reserve fuel, and some of the ships also hold 4,000 barrels of gasoline (also DESC-owned).

The Army stores small quantities of JP-8 war-reserve fuel in HEMMT 8 on board Army roll-on/roll-off ships. It currently has three ships for a grand total of 6,000 barrels of fuel.

DESC has four field offices located globally:

- DESC-EU (Europe) 314-338-7710
- DESC-PAC (Pacific) 315-473-4312
- DESC-ME (Middle East) 318-439-4650
- DESC-AM (Americas) 427-9301

Facilities and Distribution Unit

The facilities and distribution unit provides inventory accounting at worldwide storage locations and writes international agreements. It also provides support to foreign military sales agreements. To get the right quantities of fuel, at the right place, at the right time, it uses the Inventory Management Plan. Facilities and distribution personnel manage worldwide fuel terminal operations, as well as storage and acquisition programs. It programs for operations and maintenance facilities owned by the Government and operated by a contractor and those owned and operated by a contractor. It manages real property maintenance activity and military construction projects. Environmental protection specialists are responsible for ensuring prevention, control, and abatement of environmental pollution at DoD fuels facilities. Contracting specialists and officers purchase services required for storing bulk petroleum products, as well as services required for other areas of fuel operations, including environmental protection and aircraft refueling. Supply system analysts continually review planned inventory levels and programmed operation of fuel facilities to ensure optimal utilization of resources. Transportation management specialists continually review the distribution infrastructure to ensure optimal utilization of transportation resources such as pipeline tenders and guaranteed traffic programs.

The Ships Bunker Fuel Program provides various grades of ship propulsion fuels for combatant ships, Coast Guard vessels, and various classes of ships that are owned and chartered by the US Government at commercial ports worldwide. Bunker contracts are in place servicing customers at 91 ports domestically and 85 ports overseas.

The DESC tailors its business operations to provide the best customer support possible in purchasing bulk-refined petroleum products, coal, natural gas, synthetic fuels, and electricity for the Services and more than 4,000 Federal civilian agencies around the world.

Personnel and Equipment Requirements

MAJCOMs are responsible for determining and coordinating all personnel and equipment requirements. There is no exact formula for determining the number of people or equipment needed; historical data and personal experience normally will aid in the planning. A deployment requirement chart is a handy guideline for estimating personnel and equipment requirements. Special consideration should be given to ensure personnel with the required special experience identifiers (SEI) and correct types of equipment are sourced. Additionally, equipment requirements should include nonrefueling vehicles needed in the fuels operation.

Civil Engineers

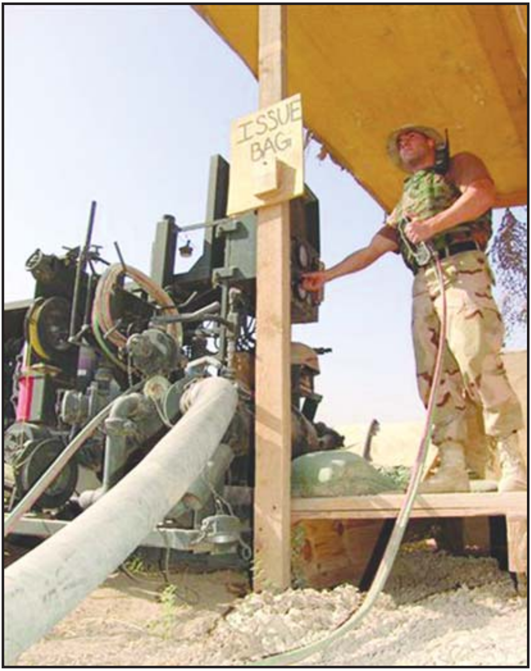
When operating out of an established base or airport, fixed-fuel facilities probably will be under the operational control of the host airport and not the responsibility of Air Force engineers. However, at bare bases, civil engineers maintain normal responsibilities of liquid fuels maintenance. They do site preparation, including construction of berms, and provide other environmental protection measures. They also provide emergency power if necessary. Unless provided by the host location, civil engineers retain responsibility for providing these services. Civil engineers are one of the most important groups in establishing a forward-deployed fuel system. The success of the refueling mission hinges on the availability of civil engineers to help prepare the surface for fuel bladders. Full sortie generation cannot be achieved unless bladders are erected and operational. Therefore, it is essential that this be accomplished in the earliest stages of deployment.

Prepositioned Equipment

Fuels mobility support equipment is strategically positioned in many parts of the world. Active-duty Air Force, civilians, and contractors maintain the equipment. There is a variety of equipment used in deployment operations. The most common are listed with basic information on each to provide an overview of the equipment. Rarely will you find all this equipment at all locations.

R-14 ATHRS

By far, the most widely used and most versatile system is the R-14 air-transportable hydrant



R-14 Operation

refueling system (ATHRS). The R-14 can be airlifted or ground shipped anywhere in the world and made fully operational in a matter of hours. A complete system contains three identical, self-sufficient modules. Each module consists of a pumping unit; two 50,000-gallon bladder tanks; and all the hoses, valves, and fittings necessary for operation. The pumping module is configured on a four-wheeled trailer and features the same components found on conventional servicing equipment. Each R-14 module can fuel one heavy aircraft at 600 gallons per minute or two fighter aircraft at 200 gallons per minute.

R-22 Trailer-Mounted Transfer Pump

The R-22 generally is used to push fuel from a bulk storage system, tank truck, or tanker aircraft to ATHRS bladder tanks. It often is used in conjunction with the R-14 system. The R-22 also can be used with a hose cart or skid-mounted filter

R-22 Transfer Pump

FFU-15E Filter Separator

separator to deliver fuel directly to aircraft. It has an 85-horsepower gasoline engine that can deliver fuel through the line at up to 900 gallons per minute. The newer models have a pumping capability of only 600 gallons per minute.

FFU-15E Skid-Mounted Filter Separator

The FFU-15E is a skid-mounted filter separator designed to filter particles and separate water from fuel. It can filter jet fuels at 600 gallons per minute, diesel at 450 gallons per minute, and gasoline at 750 gallons per minute. The FFU-15E can be configured for use with many different systems to provide clean, dry fuel. The FFU-15E also can be used with other services' equipment to provide increased flexibility in fuels operations. The FFU-15E weighs 785 pounds.

