ATP 4-43

Petroleum Supply Operations

August 2015

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Preface

ATP 4-43, *Petroleum Supply Operations*, provides techniques to accomplish petroleum supply operations.

The principal audience for ATP 4-43 is personnel of all grades and levels performing in petroleum supply positions. It is also applicable to personnel assigned to operational commands and staffs and provides both of these groups with information necessary to conduct effective petroleum supply operations. Furthermore, ATP 4-43 provides information pertinent to multi-service partners and to units that must interact with multi-service partners. Commanders and staffs of Army headquarters serving as joint task force or multinational headquarters should also refer to applicable joint or multinational doctrine concerning the range of military operations and joint or multinational forces. Trainers and educators throughout the Army will also use this publication.

Commanders, staffs, and subordinates ensure that their decisions and actions comply with applicable United States, international, and, in some cases host-nation laws and regulations. Commanders at all levels ensure that their Soldiers operate in accordance with the law of war and the rules of engagement. (FM 27-10.)

ATP 4-43 uses joint terms where applicable. Selected joint and Army terms and definitions appear in both the glossary and the text. Terms and definitions for which ATP 4-43 is the proponent publication (the authority) are italicized in text and are marked with an asterisk (*) in the glossary. Terms and definitions for which ATP 4-43 is the proponent are boldfaced in the text. For other definitions shown in the text, the term is italicized and the number of the proponent publication follows the definition.

ATP 4-43 applies to the Active Army, Army National Guard/Army National Guard of the United States, and United States Army Reserve unless otherwise stated.

The proponent of ATP 4-43 is the United States Army Quartermaster School. The preparing agency is the G3 Doctrine Division, Combined Arms Support Command. Send comments and recommendations on a DA Form 2028 (Recommended Changes to Publications and Blank Forms) to Commander, United States Army Combined Arms Support Command and Fort Lee, ATTN: ATCL-TS (ATP 4-43), 2221 A Avenue, Fort Lee, VA 23801; or submit an electronic DA Form 2028 by e-mail to: usarmy.lee.tradoc.mbx.leee-cascom-doctrine@mail.mil.

Introduction

ATP 4-43, *Petroleum Supply Operations*, is the United States Army reference for commanders, staff personnel, and Soldiers performing petroleum storage and distribution operations. ATP 4-43 expands the discussion of basic petroleum operations introduced in FM 4-40, Quartermaster Operations, and petroleum distribution discussed in ATP 4-93, *Sustainment Brigade*. Combined with these publications, ATP 4-43 provides the reader with an understanding of petroleum supply operations to include greater fidelity and detailed techniques for operations.

ATP 4-43 combines the previous version of ATP 4-43 with information from FM 10-67-1. The additions to this manual include information and techniques for petroleum tank car, class III supply point, aircraft refueling, waterfront and pipeline and terminal operations.

ATP 4-43 contains four chapters and 24 appendices:

Chapter 1 provides a brief discussion of the fundamentals of petroleum supply. It also gives the reader an understanding of the Army's role in petroleum supply in a theater of operations, in organizations at brigade and echelons-above-brigade, and its mission and responsibilities, without duplicating the information found in sustainment ADPs, ADRPs, and FMs.

Chapter 2 introduces petroleum distribution systems and equipment to provide the reader with a basic understanding of the Army's capability to accomplish its petroleum distribution mission and requirements.

Chapter 3 provides information on petroleum properties; health and safety aspects of petroleum handling to include grounding, bonding, fire prevention, environmental considerations, first aid and personal protective equipment.

Chapter 4 provides the reader with basic understanding of Army petroleum operations. This chapter includes accountability and distribution measures and the application of the various petroleum systems and equipment. It also gives the reader and understanding of quality surveillance and assurance requirements as well as the handling of petroleum packaged products.

ATP 4-43 does not introduce any new terms, rescind any terms or modify any terms.

Chapter 1

Petroleum Supply Overview

This chapter describes Army petroleum supply, principles and petroleum distribution in a theater of operations. The information in this chapter can be used by all Army organizations to plan for petroleum storage and distribution operations.

SECTION I – FUNDAMENTALS OF PETROLEUM SUPPLY

1-1. This section provides an introduction to petroleum supply distribution, a brief description and principles of petroleum supply, fuels management and operational energy.

PETROLEUM SUPPLY DESCRIPTION

1-2. Petroleum supply is the management and execution of petroleum distribution from the original source or supply point to the customer, or end-user receipt, with emphasis on the continuous improvement of the efficiency of the supply chain. Petroleum supply involves allocating the right quantities of product to the right locations at the right time on the battlefield. The petroleum mission is to ensure the force has the petroleum resources to provide operational reach, freedom of action and sustainability.

1-3. Petroleum supply involves the receipt, storage, distribution, quality assurance and surveillance, consumption, logistical planning and support of bulk petroleum, class III bulk (B), and packaged petroleum products, class III packaged (P). Petroleum includes not only the naturally derived product, but also alternative, renewable and synthetic fuels and their blends.

- Class III (B) (bulk petroleum products) includes petroleum products (fuels, lubricants) which are normally transported by pipeline, hoseline, rail tank car, tank truck, barge, or tanker and stored in tanks or containers having a capacity of more than 55 gallons.
- Class III (P) (packaged petroleum products) includes petroleum and chemical products generally lubricating oils, greases, and specialty items normally packaged by the manufacturer and procured, stored, transported, and issued in containers of 55 gallon capacity or less.

PRINCIPLES OF PETROLEUM SUPPLY

1-4. Petroleum supply is planned and executed at all levels of operations. The following describes the roles and actions at each level.

- At the strategic level, the combination of Service, agency, and commercial organizations encompass the top of the petroleum supply chain. This level of petroleum supply assists in the projection and long-term sustainment of the combatant commander's (CCDR) bulk petroleum requirements. The strategic level emphasis is on utilizing the nation's industrial base to enhance the CCDR's capabilities through leveraging of strategic resources while maintaining flexibility in the face of a dynamic logistic environment.
- At the operational level, integration of strategic aim and tactical capabilities of the force to meet the combatant command's operational requirements. The bulk petroleum logistician encounters the greatest challenges at this level because of the difficulty in integrating the capabilities from many providers who must project, distribute, and sustain bulk petroleum for the joint forces command.
- The tactical level involves the installation and operation of tactical petroleum storage and distribution systems to support their forces. Tactical units derive their sustainment primarily from the strategic and operational levels for bulk petroleum operations and leverage the benefits of that sustainment to permit freedom of action. Tactical level organizations contribute to force readiness

by applying the three imperative capabilities critical to success: unity of effort, theater wide petroleum visibility, and rapid and precise response.

- In the undeveloped theater, bulk petroleum is generally distributed using various temporary, rapidly employed systems. These systems include the *offshore petroleum discharge system* (OPDS) in over the beach operations, *inland petroleum distribution system* (IPDS), *tactical petroleum terminal* (TPT), host nation support facilities, *assault hoseline system* (AHS), petroleum tank vehicles, *fuel system supply point* (FSSP), leased shipping and other flexible systems.
- In the developed theater, bulk petroleum is generally not locally procured and is received from ocean vessels at marine terminals and transferred by pipeline to tank farms. Semi-permanent to permanent bulk petroleum storage facilities may be implemented in this setting. Pipeline system extends as far forward as practical. The system is then supplemented by other means of delivery such as barges, rail tank cars, tank vehicles and aircraft.

1-5. There is no particular arrangement of the undeveloped/developed petroleum supply chain layout in a theater of operations. The organizations and equipment involved is determined by the area of operations and the operational environment. Theater level organizations, such as the theater sustainment command (TSC), are responsible for the assessment, development and planning of the petroleum supply chain in a theater of operations, whether undeveloped or developed. Figure 1-1 illustrates a typical petroleum supply chain in both the undeveloped and developed theater.

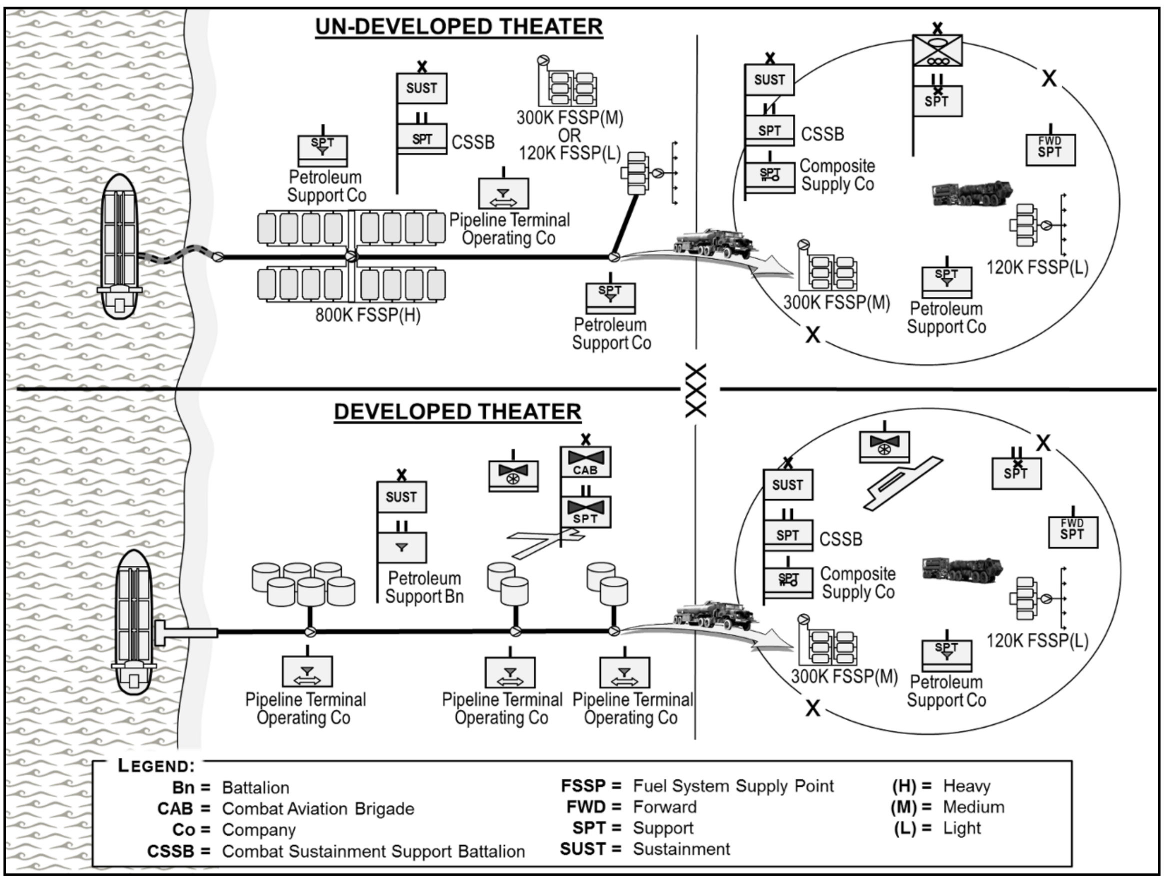

Figure 1-1. Undeveloped/developed theater

1-6. Joint Publication 4-03, *Joint Bulk Petroleum and Water Doctrine*, describes the Army's role in bulk petroleum supply as, "The Army normally provides management of overland petroleum support, including inland waterways, to United States land-based forces of all Department of Defense components. To ensure wartime support, the Army will fund and maintain tactical storage and distribution systems to supplement fixed facilities. The Army will also provide the necessary force structure to install, operate, and protect tactical petroleum storage and distribution systems, including pipelines. In an immature theater, this also includes providing a system that transports bulk petroleum inland from the high-water mark of the designated ocean beach. Thus, the Army is responsible for receiving, storing, transporting, and distributing fuels for all land-based forces from the high-water mark at sea to area support distribution centers and retail supply points.

1-7. Department of Defense 4140.25-M, *DOD Management of Bulk Petroleum Products, Natural Gas, and Coal*, states the Army will provide:

- Wartime planning and management of overland petroleum distribution support, including inland waterways to United States land base forces of all Department of Defense (DOD) components. To ensure wartime support, the Army will fund and maintain tactical storage and distribution systems to supplement fixed facilities.
- The necessary force structure to operate and install tactical petroleum storage and distribution systems, including pipelines. The Army will maintain laboratories for certification testing of petroleum and related products used in ground vehicle and equipment system applications, and other than fixed-wing aircraft.

1-8. To supplement shortfalls in the Army petroleum force structure, contracted support may be used in varying capacities. Operational contracted support of petroleum support includes, but not limited to, fixed storage facilities, bulk petroleum line haul and retail fuel support.

1-9. Petroleum fuels are identified using placard identification numbers and NATO fuel codes. These identification numbers and codes are shown in appendix M.

1-10. DOD directed the Services to standardize fuel usage, thereby minimizing the types of fuels required in joint operations. DOD 4140.25-M prescribes that jet propulsion 8 (JP8), a kerosene-based jet fuel similar to the commercial jet fuel Jet A-1, be designated as the primary fuel for land-based air and ground forces to enhance simplicity and flexibility. Additional fuel types are typically on hand and available.

1-11. Jet propulsion 5 (JP5), a kerosene-based jet fuel is primarily used for Navy carrier-based aircraft.

1-12. F-24 is a kerosene-based fuel established by the commercial fuel Jet A specification with military additives included. See appendix A for detail on F-24.

1-13. F-76 is a United States naval diesel similar to marine gas oil.

1-14. The primary goal of petroleum distribution should focus on initiating and maintaining an uninterrupted flow of "on specification" fuel with ground lines of communication as far forward as possible.

1-15. The Army supplies its own tactical bulk distribution system. The bulk petroleum distribution system in theater of operations is the network delivering bulk fuel to the end user units. The distribution system may consist of storage terminals, pump stations, pipelines, hose lines, class III supply points, tank vehicles, and rail tank cars. In an undeveloped theater, the bulk petroleum distribution system may consist of TPTs, hose lines, FSSPs, the modular fuel system and tank vehicles. In a developed theater, the bulk distribution system may be similar to that of the undeveloped theater however, a developed theater normally consists of fixed facilities. Host nation support may be available in both undeveloped and developed theaters.

FUELS MANAGEMENT

1-16. The Army Service Component Command (ASCC) determines bulk petroleum requirements for submission to the CCDR's joint petroleum office (JPO) or sub-area petroleum office (SAPO). During major contingency operations, the JPO validates the bulk petroleum requirements for planning and support purposes and provides them to Defense Logistics Agency Energy (DLA Energy) for sourcing, analysis, and development of a support plan. After JPO validation, the ASCC is responsible to provide the United States Army Petroleum Center (USAPC) a copy of the requirements. During smaller contingencies, routine requirements or for annual validation, the USAPC works directly with DLA Energy to validate unit requirements.

1-17. Defense Fuel Support Points (DFSPs) are designated storage facilities wherein DLA Energy owned fuel is stocked for distribution to multiple military end user operational and maintenance accounts (e.g., aircraft, vehicles, ships or tanks, for which fuel is purchased through multiple operational and maintenance accounts). DFSPs range in size and scope from a single tank to a pipeline system with a network of multiple terminals.

1-18. Petroleum management personnel are trained in all aspects of petroleum operations. Persons involved in contingency planning or execution of contingency operations should also have a working knowledge of fuel distribution systems. The senior fuels representative planning or deploying in support of an operation should be prepared to provide standardized refueling support in a nonstandard environment. Appendix O provides basic tool for petroleum managers to consider during operations.

1-19. The petroleum commodity is subject to fraud, waste and abuse if not accounted for and handled properly. Automating fuel systems, accurate quality surveillance, frequent physical inspections and auditing, establishing responsibility and good stewardship make fuel accountability effective and less subject to fraudulent activities. Commanders must instill upon unit personnel to exercise reasonable and prudent actions to properly use, care for, and safeguard all petroleum products in their possession. Good management of petroleum products includes the upkeep of records of inventory and documents that show gains, losses, dues-in, dues-out and balances on hand or in use.

1-20. Just-in-time logistics is not the ideal method for a bulk fuel management however, it should be considered as part of the planning and forecasting process to match the rate of distribution and quantity of storage to the demand as required.

1-21. The basic concept of fuels management in theater operations is to maintain storage levels to meet daily demand and required stock objectives and to focus on a plan that maintains constant distribution of petroleum while reducing the number of convoys and personnel required in distributing the product. This requires constant communications through all levels of the supply chain to ensure fuel is available to meet demand.

- Pipeline and hose line operations reduce the need to distribute fuel by road, rail or inland water however, increases the demand for security of its network.
- Pipeline operations are maintained by integrating multiple modes of communication along the pipeline network.

OPERATIONAL ENERGY

1-22. The *Duncan Hunter National Defense Authorization Act for Fiscal Year 2009* defines operational energy as the energy required for training, moving, and sustaining military forces and weapons platforms for military operations. Energy is critical to the joint force's ability to conduct and support operations, enabling maneuver and freedom of action and providing operational reach and endurance. Providing energy alternative capabilities and interoperability builds flexibility and resilience through increased ability to respond to changes in operational demands, and greater ability to adapt to changes in the operational environment.

1-23. Operational energy is the sum of energy and associated systems, information and processes required to train, move, and sustain forces and systems for military operations. Operational energy is focused on improving the Army's capabilities through better use of energy. Through conservation of energy resources, commanders reduce resupply operations, increase vehicle and equipment efficiency, and reduce environmental damage. Leaders must consistently plan, execute and oversee operational consumption, use alternative energy means, and incorporate the latest energy saving technologies and procedures. Employing a combination of best practices in petroleum supply operations will extend operational reach and reduce mission risk.

1-24. Operational energy, as it relates to petroleum supply, is the need for increasing the use of clean, renewable energy to reduce the dependency on fossil fuels and optimize environmental benefits and sustainability. This ongoing strategy could potentially reduce the demand for petroleum products on the battlefield, thus affecting how petroleum operations are planned and executed.

SECTION II – PETROLEUM DISTRIBUTION ORGANIZATIONS

1-25. The purpose of this section is to describe the petroleum distribution organizations and their responsibilities in the petroleum supply chain in theater. All petroleum units are dependent on higher-echelon units for administrative support, supplemental transportation and maintenance support that go beyond the ability of organic design.

1-26. Theater petroleum operations begin with the planning and coordination at the strategic level with the combatant commander and Army service component command level. Coordination is made with the JPO, DLA Energy and the USAPC. The management and accounting for theater bulk petroleum for land forces is normally performed by the TSC or expeditionary sustainment command (ESC). Theater distribution is executed at the sustainment brigade (SB) and level below. Figure 1-2 is a layout of the echelons of bulk petroleum in theater.

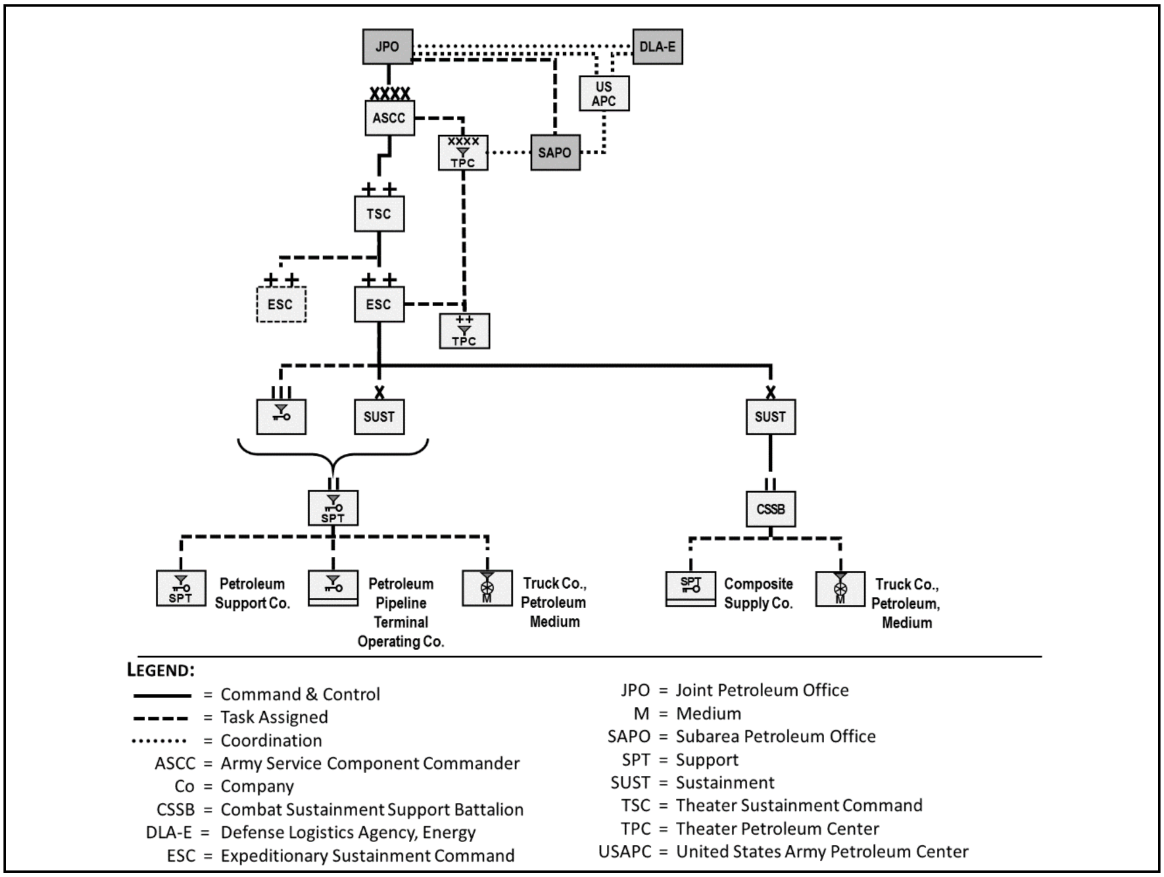

Figure 1-2. Echelons of bulk petroleum distribution in theater

STRATEGIC ORGANIZATIONS

1-27. The sustainment of unified land operations requires a continuous link between all level of command and support beginning with the strategic. The strategic level of petroleum supply operations requires close coordination and collaboration with other services, allies, host nation and other governmental organizations. Strategic level planning for petroleum supply operations in theater begins at the combatant command level and ends with the TSC at the operational level of petroleum support. Coordination with the joint petroleum office (JPO), the ASCC, DLA Energy, the USAPC and the theater petroleum center (TPC) is key to the accomplishment of theater petroleum distribution. These organizations are discussed in the following paragraphs.

COMBATANT COMMAND

1-28. The combatant command (COCOM) is in charge of utilizing and integrating air, land, sea, and amphibious forces under their commands to achieve United States national security objectives while protecting national interests.

1-29. The logistics directorate of a joint staff, J-4 at COCOM is responsible for all petroleum logistics planning and execution in support of their assigned geographic or functional area of operations.

1-30. The CCDR has the predominant fuels responsibility within a theater. The responsibility is discharged by the JPO. The JPO is responsible for the overall planning of petroleum logistic support for joint operations within their *area of responsibility*. This includes arranging for movement of fuel and related products, personnel, and support equipment.

1-31. A joint force commander is a subordinate commander to the CCDR to exercise *combatant command (command authority)* or *operational control* over a joint force. Joint forces are established at three levels: unified CCMDs, subordinate *unified commands*, and joint task forces. Joint forces can be established on either a geographic area or functional basis.

1-32. Further information on combatant commands and joint force command can be found in Joint Publication 1 - *Doctrine for the Armed Forces of the United States*.

DEFENSE LOGISTICS AGENCY – ENERGY (DLA ENERGY)

1-33. In accordance with DOD Directive 5101.8, *DOD Executive Agent (DOD EA) for Bulk Petroleum*, DLA Energy serves as class III (B) executive agent.

- Executive agent actions are strategic in nature, involve all the Services, and are designed to improve interoperability and create efficiencies.
- The executive agent initiatives offer the greatest potential of shaping the DOD fuels community to best support long-term Army transformation goals.

1-34. DLA Energy bulk fuels commodity business unit acts as principal advisor and assistant to the Director DLA Energy commander and the deputy director of operations in directing the accomplishment of mission responsibilities to provide worldwide support of authorized activities in the areas of contracting, distribution, transportation, and inventory control of: bulk fuels, including jet fuels, distillate fuels, residual fuels, automotive gasoline (for overseas locations only), specified bulk lubricating oils, aircraft engine oils, and fuel additives and crude oil.

1-35. The direct delivery fuels commodity business unit acquires and manages ground, aviation, and ship propulsion fuels delivered directly to the customer from commercial vendors and through posts, camps, and stations program.

1-36. DLA Energy is responsib1e for *quality assurance* and *on-specification delivery* of all bulk petroleum products procured and distributed through its supply chain.

JOINT PETROLEUM OFFICE

1-37. CCDR have the predominant fuels support responsibility within a theater. The joint petroleum office executes petroleum responsibilities for the combatant commander and if needed, establishes one or more sub-area petroleum offices.

1-38. The joint petroleum office collaborates with DLA Energy, Service components, sub-area petroleum office, USAPC and the theater petroleum center to plan, coordinate, and oversee all phases of bulk petroleum support for United States forces and other organizations employed or planned for possible employment in the theater.

1-39. The joint petroleum office is responsible for ensuring all participants, to include the Services, allies, coalition partners, and supporting commands coordinate their requirements and maximize their available fuel support capability to provide effective theater-wide support.

1-40. The CCDR's wartime host nation support and transportation agencies process and coordinate requests from the Service components for host nation support, infrastructure, and bulk petroleum transportation assets. For fuel infrastructure projects, the JPO has a particular critical function in coordinating with appropriate engineering agencies to ensure projects meet proper construction and international infrastructure standards. For the Army, fuel military construction project planning must include the Army corps of engineers and the USAPC. Close coordination between the CCDRs' JPO, responsible host nation agencies, military quartermaster and engineer elements is critical to ensure the timely execution of theater bulk petroleum sustainment and management. The stakeholders involved in the process may vary across different theaters of operation.

1-41. Key responsibilities of the combatant commander's joint petroleum office are discussed in Joint Publication 4-03 - *Joint Bulk Petroleum and Water Doctrine*.

SUB-AREA PETROLEUM OFFICE

1-42. A sub-area petroleum office (SAPO) is established by the CCDR as a subordinate office to perform petroleum planning and execution in an area of operations or Joint Operations Area for which the JPO is responsible. A theater may have more than one SAPO.

1-43. SAPO are normally required to:

- Conform to the administrative and technical procedures established by the CCDR and Department of Defense 4140.25-M.
- Be under the operational control of the CCDR.

1-44. Key duties and responsibilities of the sub-area petroleum office are discussed in Joint Publication 4-03 - *Joint Bulk Petroleum and Water Doctrine*.

ARMY SERVICE COMPONENT COMMAND

1-45. The ASCC is tasked to support the supported COCOMs AOR petroleum supply mission. The Army is tasked by United States Code Title 10, *Armed Forces* to support all U.S. land-based forces, including the Air Force, Marine Corps and Naval forces ashore. The Army is responsible for forward movement of fuel and water through a combination of pipelines, hose lines, barges, rail cars, tank trucks, and aircraft. The Army operates and maintains U.S. military petroleum and water facilities that are:

- Engaged in limited war.
- Committed in general war within a highly industrialized area.
- Deployed to undeveloped operational areas.
- In support of defense support of civil authorities (DSCA) operations, foreign humanitarian assistance, disaster relief, etc.

1-46. The ASCC command consists of the Army Service component commander and Service forces, such as individuals, units, detachments, organizations, and installations under that command, including the support forces that have been assigned to a combatant command or further assigned to a subordinate unified command or joint task force. ASCC can only be assigned under COCOM to one CCDR. However, Service component commanders may support multiple CCDRs in a supporting relationship, while not assigned to any of the supported CCDRs.

1-47. The mission of the petroleum and water branch of an ASCC is to provide theater bulk petroleum and water support oversight, policy, procedures, and guidance for assigned ground forces within the CCDR's area of responsibility by:

- Develops and periodically reviews petroleum and water concepts of support for exercise plans, operations plans, and contingency plans.
- Monitors the theater bulk petroleum to ensure adherence to quality assurance and surveillance and provides guidance as appropriate.
- Provides technical guidance to the ASCC staff and units within the area of responsibility.
- Establishing policies and procedures to ensure compliance related to receiving, storing, and distributing bulk petroleum and water.
- Reviews class III (B) requests and forecasts before forwarding to JPOs for validation.
- Coordinates with DLA Energy for routine and emergency bulk fuel resupply.
- Assists contracting personnel in developing bulk petroleum and water performance work statements and assisting contracting officer representatives in monitoring petroleum and water related contracts.

- Submits the Army petroleum war reserve requirement, in coordination with JPO and DLA Energy.
- Provides the petroleum capabilities report (POLCAP).
- Establishes, reviews, and validates army prepositioned stocks (APS) and operational project stocks (OPROJ).
- Conducts mission analysis based upon the daily bulk petroleum contingency report or reporting emergency petroleum, oils, and lubricants (REPOL).
- Conducts petroleum acquisition as necessary with host nation governments.
- Coordinates with JPO, DLA Energy, and Army Materiel Command for fuel and water support.
- Provides logistics planning input for stockage objectives.
- Maintains archives of bulk petroleum and water support rendered.
- Reviews and/or submits Operational Needs Statements and Equipment Sourcing Documents for petroleum and water equipment requirements.
- Submits and/or validates all requests for forces.
- Provides oversight to the government fuel card program.
- Conducts staff assistance visits and organizational inspection program.

1-48. The CCDR delegates to the ASCC the authority to establish the requirements for reporting, projecting, ordering, and accountability of bulk petroleum products for all supported military components and government agencies. The petroleum mission of the ASCC is performed by the TSC. The TSC and its subordinate units are assigned to an ASCC supporting a geographical combatant commander.

UNITED STATES ARMY PETROLEUM CENTER

1-49. The USAPC is a unique organization within the Army petroleum community. USAPC has three core areas of expertise: petroleum operations (tactical and garrison), petroleum infrastructure, and quality surveillance.

1-50. In accordance with AR 710-2, *Supply Policy Below the National Level*, USAPC will:

- Act as the Army service control point in accordance with DOD 4140.25-M. Service Control Points established by the Military Services shall serve as the central management function in coordinating requirements, technical issues, and supply actions with military units and DLA Energy.
- Represent the Army Deputy Chief of Staff, G-4 as the voting member to DLA Energy's Executive Agent component steering group in matters pertaining to class III (B).
- Support the Combined Arms Support Command in the development of Army petroleum doctrine.

1-51. USAPC will execute the following programs (For more information see AR 710-2):

- Provide Army petroleum help desk and Petroleum Technical Assistance Program.
- Petroleum infrastructure.
- Engineering Technical Review Program.
- Army Sustainment, Restoration & Modernization Program.
- Army Petroleum Military Construction Program. The USAPC plays a vital role in reviewing fuels MILCON during contingencies and must be part of the planning/reviewing process from the start.
- Army Fuel Facility Optimization Program.
- Army Quality Surveillance Program.
- Petroleum Laboratory Certification Program.
- Laboratory support.

1-52. Requirements validation. USAPC participates in validation under the following circumstances:

- During peacetime annual validation USAPC works directly with DLA Energy via the Collaboration process.
- In support of peacetime exercises or lessor contingencies, as required.

- During major contingencies, USAPC serves as a collaborative partner that provides technical assistance in requirements generation and validation. Under these circumstances, the CCDR JPO typically works directly with DLA Energy with USAPC providing assistance as needed.

1-53. Additional functions of the USAPC include, but are not limited to:

- Provide technical assistance and readiness assessments.
- Manage sustainment, restoration and modernization requirements for Army capitalized facilities and provide engineering support for those projects.
- Provide technical expertise for installation and operation of tactical bulk petroleum handling systems and automated fuel management systems.
- Establish overall Army quality surveillance programs and manage tactical and base laboratory certification and correlation programs.

THEATER PETROLEUM CENTER

1-54. The TPC serves as the operational Army link to strategic petroleum partners. Provides liaison between the DLA Energy, host/partner nations, the ASCC, APC, COCOM, and TSC as needed, and serves as the senior theater Army petroleum advisor to the COCOM with strategic through -operational planning support as needed for to the TSC petroleum & water branch or ASCC petroleum and water branch staffs. The TPC works closely with the JPO and SAPO, or serves as the SAPO, as required to ensure the seamless distribution of petroleum in theater.

1-55. The TPC is normally assigned to an ASCC, TSC, or ESC.

1-56. The unit operates primarily within the theater; however, it may be required to assist units within an area of operation or outside the theater in support of unified land operations. The unit regularly interfaces with bulk petroleum suppliers and other DOD strategic partners [APC, JPO, DLA Energy, Defense Contracting Management Agency (DCMA), United States Transportation Command (TRANSCOM), etc.] throughout the region in accordance with operational needs. The unit provides the following support:

- Liaison and coordination for bulk petroleum and alternative fuels support between U.S., multinational forces, and host nations.
- Communicates available bulk petroleum and alternative fuels data to higher headquarters.
- Determines transportation (intra and/or inter-theater) requirements for movement of bulk petroleum and/or alternative fuels from non-U.S. activities to U.S. forces.
- Determines the non-Army equipment, required for the mission, compatible with existing United States Army equipment.
- Ensures proper quality surveillance procedures are used to meet United States military standards as may be required.

QUARTERMASTER PETROLEUM LIAISON TEAM

1-57. The quartermaster petroleum liaison team provides liaison, coordination and specialized expertise for bulk petroleum and alternative fuels support between supported units, host nation petroleum activities, multinational forces, and the petroleum section of the TSC and/or sustainment brigade support operations office.

1-58. This team is normally assigned to a TSC, ESC, Special Troops Battalion Sustainment Brigade or may also be assigned to a Petroleum Group, if available.

1-59. The team operates as a sub-unit of the TPC and provides the same capabilities of the TPC on a smaller scale.

UNITED STATES TRANSPORTATION COMMAND

1-60. DOD single manager for transportation (other than Service unique or theater-assigned assets), providing common-user and commercial air, land, and sea transportation, terminal management, and aerial refueling to support the global deployment, employment, sustainment, and redeployment of U.S. forces.

1-61. The USTRANSCOM mission incorporates a plan for and providing air, land, and sea transportation of fuels for DOD during peacetime and wartime.

- The movement and redistribution of petroleum assets are accomplished through a joint effort involving the CCMDs, Service components, and DLA Energy, interfacing with USTRANSCOM components for product movement outside the operational area.
- The JPO, USTRANSCOM, represents Commander, USTRANSCOM, on all petroleum-related issues involving USTRANSCOM and components.
- The key duties and responsibilities of the USTRANSCOM JPO include the following:
  - Prepare plans, policies, and procedures for executing petroleum operations related to supporting the USTRANSCOM strategic mission.
  - Develop long-range sustainment plans for petroleum support of USTRANSCOM's inter-theater mission and contingency operations worldwide.
  - Review long-range plans for positioning of petroleum assets.
  - Serve as a voting member on DLA's Installation Planning and Review Board, providing command recommendations on budgetary expenditure for out-year military construction projects.
  - Oversee and validate all fuel data reporting by Army Materiel Command and Military Sealift Command (MSC).
  - Assist warfighting commanders on establishing their fuel-related priorities.
  - Participate in all standing Enroute Infrastructure Steering Committees, analyzing fuel-related issues.
  - Coordinate with other JPOs to de-conflict requirements.

MILITARY SEALIFT COMMAND

1-62. The MSC provides efficient, cost effective sea transportation for USTRANSCOM and the DOD.

1-63. The MSC operates vessels which sustain our warfighting forces and deliver specialized maritime services in support of national security objectives in peace and war. The U.S. Navy command is the primary executor of the MSC mission and responsible for providing ocean transportation for the military services and for other governmental agencies and departments, as directed.

1-64. The MSC provides offshore petroleum supply capability through the OPDS. When commercial facilities are not available, are damaged, or inadequate, OPDS tankers provide an effective alternative to providing high volumes of fuel to the shore.

DEFENSE CONTRACTING MANAGEMENT AGENCY

1-65. The DCMA provides contract administration services to the DOD and its partners to ensure delivery of quality products and services to the warfighter; on time, at the right location, and on cost.

1-66. DCMA assists and coordinates for the development of contracting petroleum support for any requirements outside the capability of the Army's organic support and DLA Energy.

1-67. DCMA, in partnership with the Customer-Contractor, assists in the lifecycle oversight of the contract administration.

1-68. DCMA is a separate agency under DOD and deploys its own command structure when supporting contingency operations. DCMA provides significant reach back support to an ACC, TSC or ESC during operations requiring petroleum contracted services.

ARMY CONTRACTING COMMAND

1-69. The ACC ensures contracting support to the Soldier as mission requirements emerge and as the Army transforms and operates within the continental United States and throughout the globe.

1-70. The ACC executes its worldwide mission through two subordinate commands:

- Mission & Installation Contracting Command (MICC) is responsible for Army contracting support within the continental United States. The MICC provides contracting support for the Soldier across Army commands, installations, and activities located throughout the continental United States and Puerto Rico.
- Expeditionary Contracting Command (ECC) is responsible for Army contracting support overseas, outside the continental United States. The ECC provides effective and agile contracting service in support of unified land operations for the ASCC in support of Army and joint operations as well as to other defense organizations at locations outside the continental United States.

1-71. Army Contracting Command (ACC) assists in the initiation and awarding of the contract procurement.

LOGISTICS CIVIL AUGMENTATION PROGRAM

1-72. The Logistics Civil Augmentation Program (LOGCAP) is a U.S. Army program to use civilian contractors to provide the Army with an additional capability to adequately support the current and programmed force by performing selected services in wartime and other operations.

1-73. The principal objective of LOGCAP is to provide combat support and combat service support augmentation to Army service component commanders during contingency operations.

1-74. LOGCAP augmentation functional capabilities may include class III both bulk and package. When mission planning is conducted at the theater level, if the Army petroleum mission requirements exceed the organic capabilities of the Army, LOGCAP is an option for senior level commanders to use to fill that logistical gap in capability.

1-75. Implementing LOGCAP requires Army technically qualified experts to be appointed to supervise LOGCAP operations to ensure the required services are performed correctly. Contracting officer representatives are nominated by the contracting officer to carry out this role. For details on the contracting officer representative see JP 4-10, *Operational Contract Support*.

1-76. For more on LOGCAP see AR 700-137, *Logistics Civil Augmentation Program.*

OPERATIONAL LEVEL ORGANIZATIONS

1-77. The theater Army commander and G4 uses the petroleum distribution appendix to the logistics annex of the CCMD operations plan or contingency plans as their guide in preparing the petroleum appendix of theater Army sustainment plan. The theater Army G4 develops the sustainment plan based on the tactical plan and the CCMD sustainment plan. Theater Army planning is established before the execution of theater operations.

1-78. With the advent of modular, multipurpose units it is important to recognize that mission changes affect capabilities. All petroleum units are dependent on higher-echelon units for administrative services, force health protection, supplemental transportation, and maintenance support that are beyond the ability of unit level support design.

1-79. Petroleum supply and distribution units, company size, to include truck and pipeline distribution, are normally deployed at the theater level, but may be found throughout theater where demand creates a requirement. These units plan for the storage, distribution and quality surveillance requirements for bulk petroleum products entering the theater in support of operations. These units may have specialized teams and detachments attached to it to meet specific mission requirements.

1-80. Specialized teams and detachments would include those required to meet joint petroleum office staffing requirements, liaison teams to coordinate and provide technical expertise to theater staff, and to provide petroleum laboratory support. It is expected that these teams along with the primary unit will provide petroleum technical assistance and advice throughout theater wherever it is required to include technical inspections and inventory management, when appropriate.

1-81. The fuel managed at the operational level will be under the operational control of the Army, but may be owned by DLA Energy. If the fuel is owned by DLA Energy, they are responsible for determining accounting and quality surveillance procedures.

1-82. The Army will field units capable of storing bulk petroleum fuels in large quantities suitable for resupply of multiple brigades. These units will be capable of operating one or more field storage facilities possibly in multiple locations in support of mission requirements. Each company-sized unit will be capable of receiving, storing and issuing bulk petroleum products based on specific organization design and tactical employment.

THEATER SUSTAINMENT COMMAND

1-83. The TSC and its subordinate units are assigned to an Army service component command (ASCC) supporting a combatant commander (CCDR).

1-84. The TSC provides sustainment support to Army, joint, and multinational forces in support of unified land operations in order to enable the CCDR to prevent, shape, and win our nation's wars. TSC is the materiel manager for a geographic area of responsibility. A TSC may command one or more ESCs as required.

1-85. The TSC provides operational oversight for bulk petroleum and normally includes a petroleum section, fuel and water office, and a distribution management center. Figure 1-3 shows the petroleum management and coordination of at the TSC/ESC level and below. Although figure 1-3 illustrates the relationship between the TSC and ESC and interchangeable, the ESC normally reports to the TSC and there may be one or more ESC(s) that supports a TSC.

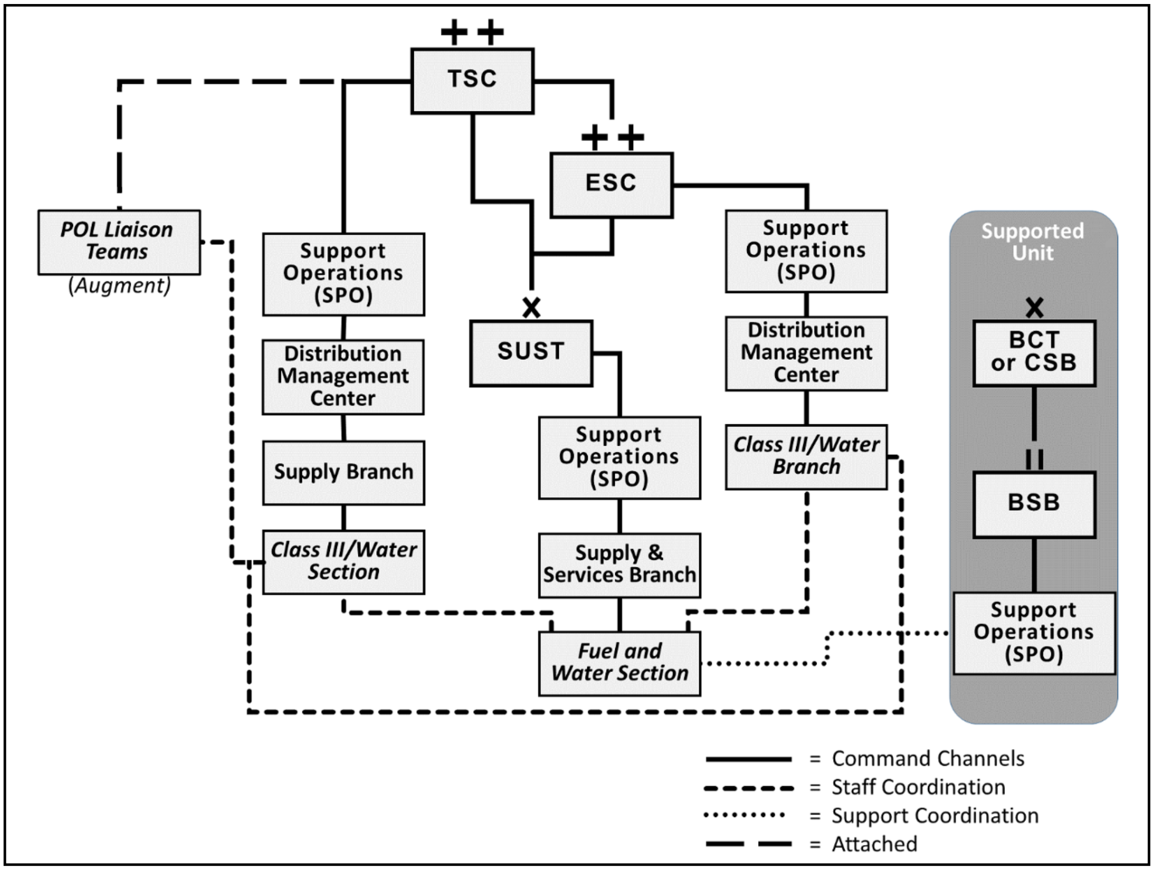

Figure 1-3. Petroleum management

1-86. The TSC petroleum officer plans, establishes and operates a theater wide petroleum distribution system and exercises direct mission command of operational and tactical petroleum operations in support of the CCDR and its assigned theater of operations. When a TSC is unavailable, the senior sustainment commander in theater is responsible for theater petroleum distribution planning and execution.

- The TSC petroleum officer coordinates with other key staff members, senior, adjacent, and subordinate and the USAPC to ensure that the distribution plan is accurate and can be supported.

Distribution, engineer, G3, G5, and other sections may need to assist in the synchronization of the plan and coordination.

- The TSC petroleum officer prepares a projected requirement to support the theater petroleum mission. All long-range materiel requirements, including facilities, materials, and equipment needed to install and operate the petroleum distribution system, are submitted as a theater operational projected requirement. Procedures are prescribed by Army Regulation 710-1, *Centralized Inventory Management* of the army supply system and Army Regulation 710-3, *Inventory Management Asset and Transaction Reporting System*.
- Army-led Service bulk petroleum support may come from tactical-level units, such as a sustainment brigade rather than a TSC. The delegation of support usually occurs in smaller scale operations.

1-87. The TSC executes its petroleum distribution mission through the use of modular forces, to include the ESC (ESC), sustainment brigade (SB), and the petroleum support battalion (PSB).

EXPEDITIONARY SUSTAINMENT COMMAND

1-88. The ESC, if employed, functions as an operational forward command post for the TSC and manages petroleum supply and distribution within an assigned area of operations. The ESC provides operational reach and a span of control for sustainment, distribution, theater opening, and reception, staging, and onward movement for Army forces. The ESC provides a similar support structure as the TSC, but lacks some of the depth and capabilities of the TSC.

1-89. The ESC petroleum section is tasked to manage and account for theater bulk petroleum. The ESC also coordinates tactical petroleum operations and quality surveillance of bulk petroleum in the theater. This organization schedule movement of product forward into the corps support area based on a combination of available storage, distribution assets, and anticipated customer demands.

QUARTERMASTER PETROLEUM GROUP

1-90. The Quartermaster petroleum group operates within a theater area of operations for distribution of petroleum and water in the theater. The organization provides bulk petroleum and water centralized management. This unit also provides the following:

- Mission command, planning, liaison, and supervision of the supply, distribution, quality surveillance, and storage of bulk petroleum for a theater of operations.
- Plan the development, design, and construction of the tactical petroleum distribution and storage facilities based on the operational plan of the theater commander.
- Operational planning for the development, rehabilitation, and extension of host nation petroleum systems and storage facilities based on the OPLAN of the theater commander.
- Coordination of requirements for construction, rehabilitation, and maintenance of petroleum facilities with the engineer command.
- Liaison with host nations for coordination of allied pipeline and distribution system.
- A base petroleum laboratory to conduct quality surveillance.

1-91. The group is normally assigned to a headquarters and headquarters company (HHC), TSC or ESC or HHC and special troops battalion sustainment brigade. There is one Quartermaster petroleum group in the Army reserve component.

1-92. This unit is dependent upon external support for:

- Area signal support.
- Construction, rehabilitation, and maintenance of petroleum facilities.
- Security forces required to protect petroleum terminals and other facilities from guerilla activity, destruction, sabotage and pilferage.

SUSTAINMENT BRIGADE

1-93. The sustainment brigade (SB), in coordination with the TSC or ESC, is responsible for providing bulk petroleum to supported forces and support to multinational forces based on memorandums of agreement. In addition, the sustainment brigade provides area and direct support to the aviation support battalion, the brigade support battalion and to forward support companies as required.

1-94. The sustainment brigade is responsible for quality surveillance and liaison with the supported forces.

COMBAT SUSTAINMENT SUPPORT BATTALION

1-95. The combat sustainment support battalion (CSSB) and fuel and water section have petroleum capabilities and responsibilities within the Sustainment Brigade as described below.

- The CSSB is attached to a sustainment brigade, the CSSB is tailored to meet specific mission requirements. The CSSB may have petroleum units attached based on the mission and capability required.
  - A CSSB could be aligned to provide general and direct support to a corps or division in an area of operations. For additional information about the sustainment brigade and CSSB capabilities see ATP 4-93, *Sustainment Brigade*.

PETROLEUM SUPPORT BATTALION

1-96. Petroleum support battalion is normally attached to the TSC or ESC and further attached to a sustainment brigade. In such cases, the battalion serves as the petroleum operational link in their specified AO. The battalion supports theater bulk petroleum storage (meeting days of supply requirements) and distribution in accordance with the bulk petroleum distribution plan. An example of the bulk petroleum distribution plan is located in JP 4-03 - *Joint Bulk Petroleum and Water Doctrine*. It distributes bulk fuel to sustainment brigades and brigade combat teams as required.

1-97. The petroleum support battalion receives bulk petroleum via pipeline, rail, or transport vehicle from terminals operated by a petroleum pipeline and terminal operating company. The petroleum support battalion also receives deliveries from DLA and commercial sources or contracts. This battalion receives and stores bulk petroleum, and transfers bulk petroleum to direct support supply units. It operates fuel tankers, pipeline, hose line and, when feasible, rail cars or barges to distribute bulk fuels.

1-98. Petroleum support battalion provides technical and operational supervision for the storage and distribution of petroleum products within their specified area of operations. Operates as a central dispatching agency to schedule and direct the flow of bulk petroleum through the petroleum pipeline. Additionally, it supervises a program for quality surveillance of petroleum products and operates and maintains a tactical petroleum laboratory. The petroleum support battalion consists of a functional petroleum battalion headquarters in the active component to provide mission command of petroleum distribution forces, petroleum quality analysis team, and provide engineer construction oversight during the early phase of operations.

1-99. The petroleum support battalion is comprised of three to five assigned or attached petroleum support companies, transportation medium truck companies (petroleum), and/or petroleum pipeline and terminal operating companies for the operation and maintenance of a military petroleum distribution system consisting of up to 375 miles of petroleum pipelines, related terminal facilities, and the transportation of class III (B). When required, this battalion can provide bulk and retail supply point distribution. The petroleum support battalion also provides quality surveillance for bulk fuels stored and distributed in their area of operations.

QUARTERMASTER FORCE PROVIDER COMPANY

1-100. The Quartermaster force provider company provides the front line Soldier a brief respite from the rigors of combat, support a task force during theater reception, rest and refit, redeployment and at base camps. This company may be used in support of major combat or stability operations such as humanitarian aid, noncombatant evacuation, disaster relief, peace keeping or peace enforcement operations.

- Normally assigned to a CSSB in support of a theater or division.

- Can be employed in direct of a brigade size element or base camp supporting up to 3600 personnel. It may also be employed to provide support for reception, staging, onward-movement and integration, redeployment, or stability operations.

1-101. The force provider service and support platoon provides the receipt, storage and issue of class III in support of the force provider company. The platoon provides retail refueling capability using Heavy Expanded Mobility Tactical Truck (HEMTT) tanker to the force provider company.

1-102. The force provide heavy platoon provides full service support for personnel residing in force provider facilities. Supports a task force during theater reception, rest and refit, redeployment and at base camps. This platoon may be used in support of major combat or stability operations such as humanitarian aid, noncombatant evacuation, disaster relief, peace keeping or peace enforcement operations. This platoon contains a fuel and water section that provides retail refueling capability using the tank and pump unit to the force provider heavy platoon.

1-103. The force provide light platoon provides capability to operate force provider with self-service support in one 600 person module or split to four separate locations supporting up to 150 personnel. This platoon contains a fuel and water section that provides retail refueling capability using the tank and pump unit to the force provider light platoon.

TACTICAL LEVEL ORGANIZATIONS

1-104. Tactical level distribution occurs in the theater of operations. The sustainment brigade normally provides the operational to tactical petroleum supply and distribution. This support may require coordination with U.S. governmental partners as with the strategic level. Petroleum support at the tactical level is linked from the combat sustainment support battalion, through the brigade support battalion and forward support company to the maneuver end user. The tactical level organizations are described below.

QUARTERMASTER COMPOSITE SUPPLY COMPANY

1-105. The Quartermaster composite supply company (CSC) provides petroleum quality surveillance, storage and distribution to a brigade combat team as well as area support to units operating in the division area. The CSC is task organized under a combat sustainment support battalions located in the corps area. Platoons or sections can be as far forward as the brigade support areas. The composite supply company provides a base capability to the division that can be augmented with additional fuel assets based on battlefield requirements.

1-106. The unit also has two 120,000 gallons FSSP and one 300,000 gallons FSSP, which can be pushed forward to be closer to brigade combat teams (BCT) if required. The CSC may augment up to three BCTs with additional capability to store and distribute fuel using 5,000 gallon tankers and HEMTT-tankers with modular fuel system tank racks on Palletized Load System (PLS) trailers. This unit provides limited local bulk petroleum distribution up to 125,000 gallons. Modular fuel system tank racks and PLS trailers may also be used by a transportation truck company for line haul petroleum distribution.

1-107. The CSC requires assets from the composite transportation company or other transportation units to distribute mobile fuel storage systems.

1-108. The CSC is comprised of a petroleum platoon, with a headquarters section, a class III storage section, a class III distribution section and a petroleum quality analysis team, which is located in the headquarters section as shown in figure 1-4 on page 1-16. The CSC is also comprised of a headquarters platoon, a supply platoon and a water platoon.

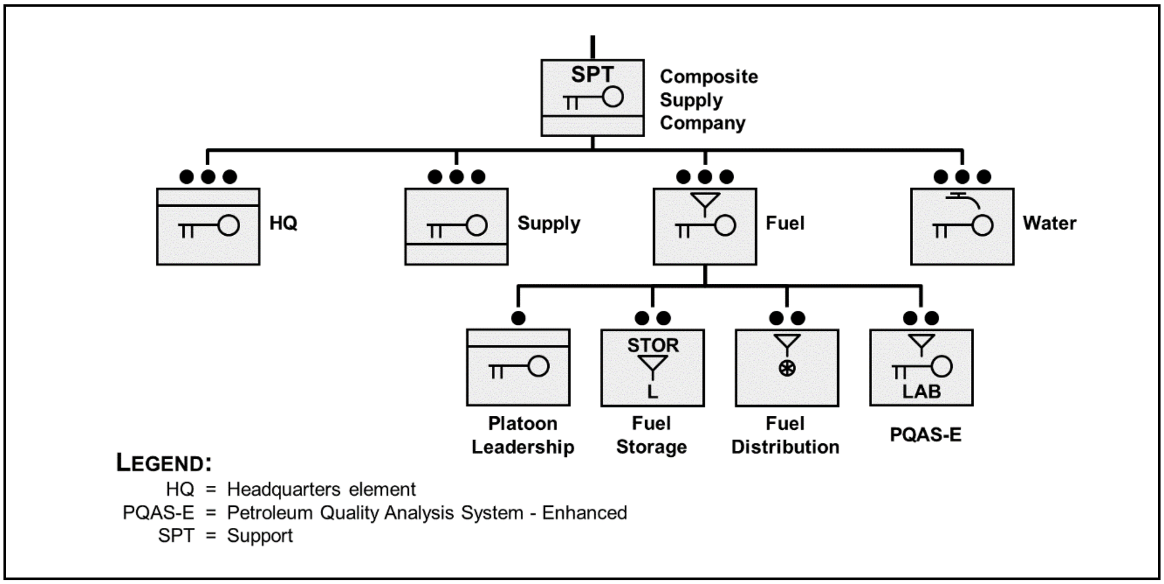

Figure 1-4. Quartermaster composite supply company

1-109. The class III (B) storage section receives, stores, and distributes up to 540,000 gallons of bulk petroleum per day. The section may deploy its two 120,000 gallon FSSPs forward to one or two BCT areas as required to support requirements, but receipt and storage capacity in division area is degraded. The section can store up to 300,000 gallons of fuel in one 300,000 gallon FSSP.

1-110. The class III (B) distribution section provides local distribution of up to 125,000 gallons using a combination of 12 x 5,000 gallon M969 tankers (60,000 gal) and 6 x 2,500 gal HEMTT fuel trucks and 20 x 2,500 gal modular fuel tank racks (65,000 gal) on PLS trailers. The section is capable of augmenting BCTs with modular fuel system, but capability is reduced when tank racks no longer used for distribution. The additional modular fuel system tank racks and PLS trailers in this section may be used by the cargo transfer company for petroleum distribution. Section includes forward area refueling equipment (FARE) capable of up to four (4) aircraft refuel points.

1-111. The petroleum quality analysis system-enhanced (PQAS-E), which resides in the composite supply company's fuel platoon headquarters section, provides direct support quality surveillance and testing capabilities to the BCT and on an area basis as well as provides quality surveillance and control measures for fuel being stored and distributed by the platoon.

QUARTERMASTER PETROLEUM SUPPORT COMPANY

1-112. The petroleum support company, shown in figure 1-5, is a modular unit responsible for receiving, storing, and distributing bulk fuels in a theater of operations in support of brigade combat teams and echelons above brigade organizations. Normally assigned to a petroleum support battalion, the company is employed throughout the echelon above brigade area to provide wholesale, retail fuel support and limited distribution at operational and tactical levels. Elements of the company may operate in the brigade support area and can be attached to any of the companies of the combat sustainment support battalion with a sustainment brigade for tailored support. Normally, there is one per petroleum support battalion, but there may be more, based on stated requirements. An 800,000 gallon FSSP is allocated from army prepositioned stocks for the petroleum support company upon opening or theater distribution missions.

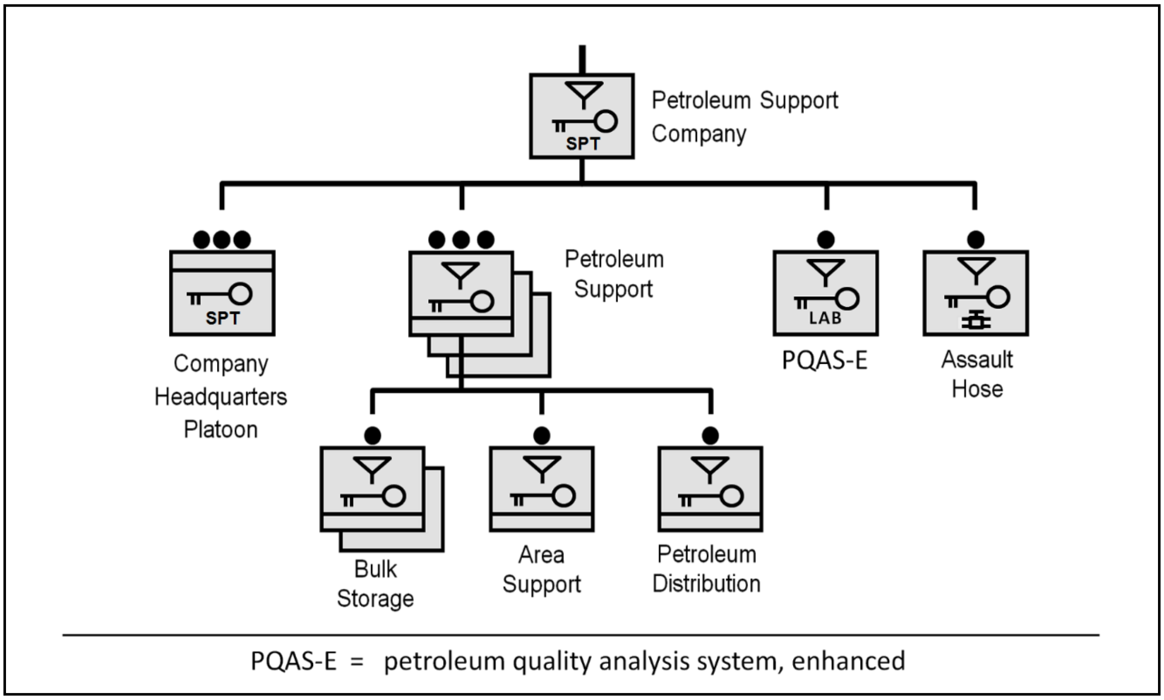

Figure 1-5. Petroleum support company

1-113. The petroleum support company can be comprised of petroleum support platoons, an assault hose line augmentation team, a pipeline operating platoon and a quality analysis team. The petroleum support platoons can be configured with 50,000 gallon or 210,000 gallon bags. Each platoon within the company can also establish and operate four refueling points using one advanced aviation forward area refueling system for transitory aircraft.

1-114. When the company is equipped with two 300,000 gallon FSSPs and one 120,000 gallon FSSP per platoon, its capabilities are:

- Operates up to three platoons, each with storage facilities for 600,000 gallons of bulk petroleum at each location for a combined total of 1.8 million gallons per day, using 50,000 gallon bags.
- Receipt and issue at each storage facility of up to 420,000 gals of bulk petroleum for a combined total of 1.2 million gallons per day, using 20,000 gallon bags.
- Operation of up to three area supply support points in direct support of non-brigade units with combined receipt, storage, and issue capability of 360,000 gallons and a distribution capability of 146,250 gallons of bulk petroleum daily. Each supply point can:
  - Store up to 120,000 gallons of bulk petroleum.
  - Receive and/or issue up to 120,000 gallons of fuel per day.
  - Distribute 48,750 gallons of bulk petroleum per day based on 75% availability of fuel dispensing vehicles at two trips per day.

1-115. When the company is equipped with two 800,000 gallon FSSPs and one 120,000 gallon FSSP per platoon, its capabilities are:

- Operates up to three platoons, each with storage facilities for 1,680,000 gallons of bulk petroleum at each location for a combined total of 5.04 million gallons per day.
- Receipt and issue at each storage facility of up to 720,000 gals of bulk petroleum for a combined total of 2.1 million gallons per day.
- Operate up to three area supply support points in direct support of non-brigade units with combined receipt, storage, and issue capability of 360,000 gallons and a distribution capability of 146,250 gallons of bulk petroleum daily. Each supply point can:
  - Store up to 120,000 gallons of bulk petroleum.

- Receive and/or issue up to 120,000 gallons of fuel per day.
- Distribute 48,750 gallons of bulk petroleum per day based on 75% availability of fuel dispensing vehicles at two trips per day.

1-116. The petroleum support company is capable of operating a fuel storage facility connecting into pipeline systems and/or operating bulk fuel railheads and/or fixed class III installations as required.

Petroleum Support Operations

1-117. The petroleum support operations section coordinates and tasks the operations of a petroleum support company. Normally assigned to the petroleum support company, this unit is dependent upon corps or theater elements for administrative and logistical and personnel support.

1-118. Petroleum Support Operations is responsible for the direction, coordination and monitoring of the receipt, storage and distribution of bulk petroleum including the delivery of bulk petroleum by organic fuel dispensing vehicles to local high volume use customers.

Petroleum Support Platoon

1-119. This petroleum support platoon provides general support to brigade and echelons above brigade on both a direct and area support basis. Normally, assigned to a petroleum support company (50,000 or 210,000 bags), it is dependent on the assigned unit for unit-level support, administrative support, personnel services, and maintenance, and the support operations section for operational direction of the platoon.

1-120. This petroleum support platoon is employed in the corps or theater support area to provide bulk petroleum to assigned customer units an area basis. Normally, there is one support operations section per petroleum support company (50,000 or 210,000 bags). There are normally three petroleum support platoons per petroleum support company (50,000 bag).

1-121. This unit operates up to two fuel facilities providing general support mission capability and can store 600,000 gallons a one location or 300,000 gallons at two locations utilizing the 50,000 gallon bags. The same configuration can be set up utilizing the 210,000 bags; 1,680,000 gallons at one location or 840,000 gallons each at two locations. The fuel facilities are set up through the use of two fuel system supply points; discussed in chapter 2. They can receive and distribute, in any combination, up to 420,000 gallons per day using a 350 gallons per minute (GPM) pump and up to 720,000 gallons per day using a 600 GPM pump.

1-122. The area support section of the petroleum support company provides direct support mission capability and can store up to 120,000 gallons of bulk petroleum.

1-123. The distribution section of the petroleum support company provides local delivery and fuel services with five 5,000 tankers and four tank and pump units. This section can distribute 48,750 gallons of fuel daily based on 75 percent availability of fuel dispensing vehicles at two trips per day.

Assault Hoseline Augmentation Team

1-124. The assault hoseline augmentation team establishes and maintains rapid hoseline linkage connecting fuel supply points to other fuel supply points or high volume users. The hoseline can be installed at a rate of up to 2.5 miles per hour. The hoseline team provides a total of 10 miles of hoseline. Normally assigned to a petroleum support company (50,000 or 210,000 tanks), it is dependent on the assigned unit for unit-level support, administrative support, personnel services, and maintenance, and the support operations section for operational direction of the platoon. This unit may also require engineer support to overcome obstacles along the hoseline trace. There is normally one per petroleum support company (50,000 or 210,000 tanks).

1-125. This team has four assault hose lines and 15 Soldiers (three per hoseline, two mechanics, and one section chief). Each AHS has 2 1/2 miles of collapsible four-inch hose packed on hose reels, three 350 gallon per minute pumps, and can distribute approximately 420,000 gallons of bulk fuel daily. This daily distribution capability is based on 20 hours of distribution operations and four hours of maintenance downtime.

Petroleum Pipeline Operating Platoon

1-126. The petroleum pipeline & terminal operating (PPTO) platoon, normally attached to a petroleum support company, establishes early entry petroleum pipeline capability at the *beach termination unit* (BTU) of the Navy OPDS, and establishes the initial theater petroleum stock objectives in the TPT with the aid of the company storage sections. The pipeline platoon is a modular sustainment unit which may operate independently, or as part of a larger unit within an area of operations.

1-127. The platoon is capable of employing and, with engineer support, constructing up to 45-miles of the inland petroleum distribution system in order to establish the initial petroleum distribution network, as well as a maximum 5-mile tactical assault hoseline for expedient bulk petroleum distribution.

Petroleum Quality Analysis Team

1-128. The petroleum quality analysis team conducts analysis of petroleum products received and stored in operating units and provides area petroleum lab support as directed, under field conditions. Normally, assigned to an aviation support battalion or combat sustainment support battalion, this team is dependent on the assigned unit for unit-level support, administrative support, personnel services, and maintenance.

1-129. The team is equipped with the petroleum quality analysis system - enhanced, which can be employed throughout the operational area.

1-130. The team ensures bulk fuel products meet specified physical and chemical properties, conducts modified B-2 level testing in accordance with the current MIL-STD 3004, *Department Of Defense Standard Practice Quality Assurance/Surveillance For Fuels, Lubricants And Related Products*, on kerosene-based (fuel) F-24, JP5, JP8, JET A, JET A-1, and diesel military mobility fuels.

1-131. This unit provides technical assistance for handling, storing, sampling, identifying, and performing quality evaluation of petroleum products and their containers for all U.S. and allied forces on an area support basis; provides petroleum quality surveillance testing under field conditions; and quality surveillance B-2-level testing on ground and aviation fuels, and limited B-level testing, using data to make recommendations for proper use, reclamation, and disposal of the product.

1-132. This unit does not have the internal capability to perform field level maintenance on organic equipment.

Petroleum Pipeline and Terminal Operating Company

1-133. The petroleum pipeline & terminal operating company, operates petroleum pipeline and terminal facilities for receipt, storage, and distribution of bulk petroleum products in support of an independent corps or theater Army area of operations.

1-134. This unit operates up to 75 miles of pipeline for distribution of 720,000 gallons per day and one TPT of up to 3.78 million gallons. When required, it will operate facilities for shipment of bulk petroleum by coastal tanker, barge, rail, and tank trucks. This company also operates a FSSP for bulk issue operations and up to and a maximum of five miles of tactical assault hoseline.

1-135. While it is normally assigned to a petroleum support battalion, the petroleum pipeline and terminal operating company may also be attached to a combat sustainment support battalion.

1-136. This company is dependent on the assigned unit for unit-level support, administrative support, personnel services, and maintenance, and the support operations section for operational direction of the platoon This unit is also dependent on military police support for pipeline security; engineer construction support for pipeline construction, terminal earth work, and road work, and engineer firefighting team for firefighting support.

1-137. This unit is responsible for providing technical support for engineer companies assigned to construct the pipeline. Civil augmentation may be provided for additional technical support on constructing, operating, maintaining, and recovering the pipeline and related equipment.

1-138. The PPTO company consists of a petroleum products control section, maintenance section, terminal operating platoon headquarters, two tank farm sections, storage and distribution section, a pipeline operating platoon headquarters, and five pipeline (pump stations) sections.

1-139. The petroleum products control section receives detailed operating instructions from the system's dispatcher/scheduler or higher headquarters and directs the company elements executing the instructions; performs supply control and accounting functions for bulk petroleum products received, stored, and issued by the company; monitors bulk petroleum requests from operating platoons; and consolidates and forwards appropriate reports to higher headquarters.

1-140. The maintenance section provides unit maintenance on the organic wheeled vehicles, materials handling equipment, compressors, and power generating equipment.

1-141. The terminal operating platoon headquarters supervises the receipt, storage, and distribution of bulk fuels; provides platoon administration, internal safety, and security; and inspects and performs quality surveillance on bulk fuels it handles.

1-142. The tank farm sections provide personnel to operate two fixed bulk petroleum terminals or one TPT. Components of the tactical petroleum terminal may also be configured to establish a class III supply point for receipt, storage, and issue of three types of fuels from tank trucks or other means of supply.

- Tank farm and/or storage and issue section personnel may be tasked to operate a BTU for ship-to-shore receipt of fuel from offshore tankers.
- The hoseline outfit may be used to allow portable dispensing beyond the reach of the pipeline.

1-143. The storage and issue section operates the FSSP, two 5,000 gallon tankers, four tank and pump units.

1-144. The pipeline operating platoon headquarters supervises and directs operation of approximately 75 miles of pipeline and up to five pump stations.

1-145. The service support section provides field and sustainment maintenance on pipeline pump stations and related equipment peculiar to the pipeline system and the tactical petroleum terminal throughout the unit's area of responsibility. Maintenance functions include ordering equipment parts, repairing and replacing valves, blinds, pressure gauges, meters, line strainers, pump units, welded pipelines, coupled lines, hose-lines, and other related pipeline equipment.

1-146. The pipeline sections operate up to five pump stations and patrol the pipeline for leaks, sabotage, and other problems.

Transportation Medium Truck Company (Petroleum)

1-147. The medium truck company petroleum, shown in figure 1-6, has a mission to provide transportation for the movement of bulk petroleum products through the utilization of tractors with associated semi-trailer tanks. This company is normally assigned to the TSC and attached to a combat sustainment support battalion or a petroleum supply battalion. This company is employed in line haul operations, primarily in the corps or division area of operations and provides bulk fuel distribution. There are two variants of the semi-trailer tank, the M1062 7.5k tanker and the M967 5,000 tanker. The medium truck company petroleum is authorized 60 tractors. For every tractor assigned, there is one semi-trailer tank assigned, either a 7,500 or a 5,000.

1-148. Assuming the medium truck company petroleum (7,500 gallons) has 100% total vehicles available (60 vehicle platforms) and utilizing the trailers to max capacity (7,500 gallons), the unit can provide a onetime lift capability for bulk fuel of 450,000 gallons.

1-149. Assuming the medium truck company petroleum (5,000 gallons) has 100% total vehicles available (60 vehicle platforms) and utilizing the trailers to max capacity (5,000 gallons), the unit can provide a onetime lift capability for bulk fuel of 300,000 gallons.

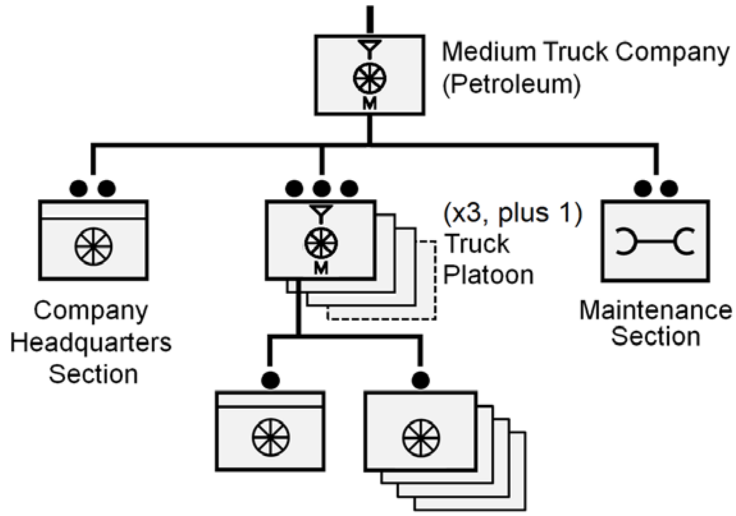

Figure 1-6. Medium truck company

BRIGADE SUPPORT BATTALION

1-150. The aviation support battalion (ASB) or brigade support battalion (BSB) provides support to its parent brigade. BSBs are organic to the brigade combat team, and select multifunctional support brigades. ASBs are structured similar to the BSB, however the ASB is organic to the combat aviation brigade. Although BSB capabilities and structure differ somewhat depending upon the type of BCT all are designed to provide direct support to its supported brigade. BSBs provide responsive support to the brigade by positioning forward support companies (FSC) with maneuver and fires battalions.

1-151. BSBs without FSCs provide sustainment by task organizing logistics assets to support specific units and missions based on mission, enemy, terrain and weather, troops and support available, time available, civil considerations (METT-TC). The type of support may vary by battalion based upon the situation and support requirements.

1-152. The BSB will also provide area support within the limits of their capabilities to other elements operating in the brigade AO.

1-153. If the BSB requires non-mobile storage of petroleum to be able to provide petroleum support to the brigade, the BSB support operations officer must request the non-mobile storage assets from the sustainment brigade. The BSB, brigade staff, and the sustainment brigade must consider the appropriate support or command relationship, to include duration, the non-mobile storage assets will have with the BSB. Once the non-mobile petroleum storage assets are on-site, the BSB must conduct complete coordination with the forward support companies and the brigade to ensure a complete understanding of the non-mobile storage support capability and requirements. The BSB petroleum platoon within the distribution company will also have a limited petroleum fuel testing capability.

1-154. For additional information about the BSB see ATP 4-90, *Brigade Support Battalion*.

DISTRIBUTION COMPANY

1-155. The distribution company provides fuel receipt, storage, and distribution in support of a brigade combat team. The fuel and water platoon of the distribution company delivers bulk fuel to the forward support companies.