SCAT Tanks

A self-contained, above-ground tank (SCAT) system will catch and hold the recovered contents of a storage bladder if it leaks or ruptures. SCAT tanks can be used for ground fuels storage and for special fuels such as JPTS and aviation gasoline (AVGAS) for unmanned aerial vehicle operations. The containment structure also serves to collect and hold fuel that might overflow while filling the storage tank. These 4,000-gallon SCAT tanks are designed to act as a secondary spill containment system for capturing fuel in the event the primary storage system (50- or 210,000-gallon bladders) collapses. Secondary containment facilities may contain single or multiple storage tanks. A secondary containment system should be constructed so spills do not escape to ground or surface waters before cleanup. The key is the ability to contain large spills, as well as leaks.

SCAT Tank

PMU-27

PMU-27

The PMU-27 is a trailer-mounted, engine-powered unit consisting of a 50-gallon-per-minute pump, filter separator, meter, hoses, connections, and nozzles. It is designed to support servicing of small aircraft and transfer of small quantities of fuel. It also is capable of defueling four 55-gallon drums simultaneously, pumping from an external source and defueling aircraft auxiliary tanks. The unit is also a ground fuels-dispensing unit.

ABFDS

The Aerial Bulk Fuel Delivery System (ABFDS) is an aerial, fuels-delivery system that enables aircraft to transport fuel rapidly to locations close to or behind enemy lines. The ABFDS consists of two 3,000-gallon aerial bladder tanks, two pumping modules, a meter, and hoses. It typically is installed in the C-130 aircraft but can be installed in the C-141, C-5, and C-17. The tanks are mounted on a delivery platform and held securely by tiedown straps. A cross-over manifold connects the two pumping modules and allows filling or evacuation of both tanks by one module. The ABFDS is capable of delivering 600 gallons per minute with one pump or 1,200 gallons per minute using both pumps. It is an extremely versatile system capable of offloading fuel into trucks, bladders, and other containers. The ABFDS also can be used with alternate capability equipment for filtration of aviation fuels, 500-gallon drum transport, wet-wing defueling, and aircraft-to-aircraft refueling.

FARP

Used primarily in quick-turn support of special operations aircraft, FARP provides a highly efficient way of transferring fuel from aircraft to aircraft in a nonstandard or hostile environment. FARP operations expand the capability of special operations forces around the world by providing a means of hot refueling from a tanker aircraft to various types of fixed- and rotor-wing receiver

Loading ABFDS in Aircraft

aircraft. Responsibility for the teams, equipment, and FARP missions falls under the Air Force Special Operations Command at Hurlburt AFB, Florida.

Refueling Units

There are many types of refueling units in use by the Air Force, but the most used in a deployed

FAM Cart

FARP Setup

R-11 Refueler

environment are the R-11, R-9, R-12, C-300, and C-301. They provide the greatest flexibility and mobility. The R-11 is the most common and is the primary refueler for servicing aircraft. The R-11 has a 6,000-gallon fuel capacity with one 60-foot hard hose. It can refuel aircraft at rates of up to 600 gallons per minute; it also can defuel aircraft and be used as a bulk-fuel hauler. The R-11 is designed for driving on improved roads and, on a limited basis, unimproved roads. Refueler road speed, fully loaded, is 60 miles per hour, depending on road and weather conditions. The R-9 is similar to the R-11 but has a capacity of 5,000 gallons.

R-12 hydrant-servicing vehicles connect to the flight-line hydrant outlets and pump fuel directly from hydrant fuel tanks to the aircraft. This provides an unlimited supply of fuel to the aircraft, eliminating using more than one vehicle to support the fuel request. The R-12 is capable of going from refuel to defuel by turning the selector switch from refuel to defuel. The strainer design allows the switch without changing strainers. The strainers are noncollapsible and can handle flow pressure from either direction. During refueling, pressure surges from the system and increases fuel pressure at the single-point receptacle. To equalize the pressure, fuel bleeds off into the vehicle's sump tank. The R-12 automatically pumps excess fuel back into the system but can be operated by pushing the manual pump button.

The hydrant servicing vehicle is a truck-mounted piece of equipment designed to transfer fuel from an in-ground installed, pressurized hydrant system into an aircraft. The max flow rate capacities for the Tri-State, Beta, and Kovatch vehicles are 1,200, 1,000, and 750 gallons per minute respectively. The defuel capability for all three trucks is 300 gallons per minute. The earlier model did the same procedure at a maximum of 200 gallons per minute.

The C-300 is a 1,200-gallon unit used to service ground fuels. It is the primary vehicle used to refuel base-support equipment and special-purpose emergency equipment. It is well-suited to make small, bulk-fuel deliveries to numerous small tanks.

Hydrant Servicing Vehicle

C-300

The C-301 is identical to the C-300 except that it is equipped with four-wheel drive to increase its maneuverability on unimproved surfaces.

Hose Carts

MH-2 series hose carts are trailer-mounted units designed for transfer of fuel between fixed-hydrant system outlets and single-point refueling aircraft receptacles. They are equipped with a filter separator, meter, flow control valve, and inlet/outlet hoses but do not have any pumping capability. Hose carts also can be used to provide filter/meter capability for filling refueling units from hydrant systems, for refueling using bladder storage and R-22 pumping systems at bare bases, and as a substitute for the FFU-15 filter separator. Hose carts

	MH-2B	MH-2C
Shipping Wt (lb)	1,700	1,760
Length (in)	119.0	138.0
Width (in)	68.0	70.0
Height (in)	80.5	80.0
Cubic Feet	377.0	448.0

MH-2 Hosecart Information

MH2 Hosecart Setup

use standardized single-point refueling nozzles; however, the hydrant quick-coupler valve (moosehead) that connects onto the installed hydrant outlet on the aircraft ramp may differ. This is a concern when using Air Force-supplied hose carts on a host airfield. Use of a hose cart in conjunction with an R-22 pumping system requires removal of the hydrant quick-coupler valve and replacement with a 4-inch KAM-LOK coupler.

GRU-17E Aircraft Fuel-Servicing Unit

The GRU-17E is a portable pantograph designed for refueling tactical aircraft during hot refueling operations (refueling aircraft with engine running or simultaneous weapons loading). It consists of four sections of pipe connected with swivel joints

GRU-17E

and mounted on casters. It is fully equipped with all components needed to operate the unit and only requires a fuel source for operation.