1-156. The fuel section receives, temporarily stores, and issues bulk petroleum to the brigade combat team. The section has no static storage capability and has the ability to displace whenever necessary.

1-157. The class III (B) section is capable of delivering class III (B) to the forward support companies within the brigade combat team using HEMTT tankers and modular fuel system trailers. The distribution capacity is based on the type of BCT it supports. See the unit authorized documents for equipment and personnel authorizations.

FORWARD SUPPORT COMPANY

1-158. The forward support company (FSC) provides support to its habitual supported battalion. The forward support company will have a petroleum section capable of receiving, mobile storage and issuing petroleum to its supported battalion. The petroleum fuel testing capability at this level is limited.

1-159. The distribution platoon class III section distributes fuel to the units they support. The class III section provides retail class III bulk fuel distribution to the supported battalion and provides refueling options in support of the BCT units passing through the supported battalion AO. Normally, the BSB distribution company pushes fuel to the FSC and the FSC pushes fuel to the maneuver battalion using FSC distribution assets.

1-160. The FSC's distribution capacity is based on the type of battalion it supports. See the unit authorized documents for equipment and personnel authorizations. Additional fuel storage capability, for an FSC, is centralized within combat sustainment support battalions (CSSB).

SPECIAL OPERATIONS COMMAND

1-161. The special operations command petroleum planner must coordinate with the joint petroleum office for petroleum support within the theater of operations.

1-162. The special operations unit deployed forward should provide a liaison to manage petroleum requirements with the TSC, ESC or SB providing area support in their area of operations.

Chapter 2

Petroleum Systems and Equipment

This chapter describes the petroleum systems and equipment used to support the Army's petroleum mission. It includes a brief description of each system, its implementation and its capabilities. A section is also included that briefly describes the black, red, amber, green (BRAG) rating system for the collapsible fabric tanks. Refer to the appropriate technical manual or manufacturer's manual for instructions on the operation, maintenance and detailed capabilities of the systems and equipment listed in this book.

SECTION I – STORAGE AND DISTRIBUTION SYSTEMS

2-1. This section describes systems used to store and distribute class III bulk petroleum products. The types of storage and distribution systems used depend on whether the theater is developed or undeveloped. Storage systems include above ground or underground steel tanks, fabric tanks and tactical systems. Distribution systems include the system used to transport bulk fuel to the using units. The distribution system can consist of ocean tanker loading and unloading facilities, storage terminals, pump stations, pipelines, hose lines, class III supply points, tank vehicles, and rail tank cars.

2-2. Storage operations are used to ensure that adequate supplies are kept on hand and ready to use. Depending on the purpose of the storage, the quantities stored may vary greatly. It is extremely important that the status of all storage tanks, to include collapsible fabric tanks, is tracked on a daily basis. This information should be reported to higher headquarters from the operating unit as it impacts the ability to meet theater requirements for storage and distribution.

2-3. Storage requirements may be met by using existing airfield/airport fuel storage tanks, tactical fuel systems, railroad tank cars, or any container that meets operational, safety, and environmental needs. Fuels managers should maximize the use of host nation storage facilities and minimize the construction of berms and the use of collapsible fabric tanks. The method of resupply, movement of fuel to U.S. dispensing systems, and the need for blending of additives should be considered in planning the use of available resources.

2-4. Tactical storage systems generally use collapsible fabric fuel tanks, which can come in various storage capacities, interconnected by short hose sections with pumps, filter separators and other associated equipment necessary for operation. Large systems are used to supplement theater storage requirements and issue to line haul trucks, pipelines or hose lines. These systems can be special purpose equipment sets designed for aircraft refueling or for use with ground vehicles.

2-5. Any equipment problems must be properly documented on quality deficiency reports in order to ensure that the specifications to which military equipment is designed and manufactured meets operational requirements and to provide the Army the ability to hold contract manufacturers accountable for defective equipment manufacturing.

2-6. Equipment maintenance, to include preventative maintenance checks and services and regularly scheduled services are among the most important tasks that must be completed to ensure mission success. Most equipment has established routine inspection intervals. Equipment in storage also requires inspections and services. These inspections can be incorporated with unit training to ensure it remains operational.

2-7. Prior to using any petroleum storage container, petroleum tank vehicle or rigid walled tactical petroleum tank, inspect the container for serviceability. The inspection should include checking for rust, scale, dirt, foreign objects, and water. If any of these faults exist in sufficient levels to cause contamination, it must be drained and clean the tank before use. Considerations for cleaning petroleum tank vehicles and rigid walled tactical petroleum tanks can be found in appendix E. The use of commercial contractors is required to clean fixed petroleum storage tanks.

2-8. There are basic considerations for maintaining petroleum products in order to prevent contamination and keep products on specification. The product name and grade must be stenciled on storage tanks, tank compartments, vehicle manhole covers, pipelines, valves, loading racks, control valves and servicing units. For marking, labeling and placards refer to appendix B for instructions. In addition, refer to appendix M for placard identification numbers in cases where petroleum storage units must that must be placarded.

2-9. When loading and unloading petroleum products, the product must be the same as the product as in the receiving container. Type C test is required upon receipt of product into inventory [color, appearance and American Petroleum Institute (API) Gravity].

2-10. Never carry mixed loads of fuel in multi-compartment tank vehicles.

2-11. Recirculation of fuel is vital to ensuring the cleanliness and quality of fuel issued meets Army and DOD standards. Recirculation is required daily, which ensures clean fuel is issued to the end user. After recirculation, take a color and appearance fuel sample and observe it for color, brightness and clarity. Also, if used for aviation refueling, an aqua-glo test must be performed. Do not use the fuel if it is contaminated. Information on recirculation procedures can be found in appendix P.

2-12. After loading and before discharging a tank vehicle, inspect the tank for water. If any water is found, drain and remove it.

2-13. Foreign objects should not be carried in pockets or clothing when working around petroleum tanks. Keep tools away from tank openings.

2-14. Keep hoses in storage compartments when not in use. Do not remove dust caps or plugs from nozzles until they are ready for use.

2-15. Product Quality Deficiency Reports (PQDR): A PQDR is a record and transmit of data regarding a defect or nonconforming condition, including deficiencies in design, specification, materiel, manufacturing, and workmanship. Anytime the equipment becomes unserviceable prior to its expected service life, a PQDR is submitted by the responsible officer of that site or equivalent. Further information regarding the PQDR can be found in Army Regulation 702-7, *Product Assurance Product Quality Deficiency Report.*

STORAGE CONTAINERS

2-16. Storage tanks are concrete, steel, and collapsible fabric containers used to store large amounts of fuel. These tanks must be large enough in size and number to hold fuel for current demands and reserve for future needs. Most storage tanks are located at fixed tank farms. Tank farms are normally groups of storage tanks and pumps connected by pipelines and manifolds. These pipelines and manifolds move fuel into, out of, and between the tanks. Tank farms are part of base terminals where tankers are loaded or unloaded, intermediate terminals where fuel is stored until it is needed elsewhere, and head terminals where fuel is issued.

2-17. The storage containers section will describe the individual tank used to store fuel in the fuel systems. For example, an individual storage container of the FSSP is the collapsible, fabric tank. This section will describe the various individual tanks and storage facilities used to store fuel. This description of the individual storage tanks will prepare the reader for further discussion of the systems.

2-18. The type of tanks used is determined by the availability of suitable commercial facilities. A theater in a developed part of the world may have adequate commercialized facilities available to meet military requirements. In this situation, the military might lease and operate the terminal or may augment the civilian work force with Soldiers. The Soldier augments would provide oversight of the operation protecting U.S. interests and assist the civilian workers with loading military vehicles. In an undeveloped theater, terminals would consist of tactical petroleum terminal and fuel units. In addition to the storage of theater reserves, tanks may be used to regulate the flow of product. When a pipeline system is being constructed, certain tanks can be set aside, usually at an intermediate terminal, to hold fuel temporarily. This is done to allow continued pumping upstream in the event of a breakdown downstream. These tanks are known as regulating tanks.

2-19. The basic petroleum operating concept is to keep storage tanks full at all times. The schedule for fuel movement through the system is based on storage capacity and product demand. Constant communication between the distribution and storage facilities is essential during construction and operation of the system.

2-20. It is extremely important that the status of all storage tanks, to include collapsible fabric tanks, is tracked on a daily basis. This information should be reported to higher headquarters from the operating unit, as it impacts the ability to meet theater requirements for storage and distribution.

5-GALLON CAN

2-21. The 5-gallon fuel can is used to issue small quantities of fuel to using units. It is especially useful when conditions are such that the container must be carried by hand or attached to the end user vehicle. The 5-gallon fuel can is made of plastic.

2-22. The 5-gallon can has a detachable spout to ease the pouring of its contents and reduce risk of spill. The can has a wide plastic band that attaches the lid to the body to prevent loss.

2-23. The 5-gallon can must be properly marked to prevent commingling or refueling of equipment with the wrong product. Refer to appendix B for proper marking.

WARNING

The 5-gallon fuel can is similar in appearance to the 5 gallon water can. Caution must be used to ensure the correct can type is used to prevent misuse or commingling product.

55-GALLON DRUM

2-24. The 55-gallon drum is used to issue petroleum products, in smaller quantities, to using units. The 55-gallon drums is considered a class III (P) product due to its capacity of less than 500 gallons.

Stacking of 55-gallon drums

2-25. Stack drums horizontally in double rows with the closures (bungs and vents) facing outward at the 3 and 9 o'clock positions. Leave at least one foot of space between the double rows. This should be enough space to allow the inspection of drum butts and chimes. Do not store your drums on end because rain, snow, and ice will collect in the drumhead, fade the makings and cause the head to rust. Water may also seep through the bungs and vents and contaminate the product. Turn the closures outward to make it easier for you to identify the contents, detect leaks, tighten bungs and change gaskets. Various methods for stacking 55 gallon drums are given below.

Nested Stacks

2-26. The number of drums you stack in each section is determined by the type of product and the terrain. Follow the procedures below when stacking drums containing low flash products in nested pyramidal rows. If space is not a factor, you may change the procedures and reduce the size of each section by stacking fewer drums in each. If the drums contain high flash products, you may stack them six tiers high instead of three or increase the number of sections in each block.

2-27. To store drums in nested stacks, the following must be considered. The layout should be 70-foot-square and then divided the section into units. The size of the layout is based on the number of drums stored. A foundation for each unit of drums should be applied by laying out four 70-foot rows of 2-inch by 6-inch lumber or other suitable dunnage. Then stand the lumber on edge, and attach cross braces between the rows to hold the lumber in place, as in Figure 2-1. Bracing must be in place at the ends of the rows to keep the drums from rolling or toppling. Drums (35 each) must be laid on their sides in each of the two rows to form the first tier. The drums must be placed with their bungs and vents facing the aisle, and at least one foot of space must be left between the double rows. Ensure that the bungs and vents are in a horizontal line and below the surface of the liquid. This is known as flooding the bungs and vents, and it ensures a tight seal and cuts down on container breathing.

2-28. Place a second tier on top of the first, and nest each drum between the two drums below it. Place the drums as outlined above. Build the third tier the same way you built the second. The finished unit contains 204 drums. There are 70 drums in the first tier, 68 in the second, and 66 in the third. A complete section of five units contains 1,020 drums. Adjustments will be made to the length of row dependent on the amount of drums to be stored. Smaller operations will require less distance.

Dunnage Stacks

2-29. Use this considerations when you are in a cold climate where nested stacks are impractical because of the formation of ice between the drums. The use of dunnage between tiers also makes it easier to handle the drums. You may stack dunnage drums in pyramids as in figure 2-1 or in vertical tiers.

2-30. The foundation for the layout and the first tier of the unit is constructed as described in the section on nested stacks.

2-31. Place two double rows of 1-inch planks on top of the first tier. Then, attach wooden cleats as in figure 2-1 to the planks at the ends of each row. Place a second tier of drums on top of the first tier, and position them so that the bungs and vents are flooded. If you stack the drums in a pyramid, position them as shown in figure 2-2 on page 2-5. If you stack the drums vertically, center them in the upper tier directly over those in the tier below. Build the third tier the same way you built the second tier. Adjustments will be made to the length of row dependent on the amount of drums to be stored. Smaller operations will require less distance.

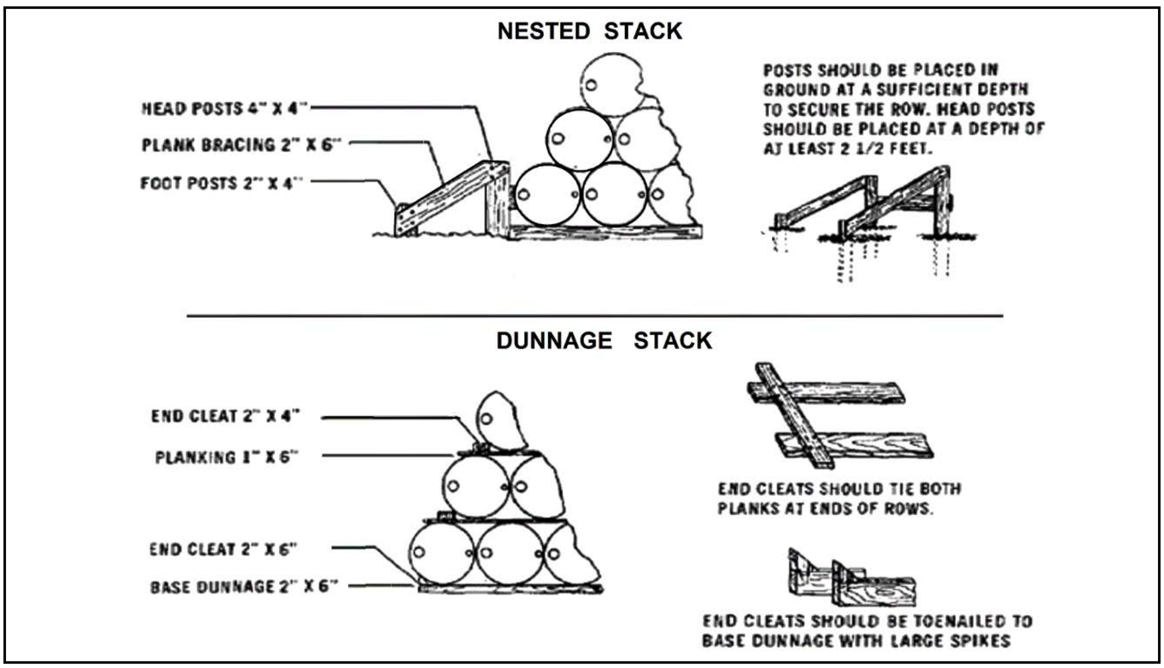

Figure 2-1. Stacking of 55-gallon drums

Palletized Stacks

2-32. Occasionally, filled 55-gallon drums may require stacking filled special drum pallets. Two pairs of 55-gallon drums are to be placed on their sides on each special pallet. Braces built on the pallet keep the drums from rolling. Place the drums on the pallet so that the bungs and vents are flooded. Stack the pallets directly on top of each other with the drum bungs and vents facing the aisles. Usually, end braces for palletized stacks are not required.

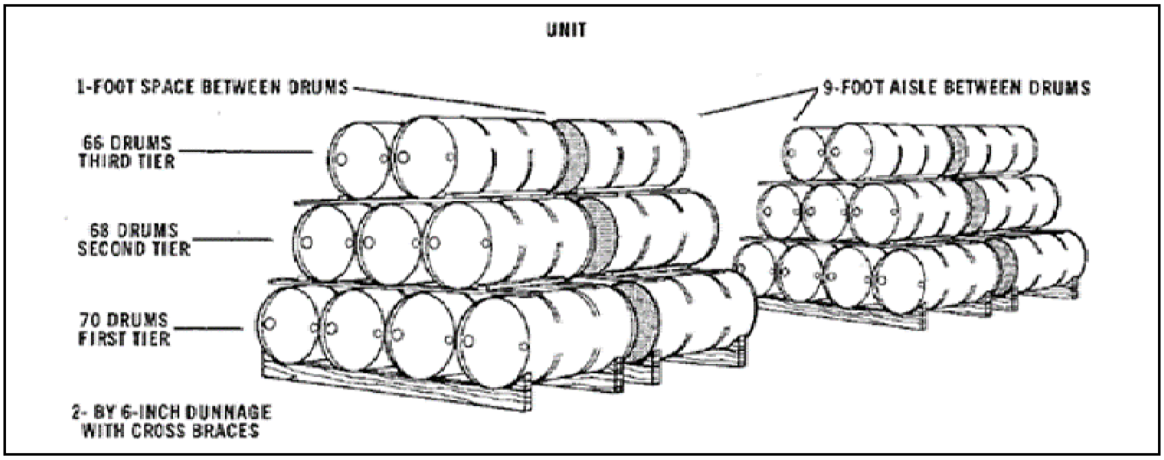

Figure 2-2. Dunnage stack of filled 55-gallon drums

2-33. Empty 55-gallon drums may be stacked by any of the methods mentioned previously. The only exception is the bungs and vents are not required to be stacked in a horizontal position. Empty drums may be stacked in sections of eight or more rows close to each other with aisles around each section. The height of the stack may vary. However, the stack is usually no higher than 12 high because a higher stack would be hard to handle. Ensure that all vent and bung plugs, on empty 55-gallon drums, are closed tightly with a wrench before stacking the drums.

2-34. Figure 2-3 shows a typical site layout for storage of multiple palletized stacks.

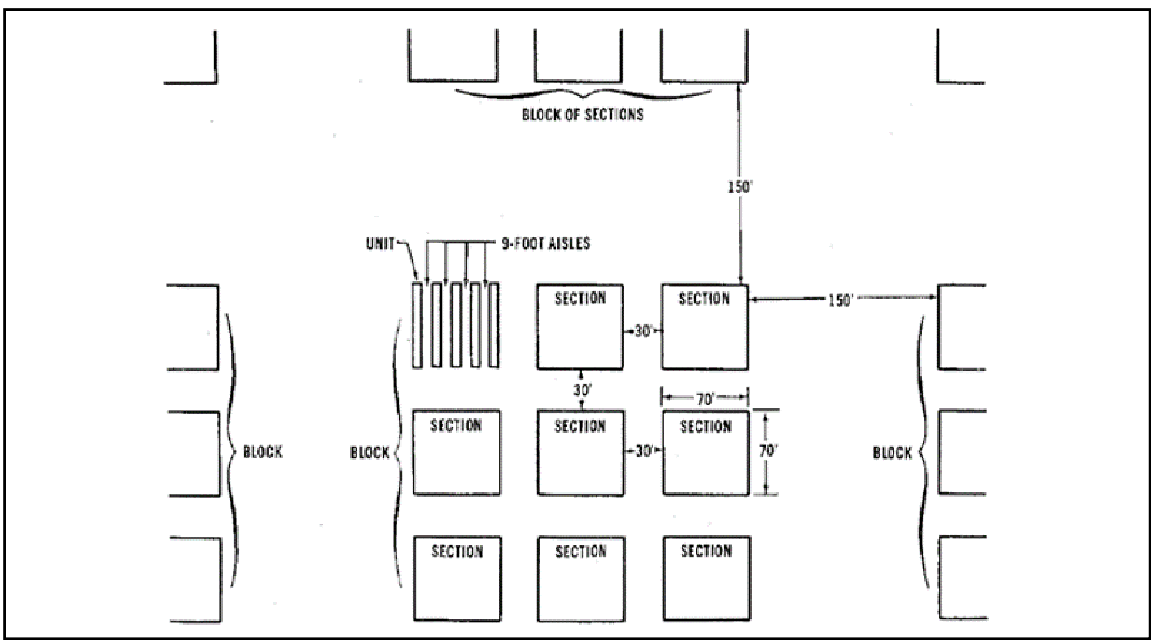

Figure 2-3. Layout of area for stacking 55-gallon drums

Inspecting Containers and Storage Areas

2-35. Containers should be inspected biweekly for signs of leaks, abnormal swelling, or corrosion. Also, the stability of the stacks must be checked. A leaking container must be removed from the stack at once. Cover all containers that need protection with tarpaulins or other suitable materials. Examine container markings often to see if they are legible. Re-label containers that are no longer clear and easy to read with all information that was in the original marking. If the contents of a container cannot be determined, set the container aside and tag it. Send a sample of the contents to the laboratory for testing and identification. Post the results of sample tests for petroleum products and have them readily available at the storage location. Ensure there is no unnecessary equipment in the area to hinder traffic movement or block access to firefighting equipment. Inspect firefighting equipment and drainage facilities regularly to see that they are in good condition. Ensure the area is free of trash, weeds, and other combustible debris.

500 Gallon Collapsible Fuel Drum

2-36. The 500-gallon collapsible drum is a lightweight, durable, non-vented collapsible container. The 500-gallon collapsible fuel drum may be used as a fuel source for transporting, storing and dispensing fuel. When filled to its 500 gallon capacity, the drum is cylindrical in shape with rounded ends. The drum fabric is made of an elastomeric coated woven fabric. The front and rear closure plates are connected by three wire ropes providing interior support. The front closure plate has a threaded coupler valve assembly. Some models have a threaded coupler valve on both the front and rear closure plates for recirculation.

Collapsible Fabric Fuel Tanks

2-37. The collapsible fabric fuel storage tanks are containers designed to store a variety of petroleum liquids. The tanks will be used to store fuel as part of a bulk fuel terminal. Fuel will be available for use in a quick response deployment operation. The tanks are made of tough polymer-coated nylon fabric, however care must be taken not to puncture or tear the material.

Note: Due to the different material properties between collapsible fuel tanks and water tanks, it is not recommended to store fuel in a collapsible water tank regardless of mission necessity. Storing water in a collapsible fuel tank is also not recommended. Commander discretion is required if mission determines a need to store water in a collapsible tank designed for fuel. Potable water standards are factors to be considered if the mission determines water must be stored in collapsible fuel tanks.

2-38. The typical collapsible fabric fuel tank, shown in the figure 2-4, is used for the storage of petroleum based fuels. Each tank assembly consists of a collapsible fabric fuel tank with two or four filler/discharge assemblies with elbow fittings, a vent fitting assembly with a passive vent fitting assembly with a flame arrestor, 2 filler/discharge hose assemblies with control valve, 2 drain fitting assemblies with 2-inch x 10-foot hose assemblies; a berm liner equipped with four 2-inch x 10-foot hose assemblies, two drain fitting assemblies and valve. Spare gaskets and o-rings, a Type II or Type III emergency repair kit and lifting sling are also provided. For further information on the operation of the collapsible bags, see appropriate TM based on size and manufacturer. For berm size and dimensions refer to TB 10-5430-253-13, *Technical Bulletin for Collapsible Fabric Fuel Tanks*.

Note: The collapsible fabric fuel tank can be referred to “bag”, “fabric tank”, “collapsible tank” and “tank” and are used interchangeably.

2-39. Collapsible fabric tank service life and fill levels are important factors in using collapsible tanks. The operator must understand gauging procedures and standardized berm dimensions for collapsible fuel tanks and submitting PQDR. Anytime a tank develops enough deficiencies to change the BRAG status or becomes unserviceable prior to it expected service life, a PQDR is submitted by the responsible officer of that site or equivalent. Data required to fill out a PQDR is located on the data plate of the tank and also on the shipping crate in which it was received.

2-40. The manufacturer stencils the maximum fill height on the tank. Maximum fill heights will vary by size and manufacturer. For the maximum fill height of the collapsible fabric tank see the appropriate TM.

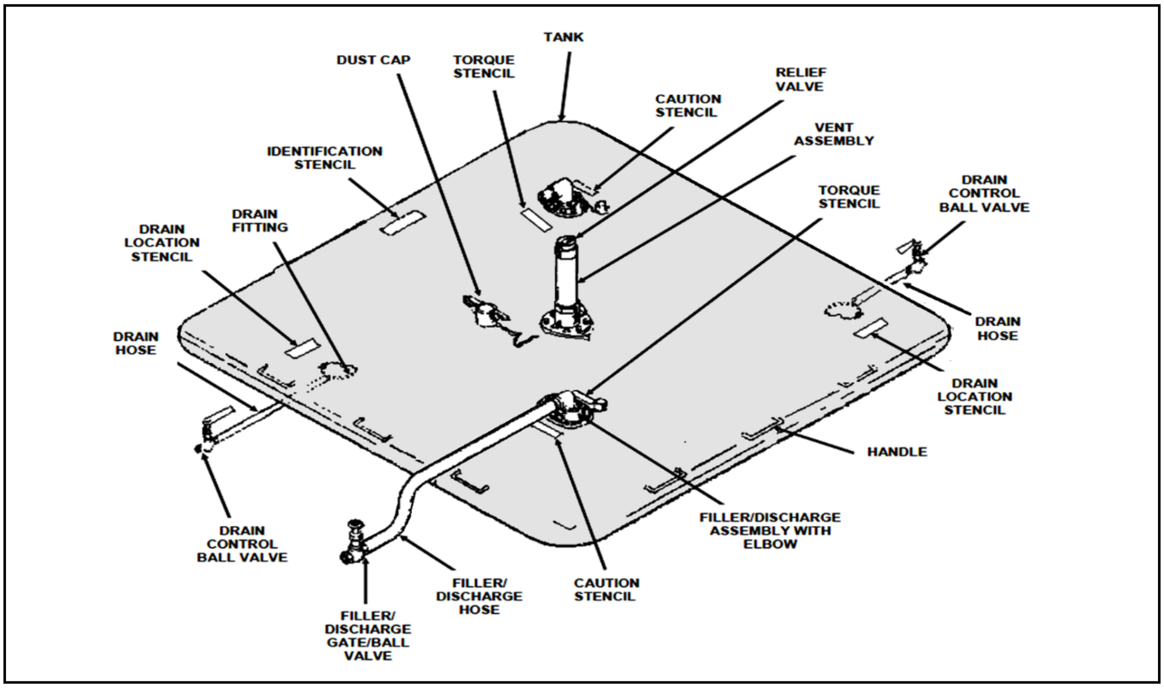

Figure 2-4. Typical collapsible fabric fuel tank

2-41. The 3,000-gallon collapsible fabric tank is made of an elastomeric coated woven fabric. The 3,000-gallon collapsible fabric tank is used for temporary storage of liquid fuels where larger collapsible tanks are not practical. The tank is generally used in small bulk petroleum operations.

2-42. The 20,000-gallon collapsible fabric tank is made of an elastomeric coated woven fabric. The 20,000-gallon collapsible fabric tank is used to store petroleum products. It is usually a part of the 120,000- gallon FSSP, but it is also issued as a single item for additional bulk storage.

2-43. The 50,000-gallon collapsible fabric tank is made of an elastomeric coated woven fabric. The 50,000-gallon collapsible fabric tank is used to store liquid fuels in large bulk petroleum operations. It is usually a part of the 300,000-gallon FSSP, but it is also issued as a single item for additional bulk storage.

2-44. The 210,000 gallon collapsible fabric tank is also called the bulk fuel tank assembly (BFTA). The BFTA is made of an elastomeric coated woven fabric. The 210,000-gallon collapsible tank is used to store liquid fuels in large bulk petroleum operations. The tanks are used in the TPT and the 800,000-gallon FSSP.

Black, Red, Amber and Green (BRAG) Rating System

2-45. The Black, Red, Amber, Green (BRAG) rating system collapsible fabric fuel tank rating procedure establishes a standardized rating system for determination of tank status and must be implemented by bulk fuel storage site supervisors to accurately record and report fuel tank conditions and usable storage capacity. The rating system will provide an assessment of the integrity of fuel tanks to prevent catastrophic fuel tank failures. The system establishes actions and precautions to be taken for each fuel tank brought under surveillance. The system can maximize the lifespan and serviceability of tanks beyond the three year minimum requirement and assist supervisors with management of the site’s capacity to maintain stockage objectives for bulk fuel storage.

2-46. The BRAG rating system for fuel bags is a system which places a fuel tank into a BRAG status based on the number of leaks, their location, size, and the ability to repair the leaks using standard repair kits. The tank status is the means to establish an overall evaluation of each fuel tank's integrity and ability to hold fuel while allowing the site supervisor to actively manage inventory levels and preserve resources. Table 2-1 on page 2-9 identifies allowable fuel quantities based on the size of the collapsible fabric tank.

- Black: Non-mission capable (NMC); non-repairable; discontinue use immediately.
- Red: Displays evidence of failure, but able to use at 50% of maximum storage capacity.
- Amber: Signs of deterioration, but able to use at 70% of the maximum storage capacity.
- Green: Fully mission capable (FMC) able to use to 100% of maximum storage capacity.

2-47. For complete information how to use the BRAG rating system see TB 10-5430-253-13.

Shelf and Service Life of Collapsible Tanks

2-48. The service-life of collapsible fuel tanks is from the wet date, or the date it is first filled, until the tank becomes unserviceable based on upon ratings from the BRAG system. The wet date and product type must be stenciled on the tank by a permanent means in a location that is easily viewable.

2-49. Shelf life is the period from which the tank is manufactured to the time when it is first filled. DOD 4140.27-M, *Shelf-Life Management Manual*, defines shelf-life as: The total period of time beginning with the date of manufacture, date of cure (for elastomeric and rubber products only), date of assembly, or date of pack (subsistence only), and terminated by the date by which an item must be used (expiration date) or subjected to inspection, test, restoration, or disposal action; or after inspection/laboratory test/restorative action that an item may remain in the combined wholesale (including manufacture's) and retail storage systems and still be suitable for issue or use by the end user.

2-50. Collapsible tanks are classified as Type II shelf-life items. Type II shelf-life items are items of supply having an assigned shelf-life time period that may be extended after completion of visual inspection/certified laboratory test, and/or restorative action.

2-51. The Army shelf-life policy for collapsible fuel tanks as defined in TB 10-5430-253-13, *Shelf and Service Life of Collapsible Fabric Fuel and Water Tanks*, states: 12 years under depot like conditions. Depot storage conditions are defined as a dry, indoor environment. If a fuel tank is not stored under depot like conditions, its shelf life is five years from the date of receipt or 12 years from the date of manufacture, whichever comes first. An example would be: a unit receives a tank that was manufactured eleven years prior. The unit puts the tank into service six months after it is received. This would mean the tank was eleven years, six months old when it was put in service. This tank would still have a minimum service life of three years.

Note: Any tank put into service anytime within the shelf-life is expected to have a use/service-life of a MINIMUM of three years.

2-52. DOD 4140.27-M defines service-life as: A general term used to quantify the average or standard life expectancy of an item or equipment while in use. When a shelf-life item is unpacked and introduced to mission requirements, installed into intended application, or merely left in storage, placed in pre-expended bins, or held as bench stock, shelf-life management stops and service life begins. To simplify service-life for collapsible fuel tanks, the service-life is the time from when the tank is wetted with fuel (wet date) until the tank becomes unserviceable. Use of the BRAG system will determine the serviceability of the tank.

2-53. The expected service-life for a collapsible fuel tank is a MINIMUM of 3 years. Anytime a tank develops enough deficiencies to change the BRAG status or becomes unserviceable prior to 3 years, a PQDR is submitted. If the tank becomes unserviceable after 3 years it is disposed of in accordance with local procedures. Operators must periodically check the dates on the data plates of the fuel tank to verify that the tank is safe for use.

2-54. A reduction in a fuel tank's BRAG status will reduce the maximum storage capacity of the bulk storage site. Once the bulk storage site supervisor determines the status of a tank has changed, that change must be recorded on a bulk storage tank record. Once the tank is designated as the BRAG status red, which is 50% of the tank's original design, the capacity will not be further reduced. When a tank is designated as BRAG status black, command guidance must be issued for corrective actions on tank disposition and replacement.

Storage Capacity

2-55. The maximum storage capacity shall be set by the status of the fuel tank. Maximum storage capacity for collapsible fabric fuel tank shall be used to determine the maximum storage capacity by cross linking the fuel tank capacity and status as shown in table 2-1.

Table 2-1. Maximum storage capacity for collapsible fabric fuel tank

STATUS	***210,000***	***50,000***	***20,000***	***10,000***
BLACK (0%)	0	0	0	0
RED (50%)	105,000	25,000	10,000	5,000
AMBER (70%)	147,000	35,000	14,000	7,000
GREEN (100%)	210,000	50,000	20,000	10,000

2-56. Methods for determining BRAG status. The following information will help the site supervisor and inspector determine the BRAG status based on a visual inspection and overall condition of a fuel tank. Seeps, weeps, drips, leaks and wet spots are terms for leakage and will be identified by CLASS. The location, quantity, size and severity of leakage all contribute to determining the BRAG status of a fuel tank. Learning and understanding these leakage definitions will take hands-on experience. When in doubt, notify the site supervisor for a final decision.

BRAG Status

- BRAG status BLACK: Critical – Non-Mission Capable (NMC).
- BRAG status RED: Major.
- BRAG status AMBER: Minor.
- BRAG status GREEN: Fully Mission Capable (FMC).

2-57. Class of fluid leakage.

- Class I: Seepage of fluid (as indicated by wetness or discoloration) not great enough to flow (wet spots).
- Class II: Leakage of fluid (as indicated by wetness) great enough when wiped dry to reappear and flow within 30 seconds. Flow is not great enough to form puddle on ground.
- Class III: Leakage of fluid great enough to flow from the tank and form a puddle of fuel on ground.

2-58. For additional information on collapsible fabric fuel tank inspections refer to TB 10-5430-253-13.

FIXED TANKS

2-59. Petroleum units are responsible for operating fixed petroleum facilities during contingency operations. In a developed theater of operations where sufficient petroleum infrastructure is available, fixed tanks can be used to support class III bulk petroleum operations.

Concrete Tanks

2-60. Concrete tanks are permanent underground tanks made of reinforced cement. These tanks are covered with a mound of earth. Most concrete tanks have manholes and ladders which provide access to the inside. Pits containing pumps and other equipment may be located nearby. Most of these tanks are coated or lined on the inside to prevent leaks and to provide a barrier between the stored fuel and the concrete. These tanks are difficult to clean and to repair if they develop cracks or leaks. All leaks should be reported for maintenance.

Steel and Underground Tanks

2-61. Steel tanks are most commonly found in a developed theater or a theater that host nation support can provide the use of permanent structured tanks for operational use. These steel tanks are common in the commercial sector. They may have either fixed or floating roofs. Floating roof tanks are most often used with high vapor pressure fuels (mogas or avgas) while fixed roof tanks are used for low vapor pressure fuels (diesel, heating oil). They are built for permanent use above ground or buried under a covering of cement or earth. Above ground welded tanks may have floating roofs. Floating roofs move up and down with the level of the fuel in the tank. The purpose of the floating roof is to reduce the amount of vapor in the space above the fuel and lessens the chance of a fire or explosion.

2-62. The welded cone roof tank is better suited for the storage of high volatile products than the bolted steel tank. In areas subject to bad weather conditions, floating roof tanks with permanent covers or domes have been developed for use.

2-63. Each above ground tank should be surrounded by a firewall high enough to contain all the fuel in the tank in the event of a leak. As a safety measure, one foot should be added to the height of the firewall.

2-64. Underground tanks may be of various types to include steel or concrete which will have a protective lining or coating.

Offshore Petroleum Discharge System

2-65. The OPDS was designed by and for the United States Navy, for use with the Army's inland petroleum distribution system (IPDS) or the Marine Corps' tactical fuel system (TFS). The petroleum products are delivered from the offshore tanker to forces onshore where ports or terminal facilities are damaged, inadequate, or nonexistent such as *joint logistics over-the shore* (JLOTS) operations. Each tanker is manned by a civilian merchant crew.

2-66. The legacy OPDS provides up to 1.2 million gallons per 20-hour day of refined petroleum to the beach, from a tanker moored four miles offshore. Each OPDS system includes one new-build support vessel and one tender. MSC is responsible for the current liquid cargo support vessel. The new system will not incorporate afloat storage of fuel, but will utilize tankers of opportunity.

2-67. The newer system, the MV Adm K R Wheeler, is capable of providing 1.7 million gallons per day from up to eight miles offshore in all bottom conditions in significantly higher sea states than the old system. The new OPDS ship utilizes dynamic positioning, which requires no anchoring system. The vessel can maintain ship position within two meters using thrusters and screws. In less than 48 hours, the crew can run the full length of conduit ashore from the ship's bow, run a float hose to a tanker from the ship's stern, and be ready to begin pumping fuel. The system is installed by MSC civilian crews with the assistance of naval support personnel. The MV Wheeler provides the hose and pumping capability for a separate fuel tanker, which provides petroleum product for transfer to shore.

2-68. The system consists of an OPDS support vessel, an embarked tender vessel, and other water craft including a lighter, amphibious, resupply cargo, which will deploy the OPDS conduit and BTU. The Navy is responsible for the operation of the BTU. Once the conduit is deployed, the support vessel will use dynamic positioning to hold the tanker supplying the fuel in place. Figure 2-5 shows how the system connects from the supporting vessel through the BTU to prepare for connection to the U.S. Army IPDS. The Army receives fuel on the outlet side of the BTU and is responsible for moving the fuel inland.

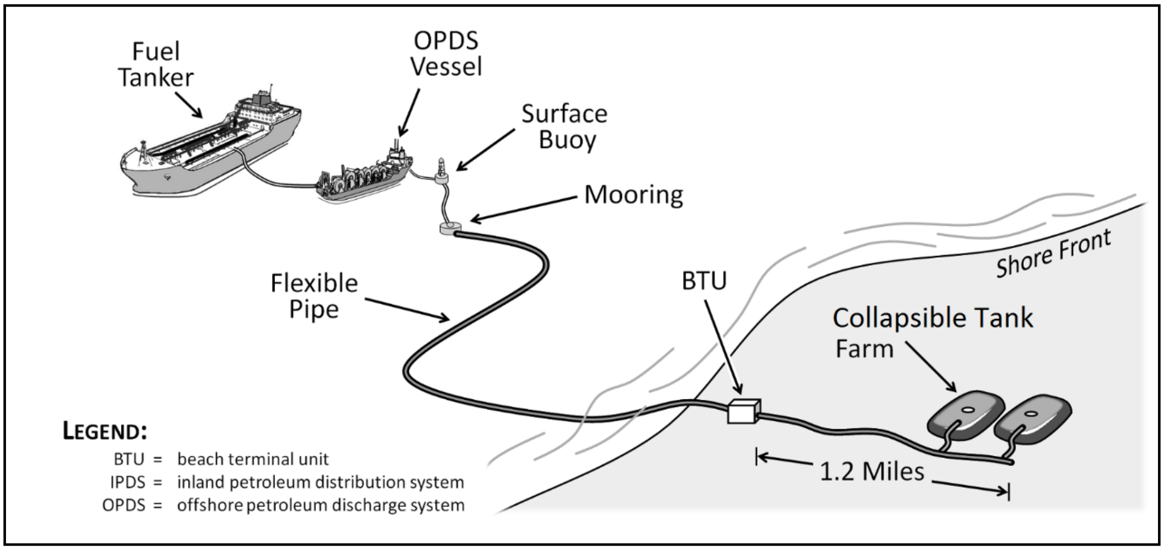

Figure 2-5. Offshore Petroleum Discharge System

DISTRIBUTION EQUIPMENT

2-69. The bulk petroleum distribution system is the compilation of equipment needed to provide bulk fuel to using units anywhere in the theater. This system includes ocean tanker loading and unloading facilities, storage terminals, pump station, pipelines, tank vehicles, and tank cars. The OPDS is the responsibility of the U.S. Navy to provide bulk fuel to the high-water mark on shore where their system will interface with the Army's/Marine Corps bulk petroleum distribution system. In austere environments where bulk fuel facilities do not already exist, the TPT will store and provide the required quantities of fuel. The IPDS is used to move bulk fuel as far forward in the theater as practical. The developed theater consists of existing bulk fuel facilities that may or may not have to be augmented to provide the required quantities of fuel. If the system has to be augmented, the IPDS pipeline and TPT fuel units will be used. Distribution equipment includes the equipment used to transport fuel throughout an area of operations to the using units.

PUMPS

2-70. The Army uses various pumps to move bulk petroleum throughout a theater of operations at all echelons. These pumps vary in size, measured in GPM. The range of the pump depends on the fuel system it supports, the amount of petroleum required and the distance it needs to transport through the pipeline/hoseline.

50 Gallons Per Minute Pump

2-71. The 50-GPM diesel/JP8 engine driven pumping assembly is used to fill, remove, and transfer fuel to, from, and between containers.

2-72. The 50-GPM electric pump is used with the tank and pump unit, which is later described in the tank vehicle section.

100 Gallons Per Minute Pump

2-73. The 100-GPM diesel/JP8 engine driven pumping assembly is used to fill, remove, and transfer fuel to, from, and between containers.

2-74. There is also a different model used as a component of the forward area refueling equipment-2 (FARE-2) system, later discussed in the chapter.

ADVANCED AVIATION FORWARD REFUELING SYSTEM PUMP

2-75. The pumping assembly is a modular, Soldier-portable pumping system, later discussed in this chapter.

2-76. The pump-engine module houses a self-priming pump that provides a flow of 225-GPM at 3400 revolutions per minute (RPM).

350 GALLONS PER MINUTE PUMP

2-77. The 350-GPM pumping assembly is mounted on a two-wheel trailer. The assembly can be moved by a towing vehicle using the attached tow bar. However, it must be towed for only short distances at speeds not exceeding 20 miles per hour on hard surfaced roads, 10 miles per hour on gravel roads or eight miles per hour on rough cross country roads. If the pumping assembly must be moved for a long distance, it should be loaded on a cargo vehicle or flatbed using a lifting device with at least a 2,000-pound capacity.

2-78. The 350-GPM pumping assembly moves fuel from the source of supply to the tanks and from the tanks to the dispensing equipment. The pump is a component of the FSSP, TPT, and the AHS, later discussed in this chapter.

2-79. There are various models of this pump.

600 GALLONS PER MINUTE PUMP

2-80. The 600-GPM pump is a wheel-mounted, diesel engine-driven, self-priming, air-cooled, centrifugal unit. The pump is close-coupled to a turbo-charged diesel engine, which can be operated manually or automatically through an electric governor. The pump and engine are mounted on a two-wheel trailer assembly with internal towing bar and leveling supports. The 600-GPM pump has a discharge head of 350 feet and is rated at 2400 RPM.

2-81. The 600-GPM pump is designed to transfer fuel from one tank to another, pump fuel to the dispensing set, pump fuel to the associated pipeline system, and to pump fuels from the tank vehicle receipt manifold to the TPT storage tanks. This pump is also a component of the 800K FSSP.

800 GALLONS PER MINUTE MAINLINE PUMP

2-82. The 800-GPM mainline pump is a horizontal split case, three-stage centrifugal, skid-mounted unit. It is driven by a turbo-charged diesel engine. The pump contains a connect-disconnect clutch to allow the engine to run without turning the pump. The engine speed control sets the engine speed RPM regardless of the discharge pressure. The pump has an approximate discharge head of 1,800 feet at 2,100 RPM.

2-83. The 800-GPM pump is primarily used as part of the pump station with the IPDS.

METERS

2-84. There are two types of meters included in the FSSP. The two types of meters are described below:

2-85. Tank volume meter is positioned at each collapsible tank inlet and outlet. One set of meters is allocated for each of the collapsible fabric fuel tanks in the system to measure the volume in each tank based on the difference between incoming and outgoing quantities.

2-86. 4-inch inline flow meter assembly. The flow meters record the total quantity passing through each side of the FSSP; one at the receipt side and one at the dispensing side.

2-87. The TPT has a 6-inch inline flow meter assembly. Four flow meters are a part of the TPT switching manifold.

2-88. For meter verification or calibration, refer to appendix Q.

DISPENSING NOZZLES

2-89. Dispensing nozzles are attached to fuel hoses for the purpose of controlling the flow of fuel into receiving equipment. They are designed with safety considerations for various fueling purposes, desired flow rate, and the equipment receiving the fuel.

2-90. Most nozzles have dust caps and/or plugs that must be used when not conducting dispensing operations, in order to prevent dirt and dust from potentially contaminating the fuel.

Note: Any nozzle used to perform aircraft refueling must be equipped with a #100 mesh screen.

SINGLE POINT REFUELING D-1 NOZZLE

2-91. The single point refueling D-1 or D-1R Nozzle is a 2 ½ inch pressure fueling nozzle that mates with the aircraft adapter for fuel servicing or the bottom load adapter on most petroleum tank vehicles and systems. The closed circuit system is designed to eliminate fuel spillage during refueling operations and regulate fuel delivery pressure. The nozzle is lightweight, rugged and equipped with a grounding cable assembly. The clip and plug ground cable connections provide grounding and bonding of the nozzle to the aircraft prior to connection and during servicing. The nozzle contains positive mechanical interlocks that prevent the nozzle from disconnecting during fueling. The D-1 nozzle operates under seven pounds per square inch at a maximum of 600-GPM.

CLOSED CIRCUIT REFUEL NOZZLE (CCR)

2-92. Closed circuit refueling (CCR) nozzle is designed to eliminate fuel spillage during refueling operations and regulate fuel delivery pressure. A flow control valve inside the CCR nozzle keeps it closed so that fuel cannot flow unless the automatic shutoff coupler is inserted in the vehicle fuel service adapter. Each CCR nozzle has a wire mesh strainer set between the nozzle inlet and dry break coupling. The CCR nozzle is equipped with a ground cable assembly (grounding plug and clip). An internal pressure regulator limits fill port pressure to 15 pounds per square inch.

OPEN PORT NOZZLE OR GRAVITY FILL NOZZLE ADAPTER

2-93. Open port nozzle is manually operated by pulling up on spring-loaded handle. Internal control valve in the open port nozzle body allows fuel to flow through discharge opening. Releasing handle seats the internal control valve and stops fuel flow. The open port nozzles used for either ground or aviation may have a cam-lock or dry-break connector. Fuel nozzles used for ground equipment typically do not have a #100 mesh screen and a dust cover. However, all open port nozzles used for aviation refueling must have a #100 mesh screen.

2-94. The gravity fill adapter is attached to the discharge end of the CCR nozzle for servicing vehicles not equipped with CCR adapters.

Note: Nozzles that can be locked in the open position are not authorized for use in tactical equipment. If the nozzle has that capability, the locking capability must be removed before use.

2-95. See appropriate FSSP TM for different open port style nozzles.

INLAND PETROLEUM DISTRIBUTION SYSTEM

2-96. The Inland Petroleum Distribution System (IPDS) is a deployable International Organization for Standardization (ISO) container configured, general support, bulk fuel storage and pipeline system. It is made up of tactical petroleum terminals (fuel units and pipeline connection assemblies), pipeline pump stations, pipeline sets, and special-purpose equipment. The system is modular in design and can be tailored for specific locations and operations.

2-97. The IPDS consists of both commercially-available and military standard petroleum equipment that can be assembled by U.S. Army personnel into an integrated petroleum distribution system. This system provides the U.S. Army with the capability required to support an operational force with bulk fuels in either a developed or an undeveloped joint operations area. Bulk fuel can be supplied from either local sources or over-the-shore by the OPDS with a capacity of 720,000 gallons of fuel per day. This fuel is then pumped inland by means of a pipeline system and pump stations to TPTs. Each TPT is constructed from fuel units (bulk fuel receipt, storage, and distribution facilities) and pipeline connection assemblies. Fuel units can be used in combination with pipeline connection assemblies, as noted in the TPT, and receive fuel from the pipeline or they can be used as separate units and receive fuel only from trucks. In either situation, the fuel unit can distribute fuel from bulk storage to tanker trucks for operational use.

2-98. Petroleum units utilize hoselines, such as the AHS, and/or pipelines for use over short and long distances to replace or supplement vehicle delivery. This reduces the number of trucks on the main and secondary supply routes while ensuring that petroleum requirements are met efficiently and effectively. The lines must be patrolled sufficiently to reduce and mitigate sabotage and theft. Generally, hose-lines can be installed rapidly and be in an operational condition in much less time than pipelines. Pipelines offer durability and the capability to operate at higher pressures meaning pump stations can be further apart.

2-99. The joint operations area plans specify fuel distribution requirements from which pipeline routes are determined, the number and locations of pump stations are calculated, and the number and locations of bulk storage facilities are determined. If OPDS is required, planning for location and installation is accomplished concurrently. In operation, the IPDS is designed to be transported to the joint operations area and installed by military units. Engineer units install the pipeline, construct the pump stations, prepare storage sites and test the system. Quartermaster units install the storage system and operate the total system when it is tested and turned over by the Army Engineers. When not in use, the IPDS is stored in predetermined configurations. These configurations and container markings allow for controlled movement tracking and subsequent planned arrival according to the requirements of the logistics program of the joint operations area scenario.

2-100. The technical configuration of the IPDS, as shown in figure 2-6, incorporates three major groups of equipment.

- The bulk petroleum storage system consists primarily of fuel units and pipeline connection assemblies. Its primary function is to receive, store, and issue fuel. To provide design flexibility to the military planner to meet joint operational requirements, fuel units can be used as independent end items or combined together with a pipeline connection assembly to form a TPT. Three fuel units and one pipeline connection assembly combine to make one standard TPT.
- The pipeline system consists of pipeline sets, pipeline pump stations, and pipeline support equipment. Its primary function is to transport fuel from one area to another. The military planner can combine as many pipeline sets (five miles each) and pump stations as is necessary to meet joint operational requirements.
- Special-purpose equipment provides specific-purpose components that are incorporated into the pipeline design to overcome specific joint operations area topographical problems or pipeline design problems. Their use is based upon the needs of the military planner when designing the IPDS.

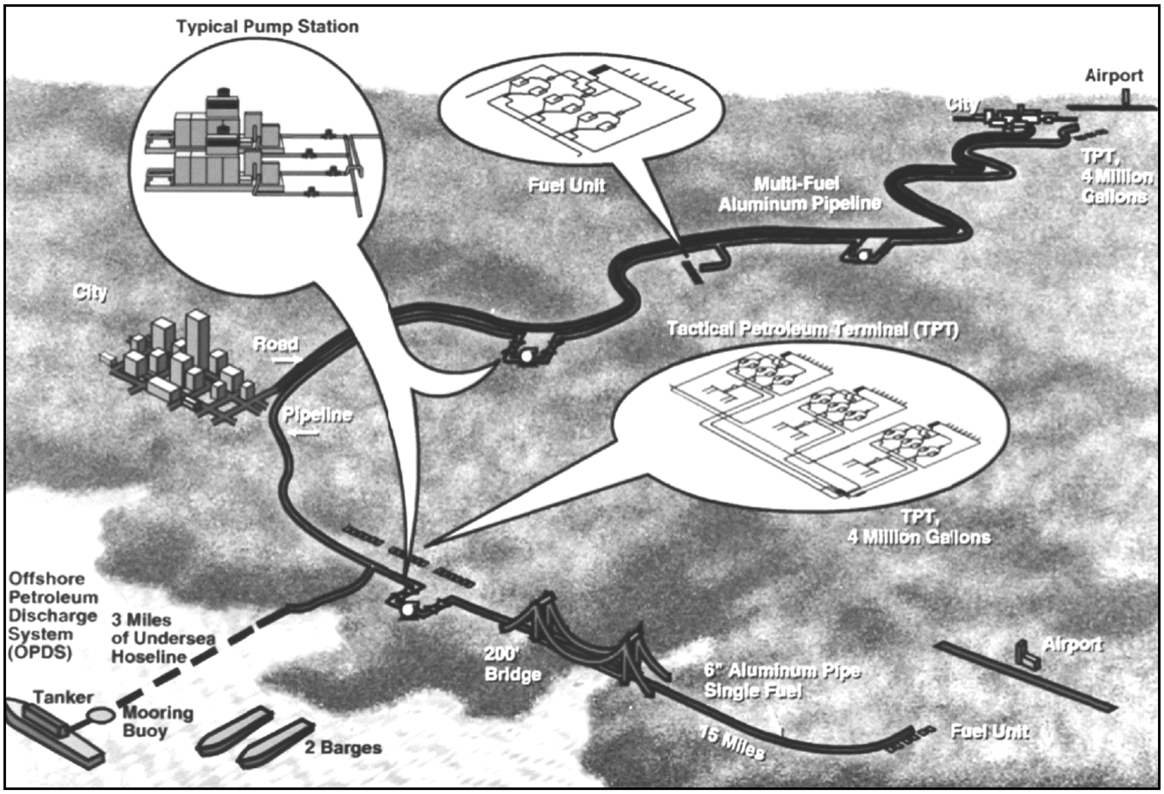

Figure 2-6. IPDS overview

TACTICAL PETROLEUM TACTICAL

2-101. The function of the TPT is to receive, store and issue bulk petroleum. The standard TPT as shown in figure 2-7, incorporates three fuel units and one pipeline connection assembly. It has a total fuel capacity of 90,000 barrels (3,780,000 gallons). The TPT is extremely flexible in use. It can accept fuel from either a pipeline or from tanker-trucks. Likewise, it can simultaneously distribute fuel to tanker-trucks or back to the pipeline. Since three separate fuel units are incorporated into the system, the TPT can store three different types of fuel, if required. It can also transfer fuel from one fuel unit to another.

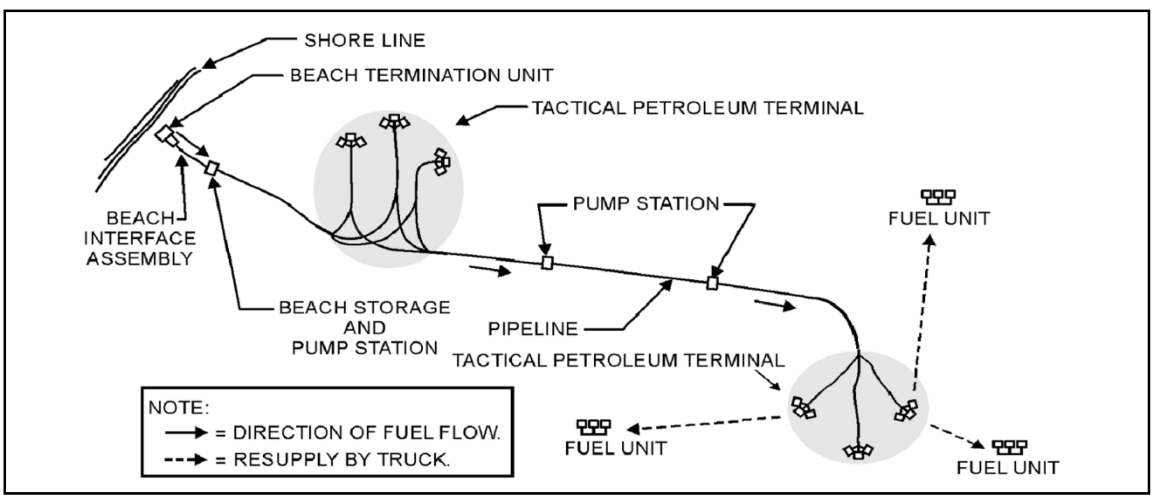

Figure 2-7. Standard TPT

FUEL UNIT

2-102. The function of the fuel unit is to receive, store and issue bulk petroleum. The fuel unit can be used as an independent unit or combined with other fuel units. As an independent unit, it is designed only for loading or unloading operations of tanker-trucks. It can, however, be directly attached to a pipeline by use of a pipeline connection assembly. Its storage capacity is 30,000 barrels (1,260,000 gallons) of fuel. The maximum allowable operating pressure of a fuel unit is 150 psi. In operation, the fuel unit receives fuel from either tanker-trucks via the tanker-truck receipt manifold or from a pipeline via the pipeline connection assembly. This fuel is then diverted to any of the six fabric collapsible fuel tanks within the fuel unit where it is stored until needed. When needed, fuel is drawn out of the fabric collapsible fuel tanks and pumped to the fuel dispensing assembly by means of a 600 GPM pump. Fuel can also be circulated within the fuel unit by use of the 600 GPM pump. It should be noted that one 50,000-gallon tank optional configuration (100,000 gallon maximum capacity) unit is supplied with each fuel unit. This unit can be used for contaminated fuel storage or provide additional storage flexibility.

TANKER-TRUCK RECEIPT MANIFOLD

2-103. The function of the tanker-truck receipt manifold is to receive fuel from tanker-trucks via the four inlet suction hose fuel lines. In operation, the tanker-truck receipt manifold, depicted in figure 2-8, receives fuel by means of the pumps on board the tanker-truck or by drawing fuel from the tanker-truck with the system's 600 GPM pump. The inlet fitting of each four-inch fuel line is a three or four-inch female quick disconnect. A self-driving grounding rod is provided with each fuel line. The manifold outlet is a six-inch double-groove tee. Adapters are provided for various host nation commercial truck configurations. In general, a graded area that is 120 feet wide by approximately 700 feet long is required to properly lay out the manifold.

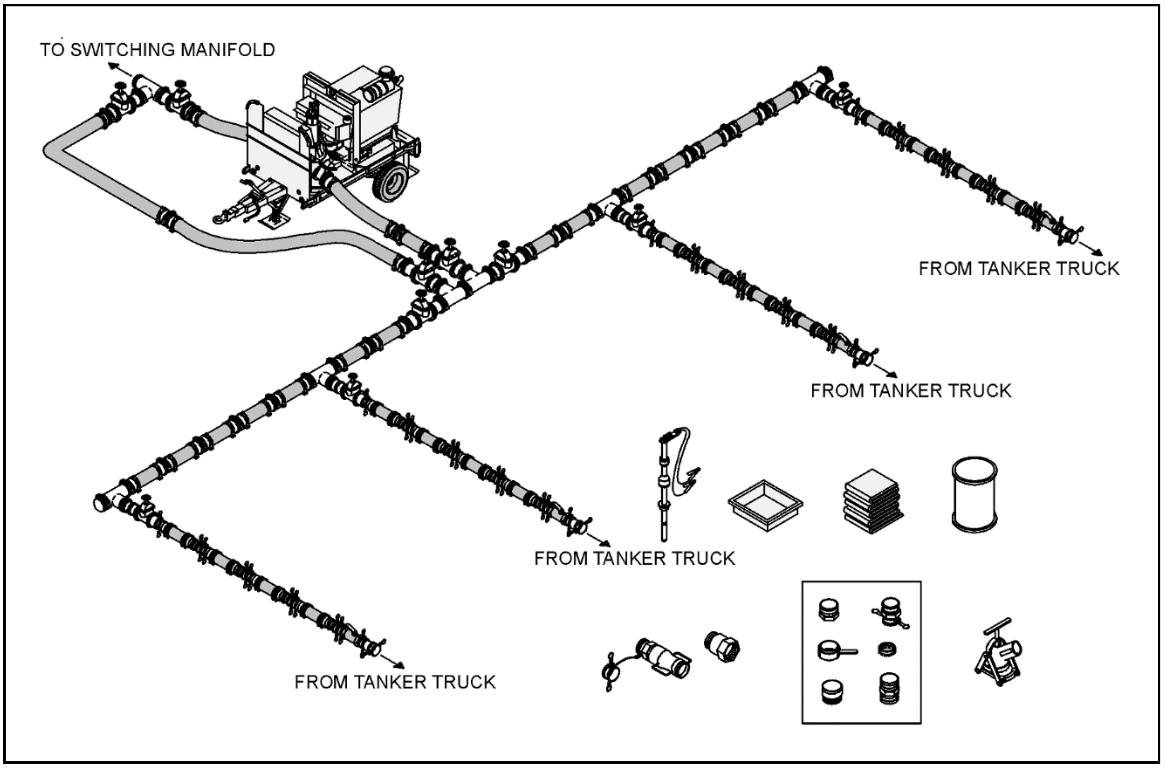

Figure 2-8. Tanker-truck receipt manifold

FUEL DISPENSING ASSEMBLY

2-104. The function of the fuel dispensing assembly is to issue bulk petroleum products from the fuel unit to tanker-trucks and/or 500-gallon collapsible drums. In operation, fuel is pumped from the tank farm assemblies to the four 350 GPM filter separators of the fuel dispensing assembly shown in figure 2-9. The filter-separators are two-stage, vertical-type units designed to remove un-dissolved water and solid contaminants. A water detection kit adapter is installed immediately downstream from each filter-separator to permit sampling of the exit stream to check fuel quality. From there, the fuel can enter any one of the 6 four-inch fuel handling lines or the two 1½-inch fuel handling lines of the fuel dispensing assembly. The outlet fining for the 6 four-inch fuel handling lines can be either a three-inch female disconnect or a D-1 quick disconnect nozzle. Three dry break coupling assemblies, two NATO tank-truck adapter coupling assemblies and two NATO rail adapter coupling assemblies are also provided. The outlet of the two 1½-inch fuel handling lines is a 1½-inch female quick-disconnect ball valve assembly. A self-driving grounding rod is provided with each fuel line outlet. A pressure control valve assembly is positioned at the downstream end of the fuel dispensing assembly to provide a constant 30 psi line pressure in this system. The physical location and layout of the fuel dispensing assembly is determined by the terrain and configuration of the TPT. The fuel dispensing assembly should be located near a road capable of supporting heavy vehicle traffic during periods of climatic weather changes. A section at least 50 feet wide and 750 feet long should be graded for the fuel dispensing assembly itself. An adjacent area 120 feet wide by 850 feet long should be graded for vehicle traffic and parking while loading.

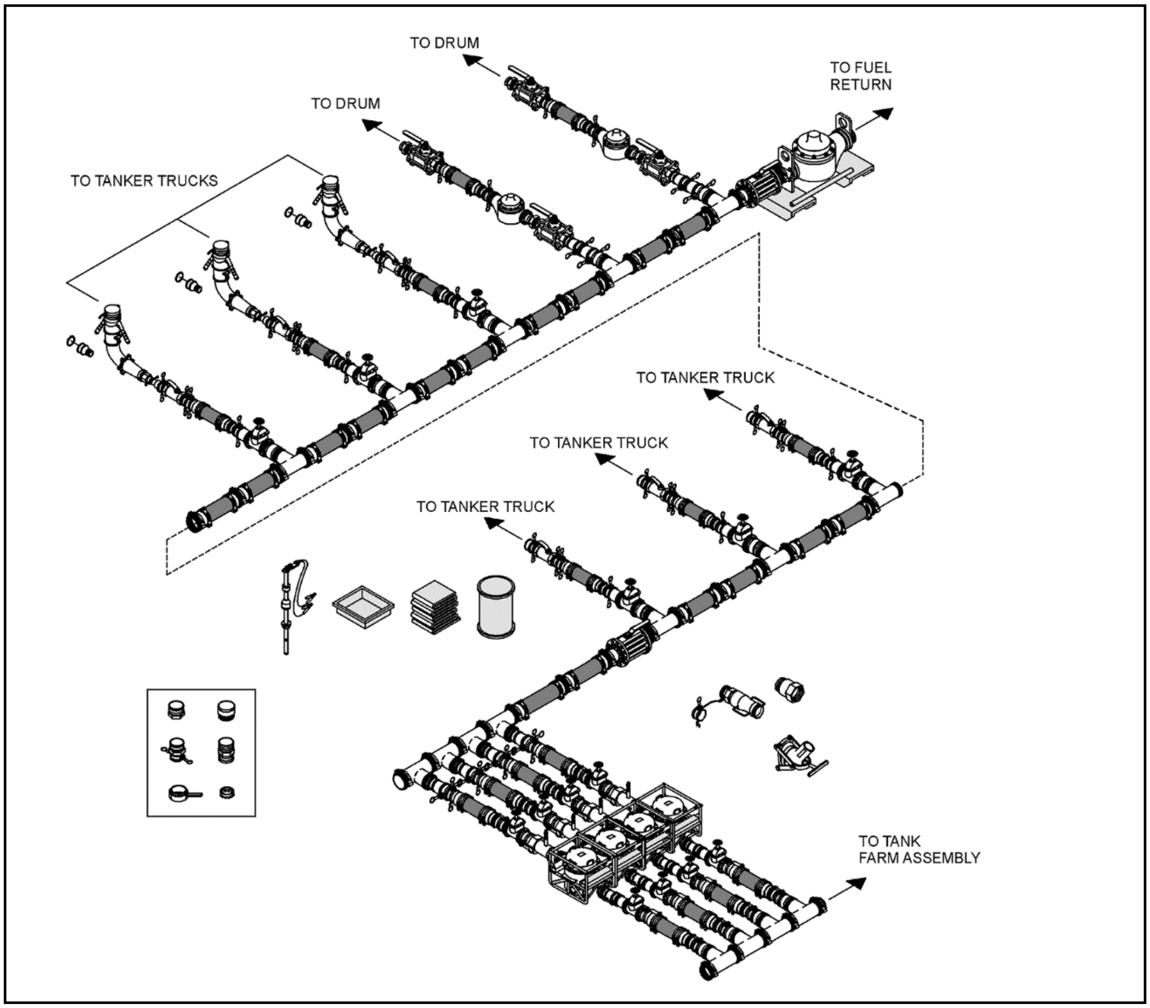

Figure 2-9. Fuel dispensing assembly

TANK FARM ASSEMBLY

2-105. The function of the tank farm assembly is to provide storage capacity for the fuel in the fuel unit. In operation, the tank farm assembly, figure 2-10 on page 2-18, stores bulk fuel until needed by the joint operations area scenario. When needed, fuel is pumped directly to the fuel dispensing assembly from the storage tanks by means of a 600-GPM pump. Fuel may also be pumped to any other storage tank in the fuel unit by means of the circulation system in the fuel unit. Range poles are provided to assist in determining the amount of fuel in each fuel tank. In general, an area approximately 200 feet long by 300 feet wide is required for this assembly if adjacent shared berms are used for fuel tank installation.

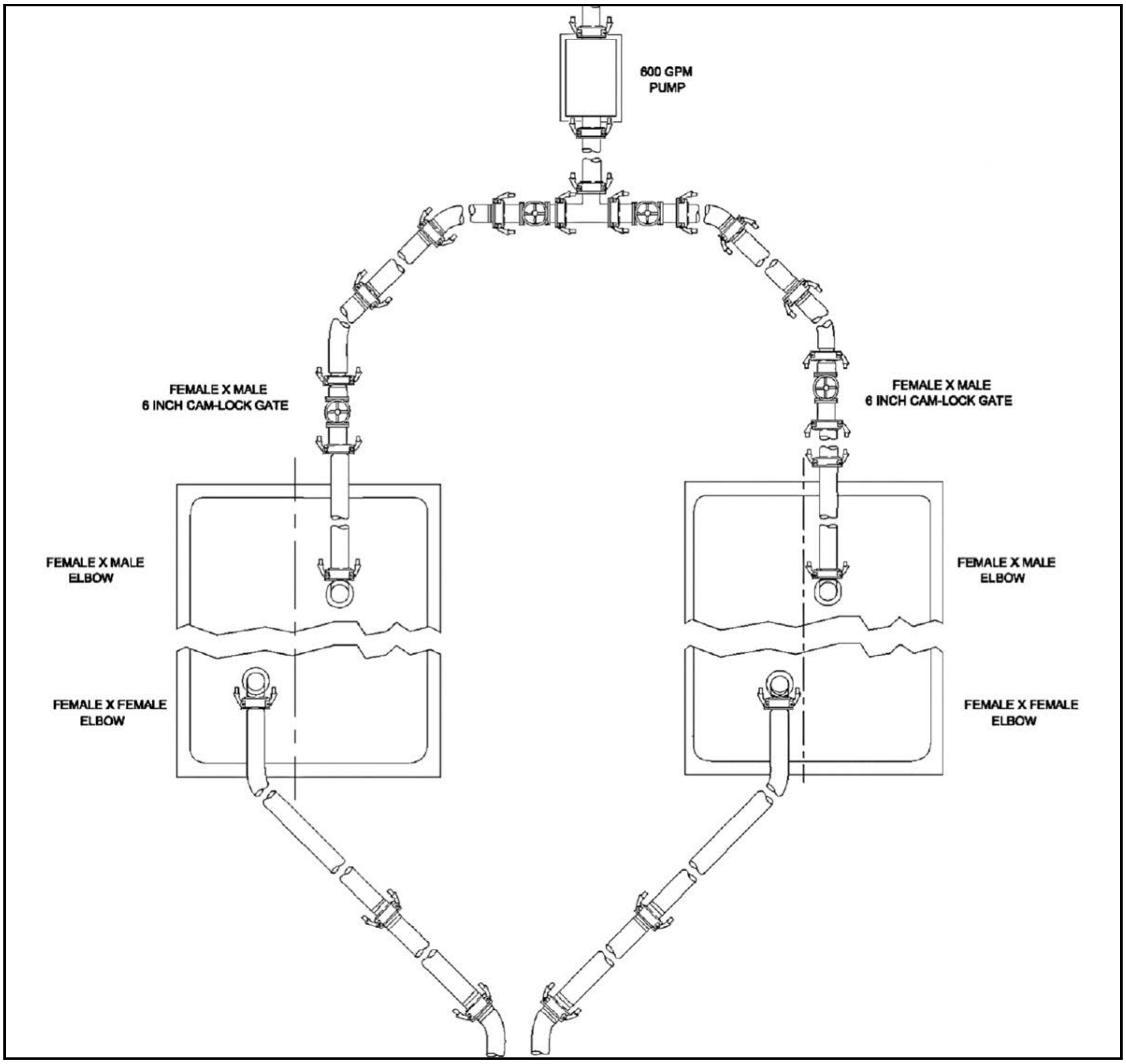

Figure 2-10. Tank farm assembly

TRANSFER HOSELINE ASSEMBLY

2-106. The function of the transfer hoseline assembly is to provide hose to ensure fuel unit layout flexibility. To ensure proper field operation, a fuel unit must have sufficient layout flexibility to accommodate the physical characteristics of the various field sites. The availability of additional six-inch dispensing hose provides this flexibility. This hose and its associated components are provided by the transfer hoseline assembly. This hose is normally packed in triple containers (TRICONs). In operation, a TRICON is placed on the back of a truck or forklift and the hose is dispersed where needed.

FIRE SUPPRESSION EQUIPMENT

2-107. Six sets of fire suppression equipment, figure 2-11, are provided with each fuel unit. Each set consists of one trailer mounted fire extinguisher assembly (twin agent unit), five 20 B:C fire extinguishers and three fire protection suits. The twin agent unit contains two firefighting agents: Dry chemical (Purple K) and aqueous film forming foam. Purple K extinguishes fires by breaking up flame propagation. Water mixed with the AFFF concentrate forms a foam which is then spread over the extinguished area to prevent re-ignition. Pressure for operating the system is provided by two on-board, compressed nitrogen cylinders. A 150-foot non-collapsible hose and discharge nozzle is provided for each chemical agent. The hose is stored on a hose reel at the back of the unit whenever it is not in use. Increased area coverage, without having to move the twin agent unit, is accomplished by use of a remote hose cart which contains an additional 150-feet of hose. The twin agent unit has the capability of extinguishing a 1,500-square foot petroleum fire. Each twin agent unit is supported with firefighting clothing. The clothing includes three aluminized proximity fire suits (with boots, gloves, and hood).

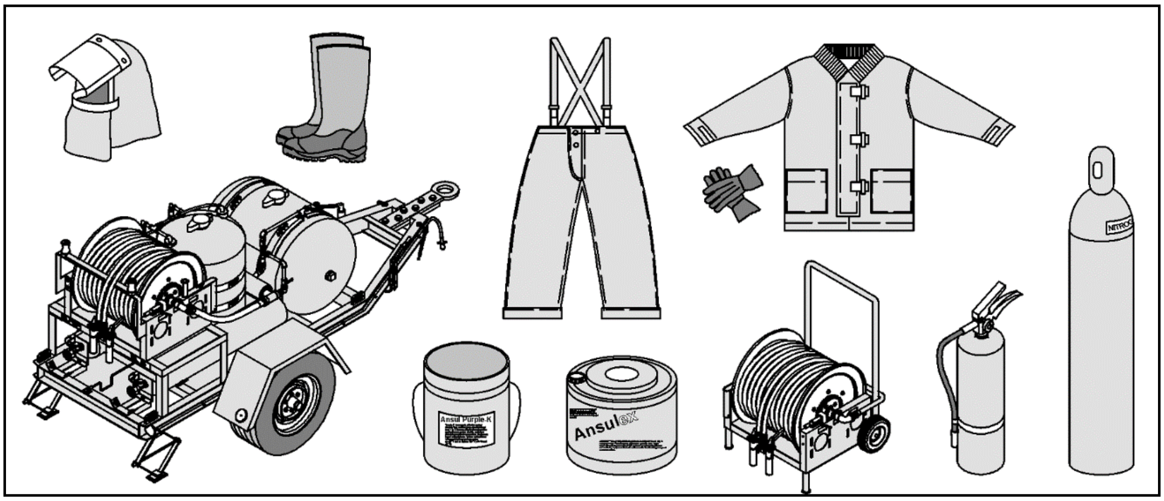

Figure 2-11. Fire suppression equipment

50,000-GALLON TANK TPT, OPTIONAL CONFIGURATION

2-108. The function of the 50,000 gallon tank TPT is to increase or supplement the fuel unit's storage capacity. The optional tank configuration, figure 2-12 on page 2-20, is a multipurpose fuel storage unit that can be used to increase or supplement the fuel unit or TPT storage capacity. It can also be used to supplement the contaminated fuel module capacity or it can be used as a stand-alone unit to provide a low-volume storage and distribution system.