Cryogenics Tanks

The most common cryogenics tanks used in a deployed environment are the TMU-24E LOX tank and the NRU-5E LIN tank. Both tanks are 400-gallon skid-mounted and can receive, store, and issue liquid oxygen or nitrogen products to service carts at bare bases or where other methods of transportation are impractical. The units are completely self-contained and weigh approximately 1,500 pounds. They are equipped with an overboard vent to facilitate transporting by air. It is the aircrew's responsibility to connect or disconnect overboard vents.

Fuel Bladders

Collapsible fuel tanks are provided in 10,000-, 50,000-, or 210,00-gallon capacity. They are constructed of single-ply, nylon fabric material

400-Gallon Liquid Oxygen Tank

with reinforced corners and impregnated with urethane or nitrile. The interior of the tank is coated with polyester. An empty 50,000-gallon bladder is 24 feet by 65 feet. An empty 10,000-gallon bladder is either 12 feet by 42 feet or 22 feet by 22 feet. An empty 210,000-gallon bladder is 192 feet

Positioning Fuel Bladder

	10K	50K	210K
Shipping Wt (lb)	225	1,500	5,000
Rolled Length (in)	104	136	192
Rolled Width (in)	31	40	61
Rolled Height (in)	32	40	43
Cubic Feet	60	126	

Coated Fuel Bladder Information

by 61 feet by 43 feet. The tanks are tested to operate between 40° F to 160° F.

Fuel Blivets

Fuel blivets are collapsible, rubber, nonvented containers for transporting and storing fuel. They are available in 55- and 500-gallon capacities. They are constructed of four-ply tire cord and equipped with swivel plates and anchor shackles at both ends to allow tiedown aboard aircraft. They can be towed (rolled) on the ground using a special lifting and towing yoke. The internal tanks are equipped with fuel and defuel valves and are

500-Gallon Fuel Blivets

	55 Gal	500 Gal
Shipping Wt (lb)	27	305
Length (in)	37-38	72-89
Width (in)	24-33	36-48
Height (in)	6-24	9-48
Cubic feet	63 full	93 full

Fuel Blivets Data

complete with external fuel-servicing adapters. Because drums are nonvented, they must be kept shaded to prevent fuel expansion and drum rupture. The drum becomes brittle below 20° F.

Managing Risk

Another important aspect of fuels operations in an AEF environment is safety planning and operational risk management. Careful planning in this area can prevent the accidental destruction or loss of aerospace forces. Everyone is responsible for making safety plans that promote mission objectives. Time, location, facilities, environmental conditions, equipment, and mission urgency can make it necessary to accept certain hazards and risks. Consider all safety standards and programs during mission planning. Keep in mind, however, that certain missions may require acceptance of unavoidable risks to reach primary mission objectives. Prior to acceptance of any risk, ensure the decision to accept risk has been made at the appropriate level. The acceptance of hazards or risks under certain conditions does not mean they should become operational norms. When full safety compliance cannot be made,

Managing Risk

practical measures must be applied to reduce or control the risk. When the need for noncompliance no longer exists, standard safety procedures must be reinstituted. When risks or hazards are accepted, all personnel involved should be completely informed of these conditions, why they exist, what adverse effects they potentially create, and how to best cope with them. The very nature of the fuels business requires strict attention to detail in safety planning. Poor planning or failure to address safety issues adequately can have disastrous effects on the mission.

Fuel Additives

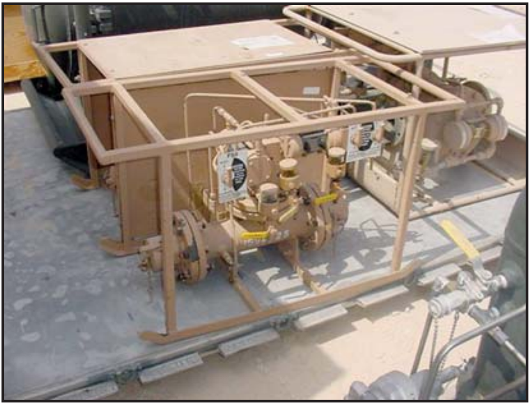
Blending

The Air Force recently developed a fuel injector specifically designed for use in a forward operating location or where no commercial in-line injection system is in place. This piece of equipment is called the Hammonds 4T-4A Fuel Additive Injector (NSN 4930-01-418-2694), manufactured by Hammonds

Sampling R-11

Additive	Blending Ratio in Gallons
Fuels System Icing Inhibitor	1:1000
Corrosion Inhibitor	1:66,660
Static Dissipator Additive	1:666,666
Thermal Stability Additive (+100)	1:4,000

Additive Blending Rates



Additive Injector

Technical Services, Inc, Houston, Texas. This injector is powered by the fuel flow through the injector turbine and requires no outside power source. In the event a Hammonds injector is not available, additives must be blended into the fuel manually. A fuel system icing inhibitor (FSII) and corrosion inhibitor (CI) may be premixed prior to adding to fuel. A conductivity additive must be added to the fuel separately and must not be premixed with other additives. Additives may be introduced into refuelers using a funnel and hose with one end submerged below the surface of the fuel. Approximately 150 percent of the refueler capacity then should be circulated before issuing fuel. An alternate method is to add required quantities of additives to a refueler, filled to not more than one-third capacity, and then finish filling the unit. Fuel then can be issued without circulation (reference Technical Order [TO] 42B-1-1).

JP8+100

Today's advanced aircraft need improved thermal stability in their jet fuel, and current special fuels, such as JP-7 and JPTS, are very expensive. The Wright Laboratory Aero Propulsion and Power Directorate developed JP8+100 to solve this economical problem, and the Air Force approved its use in May 1996.

The +100 additive contains a detergent, a dispersant to prevent fuel from gumming up on engine components, and a metal deactivator. It is designed to increase the thermal stability of jet fuel from 325° to 425° F, hence the suffix +100. Increased thermal stability will play a key role in future Air Force weapon systems. Highly thermal fuels like JP8+100 can be used as a heat sink to disperse heat from aircraft subsystems. JP8+100 also reduces coking on main burner fuel nozzles, afterburner manifolds, and feed tubes. The downside to its benefits is that the +100 additive contains a surface-active agent that disarms coalescing filters in fuel systems, does not remove water from the fuel, and allows contaminated fuel to pass through the filter. To minimize this potential hazard, the additive is injected as close to the skin of the aircraft as practical. JP8+100 requires strict quality control measures to prevent filter disarming and possible aircraft contamination (reference AFPAM 23-221).