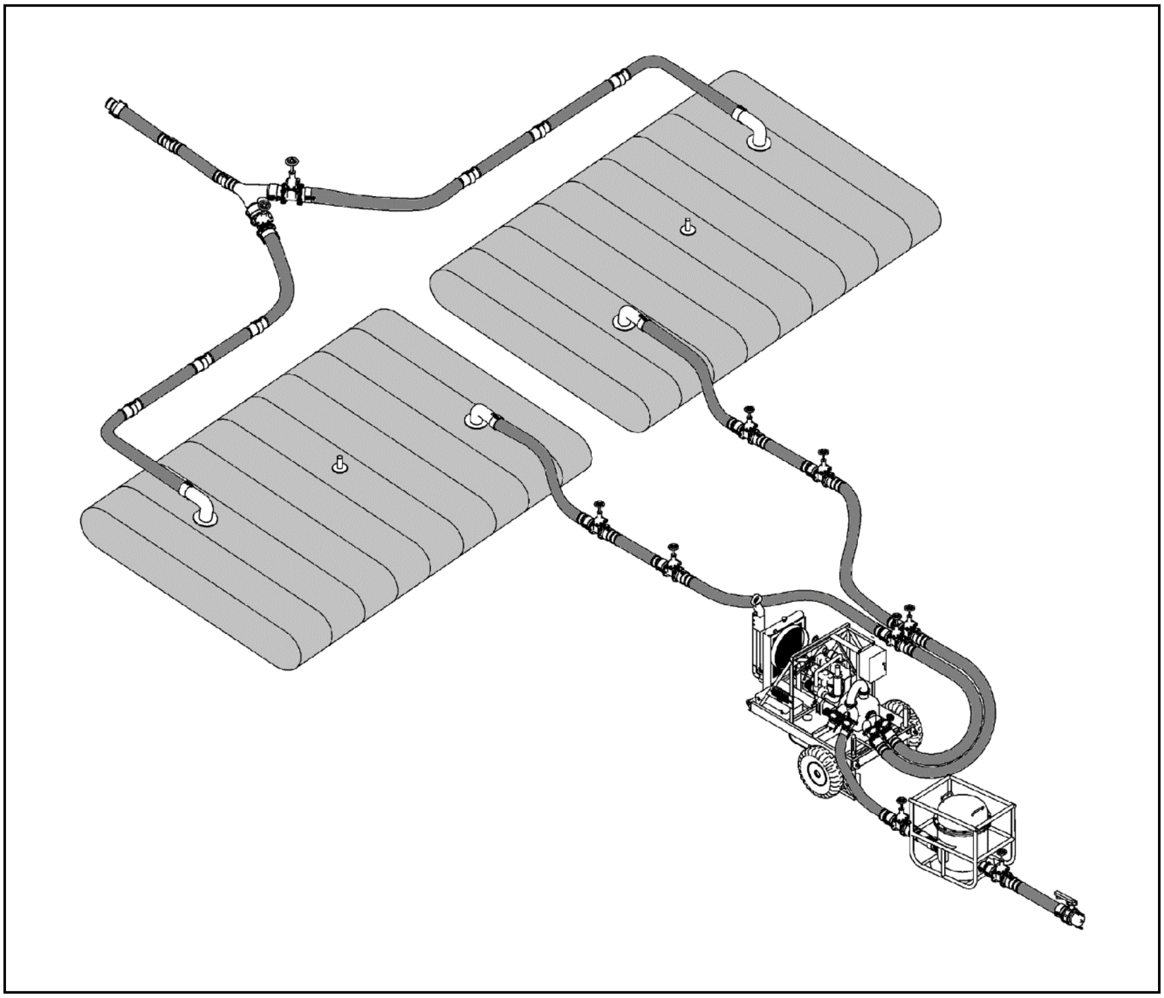

Figure 2-12. 50,000 gallon tank TPT, optional configuration

PIPELINE CONNECTION ASSEMBLY

2-109. The pipeline connection assembly provides the capability for connecting fuel units to pipelines. In the event pipelines are used to supply fuel to or receive fuel from the fuel units, a pipeline connection assembly is required. This assembly protects the low-pressure components of the 150 psi TPT from the high-pressure fluid (740 psi max) of the pipeline and provides storage for the contaminated fuel interface if two different fuels are pumped through the pipeline. Additional hose is available to connect the pipeline to the inlet of the terminal. The pipeline connection assembly contains the contaminated fuel module, switching manifold, transfer hoseline, fire suppression equipment and miscellaneous support equipment stored in 5ea 20’ ISO containers.

CONTAMINATED FUEL MODULE

2-110. The contaminated fuel module provides storage for fuel which becomes mixed or otherwise contaminated during delivery to fuel units when they are connected to a pipeline. When different types of fuel are delivered to a fuel unit via a pipeline, an interface between the two fuels exists in the pipeline. The interface is that volume of fuel where the two dissimilar products meet and partially mix. Due to this mixing, neither product maintains its required specifications and is therefore considered contaminated. The contaminated fuel module temporarily stores contaminated fuel until the fuel can be trucked to another operational area for reprocessing or mixed with a fuel of lower quality. Contaminated fuel is directed to the contaminated fuel module from the pipeline via the switching manifold. An area approximately 180 feet long by 100 feet wide is required for this assembly if adjacent berms are used for contaminated fuel tank installation. Road access is required for unloading of the tanks by tanker-truck.

SWITCHING MANIFOLD

2-111. The switching manifold controls the flow of fluids from the pipeline to the fuel units and contaminated fuel module, and from the fuel units to the pipeline. The switching manifold, figure 2-13, consists of two assemblies; the receipt manifold and the return manifold. The receipt manifold transfers fuel from the pipeline to the fuel units or to the contaminated fuel module. It contains a pressure-regulating (reducing) valve, a fuel sampling assembly, meter skid assemblies, hoses, valves, and other components. The pressure-regulating valve is used to reduce the pressure of the incoming pipeline fluid to below the 150 psi working pressure of the fuel unit or TPT. The fuel sampling assembly is used to check incoming fluid for contaminants and quality. The meter skid assembly allows measurement of fuel volume and flow rate into each of the fuel units. The return manifold transfers fuel from the fuel unit(s) to the pipeline. It contains a meter skid, hoses, valves, and other components.

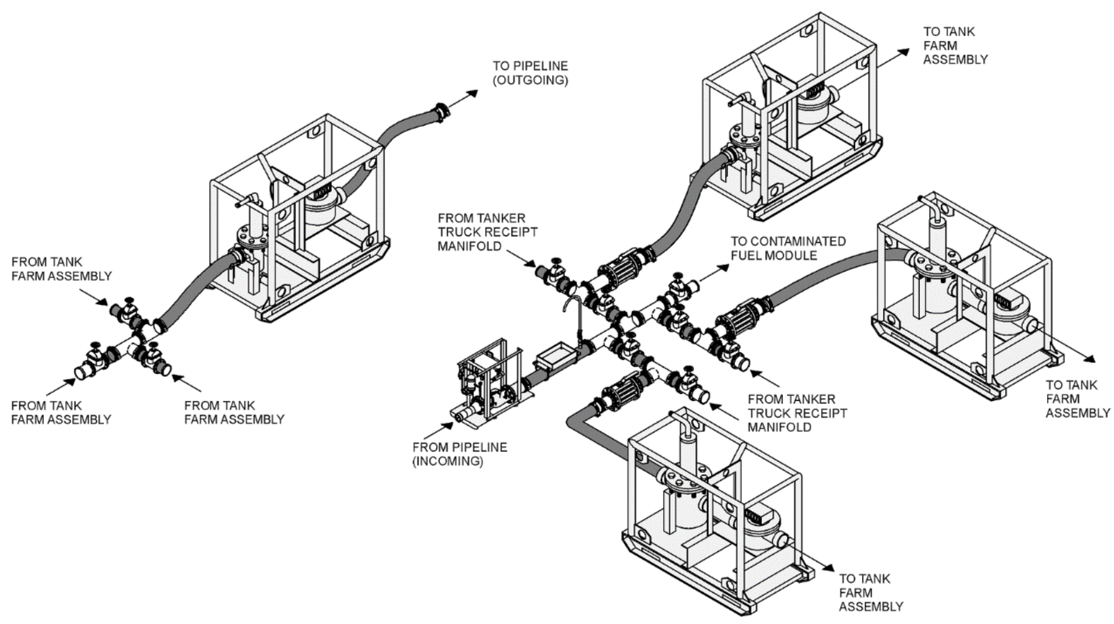

Figure 2-13. Switching manifold

PIPELINE SYSTEM

2-112. The pipeline system transports fuel via a pipeline from one area to another. In operation, the pipeline system can incorporate as much pipe and as many pump stations as is necessary to meet the joint operational requirements. The system is flexible in design so as to provide the military planner with the necessary freedom to develop a pipeline system that can cope with field conditions and topographic problems. Components from the special purpose equipment group, such as bridges and critical gap crossings, can be incorporated into the pipeline design to cope with specific topographic features, such as rivers and swamp crossings. The maximum allowable operating pressure of the pipe and the system is 740 psi. A single six-inch fuel supply line can deliver, within practical limits, a maximum of 800 GPM (1,152,000 gallons per day). The components incorporated into the pipeline system are:

- Pipeline set, 5-mile
- Pipeline pump station
- Pipeline support equipment

Pipeline Set, 5-Mile

2-113. The pipeline set, 5-mile provides pipe and associated equipment for the construction of a five-mile segment of pipeline. The 5-mile pipeline set incorporates ample pipe and associated equipment to construct a five-mile segment of pipeline. Sufficient equipment is provided to allow the military planner flexibility in pipeline design so that he can cope with joint operations area topography and constraints. Six-inch diameter aluminum line pipe is used for construction of the long runs of the pipeline. The pipe is connected using single groove coupling clamps with integral split gaskets. The pipe is thinner in the middle than at the ends (where the pipe clamps are applied) so as to reduce weight. Other components used in pipeline construction and included in the 5-mile pipeline set are:

- Six-inch aluminum, constant wall thickness pipe used for making up stock (less than 9½ feet long) joints of pipe for tie-in purposes or nonstandard pipe lengths.
- Gate valves used for isolating sections of the pipeline in case of leaks or other repair problems.
- Check valves used for assuring direction of fluid flow in the pipeline in one direction only.
- Drain valves used for draining the pipeline.
- Vent valves used for venting air from the pipeline during filling operations.
- Pipeline anchors used for securing the pipeline to the ground and directing the pipe movement.
- Assorted hardware, including elbows for pipeline direction change and expansion, culverts for road crossings, and overclamps and repair clamps for leak repair.
- Thirteen 20-foot-long ISO containers for pipeline storage.

Pipeline Pump Station

2-114. The pipeline pump station boosts the pressure in a pipeline to maintain rate of fluid flow. The IPDS pipeline pump station provides the energy to maintain the desired rate of fluid flow along the pipeline. This energy is provided by two 800 GPM (1,800 feet of head) diesel engine-driven, centrifugal pumps. These pumps are connected in parallel so that only one pump will be on-line at any given time. The other pump is a back-up pump and can be brought on-line quickly to prevent any disruption in the flow of fuel. In addition to the 800 GPM pumps, other components are required to construct a workable pump station. The strainer assembly is used to keep debris from entering the pump. The receiver assembly captures scrapers that are run through the pipeline. The launcher assembly provides the means to inject a scraper into the pipeline. Scrapers are used to purge air from the pipeline during fill and test and to periodically clean the inside of the pipeline. The 3,000-gallon collapsible fabric tank is used to store bulk fuel for the pump engines. The tank is filled by drawing fuel from the pipeline. Generally, a graded area 140 feet long and 85 feet wide is required for its construction. However, other layout designs may be required due to topographic conditions.

Pipeline Support Equipment

2-115. Pipeline support equipment provides auxiliary components for the construction and operation of a pipeline. The pipeline support equipment contains those items required to assist in the construction and operation of a pipeline system. The basis of allocation is one set of pipeline support equipment per 100 miles of pipeline to be installed. The equipment includes two 600 GPM wheel-mounted pumps, an assortment of nipples and elbows, tools, calibration instruments, critical gap crossings, a cutting and grooving machine, and an assortment of valves. An interim support items list is provided to ensure operation of the pipeline.

Special Purpose Equipment

2-116. Special purpose equipment provides overcomes specific pipeline design problems. Special purpose equipment incorporates a series of components that may be required by the military planner in designing a pipeline system. Each component has a specific function and is used only to satisfy that function. The components incorporated into the special purpose equipment group are:

- Suspension Bridge, Pipeline, 100-Foot.
- Suspension Bridge, Pipeline, 200-Foot.
- Suspension Bridge, Pipeline, 400-Foot.
- Critical Gap Crossing, Pipeline.

- Pressure Reducing Station.
- Pressure Relief Module.

Suspension Bridge, Pipeline, 100-Foot

2-117. The suspension bridge, pipeline, 100-foot provides a means for pipeline crossing of rivers, chasms, or ravines in the area of operation. The 100-foot pipeline suspension bridge is a completely portable bridge kit that can be built on-site and used for crossing 70-foot-wide rivers, chasms, or ravines. The bridge is a suspension type structure utilizing two towers to suspend the main cable across the obstacle. The towers are anchored in place and stabilized with guy lines. The main cables are suspended from the towers and anchored into the ground with dead man anchor installations. Suspended from the main cables are a series of cross beams upon which staging boards are laid. Cables are attached to the cross beam suspension lines for hand line purposes. Guy lines are attached to the suspended bridge for stability. After the bridge is built and secured, the pipeline can be laid across it. It should be noted that the 200-foot and 400-foot bridges are similar in design and function.

Critical Gap Crossing, Pipeline

2-118. The critical gap crossing, pipeline provides a means for pipeline crossing of gaps, ravines, swamps, etc., in the area of operation. The critical gap crossing provides a means for the pipeline to cross difficult terrain features such as gaps, ravines, and swamps. Each module has sufficient material to cross up to 250 feet of gap or swamp. The critical gap crossing includes four-inch steel pipe columns, cross beams, braces, and rollers. Although Figure 16 illustrates the critical gap crossing configuration, the material provided may be used in whatever configuration is necessary to cross the terrain feature. When installing the critical gap crossing over water or swamp, it is essential that the suspended pipeline be at least two feet above the high water mark to allow debris to pass under the pipeline without catching or stressing the pipe.

Pressure Reducing Station

2-119. The pressure reducing station reduces pressure at low points of a pipeline. When pumping in a pipeline is interrupted or the pipeline is shut down, the fluid in the pipeline exerts static pressure at all of the low points of the pipeline. Under normal flow, the safe working pressure of the pipeline may not be exceeded. However, the total static pressure developed during non-flow conditions may be well above the safe working pressure, especially at low points in the line. To prevent this excessive pressure, pressure-reducing stations are placed on downgrades at points where pressure may become excessive. The main components of a pressure reducing station are: Launcher, receiver, pressure-regulating valve, and strainer insert receiving barrel.

Pressure Relief Module

2-120. The pressure relief module reduces pressure in a pipeline. The pressure relief module is used to protect the pipeline from excessive pressure build up during operation or from excessive pressure surges. When the valve opens, fluid flow from the pipeline can be sent to storage or to a sump. The valve is normally set to relieve upstream pressure if it exceeds 900 psi, although this setting is adjustable downward

FUEL SYSTEM SUPPLY POINT

2-121. The FSSP is the Army's primary fuel storage and distribution system. The FSSP is used to receive, store, and issue any fuel the Army uses, both aviation and ground. The FSSP is a complete, containerized system issued in different fuel storage sizes depending on unit mission and fuel demands. The FSSP is a flexible system that can be configured to meet the demand of the unit mission, throughput and days of supply (DOS). The sizes are as follows:

- 120,000 gallon – Six 20,000 collapsible fabric fuel tanks.
- 300,000 gallon – Six 50,000 collapsible fabric fuel tanks.
- 800,000 gallon – Four 210,000 collapsible fabric fuel tanks.

2-122. The 120,000 gallon and 300,000 gallon systems each come with 350-gallon per minute pumps and filter-separators, various receipt and issue points. Figure 2-14 shows a typical layout for the 120,000 gallon and the 300,000 gallon systems.

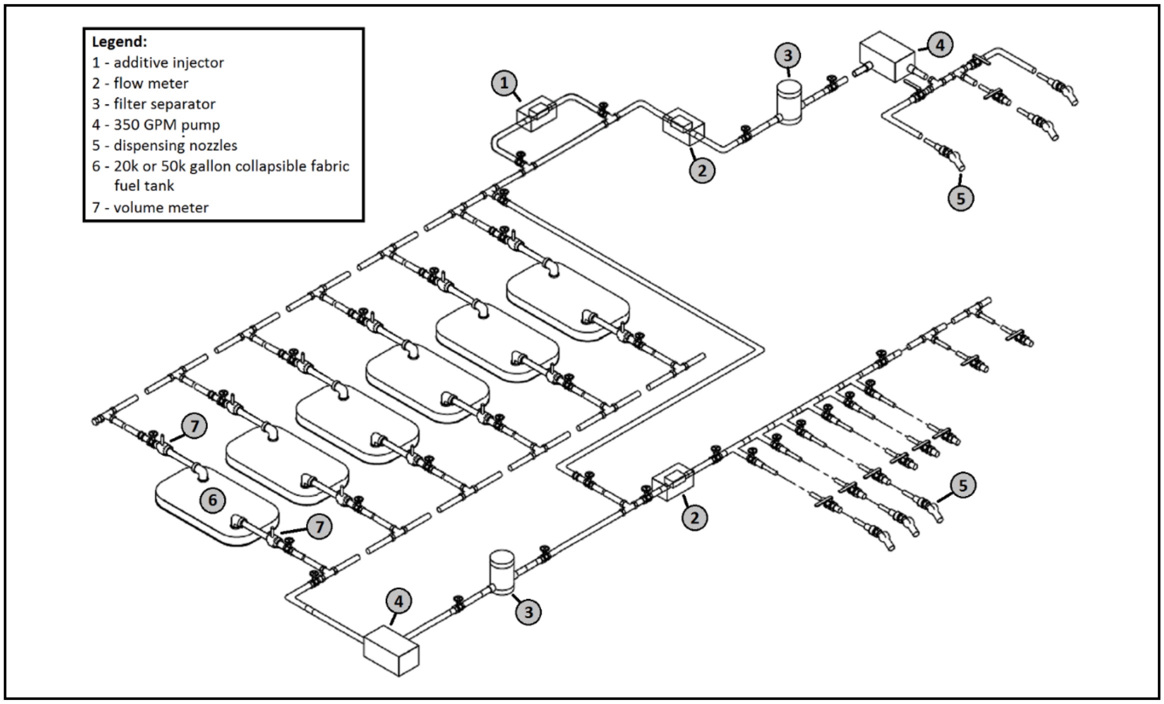

Figure 2-14. 120,000/300,000 gallon fuel system supply point

2-123. The 800,000 gallon system uses 600-GPM pumps and 350-GPM filter-separators (two connected in parallel for up to 700-GPM). The 800,000 gallon system has both receipt and issue points. The 800,000 system is part of Army Prepositioned Stock (APS). Figure 2-15 shows a typical layout for the 800,000 gallon systems.

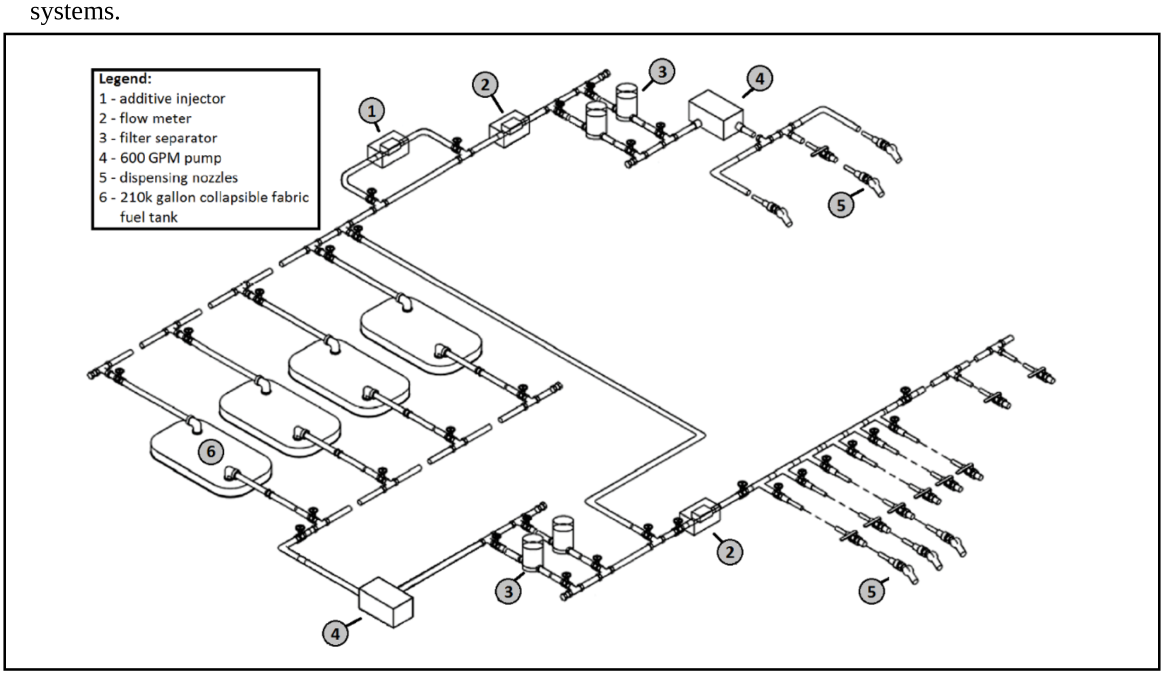

Figure 2-15. 800,000 gallon fuel system supply point

2-124. Only the 300K and 800K FSSP comes with additive injection capability.

2-125. The major components can be issued as separate items of equipment to add to the flexibility of the system. It can be set up with any number of collapsible fabric tanks to support the mission, ranging from one tank supplied with the system to all of the tanks. When needed, additional tanks, hoses and components can be used to increase the storage capability of the system.

2-126. For planning purposes, the area required to set up and operate the various sized FSSPs are as follows. The area depends on terrain, soil, and climate conditions, engineer support may be required for site development/improvement.

- The 120K and 300K FSSP requires an area of 400 feet wide x 500 feet long. An additional 100 feet must be added to each side for road and perimeter (600 feet x 700 feet).
- The 800K FSSP requires an area of 600 feet wide x 800 feet long. An additional 100 feet must be added to each side for road and perimeter (800 feet x 1,000 feet).

The 120K, 300K, & 800K FSSP set-up depends on the experience of personnel, terrain and security. For planning purposes, it should take 10 – 30 personnel no more than four days to establish the FSSP with support equipment such as forklift truck, berms and roads constructed to off-load, layout, and connect the FSSP. (Additional time may be needed for required earthwork.) Eight Soldiers are needed each shift to operate the FSSP. The FSSP is comprised of a number of separate major components to store and dispense fuel.

MODULAR FUEL SYSTEM

2-127. The modular fuel system enables fuel distribution and storage capability without collapsible fabric fuel tanks or engineer support. The system can be used in any terrain without construction or material handling equipment. The modular fuel system is a mobile and flexible fuel storage and bulk/retail distribution system. It provides the Quartermaster composite supply company the ability to rapidly establish a fuel distribution and storage capability at any location regardless of the availability of construction equipment or material handling equipment. It primarily supports brigade combat teams and support brigades. The MFS is comprised of two main modules; the tank rack module and the pump rack module, which can interact with each other to form a fuel farm or a refuel-on-the-move point as shown in figure 2-17 on page 2-27, and figure 2-18 on page 2-27. This system is commonly employed in the composite supply companies, brigade combat teams and support brigades with the HEMTT tanker/palletized load system trailer configuration for bulk petroleum replenishment operations.

TANK RACK MODULE

2-128. The modular fuel system-tank rack module enables retail operation by storing, transporting, and issuing fuel and provides bulk fuel and fuel accountability. The system can be used for line haul of bulk fuel throughout the theater. It enables these organizations to carry and distribute the required days of supply while minimizing trucks and personnel. It is configured in a 20' ISO frame. A Palletized Load System (PLS) or HEMTT-LHS can transport two TRMs, one on the truck and one on the trailer, for a total of up to 5,000-gallons of bulk petroleum. The increased mobility and capability of the HEMTT-LHS and the Palletized Load System (PLS) allows direct delivery of bulk fuel to the brigade area.

2-129. The modular fuel system-tank rack module is a 2500-gallon bulk fuel storage tank that provides the ability to rapidly establish a retail fuel distribution and storage capability at any location regardless of the availability of construction equipment or material handling equipment. The system includes the necessary hoses and fittings to connect and bulk transfer fuel to HEMTT tankers or to be the source while using the HEMTT Tanker's pump and nozzles for retail issue. A stand-alone retail capability consists of an electric continuous pump, filtration and water separation system, and a meter providing clean and dry fuel and retail accountability.

PUMP RACK MODULE

2-130. The modular fuel system-pump rack module ensures that a rapidly emplaced and relocated fuel storage system is available to satisfy fuel missions to receive, issue, and store fuel. Expansion of the battlefield, increased unit movements, and the requirement to rapidly relocate have made it necessary to develop a fuel storage, issue, and distribution system. The development and fielding of CSC that provide the

Army with the ability to respond anywhere in the world, with a brigade size force in 96 hours dictates the need for a new fuel distribution and storage capability.

2-131. The modular fuel system pump rack module is a key component of CSC distribution capability. The modular fuel system pump rack module is used in conjunction with the seven tank rack modules to form 17,500-gallon distribution platforms used by CSC for sustainment replenishment operations to FSC. The modular fuel system pump rack module is used in CSC combat replenishment operations. CSC modular fuel system pump rack modules are capable of interconnecting with tank rack modules, collapsible bags and the 5,000-gallon fuel tanker to establish fuel farms.

2-132. The modular fuel system pump rack module provides the pumping capability for tank racks in fuel farm or refuel-on-the-move configuration. The modular fuel system pump rack module is capable to establish a fuel distribution system capability at any location regardless of the availability of construction and material handling equipment. The modular fuel system configuration consists of ISO compatible modular fuel system pump rack module and TRMs that are transported; deployed and recovered using heavy expanded mobility tactical truck (HEMTT) load handling system (LHS) trucks, PLS trucks, and PLS trailers. The modular fuel system pump rack module consists of a pumping assembly with a filtration unit, fuel testing capability, spill control equipment and accessories, and appropriate hoses, valves, and fittings.

2-133. The pump rack modules has a 600 GPM pump/filtration and integrated storage with all the hosed, fittings and nozzles for eight retail or four bulk refueling points. It can also be used for aircraft refueling. The modular fuel system pump rack module also has the capability of providing necessary fuel accountability to support field operations. The modular fuel system pump rack module is deployed and recovered by organic unit assets using HEMTT LHS, the PLS, and PLS trailers. The engine module could be pulled out and then the engine module and ISO frame can be picked up by 10,000 pounds.

2-134. The modular fuel system/HEMTT tanker configuration is the primary mode during early phases of an operation (including combat operations). The system supports brigade combat teams and support brigades. While operating in this configuration, TRMs remain continuously uploaded on PLS trailers and pulled by HEMTT tankers. This configuration provides brigades with 5,000 gallon petroleum distribution platforms with the higher mobility of the HEMTT ten ton chassis as prime mover. Brigade support battalion distribution companies use this configuration to perform sustainment replenishment operations with forward support companies. Figure 2-16 illustrates the modular fuel system/HEMTT tanker configuration.

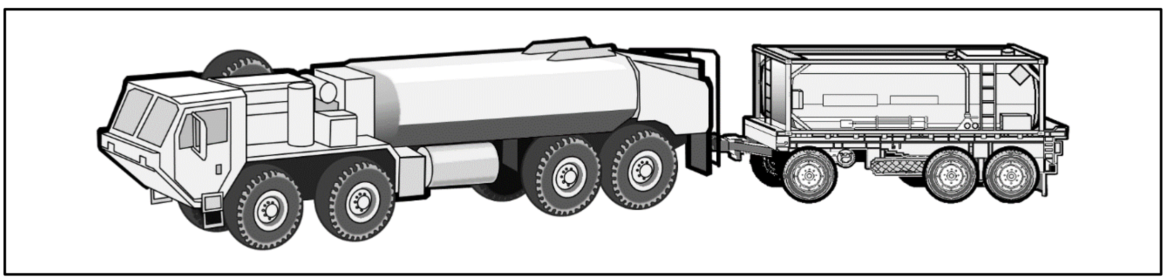

Figure 2-16. Modular fuel system/HEMTT tanker configuration

2-135. The modular fuel system pump rack module is required to interface with North Atlantic Treaty Organization (NATO) and allied nation petroleum storage and distribution systems. It complies with international petroleum industry standards for petroleum product distribution and delivery. The modular fuel system pump rack module conforms to NATO standards for demountable cargo beds (flatracks) allowing load handling system type trucks from other countries to load, unload, and transport the modular fuel system pump rack module.

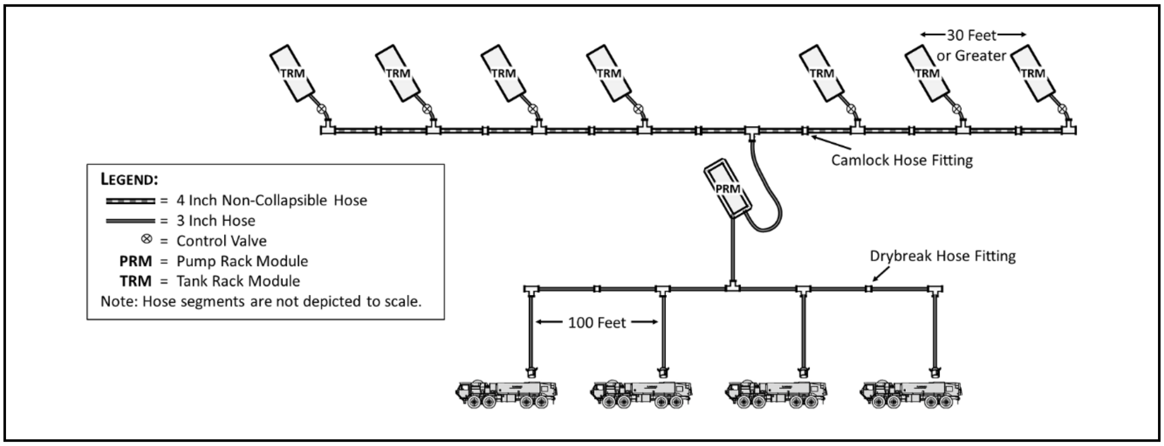

Figure 2-17. Modular fuel system bulk layout

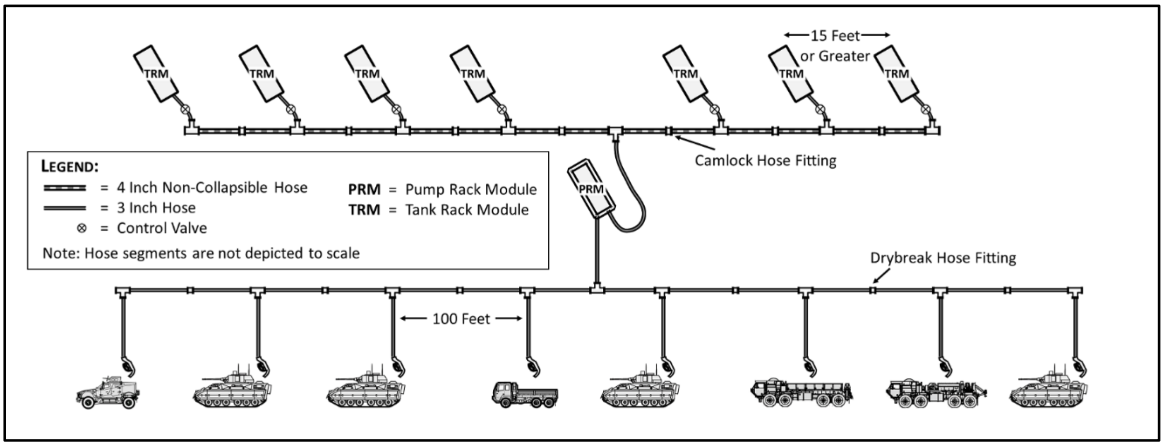

Figure 2-18. Modular fuel system retail layout

TANK VEHICLES AND TANK CARS

2-136. Petroleum vehicles, trailers and tank cars are specifically designed to transport and issue fuels throughout the theater at all levels. Missions include line-haul, bulk fuel dispensing, support of refuel-on-the-move (ROM) and aviation refueling missions as well as retail issue into ground vehicles. The vehicles and trailers can incorporate safety features required for use with liquids such as baffling in the tanks to mitigate product movement in transit. The vehicles are designed to carry fuel quantities appropriate for the mission.

Note: Tank vehicles are designed to be filled to rated capacity. Space for expansion of product is taken into account in design of the tank. Capacities may be reduced based on terrain conditions as described in appendix N.

TANK TRUCK

2-137. The following paragraphs describe the various tank trucks used by the Army to perform its petroleum mission. Tank trucks are self-mobile, wheeled fuel tankers that travel over a variety of terrain.

M978 Heavy Expanded Mobility Tactical Truck (HEMTT)

2-138. The M978 HEMTT is a 10-ton, 8X8 vehicle. It is an on-the-road and off-the-road, all weather and all-terrain vehicle. The truck has an eight-cylinder, two-cycle, turbocharged, liquid-cooled, diesel engine. The M978 can haul and dispense 2,500 gallons of bulk petroleum. The tank truck can ford water up to 48 inches deep. The M978 has a highway cruising range of 300 miles. The components of the vehicle are discussed below.

- The bulk petroleum tank is a stainless steel, 2,500-gallon, single compartment shell with one manhole cover. A cabinet at the rear of the vehicle houses the vehicle's fuel delivery manifold system, hose reels, ground cables, a dead man shutoff, and a filter separator.
- Fuel is pumped from and into the vehicle by a 300-GPM centrifugal delivery pump. The pump is driven by a power takeoff from the vehicle's engine. The vehicle also has an alternate fuel delivery pump. This 25-gallon per minute pump is powered by 24 volts direct current from the vehicle electric system.
- The filter separator is located in the cabinet at the rear of the M978 tank truck. It is a 300-GPM unit with a pressure differential indicator, filter and canister assemblies, and a manual drain valve. There is a sampling probe on the discharge side of the filter separator for use with the aqua-glo water detector test and the particulate contaminant (millipore) test kit.
- The tank truck has two hose reels in the cabinet at the rear of the vehicle. Each hose reel has 50 feet of 1½-inch dispensing hose. Each hose has a 50-GPM capacity. The hose ends have male cam-lock couplings and bonding connections. Each hose reel has a fuel-servicing nozzle. The HEMTT also has a 15-foot section of 3-inch suction hose for bulk bottom load transfer capability.

2-139. The truck can travel on all types of terrain with a full payload. It is able to transport and distribute bulk fuels in areas where other tank trucks cannot operate. The tank truck can service two vehicles at one time. The M978 can be used to perform aircraft refueling due to the filter separator capability.

2-140. The M978 HEMTT takes a minimum of two people operate the system.

Tank and Pump Unit

2-141. The tank and pump unit (TPU) is designed to be transported on a 5-ton type vehicle. When installed in a cargo truck, the tank and pump unit is used for internal distribution to the unit. The TPU can be configured to carry either 1050-gallons or 1200-gallons. The 1050-gallons capacity TPU system consists of two 525-gallon aluminum tanks with inside baffles. The 1200-gallon capacity TPU system consists of two 600-gallon aluminum tanks with baffles. In addition, the TPU is equipped with a 50-GPM, electric pump, a 50-GPM filter separator, two hose reels (each with a 40-foot length of 1½-inch non-collapsible discharge hose) and two open port or pistol grip nozzles. The tank and pump unit consists of tank control levers at the rear of the unit, a bottom loading port, fuel tanks, and a bottom loading valve that opens automatically when fuel pressure is applied and is closed automatically by the jet level sensor when the tank is full (when filled through bottom loading port).

2-142. The tank and pump unit can be used to fill and empty 5-gallon cans, 55-gallon drums, and 500-gallon collapsible drums. It can be used to temporarily store product, refuel ground vehicles. The unit may also be used to fuel aircraft if no other aircraft refueling equipment is available.

2-143. The tank and pump unit is used to dispense all types of automotive, aviation, diesel, and burner fuels. Only one type of fuel should be carried in and dispensed from the unit at one time. The tank and pump unit takes two people minimum to setup and operate. Dispensing with the tank and pump unit may be accomplished in various ways to meet different situations in the field. Even though differences exist between the models, all the tank and pump units operate basically the same.

2-144. A general description of the components and installation considerations are listed in the paragraphs below.

Pump Unit

2-145. The 50-GPM pumping assembly is used to issue bulk petroleum. The pumping assembly includes a pump and engine assembly, a filter separator, a manifold, hose reels, a ground reel, hose and fittings, and related equipment.

- The electric motor is powered by the vehicle electrical system. Electrical connection is provided by an inter-vehicle power cable attached to the NATO slave receptacle of the vehicle on one end and the electric motor on the other. The electric motor is controlled by an ON-OFF toggle switch or an ON-OFF cable assembly connected to the junction box.
- The pump is a 50-GPM, self-priming, centrifugal pump. The impeller is mounted on the extended shaft of the electric motor. The pump and engine are mounted on a common base plate to aid removal and use in other pumping operations.
- The filter separator is a vertical, 50-GPM unit that is designed for a maximum operating pressure of 75 pounds per square inch. It has filter elements and canister assemblies, a differential pressure gauge, a sight glass, and a draincock.
- The manifold controls the flow of product to the suction side of the pump. Two cam-locking couplers provide connections or inlets for the tank suction lines. The product flows from either or both tanks to the suction side of the pump through the manifold outlet and a section of hose. Some models are equipped with a discharge hose running from the filter separator to the manifold. This permits discharging from the manifold outlet when the three-way valve is positioned to close off the suction side. Other models use the manifold for suction only, and the three-way valve opens or closes the front and rear inlets on the manifold.
- The dispensing hoses are stored on two reels, each with a recoil tension spring. A 40-foot length of 1½-inch, noncollapsible discharge hose is used on each reel. Product from the filter separator enters through a pipe at the hub of the reel and is discharged through the hose.
- A ground reel is attached to the frame of the pumping assembly so that the tank and pump unit can be grounded. One section of the ground wire must be clipped to a ground rod near the tank and pump unit before the other section is connected to the vehicle being refueled.
- The metering kit consists of a meter, a hose assembly, couplers, cap screws, and washers. The meter is a volumetric, positive displacement meter. It has a five digit reset counter and a no setback totalizer that registers 9,999,999 gallons. The metering kit can be used with all tank and pump units.

The 525-Gallon/600-Gallon Tanks

2-146. Two welded aluminum, skid-mounted tanks come with the tank and pump unit. The shell of each tank has a manhole assembly, a pump port drain plug, and a discharge valve assembly. Controls for the discharge valve are on top of the tank. The discharge valve outlet is at the bottom rear of the tank, and the drain plug is at the bottom front. A baffle inside the shell reduces the surge of product during transport. Two lifting rings are attached to the top of each end of the shell to make handling easier. Tie-downs are provided for securing the tanks in the vehicle bed.

TANK SEMITRAILERS

2-147. The following paragraphs describe the various tank semitrailers uses by the Army to perform its petroleum mission. Tank semitrailers wheeled fuel tankers that travel over a variety of terrain that require additional prime mover support for transport.

M967

2-148. The M967 tank semitrailer is a bulk hauler with a self-load and self-unload capability. It is designed for general highway and limited cross country use. It has a 5,000-gallon capacity tank. It is designed to be towed by a 5-ton, 6x6 tractor truck or by a similar vehicle equipped with a fifth wheel.

2-149. The stainless steel body of the M967 consists of one 5,000-gallon fuel compartment. The compartment contains pressure and vacuum vents and a manhole with locking device. The fuel delivery system is mounted on the sides of the vehicle. On the curbside of the vehicle are a pump and engine compartment, a pump engine fuel tank, a landing gear crank, a hose trough, and an emergency shutoff valve. On the roadside of the vehicle are a hose trough, a ground board, a toolbox, a piping assembly, a control panel, and a portable grounding rod.

2-150. The M967 semitrailer is used for bulk delivery of fuel. The semitrailer does not have the dispensing capability of the M969. The four-cylinder, four-cycle auxiliary engine and pumping system can deliver bulk fuel at a rate of up to 600-GPM and can self-load at a rate of up to 300-GPM.

M969

2-151. The M969A2/A3 Semitrailer is constructed of welded stainless steel, with a single compartment tank of 5000-gallon (18,927 L) **plus a 3% capacity for product expansion**. The chassis is constructed of welded stainless steel and is equipped with full floating tandem axles and manually operated landing gear.

2-152. The semitrailer is designed to be towed by a truck tractor equipped with a fifth wheel. Authorized 5-ton truck tractors are the M818, M931 and M932 series, and M1088. The 10-ton military adapted commercial 6 x 4 truck tractors (the M915, M915A1, and M915A2) are also authorized, only when driving on hard surface highways.

2-153. The M969A3 5,000-gallon tank semitrailer may be used ONLY with the following prime movers that HAVE anti-lock braking systems: M915A2, M915A3, M915A4, M1088 family of medium tactical vehicles (FMTV), and M931/M932 series. Use of the M969A3 with the M931/M932 WITHOUT antilock brake system is NOT authorized. Tankers are not to be filled to exceed the load capacities of the tractors. Due to limited payload capacity, some of the tractors will not be able to haul fully loaded tankers. No over-load wavier is allowed for these tankers. The 10-ton military -adapted commercial 6 x 4 truck tractors (the M915, M915A1, and M915A2) with anti-lock braking system, are also authorized, only when driving on hard surface highways.

2-154. The M969A2/A3 5,000-gallon tank semitrailer can be loaded through the bottom or top fill opening. The diesel engine in combination with the Gorman Rupp 4-in. pump provides self-load/unload capability.

2-155. The M969A3 is equipped with pressure and vacuum vents, a sealed manhole, an improved vapor recovery system, two 50-foot (15.2 m) lengths of 1-1/4 in. fuel-dispensing hoses, three 4-inch hoses for loading/off loading and bulk delivery, a portable grounding rod, three static reels, and a spare tire. A ladder is provided at the rear of the semitrailer for easy access to the top of the M969A3.

2-156. The tank body and the auxiliary engine and pump assembly are identical to those of the M967. The M969A1 version of this semitrailer is equipped with a hose trough cover, a control panel cover, a rear ladder, front and rear drains, and a tachometer and lead assembly. Additional differences found on the M969A1 model are an elastomeric type drive coupling between the fuel-dispensing pump and the engine assembly, a new axle, bogie, and braking system. The vehicle components are discussed below.

- The M969 has the same equipment that is included with the M967. It also has the equipment needed for automotive refueling and limited aircraft refueling. This equipment is mounted on the sides of the vehicle. The filter separator, the pump and engine assembly, the engine's fuel tank, the landing gear crank, the emergency shutoff valve, a hose trough, and the battery compartment for two batteries are located on the curbside of the M969. A hose trough, a portable grounding rod, a control panel, the manifold valving, and a hose reel cabinet are on the roadside of the vehicle.
- The filter separator is rated at 300-GPM and 15 pound per square inch. It has three filtering stages. In the first stage, 15 filter elements remove solid particles and coalesce any water in the fuel. In the second stage, five canisters separate the water from the fuel and allows it drain into the filter separator sump. Finally, 15 go/no-go fuses act as safety devices to shut off the flow of fuel if the other two stages allow water to exceed a safe level. Three of these fuses are in each of the second-stage elements. Other parts of the filter separator include an automatic drain valve, a manual drain valve, and a pressure gauge. When water in the filter sump reaches a certain level, the water is removed by the automatic drain valve. This valve is operated by a float, which rises in water and sinks in fuel. As water enters the filter sump, the float rises. When the float rises to a certain level, a valve opens in the drain valve assembly allowing pump pressure to be applied to a diaphragm valve. The opening of the diaphragm valve causes the automatic drain valve to open, allowing the water to drain. As the water is being drained, fuel flow is continued. If water enters the sump faster

than the automatic drain valve can carry it away or if the filter elements fail, the go/no-go fuses stop the flow of fuel. The pressure gauge is located on the instrument panel in the roadside equipment cabinet. It shows the amount of restriction in the filter separator.

- Two 100-GPM meters are located in the roadside cabinet of the M969 tank semitrailer. To reset a meter to zero, the operator must push in and turn clockwise the meter reset knob on the side of the meter. The meters may be used to measure fuel during fueling or defueling operations.
- The M969 tank semitrailer has three dispensing hose assemblies. Three 14 foot sections of 4 inch suction hose are stored in troughs on the sides of the vehicle. This assembly has a bulk delivery rate of up to 600 gallon per minute and a self-load rate of 300 gallon per minute. The other two hose assemblies are located in the hose reel compartment. Each of these assemblies has a meter, a hose reel with electric rewind, 50 feet of 1 ¼ inch hose,

2-157. The M969 tank semitrailer is used primarily for bulk fuel delivery. It may also be used for limited aircraft refueling.

M1062

2-158. The M1062 7500-gallon fuel tank semitrailer is a military adapted commercial semitrailer designed to provide bulk petroleum line haul support over primary and secondary roads.

2-159. The semitrailer is designed to be towed by the M915 series tractor equipped with a fifth wheel. Maximum allowable speed is 55 mi/h (88 km/h) on primary roads and 35 mi/h (56 km/h) on secondary roads.

2-160. The M1062 has a loading capability of 600-GPM using an external pump. It has a single compartment with a capacity of 7,500-gallons **plus 3 percent expansion space** and weighs 11,566 pounds empty and about 65,556 pounds full. Full weight will vary depending on product being hauled. The entire vehicle is about 36 foot long, 8 feet wide, and 8 feet 9 inches high. A piping assembly containing a roadside front port and a rear inlet. Fuel may be bottom loaded at either opening port or unloaded at front port only.

2-161. The stainless steel tank body of the M1062 tank semitrailer is constructed as one 7,500-gallon compartment with seven baffles. The fuel-handling equipment includes all the necessary piping, fitting, hose, and valves for handling the fuel from the curbside.

Tank Unit Liquid Dispensing (TULD)

2-162. The tank unit liquid dispensing (TULD), for trailer mounting, is a portable storage used for transporting and storing liquid petroleum products. This unit is used with M1061A1 series trailers (trailer is separately authorized).

2-163. The TULD consists of one 525-gallon (lo-profile) tank or one 600-gallon (hi-profile) tank, tie down kit, storage boxes and ancillary equipment.

2-164. Only lo-profile tank has internal baffling. Internal baffling is used to prevent the surge of fuel during transport.

VAPOR RECOVERY KIT

2-165. The vapor recovery kit, as shown in figure 2-19 on page 2-32, is an option for the M978 HEMTT tank truck and is a part of the M969A3, fuel servicing (retail and bulk service) 5,000-gallon semitrailer tanker. The vapor recovery kit is an option for vapor recovery depending on the local host nation laws and regulations pertaining to vapor as a result of petroleum. The system allows a fuel depot to collect or recover the vapors and gases that are present during the loading operation. Vapors can also be recycled back to the semitrailer through the recovery system during loading operations. The system consists of a vapor tight line running from the sealed hood on the emergency valve vent (directly behind the manhole cover) to the rear of the tank. The rollover rail on the roadside of the semitrailer is used as part of the line. The adapter on the end of the line is compatible with the 4-inch quick disconnect vapor recovery connections at a majority of fuel depots.

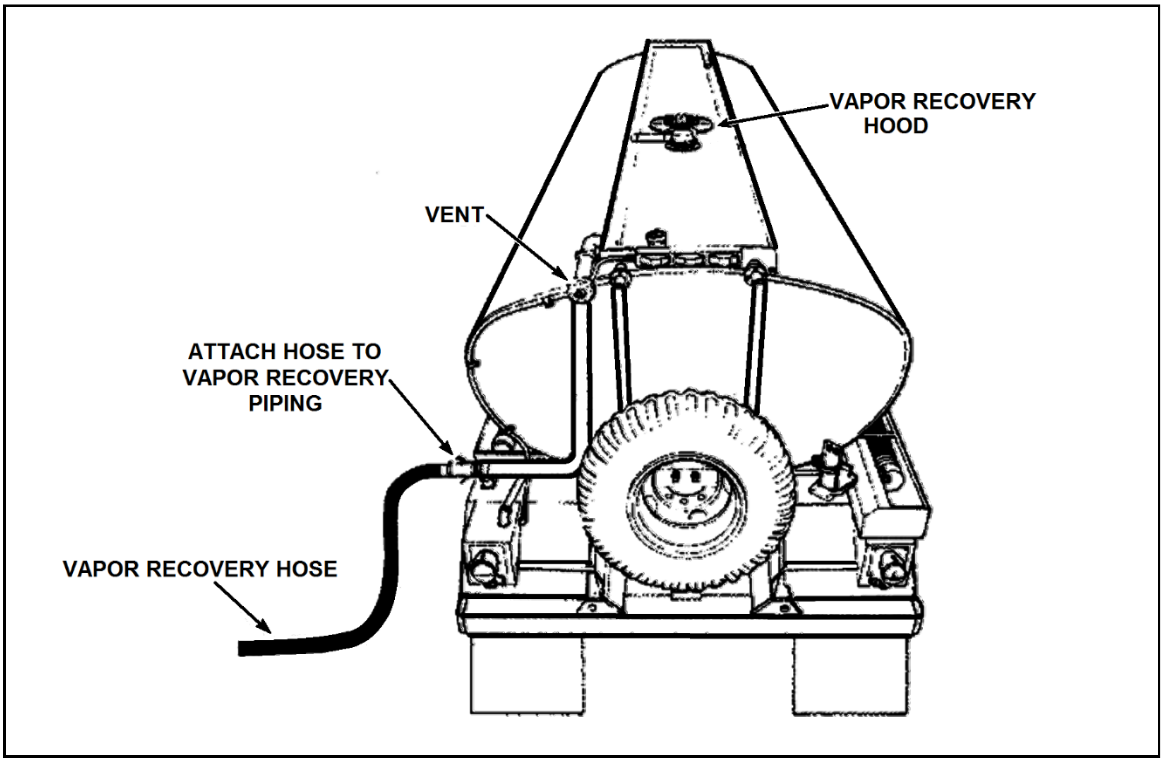

Figure 2-19. Vapor recovery kit

CAMOUFLAGE

2-166. Concealing tank vehicles is important in a theater of operations because of their tactical importance. Destroying petroleum supplies and its transportation can effectively cripple a modern, highly mobile force and ground its aircraft. Dispersion is important because of the possibility of one explosion causing other explosions. Nearby engineer units should be asked for advice and help in planning local camouflage measures; however, each unit is responsible for camouflaging the vehicles it uses.

TACTICAL AND OTHER CONCERNS

2-167. In a tactical area, the proper layout of a vehicle park may have to be modified. The tactical situation, physical limitations of the site, and requirements for protection and camouflage must be weighed against the standards for a proper layout. The following are among the concerns that must be weighed in a specific tactical area:

- Fuel supplies and tank vehicles may need to be guarded.
- Tank vehicles may have to be shielded from enemy fire.
- Vehicle park may have to be camouflaged.
- Paved areas or hardstands may be limited.

RAIL TANK CARS

2-168. When rail facilities are available, tank cars may be used along with the pipeline to transport petroleum products. Each tank car should be used to carry only one grade of product. If this is not possible, the tank car must be inspected and cleaned, in accordance with the procedures in appendix E, between loads to avoid product contamination. Tank cars vary in capacity and design. Tank cars used for petroleum products usually have one compartment and range in capacity from 6,000 to 16,000 gallons. Other tank cars have more than one tank compartment and carry more than one product at a time. Some tank cars have heaters to liquefy viscous products, but those without heaters are generally used. Figure 2-20 on page 2-33 shows a typical petroleum tank car fueling operation. The dome, safety valve, and bottom outlet of tank cars are described below. The operation and specifications of tank rail cars vary as the tank cars are commercial items produced in various types. See manufacturer's manual for details.

Dome

2-169. Each tank car compartment has a dome as shown in figure 2-20, to allow space for the product to expand as the temperature rises. The tank shell can be filled to the top. Each dome has a manhole through which the tank car may be loaded, unloaded, inspected, cleaned, and repaired. Dome covers may be hinged and bolted on or screwed on. Most domes have vents and safety valves to let out vapors.

Safety Valve

2-170. The safety valve used on most tank cars consists of a spring-loaded poppet valve which opens at a preset pressure. As pressure in the dome builds up to a point above the pressure setting of the valve, the valve is forced off the valve seat. This lets the excess vapors escape. The spring closes the valve automatically when the pressure drops to a level equal to the valve setting.

Bottom Outlet

2-171. Each tank car has a bottom outlet and is usually loaded and unloaded through it. The outlet valve as shown in figure 2-20 is controlled by a valve rod handle or valve rod hand wheel. The outlets on tank cars used in the U.S. are five inches in diameter. Outlets on tank cars used overseas are generally four inches in diameter. All outlets have male threads. A tank car elbow assembly is used to adapt a pump suction line to the 5-inch outlet. A 5- to 4-inch adapter must be installed between the elbow assembly and the tank car 5-inch outlet.

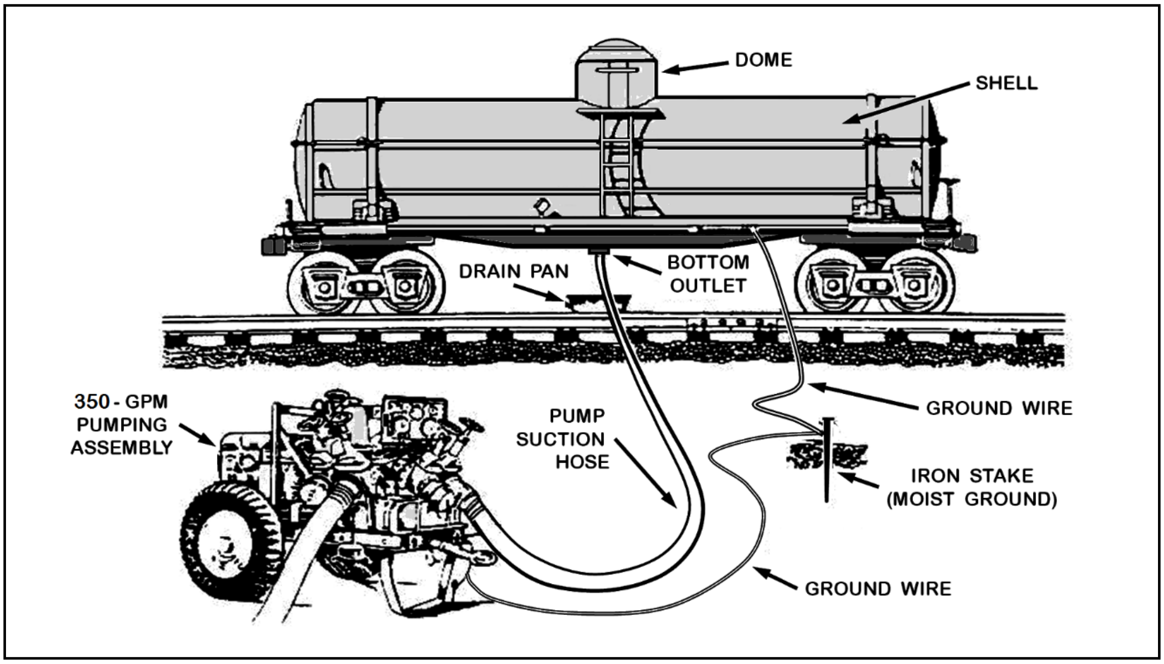

Figure 2-20. Typical petroleum tank car

ASSAULT HOSELINE SYSTEM

2-172. The AHS is a mobile petroleum distribution system used to transfer large quantities of fuel between temporary bulk storage sites at varying distances up to 2.5 miles over various terrains.

2-173. The AHS consists of a 14,000-feet of lightweight, collapsible 4-inch hose mounted on four hose reels (each hose reel contains approximately 3,500 feet of hose). The hoseline is deployed using an Employment and Retrieval System powered by a two kilowatt military tactical generator and battery system.

2-174. There are three each 350-GPM trailer mounted, diesel powered pumping unit. The pumping rate for the AHS is 350-GPM. The hose system is deployed at 2.5 miles per hour and recovered at 0.75 miles per hour. The prime movers used to deploy the system and fuel source are not part of the AHS.

2-175. The AHS is stored in eight (8) TRICON Containers and can be transported by aircraft, rail, ground vehicles and marine vessels.

2-176. This system takes six personnel (minimum) to set up and two personnel (minimum) to operate depending on the amount of pumping units used.

2-177. The area requirements for the AHS are 14,000-feet long by an approximate 20-foot wide track.

2-178. A prime mover is required to deploy the AHS and a fuel source is required to make it fully operational.

AVIATION REFUELING SYSTEMS

2-179. The following describes equipment and systems specifically in Army aviation units. For more information related to aircraft refueling, see ATP 3-04.94*, Army Techniques Publication for Forward Arming and Refueling Points*.

ADVANCED AVIATION FORWARD AREA REFUELING SYSTEM

2-180. The Advanced Aviation Forward Area Refueling System (AAFARS) is used to refuel rotary wing aircraft in remote locations. Containerized, it can be moved by truck or by utility or cargo helicopters. It uses four 500-gallon collapsible fuel drums as a fuel source and dispenses to four points simultaneously, at 55-GPM per point or to two points at 90-GPM per point.

2-181. The system includes an adapter kit that allows the AAFARS to be connected to any source which can be accessed through two-inch, three-inch, or four-inch camlock couplings. The adapters also allow connection of AAFARS components to any other fuel system components that use standard two-inch, three-inch, or four-inch camlock couplings.

2-182. The AAFARS consists of a 225-GPM pump and a 240-GPM filter-separator (uses non-standard filters), twelve 500-gallon collapsible fuel drums (four onsite, four being transported to receive fuel, and four being transported back full), four D-1 nozzles, four CCR nozzles with open port adapters, and enough hose to connect all of the components for a safe operation. All of the valves and fittings are "dry-break" unisex couplings and are environmentally friendly. This system has electrical power provided by a maintenance free battery.

2-183. It takes an open area approximately 500-feet by 300-feet to safely operate the system with aircraft entry and exit.

HEAVY EXPANDED MOBILITY TACTICAL TRUCK-TANKER AVIATION REFUELING SYSTEM

2-184. The heavy expanded mobility tactical truck-tanker aviation refueling system (HTARS), Figure 2-21 on page 2-35, is used to refuel rotary wing aircraft in remote locations. The HTARS can be transported by trailer, a high mobility multi-purpose wheeled vehicle, or aircraft. It is designed to be used with the HEMTT tanker. Theoretically, the HTARS should be able to supply 75-GPM to each of its four refueling points simultaneously.

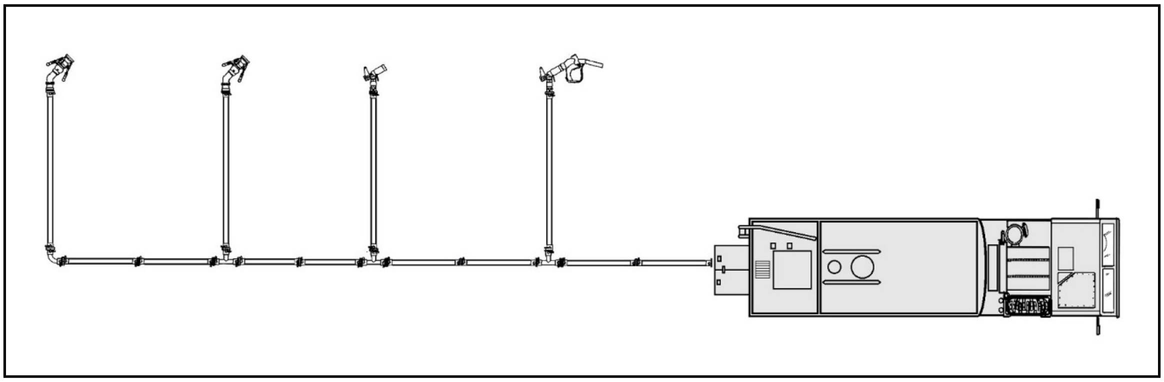

Figure 2-21. HTARS

2-185. The HTARS consists only of the hoses, valves, fittings, and nozzles necessary to install the system. All of the hoses and fittings are "dry-break" unisex couplings to allow safe operation and are environmentally friendly.

2-186. It takes an open area approximately 500-feet by 300-feet to safely operate the system with aircraft entry and exit.

2-187. In addition to being used to refuel aviation assets, it can also be used to perform the ROM operation for ground vehicles. A fuel source, pump and filter separator are required for use.

2-188. This system takes two personnel (minimum) to set up and one person per refueling point in use for cold refueling and two personnel per refueling point in use for hot refueling. Hot, warm and cold fueling operations are discussed in section VI of chapter 4 and in appendix U of this publication.

Forward Area Refueling Equipment (FARE-2)

2-189. Forward area refueling equipment (FARE-2) is used to rapidly establish a two-point refueling system for both wheeled and tracked vehicles in forward combat areas and can also be used to refuel aircraft. Containerized, it can be moved by truck or by utility or cargo helicopters. This system uses two 500-gallon collapsible fuel drums as a fuel source and dispenses to two points simultaneously at 50-GPM per point or to one point at 90-GPM. Both 500-gallon collapsible fuel drums must be used simultaneously to achieve rated fuel flow. In addition, the FARE-2 can use collapsible fabric fuel tanks, tank vehicles, and semitrailers as fuel sources.

2-190. The FARE-2 is not configured to pump various types of fuels at the same time.

2-191. Forward area refueling equipment consists of a 100-GPM pump and filter-separator, six 500-gallon collapsible fuel drums (two onsite, two being transported to receive fuel, and two being transported back full), two D-1 nozzles, two closed circuit refueling (CCR) nozzles with open port adapters, and enough hose to connect all of the components for a safe operation.

2-192. Forward area refueling equipment uses dry-break quick-disconnect connections and is equipped with 2 in. female cam-lock adapters, 3 in. female cam-lock adapters, and 4 in. female cam-lock adapters.

2-193. It takes an open area approximately 50-yards by 50-yards to safely operate the system with aircraft entry and exit.

2-194. This system takes two personnel (minimum) to set up and one person per refueling point in use for cold refueling and two personnel per refueling point in use for hot refueling.

Aircraft-To-Aircraft Refueling Systems

2-195. The purpose of the aircraft to aircraft refueling systems is to provide a continuous aviation presence in remote locations. The ability to provide support to aviation assets on the modern battlefield could prove critical to the mission success. Logistical requirements may require a more rapid and mobile response for aviation fuels than can be met by tank vehicles or the sling loading of collapsible drums into an area of operation. Aircraft-to-aircraft refueling offers a reduction in turnaround time through rapid insertion, refueling of aircraft, and extraction of class III assets. Aircraft-to-aircraft refueling systems are discussed below and procedures for aircraft-to-aircraft refueling systems are discussed in Chapter 4 and ATP 3-04.94.

Fat Hawk/Wet Hawk

2-196. A Wet Hawk is a UH-60 aircraft that provides fuel to another aircraft from its own internal and external fuel tanks via a micro-FARE system. Normal operations consists of two fuel external stores support systems (ESSS)-equipped UH-60 aircraft with a crew including four petroleum personnel and refuel equipment to support the mission. The ESSS tanks are 230-gallon tanks. One UH-60 can be configured with up to four ESSS tanks for a total external capacity of 920-gallons.

2-197. The micro-FARE system includes equipment that permits offloading fuel from a host aircraft to two other aircraft or combat systems. The system includes a 120-GPM self-priming micro-FARE pump that uses alternating current/direct current power from the host aircraft, a 50-foot electrical cable to connect the micro -FARE pump module to the host aircraft, a power supply, a 2-inch by 20-foot collapsible hose to connect the micro-FARE pump module to the host aircraft fuel source. This system also includes a defueler to permit suction defueling of the host aircraft fuel source, three 2-inch by 50-foot collapsible hoses, one valved unisex Y-coupling; two D-1 nozzles and two open port nozzles.

2-198. A Fat Hawk is a UH-60 aircraft that provides fuel and ammunition. A Fat Hawk is configured with external fuel tanks, two Hellfire racks, or two M261 rocket pods and provides the capability to refuel and rearm a platoon of OH-58D aircraft. Four aircraft comes in a platoon. A Fat Hawk can refuel and rearm these aircraft in less than 15 minutes without sling loading any fuel or ammunition.

2-199. A properly configured aircraft and a well-planned mission will result in the ability for two UH-60s with ERFS to refuel and rearm a platoon of OH-58D aircraft in 15 minutes.

Wet Wing (C-17 FARP)

2-200. The Wet Wing uses the HTARS, 100-GPM pump and two 100-GPM filter separators to deploy fuel from the U.S. Air Force C-17 Globemaster III aircraft to provide another option for aircraft to aircraft or aircraft to ground refueling.

2-201. The C-17 Globemaster III is a high wing, four engine, T-tailed military cargo and troop transport aircraft operated by the U.S. Air Force. The C-17 can take off and land on small, austere runways as short as 3,500-feet and only 90-feet wide.

2-202. The C-17 aircraft is able to deploy to forward areas where only short runways and limited ramp spaces are available. The C-17 aircraft will land in a forward area to act as a ground tanker to provide fuel to receivers on the ground. The receivers can be aircraft, trucks, fuel bags, or other equipment. The C-17 can deliver fuel through either one or both of its single point receptacles. The C-17 booster pumps are used to defuel the aircraft using the HTARS and additional Army components. Defueling can be done up to a rate of 520-GPM, depending on the number of booster pumps used.

EXTENDED RANGE FUEL SYSTEM (ERFS II)

2-203. The extended range fuel system (ERFS II) is transported by the CH-47D aircraft to provide extended flight range to aircraft through forward refueling capability. ERFS II is an autonomous system the power to operate both types of pumps is supplied by the helicopter electrical system. The ERFS II provide support to aircraft or special operational needs.

2-204. Unlike the AAFARS, the ERFS transfer is accomplished by a pump rated at 120-GPM located on the aft tank of the ERFS II. The pump supplies two refueling points 200-feet from the helicopter. The ERFS II consists of three-800-gallon tanks with a pumping rate for FARE operations rated at 120-GPM. For mission flexibility, one, two, or three 800-gallon tanks can be installed. Regardless of configuration, the principles of operation remain the same.

2-205. Hose connection size is 2-inch suction and discharge using either the standard cam-locking FARE or HTARS unisex hoses with adaptor. Fuel is received fuel into the system using the D-1 or open port nozzle and issued fuel using the D-1 or CCR nozzles.

2-206. The Fat Cow (CH-47) FARE is has capability to pump a maximum of 2320-gallons of fuel to other aircraft. Fuel is contained in a total of four 600-gallon ERFS tanks located in the cargo compartment of the tanker aircraft. One to four tanks may be installed with enough refuel equipment to set up either two refuel points per aircraft. In any configuration, the FARP can easily be set up and operational within 10 minutes of landing. Also, the on board fuel can also be used to extend the range of the tanker aircraft.

2-207. Equipment used in Fat Cow refueling operations consists of ERFS tanks, electric pump, filter separator, hoses, nozzles, grounding equipment and valves and fittings.

2-208. The system in use combines components of the ERFS, FARE, and HTARS. Major components are discussed below.

2-209. The Fat Cow uses up to four 600-gallon capacity ERFS tanks. The tanks can be filled to 580-gallons providing up to 2320-gallons for refueling other aircraft. The tanks are secured to the aircraft using 5,000- and 10,000-pound cargo strap assemblies.

2-210. Electrically driven, explosion-proof, pump assemblies are located aft of the rearmost tank, secured to the floor, and connected to the manifold. The pump receives alternating current and direct current power from the aircraft's electrical system and is connected to the utility receptacles in the cabin.

2-211. A 100-GPM filter separator is secured to the aircraft floor. This is the same filter separator used with the FARE system. It contains five elements, each in a canister, that remove free water and particulate contaminants. It has an air vent valve, a pressure differential indicator, a water sight glass, and a water drain valve that is hand operated.

2-212. The hoses used for the Fat Cow should be 2-inch in diameter. Suction hoses should be used on the suction side of the pump and collapsible discharge hose on the dispensing side of the system. Ensure enough length of hose is used to maintain required spacing between refueling points and between tanker aircraft and refueling points. The standard cam-locking hoses in the FARE system can be used. However, the unisex, dry-break couplings as used in the HTARS are recommended because of environmental considerations.

2-213. Fittings, valves, and nozzles used for the Fat Cow are the same as those used for the FARE and HTARS. A Y-fitting is used between the discharge hose following the filter separator and the discharge hose to the refueling points. Butterfly valves may be inserted for quick, positive shutoff within the system when cam-locking hoses are used. HTARS hoses have flow-no-flow valves at the dry break connections. The nozzles used are the same as those used on the FARE: CCR and D-1 nozzles.

2-214. The principles of operation and maintenance of the system is further described in the appropriate TM and ATP 3-04.94.

SECTION II – QUALITY SURVEILLANCE SYSTEMS

2-215. Quality surveillance (QS) includes all the measures used to determine and maintain the quality of government-owned petroleum products to the degree necessary to ensure that such products are suitable for their intended use.

2-216. The purpose of QS is to ensure that products meet quality standards after acceptance from the source and still meet quality standards after transfer between government agencies or issue to users. QS is complete when the product is consumed or transferred to another agency or service. Until transfer or consumption, it is the responsibility of the owning service or agency to ensure product quality.

2-217. Special equipment is designated to ensure quality surveillance is accurately and adequately being performed by petroleum operations personnel.

2-218. More information on quality surveillance is addressed in Chapter 4 of this manual, TM 4-43.31 - *Petroleum Laboratory Operations* and MIL-STD-3004 - *DOD Standard Practice Quality Assurance/Surveillance for Fuels, Lubricants and Related Products.*

PETROLEUM QUALITY ANALYSIS SYSTEM – ENHANCED

2-219. The petroleum quality analysis system - enhanced (PQAS-E) is a fully integrated fuel laboratory in a 20' ISO shelter mounted on a XCK 2000E1 trailer. The lab contains fuel test equipment, data acquisition equipment, automated instrumentation system, support equipment, supplies, tent, environmental control unit, and automated power unit.

2-220. The PQAS-E is a complete petroleum quality surveillance (QS) lab capable of conducting B-2 modified level testing (testing exceptions are existing gum and copper corrosion) in accordance with MIL-STD-3004 on kerosene based and diesel military mobility fuels.

2-221. This system takes two personnel to set up and two personnel to operate.

FUEL ADDITIVE INJECTOR

2-222. The fuel additive injector assembly, TPI-4T-4A-1, is a fluid powered, multi-additive injector system designed to inject Fuel System Icing Inhibitor (FSII), static discharge additive (SDA) and corrosion inhibitor/lubricity improver (CI/LI) additives into fuels.

2-223. The system 40 in wide, 48 in long and 40 in high. The TPI-4T-4A-1 is fielded with the 300K and 800K FSSP.

2-224. This system operates at a flow rate ranging from 150-GPM to 700-GPM.

2-225. The injection ratio capacity is the rate at which additives are injected into the system at the determine flow rate and quantity of petroleum product. The injection ratio capacity for each additive is as follows:

- CI 40 parts per million.
- SDA 40 parts per million.
- FSII 2100 parts per million.

2-226. This system takes two personnel to setup and one person to operate.

TEST KIT, AVIATION FUEL PETROLEUM

2-227. The aviation fuels petroleum test kit is intended for use in the field and is designed to be a self-contained petroleum testing apparatus capable of performing fuel testing of aviation fuels. The mission requirements will determine the type of tests that must be performed based on the types of fuel available. All testing must be performed in accordance with the applicable ASTM International.

2-228. The test kit also performs the following tests on petroleum products:

- API gravity/density.
- Particulate contaminants.
- Free water content.

2-229. This system takes one person to setup and one person to operate.

2-230. The density meter and operating instructions are included in the petroleum test kit. The density meter can be set to display the API or specific gravity number for product groups A (crude oil), B (fuels), or D (lubricants) at a reference temperature of 15°C or 60°F.

2-231. The kit contains: DMA35N w/volumetric correction function and carrying case.

2-232. The meter displays the same results that would be obtained using the hydrometer and Tables 5B & 6B of ASTM International D1250, *Standard Guide for Use of the Petroleum Measurement Tables*.

2-233. The calibration of meters should be performed through Test, Measurement and Diagnosis Equipment 4180.

SAMPLING AND GAUGING KIT, PETROLEUM

2-234. The portable petroleum sampling and gauging kit is used at bulk storage facilities. The sampling and gauging kit has the capability to determine the API gravity, temperature and sample of the fuel. The gravity and temperature results are obtained using the hydrometer, cup case thermometer, Tables 5B & 6B of ASTM International D1250. The test provides the user with an indication of product type to identify the fuel type and a volume correction factor. Also, it is used to detect bottom sediment and water.

2-235. The kit consists of an aluminum carrying case fitted with measuring and sampling equipment. The major parts of the kit are listed below.

- Olive drab, aluminum carrying case.
- Cup-case thermometer, 0°F to 180°F range.
- Innage tape and bob.
- Hydrometers, ranging from 19°F to 81°F API gravity.
- Hydrometer cylinder with removable base.
- Weighted beaker sampler.
- Wide-mouthed sampling bottle.
- Brass-coated chain.
- Gasoline-indicating paste.
- Water-indicating paste.
- Cheesecloth.
- Gravity computer with case.
- ASTM International pamphlets.

2-236. This system takes one person to setup and one person to operate.

FILTER SEPARATORS

2-237. Filter separators remove solid contaminants and entrained water from liquid fuels. As fuel is left in a motionless state at the end of operations, water can accumulate with the fuel. The water must be drained prior to any operation. The fuel mixture must be re-circulated through the filter separator before operations resume in order to remove any remaining water from the fuel. The capacity of the filter separator must suit the capacity of the pump.

2-238. Those covered in this manual range in capacity from 50-GPM to 600-GPM. All filter separators discussed in this manual use filter elements and canisters meeting the requirements of military specifications. Filter elements and canisters are used in varying numbers depending on the flow rate of the specific filter separator.

2-239. Filter separators are required for jet fuel, diesel fuels and aviation gasoline. Filter separators should be used when diesel fuel or jet fuel is pumped to the user's refueling vehicles or when vehicles are refueled. Filter separators must be used on all lines pumping aviation fuel directly to aircraft or to vehicles that refuel aircraft. In addition, all fuel loaded into aircraft refueling vehicles or systems that refuel aircraft must be filtered again before it is pumped to aircraft. This is the basic concept of filter in and filter out of all systems that refuel aircraft.

2-240. When equipped, the filter status is monitored by a sight gauge and a differential pressure gauge. The sight gauge on the vessel sump provides visual indication of the amount of water collected in the sump. A ball in the sight gauge will float on water but not on fuel, providing a direct indication of the amount of water in the sump. The differential pressure gauge is connected by hard tubing between the inlet and outlet ports to measure the pressure drop across the filter vessel. A clean, properly operating system will register two to three pounds differential pressure.

2-241. When using a filter separator for diesel fuel, the differential pressure will be higher during normal operation than with jet fuel, due to the different viscosity of the fuels. Reading of differential pressure also depends on the actual flow. All readings should be done at the same consistent flow (or operating speed); not at a low speed for new filter calibration. Readings of differential pressure must be taken when the flow is increased to rated flow. All differential pressure readings should be conducted at the rated flow of the vessel. At the start of diesel operations, make note of the differential pressure reading and when the differential pressure reading increases by 15 PSI or more, change filter elements.