FSII

FSII is diethylene glycol monomethyl ether that lowers the freezing point of water entrained in fuel, preventing the formation of ice that can clog filter elements and cause aircraft engine stalls. FSII does not lower the freezing point of the fuel, only the water in the fuel. Unlike commercial and most Navy aircraft, Air Force aircraft do not have fuel-system heaters to prevent moisture in the fuel from freezing. Water removes FSII from fuel, so introduction of water must be avoided. FSII is blended at a rate of 1 gallon of FSII per 1,000 gallons of fuel. CI is a fuel additive that prevents corrosion of steel surfaces and provides lubricity to fuel pumps and controls. CI is blended at the rate of 65 milliliters CI per 1,000 gallons of fuel.

Static Dissipator Additive

A static dissipator additive aids in relaxing static charges and decreases the possibility of fires or explosions caused by static electricity. DuPont Stadis 450 is the only approved conductivity additive for use in Air Force aviation fuels. The conductivity additive is first diluted, one part additive to nine parts jet fuel. Generally, when CU values are from 0 to 50, you should blend 31 milliliters per 1,000 gallons of fuel; and between 50 to 100 CU, blend 19 milliliters per 1,000 gallons of fuel. Actual consumption will vary based on mission profile. A normal load indicates the normal aircraft capacity, excluding ferry tanks. Official aircraft consumption factors are prescribed in AFI 65-503, *US Air Force Cost and Planning Factors*.

Fuels Chemical Warfare Contingency Operations

Preattack Operations

The key to contamination avoidance is the availability and use of overhead cover. Available facilities will determine where on the spectrum of chemical warfare (CW) contamination environment fuels personnel will be forced to work. When determining the work environment and assessing vulnerabilities, consider the following: development of a coverage strategy, types and effectiveness of available shelters, time required in types of available shelters, equipment that must be used, and ways to limit exposure.

Fuels personnel must make every effort to protect their vehicles, assets, and property in order to provide mission essential assets during a CW attack. Effective covering, dispersal, and expedient hardening are the most effective measures to avoid contamination.

The search for structures capable of providing overhead cover should encompass the entire installation. Other options include modifying vehicle pavilions by enclosing open sides with barrier materials and moving unserviceable equipment out of cover and moving serviceable equipment under cover. Be sure to cover unserviceable equipment with barrier materials if using this option.

When developing a covering strategy, identify the most critical vehicle and equipment assets and ensure they receive top priority for covering. This should include items for critical missions or items that are in high demand but short supply; for example, R-11, C-300/301, HHT/HSV, and so on.

Personnel should park vehicles and assets in facilities, if possible, and use barrier materials to prevent chemical droplets from coming in direct contact with the vehicle or asset's surface or interior. Do not cover refueling vehicles or liquid oxygen and liquid nitrogen equipment with plastic barrier materials. The plastic sheets can accumulate static electricity, which can discharge as sparks at any time, particularly during the removal process. Canvas covers are permissible, and general-purpose vehicles or privately owned vehicles can use plastic sheets.

Fuels personnel should guard against the tendency to park the majority of vehicles (to include hose carts) in the refueling operations yard because of the ease of access. Dispersal sites should be located in safe positions that are not easily seen and not within the effective range of shoulder-fired weapons. If only effective dispersal is used, the probability is high that some vehicles will escape contamination or damage. However, dispersal should be used in conjunction with expedient hardening and overhead cover whenever possible

Dispersed assets should be located in the vicinity of the work area they will support, if possible, and each dispersal site should have at least two entry/exit routes. The routes should be on concrete or asphalt if possible. Consider using the vehicles as dispersed storage locations for redundant materials that facilitate mission sustainment.

Create shuffle boxes and glove decontamination troughs for entrances and loading ramps. Cover the boot shuffle boxes and glove decontamination troughs with protective materials and ensure they contain a 5-percent chlorine solution. Change the solution every 48 hours or after 400 people use them.

Please refer to Air Force Manual (AFMAN) 10-100, Airman's Manual, for more specific guidance regarding chemical warfare in contingency operations.

Fuel Bladders

There is no need to search extensively for overhead cover or contamination protection for fuel bladders. However, if barrier materials are available (nonplastic) and time is permitting, cover the fuel bladder. Chemical agents will absorb into the surface of the fuel bladder readily. A small amount of vapor will penetrate the bladder but will not be enough to contaminate the fuel to a level that will harm personnel. You probably will not be able to decontaminate a contaminated fuel bladder since the agent quickly absorbs into the surface of the bladder.

Wear the appropriate level of chemical warfare gear (Mission-Oriented Protective Postures) [MOPP]) when dealing with a contaminated fuel bladder. The real danger from residual contamination of the fuel bladder is to people in the immediate area. If the fuel bladder remains in the crate (not set up), provide protection for the crate if available (plastic barrier materials will suffice).

Refueling fighter aircraft prior to harden aircraft shelter parking (hot pit or other) is convenient and reduces shelter congestion. It does, however, increase exposure time for contamination. Ideally, after shutdown, refueling will be accomplished with the aircraft inside the shelter. Fuel trucks and fuels personnel will be required in this process.

Fuels Personnel Working in MOPP Level 4

Keep in mind that fuel trucks and personnel may service multiple aircraft requiring movement from shelter to shelter and can engage in shell game for protection.

Postattack Operations

It is possible that fuels trucks will need to reconvene at one central bulk storage point for refueling. Should this happen, ensure refuelers are spaced out accordingly so vital assets are not all destroyed during an attack. This activity will involve the potential intermingling of clean and dirty vehicles. The necessary precautions fuels personnel must take will include the following:

- Ensure contaminated fuels trucks are properly marked and personnel are in the appropriate MOPP level.
- The 10-foot rule will be in effect for personnel that need to be in the vicinity of a contaminated fuel truck.

- A vapor hazard will exist for personnel, but the vapors will not contaminate the clean vehicles or refueling equipment.

Contact the Survival Recovery Center to determine what type (if any) chemical agents have been detected. If an item is contaminated and time is not critical, weathering is the cheapest, safest, and most practical means of decontamination.