2-242. Rated flow of the filter separator is also reduced by half when using diesel fuel. For example, a 100-GPM filter separator will only be flowing at about 50-GPM using diesel fuel.

STANDARD FILTER ELEMENT AND CANISTER ASSEMBLY

2-243. The standard DOD filter element fits inside the DOD canister. The element is a perforated tube surrounded by a fiberglass filtering material, which in turn, is wrapped with several layers of different materials. The fiberglass material filters solid particles from fuel. The outside of the element consists of layers of proprietary material. This part coalesces (combines) fine particles of water in the fuel to form water droplets, which settle because they are heavier than the fuel. The service life of the standard filter element is 36 months.

CANISTER

2-244. The standard DOD canister is a cylinder approximately five inches in diameter and 23 inches long. It consists of an outer tube and inner screen. The outer tube is made of perforated metal and supports the inner screen. The inner screen is made of a metal mesh coated with a non-sticking coating.

FUEL FLOW

2-245. For DOD style filtration equipment, the separator canister and filters elements are always configured for operation in a vertical configuration, and allows gravity to remove the water from the fuel out the bottom of the open ended separator canisters. The separator canister is installed directly over the filter element, concentric (same center axis).

2-246. For API/EI 1581, *Specifications and Qualification Procedures for Aviation Jet Fuel Filter/separators,* style filtration equipment, the separator canister and filters elements may be configured for operation in a vertical or horizontal configuration, but generally are operated in the horizontal configuration. They still use gravity to separate the water from the fuel, but the separator canister is mounted apart from the filter element, on its own sealed mount to the effluent port. The separator canister is generally installed above the filter element, to allow more time for the water to settle, and the clean fuel must travel upward to reach the effluent port.

2-247. For both the DOD and API/EI 1581 style filtration equipment, raw fuel enters the center tube of the filter element through a fitting at the bottom of the element. Solid contaminates are removed as the fuel flows outward from the perforated center tube through the fiberglass filtering material. As the fuel passes through the outer layers of the element, fine particles of water in the fuel are coalesced into droplets. The fuel containing the coalesced water passes through the outer tube of the element into the open space between the element and the canister. The coated screen of the canister does not allow water droplets to pass through it, and they fall to the bottom chamber of the filter separator. Only clean fuel passes through the screen of the canister tube into the effluent port.

100 GALLONS PER MINUTE FILTER SEPARATOR

2-248. The 100-GPM filter separator is used to remove sediment and free water in the FARE system. The 100-GPM filter separator is used with the 100-GPM pumping assembly.

2-249. The flow rate of the filter separator is 100-GPM, and its top working pressure is 75 pounds per square inch.

2-250. The 100-GPM filter separator has an aluminum tank with a removable cover. Its female inlet has a dust plug, and its male outlet has a dust cap. Filter elements and canisters, are set on a mounting plate near the bottom of the tank. The filter separator is mounted on a tubular aluminum frame. The filter separator has an air vent valve, a pressure differential indicator, a sight glass, and a manually operated water drain valve. A float ball in the sight glass shows how much water is in the tank. The ball sinks in fuel but floats in water.

Advanced Aviation Forward Area Refueling System Filter separator

2-251. The AAFARS filter separator provides filtered fuel by removing impurities and water from fuel. The filter separator has a maximum flow rate of 240-GPM and is to be employed with the 225-GPM pump.

2-252. The liquid fuel filter separator is an aluminum vessel with an integral frame and is designed to house three coalesce elements and a separator element for a total of four elements. A sump at the bottom of the vessel collects water and sediment removed from the pumpage by the filter action. The coalescer elements are one-piece, closed end, threaded-base elements and are retained to the inlet bulkhead by threaded-base adapters. The separator element is a one-piece, stainless steel screen coated on both sides with Teflon.

2-253. A standard fuel sampling port is fitted into the outlet port for fuel testing. Air is vented from the spring loaded vent valve located on top of the filter vessel.

350 Gallons Per Minute Filter separator

2-254. The 350-GPM filter separator is used to remove sediment and free water, primarily in the FSSP system. The 350-GPM filter separator is used in airfield refueling systems, motor fuel servicing equipment and military hose line systems.

2-255. The filter separator is designed for a flow rate of 350-GPM and a top working pressure of 150 pounds per square inch.

2-256. The 350-GPM filter separator consists of an aluminum pressure tank with a removable head. The tank is welded on a tubular aluminum frame for support and protection. It has an inlet pipe through which unfiltered fuel enters, an outlet pipe through which the filtered fuel leaves, an internal inlet manifold, and risers for mounting filter element and canister assemblies. The filter separator also has an air vent valve so that air can be let out of the tank, a sight glass to show the water level by means of a float ball, and a manually operated water drain valve to drain water from the tank.

SECTION III – FORCE PROVIDER FUEL SYSTEM

2-257. The force provider unit can store and distribute 1,200 gallons of petroleum using a tank and pump unit to refuel platoon equipment.

2-258. Additional fueling equipment includes a 28” x 32” aluminum frame cage with fork pockets and lifting handles, with self-priming pump (1hp 115V 1-Phase pump/motor) 30-40 GPM flow rates, Velcon VF-61 filter housing for use with AD-51225 diesel fuel filter cartridge, difference pressure gauge, flow meter with re-settable register, manual rewind hose reel, 1 ½” x 25” suction fuel hose with cam-locks, On/Off 120V explosion proof switch with 25” power cord, bonding reel, OPW 7B diesel automatic nozzle with swivel.

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Chapter 3

General Petroleum Considerations

This chapter describes general petroleum considerations to include planning considerations, safety, fire prevention and fighting procedures, grounding and bonding, fuel properties and characteristics, quality surveillance, fuel handling techniques, environmental responsibility and first aid measures.

SECTION I – PETROLEUM PROPERTIES

3-1. This section describes the properties of various petroleum products to include flash point, specific gravity and explosive range.

DESCRIPTION OF FUELS

3-2. Petroleum products are materials produced from crude oil as it is processed in oil refineries. Most of petroleum is transformed into petroleum products, which includes several categories of fuel. Petroleum products serve the purpose as fuel used to operate ground transportation, aviation, and maritime fleets, and other systems to ensure operational readiness of the force for the Department of Defense (DOD).

3-3. Refineries produce various types of petroleum products. These petroleum products include gasoline, jet fuel, diesel fuel, heating oil, and heavier fuel oils. Heavier oils can produce lubricating and other heavy oils. Lighter oils can produce gasoline and jet fuels. Appendix C provides data on petroleum products factors.

3-4. The opportunities for the use of alternate fuels, such as renewable and bio-energy, is a goal for DOD in order to reduce the dependence of petroleum products. However, DOD's reliance on petroleum-based fuel will be sustained for years to come.

FUEL TYPES

3-5. Although JP8 is the single fuel on the battlefield, the military uses several types of fuel to run its equipment. The types of fuel uses are described below.

Fuel Oil

3-6. Fuel oil is a fraction obtained from petroleum distillation, either as a distillate or a residue. Broadly speaking, fuel oil is any liquid petroleum product that is burned in a furnace or boiler for the generation of heat or used in an engine for the generation of power. If used in this sense, diesel is a type of fuel oil. The term *fuel oil* is also used in a stricter sense to refer only to the heaviest commercial fuel that can be obtained from crude oil.

Diesel Fuel

3-7. Diesel fuel in general is fuel used in diesel engines, whose fuel ignition takes place, without spark, as a result of compression of the inlet air mixture and then injection of fuel. (Glow plugs help achieve high temperatures for combustion during engine startup in cold weather.) Diesel fuel is heavier than gasoline; it is similar to heating oil but has a cetane number of 40 or more.

3-8. The most common type of diesel fuels is number 2, a specific fractional distillate of petroleum, alternatives that are not derived from petroleum, such as biodiesel, are increasingly being developed and adopted. Ultra-low sulfur diesel is a standard for defining diesel fuel with substantially lowered sulfur contents.

Kerosene

3-9. Kerosene is a combustible hydrocarbon liquid widely used as a fuel, in industry, and in households Kerosene is widely used to power jet engines of aircraft (jet fuel) and some rocket engines, but is also commonly used as a cooking, heating and lighting fuel. It is used as a cooking fuel in portable stoves for outdoor enthusiasts and is used as a heat source at construction sites and as a home heating fuel in portable and installed kerosene heaters.

Gasoline

3-10. Gasoline is a petroleum-derived liquid that is used primarily as a fuel in internal combustion engines. It is a volatile mixture of liquid hydrocarbons that can vary widely in their physical and chemical properties. The 'anti-knock' characteristic of a particular gasoline blend is measured by its octane rating. Gasoline is produced in several grades of octane rating. Tetraethyl lead and other lead compounds are no longer used to regulate and increase octane rating, but many other additives are put into gasoline to improve its chemical stability, control corrosiveness, provide fuel system 'cleaning,' and determine performance characteristics under intended use. It may be blended, or be required to be blended with oxygenates, such as methyl tert-butyl ether and alcohols such as ethanol, to improve octane ratings, extend fuel supply or reduce exhaust emissions.

Aviation Gasoline

3-11. Avgas (aviation gasoline), is an aviation fuel used in spark-ignited internal-combustion engines to propel aircraft. Aviation gasoline is the most restrictive fuel produced in a refinery. Strict process control is required to assure that the stringent requirements are met for antiknock rating, volatility and calorific values. Careful handling is essential during storage and distribution to guard against various forms of contamination. Avgas is distinguished from mogas (motor gasoline), which is the everyday gasoline used in motor vehicles. Unlike mogas, some grades of avgas still contain tetraethyl lead , a toxic substance used to prevent engine knocking (detonation). One hundred low lead (100LL) is the most common type of avgas. It contains about one-half the tetraethyl lead allowed in 100/130.

Jet Fuels or Aviation Turbine Fuel

3-12. Jet fuel or aviation turbine fuel is a type of aviation fuel designed for use in aircraft powered by gas-turbine engines. It is colorless to straw-colored in appearance. The most commonly used fuels for commercial aviation are Jet A and Jet A-1, which are produced to a standardized international specification. Military organizations around the world use a different classification system of JP for jet propellant numbers. Some are almost identical to their civilian counterparts and differ only by the amounts of a few additives; Jet A is similar to F-24, Jet A-1 is similar to JP8, Jet B is similar to JP4. Other military fuels are highly specialized products and are developed for very specific applications. Jet fuels are sometimes classified as kerosene or naphtha-type. Kerosene-type fuels include Jet A, Jet A-1, JP5, F-24 and JP8. Naphtha-type jet fuels, sometimes referred to as "wide-cut" jet fuels, include Jet B and JP4.

JET FUEL ADDITIVES

> ***Note*:** Should it become necessary to inject FSII, SDA, or CI/LI, exercise extreme caution. All of these additives, in the neat form, are extremely dangerous and can cause serious health problems, both near and long-term.

3-13. Additives are usually injected by the DFSP however, there are exceptions when petroleum organizations must inject the additives.

3-14. FSII prevents the water in fuel from freezing at normal water-freezing temperatures and help prevent microbiological growth. Frozen water particles that collect on the filter screens can cause fuel starvation. This leads to engine failure. As fuel cools, dissolved water will become free water. FSII combines with the free water to prevent this now undissolved water from freezing. If the FSII content of the fuel decreases, the icing protection also decreases. If JP8/F-24 contains less than the use limit, then blend it to use limits as soon as possible. This can be done by blending existing stocks, by locally injecting FSII during intra-terminal transfer, or by resupply. If the mission prohibits the possibility of blending or inhibiting low FSII stock, permission for limited use of stocks can be obtained by contacting the USAPC through appropriate command channels.

3-15. Static Dissipating Additive (SDA) increases the fuel's conductivity thereby permitting rapid depletion of any static charge generated during movement. A conductivity unit level below the use limit increases the hazard for explosion; a conductivity unit level above the use limit affects fuel probes on board aircraft. Blending or injection may be necessary to obtain the required level.

3-16. CI/LI in fuel attaches itself to metal surfaces such as the interior of a pipeline. It reduces the effects of water and particulate contamination from corroding the interior surface of the pipeline. CI/LI is the most significant component to JP8/F-24 that provides lubricity to fuel wetted parts in reciprocating engines.

Note: Refer to MIL-STD 3004 for the receipt and use limits for jet fuel additives.

CHARACTERISTICS AND HAZARDS

3-17. There are several characteristics and hazards the petroleum fuel handler must know to perform their petroleum duties. The characteristics and hazards are described below.

PETROLEUM PROPERTIES

3-18. The primary danger while handling petroleum is the chance of a fire or explosion. The paragraphs below describe petroleum properties affecting flammability and explosive characteristics. The paragraphs below also discuss issues and techniques related to reducing the chance of fire and explosion when storing and handling petroleum products.

Flash Point

3-19. Fuel flash point is the lowest temperature the fuel vapor will catch fire momentarily (flash) when exposed to a flame. The lower the fuel flash point, the more dangerous it is. Some sample flash points are: avgas, -40°F, and JP8, 100°F.

Explosive Range

3-20. Petroleum vapor and air may form a range of mixtures that are flammable, and possibly explosive. This range is called the mixture's "flammability limit," "explosive range," or "explosive limit." A mixture in the explosive range ignites when it contacts a spark, flame, or other ignition source. In open spaces, this causes an intense fire. In enclosed spaces, such as an empty tanker, the mixture explodes.

3-21. JP8’s explosive range, for example, is from .7 to five percent by volume of fuel vapor per given air volume.

- Any mixture above five percent by volume of fuel vapor does not ignite because it is too “rich.” For example, there is not enough oxygen present to burn the fuel. This is known as the mixture’s upper explosive limit.
- A mixture less than .7 percent by volume of fuel vapor does not ignite because it is too “lean.” For example, there is not enough fuel in the air to burn. This is known as the mixture’s lower explosive limit.

3-22. A mixture’s lower explosive limit is formed at about the product’s flash point. Thus, avgas vapors can burn or explode at temperatures as low as -40 °F. Explosive ranges vary among fuel types.

3-23. The key point is an empty or nearly empty petroleum tank or container is still very dangerous due to remaining fuel vapors.

Vapor Pressure

3-24. Vapor pressure is a measure of a fuel's tendency to form vapors (known as its volatility). Laboratory technicians normally use the Reid method to determine a liquid's vapor pressure. They determine vapor pressures at 100°F for comparison purposes. Knowing a liquid's vapor pressure has little practical application for petroleum handlers. However, petroleum products' relatively high vapor pressures (and in particular, gasoline and aviation fuels high vapor pressures) further show how easily fuels form explosive vapor mixtures in normal temperatures.

Distillation Range

3-25. Petroleum products are a mixture of hundreds of different chemical compounds. They boil (vaporize) over a relatively broad temperature range compared to pure substances. This temperature range is known as product distillation range. A product's distillation range is another relative volatility indicator. A product with a relatively low distillation range might vaporize in hoses or pumps, causing "vapor lock." Aviation fuels in particular have distillation ranges in the temperature ranges encountered during military operations.

Electrostatic Susceptibility

3-26. This is the relative degree a fuel will take on or build up a static electrical charge. Aviation peculiar fuels have relatively high electrostatic susceptibilities. This multiplies the danger of these highly volatile, flammable fuels.

Autoignition Temperature

3-27. This is the lowest temperature a fuel itself will catch fire spontaneously. Some auto-ignition temperatures are: avgas, 825°F to 960°F (440.5°C to 515.5°C) and JP8, 440°F to 475°F (227°C to 246°C). Low auto-ignition temperatures present a particular hazard in aviation refueling operations. An idling turbine engine (such as a helicopter engine) produces an exhaust with a temperature between 440 °F to 475°F. Even after the engine is shut down, its temperature stays in this range for quite some time. If this engine temperature radiates to JP8, the fuel could catch fire or explode. This could happen if a helicopter exhaust blows on a piece of refuel equipment or a fuel handler drags a hose across a hot engine.

PRODUCT CONTAMINATION

3-28. Contamination is the addition to a petroleum product of some material not normally present. Contamination may consist of solid foreign matter, free or emulsified water, mixed fuels or grades of fuel, or all of these. Products may also be contaminated with chemical or biological materials that may not be readily visible. The types of contamination are given below.

- Sediment is the general term applied to foreign solid matter. Sediment found most often consists of bits of rust, paint, metal, rubber, lint, dirt and sand.
- Water is one of the most common contaminants. It can get into fuel through leaks and condensation. Dissolved water in fuel is like vaporized moisture in the air. Fresh or salt water may be present in small droplets that produce a cloud effect, in larger droplets that cling to the sides of containers, in very large amounts that settle to the bottom in a separate layer, or in emulsions. Emulsions usually occur when fuel droplets become suspended in water. This may happen when fuel is agitated in the presence of water, as when it passes through a pump. The heavier the fuel, the longer the emulsion may last.
- Mixed fuels or grades of fuels can be as serious as any other form of contamination. Different kinds of fuel must be stored in separate tanks and pumped one at a time so that fuels will not mix in lines, filter separators, pumps, and petroleum vehicles. Be sure to mark all systems to show what type of fuel each is handling at the time. Mixed fuels or grades are hard to detect without testing.

Product Deterioration

3-29. Deterioration is any undesirable chemical or physical change that takes place in a product during storage or use. Although deterioration may be initiated or hastened by storage conditions, it is not usually observable to petroleum handling personnel. The most common forms of product deterioration are weathering, which is the loss of the more volatile components; gum formation; and the loss of oxidation inhibitors, tetraethyl lead, and anti-icing agents. The degree of deterioration can be determined only by periodic laboratory testing.

Fuel Properties and Behavior After Combustion

3-30. Additional fuel properties and behavior after combustion are described below.

Heat of Combustion

3-31. One relative measure of fire intensity or severity is the amount of heat produced as the fuel burns. Aviation peculiar fuels such as JP8 and avgas have higher heats of combustion than multipurpose or motor fuels. Therefore, they produce more severe fires. In any case, all petroleum fires are intense. They require prompt action to quench the large amounts of heat they produce.

Flame Spread Rate

3-32. Aviation fuels containing avgas or kerosene mixtures have flame spread rates of from 700 feet to 800 feet per minute. Kerosene-based fuels (JP8/F-24, Jet A-1/A, DF2) have flame spread rates of approximately 100 feet per minute.

Specific Gravity

3-33. Specific gravity is a relative measure of liquid density. Water's specific gravity is 1.0. All petroleum products have a specific gravity less than 1.0. For example, avgas specific gravity is .70 and JP8's specific gravity is .80. This means they are lighter than water and will float on any water surface. Using water to put out a petroleum fire will cause it to spread as petroleum is carried along on the water stream flowing away from the fire. For this reason, use foams or dry chemicals, if possible, to put out petroleum fires.

Solubility

3-34. Fuels will not dissolve in water. This means water-based foams can be used for putting out petroleum fires.

Flammable And Combustible Products

3-35. Hazardous liquids (including petroleum products) are classified as flammable and combustible. In these broad categories, there are several class designations based on a liquid's volatility.

3-36. Flammable and combustible liquids.

- Class I has a flash point below 100°F (37.8°C) and a vapor pressure not above 40 pounds per square inch (absolute) at 100°F. Examples include gasoline, JP4 and avgas.
- Class II has a flash point equal to 100°F (37.8°C), but less than 140°F (60°C). Examples include diesel, kerosene, and JP8.
- Class III has a flash point equal to or greater than 140°F (60°C). Examples include JP5.

3-37. Table 3-1 on page 3-6 describes the various flammable and combustible liquids classes. Heated liquids are more volatile. Therefore, heated combustible liquids require the same safety precautions as flammable liquids.

Table 3-1. Classification of flammable and combustible fuel

Classification	*Flash Point (Fahrenheit)*	*Boiling Point (Fahrenheit)*
Flammables		
Class I	Below 100	Below 100
Class IA	Below 73	At or above 100
Class IB	Above 73	
Class IC	At or above 73 and below 100	
Combustible		
Class II	At or above 100 and below 140	
Class IIIA	At or above 140 and below 200	
Class IIIB	At or above 200	

SECTION II– SAFETY AND HEALTH

3-38. Petroleum products can be handled and stored safely if users understand and respect the unique safety hazards they present. This section gives bulk petroleum receipt, storage, and issue safety techniques to include safety, storage, precautions, hazard control measures and health hazards. Explosions and fires caused by ignition of combustible mixtures of bulk petroleum vapors and air cause some of the most serious bulk fuel related accidents. The transfer and storage of petroleum, oil and lubricant products presents safety hazards and precautions that must be considered during those processes. Thus, controlling bulk fuel vapor formation and ignition sources at all times is critical in accordance with Department of the Army Pamphlet 385-90, *Army Aviation Accident Prevention Program*.

3-39. Safety training is the key to preventing accidents. Safety training must start during the Soldier's initial entry training and it must continue throughout their military service. All fuel handlers should know about petroleum and the safety principles for handling and using petroleum products. In addition, they should know self-care techniques, fire prevention, first aid, and emergency safety procedures.

3-40. Petroleum handling personnel should frequently search the Petroleum and Water Department website as well as the USAPC website for updates and messages regarding safety and health in petroleum operations.

STORAGE AND TANK VEHICLE

3-41. Storage tank safety requires adequate distances between storage tanks and proper maintenance. Tank vehicle safety also requires adequate distances between storage tanks and proper maintenance as well as proper safety fill levels, certain loading and unloading procedures and other procedures to ensure safe handling of petroleum products.

SAFE DISTANCES FOR FUEL STORAGE

3-42. To avoid complete destruction of a tank farm by fire, space the tanks a minimum clear distance of two diameters (or three diameters, center-to-center) for steel tanks. Rigid geometric patterns should be avoided. Spacing may be increased to 500 feet, but spacing over 500 feet is usually undesirable because of the lengths of the pipe between tanks and larger crews needed to operate the tank farms. Table 3-2 shows the minimum distance between tanks for fuel storage.

Table 3-2. Safe distance for fuel storage

Capacity of tank, in barrels	*Distance between tanks, in feet*
Less than 2,500	50
2,500 but less than 5,000	75
5,000	100

Capacity of tank, in barrels	*Distance between tanks, in feet*
10,000	130
15,000	160
20,000	180

3-43. A minimum distance of 100 feet will be maintained between the shell of any tank and the tank farm boundary line. The minimum clear distance between shells of adjacent aboveground vertical tanks will not be less than the diameter of the larger tank.

3-44. Tankers should be placed at minimum of 25 feet apart during transfer operations. Be aware that empty tankers are at least, if not more than, as dangerous as full tankers due to residual vapors.

TANK VEHICLE OPERATIONS SAFETY

3-45. Several factors are considered when laying out a parking area for vehicles. The following are considerations when determining the proper layout for a vehicle park.

- Leave enough space between the rows of refuelers so that they can be driven out quickly in an emergency. Position a tanker so it is headed toward the nearest exit and away from buildings or other obstructions. Do not let other vehicles block exit routes.
- Ground fuel vehicles.
- In case of a fuel leak out of a tank vehicle, keep leaks from draining towards a nearby building or water.
- Parking of refueler vehicles/trailers provide a minimum of 25 feet between the centerlines of adjacent vehicles/trailers when in the parked position or 10 feet minimum of clear space between parked fuel vehicles/trailers, whichever is greater.
- Provide a minimum of 50 feet (15 meters) between a refueler parking area and the following:
  - Uninhabited building for new projects.
  - Pump house or filter separator building.
  - Taxiing aircraft.
  - Fence, if space is a limitation [100 feet (30 meters), if space is available] and roads outside of a security fence.
  - Overhead power and communication lines.
  - Pad-mounted transformers.
  - Parked aircraft.
  - Any building other than maintenance.
- Provide side protection, such as revetments, when needed.
- Provide a minimum of 100 feet (30 meters) between a refueler parking area and the following:
  - Inhabited buildings.
  - Truck or tank car off-loading station.
  - Truck fill station.
  - Property lines.
  - Highways.
  - New petroleum operations building.
  - Airport surface detection radar equipment.
- Provide a minimum of 300 feet (90 meters) between refueler parking areas and the following:
  - Aircraft warning radar antennas.
  - Areas where airborne surveillance radar may be operated.
- Provide a minimum of 500 feet (150 m) between refueler parking areas and airport ground approach and control equipment

3-46. Be aware that empty tankers are at least, if not more than, as dangerous as full tankers due to residual vapors.

3-47. When possible, conduct petroleum operations on level ground. Always stop the engine, and set the brakes. Always chock the vehicle wheels when it is stopped. To chock the wheels, place an approved chock block between the front and rear tandem tires of the rear axle. Chock the tractor and trailer of tractor-trailer combinations.

3-48. During all loading, unloading, and fuel-servicing operations, keep tractors coupled to tank semitrailers. However, if the semitrailer is designated and appropriately administered as a temporary storage tank, the tractor can be disconnected.

3-49. Ensure the receiving vehicle's driver has been trained on and properly operates the dispensing nozzle. This will reduce the chance of spills, since the driver should be familiar with his vehicle and can safely fill it to the proper level.

3-50. Check the pressure vacuum relief valves frequently in cold weather to be sure they are operating properly.

3-51. Post NO SMOKING signs around the area of operations and enforce them. Prohibit smoking related materials around tank vehicles and in petroleum storage areas.

3-52. Keep a fire extinguisher manned and ready for use. Inspect fire extinguishers monthly for serviceability. Record the inspection date and the initials or name of the inspector on a tag. Attach the tag to the inspected extinguisher.

3-53. Bond and ground all vehicles and equipment before any operation or while parked for long periods in designated parking areas. Facilitate bonding and grounding vehicles involved in a fuel transfer by touching the hose, drop tube, or discharge nozzle to the fill cap before removing it. Keep the nozzle in contact with the fill opening at all times during a transfer operation. When the operation is complete, close the fill cover before disconnecting bonding and grounding cables. Stop transfer operations if there is an enemy attack, electrical storm, or fire in the area. Keep all possible sources of vapor ignition away during fuel transfer operations.

3-54. Make sure all electrical equipment used around tankers is in good working condition and labeled as explosion proof (if such equipment is available). Use explosion-proof extension lights, flashlights, and electric lanterns. Do not neglect normal safety procedures just because equipment is supposedly explosion-proof.

3-55. Do not drag hoses across the rear decks of combat vehicles or near their exhaust systems. Armor plates and exhaust pipes become hot during operation and could damage hoses and cause a fire. Immediately stop fuel flow if there is a tank compartment fire. Avoid driving near fires.

3-56. Remove fuel-soaked clothes immediately. Before doing this, wet the clothes with water. If no water is available, temporarily ground yourself by holding a piece of grounded equipment with both hands. Then, remove your hands from the grounded equipment and take off your fuel-soaked clothes.

STATIC ELECTRICITY

3-57. Static electricity is an imbalance of electric charges within or on the surface of a material. The charge remains until it is able to move away by means of an electric current or electrical discharge. Static electricity is named in contrast current electricity, which flows through wires or other conductors and transmits energy.

3-58. A static electric charge is created whenever two surfaces contact and separate, and at least one of the surfaces has a high resistance to electrical current (and is therefore an electrical insulator). The effects of static electricity are familiar to most people because people can feel, hear, and even see the spark as the excess charge is neutralized when brought close to a large electrical conductor (for example, a path to ground), or a region with an excess charge of the opposite polarity (positive or negative). The familiar phenomenon of a static shock–more specifically, an electrostatic discharge–is caused by the neutralization of charge.

3-59. The flowing movement of flammable liquids can build up static electricity. Non-polar liquids such as gasoline, diesel, and jet fuels exhibit significant ability for charge accumulation and charge retention during high velocity flow. Electrostatic discharges can ignite the fuel vapor. When the electrostatic discharge energy is high enough, it can ignite a fuel vapor and air mixture. Different fuels have different flammable limits and require different levels of electrostatic discharge energy to ignite. This buildup cannot be predicted or eliminated but it can be controlled.

3-60. Static electricity can be controlled and dissipated through several safety measures. Petroleum handlers should always assume that static electricity is present during all phases of operations. This includes long-term storage. Sparking (and a subsequent fire and explosion) from static electricity is a real and ever-present danger in petroleum transfer operations.

3-61. Outer clothing, especially if it is made of wool or synthetic fiber, builds a charge not only by absorbing part of the body charge, but also by rubbing against the body or underwear. When the wearer removes the charged clothes or moves them away from the body, the electrical tension or voltage increases to the danger point. If the clothes are saturated with fuel, flames may be produced due to the discharge of static electricity. Exposed nails on worn footwear can also cause sparks. This is a serious danger since fuel spills in refueling areas are common and fuel vapors near the ground ignite easily.

3-62. Before opening aircraft or vehicle fuel ports or doing any other operation that would permit fuel vapors escape into the air, fuel handlers should bond themselves to the equipment by taking hold of it with a bare hand and be cognizant avoiding inhalation vapors. If it is an aircraft or piece of metal equipment, the Soldier should take hold of a bare metal part with both hands for a few seconds. Although this type of bonding will not completely discharge static electricity, it will equalize the charge of the body with the charge on the equipment. Do not remove any piece of clothing within 50 feet of a refueling operation or in an area where a flammable vapor-air mixture may exist.

3-63. Proper clothing and footwear reduces in chance of static electricity buildup on fuel handlers and is discussed in later is this chapter.

GROUNDING AND BONDING

3-64. The two primary static electricity control methods are bonding and grounding.

3-65. Bonding is connecting two electrically conductive objects to equalize electrical potential (static charges) on them. Bonding does not dissipate static electricity. It equalizes the charge on the two objects to stop the sparking in the presence of flammable vapors. This will most likely occur when a vehicle or aircraft is being refueled. In this case, a fuel handler should bond the refueling vehicle to the vehicle being fueled.

3-66. Bond the fuel nozzle to the vehicle/equipment by maintaining metal to metal contact between the nozzle and vehicle/equipment being refueled. Maintain the bond until the refuel operation is complete.

3-67. The earth, particularly soft damp earth, can accept electrical charges. The charges then dissipate harmlessly. To ground equipment, you must provide a conductive electrical path into the ground. This prevents a static charge from collecting on the surfaces of equipment where it could discharge as a spark. Fuel handlers form this path by connecting a conductive cable from the piece of equipment to a conductive metal rod driven into the earth to the level of permanent ground moisture. The connection to the equipment must be to a clean unpainted, non-oxidized metal surface. Frozen soil (a particular problem in arctic regions) makes it difficult to get a good ground. Fuel handlers may need to drive in grounding rods at several different locations to as great a depth as possible to ground a single piece of equipment.

3-68. Another solution is to try to locate a grounding system near a heat source. If there are metal buildings or underground pipes nearby, a ground connection may be made to them.

3-69. Rocky or sandy soils are poor grounds because they have low conductivity. Chemicals can be used to condition the soil and raise its conductivity. Magnesium sulfate (Epsom salts), copper sulfate (blue vitriol), calcium chloride, sodium chloride (common table salt), and potassium nitrate (saltpeter) are some of the chemicals used for soil conditioning.

3-70. Table salt will probably be the easiest to get in the field. To use salt, prepare a grounding site by digging a hole about one foot deep and three feet across. Mix five pounds of salt with five gallons of water. Pour the mixture into the hole, and allow it to seep in. Install the ground rod and wire, and keep the soil around the rod moist. Ground rods are usually made of copper-weld steel. The rod regularly used for grounding is 3/4 inch in diameter and 6 feet long. It has one pointed end that is driven into the earth and a bolt and nut at the other end for connecting a grounding cable.

3-71. Use the following considerations to install, mark, test, and inspect ground rods.

- To install, drive the rod into the earth to a sufficient depth to reach below the permanent ground moisture level. On a fixed airfield apron or ramp, drive the rod to a depth where it's top is level with the surrounding surface. At other facilities, drive the rod to a depth where it's top is low enough or high enough so people will not trip over it. If the rod's top is level with the surrounding surface remove some soil from around the top to give room for attaching ground cable clips. Fuel handlers may use-tie-down bolts embedded in concrete ramps at fixed airfields as ground connections if they meet resistance requirements. Make ground connections to tie-down bolts on the eye of the bolt itself, not the tie-down ring.
- To mark, encircle each rod installed in a hard surface permanently or semi permanently with an 18 inch diameter yellow circle, with a two inch (approximately five centimeters) black border surrounding it. These circles must be painted on. Stencil in black the words STATIC GROUND CONNECTION and a numeric or alphanumeric rod identification code in the circle's yellow portion. Local policies and conditions determine fixed rod numbering and spacing. No requirement exists to mark temporary ground rods this way.
- To test, observe ground rods daily for damage. Test them after installation and every five years after or when obvious damage is discovered and after any damage repair. Appendix D gives detailed testing procedures.

3-72. An effective grounding system has a resistance of 10,000 ohms or less. The unit or agency that maintains fixed grounding systems must keep a log identifying each rod, the date tested, and the resistance reading. If a rod's measured resistance is greater than 10,000 ohms, immediately mark the rod DEFECTIVE-DO NOT USE and remove or replace it as soon as possible. Test grounding systems with a multimeter.

Grounding and Bonding Methods

3-73. No quick or easy way exists to test a ground's adequacy. The testing procedures in appendix D are relatively complex. The required test equipment is bulky and expensive. For these reasons, several methods and levels of grounding and bonding that meet the Army's various operational needs are given below. Some of these methods require special authorization prior to use.

3-74. Method 1. Equipment is grounded to a rod or rods with a measured resistance equal to or less than 10,000 ohms. These rod (or rods) ground both the refueling system or tanker and the vehicle or aircraft being refueled. In addition, the fuel handler bonds the refueling nozzle to the aircraft or vehicle he is refueling. Method 1 is the only acceptable grounding method, unless granted exceptions by appropriate authorities, at any fixed airfield or refueling point. It is the safest method.

3-75. Method 2. In some instances, equipment is not available to test resistance to ground. In such cases, fuel handlers can ground refueling equipment to untested grounding systems, subject to certain constraints. The unit commander authorizes this method when the location, tactical situation, or type of operation makes it impossible to test ground rods or to mark them in the manner appropriate for fixed rods. The grounding rod or rods are driven to a specific depth in the ground depending on the type of soil at the site. Refer to table 3-3 for depths of ground rods. The depth is determined by the normal depth of permanent ground moisture in the various soil types. The fuel handler grounds the refueler and the vehicle or aircraft being refueled are then grounded, and the nozzle is bonded to the aircraft. Use this method only when it is absolutely impossible to use the first method.

Table 3-3. Required depths for ground rods

Type of Soil	*Depth of Grounding Rods*
Coarse ground, cohesion less sands and gravels	6 feet
Inorganic clay, claying gravels, grave-sand-clay, claying sands, sandy clay, gravelly clay, and silty clay	4 feet

Silty gravel, gravel-sand-silt, silty sand, sand, silt, peat, muck, and swamp	3 feet

3-76. Method 3. In situations where the climate, terrain, or tactical condition make it impossible to secure a satisfactory ground rod, the authorizing commander may waive requirements to ground the aircraft or vehicle being refueled and fuel dispenser (system or refueler). The authorizing commander is the commander one level above the operating unit. However, he cannot waive the requirement to bond the fuel dispenser to the vehicle or aircraft under any circumstances. Method 3 relies on bonding alone. A bond is made between the aircraft and the refueling system or refueler and between the nozzle and the aircraft. A contact between an unbonded object and the system could produce a spark that could set off an explosion or fire. This is the least desirable method since it does nothing to dissipate electrical charges (ground).

PERSONAL PROTECTION

3-77. Personal protection is key in preventing personal injury or death. It is the individual Soldier's responsibility to take the necessary measures and precautions (wearing personal protective equipment, using safe working practices and techniques, learning proper first responder procedures, etc.) to ensure petroleum operations safety is foremost in all activities. The command's responsibility is to ensure all protective clothing, training and measures required by Occupational Safety and Health Administration, the Army Safety Program and the safety data sheet is provided to the fuel handler.

3-78. When handling petroleum products, many safety considerations must be adhered to in accordance with the appropriate safety data sheet, in order to protect the health of fuel handlers. Eye and skin contact should be avoided through the use of protective eyewear, gloves, and protective outer garments.

3-79. Inhalation exposure can occur from the vapor or aerosol mist during fuel transfers. Nearby personnel should be positioned away from the vapor/aerosol plume. Handling and transfer of fuel should be performed in well-ventilated areas.

3-80. Clothing should be promptly removed if it becomes wet with fuel. Clothing should be laundered before wearing again.

3-81. The command and fuel handler's should:

- Observe all safety precautions and procedures.
- Observe safety rules when operating, loading, and transferring products.
- Train on administering first aid and artificial respiration.
- Inspect equipment, safety devices, and work areas frequently to ensure safety and to correct hazards.
- Keep the work area free of objects that may cause accidents.
- Wear protective clothing when handling fuels. Clothing includes field wear, splash/spray resistant eye protection, hearing protection, gloves, and boots discussed later in this chapter.
- Do not wear any wool clothing items or jewelry that may spark against metal surfaces.
- Avoid exposure to fuel vapors for long periods. Perform petroleum operations in well ventilated areas.
- Use only authorized solvents for cleaning. Do not use fuel (gasoline, kerosene, etc.) or other toxic agents for cleaning.
- Use walkways on tank vehicles, tank firewalls, and berms.
- Do not load, transfer, or move petroleum fuels if an electrical storm is within three miles.
- Ensure personnel bond themselves with equipment prior to performing any petroleum operations.

3-82. Despite all other actions taken, fires may still occur and may erupt forcefully. The following considerations will assist the fuel handler in preparing for and taking appropriate actions in this event. Have a fire evacuation and firefighting plan as applicable and ensure your Soldiers are knowledgeable on fire evacuation and firefighting procedures. See unit safety officer for guidance. All fire extinguishers and suppression units (hand held, trailer mounted, vehicle mounted, and built in) must be serviceable as required. Fire extinguishers and other firefighting equipment should be located within easy reach, but where it will be safe from a fire. Small fires may be extinguished using a fire extinguisher. The priorities of firefighting are to protect personnel and prevent personal injury and death. A clear path should be made by spraying at the base of the fire near the feet of Soldiers entrapped by a fire. Continue making a path until the person is clear of the fire.

3-83. In the case of larger fires, the priority is to prevent the spread of the fire to structures, equipment, and fuel storage areas. This may be accomplished by spraying aqueous film forming foam in a manner to prevent the fire from spreading. Another method is to stay vigilant for burning debris and extinguish it as it lands near areas that are to be protected.

PERSONAL PROTECTIVE EQUIPMENT AND INDIVIDUAL PROTECTIVE EQUIPMENT

3-84. Personnel must wear personal protective equipment (PPE) or individual protective equipment (IPE) when handling fuels. It is the command's responsibility to ensure that all protective clothing required by the safety data sheet for the petroleum product handled is provided to the fuel handler. Clothing includes field wear, eye protection, hearing protection, gloves, and boots (PPE). Personnel required to wear PPE should be trained in the use of the PPE/IPE, be issued the PPE/IPE, and ensure PPE/IPE serviceability. Wear shirt sleeves rolled down and buttoned. Do not wear or carry loose items of clothing. Do not wear nylon or wool when conducting fuel operations as nylon or wool produces static electricity. Ensure footwear is serviceable.

3-85. The Joint Service Lightweight Integrated Suit Technology chemical protective ensemble and field protective mask, IPE, restricts movement and activities. Also, they make it difficult to perform even the simplest tasks. Wear mission-oriented protective posture gear only when threat forces have used chemical, biological, radiological, and nuclear threats and hazards or are likely to do so. Petroleum organizations and units should be familiar with performing petroleum mission related tasks using mission-oriented protective posture gear.

3-86. Ensure supervisors do a safety risk assessment on whether Soldiers should wear field gear during fueling operations. Field gear attire should be balanced against the facts that a Soldier could be severely injured from falling off tank vehicles or possibly injured due to the tactical situation (sniper fire, riots during contingency operations). Unless directed otherwise by the commander, Soldiers should wear full field gear in forward, remote areas, since the danger from related injuries is high. If a Soldier has their weapon, it needs to be properly secured so it does not get in their way or jeopardize safety while conducting refueling operations. The wear of field gear is at the commander's discretion.

- Wear fuel-resistant or nitrile/neoprene gloves and protective clothing to keep fuel off the skin.
- Ensure proper eye wear (goggles, safety glasses or splash/spray resistant eye wear) and hearing protection is worn when handling fuels or operating equipment.
- Wear authorized fuel handler's coveralls, which offers both fuel resistance protection and incorporates a static dissipative knit. Wear shirt sleeves rolled down and do not carry loose items on your person.
- Ensure head protection is properly worn and secure when conducting hot refueling.

3-87. A National Institute for Occupational Safety and Health approved air-purifying respirator with organic vapor cartridges or canisters may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

3-88. Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

FIRST AID MEASURES

3-89. The term first aid can be defined as "urgent and immediate lifesaving and other measures, which can be performed for casualties by nonmedical personnel when medical personnel are not immediately available.

First Aid For Petroleum-Related Injuries

3-90. If any type of petroleum product comes in contact with skin, wash it off immediately with soap and water. If any type of fuel gets in the eyes or mouth, flush them thoroughly and repeatedly with water. Do not swallow the water. Do not induce vomiting. Get medical help as quickly as possible. If possible, establish an eyewash at a refueling site. In remote areas where water is limited, ensure a substantial supply of water is on hand for petroleum handling personnel. If any type of fuel gets on clothes, promptly and carefully remove the clothes, or saturate the clothing with water. If possible, have the person make direct contact with a known grounding point prior to removing the contaminated clothing. These procedures protect the Soldier from the danger of a static spark igniting his clothes as he removes them. SDS's give additional first aid procedures for exposure to hazardous materials.

3-91. Ensure personnel are trained on combat lifesaver procedures, to include artificial respiration.

3-92. Ensure refueling sites and equipment has adequate first aid kits and equipment to conduct first aid.

3-93. For additional information regarding first aid, refer to FM 4-25.11, *First Aid*.

PETROLEUM FIREFIGHTING AND PREVENTION

3-94. The primary danger while handling petroleum is the chance of a fire or explosion. The sub sections address the classes of fires, types of firefighting equipment and key planning considerations.

Classes of Fires

3-95. Fires are distinguished by four categories:

- Class A fires involve combustibles such as wood, brush, grass, and rubbish. Water is the best agent for extinguishing class A fires.
- Class B fires involve flammable liquids such as gasoline and other fuels, solvents, lubricants, paints, and similar substances that leave no embers. A smothering or diluting agent best extinguishes class B fires.
- Class C fires involve live electrical equipment such as motors, switches, and transformers. A smothering agent, which is not an electrical conductor, best extinguishes class C fires.
- Class D fires involve combustible metals such as titanium, zirconium, sodium, and potassium. A smothering agent best extinguishes class D fires.

Elements Of Fire

3-96. Fires require three elements to keep burning. These elements are fuel, heat and oxygen. Eliminating or sufficiently controlling one or more of these elements will extinguish the fire.

- Immediately shut off the fuel flow, if possible. If the fire is in a broken pipeline, plug the break if possible. Stop the flow at the nearest valve, and use foam on the burning fuel pools. Do not use water and foam together. Water will destroy the foam's effectiveness to smother the fire and cause the fuel to spread.
- Heat is transmitted by radiation, conduction, and convection. Heat is conducted through a solid or liquid substance. Convection takes place as heated air rises from the fire and circulates. This transfers heat to all combustibles in the area. Water in streams, spray, or fog is the best way to reduce heat and vapor. However, only trained people should use this method. Inexperienced people might cause the fire to spread when using water to extinguish it. Usually, the best way to protect a storage tank near a fire is to cool it with water.
- It is impossible to remove all air in the area of a fire. However, firefighters can dilute the air, smother the fire, or both. Diluting the air means reducing the percentage of oxygen in the air to the point it can no longer support combustion.
- Foam is one of the best ways to blanket and smother a petroleum fire. To do this, spread a tight covering of foam on the burning surface to cut off all air. Foam spreads easily on the top of a burning tank. Foam tends to break down in a fire. Continue to apply foam long and fast enough to let the tank cool below the fuel ignition temperature. The depth of foam needed can vary from a

few inches for a small tank to several feet for a large tank. The foam source should furnish enough foam to put out a fire in the largest, protected single area rather than several small fires at one time. Fuel handlers can also smother small fires with sand, wet burlap, or a blanket.

SOURCES OF IGNITION

3-97. An ignition source must be present in order for fires or explosions to occur; a combustible material (petroleum vapor) and oxygen are also required. Little can be done to control oxygen in a field environment; however, the following work considerations will assist in controlling ignition sources, vapors, and increase the safety of personnel and equipment.

- Control sources of ignition for personal safety, environmental considerations, and conservation and protection of fuel supplies. Static electricity, open flames, equipment sparking, and even sunlight can constitute ignition sources.
- Friction and impact between tools and materials can create sparks. Use only authorized tools, equipment, and clothing. Use explosion proof lights and flashlights.
- Do not use open flames, heating stoves, or other devices which give off heat, sparks, static electricity and other sources of ignition in petroleum storage and work areas.
- Use of cell phones and unapproved electronic devices is prohibited during refueling operations and in areas where petroleum vapors are present.
- Cigarettes and matches/lighters are the single greatest cause of fires. Their use must be prohibited in the vicinity of bulk fuel storage.
- Electrical equipment and wires create fire hazards when they produce exposed electrical currents (arcs and sparks) or when they create excessive amounts of heat. Keep tools and equipment in safe and good working condition.
- Spontaneous heating of a combustible material takes place when its characteristics and the right environmental conditions cause a heat-producing chemical reaction. Pay particular attention to safety data sheet for cleaning and storing instructions. Storing rags and waste in proper containers and disposing of them properly can prevent this.
- Strictly enforce NO SMOKING rules and place "NO SMOKING WITHIN 50 FEET" signs where they can be seen before the individual is within 50 feet of the operation.
- For all petroleum operations, always ground and bond petroleum equipment being used (pump, filter separator, tank truck, storage tanks, etc.) and the equipment receiving fuel.
- Ensure spark arrestors are on all equipment used in and near petroleum storage areas.
- Avoid high frequency radar equipment beams in that they can ignite a flammable vapor-air mixture. The beams can ignite the mixture by inducing heat in solid materials in the beam's path or by intensifying an existing electrical charge or stray current to the point where it will arc or discharge as a spark.
- Eliminate hazards regards welding and cutting using open flames that can ignite vapors. However, welding performed on or near petroleum product-use equipment must closely control the welding process to prevent fires or explosions. Thoroughly clean and reduce vapors, in accordance with the procedures in appendix E, to acceptable safety levels in storage tanks, tank cars, tank vehicles, drums, and vehicle fuel tanks before cutting or welding them. Check local policies for doing such work.

Vapor and combustible materials

3-98. Control and minimize vapors and combustible materials in order to prevent fire, by reducing or eliminating the fuel source. In the event a fire occurs, minimizing vapors and combustible materials will ensure that the fire presents less danger and risk.

- Control spills with a proactive spill prevention program in accordance with DOD 4715.05-G-*Overseas Environmental Baseline Guidance Document*.
- Frequently inspect tank seams, joints, piping, valves, pumps, and other equipment for leaks. Repair leaks immediately. Replace defective hoses, gaskets, and faucets.

- Work and storage areas must be well-ventilated. Beware of unventilated spaces such as the inside of tank vehicles.
- Use drip pans, catch basins, or absorbent materials. Place them where they are accessible in the event of a leak or spill. In addition, place them in the most probable areas of class III leaks or spills in petroleum operations.
- The container(s) should be filled carefully to avoid overfilling and overflow.
- Empty fuel pipelines, storage tanks, drums, cans, or containers contain residual vapors and are more dangerous than a filled container.
- Inspect drums and containers for serviceability prior to use. Mark the drums and containers to note approval if they are fit for use.
- Close containers that hold or have held flammable products.
- Carefully open containers that have or may have had flammable products. Heat and temperature fluctuations can cause pressure to build up, which may suddenly release vapors when the container is opened.
- Overhead (top-loading) filling is not authorized unless approved and signed by the commander or the commander's designated representative. When overhead, make sure the drop tube or discharge hose is close to the bottom of the tank. Pump fuel at a reduced rate until the end of the hose is covered; then switch to a normal flow rate. In addition, where possible, ensure metal-to-metal contact between the dispensing hose and the bottom of the tank exists. This helps prevent vapors and the buildup of static electricity.
- All nozzles and hand actuated valves must be constantly tended to while they are being used in refueling operations. Tactical systems shall not use notched handles on nozzles; make sure the notches are modified so that the nozzles must be held open by hand.
- Areas must be clean and proper storage and dispose of materials is necessary. Relatively small heat sources easily ignite trash, rags, scrap wood, and other such items.
- Use fire resistant wall lockers and cupboards for storage in petroleum supply areas. Never store newspapers or rags in them.
- Discard petroleum waste in accordance with local procedures and in an environmentally-safe manner.
- Label safety cans or other flammable liquid waste containers with a flash point below 100°F (37.8°C) in accordance with *49 Code of Federal Regulations Part 172*.
- Ensure fuel nozzles and hoses and capped when not in use.

FIRE EXTINGUISHERS

3-99. The primary method for fighting petroleum fires at smaller class III supply points is portable, carbon dioxide fire extinguishers. Place one at each pump, receiving and issuing point and packaged product storage area. Place other extinguishers where Soldiers can access them and critical areas of the supply point quickly. Develop a supply point map showing extinguisher locations. Place a map at each checkpoint and at several locations in the area of operation.

3-100. Locate fire extinguishers (or signs indicating the closest one) throughout the supply point. The extinguishers must be in working order. The following are general guidelines for the use of fire extinguishers:

- Fire extinguishers must be in working order.
- Know how to operate the fire extinguisher.
- Know which extinguisher to use for each type of fire.
- Inspect frequently to see if extinguishers have been damaged.
- Portable fire extinguishers must be visually inspected monthly. The inspection should assure that:
  - Fire extinguishers are in their assigned place.
  - Fire extinguishers are not blocked or hidden.
  - Fire extinguishers are mounted in accordance with *NFPA Standard No. 10 (Portable Fire Extinguishers).*

    - Pressure gauges show adequate pressure to determine whether leakage has occurred. A CO_2 extinguisher must be weighed.
    - Pin and seals are in place.
    - Fire extinguishers show no visual sign of damage or abuse.
    - Nozzles are free of blockage.
- Additional mandatory inspections are required at specific intervals.
- Recharge or exchange extinguishers immediately after use.
- Follow manufacturer's instructions for charging, maintaining, and using the extinguisher.

FIRE EXTINGUISHER TYPES

3-101. The primary firefighting tool is usually fire extinguishers. The Army uses both portable handheld extinguishers and wheeled units. Portable handheld fire extinguishers are effective only in a fire's earliest stages. Wheeled fire extinguishers offer more flexibility because they have longer hoses and greater capacities.

3-102. Fire extinguishers are also referred to by the amount (weight) of agent in the extinguisher i.e. 20 pounds and by the square footage the extinguisher can cover which is expressed as a number and letter i.e. (20 B:C).

3-103. Minimum 20 B:C fire extinguishers are required for refueling operations. The exception is FARP operations and a minimum of 20 pound fire extinguisher is required.

3-104. The following are different types of fire extinguishers and their uses.

- Water extinguishers are filled with water and are typically pressurized with air and are suitable for class A fires only.
- Carbon Dioxide (CO_2) extinguishers are most effective on class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from three to eight feet. The carbon dioxide is stored as a compressed liquid in the extinguisher; as it expands, it cools the surrounding air. The cooling will often cause ice to form around the horn, where the gas is expelled from the extinguisher.
- Dry chemical extinguishers are usually rated for multiple purpose use. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant. Works well on Class B and C fires.
- The Purple-K extinguisher is a dry chemical extinguisher using the extinguishing agent potassium bicarbonate, commonly called Purple-K. This fire extinguisher is designed for use on Class B and C fires. Purple-K is highly corrosive. Purple-K extinguishers usually have a 20 pound capacity.
- This twin agent unit is a fire suppression system that is standard with large class III bulk supply systems. It has the capability of extinguishing 1500 square feet petroleum fire with two agents; potassium bicarbonate powder and aqueous film forming foam.

FIREFIGHTING TACTICS

3-105. To fight and extinguish petroleum fires effectively requires a good firefighting plan. Every class III supply point operation should have a fire prevention and firefighting plan. The plan may be very simple or complex depending on the operation. No matter what, it should cover in detail all possible fire dangers and issues. It should also address firefighting resources, to include fire departments and engineer firefighting teams, where available. Soldiers and their supervisors at the class III supply point have the primary responsibility for controlling and extinguishing fires. However, they should immediately notify their chain of command and outside support agencies such as the fire department when a fire breaks out. Ensure your firefighting plan covers fire extinguishers, trained firefighting personnel, evacuation routes, fire drills, fire investigation and any other recommendations from the local or station fire department.

3-106. Assign two people to each fire point in the supply point and three personnel per twin agent unit operation. Make sure all Soldiers in the supply point know and practice procedures for using the fire extinguishers. Also, form a firefighting team that drills extensively on firefighting techniques to quickly react to and extinguish larger fires. A five person team is appropriate for the unit level supply point.

3-107. Setup evacuation routes for vehicles and personnel. If a fire breaks out, all vehicles must be quickly moved from the area. Never lock steering wheels on petroleum vehicles. Personnel not involved in fighting the fire must also leave. Evacuation routes should be the most direct route out of the supply point. Show these routes on the maps with the fire extinguisher placement.

3-108. Use fire drills to train personnel to react quickly to fires. Fire drills should be as realistic as possible. Evacuation routes should be used and fire extinguishers manned. Conduct a fire drill as the tactical situation permits.

3-109. Investigate all fires to gain knowledge that may help prevent future fires. It is important to know how and why a fire started. Check for an unsafe working condition or an improper act done by a Soldier.

Fire Inspections

3-110. The key to petroleum fire safety is an active fire prevention program. Where the tactical situation allows for periodic fire inspections, make sure all possible fire prevention precautions are in place and are being followed. Ensure the inspection program covers the entire operation. Here are some key inspection points:

- Fire extinguishers are fully charged, properly placed, and clearly marked. They must also be protected, ready for use, and available in the number and type required.
- All equipment, grounds, bonds, and cathodic protection devices should are checked.
- Berms around storage tanks must be serviceable and adequate. Drains must be closed except during supervised draining.
- Pumps should be leak and spill free. Spills must be cleaned up and reported immediately. Inspect pump houses, if present, for proper housekeeping and proper ventilation.
- Tank farms should be clear and free of dry grass and weeds.
- Check areas near where open flames for possible sources of flammable vapor release. Ensure “NO SMOKING WITHIN 50 FEET” signs are posted in such locations to ensure that there is no smoking within 50 feet of fuel operations.
- Post and enforce rules covering those areas that permit hot work, such as cutting and welding.

ENVIRONMENTAL CONSIDERATIONS

3-111. We must take care of the environment (that is, practice environmental stewardship). The definition of stewardship is taking care of property while also caring about the rights of others. We must plan our operations without harming the environment. Good environmental stewardship allows leaders take care of Soldiers and their families. It also saves resources vital to operational readiness.

3-112. The Army has the task of reducing the environmental impact on its installations and units throughout the United States and the world. Petroleum and water units by their nature have a huge impact on the environment. It is critical for the leaders and Soldiers in these units to follow safe, legal environmental practices. By doing so, they protect their health and the health of those around them. They also prevent long term environmental damage that can lead to fines and other legal actions.

Environmental Responsibilities of Personnel

3-113. The commander must build an environmental ethic in his Soldiers. The commander sets the tone for environmental compliance. The commander is ultimately responsible however; all Soldiers are responsible for complying with all applicable environmental laws in their area of operations and their unit.

3-114. An effective training program allows personnel to carry out their responsibilities. Commanders ensure all personnel are trained on environmental issues. The commander should appoint an environmental compliance officer/hazardous waste coordinator. This person works with other environmental personnel. The commander also makes sure environmental laws are followed. The commander identifies what their requirements and priorities are concerning environmental training and qualifications of unit personnel, environmental compliance inspections that may affect the unit, and common environmental problem areas and how to avoid them. The commander also makes sure the unit environmental SOP details environmental issues and procedures the unit must follow in their theater or area of operations.

3-115. The environmental compliance in petroleum supply operations program should cover:

- Hazardous materials management in accordance with DA PAM 710-7, *Hazardous Material Management Program*.
- Hazardous waste management in accordance with the U.S. Army Environmental Command and the Resource Conservation and Recovery Act.
- Hazard Communications (HAZCOM) in accordance with DOD Instruction 6050.05, *DOD Hazard Communication (HAZCOM) Program* and AR 385-10, *Army Safety Program*.
- A spill prevention, control and countermeasure plan (SPCCP). Identifies fuel storage locations therefore, potential spill sites and those measures taken to prevent a spill from occurring.
- A spill contingency plan (SCP) required in conjunction with the SPCCP. The SCP identifies what to do, what resources are available and who to contact in the event a spill does occur. The station response team members should be identified by name and position.
- Environmental stewardship protection program measures.

3-116. Personnel at all levels must protect our environment. This includes Soldiers, NCOs, officers, commanders and appointed personnel.

3-117. Soldiers' duties include:

- Following installation environmental policies, unit SOPs, ARs, and environmental laws and regulations.
- Making sound decisions in everyday activities.
- Advising the chain of command on techniques to ensure environmental regulations are followed.
- Identifying the environmental risks in individual and team tasks.
- Supporting the Army recycling program.
- Reporting hazardous materials and hazardous waste spills immediately.

3-118. NCO's responsibilities include:

- Supervising Soldiers during petroleum operations to ensure they comply with established environmental protection policies.
- Consideration of the environment in day-to-day decisions.
- Ensuring Soldiers know the Army's environmental ethic.
- Training Soldiers to be good environmental stewards.
- A commitment to environmental protection.
- Identifying environmental risk associated with tasks.
- Planning and conduct environmentally sustainable actions and training.
- Protecting the environment during training and other activities.
- Analyzing the influence of the environment on your mission.
- Integrating environmental considerations into unit activities.
- Training peers and Soldiers to identify the environmental effects of plans, actions, and missions.
- Counseling Soldiers on the importance of protecting the environment and the results of not complying with environmental laws.
- Incorporating environmental considerations in after action reviews.
- Supporting the Army recycling program.
- Reporting hazardous material and hazardous waste spills immediately.

3-119. Officers duties and responsibilities include:

- Building an environmental ethic in Soldiers.
- Training and counseling subordinates and leaders on stewardship.
- Seeking advice on required personnel training from the local environmental coordinator.

- Enforcing compliance with laws and regulations.
- Always considering the environment in making day-to-day decisions.
- Making sure subordinates know the Army's environmental ethic.
- Committing subordinate leaders to protect the environment.
- Analyzing the influence of the environment on the mission.
- Integrating environmental considerations into unit activities, to include identifying the environmental risks associated with unit tasks.

3-120. Appointed personnel are appointed by the commander and should receive formal training. Their responsibilities include:

- Acts as an advisor on environmental regulatory compliance during training, operations, and logistics functions.
- Serves as the commander's eyes and ears for environmental matters.
- Serves as the liaison between the unit and higher headquarters who are responsible for managing the environmental compliance programs and who can provide information on training requirements certifications that unit personnel need.

SPILL DEFINITIONS

3-121. A spill is broadly defined as a release of any kind of a petroleum product or hazardous substance into the environment. Spill reaction is based largely on the nature of the material spilled. The three types of spills are:

- A small priming spill covers less than 18 inches in all directions.
- A small spill extends less than 10 feet in any direction, covers less than 50 square feet, and is not continuous.
- A large spill extends farther than 10 feet in any direction, covers an area in excess of 50 square feet, or is continuous.

3-122. Reportable spills are based on local and host nation requirements. All personnel involved in fuel handling should be cognizant of the spill reporting requirements. Any spill reaching a stream, creek, river, or any other body of water is reportable and must be contained and completely removed. Any oil spill with the potential to come into contact with the water table will be reported. Harmful quantities violate water quality standards and cause a film, sheen, or discoloration to the surface of the water or adjoining shorelines. They also cause sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

SPILL DISCOVERY

3-123. The initial component in the spill response plan is discovery. The primary responsibility of a discoverer is to notify the proper authorities who are trained and equipped to deal with an environmental incident. When a spill is discovered, the discoverer will perform the spill-drill REACT.

- Remove the source.
- Envelop the spill.
- Absorb/accumulate.
- Containerize the hazardous waste.
- Transmit a report.

3-124. Defensive actions should begin as soon as possible to prevent or minimize damage to public health and welfare or to the environment. Some general actions include:

- Eliminating sources of sparks or flames.
- Controlling the source of the discharge.
- Placing physical barriers, such as berms or dikes, to deter the spread of the oil.
- Preventing the discharge of contaminated water into storm drains or the sewer system.
- Recovering the oil or minimize its effects.

3-125. Place recovered oil and contaminated absorbents, such as rags, in Department of Transportation approved containers for disposal as hazardous waste.

ENVIRONMENTAL COMPLIANCE EQUIPMENT

3-126. Emergency spill response, whether in the field is essential. Some of the items to stock for use in garrison and during field operations could include:

- Drip pans.
- Shovels (removal of contaminated soil, digging ditches and berms).
- Sorbents (designed to absorb petroleum only).
- Containers for contaminated materials.
- Socks or dikes (flexible containment devices for spills on land).
- Booms (floating containment device for spills on water).
- Spill kit and replacement items. Information on the description of the spill kit and NSN is published in "*The Preventive Maintenance Monthly - PS Issue 643*, dated June 2006, pages 53-55".

AVIATION REFUELING SPECIAL CONSIDERATIONS

3-127. Aircraft refueling operation present some of the most dangerous hazards in refueling. Special considerations must be imposed by aircraft fuel handling personnel when conducting aircraft refueling operations.

Note: For Forward Arming Refueling Point information, refer to ATP 3-04.94.

3-128. ATP 3-04.94 addresses personnel refueling requirements to include PPE for aircraft refueling and covers emergency procedures in case of fire, firefighting and rescue techniques, and aircraft refueling point safety requirements.

3-129. A forward arming and refueling point (FARP) is a temporary facility that is organized, equipped, and deployed as far forward, or widely dispersed, as tactically feasible to provide fuel and ammunition necessary for the sustainment of aviation maneuver units in combat. Establishing a FARP allows commanders to extend the range of their aircraft or significantly increase time on station by eliminating the need for aircraft to return to the aviation unit's central base of operations to refuel and rearm. FARPs may be task organized to provide maintenance support as well as air traffic control services, if required.

3-130. FARPs are intrinsically dangerous. To mitigate these dangers, a FARP Safety Checklist should be completed after the refueling equipment is in place, but prior to the first aircraft uses the site for refueling/rearming. Discrepancies noted by the noncommissioned officer-in-charge or safety officer (OIC) should be corrected prior to the operation. An example of this FARP safety checklist is provided in ATP 3-04.94.

3-131. FARPs are employed in support of aviation operations, generally by the distribution company of an aviation support battalion, when the distance covered or endurance requirements exceed normal capabilities of the aircraft. FARPs may also be employed during rapid advances, when field trains are unable to keep pace.

3-132. Arm and hand signals are commonly used by aircraft fuel handlers to communicate with and guide aircraft safely into the FARP. Fuel handlers must know these general signals in order to communicate effectively with pilots.

Chapter 4

Petroleum Operations

Military forces require large quantities of bulk petroleum products in support of combat operations. Bulk petroleum requires special handling and storage, and has a demand significantly larger than other supply classes. In addition, bulk petroleum operations require uninterrupted supply from the commercial supplier down to the tactical level as far forward as required. Bulk petroleum operations involve determining requirements, allocating product, bulk storage, moving products forward and within theater, product quality control, accounting for the product and maintaining distribution equipment and facilities.

SECTION I – PLANNING CONSIDERATIONS

4-1. This section discusses planning considerations incorporated with petroleum operations. Planning considerations include the concept of support for petroleum in a military operation, consumption estimates, analysis of the operational environment, and security.

CONCEPT OF PETROLEUM SUPPORT

4-2. The concept of operations for class III support focuses on when, where and how to provide petroleum products to forces in the theater via timely supply, re-supply and distribution methods.

4-3. The basic petroleum operating concept is to always keep storage tanks full and secure, open lines of communication. The availability of fuel depends on the location of the theater of operations. The Army will provide its own integrated distribution system using different modes of transportation.

4-4. JP8 is identified as the single fuel for the battlefield. JP8 is the primary fuel used in forward areas for fueling all ground and aircraft systems. In reality, this policy is not always possible as JP8 may not be available in certain locations. In addition, some equipment on the battlefield still runs on other fuel i.e. avgas and gasoline.

4-5. The basic stockage concept in theater operations is to have sufficient storage to support the most demanding operation plan and keep on-hand inventories at or near maximum authorized levels, while using available transportation assets as efficiently as possible.

4-6. Petroleum products, for inland support in a theater of operations, are requested from the TSC or equivalent ESC. Once the request is allocated, it is normally pushed down from the ASCC, TSC or ESC equivalent, through the operational level sustainment brigades, to the tactical level BSB or FSC. DLA Energy is responsible for the integrated management of bulk petroleum.

4-7. The concept of operations is an integrated process that must link the operational requirements of petroleum products to the sustainment capabilities required to support demands.

4-8. Leaders of petroleum organizations should include the following in their concept of support for petroleum in accordance with the operations order, unit SOP, and specific guidelines that pertain to task or mission.

- Supported unit's concept of operations and sustainment.
- Comprehension of the mission or task at hand and the expected support role.
  - Type of support; direct, general or area.
  - Level of support.
  - Layout of the area of operations.

- Petroleum resources available and required.
- Degree of risks involved to support the mission and risk mitigations.
- Safety measures and environmental considerations to incorporate throughout operations.
- Specific guidelines that pertains to internal class III supply point operations.
    - Orientation of site.
    - Continuous quality surveillance of all petroleum products.
    - Maintaining minimum bulk fuel stock objective.
    - Accountability and reporting procedures.
    - Lines of communication.
- External support commodities needed to support the various missions, i.e. transportation (ground and air), security, engineer support, etc.
- Include running estimates pertaining to all aspects of petroleum supply operations based on the current situation and planned operations.

CONSUMPTION ESTIMATES

4-9. Consumption rate is the average quantity of an item consumed or expended expressed in a unit of measure compatible with the appropriate equipment usage profile.

4-10. Fuel consumption estimates or requirements are the foundation to an effective petroleum distribution system to support the end user in theater. In conducting operations in theater, commands will estimate fuels requirements and the necessary delivery frequency as directed by higher headquarters. At theater level, fuel consumption estimates are the basis for acquiring theater petroleum tankage and for allocating supply stockage levels throughout the theater. At echelons above brigade level, fuel consumption estimates are used to establish priorities for distribution and construction. At lower echelons, fuel consumption estimates are the basis for resupply.

4-11. Theater fuel consumption estimates must be accurately determined to develop realistic plans in support of operational forces. Determining the requirements allows the planner synchronize resupply and determine such specifics as the amount of assets required to support the mission.

4-12. Fuel consumption must be estimated as soon as the situation and/or conditions permit so that it can be balanced against known capabilities and coordinated with other supply and transportation support requirements. Troop strengths to be supported and the number of major items of fuel consuming equipment and vehicles/aircrafts in each phase of the operation are essential in the initial determination of petroleum requirements. In addition, there are minimum timelines set by DLA Energy for the establishment of contracts.

4-13. The best available fuel consumption estimates should be obtained. Some resources used to generate consumption fuel estimates are historical data, which is the most accurate source, the operation logistics planner, and integrated consumable item support on secret internet protocol router employed by all COCOM JPOs.

4-14. The operation logistics planner is used in petroleum planning to estimate the amount and type of class III required for a contemplated operation. The estimate is based on equipment factors such as burn rate, usage profile, operational environment, duration and number of items.

4-15. Accurate accountability of fuel at all levels provides accurate data for consumption estimation and its resources.

4-16. The Army Materiel Command is the component responsible for developing class III fuel burn rates for Army equipment.

OPERATIONAL ENVIRONMENT

4-17. Petroleum supply operations at the tactical-level focus on continuous supply to meet the demand of the force and its equipment, enabling tactical commanders to fight battles and engagements. Planning for petroleum supply operations involve changing or creating resupply methods that adapt to a changing operational environment. In addition, the analysis of the operational environment must include determination of the infrastructure, physical environment and resources available in relation to petroleum supply support.

4-18. There are two standard methods of petroleum supply replenishment that are conducted in an operational environment:

- Unit distribution is a method of distributing petroleum by which the receiving unit is issued supplies in its own area, with transportation furnished by the issuing agency.
- Supply point distribution is a method of distributing petroleum to the receiving unit at a supply point. The receiving unit then transports the fuel to its own area using its transportation assets.

TAMPERING, PILFERAGE AND SECURITY

4-19. Fake invoices and tanker trucks with false bottoms are some ways that can be used to pilfer bulk petroleum. Saboteurs can contaminate products. Packaged products can be hidden in trash or salvage disposal drums. Units must devise a control program to prevent product loss. Some examples of procedures are listed below.

- Require that all trucks entering and leaving the class III supply point pass through a security gate. "NO SMOKING WITHIN 50 FEET" signs must be posted around the class III supply point so they are visible from every side of the site. Ensure signs are in place at all gates and are visible when gates are open and closed.
- Permit only one-way traffic.
- Personnel should know how to protect petroleum assets once the Army takes possession of it.
- Verify that no locks and seals have been tampered with before off-loading and after loading. Safety seals are not required for fuel conveyances. However, when they are implemented, ensure that their tracking numbers are accurate, and the seals have not been tampered with. If there is an indication of tampering, make note on the shipping document and contact security before offloading the product.
- Require that any discrepancies in the amount of petroleum product loaded or discharged be reported at once to the supervisor and investigate the discrepancy. Metering fuel received is a method to accurately identify discrepancies in the amount of petroleum product transferred.
- Implement perimeter controls.
- Ensure physical security by using guards, barriers, protective lighting, entry control checks, and intrusion detection devices, as applicable.
- Establish methods to compare the documented amount of fuel expected to the physical quantity of fuel received.

4-20. Petroleum bulk fuel transport vehicles not under the surveillance of the operator or a dedicated guard force will have: (1) locked hatch covers where possible (2) locked manifold access doors (3) each manifold valve secured with a transportation seal, if a manifold access door cannot be locked (4) approved padlocks as specified in non-sparking brass locks for safety, if available.

SECTION II – CLASS III – BULK PETROLEUM DISTRIBUTION

4-21. Petroleum support in a theater of operations is one of the biggest challenges faced by planners due to the huge tonnages involved. Planners must make maximum use of all possible sources of supply and distribution in order to establish the redundancies required to ensure continued support on the asymmetrical battlefield with lean organic logistics support. Increasingly, in contingency operations, contracted support for many aspects of petroleum operations is a method of choice.

4-22. Initial entry of bulk petroleum to an area of operations was traditionally planned to be U.S.-operated or chartered ocean-going tanker to either a developed petroleum offload facility or via JLOTS using OPDS. Alternately, host nation sources of supply, such as commercial refineries, can cut the lines of communication considerably and provide more responsive support. Ocean tankers can provide over 10 million gallons in one load and are the most efficient means of transporting bulk fuel across long distances.

4-23. Pipeline is the most efficient means to transport fuel throughout the area of operations. Commercial pipelines are plentiful in many places in the world and supply most airports, even in less developed areas. IPDS can supplement commercial pipelines or extend them deeper into the AO.

4-24. The least efficient, most costly, but also most flexible means of support is via tanker truck.

4-25. DOD fuel is purchased and owned at the wholesale level by DLA Energy for direct delivery to the customer. When the Service orders and receives fuel from a defense fuel support point or a DLA Energy contract, a "sale" may take place if the fuel is transferred to single-user unit. If the fuel is transferred to a multi-user unit and that unit or site holds DLA Energy-owned (capitalized) fuel, a "sale" takes place once the fuel is issued to consuming equipment, vehicle or aircraft.

4-26. Whether a Service is holding wholesale or retail bulk fuel stocks, certain rules of accounting apply to all Services.

ACCOUNTABILITY

4-27. Personnel storing or transferring class III products must accurately account for receipt, issue, and stocks on hand for both bulk and packaged products. The biggest challenge in accounting for class III products (particularly bulk products) is adequately measuring them. Refer to AR 710-2 and DA Pamphlet 710-2-1 for detailed bulk petroleum accounting procedures. In addition, DOD Manual 4140.25-M covers the requirements and procedures for the accountability of petroleum products.

4-28. Theft of fuel continues to exact operational and financial risks. Sound accounting practices combined with strict record keeping will aid in reducing operational and financial loss by deterring waste, fraud and theft. It is a leadership imperative to deter waste, fraud and theft of petroleum products and demonstrate effective oversight practices. Petroleum accountability is the responsibility of all Soldiers and personnel. However, supervisors, noncommissioned officers and officers are ultimately responsibility to ensure proper accountability of petroleum products is maintained.

4-29. Units are responsible for all petroleum issued to them for consumption as part of their basic or operational load. Units must ensure protection, maintain control, and provide an audit trail of petroleum products on hand. Aggressive management policies must be pursued to permit prompt and accurate identification of shortages or overages.

4-30. Army units are required to maintain audit trails on all fuel issued and received for the current fiscal year of issue, plus three prior years. Using unit commanders responsible for storing and issuing fuels must designate in writing a responsible individual to maintain control of all fuels and to provide an audit trail. For additional information on petroleum accountability and maintaining audit trails, refer to AR 710-2 and DA Pamphlet 710-2-1.

4-31. The use of meters assist in the accuracy of petroleum receipts and issues. When meters are employed, a program must be established to ensure all petroleum meters are checked for accuracy and when required, calibrated by qualified personnel. Checking the meter accuracy can be achieved by the use of a calibrated prover can, a prover loop with a calibrated meter or by a third party source qualified to perform calibrations. Dispensing meters will be calibrated by a qualified third party source, when they are used to issue fuel and payment is required, creating a buyer/seller relationship. This would include any meter used to receive bulk fuel from commercial sources or other military services.

PETROLEUM PRODUCTS INVENTORY

4-32. The Army is adopting DOD inventory management practices to seamlessly interconnect capitalized and non-capitalized fuel accounts.