Isolate all contaminated items, ensure uncontaminated materials in close proximity to the contaminated zone are covered, and continue mission operations using uncontaminated equipment.

Identifying and Marking

For vehicles, the interior portion of Air Force Form 18XX should be annotated at the same time the external markings are applied or as soon as possible thereafter. Perform operational decontamination prior to marking and annotating the 18XX if the agent is still on the surface. Personnel should include the date and time of contamination, type of contamination (V-series, H-series, and so on), and location of the contamination. Personnel must notify their squadron readiness center as to the contamination status. The squadron readiness center should ensure all assets are annotated appropriately. Markings do not guarantee the assets will be identified as having been previously contaminated in the long term.

To detect the presence of a chemical agent, it is extremely important to preposition M8 paper on all assets, vehicles, and equipment, especially those that are uncovered. M8 paper should be prepositioned in multiple locations on flat surfaces that are likely to be hit during a CW attack. Fuel handlers and supervisors out on runs also should carry a supply of M8 paper.

The M8 paper should be checked as soon as possible after the wing operations center releases the base populace during Alarm Black. Fuels personnel should check M8 paper on handles and doorknobs, windowsills, drainpipe exits, exposed gauges, levers, piping, and anything that normally is done during a routine check. They should also test vehicles, assets, and equipment that did not have prepositioned M8 paper on them. A negative M8 paper reading does not equate to a hazard-free asset.

Vehicle Contamination

If there is any doubt as to the contamination status of the vehicle, question vehicle operators extensively about the vehicle's location during the last 24 hours and contact Vehicle Maintenance and request that the vehicle master record be researched. If dealing with a contaminated vehicle, ensure you wear in the appropriate MOPP level, identify the vehicle as contaminated (markings, Form 18XX, and report to your unit control center (UCC) and fuels resource control center (RCC). Always wear work gloves if CW agents have been used against the installation. Supply may designate certain bays for contaminated vehicles to avoid potential cross contamination.

Whenever possible, accomplish loading and unloading activities and fuels vehicle maintenance (checkpoint) activities in an open area with a large airflow. If the vehicle is in an enclosed area, raise the warehouse or garage door.

Vehicle and Asset Decontamination

Within 1 hour of contamination, vehicle and equipment operators must decontaminate the parts that will be touched continually. There is no need to create formal vehicle decontamination teams. However, ensure that you clearly identify dirty vehicles as containing a residual chemical hazard. The operator's or work center's accomplishment of expedient decontamination using M295 decontamination kits will suffice to continue operations. Use M295 decontamination kits to decontaminate appropriate asset surfaces if more than cursory contact is necessary; that is, leaning on hood compartment, kneeling in truck bed. Vehicle decontamination operations will not produce significant results once the agent has absorbed into the paint or other absorbent surfaces; for example, rubber, textiles, plastic

As noted earlier, please refer to AFMAN 10-100 for further guidance.

Wet-Wing Operations

In the event fuel is not immediately available from local sources, a wet-wing operation can be used to sustain operations for a minimal amount of time. Wet-wing operations are basically the same as defueling an aircraft. An R11 or FMSE can be used to extract fuel from the aircraft shown in the table that follows.

Aircraft	Qty Available to Offload
C-5	53K
C-17	27K
C-130	4K

Wet-Wing Information

Helpful Fuels Terms

ABFDS—Aerial Bulk Fuel Delivery System

Additive—agents used for improving existing characteristics or for imparting new characteristics to certain petroleum products (for example, fuel-system icing inhibitor and corrosion inhibitor).

Advanced echelon (ADVON)—an initial deployment element of personnel and equipment in a specific unit type code. The ADVON normally consists of equipment and personnel required to establish an austere operating capability of up to 7 days.

Alternate capability equipment (ACE)—hose and filter assembly allowing aircraft to be refueled directly from the ABFDS.

Alternate fuel—fuel authorized for continuous use. The operating limits, thrust outputs, and thrust transients shall not be affected adversely. The applicable aircraft flight manual shall define limitations, if any, of a significant nature on aircraft performance parameters. The use of an alternate fuel may result in a change of maintenance or overhaul cost. Engine trim adjustments may be necessary or desirable to use an alternate fuel.

American Petroleum Institute Gravity—scale for measuring the density of liquid petroleum products. Gravity is important in determining product identification because it indicates which product is heavier in relation to another product.

Area lab—laboratory that provides testing services on samples of petroleum products. The labs perform specification tests to determine the quality of products under procurement and in Air Force inventory.

Ash content—the inorganic matter in combustible material. Determined by completely burning the substance and weighing the residue. This is important where fuel requirements demand minimum ash residue after combustion. The ideal fuel is one that burns and leaves no ash.

ASTM—American Society for Testing Materials.

ATHRS—air-transportable hydrant refueling system

Auto ignition—spontaneous ignition resulting in rapid reaction of the air-fuel mixture in an engine. The flame speed is many times greater than the normal ignition spark. In a reciprocating engine, the noise associated with auto ignition is called knock.

Automated Airfield Information File (AAFIF)—information database prepared by the Defense Mapping Agency that lists comprehensive airfield data. It includes fuel support capability at overseas military and civilian airfields.

AVFUELS—aviation fuels, both gasoline and turbine.

AVGAS—aviation gasoline for reciprocating engine aircraft.

Bare base—a base that has a runway, taxiway, parking area, and source of water that can be made potable.

Bare-base system—Air Force system consisting of Harvest Eagle, Harvest Bare, and FMSE.

Designed to provide minimum essential troop facilities and operational support.

Barrel (BBL)—standard unit of measurement of petroleum liquids, consisting of 42 US standard gallons at 60° F. A barrel is not a container. Usually confused with a drum.

Benzene—a colorless liquid hydrocarbon with six carbon atoms and six hydrogen atoms arranged in a hexagonal ring structure. Used as a component in high-octane gasoline.

Benzin—term used in some countries, meaning gasoline.

Black cargo (dirty cargo)—general term used to describe liquid cargoes of crude or fuel oils.

BPD—barrels per day.

BTU—abbreviation for British Thermal Unit, amount of heat necessary to raise the temperature of 1 pound of water to 1° F. In flying operations, it indicates the amount of heat energy that can be obtained from a given weight of fuel.

Bulk petroleum products—liquid petroleum products transported by various means and stored in tanks or containers having an individual fill capacity greater than 260 liters (69 gallons).