- A non-capitalized account is an account where the fuel is owned by the Army.
- In capitalized accounts, DLA Energy owns the product stored and dispensed from Army facilities/equipment.
- The vast majority of Army fixed bulk fuel operations are capitalized; most tactical, unit level operations are not capitalized.

INVENTORY PROCEDURES

4-33. For inventory procedures pertaining to bulk petroleum and packaged products refer to AR 710-2 and DA Pamphlet 710-2-1.

MEASUREMENT

4-34. Gauging is used to determine the amount of product on hand and the amount of water in storage tanks. In addition, it is used to detect leaks or unauthorized withdrawals and to determine free space in the tank for receiving shipments. Bulk petroleum products are measured in two steps. The first step is to gauge the product. Gauging consists of measuring the bottom sediment and water and the temperature and height of the product. The height of product in a storage tank can be determined by measuring *innage* or *outage* (*ullage*). Innage is the depth of the product from its surface to the tank bottom or datum plate. Outage (ullage) is the height of space above the liquid from a reference point on the tank to the surface of the product. The second step is to calculate the net quantity of the product at 60°F. This step is needed because petroleum volume varies with temperature. The standard temperature on which to base accountability measurement is 60°F. AR 710-2 gives gauging and volume correction policies.

4-35. Special equipment is needed to measure bulk petroleum. This equipment is given below.

4-36. The two types of tape and bob are innage and outage. They are used to measure petroleum in fixed storage tanks. Both are graduated on one side to 1/8-inch divisions. The tip of the innage bob is the zero point of the tape and bob. The zero point on the outage bob is the point of contact between the snap and the eye of the bob.

4-37. The working tape and bob should be checked for accuracy with the following considerations:

- New tapes should be inspected prior to use throughout their entire length to determine that the numerals and increments between the numerals have been placed on the tape correctly.
- The tape and bob assembly should be inspected daily or prior to each use to ensure that wear in the tape snap catch, bob eye, or bob tip does not introduce error when the tape scale is being read. The tape should also be inspected for kinks at this time. Kinked or spliced tapes shall not be used.
- The working tape with bob attached should be checked for accuracy when new and at least annually thereafter, by comparison with a master tape that has been certified by or is traceable to the National Institute of Standards and Technology.

4-38. A petroleum gauge stick is used to determine the innage of a tank or a non-pressurized tank car. The stick is usually graduated in 1/8-inch divisions from the bottom upward. The gauge stick should be long enough to gauge the entire height of a tank. When using the stick, make sure to lower it vertically into the tank. Make sure it does not rest on any other object within the tank besides the bottom of the tank or the datum plate. When lowering the stick, do not splash the product as it can cause an inaccurate cut.

4-39. The tank vehicle gauge stick is used to measure the volume of petroleum products in tank vehicles. Each tank vehicle has its own gauge stick, which is graduated in 100-gallon increments for 5,000 gallon tankers and 50-gallon increments for the HEMTT tanker and modular fuel system. Estimate as closely as possible the indicated volume when the cut mark falls between divisions.

4-40. A yardstick, along with a locally produced strapping chart, can be used as a field expedient method to determine the approximate number of gallons in a 55-gallon drum. To do this, place the drum in a vertical position. Lower the yardstick into the drum to get a wet-inch-depth reading. Then use the corresponding height on the strapping chart to get the approximate number of gallons at 60°F. To make the strapping chart, measure the height of the drum and extrapolate the feet and inches by 55 gallons.

4-41. The tank car gauge stick is used to determine dome innage and shell outage in non-pressurized rail tank cars that have shell outages of one foot or less. If the tank car has more than one foot of shell outage, use a petroleum gauge stick or an innage tape and bob. The stick is 36 inches long and has two scales, with a common zero mark 12 inches from the lower end, graduated upward and downward in 1/8-inch divisions. A brass angle is used to position the gauge stick. The angle is attached at the zero mark on the gauge stick. Use the gauge stick as given below.

- Insert the gauge stick, with the short end down, through the dome hatch into the tank car so that the angle rests on the tank shell at the gauging point. The gauging point should be the highest point of the tank car shell on a line with the lengthwise center of the car. Find where the shell plates overlap along the centerline of the tank. Select a gauging point on the interior of the tank. If the product level is in the dome and the gauging stick is not visible, it may be necessary to probe with the end of the stick to find it. Make sure the angle does not rest on a rivet head and that the stick is vertical.
- Take the stick out. Read the product cut on the scale to the nearest 1/8 inch. If the cut is below the zero mark, record it as the dome innage. Get at least two readings that are the same to make sure that the gauge is accurate.

4-42. The portable petroleum sampling and gauging kit is used at bulk storage facilities. It is used to gauge tanks and storage containers, determine API gravity, and product temperature. In addition, it is used to detect bottom sediment and water, to make volume calculations, and to sample fuels. The gravity and temperature results are obtained using the hydrometer, cup case thermometer, Tables 5B & 6B of ASTM International D1250. The test provides the user with an indication of product type to identify the fuel type and a volume correction factor.

4-43. Gauging operations requires using special terms. Definitions of the following terms are found in the glossary.

- Reference Point.
- Reference Height.
- Datum Plate.
- Cut.
- Opening Gauge.
- Closing Gauge.
- Total Measured Quantity.
- Bottom Sediment and Water.
- Net Quantity of Product.
- Delivered Quantity at 60°F.
- API Gravity.

4-44. All petroleum storage containers must be gauged in accordance with AR 710-2. General safety gauging considerations are given below.

- Never conduct gauging operations in an electrical storm.
- Ensure personnel performing the gauging check to see that the tank vehicles and tanks being gauged are properly bonded and grounded. Before starting gauging operations, they should bond themselves by touching their bare hands to the tank shell being gauged.
- Ensure supervisors do a safety risk assessment on whether personnel should wear field gear during gauging operations.
- Open all hatches from the upwind side to allow the wind to blow vapors away. Avoid breathing vapors and fumes. Never allow personnel to conduct gauging operations or any other petroleum operation alone. Train Soldiers to recognize the symptoms of excess vapor inhalation and the steps to take if someone is overcome with petroleum vapors.
- Stand on the gauging platform, if the tank has one. Avoid standing on the roof.
- When using the tape & bob apparatus, keep the metallic tape against the rim of the gauging hatch at all times to avoid buildup of static electricity. Wipe the tape clean and dry after each use.
- Gauge all incoming bulk deliveries for water before the products are received. Prior to gauging for water, conduct test of water indicating paste by testing with water prior to gauging. Drain off any water found in tank cars or tank vehicles before discharging the product.
- Gauge all incoming bulk deliveries to check the quantity of fuel received. Use fuel indicating paste when conducting gauging procedures. Prior to gauging for fuel, conduct test of fuel indicating paste by testing with fuel prior to gauging.

- Allow as much time as possible for water, solids, and bubbles to settle before gauging after adding fresh stock to a fixed storage tank. If time permits, allow a two-hour settling time for all aviation, automotive, and diesel fuels. In ship-to-shore discharge, tanks may be gauged after product has settled for 30 minutes. Then, the final discharge report can be completed before the vessel sails. Let heavy products, such as burner fuels, settle for at least 24 hours.
- Take readings to the nearest 1/8 inch on measuring devices calibrated in inches. Repeat gauging until two readings match. If the tape measure is metric, the readings must be within three millimeters.
- Take the product temperature immediately before or after gauging so that the volume can be corrected to 60°F. Quantities of product are volume corrected according to AR 710-2.

4-45. Measure for bottom sediment and water each time storage tanks containing liquid petroleum products are gauged. This is necessary to find the actual product amount present in the tank. Bottom sediment and water often accumulate in different parts of a tank bottom. They usually accumulate on the side opposite a filling line or on either side of an outlet. When the tank has several hatches, take gauges from each hatch. Average the gauges to get one bottom sediment and water gauge for the entire tank.

4-46. Gauge tankers and rail tank cars with specific measuring devices as described in the paragraphs above. To measure bottom sediment and water, a thin, even coat of water-indicating paste must be applied to the gauging apparatus. This will identify the interface of water and product. The gauging apparatus' are found in the portable petroleum sampling and gauging kit. After inserting gauging apparatus, leave in position for 30 seconds. Remove the gauge stick from the tank, and look at the water cut on the scale. The water should either remove or discolor the paste on the portion of the scale that was in the water. Record the water cut as either water innage or outage.

4-47. Innage and outage gauging tapes and bobs are usually used for large, fixed storage tanks. Considerations for use are as follows:

4-48. Review the last innage gauge sheet posted to determine expected product level before gauging a tank. To get an innage gauge using the innage tape and bob, product-indicating paste on the tape should be placed above and below the expected cut of the product. Lower the tape and bob into the tank until the bob is a short distance from the bottom. To determine this, compare the length of the unwound tape with the reference height of the tank.

4-49. Unwind the tape slowly until the tip of the bob touches the tank bottom or datum plate. Make sure the bob does not rest on a rivet or other obstruction. Make sure the tape is not lowered so far into the tank that the bob tilts and causes an incorrect gauge. To ensure accurate gauge, compare the tape reading at the reference point with the reference height of the tank.

4-50. Withdraw the tape, and observe the product cut. Record the cut as the innage gauge. If the cut is hard to read, put product-indicating paste on the tape. (Grease or light lubricating oil may be used instead of the paste.) Gauge the tank again. It is usually easier to see the product cut on the back of the tape. Take readings to the nearest 1/8 inch on measuring devices calibrated in inches. Repeat gauging until two readings match. If the tape measure is metric, the readings must be within 3 millimeters. When taking opening and closing gauges, use the same gauging equipment and hatches for both gauges. Make sure the tape is lowered to the same depth for both gauges.

4-51. To get an outage gauge or ullage using the innage tape, and bob, place the unmarked side of the tape against the metal rim of the gauging hatch at the reference point. Lower the tape and bob into the tank until the bob touches the surface of the product. Wait until the bob stops moving. Lower the tape slowly until the bottom of the bob is 2 to 3 inches below the surface of the product. Record the reading on the tape at the reference point as the tape reading. Withdraw the tape, and record the product cut on the bob as the bob reading. If is the cut is hard to read, put product-indicating paste on the bob and gauge the tank again. To get the outage gauge, subtract the bob reading from the tape reading. For example, if the tape reading is 6 feet 4 inches and the bob reading is 2¼ inches, the outage gauges is 6 feet 1¾ inches. To convert the outage gauge to innage gauge, subtract the outage gauge from the reference height of the tank.

4-52. For an outage or ullage using the outage tape and bob follow the steps above in the previous paragraph. The only variation is to add the bob reading to the tape reading to get the outage gauge. In addition, subtract the outage gauge from the reference height of the tank to convert outage gauge to innage gauge.

4-53. Obtaining product temperature is necessary to correct the measured quantity to quantity at the standard temperature of 60°F. Volume-correct quantities in accordance with AR 710-2. When gauging large amounts of product, take several temperature readings at various depths. An average of these readings gives the true product temperature. As a rule, the cup-case thermometer is used to measure temperature.

4-54. To measure temperature examine the mercury column of each cup-case thermometer for separations. Replace the thermometer if the column is faulty. Mercury separations cause incorrect readings. Inspect the thermometers for accuracy. Expose them, as a group, to the same atmospheric temperature. Compare the readings. Replace any thermometer with a reading that differs from the group by 1°F or more. Ensure that all tank thermometers are calibrated annually at a minimum. Determine the minimum number of readings and the measurement levels required for the operation. If extreme differences in temperature are suspected, take more readings. Do this to find the true average temperature of the product. Attach the thermometer to the end of a gauge tape, brass-coated chain, or cord. If a cord is used, tie knots in the cord so they will show when the thermometer reaches the required level. Lower the thermometer to the required level. Leave it there at least for two minutes. Take the thermometer out of the tank, and read it at once. Shelter the cup below the hatch to reduce temperature changes caused by wind or atmosphere. Withdraw a full cup of product from the tank when taking the reading. Try not to spill it. Record the temperature to the nearest degree Fahrenheit. Add all the readings together when measurements are taken at more than one level. Divide this sum by the number of readings taken to get the true average temperature of the product.

Collapsible Fabric Fuel Tank Gauging

4-55. Collapsible fabric fuel tank gauging is a method of measuring volume in collapsible fabric fuel tanks. When performing gauging procedures on collapsible fabric fuel tanks, it should be performed at the same time daily using the same reference point. Slight alternations in procedures can lead to slight changes in physical inventories. For procedures on collapsible fabric tank gauging, refer to the technical bulletin for collapsible fabric fuel tanks.

4-56. Most manufacturers provide a strapping chart in the TM for their collapsible fabric fuel tanks. These strapping charts were developed under ideal conditions and may not provide accurate measurements in the field where surface conditions of the berms will vary. For this reason, sites will develop individual strapping charts for each bag. For more information on strapping of collapsible fabric fuel tanks, refer to the technical bulletin for collapsible fabric fuel tanks.

Volume Calculations

4-57. Do volume calculations in accordance with AR 710-2. Capacity tables showing quantities of either innage or outage gauges should be based on accurate tank calibration data. The calibration charts should be checked periodically. Also, they should be checked when repairs and modifications are made to the tank. The following paragraphs discuss volume calculations for liquid petroleum products.

Total Measured Quantity

4-58. From the tank capacity table, find the total measured quantity corresponding to the product gauge.

Bottom Sediment and Water

4-59. Find the amount of bottom sediment and water corresponding to the water gauge from the tank capacity table or from the water cut on gauge stick. Subtract this from the total measured quantity to get the net quantity of product, uncorrected.

API Gravity

4-60. Measure the API gravity with the correct hydrometer based on the expected API of the product sampled. Each hydrometer represents a segment of a scale ranging 9 to 81. The hydrometer gives both the

API gravity reading and the observed temperature reading of the sample. The observed gravity reading must be converted to API gravity at 60°F using the tables prescribed in DA Pam 710-2-1.

Volume Correction Factor

4-61. Do volume calculations in accordance with AR 710-2. Capacity tables/strapping charts showing quantities of either innage or outage gauges should be based on accurate tank data. The strapping charts should be checked when repairs and modifications are made to the tank. The following paragraphs discuss volume calculations for liquid petroleum products.

Net Quantity of Product

4-62. To determine the net quantity of product, multiply the net quantity of product (uncorrected) by the proper volume correction factor.

RECEIPT

4-63. The theater petroleum supply system begins with the receipt of bulk and packaged petroleum products. Packaged products enter the theater at dry-cargo ports or from aircraft at air terminals. Bulk petroleum enters the theater by vessel or air-landed operations. JLOTS operations use pipelines and hose lines to offload tankers at undeveloped ports into TPTs. Petroleum supply or medium transportation units distribute the petroleum products throughout the theater. This section describes the procedures, precautions and documents required to receive fuel into a bulk storage facility, FSSP, or a bulk fuel storage container.

4-64. Prior to receiving fuel from any entity, the type and quantity of fuel received must be verified, and the quality of the fuel must be checked as well. See section III of this chapter for details on performing quality surveillance tests on petroleum products before receipt.

4-65. If receiving fuel from a mobile transporter, position the transporter to ensure hose connections are safely made and secure. When unloading multiple transporters simultaneously, proper space between vehicles must be achieved. If the transporter is a tank car, follow the guidelines in section XI of this chapter.

4-66. After the transporter is positioned for receipt of fuel, compare the transporter and seal numbers with those on the shipping papers, if applicable, to verify the shipment. Inspect the seals and locks carefully for signs of tampering or pilfering. Notify the proper authority, if tampering or pilfering is suspected. If the transporter has no seals, you must carefully inspect the product to verify its quality and quantity. A calibrated meter is highly recommended on the dispensing line between the dispensing and receiving containers to provide additional verification of total product receipt.

4-67. Prior to opening the manhole (tank vehicle) or dome cover (tank car), clean all dirt and debris from around the opening. Take the cover off slowly to let the remaining pressure escape. In addition, be aware of the fumes that escape to prevent inhalation.

4-68. There are several considerations that should be followed when product is received into storage tanks. These considerations are described below.

- With all tanks, fixed and collapsible, after product has had time to settle, drain any water from the tanks. Perform quality surveillance operations on the fuel.
- For fixed tankage, inspect the empty tanks before they receive the assigned product. If the tank is dirty, free it of vapor and have it cleaned, in accordance with the procedures in appendix E. With all tanks, fixed and collapsible, drain any water collected in the bottom. If the fixed tank has a water bottom because of leaks, keep the water level below the tank inlet.
- As a general rule, receive into only one tank at a time. Watch the tank filling operation closely. For fixed tanks, take a rough gauge on all tanks every 30 minutes to avoid overflows and report cumulative receipts. DO NOT take ullages, water soundings, temperatures, and samples on any tank receiving fuel until at least 20 minutes after pumping has stopped and flow has ceased. On collapsible tanks, watch the string line over the tank to determine when the tank is close to being filled.

- When the tank is nearly filled, open up another tank's valve to divert fuel flow and close off the full tank. As a general rule, leave five percent of the fixed tank capacity for vapor space. On collapsible fuel fabric tanks, the top of the tank should just touch the string line suspended over the tank.
- When pumping fuel into an empty fixed tank, limit the flow rate until the inlet is covered by at least three feet of product. Afterwards, resume the normal flow rate.
- When pumping gasoline or jet fuel into a vapor-free tank, limit the flow rate to one-fourth or one-fifth of the maximum flow rate until the inlet is covered by three feet of product.
- As a general rule, receive into only one tank at a time.

STORAGE

4-69. Storage operations involves the act of assuming custody of petroleum products and the placing of petroleum products in a suitable storage container, tank or other designated facility. Storage is a continuation of receiving and is preliminary to the distribution or issuing operations. Storage operations include receiving, inspecting, stocking, safeguarding, inventorying, and maintaining the inventory of class III bulk petroleum consigned to the petroleum accountable officer.

4-70. Storage requirements are based on the anticipated usage by a supported unit and the stockage objective as established by the commander. Stock levels to be stored will depend on consumption rates, resupply methods, transportation assets, safety levels and distribution systems. Storage methods, land requirements, and security are the key factors in storage planning. It is important that the bulk fuel storage equipment be scheduled for delivery to the operating area in order to allow for installation of the storage systems in time to support the transportation schedule.

4-71. At the tactical class III supply point, storage of bulk petroleum products in collapsible fabric fuel tanks is the preferred method. The collapsible fabric fuel tank provides maximum flexibility in storage of bulk fuel. Storage is much more than putting product in a tank. It involves inspection, product circulation, tank repair, and even the disposal of excess product. The storage of bulk petroleum can be as dangerous as its receipt and issue, so always follow applicable procedures.

4-72. There a number of practices you should always follow when storing bulk petroleum. All environmental, safety and health considerations must be implemented to properly store bulk fuel. A separate handling system for each type of petroleum product must be used. A filter separator should be installed in the supply line between receipt point and the storage tanks, and storage tanks and the dispensing points. Properly store and lay hoses and fittings in a way that to prevent them from damage. Use dust caps and plugs on all hoses and nozzles when they are not in use.

4-73. Drain any water in your collapsible tanks through the drain fitting assembly.

4-74. Clean line strainers and nozzle screens each day. When you remove the screen in a pressure nozzle, first disconnect the adapter. If you find any damaged strainers or screens, repair or replace them at once. If you find any particles of rubber or lint in a screen, it may show that the hose is deteriorating. Sediment, scale, or rust in the nozzle screen may show the failure of a filter element.

4-75. Once the collapsible fuel tank has been filled to capacity through a meter, allow the tank to set for 24 hours. Run a string across the top of the collapsible fuel tank. This is the established maximum fill height for the tank. The string presents a visual indication when the tank is full and assists the operator to not overfill the tank.

4-76. Inspect your facilities and operations regularly. Keep records of inspections, tests, checks, tank cleaning, and maintenance. Follow up on deficiencies to ensure they are corrected.

MAINTENANCE OF PRODUCT

4-77. Circulation of bulk fuel products is key to maintaining and preserving bulk fuel. Circulate the stock in your supply point so that the heavier portions of the product do not settle to the bottom of the tank and the light ends do not come to the top. Also, circulation ensures a good mixture of all the additives in the fuel.

4-78. Consolidation of bulk fuel products includes combining identical stock so several storage tanks are filled with product and several are empty. Consolidation aims to reduce the hazards of vapors in storage tanks and well as frees space in other storage tanks in preparation to receive and issue large quantities of bulk petroleum on short notice. Consolidation reduces the number of tank switches made during receipt and issue of product.

4-79. Follow the first-in, first-out rule so that products do not deteriorate due to prolonged storage. Issue packaged products in damaged containers first, regardless of age.

4-80. Perform quality surveillance/assurance procedures as required.

DISPOSAL OF EXCESS OR CONTAMINATED PRODUCTS

4-81. Excess bulk petroleum products include quantity of bulk petroleum over and above maximum storage capacity, quantity of an item authorized to be on hand at any time or quantity intended for use.

4-82. Contaminated petroleum products include distillates and residuals of the petroleum refining process that have been contaminated before or during a usage period and can no longer satisfy the specifications of the original intended use.

4-83. Report excess bulk petroleum in excess of 500-gallons or more and/or packaged products to the next higher level of petroleum or sustainment activity for arrangement and execution of recovery of the product. At a minimum, the report should include type of product, NSN or product code, quantity, location, most recent laboratory test results, and reason for the excess.

4-84. AR 710-2 provides policy and guidance for the recovery, recycling, and disposal of contaminated petroleum based products, cleaning solutions, and solvents. Petroleum-based products include motor gasoline, aviation gasoline, jet fuels, diesel fuels, petroleum heating fuel, kerosene, engine lubricating oils, other lubricating oils, and all types of greases.

DISTRIBUTION

4-85. Distribution is often the most difficult task of the bulk fuel missions. Equipment, time-phased requirements, and distance are the main factors affecting distribution. Distribution problems will normally become more complex the longer the operation, the greater the consumption rates, and the farther inland the supply chain goes. Resupply concepts of unit distribution versus supply point distribution will also affect the type and amount of resources needed to support bulk fuel distribution.

DISTRIBUTION CONSIDERATIONS

4-86. Issuing bulk petroleum is perhaps the most important responsibility you have at the class III supply point. The purpose of petroleum supply operations in theater is to distribute large quantities of petroleum to the supported units and the end users. In a theater of operations, bulk petroleum is distributed as far forward as the tactical situation permits.

4-87. JP8 has been identified as the single fuel for the battlefield under the one fuel forward concept. However, there are several various types of other bulk fuels required based on mission needs. Fuel must be handled and distributed using a single product system. Failure to do so increasing the risk of product commingling when issuing to the user.

4-88. Ensure all environmental, safety and health considerations have been implemented before, during and after operations.

4-89. Ensure proper issuing documentation is completed in accordance with AR 710-2 and DA Pamphlet 710-2-1.

PRELIMINARY PROCEDURES

4-90. There are a number of preliminary considerations you should take before issuing bulk petroleum from your class III supply point.

Prepare Issue Schedule

4-91. Prepare an issue schedule before any transporter arrives at the supply point. Start by telling your customer how much and what type of product you have on hand. Inform them when the product can received at the supply point. If your transporters are delivering the product, tell the customer when it will arrive at their supply point. Try to avoid delays and interruptions when you are scheduling issues. In other words, do not have more transporters at your supply point than the supply point can handle at one time. In addition, ensure to have enough product on hand to fill all requests.

Inspect Equipment

4-92. Ensure the discharging equipment at the supply point is in good working condition. Inspect pumps, filter separators, collapsible tanks, hose manifolds, valves, and fittings daily to ensure they are free of leaks and contaminations.

4-93. Fuel dispensing equipment must be recirculated (flushed) through the equipment/system hoses and refueling nozzles and back to the tank each day prior to the initial issue of the day. After recirculation, the fuel should be sampled at the nozzle and visually tested for:

- Color.
- Appearance.
- Free water.
- Sediment/particulates.

Spot the Transporter

4-94. When the transporter arrives at the supply point, check the customer's issue request to ensure it is properly authorized. Then, position the transporter at an issue point.

4-95. Position the receiving and dispensing platforms on as level, equally elevated terrain as possible.

Inspect the Transporter

4-96. Open the manhole or dome cover to inspect the transporter. As part of your inspection, consider the following:

- The inside and outside of the tank must be serviceable. Check for holes, cracks, or loose plates and ensure there are no leaks in the tank. See that the tank is properly mounted to the frame and safe for the road.
- The tank should must be clean. If there is a residue on the bottom of the tank such as rust, sand, or dirt, reject the transporter and have it cleaned according to directions in appendix E. Let only authorized personnel, familiar with tank-cleaning procedures and safeguards, enter the tank.
- The interior of the tank should be free of foreign objects such as tools, bolts, or old seals. Have authorized personnel remove objects from the tank. Some objects do not contaminate the product, but they may damage valves. Also, look for residual product in the tank. Remove the residuals before you fill the tank.
- The fuel delivery system of the transporter must be free of damage. On tank cars, check the dome, dome cover, bottom outlet chamber, and safety valve to ensure they are in good condition. See that the vent holes in the dome cover are open and free of dirt.
- The tank car outlet valve must seat and seal properly. If the valve does not seat properly, reject the car and report the malfunction to the proper authority, who should schedule the repair. However, the tank car may be loaded in an emergency without repairing the valve, but report the broken valve to the unit receiving the tank car so that they can unload it through the dome. In any case, the tank car should be scheduled for repair as soon as possible. Ensure the outlet valve is closed after it is checked.
- The product last carried in the tank must be the same as the product being loaded. If it is not, follow the procedures in MIL-STD-3004. If it is necessary, flush the tank of the transporter with a small amount of product to remove any traces of the last product as well as rust and scale. Collect

this product and put it in a waste container. Appendix L has a conversion chart for procedures that should be followed when changing products in tank cars and tank trucks.

Note: Prior to conducting the dispensing of fuel into the bulk transporter, see appendix N, to note the maximum fuel quantity the tank can accept based on the road conditions of the route.

METHODS OF DISTRIBUTION

4-97. There are several ways to distribute bulk petroleum products in a theater of operation. The methods of distribution used by the Army are:

- Petroleum pipeline and terminal operations.
- Fuel system supply point operations.
- Refuel on the move.
- Aircraft refueling.
- Assault hoseline system operations.
- Tank vehicle refueling.
- Tank car refueling
- Waterfront operations.

BULK FUEL TRANSPORT

4-98. Distribution of bulk fuel requires a mode of transport to reach the destination of the intended user. The various methods of bulk fuel transport include aircraft, vessel, pipeline, hoseline, rail, and tank vehicle. The following describe general considerations in performing bulk transport throughout a theater of operations.

4-99. Planning and coordination for bulk fuel transport support requirements is vital to the movement of bulk fuel to its intended destination. For example, a prime mover must be used for semi-trailer movement as well as aviation assets must be used for operations such as the ERFS II or the Wet Hawk.

SECTION III – QUALITY SURVEILLANCE

4-100. This section discusses general instructions and minimum procedures to be used in performing quality assurance/surveillance functions of petroleum products.

4-101. Quality assurance (QA) is a planned and systematic pattern of all actions necessary to provide confidence that adequate technical requirements are established; that products and services conform to established technical requirements; and satisfactory performance is achieved.

4-102. Quality surveillance (QS) is the aggregate of measures (blending, stock rotation, sampling, etc.) used to determine and maintain the quality of product receipts and government-owned bulk petroleum products to the degree necessary to ensure that such products are suitable for their intended use.

QUALITY SURVEILLANCE CONSIDERATIONS

4-103. Fuel must be laboratory tested before and after government acceptance to make sure that it meets specifications. It must be clean and dry. A fuel is clean when it is free of suspended matter, sediment, and emulsions. A fuel is dry when it contains no undissolved water. A clean, dry fuel has a bright appearance, without cloud, haze, or visible solids.

REQUIREMENTS

4-104. Commanders will accomplish quality surveillance programs in accordance with MIL-STD-3004. Commanders will ensure an effective petroleum operational surveillance program is maintained to ensure safe delivery of acceptable fuel into vehicles and aircraft.

4-105. The Quality Surveillance Program will be established worldwide for both bulk and packaged products. This program applies to all bulk petroleum supplied by commercial sources under DLA Energy regional type contracts, procured locally, or received from Army, other military services, or DLA Energy depot stocks.

Quality Surveillance Program

4-106. This program is conducted to:

- Ensure acceptable quality of product supplied from commercial sources directly to United States Army, ARNG, and USAR units.
- Maintain the quality of Army-owned petroleum products and containers.

4-107. Quality Surveillance unless otherwise specified in the regulation, will be conducted on all bulk petroleum products and containers at the frequencies established in MIL-STD-3004, or more frequently if desired for closer surveillance or when directed by USAPC.

4-108. Commanders in theater will establish a sampling schedule at the frequencies established in MIL-STD-3004 or more frequently, if desired. The commander of the activity required to submit samples under this program will ensure that a petroleum supply specialist is assigned to take product samples and maintain a sample log for all samples submitted. The log will indicate assigned sample numbers, sample history, and test results. Bulk petroleum delivered through commercial vendors or drawn from other military services must be sampled and tested when the quantity exceeds 10,000 gallons annually. This applies to products received under DLA Energy regional type contracts, inter-service support agreements, DLA Energy depot stock or from a defense fuel support point.

RESPONSIBILITY

4-109. The quality surveillance mission is to maintain the quality of petroleum products from point of origin to point of use. The quality surveillance program encompasses, but is not limited to, bulk fuel in waterborne carriers, tank cars, tank vehicles, pipeline systems, bulk storage, and packaged products. This includes inspecting, sampling, testing, handling, and performing preventive maintenance. The mission is also to recommend and assist in recovering, upgrading, downgrading, or disposing of products.

4-110. Any unit or organization that has military owned fuel in its physical possession is responsible for setting up and maintaining an adequate quality surveillance program. Each unit involved in petroleum refueling is responsible for ensuring that the fuel pumped into its point of use is clean, bright, and on specification and that it does not contain any free water or sediment.

4-111. An effective quality surveillance program requires properly trained personnel. Personnel concerned with handling fuels and lubricants should be suitably trained and able to perform their duties.

4-112. Responsibilities of quality surveillance and assurance at varies at different levels of commands and petroleum organizations are described chapter 2.

4-113. Petroleum laboratory personnel are responsible for the operation and maintenance of laboratories to test all petroleum products in the command in a reasonable time. Information on testing procedures is contained in the appropriate ASTM International Standard. For more information on petroleum laboratory support and operations refer to TM 4-43.31.

SAMPLES TYPES AND SAMPLING PROCEDURES

4-114. A sample is a portion extracted from a total volume which may or may not contain constituents in the same proportions that are present in that total volume.

4-115. Bulk products samples can be taken from storage tanks, delivery trucks, intermodal containers, pipelines, barges or tankers. Samples may be taken either manually (upper, middle, lower, bottom, composite all-level) or automatically (line, flow- proportionate).

TYPES OF SAMPLES

4-116. Samples are important because they are used to determine the type and quality of petroleum products. A sample is a small amount of petroleum which is representative of the whole product. The sample types are given below.

All level Sample

4-117. A sample obtained by submerging a stoppered beaker or bottle to a point as near as possible to the draw off level, then opening the sampler and raising it at such a rate that it is approximately three fourths full as it emerges from the liquid.

Upper Sample

4-118. One taken from the middle point of the upper third of the tank contents.

Middle Sample

4-119. A spot sample taken from the middle tank's contents (a distance of one-half of depth of liquid below the liquid's surface).

Lower Sample

4-120. One taken at the middle point of the lower third of the tank contents.

Top Sample

4-121. One taken within six inches below the top surface of the tank contents.

Composite Sample

4-122. A blend of spot samples mixed in proportion to the volumes of material from which the spot samples were obtained.

Drain Sample

4-123. One taken from the draw-off or discharge valve.

Bottom Sample

4-124. One taken on the bottom surface of the tank, container, or pipeline at its lowest point. The drain and bottom samples are usually obtained to check for water, sludge, scale, or other contaminants.

Conveyance Volumetric Composite Sample

4-125. A blend of individual all-level samples from each compartment of the ship, barge, or carrier that contains the same grade of product in proportion to the volume of product in each compartment.

Spot Sample

4-126. A sample taken at a specific location in a tank or from a flowing stream in a pipe at a specific time.

Tube or Thief Sample

4-127. One taken with a sampling tube or special thief, either as a core or spot sample from a specified point in the container.

TYPES OF SAMPLERS

4-128. There are several different types of samplers used to take liquid petroleum samples. These are given below.

- The weighted beaker sampler is a copper bottle permanently attached to a lead base. A drop cord or brass-coated chain is connected to the stopper so that the sampler can be opened anywhere beneath the surface of the product. This sampler is used to take upper, middle, lower, or all-levels samples of petroleum products at no more than 16 pounds per square inch Reid vapor pressure. It is used to take samples from tank cars, tank vehicles, barges, ship tanks, and shore storage tanks.
- The Bacon bomb thief obtains samples from storage tanks, tank cars and drums using thief method. Plunger opens to admit the sample when bomb is lowered to the bottom or when plunger is released at any desired level. Plunger seals tight when bomb is withdrawn.
- The weighted bottle (glass cylinder) sampler consists of a glass bottle within a square, weighted metal holder. A drop cord is attached through a ring in the stopper so that a short, quick pull on the cord opens the bottle at any desired point under the surface of the liquid. This sampler has the same applications as the weighted beaker sampler, but because of its wider mouth, can be used for sampling heavier products.

SAMPLE SIZE

4-129. Sample size varies with product type and the type of test required. As a rule, liquid samples should be one gallon and semisolid samples should be five pounds. Special samples sizes will be dictated by the laboratory. Two one-gallon samples should be submitted when jet fuels are tested for full specification.

SAMPLE CONSIDERATIONS

4-130. Specific information on standard sampling procedures are located in *API Manual of Petroleum Measurement Standards*, Chapter 8, Section 1, ASTM International D4057, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products* and/or ASTM International D4177, *Automatic Sampling of Petroleum and Petroleum Products*.

4-131. Many considerations must be taken to ensure that samples are representative. The types of precautions depend on the type of products being sampled; the tank, carrier, or container; and the sampling procedure used. Each sampling procedure is suitable for a specific product under definite storage, transportation, and container conditions. Since a sample is used for determining physical and chemical characteristics of a product, the basic principle of each procedure is to take a sample in such a manner and from such a location in the tank or container that the sample will be truly representative of the product.

4-132. All sampling equipment and containers must be clean, dry, and free of lint and fibrous material. Samplers and containers must be rinsed with a portion of the product being sampled. This is to make sure the product is not contaminated with a previous material. Rinse all cans to remove any soldering flux. Samplers must be clean immediately after use and stored in a place where to keep them

4-133. Tank samples must not be drawn from storage tank cleanout lines, water draw offs, bleeder valves, or hoses. These samples are not representative of the product in the tank. If a service station tank does not have a manhole or sampling hatch, take the sample from the service hose after discharging a volume of product approximately two times the capacity of the hose.

4-134. A sample container must not exceed 90 percent of its capacity. If the container is filled to capacity, it may leak due to thermal expansion of the product. Do not use sealing wax, paraffin, rubber gaskets, pressure-sensitive tape, or similar material to seal containers. Crate light sample containers well so that they will withstand shipment. Samples must be placed in clean, dry cans or brown bottles to protect them from direct sunlight.

4-135. Carefully handle all samples of gasoline and jet fuel that require vapor pressure tests. Cool these samples, if possible, to prevent the loss of light ends and volatile materials.

4-136. Fuel samples may be collected in in glass bottles if they are to be submitted for water and sediment tests to a local laboratory. Submit one gallon DOT-approved metal sample containers for gasoline or aviation fuels which will be shipped by a military or commercial activity.

SAMPLE IDENTIFICATION

4-137. Each petroleum sample shipped to a petroleum laboratory for analysis must have a completed sample tag securely attached. The tag is DD Form 2927 (Petroleum and Lubricants Sample Identification Tag) or other equivalent approved tag shown in figure S-1 on page S-2. DD Form 2927 replaces DA Form 1804 (Petroleum Sample Tag). Information on the tag shall include the location of the facility at which the sample is taken, name of personnel taking the sample, grade of material, quantity represented, specification of material when known, storage tank number and location, date sample was taken, type of sample and reason for sample. For turbine fuel electrical conductivity [in picosiemens per meter (pS/m) units] results, specify tank ambient temperature and request correction of conductivity value to that temperature.

4-138. A sample log should be maintained to track quality surveillance for storage tanks, facilities, refueling systems and vehicles, and bulk deliveries. The sample log should contain the date sampled, name of person taking the sample, sample source, type of sample, date sample results are received, results, and a remarks block.

4-139. Each sample shall be assigned a serial number that shall be determined by taking the calendar year as the prefix number and assigning consecutive numbers as the samples are submitted. For example, the first sample submitted in 2003 would be 03-1, the second 03-2, and so forth. Such sample numbers shall be shown on the sample identification tag and all shipping documents and correspondence pertaining to the sample.

4-140. No person should be permitted to draw a fuel sample unless they are thoroughly familiar with and can satisfactorily perform all required sampling as outlined in this section. The importance of good sampling techniques cannot be overemphasized. If a sample submitted for testing does not truly represent the sampled product, the value of the test is lost.

TESTING PETROLEUM PRODUCTS

4-141. Quality surveillance testing represents the balance between good QS practices, cost of quality, and associated risks, and the need to confirm adherence to specification requirements through full specification testing. Only by thorough testing procedures can quality surveillance be maintained.

4-142. MIL-STD-3004, Table IX outlines the minimum sampling and testing requirements considered necessary for determining the quality of petroleum and related products. It covers the conditions under which a sample is taken, the type of sample, and the types of tests required to determine whether the quality is within acceptable limits.

4-143. MIL-STD-3004, Table VIII outlines the minimum frequency for testing petroleum and related products by broad category. Since it is the responsibility of the cognizant quality assurance representative, petroleum officer, or supply officer to maintain strict quality surveillance, the frequency of testing may be increased as required. Considerations for increased testing are conditions of storage, age of stock, and type of product. When a long term storage product is tested, a record of the results shall be maintained to provide a basis for determining product deterioration. Whenever consecutive results indicate possible deterioration, testing frequency must be increased. Once the trend reflects measurable deterioration, the reporting procedures in MIL-STD-3004 shall be followed. This is especially important for a property such as color that presents no operational problem, but may indicate possible deterioration.

4-144. MIL-STD-3004, Tables X through XXV provides a detailed breakdown of the type of tests required for each product class. These tests are those most likely to reveal contamination/deterioration which may have occurred during product handling or storage. Tables X through XXV designates Service and NATO prescribed B-2 tests for specific products. When a product being tested fails to meet the specification limits due to contamination, the procedures outlined in MIL-STD-3004, Identification of a Non-conforming Product or MIL-STD-3004, Disposition Instructions are to be initiated.

4-145. All terminals (commercial and military) receiving and storing bulk products must be equipped and capable of performing tests required by MIL-STD-3004, Table IX. When the capability does not exist at the terminal or facility, other laboratories, either commercial or military, may be used.

FIELD TESTS FOR CONTAMINATION

4-146. There are several ways to check for product contamination in the field. Product temperature and gravity, visual checks, particulate contamination by color and the aqua-glo test all provide clues to product contamination.

4-147. These tests are given below:

- When a shipment arrives at a class III facility, take the temperature and API gravity of the product. Determine the API gravity of the product. Gravity indicates uniformity of fuel more reliably than its quality. If the API gravity is out of range of that of the expected product, or if the difference at the same temperature is greater than 1/2 degree, do not unload the product until it is laboratory tested, as it may be contaminated.
- Visual checks are performed to view the proper color in a fuel, which indicates freshness and uniformity, but not quality. Look at the product carefully each time a transporter is loaded or unloaded. When the color is off, it does not necessarily mean the product is off specification. However, it may show contamination or deterioration that may merit further investigation. If the fuel is cloudy or hazy, it probably contains undissolved water.
- Particulate contamination may be determined using the color method/particulate rating guide in a field environment. Samples are checked against a color standard/particulate rating guide to determine if a product is suitable for use. This method does not replace requirement to have active filter separators checked every 30 days by a laboratory. The particulate contamination test is performed using the Millipore test kit.
- The aqua-glo measures water in parts per million. Tests results in excess of 10 parts per million indicate aviation fuel is not suitable for Army use.

LABORATORY TESTS

4-148. Laboratory tests ensure fuels meet specifications, identify unknown products, detect contamination, verify unfavorable field tests, and provide the basis for disposition of unacceptable fuel. Laboratory tests include, but are not limited to, distillation, gravity, corrosion, water tolerance, particulate matter, freeze point, vapor pressure, gum content, tetraethyl lead, and sulfur.

4-149. Products shall be tested in accordance with the appropriate MIL-STD-3004 table before entry into and after discharge from a pipeline. For pipelines carrying aviation turbine fuels and automotive gasoline, laboratory facilities shall be made available to perform identification tests on products at terminals along the pipeline system.

4-150. Fuel must be tested by a laboratory when--

- Requested by petroleum offices.
- The quality of fuel is questioned or it cannot be classified.
- It is determined that an aviation fuel may be contaminated or commingled. Do not use the suspected fuel unless laboratory tests prove it is usable.
- Commercial deliveries of bulk fuel are received and samples are required in accordance with AR 710-2 and DA Pamphlet 710-2-1.
- Additional requirements are detailed in MIL-STD-3004.

PRODUCT RECLAMATION AND DISPOSITION

4-151. Reclamation is the process of restoring or changing a contaminated or off-specification petroleum product so that it will either meet specifications or will be within use limits. The process of reclamation, when properly applied, will result in downgrading, blending, purification, or dehydration. Reclamation may be recommended by the laboratory when products are identified or classified or when contaminated or deteriorated products are analyzed.

RECLAMATION TECHNIQUES

4-152. Downgrading is the procedure by which an off-specification or slightly contaminated product is approved for use as a lower grade of a similar petroleum product.

4-153. Blending for reclamation is the procedure by which an off-specification product is mixed with on-specification stocks to produce a product of intermediate grade or quality that is wholly within use limits. However, it is unlikely that an old product deficient in many of its critical properties could be brought within use limits. Unless all critical properties can be brought up to use limits, downgrading or other types of disposition must be considered (MIL-STD-3004).

4-154. Dehydration is the removal of water by a filtering or settling process. Free water settles out of most light products if allowed to stand undisturbed for about 24 hours. Excess water can then be drawn off, and the water that remains, except dissolved water, can be removed by adequate filter separators. Warming residual products may help to break emulsions, permitting the water content to be removed as free water.

4-155. Filtration or purification is the removal of contaminating agents by settling, filtration, or a filter separator. Coarse particles of dirt, mill scale, and rust settle out of light products if allowed to stand undisturbed after receipt. A minimum tank settling period of two hours is required for all aviation fuels, automotive gasoline, and diesel fuels after fresh stocks have been added. At least 24 hours is advisable for heavy products, such as burner fuels. In addition, the product should be subjected to visual or quality tests prior to issue. Fine particles can be removed by adequate filter separators.

DISPOSITION CONSIDERATIONS

4-156. When a DLA-owned product does not meet specification limits at intermediate storage points, the activity having physical possession of the product will contact the DLA Energy, for a decision about its use or disposition.

4-157. When an Army-owned product does not meet use limits at the location of use, the USAPC shall be contacted for a decision concerning its use or disposition. The request for disposition instructions should include the following information:

- Specification and grade.
- Quantity.
- Location.
- Date of receipt.
- Name of manufacturer, contract number, batch number, qualification number, and date of manufacture.
- Type of container or storage.
- Accountable military department.
- Need for replacement product.
- Detail laboratory test results.
- Recommended alternate use, disposition, or recovery measures.

FILTER SEPARATORS

4-158. It is mandatory recirculation through a serviceable and tested filter separator be performed prior to the first refueling of the day. Recirculation of fuel and filter separator inspection includes differential pressure checks and if required, the aqua-glo test to be performed. It is also mandatory to perform recirculation when a sample is required from filter separator or the nozzle, e.g. the filter effectiveness test or type "c" testing. Appendix S discusses how to conduct the filter effectiveness test.

4-159. Water must be drained prior to use of any filter separator. It is mandatory recirculation through filter separator be performed prior to the first refueling of the day. When fuel is left in the dispensing hose at the end of the day's operation, it should be recirculated through the filter separator before operations resume.

Note: The filter separator flow capacity must be equal to or greater than the pump rated capacity. If pump rated capacity exceeds the filter separator capacity, additional filter separators are required.

4-160. Various numbers of filter elements and canisters are used in filter separators depending on the flow rate of the filter separator. Multiple filter separators may be required to meet the required flow rate of the system.

4-161. Filter separators must also be used on all lines pumping aviation fuel directly to aircraft or to vehicles that refuel aircraft. In addition, all fuel loaded into aircraft refueling vehicles must be filtered again before it is pumped to aircraft.

4-162. Two filtrations are required to pump fuel into an aircraft. Fuel must be filtered going into the system/vehicle that refuels an aircraft and it must be filtered again when it is issued to the aircraft. Any deviations to this requirement will be coordinated with USAPC.

4-163. The following must be performed to keep filter separators serviceable and in good condition. Check the performance of all filter separators, regardless of product in service, every 30 days by submitting samples. The minimum sampling and testing requirements for petroleum products by the location of the stock is covered in MIL-STD-3004. Send the samples to a designated laboratory. Filter separators not in use will be tested immediately before being placed in service and every 30 days thereafter while in use. Change the elements when two consecutive samples fail for excessive particulate contamination or water.

- Ensure filter separator elements are changed every 36 months or when pressure differential gauge readings or laboratory tests indicate filter malfunctions.
- After coalescing/filtering elements are replaced, the filter separator vessel must be stenciled *DATE CHANGED* with the *MONTH AND YEAR*.
- Check the filters/separator sumps each day, and drain any water.
- Check the accuracy of the pressure differential indicator or gauge annually. Keep a record of this check by marking the indicator and by keeping a logbook.
- Keep a daily record of pressure differential readings. Change the elements immediately if the pressure differential exceeds the limits listed in the appropriate TM for a refueling vehicle.
- After installing new filter elements, they should be checked for effectiveness by the supporting petroleum laboratory. Check new filter elements if there is no increase in the pressure differential after several months of operation. The elements may not be properly installed, or some may be ruptured.

FUEL CONSIDERATIONS

4-164. The quality and cleanliness of fuel are vital to the safe operation of aircraft and equipment. Fine sediment in the fuel may block the engine fuel supply system and erode critical parts in the engine and fuel control systems.

4-165. In aircraft, free water (water not dissolved in the fuel) may freeze at high altitudes and plug the fuel screens. This can cause the engine to flame out and possible loss of aircraft. Saltwater is extremely dangerous because of its potential effect on certain aircraft systems. Also, contaminants must be separated out of fuel before the fuel can be pumped into the aircraft. Turbine engine filters cannot remove fine sediment, excessive amounts of sediment, or water from the fuel. Separating the contaminants from JP5 and JP8 is time consuming and further complicated by their high viscosity and specific gravity.

AUTHORIZED PERSONNEL

4-166. Sampling and testing of petroleum products must be done by trained personnel. Personnel requirements are described below.

- No person must be permitted to draw a fuel sample unless he is thoroughly familiar with and can satisfactorily perform all required sampling as outlined in chapter 3. The importance of good sampling techniques cannot be overemphasized. If a sample submitted for testing does not truly represent the sampled product, the value of the test is lost.
- All petroleum testing must be done by trained personnel. Only trained personnel may teach operators to perform API gravity, aqua-glo, and particulate contaminates by color indicator/particulate rating method tests on fuel owned by their units. (The color indicator/particulate rating method tests is not a substitute for monthly laboratory filter effectiveness testing.) Do not let untrained personnel conduct these tests. Trained personnel are available to make liaison visits and to give technical help to units they support.

FUEL CONTAMINATION HAZARDS

4-167. Quality surveillance testing and sampling are used to find common contamination hazards. The hazards that affect equipment are sediment, water, microbiological growth, and commingled fuel.

Sediment

4-168. Sediment from tanks, pipes, hoses, pumps, people, and the air contaminates fuel. The most common sediments found in aviation fuels are pieces of rust, paint, metal, rubber, dust, and sand. Sediment is classified by particle size.

- Coarse sediment consists of particles that are 10 microns in size or larger (25,400 microns equal 1 inch). Coarse sediment settles out of fuel easily, and it can also be removed by adequate filtering. Particles of coarse sediment clog nozzle screens, other fine screens throughout the aircraft fuel system, and most dangerously, the fuel orifices of aircraft engines. Particles of this size also become wedged in sliding valve clearances and valve shoulders where they cause excessive wear in the fuel controls and fuel injection equipment.
- Fine sediment consists of particles that are smaller than 10 microns in size. Removing fine sediment by settling or filtering is effective only to a limited degree. Fine sediment accumulates in fuel controls and forms a dark, shellac-like surface on the sliding valves. It can also form a sludge like material that causes fuel injection equipment to operate sluggishly. Particles of fine sediment are not visible to the naked eye, but they do scatter light. This light-scattering property makes them show up as point flashes of light or as a slight haze in the fuel.
- Water, either fresh or saltwater, may be in fuel. Water (fresh or salt) may be present as dissolved or free water.
  - Free water can be removed from fuel by adequate filtering or free water may separate and collect on the bottom of the container with adequate settling time. It can be seen in the fuel as a cloud, emulsion, droplets, or in large amounts at the bottom of a tank, sample container, or filter separator. Free water can freeze in aircraft fuel systems, which can cause the engines to fail.
  - Dissolved water is water that has been absorbed by the fuel. It cannot be seen and cannot be separated out of the fuel by filtration or mechanical means. The danger of dissolved water is that it settles out as free water when the fuel is cooled to a temperature lower than that at which the water is dissolved. Such a cooling of fuel is likely at high altitudes. Once freed, all the dangers of free water are present.

Microbiological Growth

4-169. If there is no water in the fuel, microbes cannot grow. Microbiological growth is brown, black, or gray and looks stringy or fibrous. It causes problems because these organisms hold rust and water in suspension and act as stabilizing agents for water-fuel emulsions. Microbiological growth in aircraft fuel is a reliable indication that the fuel filters have failed, that the water has not been properly stripped from the fuel, or that the fuel storage tanks need to be cleaned more frequently. FSII in military jet fuel helps curb microbiological growth. However, it is still necessary to remove all water from aviation fuel and aircraft fuel systems.

Commingled Fuel

4-170. The inadvertent mixing of two or more different fuels is known as commingling. A fuel that has been contaminated by commingling with another petroleum product is extremely dangerous whether in storage or in use, because there may be no apparent visual or odor change. This type of contamination is usually caused by carelessness or a misunderstanding of the operations of a fuel system. Due to the problem in detecting commingled fuels, you must be careful where two different fuels are handled in close association.

SAMPLING AND TESTING FREQUENCY

4-171. Frequency of sampling and tested of aviation fuels depends on several factors. It depends upon whether the fuel is taken from a fuel source, a system or refueler, or an aircraft tank.

Fuel from Fuel Sources

4-172. Identify aviation fuels before they are used to fuel aircraft. Each fuel source must be sampled, identified by visual check of the color and appearance, and then classified by the API gravity test. Sampling and testing will be performed by the supplying unit. Verification will be performed by the receiving unit through receipt testing.

Fuel in a System or Refueler

4-173. The fuel in a system or refueler must be sampled and tested daily for water prior to the start of refueling operations and again when changing the filter elements of the filter separator on the system or refueler. Perform this test with the aqua-glo kit. The aqua-glo test must be taken on a moving stream of fuel. Test system/refuelers during the daily preoperational recirculation of fuel. Sample the fuel in a system when the pump is operating and at least one nozzle is open. This sampling and testing should be performed on the system by the parent unit before the system is deployed to a forward area.

LABORATORY TESTING

4-174. Laboratory testing ensures that the fuel's quality meets specifications; that unknown products are identified; that existing or potential contamination causes are identified. Laboratory testing also ensures that unfavorable field test results are corroborated and that off-specification fuels are not used. Each using agency, installation, and unit submits petroleum samples to its supporting laboratory for testing by qualified technicians in accordance in AR 710-2 and MIL-STD-3004:

- When requested by petroleum offices.
- When fuel quality is questionable.
- When local classification is not possible or needs corroboration.
- When a filter separator is first placed in service, after changing the filter elements, and every 30 days thereafter.
- After any aircraft crash in which the engine failed or engine failure is suspected.

Fuel classification (API gravity test)

4-175. Each type and grade of fuel has a particular API gravity range. The API gravity test shows whether a fuel is actually what it is supposed to be. It is used hand in hand with visual examination. A visual check differentiates fuels by color: JP8/F-24 are water white to straw yellow; gasoline is clear to light yellow; diesel lime to straw to brown and avgas, grade 100LL, is blue. The API gravity test confirms the color identification. This test is necessary because the dyes used in fuels may lose color with age or when subjected to heat. API is a measure of how heavy or light a petroleum liquid is compared to water: if its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks. API gravity is thus an inverse measure of the relative density of a petroleum liquid and the density of water, but it is used to compare the relative densities of petroleum liquids. Appendix G includes the API gravity ranges of common military fuels, an equipment list, and the procedures required to conduct the API gravity test.

Water detection (Aqua-Glo test)

4-176. The presence of water in a fuel is tested with the automotive/aviation fuel water detector kit, commonly called the aqua-glo kit. Aviation fuels may not be used if they contain more than 10 PPM of water. The aqua-glo water detection test checks to see that the filter separator is working properly. If a reading is below the maximum allowable amount (10 PPM), the fuel is within the limits prescribed by military specification. If the test shows more than 10 PPM of water in the sample, the fuel does not meet specification. This shows that the filter separator failed or that there is a malfunction in the system. Preoperational checks along with recirculation should be performed again to ensure operator error was not the cause of the failure. After numerous failures segregate the fuel, research the source of water in the fuel, submit sample to the laboratory and contact USAPC. A passing aqua-glo test is required daily from each fuel source prior to issuing fuel to aircraft.

4-177. Procedures to perform the aqua-glo test can be referenced in the Gammon technical products operating procedure manual or appropriate TM.

Fibrous material

4-178. Samples of fuel that are to be dispensed to aircraft should contain no more than 10 fibers when a one-quart sample is visually examined. When more than 10 fibers can be seen, the filter or filter separator elements are not functioning properly. Recirculate and submit sample to laboratory for further testing.

Filter membrane color ratings

4-179. Filter membrane color ratings are used to determine the quality of aviation turbine fuels (its particulate contamination). A method of determining particulate contaminant is ASTM International D 2276, *Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling*.

SAMPLING AFTER AIRCRAFT ACCIDENTS/INCIDENTS

4-180. Fuel samples are taken after aircraft mishaps by an accident investigating team appointed by the proper authority. See DA Pamphlet 385-40, *Army Accident Investigations and Reporting* for investigation of Class A through E accidents/incidents as required as part of the aircraft accident prevention program. Combat losses are not considered accidents. Therefore, the sampling requirements described below do not apply to incidents classified as combat losses.

Sampling From Aircraft

4-181. Fuel and lubricant samples should be taken from the aircraft as soon as possible after the incident. To sample from aircraft, consider the use of the sampling kit assembled for this purpose. A 4-ounce sample of fuel from the aircraft tank is required. If the aircraft has tanks that do not flow into each other, take a sample from each tank. The sample should be checked for color, visible water, sediment, and contaminants. A 2-gallon sample should be used if the aircraft used jet fuel (clear to amber). If the aircraft operates with avgas (green or light blue), draw a 5-gallon sample. Draw a 1-gallon of lubricating oil from the aircraft.

4-182. All samples containers must be closed tightly and accompanied with a DD Form 2927. More details of sampling and tagging procedures are found in appendix S and MIL-STD-3004. Forward these samples to the appropriate petroleum laboratory in accordance with AR 710-2.

Sampling from Fuel Sources

4-183. When sampling from fuel sources, retrace the fuel records of the aircraft and obtain information and collect the samples. Record the date of the last refueling before the incident; the system or number of the refueler (tank vehicle); and the name of the unit, organization, or supplier of the last refueling service. The results of the filter effectiveness and aqua-glo tests of the refueler must be checked as well as the records of the daily filter pressure differential readings. Contact the organization that provided the last refueling. Record the date that the applicable refueler, tank, or drum was filled and the bulk storage system from which it was filled. Contact the organization responsible for the bulk storage system. Record the date the fuel was received into the storage system and the supplier of the fuel.

4-184. The bulk storage test results must be checked. If the fuel in storage has not been tested for 90 days, it should be retested. The storage tank records should show the daily water bottom checks and test results when products were received. A 2-gallon sample must be drawn from the refueler, tank, or drum that was used to refuel the aircraft. In addition, a sample from the bulk storage system from which the refueler, tank, or drum was filled must be drawn.

AVGAS CONSIDERATIONS

4-185. It is imperative that all sampling and testing of avgas is performed by trained personnel in accordance with MIL-STD-3004.

4-186. Avgas must pass through one filtration between the storage system and the consuming equipment.

Sampling and Testing

4-187. Upon initial receipt of bulk avgas, a 1-quart sample is required to perform a visual test for color, water and sediment. The color must be the same as reported on the refinery test report and there shall be no water of solids present. Protect the one-quart sample from the sunlight and mark as "RETAIN" after conducting the visual inspection. A one gallon all-level sample must be taken and sent to the area laboratory for specification testing. Every 30 days, a one gallon all level sample must be drawn and forwarded to the area laboratory for specification testing. Prior to issuing avgas from any SCAT, conduct a one quart sample must be drawn from the dispensing nozzle and a visual inspection for color and appearance must be conducted.

4-188. For the collapsible fabric fuel tank or the collapsible fabric drums, samples will be conducted in the same process as with the SCATs. However, the sample must be taken downstream of the filter separator.

4-189. Upon receipt of drummed (55-gallon metal drums) avgas, a 1-quart, all level samples and a 1-gallon sample must be drawn from a drum selected at random from each batch/lot. Samples will be conducted as in the same process as with the SCATs however, the frequency of the 1-gallon all levels sample is every 90 days as oppose to every 30 days with the SCAT.

SECTION IV – PETROLEUM PIPELINE OPERATIONS

4-190. Petroleum pipeline operations consists of the IPDS which is used to interface with an existing fuel source, such as a refinery, or with the OPDS. Petroleum planners at all levels should be familiar with the capabilities and employment of this system for use during early entry operations in developed and undeveloped theaters. Terminal operations may include both tactical and fixed facilities.

SITE SELECTION

4-191. Tactical petroleum terminal (TPT) fuel units must be located in the area that they are to conduct supply. The general location is designated by the petroleum planner or senior headquarters, which is responsible for the design, construction, and operation of the distribution system. Site selection is relative to the location of class III supply points and transportation routes, whether by pipeline, tanker truck, barge, or rail tank car. The specific location may need to be modified due to site constructability.

4-192. The site selected should be level and drained to prevent water damage. Select a site that has easy access to road networks; this is a prime consideration if it will be used to fill tank trucks. Avoid low areas where vapors may collect. Environmental protection considerations for siting must be addressed. Consult with the local environmental officer to ensure compliance with local and host nation requirements. In general, the tactical terminal should not be located uphill or upstream from a population center/base, potable water supply or other environmentally sensitive areas.

4-193. The engineer unit tasked to the construction site must work closely with the petroleum personnel as to exact layout and placement of the tank farm. The selected sites should be in non-congested areas where other facilities do not interfere and where sabotage and sneak raids are relatively easy to defend against. TPT fuel units should never be located in drainage areas above critical installations.

4-194. Locate TPT fuel units so that in the event of a tank farm fire, the fire will not spread to other supply areas or installation areas. The TPT site should have the following features, as permitted:

- Adequate road and/or rail facilities.
- An area large enough for proper tank dispersion and expansion of the tank farm. This is a major factor when collapsible fabric tanks are used because of the large area required.
- Absence of distinctive landmarks or terrain features that could aid enemy aircraft in locating and identifying the site or could be used to adjust artillery fire.

4-195. Using both aerial and ground reconnaissance, the Army will probably preselect a specific site or at least a desired area in which to set up the TPT. There is no completely ideal site. When picking a site, a decision must be made. When evaluating the site, the following factors must be considered in site selection:

- The need for the terminal in a general area can be decided only by the distribution plan.
- The ability to supply the terminal with fuel must be considered.
- The site selected must be able to hold the equipment and roadways needed. Compromise and rearrangement of equipment will often be necessary.
- The selected site should be reasonably level and well drained. The least amount of earth moving work needed is better. Low and swampy areas should be avoided. The site should be as free as possible from heavy obstructions such as large rocks and trees.
- If possible, the site should be located relatively near existing road systems capable of carrying the traffic anticipated. There must be access to that road system or a new road may need to be constructed to connect the roads.
- Water must be available at the site or making it available at the site. The operation must have water available for safety reasons even if it must be hauled to the site. Water must be available for the charging of the dry chemical/AFFF wheel-mounted fire extinguisher. It is also needed for general fire protection and personnel safety.
- After the site has been selected, a preliminary layout should be made. This shows all the major equipment and system locations, including tanks, pumps, floodlight sets, fuel-dispensing areas, tank vehicle receipt areas, and the access roads. The characteristics of the site available should be evaluated. Then the preliminary layout should be reviewed and corrected if needed for a final layout on which equipment locations are firm. Final road work and tank pad and berm construction must be based on this final layout.

SITE PREPARATION AND EARTHWORK

4-196. Site preparation work should be based on a grading plan that reduces cut and fill operations even if the plan is roughly prepared in the field. The plan should be based on actual on-site elevations and survey, observation of obstructions, and knowledge of the types of soils that appear to be present. The first step to prepare the site is to cut an access road to the site unless one already exists. Stake out the area that must be cleared. Mark where the major components will be located. Cut, grub, doze, or if necessary, blast major obstructions; for example, trees, boulders, or buildings. Clear and grade the areas where a fuel unit will be located, transfer systems installed, roadways built, and loading and unloading facilities installed. There must be good drainage from the site. Plan cuts and fills so that the volume of cut soils roughly equals the required fill for low spots, tank berms, and roadways. If the area is fairly flat and requires only minimal grading, the materials for roadways and tank berms can come from a borrow pit near the site which can, if desired, be converted to a reserve water storage basin. Keep in mind that the major equipment, most particularly the bags, should be set on virgin or cut soils, if possible, rather than on fill. If tankage must be located on a filled area, the fill must be compacted as it is placed. Compaction after a deep fill has little effect. When extensive fill is required, the slopes must be such as to prevent slides and reduce erosion. As a general rule, there should be no slopes greater than 2:1 (approximately 25°) in sandy or loamy soils.

ROAD

4-197. Road must be fully compacted and have good drainage. If possible, they must have at least a surface of gravel or crushed rock. Each side of the road should have an adequate swale or ditch for good drainage. Drainage culverts should be placed as required. The road, swale, ditch, and drain culvert requirements will depend on the site and anticipated rainfall. Roads must be constructed wide enough to accommodate passage of arriving, departing and emergency vehicles to permit ready access to all areas for installation, operation, fuel loading and unloading, and firefighting.

TANK PAD AND BERM CONSTRUCTION

4-198. Proper tank pad and berm construction is most important to provide for tank operation and protection from spill or a fire resulting from the spill. Tank pads are preferably constructed of a loamy or clay soil containing some sand so that a smooth area can be graded and hold its shape. The longest slope should be approximately 1° (degree) from horizontal. The low point should be where the tank drain will end up when the tank is unrolled. A small ditch and a basin for the tank drain line and drain valve can be excavated by hand at the time the tank is unrolled. The low point permits maximum pump out of the tank and drainage through the drain line. The base of the tank pad area must be virgin, cut, or well compacted soil. To avoid damage to the tank bottom, sticks, stones, or sharp objects must be removed before the tank is installed. Berms may be constructed before, after, or simultaneously with tank pad construction, depending on job conditions. Tank pad rough grading should be completed before berm construction and should be finished after berm construction. The preferred materials are soils containing a fairly high clay content to hold shape and sealing. The berm should be compacted as it is constructed. Berm liners should be installed after the pad and berm are completed. Refer to TB 10-5430-253-13 for further details.

PADS FOR OTHER EQUIPMENT

4-199. To the extent possible, all operating equipment should be set on virgin or cut soils rather than fill. If a filled area cannot be avoided, it must be well compacted. This is particularly important for the pumps and floodlight sets. If available, it is recommended that the areas on which equipment is placed be covered with a 6 to 7-inch layer of coarse gravel or crushed rock. The gravel or crushed rock should extend out and around the equipment for several feet. This will provide a high and dry area from which to operate and maintain the equipment. If coarse gravel or crushed rock is available, place it around often-operated valve stations.

DUTIES OF PIPELINE AND TERMINAL PERSONNEL

4-200. Effective operation of the sections requires identifying key personnel and understanding their primary duties and responsibilities. Key personnel in each tank farm section are discussed below.

- The petroleum officer is supervisor of the control section. They are responsible for a smooth running operation. Their duties consist of monitoring the work, coordinating with higher headquarters, and making sure required reports are accurate and submitted on time. In addition, they should be sure an SOP is available and up to date at all times.
- The responsible petroleum officer obtains or develops pumping schedules for transfer, storage, and delivery. Personnel under their supervision make the hourly pumping and delivery report to the chief dispatcher of the petroleum operating unit. This report should contain the following information:
  - Capacity of storage tanks at each installation.
  - Line fill and throughput for each section of pipeline.
  - Number of barrels pumped from storage location.
  - Number of barrels received at each storage location.
  - Cumulative barrels corrected to 60°F (16°C).
  - Suction and discharge pressures.
  - Revolutions per minute for operating pumps.
  - Batch changes and interface cuts (when multi-product systems are used).
  - Rates of flow.
  - Number and location of pump stations.
  - Stock status and daily needs.
  - Physical and chemical properties of each petroleum product pumped.

  - Prepare schedules for the entire distribution system. These schedules include the time, type, and quantity of product to be received, transferred, or issued; flow rates; and operating pressures.
  - Prepare order showing operations in chronological sequence for each element. The orders (when multi-product systems are used) will show batch numbers; specific amounts of product by type; interface cuts; line temperature; suction pressure; and discharge pressure.
  - Issue dispatching instructions to all elements of the distribution system.
  - Monitor the flow of product through the system to prevent commingling of product (when multi-product systems are used); ensure compliance with operation orders; and detect line breaks, leakage, and other problem areas.
- The section chief supervises the installation, operation, and maintenance of petroleum storage facilities. They also supervise and control the tank farm section personnel.
- Petroleum inventory control specialist assists the section chief in coordination of tank farm operations and maintenance. They maintain control of opening and closing inventories in accordance with AR 710-2. In addition, they maintain records on receiving and shipping and supervises the second shift.
- The petroleum heavy vehicle operator operates vehicles used to support the hose line outfit equipment and evacuate fuel products.
- The petroleum supply specialist operates and maintains the TPT, FSSP, or other service or civilian equipment as required. They complete the appropriate receipt and shipping documents as required and is responsible for--
  - Operating tank farm transfer and booster pumps, switching manifolds, and loading facilities.
  - Gauging and sampling incoming bulk fuels and bulk fuels in tanks and maintain records.
  - Performing PMCS on tanks, coupled lines, hose line, valves, fittings, pumps, and filter separators.
  - Serving as fireguards and operating fire extinguishers and fire-suppression equipment.
  - Directing flow of fuel into proper storage.
  - Driving and maintaining the tactical vehicles used in the control of and in support of tank farm operations.

DEPLOYMENT AND LAYOUT

4-201. The layout requirements for a fuel storage site must be flexible to fit the particular site and service. These arrangements may be modified for practicality at a particular site. The objective in any equipment arrangement is to provide for efficient and safety in operations. As a general rule, the fuel storage site should be arranged for maximum spacing between tank farm units and fuel units to the extent the particular operating site requirements and hoseline availability permit. This will provide for the highest level of safety for the equipment and the operating personnel without adversely affecting operating efficiency. Specific area service requirements may also affect layout and spacing.

4-202. Figure 4-1 shows a typical TPT layout. It has been arranged to make full use of the transfer hose lines between fuel modules. The equipment is wide-spaced for security reasons. Terrain or operational situations could account for different appearances in wide-space layouts. The installing and operating authority makes the final determination of fuel storage site layout. In a relatively secure area or when property availability is limited, the layout arrangement should be a close-spaced fuel storage site layout.

4-203. When the pipeline is planned, the layout plans for the pump station are included. Standard plans are used, with modifications for special purposes. The engineer unit constructs the pump stations. Each facility is a complete unit and has the required number of pumping units with manifolds and valves. In addition to the 800-GPM pumps, other components are required to construct a workable pump station. The strainer assembly is used to keep debris from entering the pump. The receiver assembly captures scrapers that are run through the pipeline. The launcher assembly provides the means to inject a scraper into the pipeline. Scrapers are used to purge air from the pipeline during fill and test and to periodically clean the inside of the pipeline. The 3,000-gallon collapsible fabric tank is used to store bulk fuel for the pump engines. The tank is filled by drawing fuel from the pipeline. Generally, a graded area 140 feet long and 95 feet wide is required for its construction. However, other layout designs may be required due to topographic conditions.

4-204. A typical TPT layout is shown in figure 4-1. The layout is an example of a TPT which has been arranged to make full use of the transfer hoseline provided for wide spacing between fuel modules. The layout assumes that adequately sized property is available and the equipment is wide-spaced for security reasons. In many locations, due to terrain or operational situations, the layout may have to differ substantially from that shown. In a relatively secure area or when property available is limited, it will be appropriate to arrange the system with much closer spacing between fuel units and equipment. A close-spaced TPT layout is tankage in a straight line. Security demands or terrain may dictate otherwise. Road access should always be considered when planning a TPT site. Ideally, there should be a limited number of entry points into the TPT area, with each entry point having a control or checkpoint to monitor and route traffic in and out of the area. A road that can support two-way tank vehicle traffic should run along the perimeter of the TPT site. This road gives access to each fuel unit's fuel-dispensing assembly. In the fuel-dispensing areas, the roadway should be widened to at least 40 feet. Through traffic should be routed away from the fuel-dispensing area. Similar fuel handling areas are needed for the contaminated fuel module and the tanker truck receipt manifolds. Secondary roads should be made for MHE, pumps, fire-suppression equipment, and maintenance equipment to be moved. Under-road culverts through which hoselines pass allow vehicles to cross over the hoselines without damaging them. These culverts are installed as necessary. The hoseline suspension kit may also be used to provide for crossing under the hoseline.

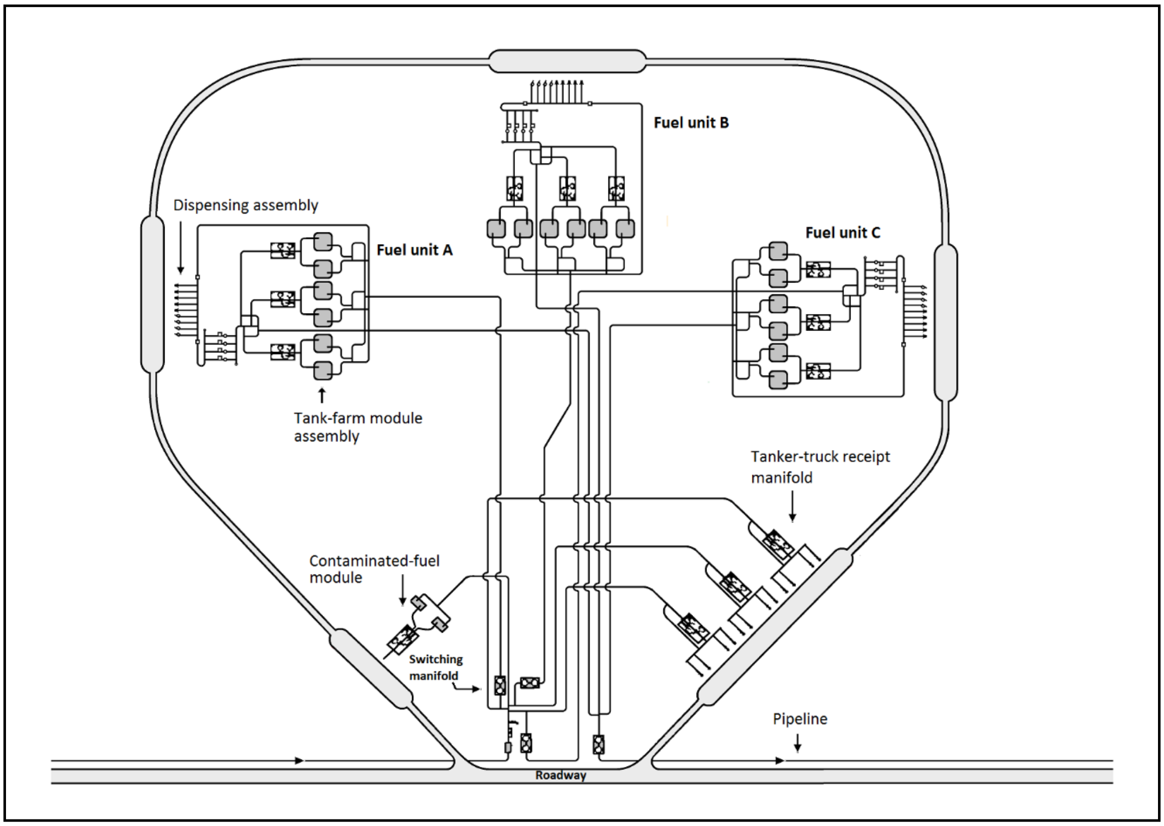

Figure 4-1. Typical TPT layout

4-205. Access must be provided to the pumps and near each tank berm. An important point shown on the general TPT layout is the location of the fire-suppression equipment. A wheel-mounted fire extinguisher should be located near each tank berm, at each fuel-dispensing assembly, at each tank vehicle receipt assembly, and at the contaminated fuel module. Extra units should be stationed at a central point ready for use anywhere in the TPT. Covered shelters or containers for housing the Kevlar fire-fighting clothing and extra fire-fighting supplies should be provided at central, easily accessible locations around the TPT.

4-206. The 20-pound hand-held fire extinguishers should be distributed and located at each pump, each floodlight set, each fuel-dispensing area, and other operating areas at the discretion of the operating supervision. Personnel must know where all fire-fighting equipment is located at all times to prevent confusion in an emergency. Readily visible signs identifying the locations of fire extinguishers would be helpful. The floodlight sets should be placed to give light to the fuel-dispensing areas, fuel receipt areas, and heavy operating areas around the pumps and the switching manifold.

LINE OPERATIONS

4-207. Line operations are the control, planning for, organization, coordination, and direction of the pipeline and terminal operations.

PLANNING

4-208. Planning includes the layout of the operation, workflow, shift schedule, spill response, and man hours of the operation. It determines the order to include gauging, sampling, performing PMCS, fire suppression, and all other aspects of operations.

ORGANIZING

4-209. The platoon leader organizes the operations to provide bulk fuel to serviced units and to ensure that the platoon operations interface with those of the larger system. It is essential that operations be organized so that Soldiers know what is expected of them and they can perform their duties with confidence.

COORDINATING

4-210. Coordination is one of the most important duties the platoon headquarters performs. Coordination ties planning, organizing, controlling, and directing together. The flow of bulk fuel; the cleaning and maintenance of equipment; and the receipt, storage, and issue of bulk fuel all rely on clear, concise coordination. Since the platoon operates on shifts, the work schedule must ensure efficient use of Soldiers and equipment. When the shift changes, the oncoming section is briefed on the day’s operations and to prepare them to resolve any ongoing problems.

DIRECTING

4-211. Pipeline systems, terminal design, product demands, and the nature of each receipt or issue of product determine specific operating procedures. However, there are certain rules and procedures that must be followed at any terminal for efficient operation and safety.

4-212. Determining the flow rate and units of measurement in pipeline/hoseline operations is required during pipeline operations. The units of measurement can be barrels, gallons, cubic feet, cubic yard or liters depending on the area of operations and the organizations involved in the distribution chain. The flow conversion chart, in appendix F, provide a tool for conversion of units of measurement and units of velocity and flow conversion.

Note: With the introduction of JP8 as the single fuel on the battlefield, batching and scheduling may not be needed in military pipelines and hoselines. However, for purposes of this manual, batching and scheduling procedures and fixed tankage will be discussed in the event multi-fuel pipelines are required or commercial facilities are operated by Army personnel. Motor gasoline and diesel fuel will also be discussed in the event commercial facilities are operated by Army personnel.

4-213. All personnel must be trained to know the entire system so that each person will be familiar with what the others are doing. Only experienced and qualified personnel should be assigned to independent work. Each person must receive complete operational instructions and must understand them. Personnel should be trained to anticipate emergencies so that they can cope with various situations.

4-214. There are general operating considerations that should be followed. They are listed below.

- Operations should be stopped and started slowly and carefully. Valves should be opened and closed slowly and pressures brought up gradually. Pressure gauges should be watched so that working pressures are not exceeded.
- During continuous pumping operations, the receiving tank should not be closed off until another tank is opened. If the pipeline is not in use, tank valves will normally be closed except where they need to be left open to relieve line pressure caused by thermos expansion. All hatches on fixed tankage must be closed except when in use for gauging or sampling.
- There must be positive communications between personnel at operating points in the system at all times.
- Water bottoms must never be used in fixed tankage unless they are authorized by the proper technical authority. If water bottoms are authorized, they should be checked monthly for hydrogen sulfide. Hydrogen sulfide is corrosive and causes the product to fail the copper strip corrosion test.
- Ensure you have good communications with the upstream pumping stations. You must keep in close touch during hoseline operations to prevent accidents such as overfilled or ruptured tanks.
- Ensure proper ullage space in the storage tanks to handle the incoming shipment after receipt of a pumping order. The pumping order notes how much product will be delivered to the supply point. Then check pumps, filter separators, hose, manifolds, valves, and fittings to ensure they are clean and in good working condition. Also, ensure that the major items of equipment in the supply point are grounded and bonded.
- Inform the dispatcher when ready to receive the product. Once the products start to flow, have some crew members walk the length of the hoseline to look for leaks in the hose, fittings, and valves.
- The dispatcher must reduce the flow rate upon receipt of most of the shipment or when filling the last storage tank. Then, gradually shut down the hoseline. You must keep in close touch with the dispatcher so as to keep from overfilling or rupturing a storage tank.
- Pipeline operations hydraulics is address in appendix H of this manual.

RECEIPT OF PRODUCT

4-215. There are a number of general considerations that need to be followed when product is pumped into tanks. These considerations are described paragraph 4-68 above.

ISSUE OF PRODUCT

4-216. The first in, first out policy (the issue of oldest stocks first) should be followed, and products should not be mixed. Follow the considerations below for issuing fuel.

- Average issues seldom require more than one tank on line at a time. When large issues are made from tanks with individual pumps, product may have to be issued from two or more tanks at a time to have the desired flow rate. When this is done, position an operator at each pump to regulate product flow.
- In some facilities, the operators may be able to remotely control individual tank pumps electronically at the tank, booster pump station, or delivery point. They can shut down pumps quickly in an emergency and operate the pumps without constantly being at each pump. However, an operator must be at each pump when gasoline or jet fuel is issued.
- Conduct quality surveillance according to MIL-STD-3004.

INTRA-TERMINAL TRANSFERS

4-217. Product may be transferred between tanks in a terminal when the terminal is not receiving product. Product may be circulated to end stratification and maintain product quality. All free bottom water should be drawn off before such operations. Pipelines should be checked periodically during intra-terminal transfers.

LINE DISPLACEMENT

4-218. Lines should be kept filled with product. However, lines that are shutdown are sometimes drained to prevent pilferage or sabotage. Temperature changes, pressure loss, or air release may cause inaccurate issues or receipts. Therefore, lines must be filled or packed before each operation. Where there is a loop or double line system, lines may be filled by circulating product in them with or without booster pumps. A line may be filled by allowing air to escape through one or more vents at the high points and at the end of the line. This process is much slower, and it may leave air pockets in the line and cause gauging errors. However, this may be the only means available. Water may be used to displace product only if specifically authorized by a higher authority. This process is used as a last resort because it is difficult to remove and dispose of the water completely.

PIPELINE METERS

4-219. Pipeline meters are used by commercial activities and are not included in the IPDS pipeline. Pipeline meters may reduce loss of product caused by leaks by allowing more reliable, continuous checks of pipelines. Also, they may reduce losses from terminal operations by providing a means of checking product receipts and deliveries. Meters may not stay accurate when they are in constant use. They should be verified periodically or when their accuracy is in doubt.

RECORDS AND REPORTS

4-220. DA Form 5464-R (Petroleum Products Pipeline Leakage Report) is used to report a leak found anywhere along the pipeline.

4-221. A class III status report must be kept for each terminal in the pipeline system on a daily basis. The report shows the stock status of the terminal for the past 24 hours. It is sent to higher headquarters or to the dispatcher office. File copies are kept at the terminal and at higher headquarters. These copies are a permanent record of terminal activities. They are part of the total record for the pipeline system. Although there is no prescribed form for this report, the minimum information needed in the report is as follows:

- Supply point number.
- Date.
- Report period.
- Receipts of product, by type, into the terminal.
- Total issues of product, by type, from the terminal.
- Total amount of product on hand, by type, in storage tanks, tank vehicles, barges, and packages at the end of the period.
- Total ullage available for specific products by tank designation at the end of the period.
- Information on unusable storage. (Location and causes of leaks, ruptures, or other damage; other reasons for unusable storage space; and anticipated changes in ullage due to maintenance are all reported.)
- Estimated requirements and issues, by type, for the next 24-hour period.

Daily Terminal Inventory Report

4-222. The daily terminal inventory report is used only by coastal terminals that receive products by tanker. The report shows levels of terminal bulk fuel stock and permits tanker cargo adjustments before loading.

4-223. The report is submitted daily to the JPO. This report gives the location of the terminal and the following information for each product:

- Military inventory in shore tankage.
- Commercial inventory in shore tankage allocated for military use.
- Usable inventory aboard floating storage.
- Days of supply on hand.
- Usable inventory in port tankers being discharged or awaiting discharge.

4-224. DA Form 5463-R (Petroleum Products Tank Farm Outturn Record) is used to record the flow of petroleum products from the storage tank area to tank cars, tank vehicles, and pipelines. It is used when shipments from the tank farm are consigned to outgoing vessels, tank cars, or tank vehicles. The form is also used if product is transferred from the dock area to the loading rack, bypassing terminal storage in emergencies.

Weekly Bulk Petroleum Terminal Message Report

4-225. The bulk petroleum terminal message report is an operational report for DLA Energy commodity management and for tanker cargo scheduling review. The report is also used to answer inquiries from all levels of the federal government. Reports are prepared as of 0800 (local time) on Friday of each week. They are to arrive at DLA Energy no later than the following Monday. Information copies are sent to the proper JPO and DLA Energy fuel region. Instructions for preparing the report are given in DOD 4140.25-M.

Annual Bulk Petroleum Storage Facilities Report

4-226. This annual bulk petroleum storage facilities report (RCS:DD-M(A)506) gives data on all bulk petroleum storage facilities of 500-barrel capacity or more, either singly or in manifold systems. The report, in a machine produced format, is provided annually by the DLA Energy. It is based on annual review and updates from the military departments and DLA Energy activities. All storage capacity changes, including product allocation changes, in excess of 10,000 barrels at any activity must be reported to the DLA Energy as changes occur. Instructions for preparing the report are given in DOD 4140.25-M.

TESTING OPERATIONS

4-227. The operations section maintains daily pumping schedules for the forecasted week. The pumping schedules are used to coordinate tests of fuel before pumping begins. Arrangements are also made for line sampling and testing while the product is enroute. This is done to mark the progress and position of interfaces. Instructions for testing and disposing of interface are given to the terminals where they are to be taken off.

PUMPING OPERATIONS

4-228. The chief dispatcher decides the specific times batches are to be pumped into the line. All stations along the line are informed of the starting time, amount of product, route, and destination. The input station reports every hour on cumulative barrels pumped, temperatures, pressures, and batch numbers. Pump stations along the line report every hour on line and atmospheric temperatures, pressures, product code, and batch number. The reports are sent to the district dispatchers who sends the reports to the chief dispatcher. Pump stations are informed of the expected arrival time of scrapers that may be in the line.

OPERATION REPORTS

4-229. Operation reports cover hourly pumping and delivery data from the various pipeline pump stations. These reports are sent to the appropriate district dispatcher. The reports provide a check on the operation of the line. The chief dispatcher decides the progress of batches and the position of interfaces by using the various operation reports. This information is recorded on the daily pumping record. Some of the information is used along with the graphic progress chart. Discrepancies between barrels pumped and barrels delivered must be investigated. The pipeline day begins at midnight. At that time, the chief dispatcher sends a time signal to regulate all clocks in the system. The first report is made at 0100. Station 1 reports first, and all others follow in order. The report from a branch line takeoff station follows that from the main line station where the branch begins. Reports from input stations, way stations, and takeoff stations will differ in content. Reports need be no more than a single line. They are letter and figure-coded to save space and time. Data should be arranged in sequence. Then, they will coincide with station logs and dispatcher's pumping record. More station reports and information are given below.

Input Station Report

4-230. An input station provides various data to the dispatcher. These data include--

- Batch number (in multi-product pipelines) and product code.
- Tank number from which fuel is being pumped.
- Suction pressure.
- Station discharge pressure.
- Any change in gravity.
- Barrels pumped in last hour, corrected to 60°F.
- Cumulative barrels pumped since midnight, corrected to 60°F.

Pump Station Report

4-231. A pump station provides various data to the dispatcher. This data may include:

- Suction pressure.
- Discharge pressure.
- Engine RPM.
- API (if multi-product).

Takeoff Receiving Station Report

4-232. A takeoff station provides various data to the dispatcher. These data include--

- Batch number.
- Tank number into which fuel is being pumped.
- Product or grade (API gravity).
- Observed temperature.
- Sample number.
- Cumulative barrels received since midnight, corrected to 60°F.

SCHEDULES

4-233. Pipeline scheduling is the basic plan that governs the movement of products throughout the system. Usually, a pipeline schedule covers one month's operations and shows the pumping sequence, the volume, and the product to be delivered by the pipeline each day. The schedule for fuel movement through the system is based on storage capacity and product demand. Constant communication between the distribution and storage facilities is essential during construction and operation of the system.

4-234. Scheduling is planning the movement of bulk petroleum products by pipeline from the base terminal to intermediate terminals and pipe head terminals. Before products can be scheduled for movement, the chief dispatcher must determine when and where specific products will be required and how much storage space is available. They must also know how long it will take the product to reach its destination after it has been started through the pipeline. Past experience is the best way to determine daily requirements throughout the pipeline system. With the above factors in mind, the chief dispatcher prepares consumption graphs. These graphs show projected consumption and deliveries. Under the supervision of the chief dispatcher, the scheduling and distribution sections prepare a monthly pipeline schedule and a daily pumping schedule.

CONSUMPTION GRAPH

4-235. The chief dispatcher keeps a consumption graph for each separate product handled at each storage point. Each terminal keeps similar graphs for their site, and may keep consumption graphs for large volume users. The graphs are valuable in showing present and future stocks and storage positions. They also show trends in consumption. Sudden increases or decreases in consumption are quickly recognized and can be reflected in scheduling. A consumption graph must show the total barrels of any given product for each terminal or storage location. A separate graph should not be prepared for each tank. Figure 4-2 on page 4-34 is an example of a typical consumption graph.

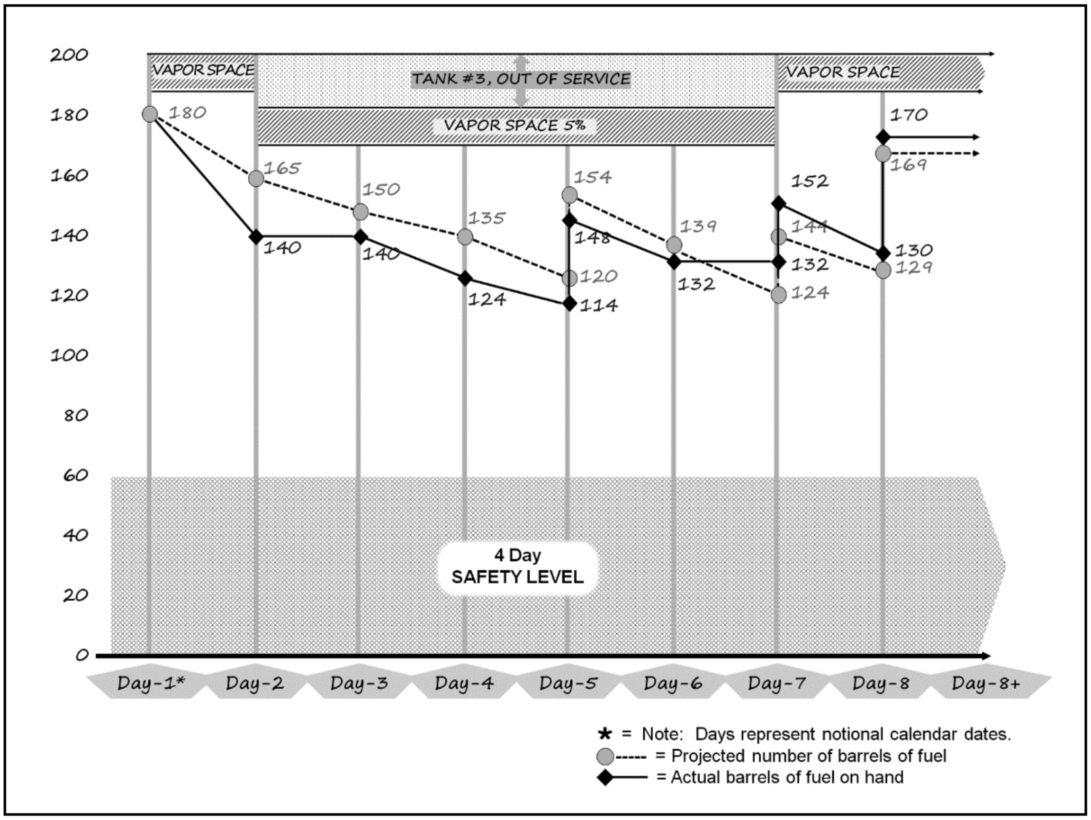

Figure 4-2. Consumption graph

4-236. Information for the consumption graph is given below.

- Storage capacity for the product in thousands of barrels (vertical axis) is plotted against time in daily intervals (horizontal axis). Days are figured from 0001 of one day to 0001 of the next.
- Allowance for vapor space is five percent of the total storage capacity. This is reflected at the top of the graph.
- Safety level is shown at the bottom. The safety level is normally determined (at theater level) based on collective data.
- Calculated issues and receipts are shown by a broken line. Actual issues and receipts are shown by a solid line. All receipts are shown by a vertical line at the end of the day. Daily issues to local customers and pipeline issues are shown on the same graph.
- Allowances must be made for tank cleaning and repairs. The reduced storage capacity is subtracted from the total capacity.
- Differences in stock on hand from day to day show the rate of consumption. The average consumption rate from past experiences is used to plan for future issues. Based on this projected consumption rate, the system must be replenished by pipeline.

MONTHLY PIPELINE SCHEDULE

4-237. The monthly pipeline schedule as shown in figure 4-3 on page 4-35 shows the programmed movement of products through the pipeline. The products required for the 30-day period must be determined. Then, a schedule can be prepared to compute the time it will take for a product to reach its destination after it has started into the pipeline. This schedule is merely a graph which shows line capacity in barrels (distance) plotted against time (hour). It is prepared on a sloping tabletop, which can be equipped with a full length parallel rule. It is best to use an adjustable protractor with the parallel rule to ensure that the flow is plotted correctly. Information on this graph is given below.

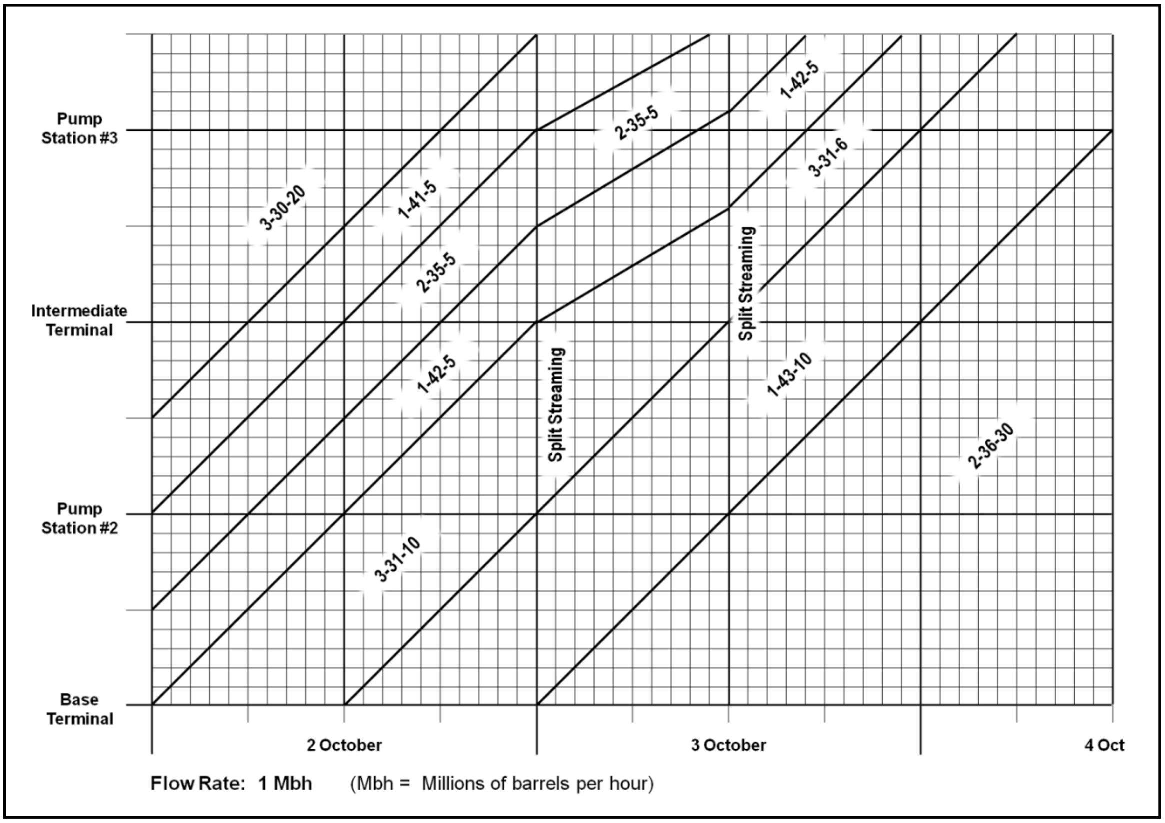

Figure 4-3. Monthly pipeline schedule

- Before the graph is made, the number of hours a line is to be pumped each day must be determined.
- Time is shown from the beginning to the end of a given working day. The chart is drawn with the vertical axis showing line fill.
- The horizontal axis is drawn to show the time period.
- Terminals are located on the chart by their respective line fill distance downstream from the base terminal. The terminals are plotted vertically.
- Each batch is labeled by product and batch number. Each type of product is marked on the graph with a different color.
- The distance in barrels divided by the pumping rate equals the number of hours it will take for a given batch to reach a designated place.
- The slope of the throughput lines stays constant when there is no intermediate stripping and when the pumping rate stays the same. Stripping is when all or part of one or more batches is taken off the main pipeline at an intermediate terminal.
- When products are taken into a terminal and half of the pipeline is shut down, this is plotted on the monthly pipeline schedule. A dotted line on the horizontal time axis shows the time the pipeline is shut down. A dotted line on the vertical axis shows the portion of the pipeline to be shut down. A second vertical dotted line shows when the pipeline goes back on stream. It should be noted on the schedule that this is a static condition.
- Stripping of product at a terminal is shown in the same manner as a static condition--with horizontal and vertical dotted lines. It is noted in the block formed by the dotted lines that a stripping action is taking place.
- The vertical lines represent terminals and stations. The points at which the sloping lines intersect the vertical lines show scheduled arrival times.
- When all of the throughput lines have been drawn, the graph represents all scheduled pumping and delivery operations for the month.

DAILY PIPELINE SCHEDULE

4-238. The daily pumping schedule is used as a basis for preparing pumping orders. It is an abbreviated tabular form of the monthly schedule for each day concerned. This schedule shows changes and emergency needs. It is usually prepared a week in advance so that the dispatching section can have a week's supply. The dispatching section uses the daily pumping schedule to prepare the graphic progress chart and the daily pumping order.

BATCHING (MULTI-PRODUCT PIPELINE)

4-239. Batching is determining the sequence in which two or more products are to be pumped and introducing those products into the pipeline in a sequence that results in the least formation of interfacial material.

4-240. Pipelines between bulk terminals can be multiproduct lines. Problems caused by pumping more than one product through a pipeline involve mixing of the products and disposing of the mixed portions (interfaces). The progress of the different products and the interfaces must be followed so that the products can be taken off the line at the right place. The volume of interfaces depends on differences in gravity and viscosity of adjacent products and on the pressure and velocity of the stream. It also depends on the interior condition of the pipe, the number of pump stations, and the distance traveled by the interface. The differences in gravity and viscosity will also affect interface disposal. Interface size can be reduced by maintaining a pumping rate needed to keep the heaviest product in the line in turbulent flow. The size also can be reduced by putting products in the line in proper batching sequence and by keeping the line pressurized during a shutdown. Positive pressure will prevent the speed of the interface and the interface volume will be cut down, whether the interface stops on level ground or on a slope.

BATCHING CONSIDERATIONS

4-241. Batches should be arranged to protect critical products and to produce interfaces that can be used. Closely related products are adjacent in descending or ascending order of quality or gravity. Products most closely related in quality have the least difference in gravity. They form interfaces that spread less with distance traveled. Also, they are most easily disposed of in one or both of the adjacent fuels. This method of batching simplifies quality surveillance. Disposal of interfaces is also simplified by making heart cuts for deliveries along the line. Heart cuts are portions of pure product taken from the line before and after the interface at intermediate terminals. When heart cuts are made, the final terminal for any product is the only place where interfaces are handled. When a complete batch is taken off at an intermediate point, the interfaces must be taken off also. The preceding and following batches are then brought together with as little mixing as possible. The quality surveillance officer or chief dispatcher gives instructions on disposing of interfaces.

DISPOSING OF INTERFACES

4-242. There are three ways to dispose interfaces. These ways depend on the type of batch change. They are as follows:

- All of the mixture is cut into one or the other of the adjacent products. This protects critical products and creates usable interfaces. The dispatcher should determine percentages of each product in the interface to be cut into the adjacent products.
- The mixture is divided between the two adjacent products, usually at the mid-gravity point. This provides minimum contamination for both products if blending tolerances are considered. Dispatching personnel should determine percentages of each product in the interface to be cut into the adjacent products.
- The whole interface is taken off the line into a slop tank and is blended with incoming products later. This mixture becomes a new product with its own identity. Dispatching personnel should determine the percentages of product in slop tanks that are to be used in blending.

BATCH DESIGNATION

4-243. Product code numbers form the first part of a numerical batch designation. The batch number forms the second part. For example, 1-21 is the batch designation for the twenty-first batch mogas pumped since the first of the fiscal year. Product code numbers in a pumping sequence may be in numerical order. Batch numbers are assigned for each fiscal year, beginning with number one for the first batch of any fuel. Pump stations record the numbers of passing batches at all times. The time of each batch change is recorded and reported to the dispatcher.

DETECTION OF BATCH CHANGES

4-244. In control of product flow through the pipeline, it must be determined where one batch ends and another batch begins. The following methods are used to detect batch changes in the pipeline:

- Batch changes may be detected by differences in gravity of two adjacent products. There may be a great difference, as between mogas and JP8. There may be little difference, as between DF1 and DF2.
- Batch changes may be detected by differences in color of two adjacent products. There may be a great difference in color or almost no difference.
- Kerosene or some neutral product (in a relatively small amount) may be used as a liquid buffer to separate incompatible products. Water is not used to separate products.
- A physical buffer is an object, such as a pig, rubber ball, or scraper constructed entirely of polyurethane, placed in the line to separate batches and cut down on the interface.
- A plug of dye is injected into a line to separate like products belonging to different customers. Also, it is used to separate similar products with little or no color differences, such as DF-1 from DF-2.

BATCH RESIDUES

4-245. After deliveries and in idle pumps or stations after shutdowns, fuel stays in delivery lines, dead ends of pipes, and manifolds. Pipe 6⅝-inches in diameter holds about 1½-gallons per foot. Fuel in delivery lines should be displaced as much as possible before new deliveries are started. Pumps and pump manifolds of an idle station may have 5 or 6 barrels of fuel. This residue should be kept current with changing batches so that it is not pumped into the line at the wrong time. A pump or pump station not on the line should be started up just before each batch changes and idled through the change to flush the system.

PRODUCT CUTS

4-246. There may be times when product cuts are needed. A number of factors must be considered when making such cut.

DETERMINING THE CUT

4-247. The type of batch change being made determines the right time to make the cut. A line sampling station may be a distance upstream from the pipeline manifold. This distance is equal to a specific time interval, usually about 15 minutes at the normal rate of flow. The interval is not specified, but it should be known because it represents the time available to prepare for the cut. Also, the interval determines the actual time of the operation.

Preparing for Color Change

4-248. While preparing for a color change, the sampler should take a sample from the line before the change is expected. Beginning with the sample in which the first change is noted, successive samples are taken at one-minute intervals. These samples are arranged in the order taken so that a definite time can be fixed for the first and final change.

Preparing for Gravity Change

4-249. When preparing for a gravity change, the terminal operations officer or the dispatcher gives the station the corrected API gravities of the two products. These gravities are converted to the gravities at the existing line temperature. This gives the complete gravity range through which the batch change will take place. The gravities must be converted each time the line temperature changes. Observed gravities and the times are recorded from the first change to the final change.

MAKING THE CUT

4-250. The terminal operations officer or the dispatcher issue instructions for making a cut. The sampler watching the batch change is the key person in the operation. When the time comes, the sampler or an assistant operates the valves to make the cut.

DISPATCHING AND RECORDS CONTROL OF PRODUCT IN PIPELINES

4-251. The dispatching and records control of product in the pipeline entails maintaining a record of daily, weekly and monthly operations. Product control also involves accountability and management products in the pipeline. Dispatching is the process for controlling the movement of products through the pipeline by regulating pump stations and line pressures. Such control may be exercised in theater early entry operations, by the petroleum pipeline and terminal operating company operating the receiving or base terminal.

DAILY PUMPING RECORD

4-252. The format may be changed locally to suit local needs or the requirements of higher headquarters. The daily pumping record details operations of the whole line in the same way the station log details station operations. The chief dispatcher uses data in hourly operations reports to keep the daily pumping record. The vertical axis shows a complete pipeline day beginning at 0000 and ending at 2400. The horizontal axis is divided into separate sections for each pump station and terminal in the pipeline system. Station sections are labeled by station number or location. The first section is used for the base terminal. Other stations and terminals follow from left to right downstream.

INFORMATION RECORDED

4-253. The tank column next to the left-hand time column is used to record the number of the tank from which fuel is being pumped. Cumulative input is the hourly batch total of fuel pumped. The initial station suction pressure is that supplied by gravity or a feeder pump. Individual pump discharge pressures and revolutions per minute are recorded to show any problems. Revolutions per minute should be the same for all pumps operating properly. Suction pressure for pump number 1 only is recorded. This is because the discharge pressure of pump number 1 is the suction pressure of the next pump when multiple pumps are on-line pumping at the same location. Cumulative takeoff at depots and terminals is the hourly total of deliveries from the line. Rate of flow beyond a takeoff terminal should be no more than the amount pumped into the pipeline minus the rate of takeoff. Therefore, rate of flow beyond a full-stream takeoff must be zero. The tank column for delivery terminals is for the number of the tank receiving product from the line. Temperatures also help samplers to see gravity changes. A section for remarks can be placed below each station section of the format. Batch numbers and changes, switching times, scraper launchings and arrivals, and other needed information may be put in the remarks section.

PREPARATION AND POSTING

4-254. The daily pumping record is prepared by the dispatcher on duty at designed times (for example, midnight and at 0700 or 0800). Postings for 2400 on the old sheet are carried over to 0000 on the new sheet. Properly arranged station logs help the dispatcher when he prepares and posts the daily pumping record. Batch changes, showing time of first and final change (gravity or color) and rate of flow, are posted in the remarks section. Discharge pressures should be monitored closely. Any drop in discharge pressure could be the result of a line tap or break. When a batch is completed at the terminal, the batch number and barrels pumped, since the initiation of the day, should be shown under the respective section. The number of barrels short or over for each hour should be entered in the end point block. The pipeline is over (black) when total deliveries exceed total pumping. The pipeline is short (red) when the total pumping exceeds the total deliveries. A cumulative (over or short) is carried for a complete day only. The cumulative total for each shift can be checked by subtracting the hourly deliveries from the hourly pumping since midnight.

GRAPHIC PROGRESS CHART

4-255. The graphic progress chart shows the position of batches and their progress through the pipeline. It is prepared one day in advance but maybe prepared covering up to a week. The chart covers a 24-hour period.

Preparation

4-256. The graphic progress chart is prepared as follows:

- Hours are shown on the vertical axis.
- Line fill terminals and pump stations are shown on the horizontal axis. Line fill is shown to the right of the midpoint, zero barrels. Scheduled input is shown to the left of the midpoint. The midpoint represents the base terminal.
- Terminals, stations, and branch lines are shown on the vertical lines at the corresponding downstream line fill distance from the input point or base terminal.
- To determine when a new product is to be started into the line, a horizontal line is drawn left from the entry point (base terminal). The line is drawn a distance equal to the number of barrels scheduled to enter. An adjustable triangle that has been preset for the desired rate of flow is used to draw a sloping, broken line from the end of the quantity line back to the base terminal time line. The point where the broken line crossed the base terminal time line shows the time that the new product must be started.
- A solid sloping line is extended to the right from the base terminal time line at the same rate of flow. The degree of slope of this line shows the pumping rate of the throughput line. If the terminal is told to strip product from the pipeline, the slope of the throughput line must be changed. The stripping action is shown by a broken vertical line.
- Shutdown of the line is shown by a broken horizontal line.
- The points at which the sloping lines intersect the vertical lines (terminals and stations) show schedule arrival times.

Use

4-257. The chart is put in use at midnight. The dispatcher transfers batch positions from the bottom of the previous day’s chart to the top of the new chart. Actual positions of a given batch are determined by hourly deliveries at terminals and the reported passing of interfaces. When batches are moving ahead of or behind schedule, the dispatcher can adjust the chart to show the change of the flow rate. The dispatcher draws a new broken flow rate line to project delivery. As a rule, the desired action is to adjust the flow rate temporarily to put the batch on schedule. Each hour, the dispatcher draws horizontal lines using the appropriate color for each batch to show the position of the different fuels in the line. When all the batch lines have been drawn, the chart represents all scheduled pumping and delivery operations for the day.

DAILY PUMPING ORDER

4-258. There is no set format for the daily pumping order. General guidelines for preparing the order are as follows:

- Time is shown in chronological sequence. Definite times should be shown for specific actions.
- Locations are shown from the base terminal through intermediate terminals and pump stations to the head terminal.
- Specific orders must be given for the respective terminals and stations. Orders should be stated briefly and clearly.
- All product and batch numbers must be designated.

- Amounts of products to be handled and type of interface cuts must be specified.

SECTION V – CLASS III SUPPLY POINT

4-259. This section covers the movement, establishment, arrangement, and operation of tactical class III supply points, particularly the FSSP. All examples concerning the number of personnel and amount of equipment are based on the supply section of a petroleum support company. Although the personnel and equipment may change, the principles and techniques will remain the same.

DUTIES OF CLASS III PERSONNEL

4-260. One of the most important tasks associated with managing a class III supply point is employment of its qualified personnel. The following should be addressed when determining personnel requirements:

- How many do you need for a specific operation?
- Where should you place them in relation to the equipment?
- What tasks should you give them to perform?

4-261. It is important that personnel at the class III supply point receive specific tasks, but their assignments should also be flexible. For example, if you have no issues scheduled for the FSSP, you can use the workers assigned to improve the fire walls around the collapsible tanks. On the other hand, there may be a time when the supply point, or a section of it, is not busy. Workers can then be used to improve the camouflage and concealment of the area, improve drainage ditches and roadways, make sure the safety equipment is serviceable, and perform operator and organizational maintenance on the equipment in the supply point. Although the number of persons you assign to a specific task may vary greatly with your mission, it is still possible to obtain an average number for each operation.

4-262. The duties of supervisors of the class III supply point should include the following:

- Conduct map/site recon and select a direct, efficient route, which is free of obstacles.
- Develop site diagram, operational procedures, and site SOP. The contents of the SOP should include the following, at a minimum:
  - References- all applicable references used to develop SOP.
  - Accountability, quality surveillance, refueling operations, safety, fire plan, spill contingency, environmental requirements, training, etc.
  - Purpose- reason SOP is being established.
  - Responsibility- responsibility personnel for each set of procedures.
  - Procedures- state which operating methods are to be used and intervals when applicable.
  - Signs and symbols- explanation of symbols and/or signs used.
  - Miscellaneous- any other pertinent information.
  - Special instructions.
- Apply risk management procedures tailored to the mission. Understand and supervise the risk management process, risk controls, and command guidance directed by higher headquarters assess variable hazards continuously and report risks and risk reduction measures as appropriate to the chain of command.
- Ensure class III supply point personnel follow all applicable petroleum handling safety measures. Firefighting and prevention measures must be established and incorporated in to the operation.
- Ensure environmental stewardship measures are followed.
- Enforce wearing of appropriate PPE as required.
- Supervise before-, during-, and after-operations PMCS on system's components according to unit SOP and appropriate TMs.
- Ensure communications with team and higher headquarters are in place in accordance with unit communications instructions and company/battalion SOP.
- Ensure proper quality surveillance is established and maintained.

- Supervise layout and operation of class III supply point according to unit SOP and appropriate field manuals/TMs. Ensure personnel are trained and licensed to operate the system.
- Ensure cover and concealment of vehicles, shelters, and equipment is employed, where applicable.
- Inspect the tanker. Review DA Form 2765-1 (Request for Issue or Turn-In).
- Notify section chiefs of tank vehicle arrival times. Prepare delivery and distribution schedules to avoid delays. Vehicle backup increases the risk of enemy attack.
- Properly document receipts, inventories, and issues quantities in accordance with the section II of this chapter and AR 710-2, unit SOP and appropriate regulations.
- Determine if loss or gain figures fall within the allowable loss or gain ranges. Investigate any unacceptable range deviation immediately to determine the cause.
- Ensure that personnel use DA Form 3857 (Commercial Deliveries of Bulk Petroleum Products Checklist) to receive petroleum from commercial sources.
- Supervise evacuation of class III supply point according to unit SOP and appropriate FMs/TMs.
- Supervise retrieval and packing of class III supply point according to unit SOP and appropriate FMs/TMs.
- Supervise handling of 500-gallon fuel drums by Soldiers with the military occupational skill of petroleum supply specialist, if required. Refer to appropriate field or TM for guidance on handling the 500-gallon fuel drum.
- Make sure that all personnel are on hand for the class III supply point operations. Personnel needed to operate a class III supply point and their primary duties are shown in *STP 10-92F15-SM-TG, Soldier's Manual and Trainer's Guide MOS 92F Petroleum Supply Specialist*. In some situations, you will have to augment personnel.

LAYOUT

4-263. After selecting the specific site(s) for the class III supply point, develop a flow plan for the most efficient and effective use possible. The goal should be to minimize the handling of products and containers as much as possible and simplify the process. The flow plan identifies steps which can be eliminated, combined, or changed to make the operation more resourceful. The flow plan can also show unnecessary delays in handling and transporting. When developing the plan, consider the location of bulk storage, packaged product storage. Also consider the flow of traffic and access points through the supply point. Only one-way traffic should be permitted in the supply point. Study and draw out the area, and make up a flow plan before the supply point moves to the new location.

OPERATION

4-264. The operation of the class III supply point consists of the receipt, storage and issue of bulk petroleum at class III supply points. The FSSP is the Army's primary class III supply point system however; these operational techniques can be applied to all class III supply point operations. Other class III operations include the following:

- Modular fuel system operations.
- Forward area refueling point operations.
- Assault hoseline operations
- Advanced aviation forward area refueling system operations
- Tactical petroleum terminal operations

4-265. Bulk petroleum is normally delivered to at the class III supply point in 5,000-gallon and 7,500-gallon tank semitrailers however; 2,500 gallons tank rack modules or the Fuel HEMTT tank truck can be used as well. Also, bulk petroleum can be received by petroleum tank cars and through the assault hoseline at the class III supply point. When bulk petroleum arrives at the class III supply point, it can be stored in various sized collapsible fabric fuel tanks. From the supply point, issues can be made to tank vehicles and tank cars, or transferred to other class III supply points via the assault hoseline.

4-266. Follow the same safety procedures and precautions as well as environmental compliance measures in chapter 3.

4-267. Products handled should be marked to identify them at each storage point with stenciled marks, decals or placards in accordance with appendix B.

PRELIMINARY CONSIDERATIONS

4-268. Some of the things to accomplish before receiving and issuing bulk petroleum are outlined below. They apply primarily to tank vehicles and tank cars. Appendix J provides a series of general checks on class III supply point loading and unloading procedures. Some of the items on the list, however, do not apply to tactical class III supply point operations, but apply to terminal operations instead.

4-269. Prepare and plan for a delivery schedule to avoid delays and interruptions at the class III supply point. Before the product arrives, the type and amount of product and the approximate date and time it will arrive must be identified and synchronized with other tasks.

MOVING FUEL OPERATIONS

4-270. Operations are normally maintained at an existing site while moving the equipment and operations of additional fuel system in order to maintain the continuous customer support during operations. Once the additional fuel system is established and operational, the pre-existing site can then breakdown and move to occupy a new location. This process is called "leap-frogging".

4-271. Use meters when available and applicable for a more accurate accountability of bulk petroleum distribution. Ensure meters are tested and/or calibrated at least every 12 months in accordance with AR 710-2.

4-272. When required, the adding and blending of CI/LI, FSII, and SDA additives to commercial JET- A1 to obtain JP8 is necessary to ensure JP8 is on-specification as suitable for use. Procedures for additive injection can be found in the appropriate manufacturer's manual.

INSPECTIONS

4-273. Inspections are the key to finding out how well the class III supply point is performing. Inspections give you firsthand information on how the equipment and products are maintained from day to day. Inspections let you make on-the-spot corrections. Inspections also provide information on the availability of required publications, accuracy of supply records and procedures, supply economy practices, care of tools and equipment, and status of authorized stock levels of equipment and repair parts. Follow the steps below when inspecting your class III supply point:

- Inspect the collapsible tanks and hoses in your supply point each day for signs of leaks, tears, punctures, unusual wear, and fabric deterioration.
- Inspect the operating equipment in the supply point daily to evaluate operator maintenance and ensure that the equipment is in good working order.
- Inspect fire-fighting equipment and drainage facilities weekly to see that they are in good condition.
- Make sure that the storage area is free of trash, weeds, or other combustible material.
- Survey the traffic control system often to ensure that traffic is routed efficiently. See that there is no unnecessary equipment in the area to hinder traffic movement or access to firefighting-equipment.

FUEL SYSTEM SUPPLY POINT

4-274. When you select the FSSP site, consider cover and concealment, road nets, dispersion factors, terrain, and site preparation requirements. Make sure the site is suitable for the fuel system layout.

4-275. Choose a site for the receiving, truck bottom loading, and vehicle refueling points that is next to a road in the class III supply point. Plan for ease in loading or unloading trucks and refuel vehicles without leaving the road nets in the supply point.

4-276. Consider the distance between items in selecting the sites for the equipment in the FSSP. These distances are approximate, and they can vary with the terrain, natural cover, concealment, hose available, and road nets. In the traditional set up, (tanks in a linear configuration) the 120K/300K FSSP, the inlet/outlet of the collapsible tanks are no more than 60 feet apart. For the 800K FSSP, the collapsible tanks inlet/outlet is no more than 100 feet apart. The tank spacing may vary when using layouts other than the linear configuration and the amount of hose available.

4-277. The site preparation must include a layout for the major items of equipment in the FSSP; the collapsible tanks, the pumps, and the filter separators. Slope the tank sites gently toward the manifold end to help drain the tanks when they are removed. Slope the site for each tank no more than one degree in the direction of the tank's suction port. Build a firewall around each tank. Make it large enough to hold the contents of the tank and 1 foot of freeboard. Information on berm size can be found in TB 10-5430-253-13. The pump and filter separator sites must be cleared of dry grass, leaves, and trash.

4-278. When placing the collapsible fabric fuel tanks and the associated firewalls and berms, tank space firewall and berm calculations and address in appendix K of the manual.

4-279. When handling two types of fuel (for example, JP8 and mogas), separate systems are required. One FSSP may be divided depending on the storage requirement however, if the FSSP is divided, additional equipment (pumps, filter separators, etc.) is required. If none of these arrangements are suitable, you may change them to fit your needs.

4-280. The best way to layout the FSSP is to put the collapsible tanks in their prepared sites first. Then put the pumps and filter separators in place and layout all the fitting assemblies and hoses. Then make the connections and attach the fuel- and oil-servicing nozzles. Make sure to place the components in position to conform to the arrangement choice for the fuel system. In addition, flow and volume meters should be placed within the FSSP to accurately account for the movement and transfer of fuel.

4-281. Place FSSP equipment onsite according to layout plan. Consider laying equipment in this order and in accordance with appropriate TM:

- Collapsible tanks.
  - Avoid stepping on bags as you unfold them.
  - Inspect bags, tank filler, and vent assemblies for serviceability as the tanks are laid out.
  - Check for proper torque of all bolts on the tank.
- Pumps and filter separators.
  - Place 350-GPM pump in position.
  - Lower retractable support and chock wheels on pumps.
  - Place 350-GPM filter separator in position.
  - Put shims under skids to help level them.
  - Ground each pump and filter separator when placed.
- Fitting assemblies/hoses.
  - Ensure suction hoses are on the receiving side of system and discharge hoses are on the dispensing side.
  - Place a 3-inch discharge hose at tank truck bottom loading points.
  - Place a 1 1/2-inch discharge hose at 500-gallon collapsible drum filling points.
  - Place a 1-inch discharge hose at vehicle refueling points.
  - Keep all dust plugs and caps on hoses and fittings until they are connected.
  - Ensure hose end strainers are emplace in accordance with appendix R.
- Fuel- and oil-servicing nozzles.
  - Attach nozzles to 1-inch discharge nozzles. Make sure each nozzle has a dust cover.
  - Place supports under nozzles to prevent them from lying on ground.

- Assemble FSSP equipment.
  - Position and connect components as outlined in appropriate TM.
  - Recheck all connections to make sure they are tight. Ensure drip pans are in place under nozzles and other connections that are likely to leak.

4-282. The operation of the FSSP consists of three areas: the receiving side, pumps and valves and the dispensing side. Ensure there are sufficient resources available, to include personnel, operational equipment, external support, safety and environment equipment and communications equipment to operate the class III supply point efficiently and effectively.

- The receiving manifold is the point where bulk petroleum is transferred bulk the transporter to the fuel system.
- Pumps and valves control the flow of the fuel throughout the entire system on the discharge and receiving manifold of the collapsible tanks.
- The dispensing side of the system is the part of the system that delivers bulk fuel out of the system to tank vehicles, aircraft, retail points and other systems.

MODULAR FUEL SYSTEM

4-283. The PRM and TRMs within the CSC are primarily used to support BCTs with ROM, forward positioning of bulk storage and distribution, and bulk replenishment. These various concepts are described in the following paragraphs.

4-284. The TRMs within the CSC can be used for bulk replenishment operations to BCTs. Full TRMs are sent forward where either the TRMs are swapped for an empty TRMs or the fuel is transferred to empty HEMTT Tankers.

4-285. The CSC can provide one ROM point in support of a BCT using MFS (PRM and TRMs). A ROM mission is a heavily coordinated on call operation. It supports onward movement of forces by providing a quick refueling capability while they are in route. Fuel dispensing is usually measured in dispensing time to individual combat platform versus gallons issued. Further details on ROM operations are described in section VI.

4-286. With TRMs, the MFS can be used to rapidly establish a bulk storage site. Collapsible storage tanks, hoses and fittings can be removed from FSSPs and used with the PRM to form a larger capacity bulk storage site.

4-287. TRMs are used to support retail replenishment operations. The TRM, while coupled with a HEMTT Tanker, forms a 5000-gallon distribution platform. In this configuration, the TRM can be the fuel source while using the HEMTT Tanker's pump, hoses and nozzles to provide fuel to combat platforms. If time permit, the fuel can be transferred from the TRM to the HEMTT tanker.

4-288. The TRM has an electric pump, one hose and retail nozzle. It is capable of performing retail operations while mounted on a HEMTT-LHS, PLS trailer or on the ground.

SECTION VI – REFUEL ON THE MOVE

4-289. The following section discusses the concept, planning considerations and employment of the refuel on the move (ROM).

CONCEPT

4-290. The Army's highly mobile force depends on fuel to sustain it on the battlefield more than it ever has in the past. A mobile and maneuverable force needs large amounts of fuel in a timely fashion to maintain its offensive posture. Combat forces must be refueled efficiently, rapidly, and safely. For combat forces to remain maneuverable, fuel resupply must be flexible and innovative.

4-291. Although ROM can be tailored to other tactical situations, the two primary purposes of a ROM is to:

- Provide a "fuel splash" for convoy movements to extend maneuverability to reach the intended destination when complete refueling operations are either not practical or unneeded.
- Provide fuel between engagements to extend the time that U.S. forces can spend on the objective.

4-292. When vehicles enter a ROM site for refueling, a predetermined amount of fuel is issued (usually timed) and the vehicles move out to return to their convoy or formation. The rapid employment of the ROM distinguishes it from routine convoy refueling operations.

4-293. The manner in which this refueling is done depends upon the tactical situation. Each refueling operation is unique depending on the number of vehicles to be refueled, the distance the unit is traveling, and how many times the unit wants to be refueled. However, the assembly and operation of each ROM are basically the same.

4-294. Ideally ROM operations utilize rear fuel assets while forward assets remain full. In the BCT concept, ideally the distribution company conducts the ROM, while the forward support companies pass through remaining full. The concept can be extended based on the size and scope of the operation, for example the combat sustainment support battalion can be the force conducting the ROM for the whole division, while the entirety of the brigade combat team's fuel assets push through remaining topped off.

4-295. ROM operations can be conducted by any level unit to meet mission requirements. Typically, a forward support company will conduct ROM operations to support maneuver units between engagements or to increase time on target while maneuver units peel back and flow through the ROM and return to the current engagement.

4-296. A ROM can be as simple as utilizing HEMTTs or MFS, and as complex as needed utilizing any equipment available to support the largest of movements.

PLANNING CONSIDERATIONS

4-297. In planning a ROM operation, METT-TC must be considered. Based on these considerations, identify plan, and conduct the type of ROM operations that best support the commander's scheme of maneuver.

MISSION

4-298. The mission drives the need for ROM operations. Since the ROM site is a vulnerable, high value target, consider other refueling options which will do the mission. ROM missions are most often used to support extended moves to a tactical assembly area before an attack or before retrograde moves.

ENEMY

4-299. Known or expected enemy activity in the area of operations and area of interest must be considered. Clear and secure the ROM site before the fuel trucks arrive. Risk increases significantly as the ROM gets closer to the enemy. Consider enemy artillery range when choosing the ROM sites and concealing its operations. Air defense assets should support the ROM site if there is any enemy air threat.

TERRAIN

4-300. A thorough terrain analysis is an essential part of a successful ROM operation. Examine the routes of march, supporting road networks, cover and concealment, the locations of check points, and whether or not the terrain can support loaded fuel trucks and high traffic flow. A movement using multiple routes of march may require several ROM sites. Wet, swampy, or restrictive terrain will not support most ROM operations due to the weight of the fuel trucks and the high traffic flow.

TROOPS

4-301. The status of combat vehicle crew and supporting unit Soldiers must be analyzed. Do they have enough crew members to operate the issue nozzle themselves and let the driver remain in the vehicle during refueling? Are the Soldiers trained on ROM operations? Analyze the forces available to secure the ROM site and perform traffic control.

TIME

4-302. Time must be considered. Consider the time it will take to cover the distances vehicles will be moving; the amount of time available to coordinate, secure, establish, and camouflage the ROM site; the acceptance rate of unit vehicles and the number of minutes of fuel they will receive. Also, determine how far in advance of the main body the security force and fuel trucks can deploy while still concealing the projected unit move. The ROM site personnel must ensure each vehicle receives the correct number of minutes of fuel. If not, the following march units will back up. A ROM planning tool is located in appendix T.

CIVIL CONSIDERATIONS

4-303. The civilian population and traffic in the surrounding area of the location of the ROM must be considered before selecting a location. The location should be in the least populated and travelled area by the civilian population as possible. Civilians can cause disruption in the execution of the ROM and require enhanced security as their population in the ROM area increases.

ESTABLISH THE ROM SITE

4-304. Prior to selecting the site layout for the ROM, the information gathered from the METT-TC analysis should be considered. Make the most use of natural cover and concealment. Consider all environmental safety and mishaps when selecting the site to mitigate the risk.

EQUIPMENT PLACEMENT

4-305. Ensure there is enough room in the site to allow minimum spacing between vehicles. Ensure the vehicles being refueled by the ROM have the most efficient entry and exit lane possible.

VEHICLE HOLDING/MARSHALLING AREAS

4-306. Set up the vehicle holding/marshalling areas at locations before and after the ROM site. ROM site executors establish these areas using the following criteria.

- Coordinate areas prior to the execution of the operation.
- Use the area prior to the ROM site to organize the march column into serials of vehicles equal to the number of refueling points available.
- Move the vehicles forward out of the holding area one serial at a time into position to receive the predetermined amount of fuel using "follow me" vehicles.
- When each serial has received its allotted fuel, it moves to the holding area, after the ROM site. In the second holding area, organize the vehicles back into their convoy march elements or combat formations

OPERATION

4-307. Successful conduct of ROM operations will require all units to work together, to include both supporting and supported units. The operation must cover details of the organization, sustainment, and protection of ROM site(s) and the timely, synchronized execution of the overall operation.

RESPONSIBILITIES

4-308. Determine support requirements to conduct ROM operations and coordinate for external support, if required. Coordinate with higher headquarters for operational and intelligence data. Analyze all factors involved, including the METT-TC, to determine the type of refueling operation needed to support the mission. Assist in the selection of the ROM site based on the METT-TC, the ROM configuration, and the established march route. Coordinate for ROM security support prior to execution. Coordinate with the military police for traffic control support at the site, if required. Receive, review and coordinate for estimated fuel requirements.

4-309. Set up, perform PMCS, operate, and retrieve the equipment used in the operation. Ensure safety equipment is in place and personnel are familiar with procedures. Ensure personnel are familiar and equipped with operational control signals (flags, lights, radio) to be used. Man fuel nozzles to refuel vehicles when convoy personnel (assistant driver or commander) are not available to refuel their own vehicles. Ensure vehicles safely enter and move through the ROM site and receive the prescribed amount/time of fuel.

4-310. March unit commanders are subordinate to the ROM site commanders during the refueling operation. Before entering the ROM site, vehicle operators prepare to stage in accordance with unit SOP. March unit personnel take instruction from ROM personnel. ROM site personnel regulate the amount of fuel issue in accordance with the predetermined limits. Unit SOP should establish vehicle drivers will remain in their vehicles during the entire operate for timely flow. Unit SOP will also establish hand and arm signals that are best suited for the guiding and flow of traffic through the ROM.

ROM EQUIPMENT CONFIGURATION

4-311. ROM is a concept that is equipment independent. As long as the concept is followed, any number of current equipment configurations can be used to do a ROM operation. ROM operations can be employed anywhere on the battlefield where there is a need to rapidly refuel combat vehicles.

4-312. The ROM is can be configured in various methods. Figure 4-4 shows a recommended layout and marshaling areas for a ROM operation. This set up is referred to as the long site configuration. The ROM can be set up any number of ways using any combination of trucks, semitrailer or HEMTT, and equipment available, such as FSSP, HTARS, or AAFARS hoses.

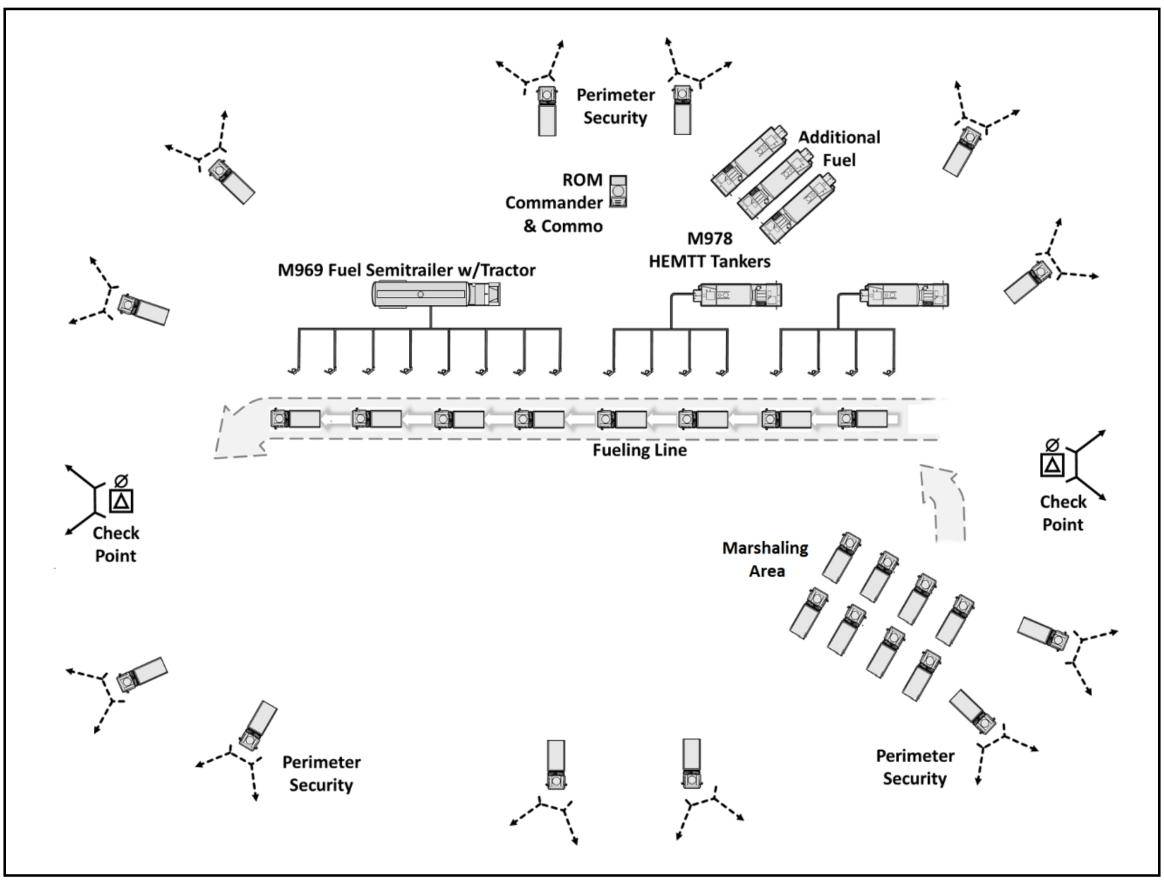

Figure 4-4. Example ROM layout

4-313. If conducting multiple tanker operations, fuel should not be received into and dispensed out of the same tanker at the same time. This would only be possible through top loading, which is a safety hazard. As a tanker is emptied, the fuel dispensing source is transferred to the backup tanker by the resetting of the values at the Y and/or T. This will allow fuel issues to continue to the combat vehicles. Fuel semitrailers can be shuttled to and from the ROM site to maintain a fueling tanker on-site.

4-314. The ROM layout can be configured in a way that the refueling vehicles are parallel to the vehicle receiving fuel when operations are conducted. This is referred to as a short site configuration as shown in Figure 4-5.

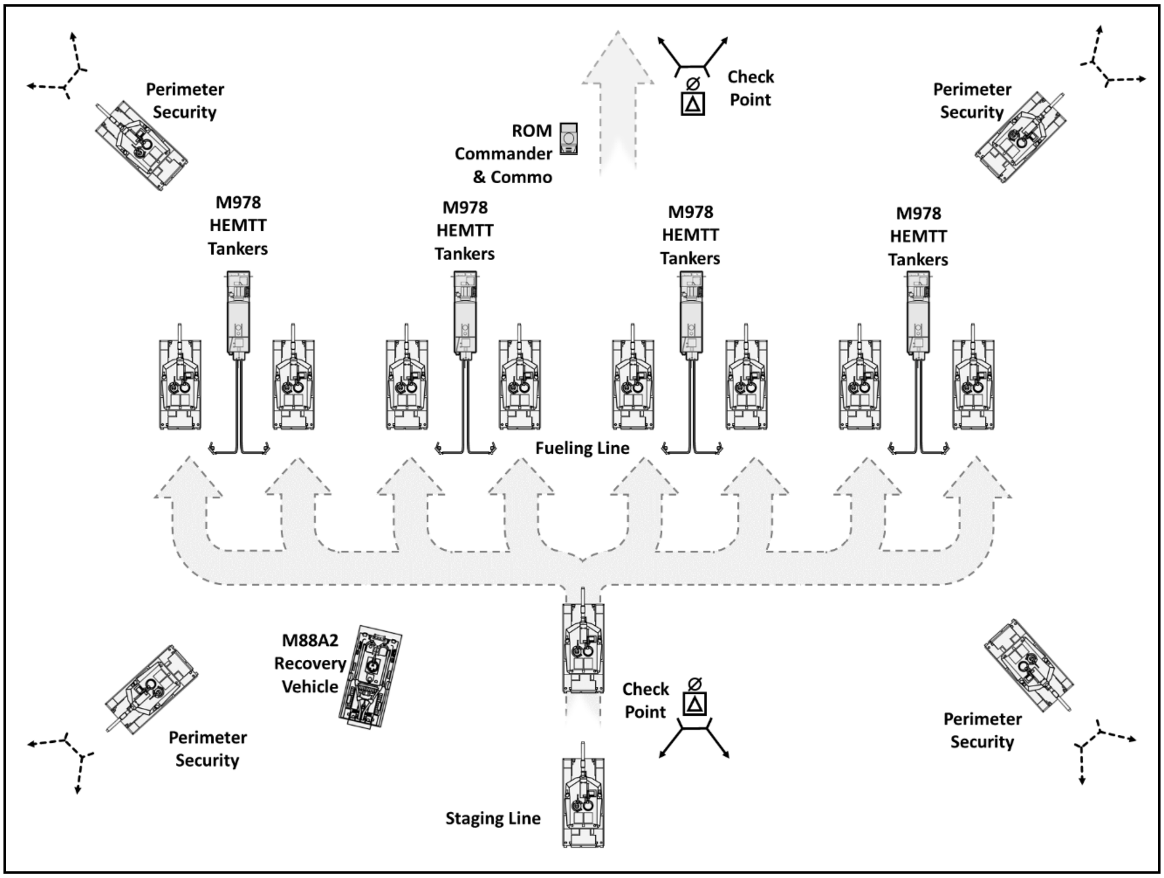

Figure 4-5. ROM alternate configuration layout

Mini-ROM

4-315. Setting up several Mini-ROMs, dispersed within the same general area, can reduce the vulnerability and risk of the operation in some cases. More security personnel may be required to cover the larger operational area. More traffic control personnel may be required as a result of the multiple ROM sites.

COLLAPSIBLE FABRIC FUEL TANK(S) WITH PUMP AND FILTER SEPARATOR

4-316. Collapsible fabric fuel tanks could be used as the fuel source in ROM operations when the tactical situation does not dictate a highly mobile refueling system and large quantities of fuel are paramount.

4-317. The ROM system using collapsible tanks should be avoided in forward areas where vulnerability to enemy actions and lack of mobility expose operations to high risk. Planning for ROM operations using collapsible fabric fuel tanks should take into account the additional terrain requirements. The terrain must be level and free of debris. Additional area is required for setting up the equipment (for example, collapsible tanks, pumps, and filter separators).

NIGHT OR LIMITED VISIBILITY OPERATIONS

4-318. Night or limited visibility operations add risk to the ROM execution and could possibly delay operations.

4-319. Special considerations for night or limited visibility operations are should be implemented to mitigate the risk and reduce the possible delay to the execution of the ROM. These considerations are listed below.

- The use of a lighting system and lighting signals, such as chemical lights, flashlights or bag lights is required to guide vehicle operators through the ROM and to signals between ROM site personnel.
- Radio communications should be a requirement in night operations to allow an increase in control of vehicle movement.
- Conduct daylight rehearsal to ensure all ROM personnel involved in ROM operations know their role in the execution of the night or limited visibility ROM.

SECTION VII – AIRCRAFT REFUELING

4-320. This section provides guidance for Army aircraft refueling operations. It provides an overview of techniques and systems to be used by aircrews, ground crews, and other refueling point personnel during aircraft refueling and defueling. Step-by-step procedures of specific tasks can be found in the appropriate TM, STP or other appropriate regulation. This section is oriented toward operations at temporary and forward area refueling points. The quality surveillance section of this chapter covers section covers quality surveillance related aircraft refueling and defueling.

4-321. Aircraft fuel distribution is accomplished through three means: rapid refuel points (RRP) and FARPs and mobile refueler. RRPs are established to rapidly refuel large numbers of aircraft during surge periods, such as air assaults. RRPs are generally longer duration operations that are time consuming to establish and difficult to move. The bulk fuel storage and distribution capability of the RRP allows the air assault task force to refuel a complete light and/or heavy serial simultaneously, thus minimizing ground time and enhancing the rapid buildup of combat power. Maintaining separation between heavy and light aircraft requires separating the RRP into heavy and light sections. The total number of points is METT-TC dependent. When operated by more than one unit, the RRP is known as a consolidated RRP.

Note: In most small helicopters, the fill port is on the right and the pilot's exit is to the right, so an accident at the nozzle could block the pilot's escape route. The copilot's exit is to the left; therefore, he usually operates the aircraft during refueling. Throughout this section, when the pilot is referred to, both the pilot and copilot are included.

4-322. Refueling can be accomplished with the aircraft engines turned on or running (hot or rapid refuel), with the aircraft engines operating off the auxiliary power unit (APU) (warm refuel), or with the aircraft engines turned off (cold refuel). Ensure that unit-specific SOPs are followed when refueling aircraft. Refer to appendix U for details of these methods.

4-323. For site selection detail and planning considerations, additional refueling safety, personal protective equipment, and basic crash rescue plan and training, see ATP 3-04-94.

TYPES OF AIRCRAFT REFUELING

4-324. In aircraft refueling operations, there are two nozzle types of refueling systems, closed-circuit and open port as is the policy for their use. The type of nozzle used influences the safety of the operation and therefore, refueling policy. Nozzles and hoses are equipment elements that are common to all refueling operations whether refueling service is supplied by a FARE system, a larger temporary system, or a refueler.

Closed-Circuit Refueling

4-325. CCR is a system of refueling in which the nozzle mates with and locks into the fuel tank. This eliminates spillage. Any closed system of aircraft refueling depends on two basic pieces of equipment a receiver that is mounted in the aircraft and a nozzle. These two pieces of equipment are designed for each other. They mate or lock together before fuel can flow through them. The Army uses two types of refueling nozzles to perform this operation. They are the closed circuit refueling nozzle (CCR) that is part of the FARE system and the D-1 pressure nozzle (also called the single point nozzle).

4-326. Use of closed-circuit equipment is especially desirable when aircraft are being serviced by the rapid-refueling method. Rapid refueling is used to reduce the ground time needed to refuel aircraft, particularly helicopters used in support of combat operations. Reducing ground time does two things. First, it reduces the amount of time that the aircraft is a stationary target. Second, it cuts the time that ground forces are without air support. In spite of its major advantage in a tactical situation, rapid refueling is less safe than refueling with the engines shut down. Closed circuit equipment is preferred because of its built in safety features. CCR prevents spills; prevents fuel vapors from escaping at the aircraft fill port; and prevents dirt, water, and other contaminants from entering the air craft fuel supply during refueling. These factors contribute to safe ground operations by reducing the fire hazard and safe flight operations by protecting the quality of the fuel used.

Open-Port (Gravity-Fill) Nozzle Adapter

4-327. An open-port nozzle adapter changes the CCR nozzle making it possible to service an aircraft using the open-port refueling method. The nozzle adapter is used when the aircraft is not adapted to CCR or when the CCR receptacle is damaged; the adapter is not used in closed-circuit refueling. The open port nozzle adapter is like the conventional nozzle used to refuel vehicles. It has its own dust cap. A squeeze-type, trigger grip opens and shuts the flow control valve of the adapter, but the flow control valve of the CCR nozzle itself must be open before fuel can flow.

4-328. Open-port refueling is refueling by inserting an automotive-type nozzle into a fill port of a larger diameter. Most of the Army’s fueling nozzles are designed for open-port refueling. Because the port is larger than the nozzle, fuel vapors can escape through the fill port during open-port refueling operations. Airborne dust and dirt, as well as rain, snow, and ice, can get into the fill port during refueling. This contamination lowers the quality of the fuel in the tanks and endangers the aircraft. Therefore, a 100 mesh screen is required in all open port refueling operations. Spills from overflowing tanks are possible in open-port refueling. Spills can be caused from the sudden power surge that occurs when another nozzle in the system stops pumping. This throws the whole push of the pump to the operating nozzle. Because of these dangers, rapid refueling by the open-port method is restricted to combat, vital training, or testing use.

4-329. No Army, open-port nozzle may be equipped to stay open automatically. Open-port nozzles must be held open by hand throughout their use in refueling. If any automatic device has been added to the nozzle to hold it open automatically, the device must be removed.

REFUELING POLICY

4-330. Except as indicated below, an aircraft may not be refueled with its engines operating. The engines must be shut down before refueling begins. The exceptions are described below.

- Closed-circuit rapid refueling. All Army aircraft may be refueled with engines running provided that closed-circuit equipment is used.
- Open-port rapid refueling. In combat operations, the open-port method of rapid refueling may be used for helicopters when, in the judgment of the aviation commander only, the requirements of the tactical mission and the benefits of reducing ground time outweigh the risks of this method of refueling. In noncombat situations, helicopters may be refueled by this method only when there are compelling reasons to do so. Example: Aviation commanders may decide that open-port rapid refueling must be done for purposes of training, field testing, or combat testing. When the FARE system is used for rapid refueling in a training situation, a berm should be built around the 500-gallon drums whenever possible.

AIRCRAFT REFUELING HOSE

4-331. Hose used for aircraft refueling operations must be in good condition. Hose should be inspected before use. If bulges, blisters, tears, excessive cracks, dry rot, or soft spots are noticed, replace the hose. If during normal operations the hose leaks or bulges, discontinue operations and replace the hose immediately.

4-332. Hose that has been removed from service because it failed when tested or is damaged may be repaired and returned to use after testing. If part of the hose is in good condition and is long enough, cut off the damaged part and replace the coupling. Be sure that the entire damaged portion is removed, including any part that shows signs of carcass saturation. If the hose leaks at the coupling juncture, cut off at least the portion that is inserted into the coupling. Test the recoupled hose at its operating pressure. Lengths of suction hose that are in good condition but too short to justify recoupling may be saved and prepared for use in defueling.

Note. Unisex fittings will not connect if the flow handles are in the flow position.

SITE LAYOUT

4-333. The tactical setup of the refueling/rearming system should take advantage of terrain features, thus achieving maximum dispersion and obstacle avoidance. When planning the layout, personnel must consider the minimum spacing required between aircraft during refueling. The spacing will depend on the type of aircraft and its rotor size; double rotor blade length is the standard separation. Extra care and diligent air traffic control must be taken for forward area refueling point operations that will facilitate multiple airframes. Other factors to consider are METT-TC, the required spacing between aircraft, prevailing wind direction, vapor collection, drainage, camouflage, and location of a passenger marshaling area.

SPACING BETWEEN AIRCRAFT

4-334. The spacing between aircraft depends on the type of aircraft, as well as the dimensions of the fuselage and the size of the circular pattern created by the rotor blades. The spacing reduces the possibility of collisions, and minimizes the impact of rotor wash damaging another aircraft. Table 4-1 shows the MINIMUM spacing to be used between aircraft during refueling/rearming operations. It may be necessary to provide additional spacing between refueling/rearming points (e.g. browning-out in desert terrain).

- The UH-60 is equipped with CCR and D-1 receivers. When the D-1 nozzle is available, it should be used. Otherwise, the CCR nozzle is used for refueling the UH-60.
- Use the same layout to fuel all of the small Army helicopters. The fueling nozzles must be placed so that there is a 100-foot space between nozzles.
- Establish a designated refueling point for CH-47 helicopters, if multiple airframes are being serviced at the FARP. Enough space must be allowed between a CH-47 and any other helicopters so that the rotor wash from the CH-47 will not impact other helicopters. This may be accomplished in one of two ways. One or two additional 50 foot discharges hose can be added in between points to achieve the required safe fueling distance between helicopters. A second approach is to ensure that the adjacent refueling point remains empty during refueling of the CH-47. This will provide the necessary spacing between refueling points until the CH-47 helicopter has departed the forward area refueling point. If a CH-47 is refueled at a two-point refueling system, have it land between the two nozzles and do not allow other aircraft to land at the other point until the CH-47 has cleared the area.

Table 4-1. Minimum distance rotor hub-to-rotor hub

Aircraft	***Distance (feet)***
CH-47	180 (side by side); 140 (nose to tail)
UH-1, UH-60, AH-64, OH-58	100
AH-64 and all other light aircraft	150 (side by side)

Note: UH-72s will not be hot refueled (open port) without express permission by the aviation commander.

WIND DIRECTION

4-335. In an area that has a prevailing wind pattern, lay out the refueling system across the wind (at a right angle to the wind) so that helicopters can land, refuel, and take off into the wind. Because this arrangement is not always possible, the recommended layout provides sufficient distance between nozzles to allow aircraft to land into the wind regardless of wind direction. Similar approaches and landing directions apply to CH-47 helicopters.

VAPOR COLLECTION

4-336. Another advantage of a crosswind layout is that the wind will carry fuel vapors away from, rather than across, the refueling point. Because fuel vapors are heavier than air, they will flow downhill. For this reason, lay out the refueling point out on the higher portion of a sloped site and not in a hollow or a valley.

DRAINAGE

4-337. Position the refueling point on a part of the site that is firm. Do not lay out equipment in a place where a spill will drain into a stream, river, wetland, seashore, lake, or other environmentally sensitive area.

CAMOUFLAGE

4-338. If time, terrain and threat level permit, camouflage or emplace the refuel vehicles along the edging of natural terrain to mask the vehicular outline.

PASSENGER MARSHALLING AREA

4-339. The layout of a marshalling area is not fixed, but is contingent on available space and needs of the unit.

OPERATION

4-340. Preparation for aircraft refueling operations have special considerations to mitigate the risk of mishap. The petroleum handling personnel must ensure all safety precautions have been taken. They must verify all safety and fire-fighting equipment is in place and serviceable. Landing lights should be checked, if they are required. As soon as the system is full of fuel and ready to operate each day, a sample must be drawn from each nozzle. If the fuel does not pass tests and inspections, do not use it. Isolate it, resample it, send the sample to the supporting laboratory, and await the laboratory's instructions on disposition.

4-341. Aircraft refueling operations are addressed in appendix U.

EMERGENCY FIRE AND RESCUE PROCEDURES

4-342. The best preparation for coping with an emergency is the firefighting and rescue training that all refueling personnel should receive. The procedures and guidelines of what personnel should do in a fire or crash emergency are found in ATP 3-04.94.

4-343. For detailed employment of the AAFARS, HTARS, FARE and modular fuel system, ERFS II, FAT Hawk in aviation support operations see ATP 3-04.94.

4-344. For details on the Forward Arming and Refueling Point Planning Checklist see ATP 3-04.94.

SECTION VIII – ASSAULT HOSELINE SYSTEM OPERATIONS

4-345. The AHS is used to distribute bulk petroleum to establish and maintain linkage between high volume users in a variety of configurations. The AHS can be temporarily connected to a rigid pipeline for bulk delivery of petroleum to FSSPs. Where railroad transportation ends, the AHS can be connected to railway tank cars to transport bulk fuel to class III supply points or bulk storage terminals. The system can be deployed and recovered over various types of terrain.