C-Day—the unnamed day on which a deployment operation commences or is to commence.

CI—corrosion inhibitor.

Class III—category of supplies, including petroleum fuels, lubricants, compressed gases, chemicals, and so forth.

Classes of fires—

- Class A, fire of ordinary combustibles, such as paper, wood, extinguishable by water.
- Class B, fire of flammable liquids like gasoline, oil, and grease and extinguished by smothering
- Class C, fires involving electrical equipment and are extinguished by nonconducting agents.
- Class D, fires involving burning metal.

Clean cargo—aviation and motor gasoline, diesel oils, lubricating oils, jet fuels, and kerosene.

Cloud point—the temperature at which paraffin or other solid substances begin to crystallize or separate from solution, imparting a cloudy appearance to the oil. Important in arctic or polar operations. Wax crystals will plug fuel injectors and stop the engine.

Collocated operating base (COB)—active allied host-nation base designated for joint use by US wartime augmentation forces or relocation in-place forces. COBs are not US bases.

Color—various types of petroleum products, such as aviation and automotive gasoline, are dyed to permit a rapid visual determination of product and grade. Visually detectable changes in color intensity or hue may be an indication of product contamination or deterioration.

Commingling—mixture of two or more petroleum products normally attributed to improper handling.

Common servicing—function (achieved through agreement) performed by one service in support of another for which reimbursement is not required from the service that is receiving the support.

Composite sample—a mixture of samples taken from the upper, middle, and lower thirds of a container.

Conductivity—test that measures the electrical conductance of the fuel in picosiemens per meter, normally referred to as conductivity units. The higher the number, the more rapidly the fuel will dissipate any electrical charge within the fuel. Conductivity additive raises this number to a point where the fuel is unlikely to accumulate electrical charges strong enough to cause sparks and subsequent ignition.

Conductivity additive—fuel additive that aids in relaxing static charges in fuel by increasing conductivity.

Distribution plan—a summary of contract award data prepared and published by DESC to advise CONUS and overseas fuel regions and other petroleum management activities how requirements of a procurement program and delivery period will be supported.

Downgrading—the procedure by which a product is approved for use as a lower grade of the same or similar product, usually performed as a result of contamination or an off-specification condition.

Drum—a 16- or 18-gauge steel cylinder container (generally, 55-gallon size) for petroleum products, often erroneously referred to as a barrel.

Drum thief—a metal or plastic tube used to withdraw samples from drums.

Emergency fuel—per TO 42B1-1-14, a fuel that may cause significant damage to the engine or other systems; therefore, its use shall be limited to one flight. The applicable aircraft flight manual or system manager should be consulted regarding operating restrictions and postflight maintenance actions necessary when using an emergency fuel. Examples of conditions that might warrant use of emergency fuels are accomplishing an important military mission, countering enemy actions, emergency evacuation flights, and emergency aerial refueling.

Explosive limits—the limits of percentage composition of mixtures of gases and air within which an explosion takes place when the mixture is ignited. The lower limit of flammability corresponds to the minimum amount of combustible gas and the upper limit to the maximum amount of combustible gas capable of conferring flammability on the mixture. Also referred to as flammable limits and explosive range.

FARE—forward air-refueling equipment.

Fire point—the lowest temperature at which, under specified conditions in a standardized apparatus, a petroleum product vaporizes rapidly enough to form an air-vapor mixture above its surface, which burns continuously when ignited by a small flame.

Flammable—a term describing any combustible material that can be ignited easily and which will burn rapidly. Petroleum products that have flashpoints of 37.8° C (100° F) or lower are classified as flammable.

Flashpoint—the lowest temperature at which vapors rising from a petroleum product will ignite momentarily on application of a flame under specified conditions.

Forward area refueling point (FARP)—an operation used to hot refuel aircraft in areas where fuel is otherwise not available. Fuel is transferred from a source aircraft's (C-130, C-141, C-17, or C-5) internal tanks to receiver aircraft while both aircraft engines are running, typically at remote locations under blackout conditions.

Fuels mobility support equipment (FMSE)—air-transportable, fuels-handling equipment (excluding refueling vehicles) used to receive and issue fuel at bare bases and to augment locations with fixed-fuel facilities. Examples include air-transportable hydrant systems (R-14s), bulk pumps (R-22s), and filter separators (FFU-15s).

Fuels operational readiness contingency equipment (FORCE)—provides a joint capability to fuel aircraft in a limited, bare base or commercial sites without infrastructure. One FORCE set allows a base to receive fuel at perimeter of base, store 1.2 million gallons of fuel, and issue 400,000 gallons per day. Compared to old FMSE, FORCE reduces lift and footprint requirements 29 percent; increases throughput of fuel by 40 percent; and improves safety, reliability, and flexibility of the system.

Fuel system icing inhibitor (FSII)—an agent (diethylene glycol monomethyl ether) used as an anti-icing additive for jet turbine engine fuels.

GPH—gallons per hour.

GPM—gallons per minute.

Ground products—those refined petroleum products normally intended for use in administrative, combat, and tactical vehicles;

materiel-handling equipment; special purpose vehicles; and stationary power and heating equipment. Products include motor gasoline, diesel fuels (except DFM/F76), fuel oils, kerosene, and ground equipment lubricating oils.

Harvest Bare—a nickname for an air-transportable package of hard-wall shelters and equipment designed to support Air Force operational squadrons and personnel at bare bases. The package includes housekeeping, aircraft maintenance, and some vehicular support. Harvest Bare is intended to provide a broad base of logistics support for sustained Air Force operations.

Harvest Eagle—a nickname for an air-transportable package of housekeeping equipment, spare parts, and supplies required for support of Air Force general-purpose forces and personnel at bare bases. Each kit is designed to provide soft-wall housekeeping support for 1,100 persons. Harvest Eagle is not intended to be an all-inclusive package of logistics support for sustained air operations; however, it may be used until augmented by Harvest Bare.

HEMMT—Army refueling vehicle.

JPTS—thermally stable jet fuel.

Ignition point—the point on a temperature scale at which a substance may be ignited or produce combustion.

Limiting factor—a factor or condition that either temporarily or permanently impedes mission accomplishment.

LIN—liquid nitrogen.

LOX—liquid oxygen.