DUTIES OF ASSAULT HOSELINE PERSONNEL

4-346. Personnel duties and requirements of the hoseline layout will be according to mission requirements (i.e. distance and configuration of the layout), the unit SOP and the appropriate TM.

4-347. Duties of the personnel performing the layout and operation of the AHS should include the following:

- Personnel are required to dissemble the TRICONs and assemble the employment and retrieval system as well as the pumping unit in accordance with the appropriate TM.
- Operate a forklift to load/unload the employment and retrieval system.
- Personnel will be required to operate and maintain the pump(s) and generator.
- If security is a risk, personnel may be required to secure the hoseline.
- During the deployment or recovery of the AHS, personnel will be required to do the following:
  - The powered or manual deployment of the hoseline from the ERS.
  - Ground guide for the operator of the prime mover using appropriate hand and arm signals.
  - If required, assembly of the suspension supports kit, roadway crossing kit, and the AHS.
- Personnel must also be prepared to use the hoseline repair kit, pressure reduce stations support kit and the launching of the scraper when applicable.

LAYOUT

4-348. The assault hoseline deployment and layout should be according to the appropriate TM. The assault hoseline layout should be in accordance with the following criteria to properly layout the system.

4-349. Special considerations should be taken during the layout and retrieval of the assault hoseline to mitigate the hazard of a mishap. The following considerations should be adhered to when conduct AHS operations.

- Use correct hand signals.
- Do not exceed 20 miles per hour during deployment.
- Ensure coupling half are not caught on the power unit.
- Watch out for the safety of the hose line handlers.
- Keep limbs clear of equipment during reel operation.
- Ensure the control cable is under the hose line.
- Secure reels before operating the system across a slope.

ROUTE SELECTION

4-350. A route reconnaissance of the area between the stations in which the AHS is intended to be deployed should be conducted to determine the best, most efficient route to layout the hoseline and to produce multiple courses of actions to provide flexibility in the deployment. In addition, when planning the route, METT-TC analysis, as discussed with the ROM previously in this chapter, should be used to determine the route. Consider the following when completing route reconnaissance:

- Whether the AHS will operate independently or as part of a large system.
- Expected length of time the AHS will be required to operate.
- Elevation changes and total distance the AHS will encounter along its route.

4-351. Select a direct route which is free of obstacles. If possible, try to parallel an existing road to aid construction, operation, and security. A route parallel to a secondary, all-weather road is better than a heavily traveled main supply route. If the course curves vary to a great extent, construct a cross-country cutoff. Bypass difficult terrain such as marshes, swamps, and water courses. In addition, avoid heavily populated areas. Take advantage of natural cover and concealment such as fence lines, woods, and hedgerows. However, do not disturb the natural cover by grading or leveling. Avoid rocky areas, which might damage the hose.

DEPLOYMENT OF AHS

4-352. Deployment of the AHS involves the layout of the hoseline, pump, and obstacles passing equipment. A well planned route can simplify the effort of the system layout.

Crossing Streams or Gaps

4-353. If there is a bridge, suspend the hoseline on improvised brackets outside the bridge railing. If there is no bridge, lay the hoseline directly in the stream bed if it is narrow and not apt to flood. Use the hoseline suspension kit to cross a wide stream. The hoseline suspension kit should be used to cross gaps in the same manner as crossing streams. For a wide crossing, build a suspension bridge with a flat deck or floor to hold the hose. This eliminates the sags that occur when the suspension kit is used.

Crossing Roads

4-354. To cross a highway or railroad, run the hoseline under a bridge or through a culvert, if possible. You can pull the hoseline through the culvert with a rope or push it through with a piece of lumber or a small-diameter pipe. If there is no bridge, install the roadway crossing guard to protect the hoseline. Never bury unprotected hoseline in a railroad. When crossing a railbed, you can either install a piece of heavy wall pipe in a shallow ditch under the rails or suspend the hose over the railbed at a suitable height. As soon as possible, replace the hoseline at a railway crossing with welded pipeline because of the fire hazards caused by trains.

Pumping Stations

4-355. When selecting pump station sites, the location of the lead or first pump station will be determined by the location of the fuel source.

4-356. Pump stations are intended to be spaced at approximately one mile intervals, assuming that the route is reasonably direct and the terrain is level. However, a substantial rise or fall in elevation along the AHS route may require adjustment of standard spacing intervals between pump stations.

4-357. When substantial rise or fall in elevation occurs between two consecutive pump stations the following pump station movements must be performed:

- If the next downline pump station is substantially higher in elevation than the upline pump station, decrease distance between the pump stations.
- If the next downline pump station is substantially lower in elevation than the upline pump station, increase distance between the pump stations.

4-358. Adjusting distance between pump stations when elevation changes occur assures that the AHS pressure will be maintained within optimum operational range. Under optimal spacing conditions, the AHS will deliver fuel to the suction port of each pump station at a pressure of 20 pounds per square inch.

4-359. For AHS hydraulics, see appendix I of this manual.

Pressure-Reducing Stations

4-360. When you place the hoseline on a steep downhill slope for some distance, there may be more pressure on the hoseline than withstand. If this occurs, install a pressure-reducing station in the line to relieve the pressure. The station consists of a regulating (receiving) storage tank and pump.

Check Valves

4-361. Check valves must be installed in the hoseline system to keep the fuel from back flowing when the pump flow stops. A backflow is usually the result of the hoseline sections lying on an uphill slope. The check valve has a hinged disk, which closes when the fuel flows in the wrong direction and pushes against it. Place the check valve at the downstream end of the pump discharge manifold and near the bottom end in hoselines on uphill slopes.

Hoseline Testing

4-362. After layout of the assault hoseline, fill the system with fuel and run a pressure test to check for leaks. Start the pumps slowly, and raise the fluid pressure in the system gradually in increments of 50 pounds per square inch. Inspect the hoseline each time the pressure is increased. Repeat the pounds per square inch increases until the 350-GPM pump is at the maximum operating speed or 150 pounds per square inch is achieved. Even though the design burst pressure of the hose is higher, your test should not exceed the rated safe working pressure of 150 pounds per square inch. If the line pressure does not build up, cease operations because the line probably has a leak. Fix leaks at couplings, fittings, or valves by tightening, adjusting, or replacing gaskets.

4-363. For additional information on the maintenance of the AHS, see the appropriate TM.

4-364. AHS operations is similar to pipeline operations for the purpose of line operations, scheduling, batching and dispatching records. See petroleum pipeline operations in this chapter for information line operations, scheduling, batching and dispatching records.

SECTION IX – TANK VEHICLE OPERATIONS

4-365. Petroleum tank vehicles serve two functions. They may be used for fuel servicing or bulk transport. The major difference is that fuel servicing vehicles have a filter separator and bulk transporters do not.

PREPARATION FOR OPERATION

4-366. Petroleum tank trucks must have two mountable (minimum rated at 20 B:C), dry chemical fire extinguisher. The term "20 B:C" refers to the square feet (i.e. 4 x 5 feet) that the particular fire extinguisher can put out, when used properly. The "B:C" indicates the classification of fire that this particular fire extinguisher is designed to combat. Fuel trucks must be properly grounded and bonded during fuel transfer operations.

4-367. Use the appropriate TM or manufacturer operating manual for instructions on the operation, troubleshooting and maintenance on petroleum tank trucks and tank semi-trailers. Preventive maintenance checks and services must be performed to ensure petroleum tank vehicles are ready for operation.

4-368. Fuel will be circulated through the piping, filter separator, hose, and nozzle at normal operating pressure. The required fuel sample will be taken directly from the nozzle. Immediately after the container is filled, the cap and seal are secured to prevent evaporation and leakage. Conduct a visual inspection on the sample for color, sediment and appearance. Filter separator pressure differential must be checked and recorded. Check for current filter effectiveness test must be in accordance with the quality surveillance section of this manual. For recirculation procedures see appendix P.

4-369. Ensure proper distance between tank vehicles is established prior to operation.

4-370. Tank cars should be inspected before each use according to MIL-STD-3004. The inside of the tank, including the dome, should be free of rust, scale, dirt, and sludge before new fuel is loaded. These inspections should be made by those responsible for loading the fuel. Personnel responsible for cleaning the inside of tank cars and tank vehicles, whenever necessary, must be properly trained and have proper equipment.

4-371. All fuel, except gasoline, must pass through a filter separator before it is loaded into a refueler. It must be filtered again before it is pumped into an aircraft.

4-372. Tank vehicles must carry only one grade or type of fuel.

4-373. All grounding and bonding procedures must be followed in accordance with chapter 3 of this manual.

USE OF TANK VEHICLES

4-374. Operation and maintenance of vehicles must be in accordance with appropriate TM. When using the tank vehicle as a mobile filling station, the retail refueling points must be at least 25 feet apart. Ensure all spill prevention/clean up materials and kits are on hand during the refueling operation.

4-375. Refueling from a tank vehicle requires at least two people. If only the vehicle operator and his assistant are present, the operator should attend the pump and the assistant should handle the nozzle. A fire extinguisher should be within reach of each.

4-376. Equipment receiving fuel should have engines shutdown as a safety precaution. Refuel equipment using the appropriate nozzle for the task and ensure the procedure is in accordance with appropriate TM.

4-377. Ensure personnel conducting refueling are prepared for a fire emergency and the procedures in case of fire in accordance with unit SOP and chapter 3 of this manual.

4-378. When you receive bulk petroleum into a class III supply point from a tank vehicle, there are points to consider during transfer operations. Be cognizant of grounding and bonding, spill prevention, fire-fighting and prevention and the appropriate manifold valves to open and close during operations.

4-379. Always unload a tank car through the bottom outlet. However, if the bottom outlet is broken or you do not have the necessary adapter fittings, unload the tank car through the dome. No matter how you unload the car, always follow applicable safety precautions and the preliminary procedures discussed previously.

SECTION X – DEFUELING OPERATIONS

4-380. This section discusses defueling of equipment or containers, the safety precautions associated with defueling and the procedures. Defueling is the removal of fuel from a tank or container into a tank vehicle or fuel container.

METHOD

4-381. Fuel must be removed from the fuel tank of equipment when maintenance must be done on the fuel system, when the fuel level gauges are to be calibrated, and when work on the equipment requires use of electrical equipment or other equipment that might generate heat or sparks. The tank must also be defueled if the equipment is to be shipped or stored, in some cases.

4-382. Defueling is more hazardous than fueling because, even though relatively small amounts of fuel are involved, the procedure is more difficult and drainage provisions are usually inconvenient. All safety precautions must be observed. The general rule of defueling is that it must be done outdoors without damage to the equipment or its fuel system, without fuel waste, and without safety violations. Fuel tanks or containers must be defueled by power or by gravity. For speed and efficiency, power should be used to remove most of the fuel and only final draining should be done by gravity.

POWER DEFUELING

4-383. The bulk of the fuel in containers or tanks should be removed by suction using a powered pump. A pump/engine assembly or the pump of a refueler provides the power. The aircraft can be defueled either with a defueling tube or by using a piece of salvaged suction hose. The defueling tube or suction hose must not cause damage to the fuel tank or equipment.

4-384. A defueling tube is fitted onto the suction hose. The tube is inserted into the tank and most of the fuel is pumped out.

4-385. A piece of 1 or 1 1/2-inch salvaged suction hose may also be used to defuel equipment. Generally, the smaller the diameter of the end of the salvaged suction hose, the more suction power the pumping system will have over the fuel; thus, speeding the defueling process. The end that will be inserted into the tank is cut at an angle so that the reinforcing wire is cut only once. The cut end of the reinforcing wire is also rounded to keep it from damaging the fuel tank. The hose is inserted into the tank and most of the fuel is pumped out.

GRAVITY DEFUELING

4-386. Gravity defueling is the process of draining the tanks by opening the drain valves or petcocks of the equipment fuel system or tank. It is a slow and hazardous process. Some suitable container must be placed under the valves to receive the fuel. Except in an emergency, this method should be used only to complete the draining of the equipment fuel system after the bulk of the fuel has been removed by a pump.

DEFUELING TECHNIQUES

4-387. Prior to beginning the defuel operation, take samples of the fuel to be defueled from the aircraft's drains and inspect them for contamination. Only acceptable, non-suspect fuel should be defuel into an acceptable, on specification tank vehicle or container.

4-388. The defuel operator will determine the status of the fuel, that is, suspect or non-suspect. Fuel is considered suspect if the equipment has malfunctioned and the fuel is believed to have contributed to the problem or the fuel is thought to be of the wrong type. If the fuel is suspect, the commander of the defueling unit determines whether or not the defueling should occur. If it is decided the defueling should occur, the tank or container receiving the fuel must be sampled and tested in accordance with Section III – Quality Surveillance for this chapter.

4-389. The defuel operator will identify the amount of fuel to be removed from the equipment. Once the amount is determined, the defuel operator will ensure the equipment performing the defuel operation has enough space to receive the fuel.

4-390. Defueling must be done outdoors, except when the responsible commander directs indoor defueling. When defueling is done outdoors, general safety precautions must be followed. Situations may exist where defueling the equipment outdoors made be impossible. In such a situation, the responsible commander must be notified immediately and all alternatives to indoor defueling should be considered.

GENERAL SAFETY PRECAUTIONS

4-391. The general safety precautions for defueling are as follows:

- Both the equipment performing the defueling and the fuel tank or container being defueled must be properly grounded and bonded in the same manner as in aircraft refueling.
- No aircraft, vehicle, electrical equipment, open-flame device, or any other spark generator must be allowed to operate within 50 feet of the aircraft. Fuel tank openings must be at least 50 feet from any hangar or building. They must be the proper minimum distance from radar equipment.
- Proper PPE must be worn when conducting defueling.
- Engines and electrical systems of the equipment being defueled must be shut down.
- Only those personnel actually required to conduct the defueling operation and to operate the fire equipment are allowed within 50 feet of the aircraft.
- All defueling operations must be ceased if there is an electrical storm in the immediate area or if there is a fire, fuel spill, crash, or accident at the refueling point.
- The fire chief or senior fire officer will decide when a defueling operation warrants a fire truck and firefighting personnel present. Fuel service personnel will man fire extinguishers for all defueling operations.

TANK VEHICLE DEFUELING

4-392. There are considerations for defueling into a tank vehicle. The tank vehicle should be staged in the same position as when refueling, but parked as far from the aircraft as the length of the hose will permit. Park the tank vehicle so that there is a clear and open route to drive away from the aircraft in an emergency. The vehicle and equipment must be grounded and bonded as required. If the equipment has a drain port, attach the suction hose to the aircraft's drain port using the required adapters. Record the fuel drawn as a receipt on the proper document if receiving the fuel from a user end point or from an external organization.

CONTAINER DEFUELING

4-393. Gravity defueling is the removal of fuel from a container or tank using the weight of fuel and the fuel system's drain valves or petcocks to completely empty the system.

4-394. The process creates hazards and safety considerations must be followed to mitigate the risk. Fuel builds considerable static charge as it falls into the container. Fuel splashes and agitates the fuel already in the container. The person who opens the fuel system's drain valves or petcocks is likely to get his or her arm and sleeve wet with fuel. Fuel soaked clothing should be removed with care. A fire truck (as required) or personnel with fire extinguishers must stand by during the entire operation. The considerations for defueling into containers are similar to the considerations of tank vehicle defueling.

INDOOR DEFUELING

4-395. The same precautions apply to indoor defueling as outdoor defueling, except for the following exception:

- All equipment that presents a fire hazard must be moved outdoors and parked at least 50 feet away from the building.
- Doors and windows must be open to allow maximum ventilation and permit the force of a possible explosion to dissipate.
- All engines, electrical equipment, or other possible spark sources within 50 feet must be turned off. Do not start or continue the operation if there is an electrical storm in the immediate area or a fuel spill, crash, fire, or any other emergency.
- All personnel and equipment that is not required for defueling must be at least 50 feet clear of the operation.

EVACUATION OF HOSES

4-396. The evacuation of hoses is the clearing and draining of hoses during its recovery or replacement. It is necessary to clear and drain hoses prior to disconnecting the hoses from the system for environmental and safety purposes.

4-397. Considerations for evacuating hoses include the following:

- Set the fuel system to defuel from the dispensing points to the source of the fuel. This is simply reversing the pumping system to draw fuel from the dispensing points instead of pushing fuel.
- Once the system is drawing or clearing fuel, the hoses are rolled from the direction of the dispensing point to the suction pump source. As the hoses are rolled, the operator ensures that portion of the hose is completely drained before proceeding. If quick disconnect hoses are used, close the dispensing side of the hose prior to rolling. Once the hose is rolled and completely drained, close the pump side of the hose and disconnect.

DRAINED FUEL DISPOSITION

4-398. Drained fuel should be disposed of properly. Dispose of all drained fuel according to installation or local environmental policy.

SECTION XI – WATERFRONT OPERATIONS

4-399. Waterfront operations include the discharging and receiving of fuel through the OPDS to the BTU. The Army then assumes responsibility at the outlet side of the BTU. It is important for the Army petroleum fuel handler and planner to understand the aspects of petroleum waterfront operations in a theater of operations and how it is implemented.

4-400. Piers and wharves are permanent structures built in protected harbors. They are built using timber, concrete, or steel. Petroleum base terminals in developed theaters have piers or wharves equipped to load and unload tankers and barges. No vessel should be allowed to dock or moor within 50 feet of a vessel that is unloading bulk cargo, unless the depot officer or supervisor and the master of the vessel transferring cargo agree.

4-401. Piers and wharves at base terminals are equipped with ship-to-shore hoselines; standard 4-, 6-, 8-, or 12-inch pipelines; a loading and unloading manifold; valves; and fittings. Booster pump stations are installed where needed. Each facility should have at least one ballast tank with separate pipelines to receive and discharge water and an oil and water separator to remove product from ballast water during a transfer. Fire-fighting equipment must be on hand during transfer, to include a supply of water (preferably fresh water). Also, all piers and wharves must have the proper grounding connections for fuel transfer operations.

TEMPORARY STRUCTURES

4-402. Existing loading and unloading facilities in a developed theater may also require self-elevating piers and pipeline jetties. The self-elevating pier and pipeline jetty are described below.

4-403. A self-elevating pier is a steel barge which must be towed into place. It has jacks, caissons, and machinery that raise the pier above the water to form a working platform. Depending upon navigable conditions at the erection site, self-elevating pier may be employed as single piers butted against a beach or as finger, marginal, T-head, or L-head piers.

4-404. A pipeline jetty is a structure made of pilings and timber that extends as far as 1,000 feet from the shore. It is only wide enough to support pipelines and to provide a walkway with a 40 by 70 foot working platform at the tanker end. The pipeline jetties are used in protected harbors to transfer fuel.

RESPONSIBILITIES

4-405. Commanders of commercial tank vessels and commanding officers of military tank vessels are responsible for the loading plans for their vessels. Their decisions are final concerning the cargo layout. Petroleum shore inspectors inspect all vessel tanks and pipeline systems before loading. Their decisions on quality control of product are final.

4-406. The inspectors review the loading plans and consider bulkheads, lines, tank capacities, and trim. In the case of split cargo, the inspectors must ensure that the vessel is physically able to carry two or more grades of products without contamination. The inspectors make sure that bulkheads are secure and that there are double valves or line blanks to separate and to protect each system. If valves are used they must be lashed and sealed in the proper position and the seal numbers must be placed on the shipping document.

4-407. Shore operators must make sure that precautions are taken against fire, product contamination, and safety hazards. All loading plans must be coordinated between the ship's officer and the responsible shore authority. Shore attendants should know loading terms and factors governing vessel loading and unloading.

4-408. Prior to offloading refer to MIL-STD-3004 for testing requirements.

SECTION XII – TANK CAR OPERATIONS

4-409. The petroleum tank car is an addition capability for the transport of bulk petroleum by rail, where rail lines are available. Transport by rail enables higher volumes of bulk petroleum to be distributed over a theater of operations and increases flexibility. The petroleum tank car is described to chapter 2.

4-410. The use of rail facility must be designed and arranged so that the system can be easily and safely used to perform the off-loading and loading of bulk petroleum fuels. In addition, hazardous waste and environmental hazard considerations must be considered before construction. Refer to UFC 3-460-01, *Design: Petroleum Fuel Facilities* for details of facility design requirements.

4-411. Procedures for loading and unloading tank cars are given in appendix X.

SECTION XIII – CLASS III – PACKAGED PETROLEUM PRODUCTS

4-412. Packaged petroleum products are not the same as packaged petroleum fuels. Both are described below.

4-413. Packaged petroleum products include lubricants, greases, hydraulic fluids, and other specialty products that have been packaged at the procurement source. They are received directly from the vendor or issued through general supply depots or supply points following MILSTRIP.

4-414. Packaged petroleum fuels include fuel in reusable containers of 55-gallons or less. The containers used most often are 5-gallon cans, and 55-gallon drums. Fuels are usually issued in bulk. The need to transfer bulk petroleum fuels to packaged containers depends on such operational factors as the quantities required for daily operations, the capabilities of the units to receive and store fuels, the existence of a bulk distribution system, and the tactical situation.

> ***Note***: The management of packaged petroleum products is a general supply function. In some cases, the petroleum supply specialist may be tasked to perform these duties.

4-415. Soldiers storing or transferring class III products must accurately account for receipt, issue, and stocks on hand for both bulk and packaged products. Unit must ensure protection, maintain control, and provide an audit trail. Inventory all packaged petroleum products at least once a year according to procedures in AR 735-5, *Property Accountability Policies*. Adjust any inventory discrepancies.

- Aggressive management policies must be pursued to permit prompt and accurate identification of shortages or overages.
- Using unit commanders responsible for receiving storing and issuing packaged petroleum products performs the following:
  - Designates in writing a responsible individual to maintain control of all fuels and to provide an audit.
  - Customer or using unit commanders designate in writing a responsible individual to maintain control of all fuels and provide an audit trail.

4-416. All petroleum packaged products must be inspected at the frequencies established in MIL-STD-3004, or more frequently if desired for closer surveillance or when directed by USAPC. Quality surveillance of packaged petroleum will be conducted in accordance with procedures outlined in DA Pam 710-2-1. Unit will establish a packaged products standard operating procedure in accordance with AR 710-2.

4-417. Products must be checked against the DOD Quality Status List (QSL) during required inspections. FED-STD-793B will be utilized to extend shelf life of General Services Administration products. For greater detail on shelf-life management, refer to DOD 4140.27-M.

4-418. Products with expired shelf life that are not listed on the QSL should be reported to USAPC before submitting samples to a designated laboratory. When products are identified for shelf life update, those products will not be used until the laboratory analysis indicates the product meets use limits. Products with expired shelf life may not be used pending assurance that the items suitability for use has been verified through laboratory analysis.

4-419. AR 710-2 discusses the inspection criteria of all packaged product on-hand and in-storage. Active inventory should be checked regularly (1-3 months) in the QSL, and in the storage room by conducting visual inspections (ensuring containers are still intact, and that no leakage, unusual odors, or discoloration are present), and that product shelf-life expiration date has not been exceeded prior to identifying items that require sample submittal for lab testing. Activity will need to determine if they have enough product on hand to justify submitting a sample for testing to a DOD certified lab. The Army petroleum lab is DOD certified for testing, and is located at New Cumberland, PA. Only laboratories that have been DOD certified will be used for testing packaged petroleum products. If not enough product is on hand for test submittal, continue to use the remainder of the product until it reaches its shelf-life expiration date. At that point, product would need to be properly disposed of, or removed from active inventory, and placed in a temporary hold status known as: Condition Code 'J', which is an inactive inventory status. When items are in Condition Code 'J' status, labels should be placed on products stating "Not for Use". While in Condition Code 'J' Status for a maximum of 45 days. However, by checking the QSL, the activity will be able to benefit from any product extensions granted to other units/agencies that have submitted products for testing.

4-420. Packaged products petroleum management includes the following areas and must be adhered to by all organizations managing packaged petroleum:

- Ensure that high-flash and low-flash products are stored separately.
- Require that containers be inspected before they are placed in storage.
- Check that no containers are stored in direct contact with the ground.
- Ensure that packaged lubes stored outdoors are covered with tarpaulins or stored in sheds.
- First in, first out use policy; ensure that stocks are rotated so that oldest stocks are issued first.
- Inspect containers weekly for damage and leaks.
- Supervise the annual inventory of packaged products.
- Adjust inventory discrepancies according to AR 710-2 and DA Pam 710-2-1.
- Require collection of flammable producing materials prior to entering the storage area.
- Inspect all packaged (lubricant) products for shelf-life and containers condition.
- Required management of product shelf life.
- Use of the DOD Quality Status List to manage shelf life.
- Procedures for contacting the USAPC when items are not identified on the QSL.
- Marking of containers with new shelf-life test information.
- Segregation of off-specification items.
- Disposal procedures for off-specification product.

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Appendix A
Supply Chain Conversion from JP8 to F-24

This appendix provides technical guidance on supply chain conversion from JP8 to Jet A with Additives (F-24) as the primary kerosene based aviation product procured in CONUS. Jet A is the predominate product used by the aviation industry and represents over 90% of the CONUS jet fuel market. This appendix provides general procedures which are relevant in distinguishing CONUS/OCONUS operations regarding usage of JP8 and Jet A with Additives.

A-1. JP8 is a military fuel specification and a DLA Energy product accounting code, produced to MIL-DTL 83133, referring to jet fuel utilized in OCONUS consisting of commercial Jet A-1 fuel with three additives: Fuel System Icing Inhibitor (FSII), Static Dissipater Additive (SDA), and Corrosion Inhibitor/Lubricity Improver (CI/LI). JP8 is a military specification kerosene based aviation fuel. Additional basic facts: It has a freeze point of -47 degrees Celsius and will include anti-oxidants if it has been hydro-processed. JP8 can be used as a pre-positioned stock fuel, i.e., it can be stored for periods longer than 36 months without major concern. JP8's assigned NSN is 9130-01-031-5816. Its assigned NATO fuel product identification code is F-34.

A-2. F-24 is a NATO fuel product identification code referring to jet fuel utilized in CONUS consisting of commercial Jet A fuel with three additives: FSII, SDA, and CI/LI. It is governed by ASTM International D1655-14a, *Standard Specification for Aviation Turbine Fuels*. Additional basic facts: It has a freeze point of -40 degrees Celsius and may or may not include anti-oxidants if it has been hydro-processed. Currently, F-24 has a DLA Energy product accounting code of JAA and an NSN of 9130-00-359-2026.

Note: The JAA accounting code is also utilized for different variants of Jet A, i.e., Jet A "neat" (w/out additives), Jet A with FSII, etc. When receiving F-24/JAA, it is the responsibility of the Responsible Officer (RO) to ensure that delivery documentation reflects the product as F-24. However, if the receipt documentation reflects the delivery as Jet A, the required intra-governmental receipt limit additive levels reflected in MIL-STD 3004, must be annotated for acceptance.

A-3. JP8 and Jet A with Additives (F-24) are fully interchangeable fuels for aviation and ground use in accordance with Single Fuel Policy. TACOM Research Development & Engineering Center (TARDEC) (ground) and Aviation Missile Research Development & Engineering Center (AMRDEC) (aviation) approve CONUS use of Jet A with the full additive package (SDA, FSII, and CI/LI.). Prior to delivery, DLA Energy will fully additize Jet A at the intra-governmental receipt limit in MIL-STD 3004.

A-4. DLA Energy business rules for conversion to F-24. The end-state is to convert from JP8 to Jet A (with the additive package) within CONUS (this also includes Hawaii). The desired outcomes of the conversion include streamlining the CONUS supply chain by eliminating a military specialty fuel, increasing competition by improving the supplier base, and optimizing fuel storage facilities and the commercial transportation network. DLA Energy policy (P-21) defines the business rules that govern the transition from military specification JP8 to commercial specification Jet A with Additives (F-24).

A-5. Jet A with Additives will be identified as F-24. All Army installation level fixed storage and refueling equipment shall be marked F-24 in CONUS operations (this also includes Hawaii). Only those sources of Jet A that are identified as F-24 are authorized for tactical ground and aviation use. Tactical refueling equipment currently in service with JP8 shall be remarked as F-24 once F-24 has been received. Units that receive bulk F-24 at an installation bulk fuel facility will carry it as F-24 on unit level accountable records.

A-6. JP8 will continue to be the predominate fuel in OCONUS operations, therefore, Army installation level fixed storage and refueling equipment shall be marked JP8 in OCONUS operations. When a unit deploys, markings will be changed to JP8.

> ***Note:*** Jet A is not produced with an antioxidant therefore tactical equipment in Army Pre-positioned Stock (APS) storage shall continue to be fueled with JP8, JP5 or Diesel to mitigate any readiness concerns related to long term storage. United States Army Petroleum Center (USAPC) will coordinate all stock rotation requirements with Army users and DLA Energy, as required.

A-7. Use of JET A Neat. Use of Jet A neat, i.e., Jet A without additives, will break down engine parts sooner due to lower lubricity levels than diesel and JP8 and, as a result, is not authorized for use in Army ground equipment. Refer to AR 70-12 for primary and alternate fuels.

> ***Note:*** This guidance "does not" include manufacturers who have specified their equipment can "only" be operated with diesel fuel, or any fuel DLA Energy re-grades to meet the specification required to be used in ground equipment. If users are unsure of what fuel can be used when operating specific equipment, contact USAPC.

A-8. ASTM International D1655-14a and MIL-STD 3004 shall be used by installation and tactical labs for quality surveillance testing of F-24.

A-9. Instructions for marking equipment is provided in appendix B. Commercial equipment will be marked IAW MIL-STD 161G, *Identification Methods for Bulk Petroleum*. Commercial/installation CONUS based equipment is to be labeled with Jet Fuel F-24. All tactical equipment while in CONUS will be labeled F-24. OCONUS tactical equipment will be labeled JP8.

A-10. Tanks will not need to be cleaned, purged, or have filter elements changed prior to conversion from JP-8 to F-24.

A-11. Follow local guidance provided at the time of deployment when either entering or exiting a theater of operations, too many variations of requirements for tank preparation before deployment can exist to address them all. Theoretically, filter changes should not be required when arriving OCONUS provided fuel tankers or other fueling equipment are deployed with filters in place. Filters may also go back and forth between JP8 and F-24 over the authorized 36 month life span.

A-12. Testing requirements. The USAPC staff chemist will provide testing requirements/guidance on F-24 and JP8.

A-13. DOT HAZMAT Placard. The UN1863 HAZMAT placard is required to be displayed for both F-24 and JP8 in accordance with Department of Transportation policies.

A-14. Safety data sheets (SDS). Any commercial Jet A SDS provided from the issuing bulk fuel facility or vendor is acceptable for F-24. If a copy of a Jet A SDS is unattainable from the issuing bulk fuel facility or vendor, contact USAPC.

A-15. Contact USAPC for additional guidance required reference to JP8 and F-24.

Appendix B
Marking, Labeling and Placards

The purpose of this appendix is to discuss guidance for marking and placards for bulk petroleum vehicles, equipment and storage containers. Each bulk packaging, freight container, unit load device, transport vehicle or rail car containing any quantity of a petroleum product must be placarded and marked.

VEHICLE MARKING AND LABELING

B-1. Specific markings are required on all vehicles transporting hazardous material. The following are the required markings and their specifications:

- FLAMMABLE - marked on both sides and the back of the tank body, stenciled in block letters and numbers, 6 inches (152.4 mm) high and shall be of a color that contrasts with the background for visibility.
- NO SMOKING WITHIN 50 FEET – marked on both sides and the back of the tank body, stenciled in block letters and numbers, 3 inches (76.2 mm) high and shall be of a color that contrasts with the background for visibility .
- (Number) GALS – marked on both outside triangular guards near the manhole cover, with the gallon capacity stenciled in block letters and numbers, 2 inches (50.8 mm) high and shall be of a color that contrasts with the background for visibility.
- Military symbol for the type of fuel the tank contains, (e.g., JP8), marked on both sides of the tank body, vertically centered toward the rear of the tank. These markings should be 6 inches (152.4 mm) high for semitrailers, 4 inches (101.6 mm) high for trucks, and 3 inches (76.2 mm) high for two-wheeled trailers, and shall be of a color that contrasts with the background for visibility.
- EMERGENCY FUEL SHUTOFF (method of operation) – marked adjacent to each emergency fuel shutoff control in block letter also indicating method of emergency fuel shutoff operation, e.g., Push, Pull, Turn, etc. It shall be marked in letters at least 2 inches (50.8 mm) high and shall be of a color that contrasts with the background for visibility.

B-2. Each bulk transport vehicle containing any quantity of a hazardous material must be placarded on each side and each end with the type of placards.

- Visibility and display of placards: Each placard on a transport vehicle must—
  - Be securely attached or affixed thereto or placed in a holder thereon.
  - Be located clear of appurtenances and devices such as ladders, pipes, doors, and tarpaulins.
  - UN Number, the four-digit numbers that identify hazardous materials, and articles (such as explosives, flammable liquids, toxic substances, etc.) 1863 for Jet Fuels, 1993 for Diesel, 1201 gasoline, and 1203 for Avgas 100.

STORAGE TANK MARKING AND LABELING

B-3. Identify all pipelines and tanks as to product service by color coding, banding, product names, NATO designation, and directions of flow in accordance with MIL-STD-161G, *Identification Methods for Bulk Petroleum*. Mark valves, pumps, meters, and other items of equipment with easily discernible painted numbers or numbered corrosion-resistant metal or plastic tags attached with a suitable fastener. Ensure numbers correspond to those on the schematic flow diagrams and other drawings for the installation.

MARKINGS

B-4. Storage tanks must have the NATO fuel designation stenciled on each tank, along with the US designation (e.g., JP8 F-34; JP5 F44). Provide identification banding or coding on tanks and piping according to MIL-STD-161G and maintain and inspect according to paragraph 10.16.

IDENTIFYING COLOR

B-5. The method prescribed in MIL-STD-101C, *Color Code for Pipelines and for Compressed Gas Cylinders*, pertains to petroleum products and hydrocarbon missile fuels and is intended to reduce the chances of accidental mixing of products during operation of permanently installed military bulk storage and dispensing systems. MIL-STD-101C permits only the use of "yellow" as the identifying color for petroleum products and hydrocarbon missile fuels. All other colors will be removed or obliterated. In addition, MIL-STD-101C discusses general and detailed requirements as well as product groups and size of letters and bands.

Appendix C
Petroleum Product Factors

This appendix displays petroleum factors that enable the petroleum handler and planners to plan and execute petroleum operations.

C-1. Table C-1 shows the petroleum product factors of various types of petroleum products.

Table C-1. Petroleum product factors

Fuel	*API @ 60°F*				*Pounds per*			*Barrels per*			*Barrels/day to equal*	
	Range	*Average*	*Density @ 15°C (kg/m3)*	*Specific Gravity*	*U.S. Gallon*	*Imperial Gallon*	*Barrel*	*Long Tons*	*Metric Tons*	*Short Tons*	*One Metric Ton Per Year*	*One Long Ton Per Year*
Avgas (All)	60-75	66.0	0.7160	0.7165	5.9747	7.1761	250.94	8925.6	8784.6	7969.3	24.07	24.45
Mogas (All)	49-61	58.4	0.7447	0.7451	6.2141	7.4638	260.99	8581.6	8446.1	7662.2	23.14	23.51
Jet Fuels:												
JP4	45-57	53.5	0.7641	0.7644	6.3760	7.6582	267.79	8363.8	8231.6	7467.6	22.55	22.91
F-24/ Jet A	37-51	42.2	0.8141	0.8146	6.7933	8.1593	285.32	7850.1	7726.1	7009.0	21.17	21.51
JP5	36-48	41.0	0.8198	0.8203	6.8408	8.2164	287.31	7795.5	7672.4	6960.2	21.02	21.36
JP8/ Jet A-1	37-51	44.0	0.8057	0.8063	6.7232	8.0751	282.37	7931.9	7806.6	7082.1	21.39	21.73
JPTS	46-53	50.1	0.7787	0.7792	6.4979	7.8045	272.91	8206.9	8077.3	7327.6	22.13	22.48
TS1	37-51	47.0	0.7920	0.7925	6.6088	7.9378	277.57	8069.1	7941.7	7204.6	21.76	22.11
Diesel Fuels:												
F-76	36-46	36.0	0.8442	0.8448	7.0444	8.4610	295.87	7570.2	7450.6	6759.1	20.41	20.74
No.1 Diesel	30-42	41.2	0.8188	0.8193	6.8325	8.2064	286.96	7805.0	7681.7	6968.7	21.05	21.38
No.2 Diesel	30-42	37.0	0.8392	0.8398	7.0027	8.4109	294.11	7615.3	7495.0	6799.3	20.53	20.86
Cleaning Solvent	45-55	48.0	0.7878	0.7883	6.5738	7.8957	276.10	8112.1	7984.0	7243.0	21.87	22.23
Other Naphthas	50-74	62.0	0.7308	0.7313	6.0982	7.3244	256.12	8744.9	8606.7	7807.9	23.58	23.96
Kerosene	39-46	42	0.815	0.8156	6.8008	8.1683	285.63	7841.4	7717.5	7001.2	21.14	21.48
Residual Fuel Oils:												
IFO 380	12-21	13.7	0.9739	0.9745	8.1267	9.7609	341.32	6562.0	6458.4	5858.9	17.69	17.98
Fuel oil #6	3-25	13.3	0.9766	0.9772	8.1492	9.7880	342.27	6543.9	6440.5	5842.7	17.65	17.93

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Appendix D
Procedures for Testing Resistance to Ground

The following shows the methods for testing resistance to ground. There are two methods which require basic mathematical calculations; testing against a known ground and testing against two stakes.

TESTING AGAINST A KNOWN GROUND

D-1. When a ground rod is being tested against a known ground, the resistance of the known ground is so small that the total resistance in the test circuit is accepted as a measure of the ground rod's resistance. Since the known ground may be some distance from the ground rod being tested, inspectors should carry with them up to 500-feet of building wire, type TW, number 14 AWG or larger, solid copper (or any other solid copper wire number 14 AWG or larger). To test against the known ground, connect a 24-volt aircraft battery, the ground rod being tested, a multimeter, and the known ground in series. Read the battery voltage and the milliamperes flowing through the circuit. Use the following formula to find the resistance, E equals volts, and I equals milliamperes: resistance = (1,000 x E) ÷ I.

D-2. Take a second set of readings with the polarity of the battery reversed (reverse the flow of current in the circuit). Use the same formula to find the resistances. The average will approximate the true resistance of the ground rod.

TESTING AGAINST TWO TEST STAKES

D-3. Use this method of testing the ground rod's resistance when there is no known ground against which to test. Drive two test stakes (other ground rods) into the earth near the ground rod being tested. Use R1 to equal the resistance in ohms of rod 1, R2 to equal the resistance of rod 2, and R3 the resistance of rod 3. Test and compute the resistance between each pair of rods (rods 1 and 2, rods 1 and 3, and rods 2 and 3) using the method and formula used to test against a known ground. Let A be the resistance between rod 1 and 2 (R1 + R2=A). Let B be the resistance between rods 1 and 3 (R1 + R3=B), and C be the resistance between rods 2 and 3 (R2 + R3=C). Use these figures to solve the following equations for the resistance of the three rods:

- R1 = (A +B –C) ÷ 2
- R2 = (A + C – B) ÷ 2
- R3 = (B + C –A) ÷ 2

D-4. Not one of these resistances should be more than 10,000 ohms. If the resistance is higher, redrive and retest rods until resistances are below 10,000 ohms. If after continued tests the resistance is not below 10,000 ohms, remove the rod or mark it.

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Appendix E

Purging Petroleum Tank Vehicles and Rigid Walled Tactical Petroleum Tanks

This appendix provides guidance for draining/cleaning petroleum tank vehicles/rigid walled tactical petroleum tanks prior to deployments, Field Training Exercises (FTX) and any other instance where draining/cleaning is required. It focuses on existing procedures while improving on processes currently in place. All regulatory guidance remains in effect. For the purpose of this document, petroleum tank vehicles will be referred to as "tank vehicles" and rigid wall tactical petroleum tanks will be referred to as "tanks" for the remainder of this document.

GENERAL

E-1. There are times when tank vehicles/tanks must be drained, cleaned, and/or vapor freed. For the purpose of this appendix, vapor free is when using an explosive meter to test the atmosphere; the meter reads .0 for the lower explosive limit. Some examples when vapor free may be required are: transported by air; transported below deck on ships; when hot work is required for maintenance. Also, when changing from certain products or when the last product carried is unknown; cleaning/purging will be required. Mission, time available and location will determine the method to be used. It should be noted that atmospheric testing described in this document does not meet all requirements for confined space entry IAW OSHA 29 Code of Federal Regulations 1910.146. *Permit-Required Confined Spaces.*

PREPARATION OF TANK VEHICLES/TANKS

E-2. There are five basic options to prepare tank vehicles/tanks for storage, deployment, FTX or maintenance. These options are described in paragraphs E-3 through E-7. For all methods, contain and capture as much product as possible when draining in containers and drums for turn in. Turn in according to the local environmental office procedures and IAW SPCC Plan for appropriate disposal.

Note: If the tank vehicle/tank has a filter separator, the elements and canisters must be removed. If the canisters are not damaged, they are reusable.

E-3. The drain empty option requires the following procedures:

- Ground and bond the tank vehicle/tank.
- Follow procedures in the appropriate vehicle/equipment technical manual (TM) to completely drain the tanker shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.
- If applicable, remove filter elements and canisters from the filter separator.
- Ensure all low points within the system have been drained.
- Once all fuel has been drained, close all valves, hatches and nozzles. Replace all caps and plugs.
- Install new filter elements in the filter separator if required.

E-4. The natural/forced ventilation option requires the following procedures:

- Ground and bond the tank vehicle/tank.
- Follow procedures in the appropriate vehicle/equipment TM to completely drain the tank shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.
- If applicable, remove filter elements and canisters from the filter separator.
- Ensure all low points within the system have been drained.

- Ensure all hatches, valves and nozzles are open and all caps and plugs removed. Natural ventilation may take more time than forced ventilation to vapor free the tank vehicle/tank. Note: If using natural ventilation go to step 9.
- For forced ventilation, the air mover may be mounted on the tank shell or connected through suitable air ducts. This will push air into the tank compartment fill openings on top of the tank shell. Air movers, including fan blowers must be approved for use in Class 1 Division 1 environments (explosive-proof). Air movers must be bonded to the tank shell.
- Whether using an air mover or ducting to connect to the fuel compartment hatch on the tank, ensure a tight seal is obtained. Use tape if necessary to seal the compartment opening completely.
- Turn on the air blower and force air into fuel compartments, piping, system components and hoses.
- When vapors are released into the open air, precautions must be taken to eliminate ignition sources near the point of release.
- Using an explosive meter, frequent testing of the atmosphere for vapors is required to determine the effectiveness of the ventilation.
- When dry and vapor free, close all valves, hatches and nozzles. Install new filter elements in the filter separator if required.

E-5. The steam dry option requires the following procedures:

- This procedure will be performed at the DOL maintenance or through a commercial contractor. The following procedures must be performed prior to having the tank vehicle/tank steam cleaned.
  - Ground and bond the tank vehicle/tank.
  - Follow procedures in the appropriate vehicle/equipment TM to completely drain the tanker shell and piping. Where applicable, drain manifold, meter, pump housing, filter separator and hoses.
  - If applicable, remove filter elements and canisters from the filter separator.
  - Ensure all low points within the system have been drained.
  - Once all fuel has been drained, close all valves, hatches and nozzles. Replace all caps and plugs.
  - The vehicle/tank is now ready to take to DOL maintenance or a contractor for steam cleaning.

E-6. The flushing with water option requires the following procedures:

- Requires a facility with an oil and water separator.
- Ground and bond the tank vehicle/tank.
- Follow procedures in the appropriate vehicle/equipment TM to completely drain the tanker shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.
- If applicable, remove filter elements and canisters from the filter separator.
- Ensure all low points within the system have been drained.
- Once all fuel has been drained, close all valves, hatches and nozzles. Replace all caps and plugs.
- Position the tank vehicle/tank over an oil water separator at an authorized hazardous waste disposal site for the unit or installation.
- Completely fill tank vehicle/tank with water and allow it to overflow until all traces of product are removed.
- If tank vehicle/tank has an onboard pump, follow instructions in the appropriate TM to circulate the water through the entire system to include hoses for 3-5 minutes.
- Follow procedures in the appropriate vehicle/equipment TM to completely drain the tanker shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.
- Ensure all low points within the system have been drained.
- Use natural/forced ventilation to finish the drying process. If required use an explosive meter to perform atmospheric testing to ensure the tank vehicle/tank is vapor free. Take vapor readings hourly until the tank is vapor free.
- When dry and vapor free, close all valves, hatches and nozzles. Install new filter elements in the filter separator if required.

E-7. The purge with CitriKleen option requires the following procedures:

- This procedure was developed to clean fuel equipment and tank vehicles/tanks that are being prepared for deployment or maintenance and must be vapor free. This is the least preferred method to vapor free a tank and should be used only when other methods are not available. Care must be taken to ensure purging solution is not left in the shell, piping, manifolds, valves or other parts of the system. IAW Ground Precautionary Message, TACOM 94-02, *Maintenance Advisory" For Purging All Fuel Tankers Using a Biodegradable Purging Solution*, the only authorized purging solution is CitriKleen (NSN 7930-01-350-7034 or 7930-01-350-7035). The purging solution can be transferred into another tank vehicle/tank and re-used up to "three" times. The amounts of CitriKleen required for the various shell capacities are listed below:
  - 7500 gallon capacity use - 18 gallons of CitriKleen
  - 5000 gallon capacity use - 12 gallons of CitriKleen
  - 2500 gallon capacity use - 8 gallons of CitriKleen
  - 1200 gallon capacity use - 3 gallons of CitriKleen
  - 525/600 gallon capacity use - 1.5 gallons of CitriKleen
- Requires a facility with an Oil and Water Separator.
- Ground and bond the tank vehicle/tank.
- Follow procedures in the appropriate vehicle/equipment TM to completely drain the tank shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.
- If applicable, remove filter elements and canisters from the filter.
- Ensure all low points within the system have been drained.
- Once all fuel has been drained, close all valves, hatches and nozzles. Replace all caps and plugs.
- Fill tank shell half way (50%) with water. Add CitriKleen. The amount will be based on the shell capacity. Continue to fill the tank shell to full capacity.
- Close and secure all hatches and valves.
- Disconnect ground cable from tank vehicle/tank.
- Drive a minimum of six miles breaking frequently to agitate the purging solution mixture around the tank shell.
- Ground and bond the tank vehicle/tank. If vehicle has an onboard pump, follow instructions in the appropriate TM to circulate the purging solution mixture through the entire system to include hoses for 3-5 minutes.

Note: If the purging solution is being reused, pump the solution to the next tank vehicle/tank and repeat steps 1-12. If you are not reusing the purging solution, continue with steps 13-20.

- If you are not going to transfer the purging solution mixture to another tank vehicle/tank, position the tank vehicle/tank over an oil water separator at an authorized hazard waste disposal site for the unit or installation and ground/bond.
- Follow procedures in the appropriate tank vehicle/equipment TM to completely drain the tank shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses. Ensure all low points are drained.
- For tank vehicles/tanks WITHOUT on-board pumps - After all purging solution mixture has been drained, while leaving all valves and ports open, rinse tank shell with clean water.
- For tank vehicles/tanks WITH on-board pumps:
  - Once all the purging solution mixture has been drained, rinse the tank shell with clean water.
  - Close all valves and nozzles. Replace all caps and plugs and fill with 300-500 gallons of clean water.
  - Circulate the water through the entire system to include hoses for 3-5 minutes.
  - Follow procedures in the appropriate vehicle technical manual to completely drain the tanker shell and piping. Where applicable drain manifold, meter, pump housing, filter separator and hoses.

- Ensure all low points are drained.
- Using an explosive meter, perform atmosphere testing to determine the effectiveness of the purging.
- If tank is not vapor free, use natural/forced ventilation to finish the vapor freeing and drying process. Take vapor reading hourly until the tank is vapor free.
- When dry and vapor free, close all valves, hatches and nozzles. Install new filter elements in the filter separator if required.

E-8. A tank vehicle/tank is considered a confined space. You must comply with all applicable sections of 29 CFR 1910.146, and any local/installation regulations before entering. Prior to entering a tank vehicle/tank, consult your local/installation environmental, safety and medical personnel for additional guidance.

Appendix F

Flow Conversion Chart

The flow conversion chart is a tool developed to assist the petroleum planner on in calculating the rate of flow of petroleum products under various units of measurement.

F-1. Table F-1 provides a consolidated reference on flow conversion in units of measurement and velocity. This is significant when operating in environments or with systems that require accounting to be recorded in different units of flow.

Table F-1. Flow conversion table

Convert from	***Convert to***	***Multiply by***
Barrels per day	gallons per hour	1.75
	gallons per minute	0.0292
Barrels per hour	cubic feet per minute	0.0936
	cubic feet per second	0.00156
	gallons per minute	0.7
Gallons per hour	cubic feet per hour	0.1337
	cubic feet per second	0.002228
	gallons per minute	0.016667
Gallons per minute	barrels per day	34.2857
	barrels per hour	1.4286
	barrels per minute	0.02381
	cubic feet per day	192.5
	cubic feet per minute	0.13368
	gallons per day	1,440
	liters per second	0.6308
	cubic feet per second	0.002228
Cubic feet per minute	gallons per second	0.1247
	liters per second	0.472
	cubic centimeters per second	472.0
Cubic feet per second	million gallons per day	0.646317
	gallons per minute	448.831
Cubic feet per yard	cubic feet per second	0.45
	gallons per second	3.367
	liters per second	12.74
Liters per minute	cubic feet per second	0.0005886
	gallons per second	0.004403

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Appendix G

Volume Correction

The purpose of volume correction is to account for variation in either the sample or the method of measurement of petroleum products. Temperature and fuel classification can allow measurements to deviate and alter fuel quantities.

ASTM INTERMATIONAL/AMERICAN PETROLEUM INSTITUTE/ ENERGY INSTITUTE OF PETROLEUM TABLE 5A/B

G-1. American Petroleum Institute API Gravity is an arbitrary scale expressing the gravity or density of liquid petroleum products. The measuring scale is calibrated in terms of degrees API. The gravity of any petroleum product is corrected to 60°F (15°C). Gravity is the ratio of the weight of any quantity of matter, a petroleum product for example, to the weight of an equal quantity of water; usually determined by use of a hydrometer.

G-2. A fuel sample is placed in a test cylinder and a hydrometer is inserted. The degrees API are read and the sample temperature recorded. Using the gravity computer, the API is determined. The aviation fuel contamination test kit is a one-man portable kit consisting of various types of testing equipment with the capability of determining temperature and API gravity.

Note: The density meter can be used to display the same results that would be obtained using the hydrometer and Tables 5B & 6B of ASTM International D1250.

G-3. Tables 5B & 6B of ASTM International D1250 gives the values of API gravities at 60°F (15°C) corresponding to API gravities observed with a glass hydrometer at temperatures other than 60°F (15°C). In converting API gravity at the observed temperature (hydrometer indication) to the corresponding API gravity at 60°F (15°C), two corrections are necessary. The first correction is the change in volume of the glass hydrometer by temperature. The second correction is the change in volume of the oil. Both corrections have been applied to this table.

***Note*:** This table must be used with API gravities (hydrometer indications) measured with a soft glass hydrometer calibrated at 60°F (15°C).

FUEL CLASSIFICATION BY AMERICAN PETROLEUM INSTITUTE/ ENERGY INSTITUTE GRAVITY PROCEDURES

G-4. The first step in volume conversion is fuel classification and temperature.

- Taking the Readings. Described below are the procedures that must be followed during fuel classification.
- Draw a 300-milliliter sample of fuel from the drum, nozzle, or other fuel source. Put it into a clean dry sample bottle, quart bottle with lid, or a sample can. Cover the sample container. Take the sample to a tent, building, or other sheltered place to conduct the test. Conduct the test promptly while the sample is fresh.
- Agitate the contents of the sample container by shaking it thoroughly.
- Slowly and carefully pour the sample down the inside of a clean, dry hydrometer cylinder, filling the cylinder approximately 3/4 full.
- Allow any air bubbles that are deep in the liquid to rise to the surface. Hold the cylinder just below the rim with one hand, and tap the top of the cylinder sharply with the cupped palm of the other hand to remove surface air bubbles.

- Set the cylinder on a level surface where it is protected from air currents.
- Use the hydrometer with the range closest to the API gravity range of the fuel you think you are testing. API gravity ranges are shown in figure G-1. For example, if you think the fuel is diesel and the API gravity range of diesel is between 30.0 and 42.0, use the third or fourth hydrometer from the equipment list.
- Check the mercury column if the hydrometer being used has a built-in thermometer. If the mercury has separated, the hydrometer will not take acceptable temperature readings, and you should use another hydrometer. If a hydrometer with an accurate thermometer is not available, you may use a calibrated tank thermometer to measure the temperature.
- Lower the hydrometer gently into the sample.

Note: If the hydrometer sinks or floats with the scale out of the fuel, you have selected the wrong one for the type of fuel you are testing. Try another hydrometer close to the same range. Keep trying until a hydrometer floats in the sample.

- Stir the sample gently by raising and lowering the hydrometer, and watch the movement of the mercury in the thermometer. (A fast registering thermometer should give an accurate reading in 30 to 45 seconds.) When the mercury stops moving, take a temperature reading and record it.
- Allow the hydrometer to come to rest, but not touching the side of the cylinder. If it moves to the side, move it back to the center of the liquid and spin it gently.
- When the hydrometer is floating freely at rest, read it to the nearest scale division. Have your eye slightly below the level of the liquid, and raise it slowly until the surface of the liquid appears to be a straight line across the hydrometer scale. Record the gravity reading to the nearest scale division as shown in figure G-2 on page G-3.
- Stir the sample gently again by raising and lowering the hydrometer, and take a second temperature reading. If the temperature of the fuel has not varied more than 1°F from the previous reading, record the temperature to the nearest 1°F. This is your test temperature reading. If the temperature of the sample has changed more than 1°F, repeat steps 9 through 12 until the temperature is stable (within 1°F).

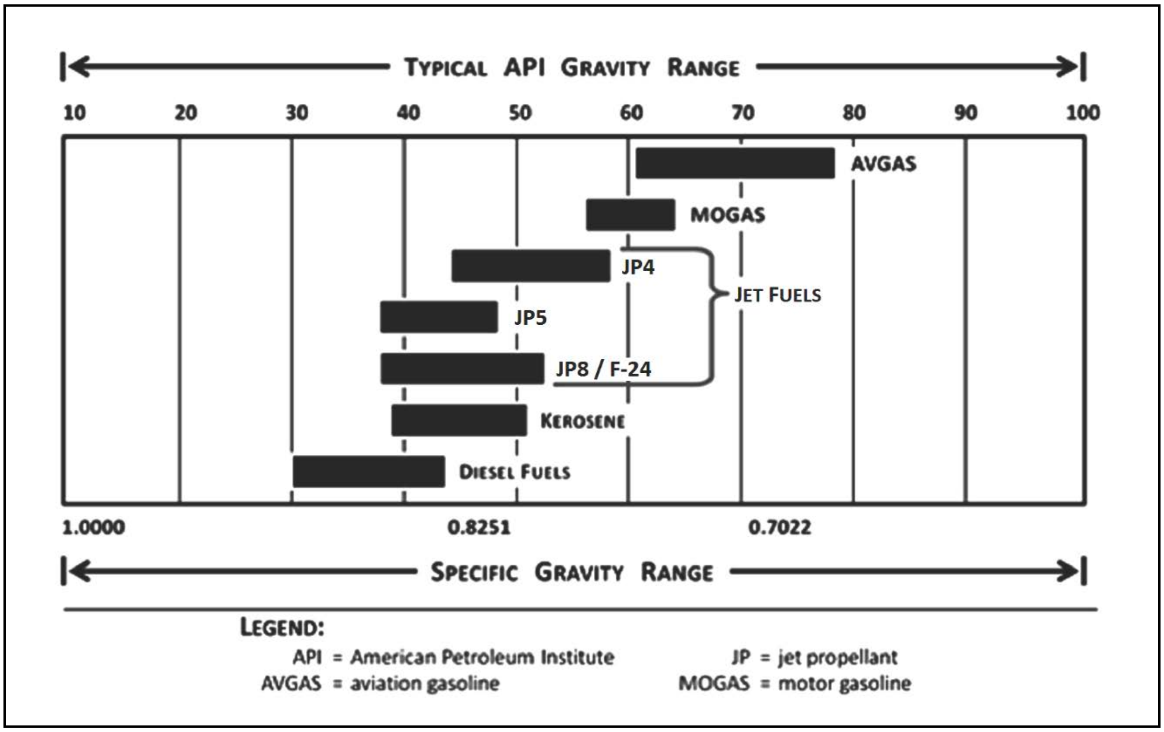

Figure G-1. Typical API gravity ranges (corrected to 60 degrees)

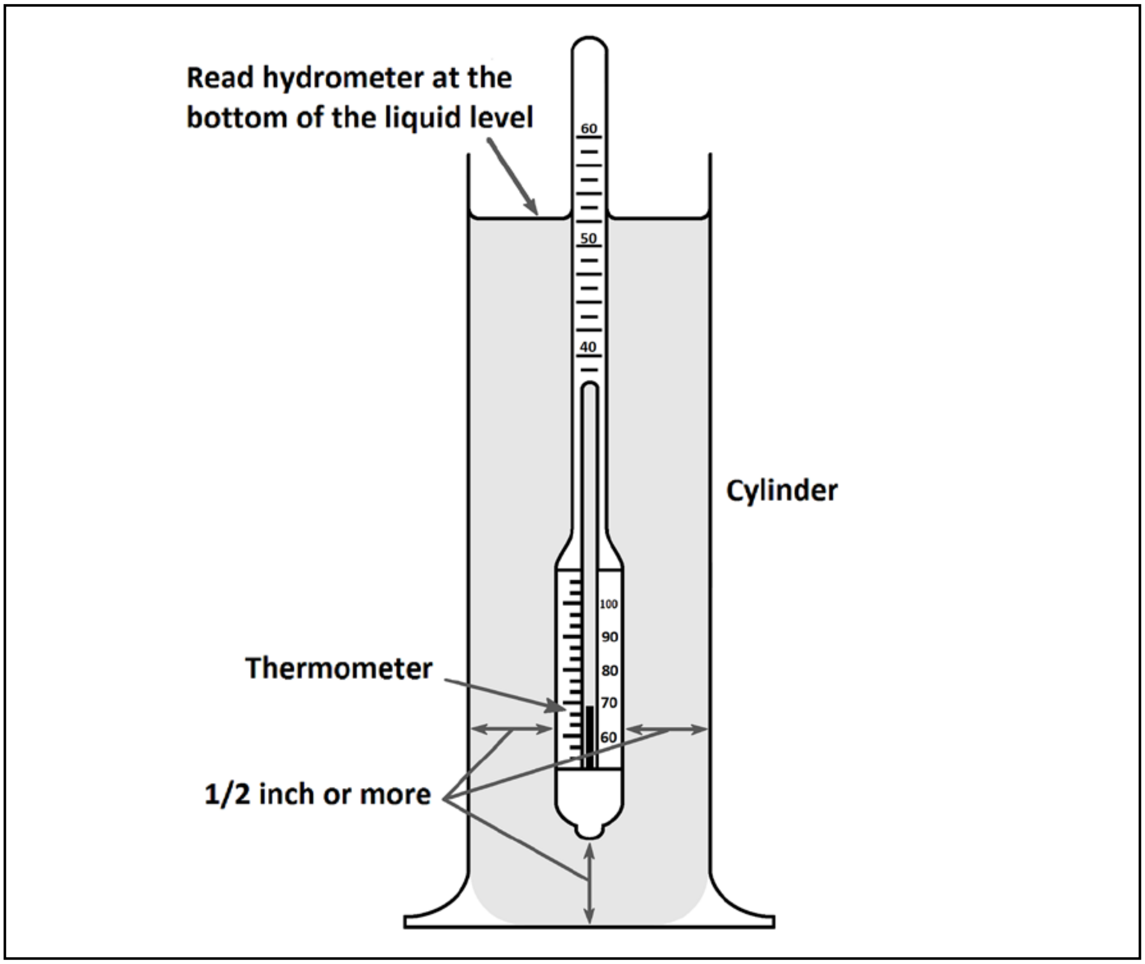

Figure G-2. Hydrometer ready to be read

CORRECTING OBSERVED READING TO 60°F

G-5. Using Table 5A/B, correct the API gravity of the observed temperature to API gravity at 60°F. Table 5A is used for JP4 and Table 5B is used for petroleum products other than JP4. Example: Assume the observed hydrometer reading is 40.4 and the observed temperature is 83 F. The product is not JP4. The steps are given below to correct the observed reading to 60°F.

> ***Note***: Rounding may not be required on all tables. The steps below involve procedures for rounding.

- Find the Table 5B page that lists API gravity of 40 through 45 at observed temperature across the top and the observed temperature range of 60 through 90°F down the left side.
- Read down the left side until you find the observed temperature (83.0°F). The observed API reading of 40.4 is rounded to 40.5 (The API gravity is in increments of 0.5, so the observed API gravity must be rounded to the nearest 0.5). Read across the table to where the observed API gravity of 40.5 intersects the observed temperature of 83.0°F. The API gravity at 60°F is 38.7.

Note: For more precise API gravity correction to 60°F, interpolation is used. See ASTM International D1298, *Petroleum, Crude, and Liquid Petroleum Products by Hydrometer Method, Density, Relative Density, or API Gravity*. However, when API gravity is corrected to 60°F for the purpose of volume correction using Tables 5B & 6B of ASTM International D1250, interpolation is not required.

- API gravity that is recorded on the gauge worksheet for volume correction use only must be rounded off to the nearest 0.5. Round off to the nearest 0.5 as follows:
  - If the fraction is .1 or .2, round down to the nearest whole degree. (For example, 42.2 becomes 42.0.)
  - If the fraction is .3, .4, .5, .6, or .7, round to the nearest .5 degree. (For example 38.3 becomes 38.5, or 38.7 becomes 38.5.)
  - If the fraction is .8 or .9, round up to the nearest whole number. (For example, 42.8 becomes 43.0.)

CLASSIFYING THE FUEL

G-6. The fuel is now classified. The steps are described below:

- Compare the corrected API gravity with the API gravity ranges shown in Figure I-1, page I-2. If the corrected API gravity of the product is lower or higher than expected, it indicates possible commingling with either heavier or lighter products.
- If the corrected API gravity is NOT within range for the fuel you are testing, isolate and mark the fuel container; sample the fuel; and send the sample to your supporting laboratory for identification, complete analysis, and disposition instructions. Do not use the fuel until you receive disposition instructions from the laboratory.

AMERICAN SOCIETY FOR TESTING AND MATERIALS/AMERICAN PETROLEUM INSTITUTE/INSTITUTE OF PETROLEUM TABLE 6A/B

G-7. Table 6A/B gives you the facts you need to convert product volumes observed at temperatures other than 60°F for values of API gravity in the range of 0 to 100 API. The volume correction factor in these tables makes no allowance for the thermal expansion of tanks and other containers. You must use these tables with API gravity values at 60°F and values measured at Fahrenheit temperatures. Table 6A is used for JP4 and table 6B is used for all petroleum products other than JP4. For example, what is the volume of 63,162 gallons of diesel at 83°F? The product's API gravity at 60°F is 38.5. Use the Table 6B column "API gravity at 60°F," headed 38.5 API, and note that against an "Observed Temperature" of 83°F the factor is .9890. Therefore, 1 US gallon of product having a gravity of 38.5 API at 60°F and measured at 83 F occupies at 60°F a volume of .9890. Thus, 63,162 US gallons measured at 83°F occupy a volume of 63,162 X. 9890 (or 62,467) US gallons at 60°F.

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Appendix H
Pipeline Operations Hydraulics

This appendix covers the petroleum product chemical and physical properties that are pertinent to pipeline/hoseline hydraulics. The physical properties that affect product storage and movement in pipelines are address in this appendix. These properties include density, gravity, viscosity, compressibility, effect of temperature, and vapor pressure. In addition, this appendix discusses the mechanics and mathematical formulas required to determine pipeline hydraulics.

PHYSICAL PROPERTIES OF PETROLEUM

H-1. This section covers the physical properties related to pipeline hydraulics. The petroleum handler needs to be familiar with these properties in order to understand how hydraulics works.

DENSITY

H-2. The weight density or specific weight of a petroleum product is its weight per unit of volume, or unit quantity. In the metric system of measurement, the mass of one cubic centimeter of water is one gram. Therefore, the density or specific weight of water is one gram per cubic centimeter. In the English system of measurement, the density or specific weight of water is expressed as 62.3 pounds per cubic foot. Specific volume is the space occupied by a unit quantity. In the metric system, one gram of water occupies one cubic centimeter. In the English system, 62.3 pounds of water occupies one cubic foot. Density is important is determining the space petroleum occupies in the pipeline and how much force is required to move it.

GRAVITY

H-3. Petroleum operations are concerned with specific gravity and API gravity. API gravity is used to determine the lightness or heaviness of crude oils and other hydrocarbons. The lighter the product, the easier it is to move through the pipeline. API gravity is also used to calculate the number of barrels per metric ton. Specific gravity used to determine the pounds per square inch or head (in feet) in a petroleum product. Petroleum products moved by pipeline are lighter than water. Therefore, their specific gravities are fractions in a narrow numerical range. Specific gravity is measured with a hydrometer.

H-4. The petroleum industry uses the API gravity scale almost exclusively to designate gravities of products. API gravity is based on reciprocals of specific gravities. They are whole numbers with a greater numerical spread. The API gravity scale has a range of 0° to 100°. Water has a gravity of 10°. This leaves a spread of 90° between the heaviest and lightest petroleum products. API gravity is inversely proportionate to specific gravity. In other words, the higher the specific gravity, the heavier the product and the lower the API gravity. The lightest products have the highest API gravity.

VISCOSITY

H-5. Viscosity is the internal resistance of a liquid to flow. Viscosity is also an important characteristic in determining the flow rate of petroleum in a pipeline. A liquid is said to be viscous if it is sluggish or thick. Lubricating oil must be viscous enough to maintain a lubricating film under all operating conditions. However, it must not be so viscous that it becomes a drag or causes a power loss. Absolute viscosity is a measure of the force required to produce motion. The unit of force in the metric system is called the poise. One poise is equal to 100 centipoises. Viscosity is measured by noting the time in seconds for a standard amount of product to flow through a viscosimeter. The Saybolt Universal instrument is the type of viscosimeter commonly used for such measurements. A more accurate instrument for measuring viscosity is the Ubbelohde viscosimeter.

COMPRESSIBILITY

H-6. All fluids are compressible to an extent. That is, they can be made to occupy less space by increasing the pressure or decreasing the temperature. Liquids have perfect elasticity. They return to their original volume when the pressure is lowered or the temperature is increased. Products of the highest American Petroleum Institute gravity have the greatest compressibility. They can generate the highest surge pressure, known as hydraulic shock or water hammer. Products of high American Petroleum Institute gravity can also be transferred at the highest rate of flow. This also increases the possibility of surge pressure. Surge pressure must be avoided. Apart from surge pressure, compressibility has little significance in military dispatching of petroleum products.

TEMPERATURE

H-7. Product temperature affects all of the properties discussed above. Volume, American Petroleum Institute gravity, compressibility, and volatility increase with temperature. Density, specific gravity, and viscosity decrease when the temperature increases. Pipeline throughput is higher in summer than in winter and requires less power. A pipeline heated by the sun delivers a greater volume. The American Petroleum Institute gravity is also higher in a pipeline than in the cool interior of a storage tank. Lubricating oil may be too thick to lubricate an engine properly when the engine is started on a cold morning. The same engine oil may thin out under operating temperatures. The change in viscosity with temperature is called viscosity index. It varies from product to product.

MEASUREMENTS

H-8. Product is measured and tested many times between manufacture and consumption. Input stations report to the dispatcher temperatures and quantities pumped every hour. Takeoff stations report temperatures and quantities received every hour. Quantities are determined by gauging and because of the effects of temperature on volume and gravity, all measurements are corrected to 60°F 60° Fahrenheit (15.6°C).

CORRECTIONS

H-9. Volume correction to 60° Fahrenheit requires observation of both gravity and temperature. They should be taken as close to the same time as possible. Combination hydrometers and thermometers make this easier. If specific gravity is taken, it must be converted to American Petroleum Institute gravity. Gravity at the observed temperature is corrected 60° Fahrenheit. Volume correction factors are based on true or corrected gravity. Corrections are made according to the American Society for Testing and Materials/American Petroleum Institute/Institute of Petroleum measurement table 5B and 6B, volume correction. Gravity must be corrected to 60° Fahrenheit to ensure that the multiplier is selected from the proper group. The multiplier is a ratio volume at 60° Fahrenheit to volume at the observed temperature. If the observed temperature is higher than 60° Fahrenheit, the multiplier is less than one and the corrected volume will be smaller. If observed temperature is less than 60° Fahrenheit, the multiplier is less than one and the corrected volume will be larger.

FLOW IN PIPELINE HYDRAULICS

H-10. The principles of hydraulics govern flow in pipelines. Hydraulics is the branch of science that deals with the behavior of liquids. It also deals with the equipment required to raise liquids to higher elevations and to transfer them from place to place. The broad subject includes the pressure and the equilibrium of liquids at rest (hydrokinetics), as in an operating pipeline, and forces exerted on liquids by objects in motion (hydrodynamics), as in pumping equipment.

PIPELINE PRESSURE

H-11. Pressure is the main element in pipeline hydraulics. All forces producing pipeline flow and those opposing it can be measured in terms of pressure or head. Coupled military pipelines are low-pressure systems that have a maximum safe operating pressure of 740 PSI. The low pressure requires closer pump station spacing than in commercial pipeline. Pump stations are spaced up to 15 miles apart in military systems on level terrain. Welded lines constructed for the military operate at higher pressures. The two types of pressure in a pipeline are static and dynamic.

H-12. Static pressure is a measure of pressure in liquids at rest. At any level in any size or shape of container, static pressure depends solely upon the vertical height of liquid above that level. Unit pressure at the bottom of all containers is the same, 1 pounds per square inch. A column of water one inch square and about 27 inches high weighs one pound. The force of one pound acts on an area of one square inch in the first container. A second container would hold 4 pounds of water distributed over 4 square inches. The third container would hold 16 pounds distributed over 16 square inches. A fourth would hold 64 pounds distributed over 64 square inches. Total pressure varies at the bottom of all containers, but unit pressure is the same, 1 pounds per square inch. The height of water in all the containers, 27 inches or 2.31 feet, is the head required to produce a pressure of 1 pounds per square inch. Static pressure in any column of water is the head in feet divided by 2.31 or multiplied by 0.433. Static pressure is proportionally less in a petroleum product because of its lower specific gravity. The various formulas for converting head to pressure and vice versa are as follows:

- Pounds per square inch = [head (in feet) x specific gravity] ÷ 2.31.
- Pounds per square inch = 0.433 x head (in feet) x specific gravity.
- Head (in feet) = pounds per square inch ÷ 0.433 x specific gravity.

H-13. Dynamic pressure or head is a measure of pressure in liquids in motion. Dynamic head is also a measure of potential energy or energy of position. Figure H-1 shows the relationship between static head and dynamic head. Static head at ground level behind the nozzle is measured by the vertical height of liquid in the tank above the ground. When liquid starts to flow down the pipe, it loses static head, but it gains in dynamic head. Potential energy becomes kinetic energy or energy in motion. Dynamic head or velocity is greatest at ground level where the stream changes direction and starts to rise. Dynamic head decreases after that until all velocity is lost. Meanwhile, the stream regains some portion of its initial static head and final static head is the head loss because of friction and change in direction. In other words, dynamic head is the static head required to accelerate the stream to its flowing velocity. It is the elevation to which a pump can push a column of liquid.

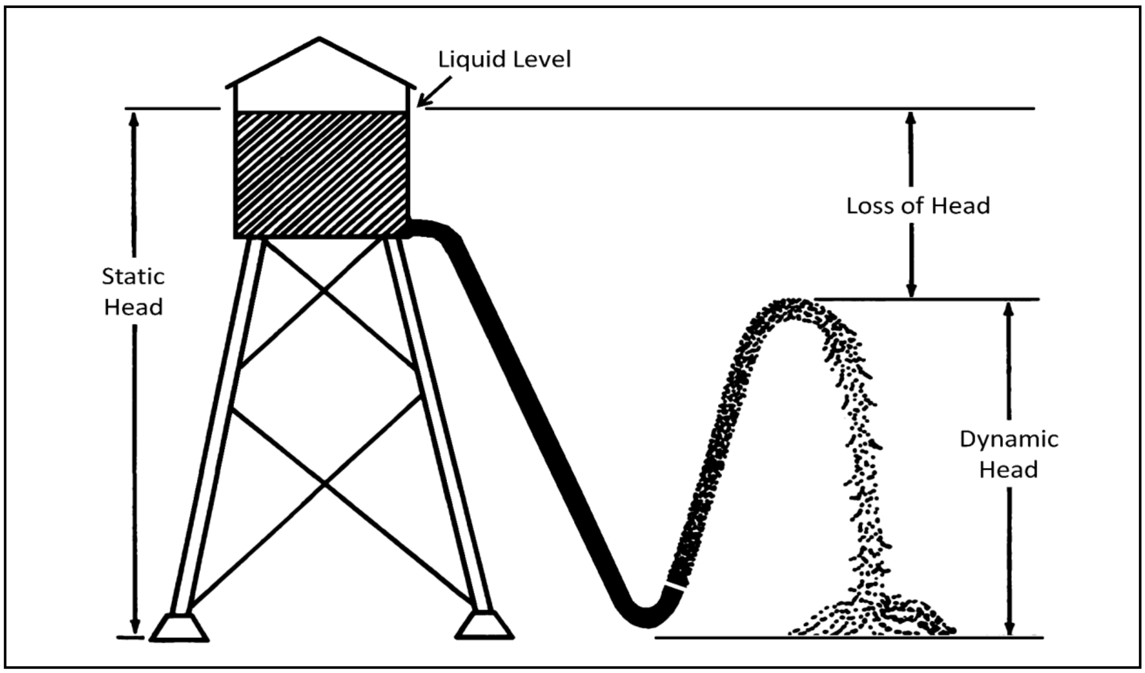

Figure H-1. Relationship between static head and dynamic head

PASCAL'S LAW

H-14. Pascal's law states that pressure, applied to the surface of a liquid, is transmitted equally in all directions through the liquid. It adds that, at any point, pressure acts at right angles to the confining container with undiminished intensity. Figure H-2 shows Pascal's law and the effect of total pressure. Unit pressure is the same on both pistons, 10 pounds per square inch. This pressure is transmitted throughout the liquid. Therefore, a total pressure of 30 pounds on one piston can exert a total pressure of 1,000 pounds on the other. This principle is used in hydraulic presses, jacks, and brakes.