MIKE (M)—Single letter abbreviation used to designate units in thousands; for example, 100,000 barrels may be referred to as 100M barrels or 100 MIKE barrels.

Naptha—a term applied to refined, partly refined, and unrefined petroleum products and liquid products derived from natural gas that distill mainly between 175°C (347°F) and 237.8°C (462°F).

Operation plan (OPLAN)—a plan for a single or series of connected operations to be carried out simultaneously or in succession. It usually is based on stated assumptions and is the form of directive employed by higher authority to permit subordinate commanders to prepare supporting plans and orders.

Outsized cargo—a single item that exceeds the dimensions of 810 x 117 x 105 inches but is less than 1,453 x 216 x 114 inches.

Oversized cargo—a single item that exceeds the usable dimensions of a 463L pallet (104 inches x 84 inches) and a height established by the cargo envelope of the particular model aircraft (96 inches for military aircraft and 48 inches for Civil Reserve Air Fleet) but not to exceed 810 x 117 x 105 inches.

Packaged fuel—bulk petroleum fuels, which, because of operational necessity, are packaged and supplied in containers of 5- to 55-gallon capacity. Fuels in military collapsible containers of 500-gallon capacity or less are also included in this category.

Pipeline time quantity—that quantity calculated by multiplying the daily demand rate by the amount of time, in days, required to deliver products from source to terminal, including discharge and settling times as applicable.

POL—petroleum, oils, and lubricants. Also, refers to all products handled by Air Force fuels management personnel including LOX, demineralized water (DW).

Prepositioned war reserve materiel requirement (WRM)—the portion of the WRM requirement that current Secretary of Defense guidance dictates be reserved and positioned at or near the point of planned use prior to hostilities; intended to reduce reaction time and ensure timely support of a specific force or project until replenishment can be effected.

Prepositioned WRM Stock—assets designed to satisfy the prepositioned WRM requirement.

Primary fuel—per TO 42B1-1-14, the fuel or fuels used during aircraft tests to demonstrate system performance (contract compliance) through the complete operating range for any steady-state and transient operating condition.

Peacetime operating stock—logistics resources that are on hand or on order necessary to support day-to-day operational requirements; can also be used to offset sustaining combat requirements.

Primary stockage objective—the maximum quantity of materiel authorized to be on hand to sustain current operations. It consists of the safety level quantity and economic resupply quantity.

REPOL—petroleum damage deficiency report.

Shell capacity—the gross volume of a petroleum storage tank as determined from tank calibration. The term is synonymous with rated storage capacity.

Short ton—unit of weight equal to 2,000 pounds.

Sortie rate—rate at which assigned aircraft are scheduled to fly. Example, if a squadron of 18 aircraft were expected to achieve a 1.5 sortie rate, it would have to fly a total of 27 missions (1.5 times 18) in 1 day.

Source Identification and Ordering Authorization (SIOATH) Form—a form listing contractor supply sources and effective prices and quantities for authorized activities to order or requisition. It also advises the ordering activities of the supply data necessary to schedule a product and place an order.

Special Experience Identifier (SEI)—a three-digit number used to identify personnel with special training or skills. SEIs in fuels are FARRP-035, cryotainer maintenance-036, cryoproduction-037, laboratory-039, accounting-040, ABFDS-369, and ATHRS-387.

Specific gravity—the ratio of the weight of a given volume of the material at 60° F to the weight of an equal volume of distilled water at the same temperature, both weights being corrected for buoyancy of air.

Surfactant—a substance capable of reducing.

Water entrained—free water that is suspended throughout a fuel sample and has not settled to the bottom of the container. This water is normally separated from the fuel by ground-servicing equipment filter separators.

Water, free—all water present in fuel that has not been dissolved in the fuel. This water normally is separated from the fuel by ground-servicing equipment filter separators.

Water Separation Index Modified (WSIM)— measures the water separation characteristics of fuels. This test reflects the ease with which fuel releases dispersed or emulsified water. Surfactants have an adverse effect on the WSIM rating. Fuels with low WSIM ratings will poison filter separators and prevent them from functioning properly.

Fuels Airfield Site Survey

The following is a sample guide of the kind of information a fuels person needs to determine fuel support capability at a deployed location. The survey is not all-inclusive but provides a good foundation to build from. This survey is broken out by work area; however, a deployed environment may not be configured in this manner.

Bulk Storage

- What products will be stored? Where will they be stored, on or off base?
- How many tanks are available, and what is the storage capacity?
- What are minimum and maximum inventory levels?
- How many fill stands are there, and what is their pumping capacity? Are they top or bottom loader types?
- How far are fill stands from the refueling area?
- Are they equipped with meters?
- How is the product resupplied, what is the resupply capability, and are special adapters needed?
- How many receipt headers exist. Where are they located?
- How many trucks can offload simultaneously?
- What is the total per-hour receiving, using all methods of receipt for each grade of product (in gallons); can fuel be resupplied year round?
- Are LOX, LIN, DW, ground fuels, or deicing fluid available?
- If not, where can they be obtained, and what is their resupply rate?

- How are ground fuels resupplied?
- Does a fuel service station exist?
- Where is it located? What products are stored and dispensed?
- Are bulk storage tanks dedicated to sole Air Force, Joint service, or combined operations use?
- Do earthen or sandbagged dikes exist for fuel bladder placement?
- Does FMSE positioning facilitate combat quick turns?
- Are available personnel trained to assemble FMSE systems?
- Is backup power available for fuels systems?
- Who is designated to maintain the system?

Hydrant Systems

- What types of hydrant systems are available—fixed, portable—and what is their condition?
- What is the storage capacity?
- What is the receipt capability; can the system receive directly from commercial source?
- How many outlets are available?
- What is the refueling capacity of the system?
- How many aircraft can be serviced simultaneously; what is the flow rate?
- Can large aircraft (C-5, B-52, C-17) be parked on outlets?
- Can they taxi on and off, or do they have to be towed?
- Are outlets far enough apart to permit simultaneous parking of more than one large aircraft on the same lateral?
- How many fill stands are available; what is their location and pumping capacity?
- How many and where are the offloading headers located for defueling?

- How many hosecarts are available? What is their condition? Are special adapters needed?
- Who will maintain the system and equipment?
- Is emergency power available?

Refueling Equipment

- How many refueling units are available?
- What is their condition?
- Who will maintain refuelers?
- How many general-purpose vehicles are designated for POL?
- What type of communication is available; for example, number of phones, hot lines, mobile radios?
- Is computer connectivity available?
- Where will the fuels information service center be located? (building and phone number)
- Does facility have backup power?
- Are WRM units designated for the deployed location; when will they arrive?
- What security measures are available for the compound?
- Where will refueler parking area be located?
- What is the average turnaround time for refueling from full on the line to the fill stand and back?

POL Laboratory

- Is a fuels lab available at the host site? If not, where will the lab be located?
- Is the host lab equipped, supplied, and manned with trained technicians to perform necessary analysis?
- Where and how far (distance and travel time) is the nearest commercial or area laboratory?

Fuels Personnel

- What is the host base's fuels personnel strength?
- How many are designated to arrive?
- Are provisions ready, such as quarters, latrines, and meals?
- Will additional fuels personnel be required because of increased flying?
- Are there sufficient numbers of SEI-qualified people to man lab, accounting, cryogenics, and FMSE functions?
- Identify any limiting factors or shortfalls that would adversely impact the mission of the deployed unit.

Unit Type Codes

Personnel Unit Type Codes

JFA7M POL FUELS 7 LVL SUPERVISOR
JFA7S POL FUELS 7 LVL SUPERVISOR
JFA9M POL FUELS 9 LVL MANAGER
JFABA POL AUGMENTATION PACKAGE
JFABB POL FUELS BUILDING BLOCK PKG
JFABF POL ABFDS OPERATIONS CREW
JFACM POL CRYOGENICS MAINTENANCE
JFAFT POL FMSE SET-UP TEAM
JFAQT POL TECHNICAL ASSISTANCE TEAM
JFARC POL FUELS RESOURCE CONTROLLERS
JFARM POL REFUELING EQUIPMENT MANAGER
JFARP FORWARD AREA REFUELING TEAM
JFASA POL FUELS SPECIALTY SUPPORT
JFDE2 POL FSII INJECTION TEAM

Equipment Unit Type Codes

JFA3K POL 3 K FUEL STORAGE BLADDER
JFACS POL CRYOGENIC SAMPLING KIT
JFALB POL 210K FUEL STORAGE BLADDER
JFALN POL 210K BERM LINER
JFALS POL TECH LAB MATERIAL AND EQUIP
JFANV AF FUELS NIGHT VISION GOGGLES
JFAXC POL 01 200K BULK STG SYS
JFDBS BS FORCE 800K GALLONS BULK STORAGE
JFDEE POL FUEL INVASION PIPELINE
JFDEG POL R14 ATHRS FUEL STG ACFT
JFDEJ POL R22 FUEL PUMP
JFDEK POL 01 PMU 27 50GPM PUMP SVC
JFDEL POL 10K FUEL STORAGE BLADDER
JFDEM POL 50K FUEL STORAGE BLADDER

JFDEN POL GRU17E FUEL SERVICING
JFDEP POL FUEL FILTER-SEPARATOR
JFDEQ POL 400 GAL LOX STORAGE TANK
JFDER POL 01 400 GAL LIN STORAGE
JFDES POL 01 FUELS SUPPORT KIT
JFDET POL 02 PMU-27 PUMPS 50 GPM
JFDEU POL 03 R14 ATHRS STG ACFT SVS
JFDEV POL 02 R22 PUMPS 600-900 GPM
JFDEW POL 01 ABFDS SYSTEM
JFDEX POL 04 ABFDS SYSTEM
JFDEY POL 01 ABFDS DEL SYS-ACE
JFDFF FF FULL FORCE PACKAGE
JFDFS FORCE STARTER
JFDFU FU FORCE 1200 GPM FILTER SEPERATOR UNIT
JFDGE POL FUEL ADDITIVE INJECTOR
JFDGF POL LABORATORY KIT
JFDHL HL FORCE HOSE LINE
JFDIS IS FORCE INCREASED STORAGE
JFDPU PU FORCE 900 GPM PUMP
JFDRC RC RECEIPT CAPABILITY
JFDSC SC FORCE ADDITIONAL SERVICING CAPABILITY
JFDSP FORCE SERVICING PLATFORM
UFM71 POL 01 C300 GPOL SVC TNK TK
UFM72 POL 01 C-301 GPOL SVC TANK TRK
UFM73 POL 01 R-12 HYD SERVICING VEH
UFM74 POL 01 R-11 FUEL TANK TRUCK
UFM75 POL 01 L-304 GPOL SVC TANK TRK

UTC MISCAP can be found in AFPAM 23-221, Attachment 14

References and Supporting Information

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AFI 23-201, *Fuels Management*

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DoD 4140.25M, *DoD Management of Bulk Petroleum Products, Natural Gas, and Coal*

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TO 37-1-1, *Operation, Inspection of Permanent Fuel Systems*

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TO 37A9-3-5-1, *A/E32R-14 Fuel System*

TO 37A9-3-7-1, *C-130 ABFDS*

TO 37A9-3-8-11, *A/M32R-25 Fuel System*

TO 37A9-3-11-1, *GRU-17/E*

TO 37A12-15-1, *10K/50K Bladders*

TO 37C2-8-10-4, 4*00 Gal LOX/LIN Storage Tank*

TO 42B-1-1, *Quality Control*

The Unsung Heroes of the Flight Line

Most people don't care, or realize as well, the job done by base POL. To the pilots and crews, refueling's a bore and the reason, I feel, is they don't know the score. From drawing board to production line, it takes large appropriations to build a great aircraft, and get it on station. And lost in the shuffle, at least seems the rule, is the need for this "bird" to be fed good clean fuel. The engine men settle for no less than perfection, and the radar men strive for much finer detection, but exposed to the corrections of every known tool, the aircraft goes nowhere without the right fuel. But POL's job can be very complex, from receiving at bulk to their quality checks. They, too, tune equipment with no element of guess, to ensure that pumps hum and filters coalesce. They check each sample by chemical test, and their quality control plan is always the best. From lead acetate paper to isometric titration, the fuel runs the gamut to meet specification. The process seems simple: You place a call to the POL dispatcher, who checks the chart on the wall. He sends out a unit in accordance with the order be it JP, or AVGAS, or demineralized water. So the next time you observe an aircraft go off, full bore down the runway, with nary a cough, and rise in the air, a most thrilling show, POL played a big part in making it go.

—Unknown Author

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