ATMOSPHERIC PRESSURE

H-15. Atmospheric pressure is caused by the weight of air above the earth. It is the same everywhere at any given elevation. Atmospheric pressure is similar to static pressure in liquids. The height of a column of air depends upon the height of the column. It is measured by the height in inches it raises a column of mercury in a barometer. Atmospheric pressure is 14.695 pounds per square inch at sea level and proportionally less at higher altitudes. Maximum suction lift of centrifugal pumps at sea level is 33(+) feet of water (14.695 pounds per square inch x 2.31). Pump engines are affected at elevations greater than 3,000 feet because of thinner air. This same condition lowers atmospheric pressure. Design loads on pumps are usually reduced by 4 percent for each 1,000 feet of elevation above 3,000 feet. Normal suction pressure of 20 pounds per square inch is based on a design fuel of 0.725 specific gravity. This pressure should be increased to 30 pounds per square inch for elevations over 5,000 feet.

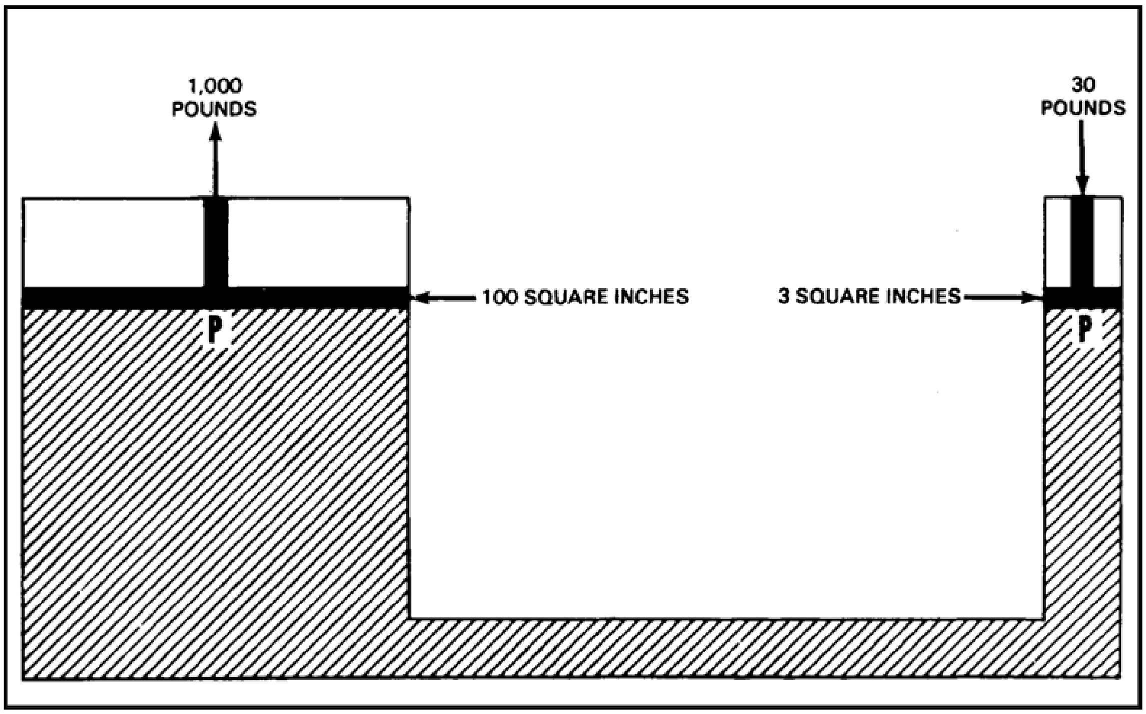

Figure H-2. Illustration of Pascal's law

VACUUM

H-16. A vacuum is created when pressure is reduced below atmospheric level. The theoretical limit of pressure reduction is absolute zero or perfect vacuum. Vacuums are measured as absolute pressure in inches of mercury. Pump suction reduces atmospheric pressure at the point of intake. This allows atmospheric pressure on the source of supply to push liquids into the pump.

VAPOR PRESSURE

H-17. All liquids, especially light petroleum products, tend to vaporize. This results from motion of the molecules of which they are composed. Motion of molecules near the surface causes some to escape into the air. The tendency to vaporize is called volatility. Volatility increases with temperature and decreases with pressure. Vapor pressure is formed when a vaporizing liquid is confined in a closed container like that used in the Reid vapor pressure test. The temperature at which a substance boils or is converted into vapor by bubbles forming in the liquid is the boiling point of the liquid. For this reason, liquids boil at lower temperatures at high elevations than at sea level. Vapor pressure reduces the effect of atmospheric pressure acting on the liquid. Maximum net suction lift is reduced accordingly. For this reason, pump suction pressure always must be greater than the vapor pressure of the product. Normal suction pressure of 20 pounds per square inch should be increased to 30 pounds per square inch for operating temperatures over 100°F.

NATURE OF FLOW

H-18. The three types of flow are laminar, transitional and turbulent. Liquids flow in pipelines because of gravity or pump action. In both cases, they flow because of pressure. Pressure is supplied by weight of the liquid in gravity flow and by pump action in discharge flow. While pressure and head are almost synonymous, they are actually proportional to each other.

H-19. Flow in a pipeline continues until the head producing it has been lost. The loss of head or the difference between pressure at the source and at any point downstream is caused by factors that resist flow. The main factors that resist flow are friction of the pipe walls and viscosity of the liquid. To calculate friction loss several factors and equations are used.

- Determine the kinematic viscosity of the fuel used in the pipeline system. Use figure H-3 on page H-6, to determine kinematic viscosity using the following steps:
- Determine the type of fuel to be used in the pipeline system and the temperature.
- Find the temperature along the bottom axis of the figure and use a straight edge to make a vertical line that intersects the graphic line of the fuel type used.
- At the point of intersection, turn the straight edge horizontal and make a horizontal line to the vertical axis showing kinematic viscosity on the left.
- The point where the horizontal line intersects the vertical axis is the kinematic viscosity value in centistokes. If a reading in feet squared per second is needed use this formula: Feet squared per second = centistokes / 92,900.
- Determine the Reynold’s Number using this formula:
- Design data formula. Reynold’s Number = velocity in feet per second x inside diameter of the pipe in feet/kinematic viscosity in feet squared per second.
- Field data formula: Reynold’s Number = 3160 x flow rate in GPM/inside diameter of the pipe in inches x kinematic viscosity in centistokes.
- Determine the friction factor using this formula: Friction factor = 64/Reynolds Number.
- Determine head loss due to friction over a given length or distance of pipe using the Darcy-Weisbach Equations:
- Design data formula: Head loss = friction factor x length of pipe in feet x velocity squared in feet per second/64.4 x inside diameter of pipe in feet.
- Modified formula: Head loss = 0.031 x friction factor x length of pipe in feet x flow rate squared in GPM/inside diameter of the pipe in inches to the fifth power.

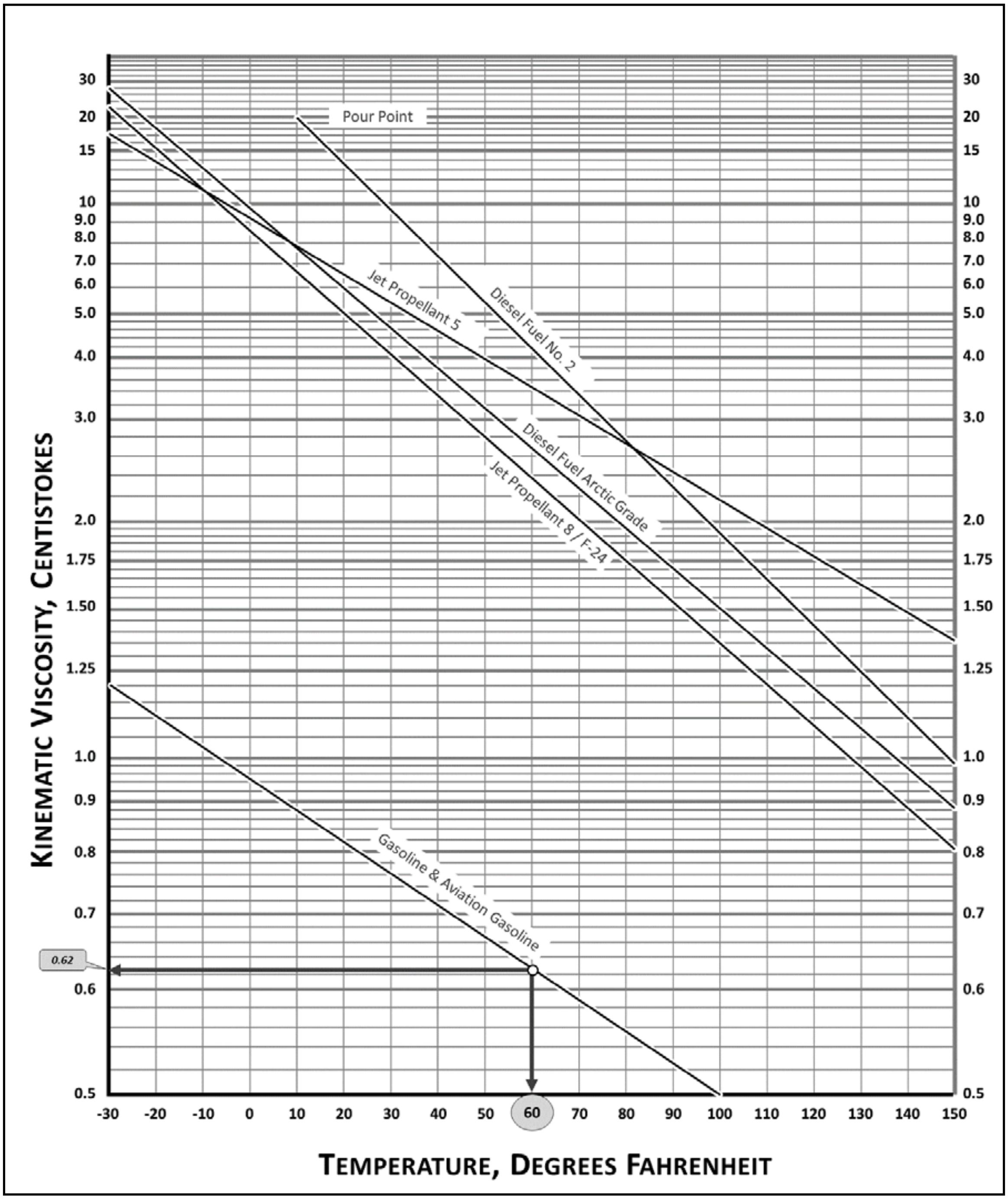

Figure H-3. Kinematic viscosities for common military fuels

The rate of flow depends on pump pressure and differences in elevation. It also depends on gravity and viscosity of the product, diameter and length of the pipe, and roughness of the pipe.

Appendix I

Assault Hoseline Hydraulics

This appendix provides the information necessary to provide an understanding of the sequence of events and consideration of installing an Assault Hoseline System. It covers terrain surveys, site considerations and locations, hydraulic profiles, pump station locations, and other considerations.

TOPOGRAPHICAL SURVEY

I-1. Prior to installing assault hoseline system equipment, a thorough study of the terrain is required, using a topographic map supplemented by aerial surveys, maps, photographs, and charts. Based on this survey, the optimum trace is selected and a hydraulic profile of the assault hoseline system is constructed. Using the profile and the hydraulic limitations of the pumps, mark the assault hoseline system trace and the required locations for pump stations, pressure reducing valves, and any other pieces of equipment required to be placed. Items to consider when completing the survey follow:

- Whether the assault hoseline system will operate independently or as part of a large system.
- Expected length of time the assault hoseline system will be required to operate.
- Elevation changes and total distance the assault hoseline system will encounter along its route.

ROUTE RECONNAISSANCE AND SITE LOCATION

I-2. Marking of the assault hoseline system trace and placement of components can be done when conducting the physical reconnaissance. Stakes or other marking devices can be used to indicate the actual path of the assault hoseline system and the location of specific components, as determined by the map recon and hydraulic profile. When selecting a route for the assault hoseline system, consider the following:

- The route should be direct and present a minimum number of obstacles and obstructions.
- A route parallel to a secondary all-weather road is preferable to one along a heavily-traveled road.
- If roadways do not exist or cannot be utilized, select a route that is accessible to vehicles required for laying the assault hoseline system.
- Keep security precautions in mind. Utilize natural camouflage wherever possible and avoid routing the assault hoseline system through populated areas.
- Avoid difficult terrain when possible.

INSTALLATION CONSIDERATIONS

I-3. When installing the assault hoseline system consider the following:

- Plan to locate the junction of two assault hoseline system lengths at installation sites for each pump station.
- Pump stations must be located in accordance with the hydraulic profile. The pump station should be on firm ground and should be as level as possible.

PUMP STATION SELECTION

I-4. When selecting pump station sites, the location of the lead or first pump station will be determined by the location of the fuel source. Pump stations are intended to be spaced at approximately one mile intervals, assuming that the route is reasonably direct and the terrain is level. However, a substantial rise or fall in elevation along the assault hoseline system route may require adjustment of standard spacing intervals between pump stations. When substantial rise or fall in elevation occurs between two consecutive pump stations, the following pump station movements must be performed:

- If the next downline pump station is substantially higher in elevation than the upline pump station, decrease distance between the pump stations.
- If the next downline pump station is substantially lower in elevation than the upline pump station, increase distance between the pump stations.

I-5. Adjusting distance between pump stations when elevation changes occur assures that the assault hoseline system pressure will be maintained within optimum operational range. Under optimal spacing conditions, the assault hoseline system will deliver fuel to the suction port of each pump station at a pressure of 20 pounds per square inch. Whenever pressure falls below 20 psi, pumping assemblies are designed to begin reducing speed when operated in the electric automatic mode. Therefore, if an upline pump station is substantially lower than the next downline station and the elevation difference has not been offset by spacing adjustment between pump stations, suction pressure at the downline pump station may fall below 20 psi and cause that pump to slow down. This in turn will cause remaining downline pump stations to slow down, seriously degrading overall performance.

GROUND PROFILE CONSTRUCTION

I-6. A ground profile (drawn on graph paper) is needed to determine the location of pump stations. Proper drawing of the ground profile will ensure that the assault hoseline system will perform within its optimal operational range. To construct a ground profile, first obtain a topographical map or other source of material that provides accurate information about terrain along the projected assault hoseline route. Using this information, draw a ground profile of the assault hoseline system route on graph paper as follows:

- Divide the horizontal base of the ground profile graph, shown in figure I-1, into spaces that represent uniform distances, such as 1,000-foot intervals. However, any suitable scale can be used. The ground profile base represents the horizontal distance the assault hoseline system will cross.
- Divide the vertical left-hand edge of the ground profile graph into spaces that represent uniform changes in elevation, such as 100-foot intervals. Again, any suitable scale can be used. However, the scale must include at least the highest and lowest elevations along the assault hoseline system route.

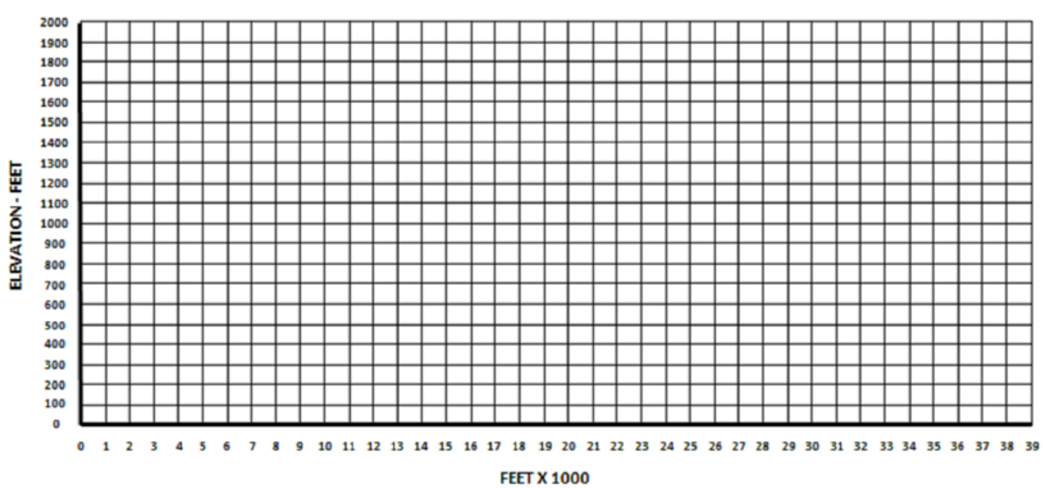

Figure I-1. Graph paper

- At left-hand edge of the ground profile graph, shown in figure I-2, mark a point that represents the lead pump station elevation.
- Continuing across the ground profile graph mark points where significant changes in elevation occur along the assault hoseline system route.

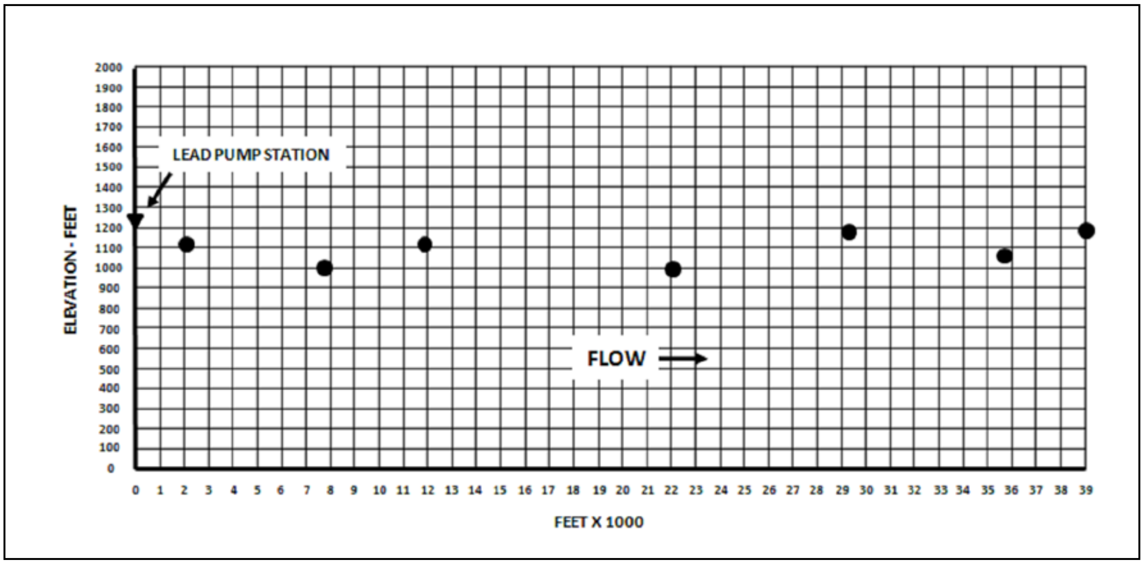

Figure I-2. Elevation changes

- To complete the ground profile, figure I-3, join the points marked on the ground profile graph with a straight line.

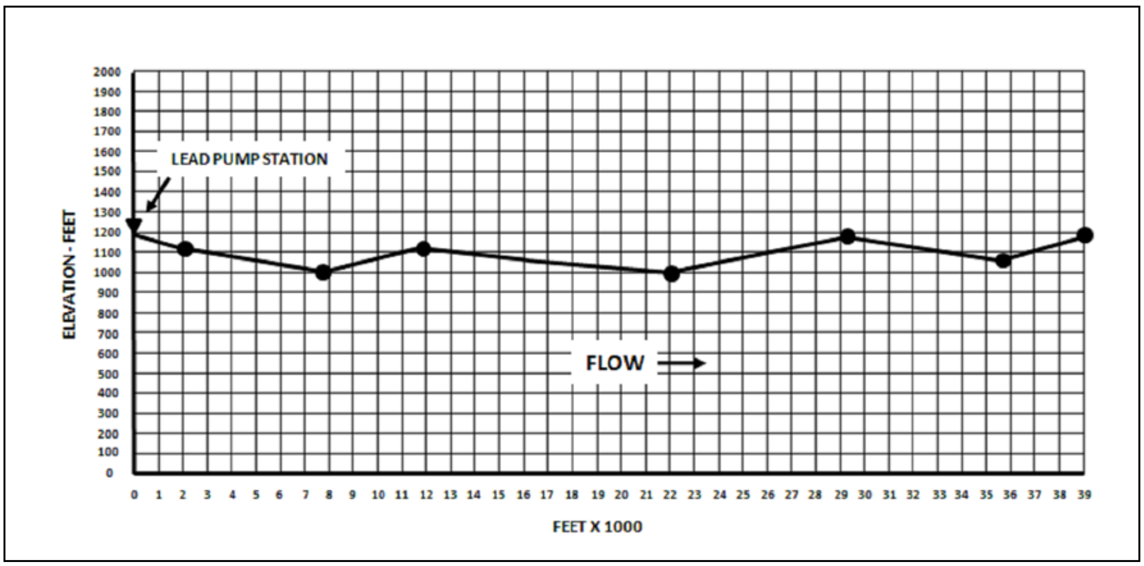

Figure I-3. Ground profile

PUMP STATION TRIANGLE CONSTRUCTION

I-7. A pump spacing triangle can be utilized to determine the location of each pump station. A properly constructed pump spacing triangle will ensure that the assault hoseline system performs within its optimal operational range. To construct a spacing triangle, obtain a piece of graph paper, transparent sheet, or cardboard thick enough to be used as a straight edge. See paragraph I-8 for a ground profile example with significant changes in elevation. Otherwise, design the pump spacing triangle as follows.

- Using the information shown below, determine the specific gravity of the fuel type that will be transported through the assault hoseline system.
  - Gasoline specific gravity: 0.7250.
  - Diesel fuel-2 specific gravity: 0.8448.

  - Jet propellant-4 specific gravity: 0.7753
  - Jet propellant-5 specific gravity: .8203.
  - Jet propellant-8 specific gravity: 0.8063.
- The 350 GPM pump has a total discharge head of 275 feet. Pumps require a suction pressure of 20 psi to operate properly. To properly design the pump spacing triangle, first determine the Net Available Head (NAH) as follows:

Note: All examples use JP8 specific gravity.

- Convert the 20 psi needed by each pump to feet of head using this formula: Feet of head = (2.31 x psi) / specific gravity. Using this formula the feet of head for this scenario is 57.3.
- To determine the net available head use this formula: Total discharge head – feet of head. Using this formula the net available head for this scenario is 218.
- Divide the vertical, left-hand edge of the pump spacing triangle, into spaces on the same uniform scale used to represent elevation changes on the ground profile graph. Mark off spaces along the vertical side of pump spacing triangle to the net available head:
- To determine friction loss, or the horizontal side of the pump spacing triangle, use this formula: Net available head/Friction loss of hoseline. Friction loss is approximately 2 psi per 100 feet of assault hoseline system. Using this formula the friction loss for this scenario is 2.064 miles. To convert friction loss distance from miles to feet use this formula: Friction loss distance (in miles) X 5280. Using this formula the friction loss distance in feet for this scenario is 10,898 feet.
- Divide the horizontal base of pump spacing triangle into spaces on the same uniform scale used to divide the ground profile graph base. Mark off spaces along the pump spacing triangle base to the friction loss distance.
- Draw a straight line, or hypotenuse from the net available head mark on the vertical scale to the friction loss distance mark on the horizontal scale. This line will form the long side of the triangle, or the hydraulic gradient.
- Making sure all lines have a straight edge, cut the triangle along the three sides drawn (horizontal, vertical, and hydraulic gradient).

DETERMINE LOCATION OF PUMP STATIONS

I-8. Refer to figure I-4 on page I-5 for determining the location of pump stations. Using the ground profile graph and the pump spacing triangle and determine pump station locations as follows:

- Place the pump spacing triangle on the ground profile graph.
- Align the vertical side of the pump spacing triangle with the vertical (elevation) side of the ground profile graph. Ensure the zero mark of the pump spacing triangle is on the lead pump station mark of the ground profile graph.
- Ensure the horizontal side of the spacing triangle is exactly parallel with horizontal base of ground profile graph. Horizontal space on both the pump spacing triangle and ground profile graph should be exactly aligned.
- Note: If the level of the ground profile is below the base of the pump spacing triangle, extend the pump spacing triangle hydraulic gradient until it crosses the ground profile.
- Mark the point at which the hydraulic gradient crosses the ground profile. This will be the second pump station location, or PS #2.
- To determine the next pump station location, PS #3, place the pump spacing triangle zero mark on the PS #2 mark of the ground profile graph. Mark the point at which the pump spacing triangle hydraulic gradient crosses the ground profile. This identifies PS #3 location.
- Remaining pump stations can be determined by using the same procedure.

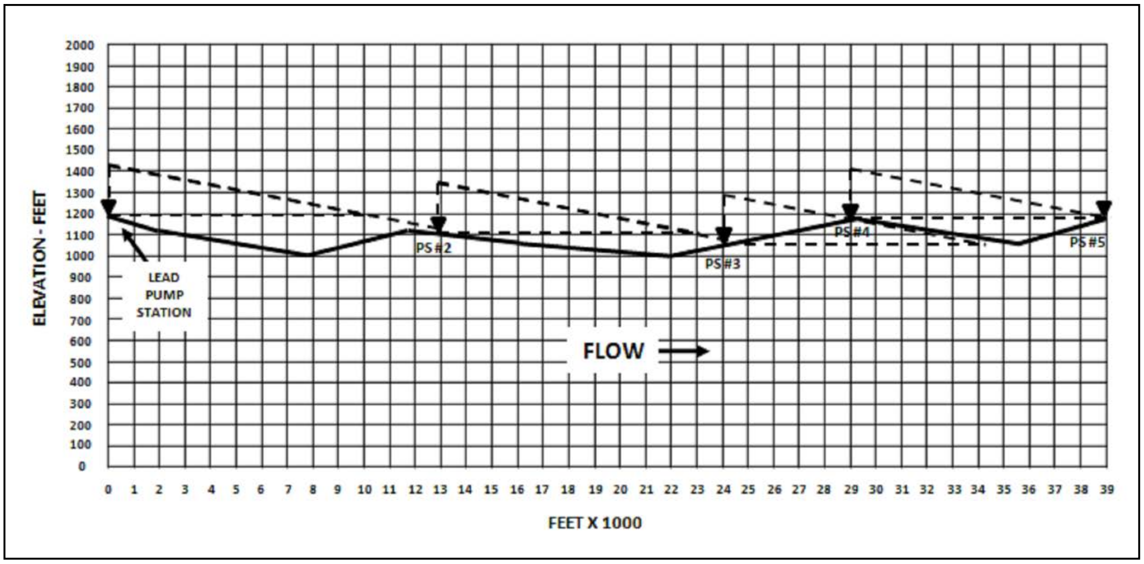

Figure I-4. Pump station locations

GROUND PROFILES WITH SIGNIFICANT ELEVATION CHANGES

I-9. When you place the hoseline on a steep downhill slope for some distance, there may be more pressure on the hoseline than withstand. If this occurs, install a pressure-reducing station in the line to relieve the pressure. The station consists of a regulating (receiving) storage tank and pump.

I-10. To construct a pump spacing triangle for a ground profile with significant elevation changes, similar to figure I-5, use the same steps identified in paragraph I-6.

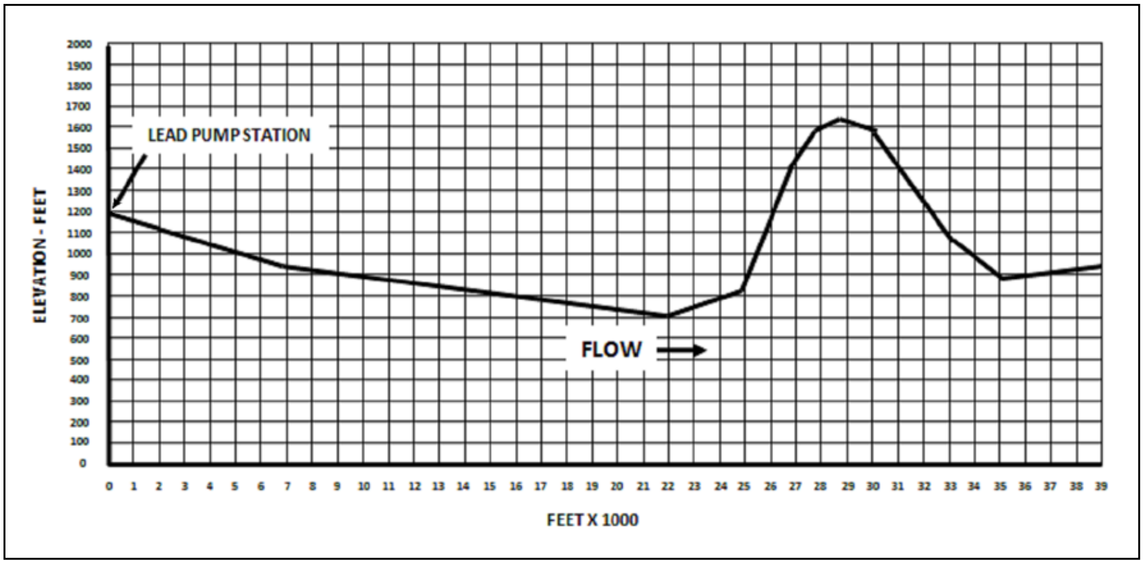

Figure I-5. Ground profile with significant elevation change

I-11. To determine pump station locations refer to figure I-6 on page I-6, and follow the steps in paragraph I-7.

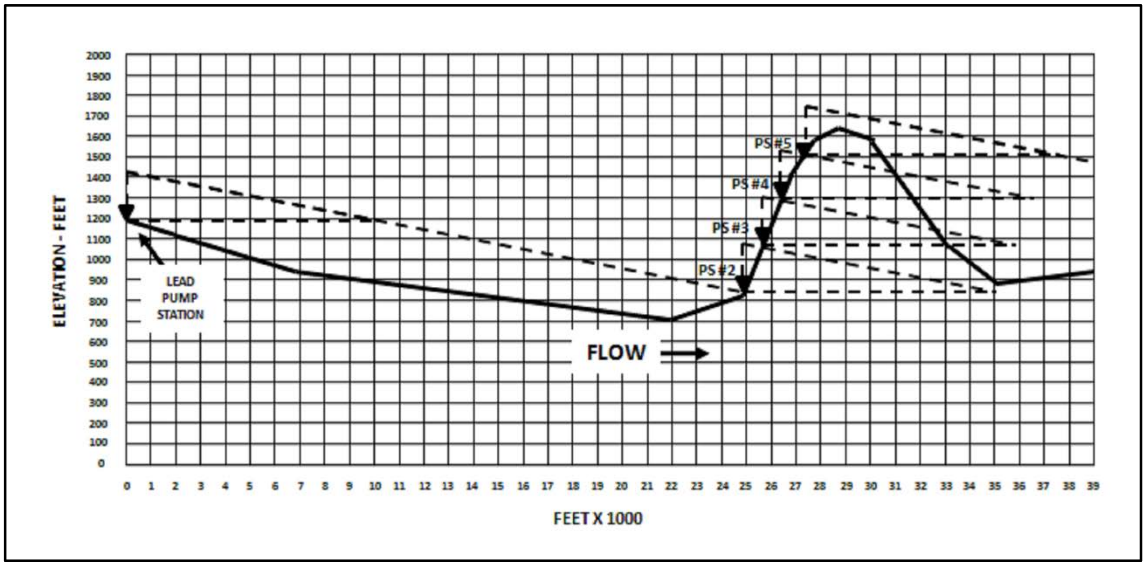

Figure I-6. Ground profile with significant elevation change pump station locations

DETERMINE LOCATION OF OVERPRESSURE

I-12. After locations of pumping stations have been plotted, check ground profile for any sharp declines in elevation along assault hoseline system route. An excessive drop in elevation will significantly increase hydraulic pressure.

CAUTION

To prevent damage to assault hoseline system components do not allow hydraulic pressure to exceed 150 pounds per square inch (psi).

- If pressure builds to more than 150 psi, the assault hoseline system can rupture and equipment failure may result. Therefore, when a sharp elevation drop along the assault hoseline system route is indicated by the ground profile graph, a pressure-reducing station must be installed in the assault hoseline system. To determine pressure-reducing station locations, refer to ground profile graph and proceed as follows:
- Determine the feet of head for 150 psi using the formula at the third bullet under paragraph I-6. In this scenario the feet of head is 430 feet.
- Mark crest of hill on ground profile graph, figure I-7 on page I-7.
- Draw a vertical line from the crest of hill down the that equates to the feet of head (430 for this scenario), figure I-7 on page I-7.
- Draw a horizontal line outward from the vertical line until it intersects the ground profile line. Ensure the horizontal line is parallel to horizontal base of ground profile graph, figure I-7 on page I-7.
- Where the horizontal line intersects the ground profile line is the location of the pressure-reducing station, figure I-7 on page I-7.
- Draw a vertical line from the first pressure-reducing station down the identified feet of head, figure I-7 on page I-7.
- Draw a horizontal line outward from the vertical line until it intersects the ground profile line. Ensure the horizontal line is parallel to horizontal base of ground profile graph, figure I-7 on page I-7.

- Where the horizontal line intersects the ground profile is the location of the next pressure-reducing station. If the horizontal line does not intersect the ground profile, no additional pressure-reducing stations are needed as shown in figure I-7.
- Repeat this process for all sharp declines until all pressure-reducing station locations are identified.

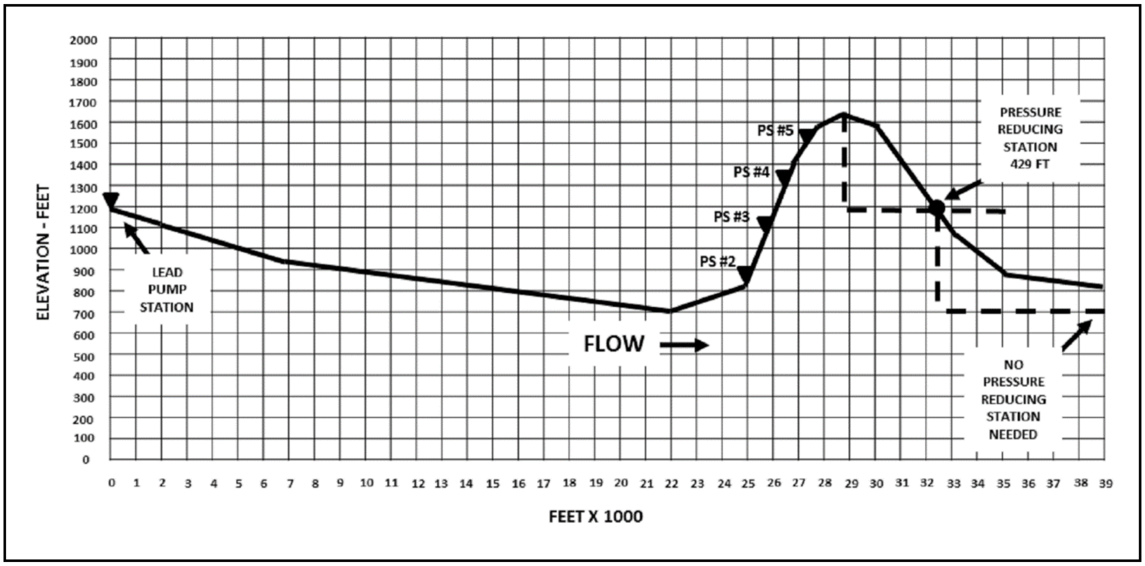

Figure I-7. Pressure-reducing stations

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Appendix J

Delivery and Unloading Procedures

The checklist for delivery and unloading of bulk petroleum products provides the petroleum handler a guide to perform checks to prepare for delivery and to conduct unloading operations.

J-1. When preparing for delivery perform the following checks:

- Is gauging, sampling, measuring and testing equipment on hand and serviceable?
- Has receiving tank been gauged to determine if there is space to receive the scheduled quantity?
- Are accountable documents on hand to accurately record the transfer responsibility from the deliverer to the recipient?

J-2. Prior to unloading perform the following checks:

- Have the vendor's delivery documents been checked for completeness?
- Has the delivery conveyance been spotted at the correct location?
- Have adequate fire extinguishers and NO SMOKING/FLAMMABLE signs been positioned?
- Has the delivery conveyance been properly bonded and grounded?
- Have the fittings, manhole cover, and valve seals been inspected for defects?
- Have the cargo hatches or manhole cover been opened to determine level of product?
- Is product clear and bright as viewed through a clean jar?
- Has the delivery tank been checked for water using water-finding paste on the gauge stick or tape?
- Has cargo temperature been determined at time of delivery?
- Has the cargo tank been gauged to determine quantity?
- Has API gravity been performed?
- Has the measured quantity been volume corrected to 60°F in accordance with DA Pamphlet 710-2-1 and applicable TM?
- Have quantity surveillance samples been taken?

J-3. During unloading operations perform the following checks:

- Are receiving personnel and the driver of the conveyance standing by?
- Is traffic being controlled to avoid the unloading area as much as possible?
- Are dispersing operations discontinued during unloading operations?

J-4. After cargo is unloaded perform the following checks:

- Has the delivery conveyance been inspected to ensure the cargo tank is completely empty?
- Has the vehicle ground been disconnected and the discharge hoses secured?
- Has the receiving tank been gauged?
- Compare quantity received against quantity shipped. Investigate any discrepancies.

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Appendix K
Berm Calculations

Berm, firewall, and dyke will all be referred to as the "Berm". The berm, firewall and dyke provide the same function and are intended to protect against fire, contain leaks and protect against damage from weapons fire, bombs and shrapnel. Berms are constructed relative to the size of the petroleum storage tank it must support prior to the layout or construction of the storage tank. The following are calculations that can be used to determine size, height, capacity. For information on berms, refer to TB 10-5430-253-13.

BERM DIMENSIONS

K-1. The calculation of the containment barrier must hold 100% of the storage container's capacity plus one (1) foot added on as freeboard.

K-2. The exception to the minimum berm height is for tactical fuel systems.

- Working space between edge of collapsible tanks and berm should be 3 feet and berm height should be 3 feet for 3K and 10K tanks, 4 feet for 20K and 50K tanks, and 5 feet for 210K tanks. Table K-1 shows the outside berm dimensions relative to the size of the collapsible fuel fabric tank.

Table K-1. Berm dimensions for collapsible fabric fuel tanks

Collapsible Fuel Fabric Tank Size	*Tank Dimensions (dry)*	*Berm Dimensions (outside)*
3,000 gallon	14 feet by 14 feet	58 feet by 58 feet
10,000 gallon	22 feet by 22 feet	66 feet by 66 feet
20,000 gallon	30 feet by 30 feet	74 feet by 74 feet
50,000 gallon	30 feet by 75 feet	74 feet by 119 feet
210,000 gallon	75 feet by 75 feet	119 feet by 119 feet

K-3. To check the Berm Volume:

- Volume(gallons) = [(length x width x height) x 7.48]
- Volume(barrels) = [(length x width x height) x 7.48] ÷ 42

Note: Height= height [minus (-)] freeboard.

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Appendix L
Conversion Formulas

The following formulas are used in computing weight or quantity conversions for bulk petroleum products.

CONVERSION FORMULAS FOR PETROLEUM PRODUCTS

L-1. Converting API Gravity to Specific Gravity.

- 141.5 ÷ (API + 131.5) = Specific Gravity

L-2. Converting Specific Gravity to API Gravity. Useful when OCONUS to identify product gravity from SG to API.

- (141.5 ÷ SG) – 131.5 = API Gravity

L-3. Converting Pounds to Gallons. In issuing fuel to an aircraft the quantity information provided by the flight crew most likely will be in pounds of fuel requested. The following formula will allow conversion from pounds to the quantity in gallons.

- Step 1. Convert API gravity to Specific Gravity (SG).
- Step 2. Multiply the weight of one gallon of water (8.33 lb.) by the specific Gravity (SG) of the fuel (8.33 lbs. x SG = Wt. of one gallon of fuel).

  Step 3. Divided the weight of the entire load of fuel by the weight of one gallon of fuel (Total # of pounds ÷ Weight of one gallon of fuel = Total gallons).

L-4. Converting Gallons to Pounds. For a load of fuel to be sling loaded calculate the weight of the fuel and the weight of the container to determine total weight. In addition, when a transporter has a bridge to cross with a weight restrictions calculate the weight of fuel plus weight of transporter.

- Step 1. Convert API gravity to specific gravity (SG).
- Step 2. Multiply the weight of one gallon of water (8.33 lbs) by the Specific Gravity (SG) of the fuel (8.33 lbs. x SG = Wt. of one gallon of fuel).
- Step 3. Divide the weight of the entire load of fuel by the weight of one gallon of fuel (Total # of Gallons x Weight of one gallon of fuel = Total pounds).

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Appendix M

NATO Fuel Codes and Placard Identification Numbers

Table M-1 lists NATO fuel codes and placard identification numbers.

Table M-1. NATO fuel codes and placard identification numbers

PRODUCT	***NATO FUEL CODES***	***PLACARD IDENTIFICATION NO***
AVGAS 100LL	F-18	UN 1203
Gasoline Automotive	F-57/F-67	UN 1203
JP4	F-40	UN 1863
Jet A-1	F-35	UN 1863
Jet A with Additives	F-24	UN 1863
Jet A with Additives +100	F-27	UN 1863
JP8	F-34	UN 1863
JP8+100	F-37	UN 1863
JP5	F-44	UN 1863
Diesel fuel grade 1	F-65	NA 1993
Diesel fuel grade 2	F-54	NA 1993
Diesel fuel marine	F-76/F-77	NA 1993

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Appendix N

Capacities for Tank Vehicles, On/Off Road

Table N-1 lists the capacities in liquid quantities (gallons) for various vehicles ranging from 2,500 gallons to 7,500 gallons. It is important that the petroleum planners and handlers know the maximum quantities of petroleum products that can be transported by vehicle through various road conditions.

Table N-1. Capacities for fuel tankers

Model Number	***On-Highway Load Limit (gallon)***	***Off-Highway Load Limit (gallon)***
M967 Series	5,000	3,000
M969 Series	5,000	3,000
M1062(7,500 gallons)	7,500	Not recommended for off-highway use
M978 HEMTT	2,500	2,500
Tank Rack Module	2,500	2,500

Note: Refer to the appropriate TM to determine prime mover requirements for different model tankers. Depending on the prime mover, weight restrictions may limit load capacity of the tanker.

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Appendix O
Petroleum Leader's Management Tool

This appendix provides a tool for petroleum leaders to manage petroleum operations in their organizations. This list is not all inclusive.

O-1. Basic principles:

- Are fuel hydrometers on-hand?
- Are thermometers checked?
- Are API Gravity tables, 5B and 6B, on-hand?
- Is fuel API Gravity corrected to 60° F?
- Are fuels visually inspected prior to receipt?
- Is fuel handled in a single product system?
- Are fuels recirculated?
- Are packaged products inspected every 90 days?
- Does the unit have a SOP for packaged product management?

O-2. Safety and Security:

- Are fuel systems properly grounded?
- Are fire extinguishers accessible/ available?
- Is fire extinguisher correct for class of fire?
- Are containers for rags and smoking material present in work areas?
- Are personnel properly trained in first aid procedures?
- Are control and security measures in place?

O-3. Sampling and Gauging:

- Is DD Form 2927 (Petroleum and Lubricants Sample Identification Tag) completed and attached to sample submitted?
- Is a log of sample submissions maintained?
- Are laboratory analysis reports on-hand?
- Are linear gauges taken to 1/8- inch?
- Are gauge readings repeated until two are the same?
- Are water finding and gasoline finding pastes used?
- Are opening and closing gauges taken?
- Is DD Form 2921 (Physical Inventory of Petroleum Products) prepared, with gauge, API and temperature data, and in file?
- Is volume correction applied to quantities of 3,500 gallons or greater when issued and month inventory?

O-4. Filter Separator:

- Is equipment properly grounded?
- Is date (month and year) of last change of filter elements stenciled on equipment?
- Have filter elements been changed within the past 36 months?
- Is a record of pressure differential gauge readings available?
- Are filter effectiveness samples submitted monthly for testing?
- Are sample reports (Petroleum Laboratory Report) on file?

O-5. Field Operations:

- Are support requirements (material handling equipment, trailers, rail, and fuel vehicles) coordinated?
- Is area sufficient for equipment?
- Are low areas avoided for fuel storage?
- Is location reasonably level?
- Are berm liners, drip pans, spill kits; (absorbent materials, etc.), grounding rods, and fire extinguishers in place?
- Is traffic flow one way and signs posted?

O-6. Quality Surveillance:

- Are products recirculated?
- Are fuel handling systems inspected?
- Is sampling referenced in unit SOP?
- Are samples submitted for testing?
- Is a fuel sample log maintained by the unit?
- Are lab reports reviewed and on-hand?
- If aviation, is aqua-glo performed and log maintained?

O-7. Environmental Protection:

- Does the unit have reporting procedures in their SOP?
- Are procedures for various operating environments listed in the unit SOP?
- Is the Environmental Engineer’s contact information on-hand?
- Is containment and clean-up equipment for field operating environments listed in unit SOP’s and on-hand?
- Does the unit SOP account for local, state and host nation environmental requirements?

O-8. Accountability:

- Are gains and losses reviewed and within tolerance levels?
- Are Fleet credit card and air card on the unit property account?
- Is the unit SOP on fuel accountability current?
- Is accounting receipt and issue documents filled out and on-hand in accordance with the regulation?
- Is volume correction applied to quantities of 3,500 gallons or greater when issued and at end of the month inventory?
- Are inventories conducted and documented?
- Is the monthly bulk account summary (MBPAS), DD Form 1348-8 (DOD MILSPETS: DFSP Inventory Accounting Document and End-of-Month Report) and adjustment action in accordance with the regulation?
- Is the MBPAS submitted, within three working days, to the approving authority for action?

Appendix P

Recirculation

The purpose of this appendix is to clarify the procedures for recirculation in Army fuel systems and vehicles. Recirculation of fuel is vital to ensuring the cleanliness and quality of fuel issued meets Army and DOD standards.

P-1. Recirculation, circulation, product consolidation, flushing and fuel line displacement are commonly used terms that are interchanged and many times refer to the same thing. Each of these operations has different procedures and can have specific purposes. However, the end result is the same, replacing the fuel contained in hoses/pipes downstream of the filter separator with fuel that has passed through a filter separator. However, for the purpose of this appendix all these operations will be synonymous with recirculation. Also, depending on the mission and layout of the refueling system, it may be necessary to use one or a combination of the following methods to meet the daily requirements to ensure the quality of the fuel:

- Pumping fuel through system components to include filter separators, hoses/pipes and refueling nozzles back into the same tank/truck/container that the fuel came from.
- Consolidating product by pumping fuel through system components to include filter separators, hoses/pipes back into a tank/container within the system other than the one the fuel came from.
- Displacing the amount of fuel contained in hoses/pipes downstream of the filter separator to the nozzle/issue point with product that has been pumped through the filter separator. The fuel being displaced is pushed out the nozzle/issue point into a tank vehicle or container which is not part of the refueling system.

P-2. For tactical fuel systems, displacing/replacing/recirculating/flushing twice the amount of fuel contained in the installed hoses/pipes which are downstream of the filter separator to the nozzle is sufficient. To calculate the amount of fuel contained in the hoses, take the amount of fuel contained in a length of hose and multiply it by the number of hoses between the filter separator and the nozzle. Doubling this number gives you the amount of fuel required to be recirculated.

P-3. For refueling vehicles, displacing/replacing/recirculating/flushing twice the amount of fuel contained in the installed hoses/pipes which are downstream of the filter separator to the nozzle is necessary/ sufficient. If there is a recirculation adapter on the vehicle recirculation of three to five minutes will ensure the product downstream of the filter separator has been replaced with clean product, and has displaced twice the amount of fuel contained in the installed hoses/pipes downstream of the filter separator. Note: Refer to vehicle technical manual for quantity of fuel required in vehicle tank compartment to be able to perform this operation.

P-4. For fixed type systems, displacing/replacing/recirculating/flushing twice the amount of fuel contained in the installed hoses/pipes which are downstream of the filter separator to the nozzle is sufficient. To calculate the amount of fuel contained in the hoses, take the amount of fuel contained in a length of hose and multiply it by the number of hoses between the filter separator and the nozzle. Doubling this number gives you the amount of fuel required to be recirculated.

P-5. The following tables, tables P-1 through P-3 on pages P-1 and P-2, show the amount of fuel in suction and discharge hoses.

Table P-1.Suction hose

Diameter X Length (inches X feet)	*Working Pressure (pounds per square inch)*	*Burst Pressure (pounds per square inch)*	*Fuel Content (Gallons)*
2x10	100	400	1.7
2x25	100	400	4.3
4x10	75	300	6.6

Table P-1. Suction hose *(continued)*

Diameter X Length (inches X feet)	***Working Pressure (pounds per square inch)***	***Burst Pressure (pounds per square inch)***	***Fuel Content (Gallons)***
4x25	75	300	16.5
6x10	75	300	15
2x10	100	400	1.7

Table P-2. Discharge hose

Diameter X Length (inches X feet)	***Working Pressure (pounds per square inch)***	***Burst Pressure (pounds per square inch)***	***Fuel Content (Gallons)***
2x25	150	600	4.3
2x50	150	600	8.5
4x50	150	600	33
6x50	150	600	75

Note: Working/burst pressures may vary by manufacturer.

Table P-3. Fuel content per foot

2 inch	0.17 Gallons
4 inch	0.66 Gallons
6 inch	1.5 Gallons

P-6. It is mandatory recirculation be performed prior to the first refueling of the day. This should be accomplished in conjunction with daily preventive maintenance checks and services (PMCS) for the refueling system or vehicle. Recirculation during PMCS allows the differential pressure to be checked on the filter separator and if required, the aqua-glo test performed. It is also mandatory to perform recirculation when a sample is required from filter separator or the nozzle, e.g. the filter effectiveness test or type "C" testing.

P-7. Fixed type bulk storage systems may not require daily recirculation. This type of system would be required to be recirculated if directly fueling aircraft or when directed to do so.

Appendix Q
Meter Verification

Calibration is required for master meters, and meters used at the point-of-sale. Personnel who have been certified by an official calibration laboratory (or other certifying agency) shall perform these calibrations. Non-certified personnel may verify meters/gauges that are not used at the point-of-sale by means of a master meter or calibrated meter. Non-certified personnel performing verifications on non-point-of-sale meters/gauges should be familiar with proper calibration procedures.

Q-1. The meter assemblies must be tested and flow rates verified for the following conditions:

- Visual damage.
- After repair or replacement of any internal parts or meter register.
- When the meter assembly shows any signs of malfunction.
- Suspected erroneous readings.

Q-2. The following procedures are for use with meters in tactical fuel systems only.

- For the purpose of this document, a master meter is a meter that has been calibrated per commercial standards by a certified meter calibration commercial agency per API or NIST standards. Master meters are used to retest and verify flow rates of any other meter against the master meter at any time in the future. Organizations should coordinate with their supporting maintenance activities for obtaining commercial support for calibration of the meters designated as master meters. The master meters are calibrated annually and kept stored in a dry indoor location that will avoid any excessive handling of the master meter until it is utilized. The following sub-paragraphs describe the steps used to test and verify meters using the master meter method:
  - Using fuel storage and tactical fuel system components, construct a master meter testing assembly as shown in figure Q-1 on page Q-2. Hoses should be the same size as the connection on meter (i.e. four inch hoses for four inch meter).
  - To test a meter assembly, the master meter is normally installed downstream of the meter to be tested as depicted in the figure Q-1. The meters should be installed close to each other (one hose length apart).
  - During the testing, ensure that the inlet and discharge lines at each meter are straight for a minimum of five pipe diameters before and after the meter, (recommend using a 10 foot section of suction hose for this purpose).
  - Prior to the actual testing, ensure all hoselines are packed (filled with fluid).
  - Once fuel lines are packed with fuel, reset each meter readout to zero and then pump fluid through the meters at approximately 200 GPM. GPM can be determined by pumping for two minutes and dividing the master meter reading by two (two minutes). If flow rates are over or under 200 GPM, adjust pump RPM, reset the master meter, and run another two minute test. GPMs are approximate; if near 200 GPM proceed with the master meter test.
  - Reset the master meter and meter to be tested to zero. Pump fuel through the master meter testing assembly for five minutes, shut off the flow, and compare the reading of the meter being tested against the reading of the master meter.
  - If there is more than a 5-gallon difference in reading, adjust the meters register IAW meter manufacturers procedures and repeat the test.
  - A minimum of two test runs must be performed where each run has a difference of less than 5-gallons.

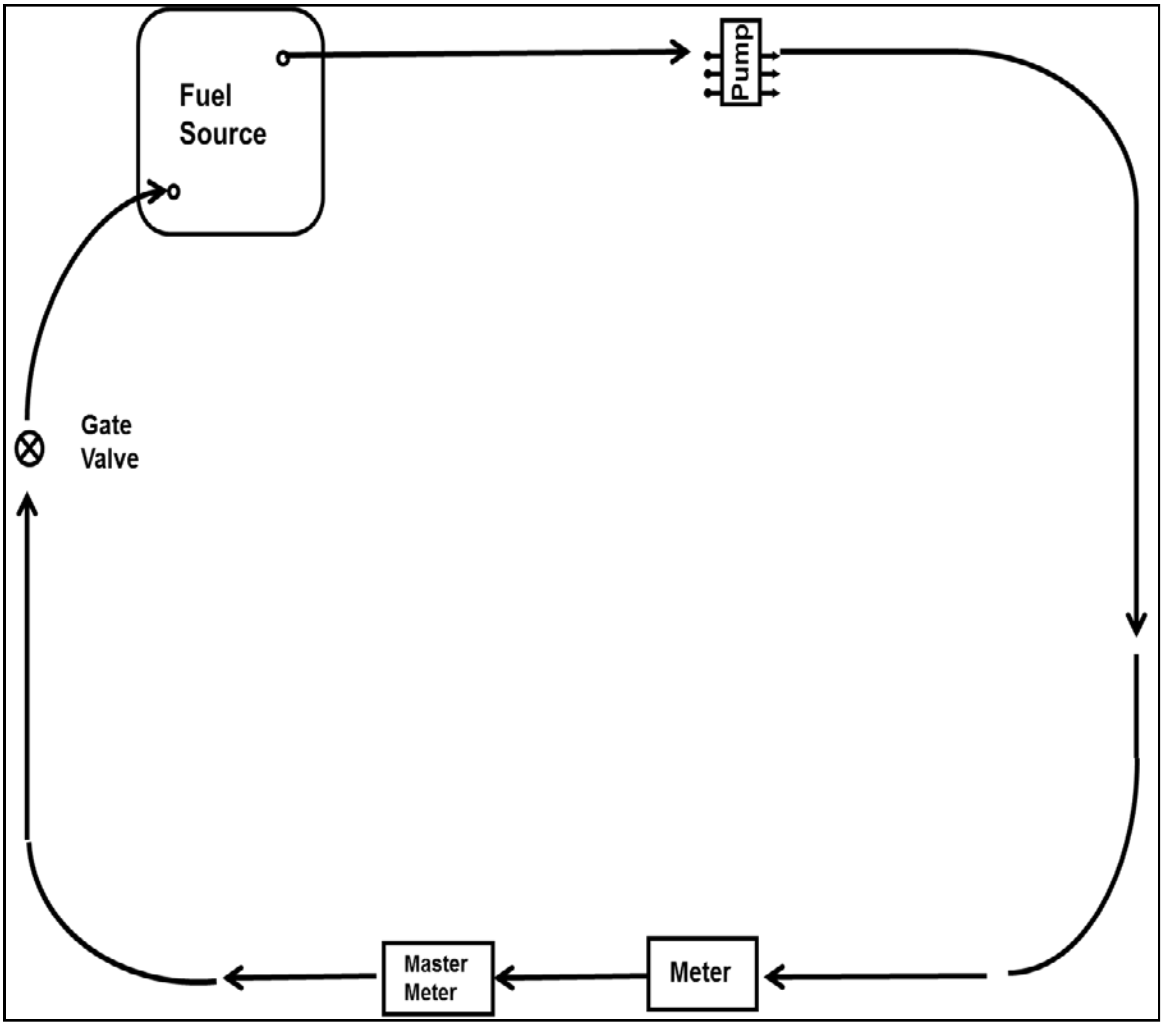

Figure Q-1. Master meter layout

Appendix R
Hose End Strainer

The purpose of this appendix is to describe to use and purpose of the hose end strainer.

R-1. Periodically, Soldiers have issues with fuel pumps shutting down at fuel points because debris in the fuel gets lodged in the pump strainer. Cleaning the pump strainer is a time consuming process. Use of a hose end strainer will reduce the need to frequently clean the strainer on the pump and also reduce the risk of damage to the pump. These are general procedures which will reduce downtime of fuel points due to pump strainers being clogged.

R-2. Solid contamination in the fuel is the cause of many fuel points shutting down. This is a result of clean fuel being put in fuel trucks that are not properly cleaned. The physical conditions of the trucks along with the environment they operate in contribute to solid contamination in the fuel. Current and future contingencies will involve contracted line haul support.

R-3. The 120/300k FSSP technical manual provides NSN: 4730-01-540-4264; P/N: 735SBA4000ASAJ (41592) for the four inch hose end strainer. This hose end strainer is also provided in the 800,000 gallon FSSP technical manual; P/N: 735SBA4000ASAJ (41592). This strainer can be obtained through normal supply channels or directly from the manufacturer.

R-4. The strainer is a 4 inch female x 4 inch male cam-lock and is designed for flow into female end. At the receipt point, this strainer will be installed on the end of the hose that will be connected to the truck being downloaded.

R-5. The strainer shall be removed from the hose and cleaned after every truck download or sooner if the strainer is getting clogged. Reduced flow rate and/or pump cavitation while product is still in the truck is an indication the strainer is clogged.

R-6. Use of the hose end strainer will keep large debris and sediment from entering the system and damaging components. The use of the strainer will also allow you to determine exactly which trucks are coming in with solid contamination in the fuel.

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Appendix S
Filter Effectiveness

Published policy establishes the requirement to check performance of all in service filter separators every 30 days through the submission of samples to a certified laboratory for Filter Effectiveness (FE) or (FET). This is a key element of the Army Bulk Fuel Quality Surveillance Program to ensure clean fuel is dispensed into end use aircraft, vehicles and other equipment.

S-1. DA PAM 710-2-1 provides FE sampling procedures including the preferred sample method, a matched-weight monitor sampling device. This is the most efficient and cost effective way to perform the FE which involves passing one gallon of fuel through a matched weight monitor downstream of the filter separator under flow conditions.

S-2. Refer to the petroleum testing kit TM for instruction on use of the quick connect adapter device to obtain a millipore sample to meet FE monthly requirements.

S-3. All units with modification table of organization and equipment (MTOE) authorized millipore sampling equipment shall comply with monthly FE testing by using the millipore kit vice submitting one-gallon samples to the supporting fuels lab. One-gallon samples are authorized on an exception basis only if millipore equipment is not an authorized MTOE item and/or the millipore sampling device is inoperable and in the process of being repaired/replaced. All installations/units that are not authorized MTOE equipment will take action to obtain millipore equipment through normal supply channels. Deviations from these procedures shall be coordinated through the U.S. Army Petroleum Center (USAPC).

S-4. One-gallon samples are far more expensive to package and ship than monitors. They are also more labor intensive and costly to test in the laboratory and result in a significant volume of hazardous waste stream at the laboratory. Overall costs of one-gallon samples can exceed 100%-400% of comparative costs of millipore submissions to the lab.

S-5. Multiple millipore monitors can be shipped in the same packaging further reducing the overall cost per sample. One-gallon cans cannot be shipped through the U.S. Postal Service.

S-6. Unit level attention to managing sample submission cycles also allows for cost savings by reducing the need for next day or air shipment to a supporting laboratory to meet the 30 day testing requirement.

S-7. Activities that choose to use the Army Petroleum Lab New Cumberland must contact them to set up an account prior to submission of samples. This applies only to those activities that do not have a current activity code assigned by the lab.

S-8. All samples must be shipped with a DD Form 2927 (Petroleum and Lubricants Sample Identification Tag) attached to the sample. Figure S-1 on page S-2 shows an example of a completed sample tag.

Product and Type: JP8
Date Received:
Installation: Fort Lee, Virginia
Sample Number: 13-095
Product and Type: JP8, Turbine Fuel, Aviation
Lab Number:
Specification Number: MIL-T-83133
NSN: 9130-01-031-5816
Product Contract Number:
Batch/Lot/Emulsion Number:
Manufacturer/Supplier: DLA Energy
Quantity Represented: 2300
Sample Source: A-103
FIII/Delivery/DCM Date:
Local Sample Number: 13-210
Sampled By: John Doe
Date Sampled: 10/31/2013
Time Sampled: 1300
Organization, Address, Telephone, Fax Number and Email of Submitter/POC:
PWD MIF
Fort Lee, Virignia
804-734-1234
804-734-4321
john.doe.mil@mail.mil

Test Series: [ ] A Test [ ] B-2 Test [ ] B-1 Test [ ] C Test [ ] Special (see back)
Sample Priority: [X] Routine [ ] Urgent [ ] Special
Sample Information: [X] Filter Effectiveness [ ] Procurement [ ] Packaged [ ] Into-Plane [ ] Correlation Sample (see back) [ ] Storage Surveillance [ ] Special/Additional information on back
Sample Type: [ ] Upper [ ] Middle [ ] Lower [ ] Bottom [ ] Composite [ ] All-level [ ] In-Line [ ] Other (specify)
DD FORM 2927 (JUL 2007) S/N 0102LF1287400

Special/Additional Information

Correlation Information
Submitting Activity Results and Methods
Particulates ________ by ________
FSII ________ by ________
Flash Point ________ by ________
Time Filtration ________ by ________
For Area or Regional Laboratory Use Only

DD FORM 2927 (JUL 2007) (BACK)

SAMPLE

Figure S-1. DD Form 2927 – Petroleum and Lubricants Sample Identification Tag

Appendix T

ROM Planning Tool

This appendix covers considerations when planning the execution of ROM operations. These considerations include planning based on number of convoys and vehicles in each convoy, the time to conduct the ROM, the terrain considerations and the number of refueling points required to conduct the ROM.

ROM PLANNING CONSIDERATIONS

T-1. Serials of the convoy, vehicle types, and maximum number of vehicles in each serial can provide a rough estimate of fuel and site requirements to accomplish a mission by multiplying total number of vehicles by refueling time allotted. For instance, if requirements identified eight serials with 25 vehicles in each serial and three minutes time per vehicle on refueling point. First multiply amount of serials by vehicles, then multiply amount of time given by known amount in GPM by system. Next, multiply vehicles by gallons for total fuel estimate. Flow rate (GPM) varies with the system type.

8 serials x 25 vehicles=200 vehicles

3 minutes x 35-gpm = 105 gallons per vehicle refuel

200 vehicles x 105 gallons = 21,000 gallons for the total fuel estimate

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Note: The lowest GPM per dispensing point is the maximum GPM per system. When calculating rough estimate do it according to system use for instance, M969A3 will only provide 23.75 gallons for an eight point ROM setup. Nozzle flow rates: 1 ½-inch nozzle flow rate is 40 GPM; 1-inch nozzle flow rate is 15 GPM.

T-2. Time between convoys affects total operational time on site from initial holding area to reassembly area. Serial breakdown and amount of points required within each convoy can be identified by breaking the convoy into serials rather than taking serials required and dividing it by total vehicles in convoy.

Note: When identifying refueling time on point, include the time for entering and exiting the point.

T-3. For the formula below two minutes has been given for both entering and exiting points.

T-4. If the refueling time per convoy is limited to 45 minutes and the largest convoy has 44 vehicles and each vehicle is to receive three minutes of refueling time with additional time four minutes for entering and exiting point, the total time for one refueling serial would be seven minutes. Divide total time allotted for convoy 45 minutes by seven equals 6.4. The total refueling serials allowed for one convoy serial is six.

T-5. To identify points required, divide 44 (total vehicles in largest convoy) by 6 (refueling serials) equals 7.3. Total refueling points required is eight. If convoy vehicles have fueling ports on both driver and passenger side, the greatest number of vehicles in one convoy (driver/passenger) need to be identified by refueling port side in the six refueling serials. For instance, the greatest number of passenger side port is the third convoy with 24. Total points for passenger would be 24 divided by 6 = 4 (refueling points). The greatest number of driver side port vehicles is the first and third convoys of 20. Next, divide 20 by 6 = 3.3, which will require 4 refueling points. Table T-1 on page T-2 gives an example of documenting number of refueling points required.

T-6. Other considerations include distance between points for ROM operations. For example, a ROM support M1A1 Abrams tank track vehicle would require a greater distance between points than a ROM supporting the M998 cargo troop carrier due to the size of the tank track vehicle and the exhaust fumes.

Table T-1. Number of refueling points required

Vehicle:	*1st*	*2nd*	*3rd*	*4th*	*5th*
M998	6	4	8	2	12
M1036	12	10	16	10	10
M984	4	2		8	4
M916	16	12	20	8	6
Passenger side					

T-7. Table T-2 shows an example of fuel usage tracker based on the capability of a vehicle. The table is based on the type of vehicle, identify fueling port (driver/passenger/rear), fuel tank capacity, type of fuel required, mobility (turning radius, terrain), length (point separation 50/100/200ft), miles per gallon, and fuel capacity.

Table T-2. Fuel usage per vehicle type

Vehicle	*Fuel Tank Capacity*	*Mileage Per Tank/Tanks*	*Average Gallon Per Mile*	*Type of Fuel*	*Fuel Port Side*
M 998 Cargo/ Troop Carrier	25 gals	337 miles	337 miles ÷ 25 = 13.4	DF1,DF2, DFA, JP8	Passenger

T-8. Table T-3 shows an example of a total fuel estimate. Divide miles travel by mileage per gallon, and then multiply number by total quantity.

Table T-3. Fuel estimate

Vehicles:	*Quantity:*	*Miles per gallon:*	*Gallons per vehicle to travel 150 miles*	*Total gallons:*
M998	35	13.4 mpg	150 miles ÷ 13.4 = 11.2	35 each x 11.2 = 392 gals

PRIMARY ROAD

T-9. Two or more lanes, all-weather, maintained, hard surface roads with good driving visibility used for heavy and high density traffic. These roads have lanes with a minimum width of 2.7 m (9 ft.) and the legal maximum GVW/gross combined weight for the country or state is assured for all bridges. Surface roughness values ranges from 0.1 inch RMS to 0.3 inch RMS.

SECONDARY ROAD

T-10. Two lane, all-weather, occasionally maintained, hard or loose surface (paved, crushed rock, gravel) roads intended for medium-weight, low density traffic. These roads have lanes with a minimum width of 2.4 m (8 ft.) and no guarantee that the legal maximum GVW/gross combined weight for the country or state is assured for all bridges. Surface roughness values ranges from 0.1 inch RMS to 0.6 inch RMS.

CROSS COUNTRY

T-11. Vehicle operations over virgin terrain which has no previous traffic (Cross-Country) and over combat and pioneer trails.

ROM EXECUTION CONSIDERATIONS

T-12. Table T-4 represents considerations that should be taken before, during and post ROM execution.

Table T-4. ROM execution

Pre-execution
ROM requirement identified
Site RECON
Final plan established and briefed
Order given
Equipment and personnel assembled
Inspection of equipment and personnel
Rehearsal
Final inspection
Execution
Quartering party departs
ROM main body departs
Security element secures ROM site
Quartering party arrives at ROM site
Quartering party actions complete
Main body arrives at ROM site
Complete ROM is assembled
Lines packed, nozzles and valves checked
Camouflage complete, all support items (warming tents, hazardous waste area, spill kits, etc) complete
First march unit arrives at ROM
Last march unit completes ROM
Post Execution
ROM equipment recovered, secured, and inventoried
Sensitive items inventory complete
ROM party departs ROM site
Security element departs ROM site
ROM party returns to base location
After operations PMCS complete, fuel supply replenished
After Action Review
ROM party released
Sleep plan instituted

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Appendix U

Aircraft Refueling Operations

This appendix discusses various aircraft refueling techniques. The various techniques include cold refueling, warm refueling, and hot refueling of aircraft.

COLD REFUEL FOR AIRCRAFT

U-1. 'Cold Refuel' refers to performing standard aircraft refueling operations, but without the aircraft or auxiliary power unit (APU) running and the rotor blades dormant.

POSITION THE REFUELER

U-2. Drive the tank vehicle into position in front of the aircraft. Do not drive the refueler directly toward the aircraft because brake failure could cause a serious accident.

U-3. Keep a distance of at least 10 feet between the refueler and the aircraft. There must be at least 10 feet between the refueler and rotor blades of a helicopter. Keep a distance of at least 20 feet between the exhaust pipe of the pump engine (or truck engine) and the aircraft fill port and tank vent.

U-4. Park the refueler so that there is a clear open path to drive it away from the aircraft in an emergency. Do not detach a tank semitrailer from its tractor when refueling an aircraft. The tractor must be ready to pull the trailer away from the aircraft if the need arises.

U-5. If the refueler can be driven into position without backing, do so. If the refueler must be backed toward the aircraft, bring the truck to a full stop 20 to 25 feet away from the aircraft or its rotor blades. Have another Soldier act as a ground guide. Follow his signals to guide the final backing approach until he stops the refueler at the proper distance from the aircraft and its fill port or vent.

U-6. Stop the refueler's engine (unless it powers the pump), and set the brake. Chock the tires of the refueler and, if appropriate, the aircraft.

CHECK THE AIRCRAFT

U-7. Check the interior of the aircraft. No one should be on board during refueling unless the pilot must be onboard to monitor the quantity of fuel to be loaded. Find out before starting the refueling sequence whether or not there is a person in the aircraft. Check with the pilot to ensure that all armaments are on SAFE.

POSITION FIRE EXTINGUISHERS

U-8. Place the 20 B:C (minimum) truck fire extinguisher by the pump. Place the other 20 B:C (minimum) fire extinguisher by the aircraft fill port. If possible, have members of the ground crew or aircrew man these two fire extinguishers. If there are no personnel available to man the fire extinguishers, place them near the pump and nozzle operators. Position them where they will not be in the operator's way and where they are not likely to be engulfed if a fire should start.

GROUND THE REFUELER

U-9. Unreel the ground cable, and attach it to an existing ground rod. If no ground rod exists at the location, drive the refueler's ground rod into the earth to required depth and attach the clip to the rod.

U-10. Attach the second ground cable and bond it to the aircraft. Ensure that this connection is to a metal (non-painted) surface, not to include an antenna.

U-11. Bond the nozzle to the aircraft before the dust cap is removed from the nozzle and the cap is removed from the fill port. If the aircraft has a receiver for the bond plug, use the plug. If not, attach the bonding clip to a bare metal part of the aircraft.

OPEN FILL PORT

U-12. Open the fill port and remove the nozzle dust cap. If an open-port nozzle or the CCR nozzle adapter is being used, put the nozzle well down into the fill port. Do not open the nozzle until it is inside the fill port. If the CCR nozzle is being used, mate the nozzle into the fill port. If they will not latch together, look for dirt in the fill port or on the nozzle. Wipe the fill port out and clean the nozzle; then mate the two together.

U-13. Insert the fuel nozzle into the fuel port. Maintain contact with the fuel nozzle at all times. All fuel nozzles used to refuel aircraft must have a #100 mesh screen. The procedures for refueling depend on the type of refueling. They are described below.

CCR NOZZLE REFUELING

U-14. Mate the CCR nozzle to the fill port. Pull back on the control handle latch, and then push the flow control handle up toward the aircraft and into the FLOW position. If the tank will be filled completely, watch the back of the nozzle. A red indicator will pop up at the back of the nozzle when the tank is full. The flow shuts off automatically. If the tank will be filled only partially, watch the pilot for a signal to stop the flow. Pull the flow control handle back toward the hose to move it into the NO FLOW position.

U-15. Open the nozzle slowly to reduce splashing and to reduce the turbulence of the fuel already in the tank. Do not leave the nozzle at any time during the refueling operation. Do not block or wedge the nozzle lever open. If the nozzle handle has been notched, remove the notches so that the handle cannot stay open unless someone is holding it open. Slow the flow of fuel as the tank nears the fill level. Top off the tank so that the fuel will not overflow. Stop the flow completely before taking the nozzle out of the fill port.

D-1 NOZZLE REFUELING

U-16. Remove the dust cover from the end of the nozzle body. Mate the D-1 (single-point) nozzle to the receiver mounted on the aircraft by gripping the two handgrip handles and turning them clockwise to lock the nozzle to the receiver. Turn the latch handle forward, parallel to the hoseline, to allow fuel to flow. (The latch handle will not turn to the OPEN position unless the nozzle is locked to the receiver. If it will not turn, release the nozzle by turning the handgrips counterclockwise. Begin again.) The M978 HEMTT (2,500-gallon tank vehicle) is equipped with a fuel safety device (deadman control) and a D-1 nozzle. To start the flow of fuel to the nozzle, squeeze the deadman control. (NOTE: Never allow the deadman control to be wedged open.). The flow is stopped by releasing the pressure on the deadman control upon the pilot's signal. Turn the latch handle clockwise, across the hoseline, and turn the handgrip handles counterclockwise to release the nozzle from the receiver. (The handgrip handles will not turn back to release the nozzle unless the latch handle has been turned back to the NO-FLOW position.).

U-17. Replace the cap on the fill port. Replace the nozzle dust cap before disconnecting the nozzle bond. Remove the nozzle bond plug or undo the bonding clip. Reel up the hose and nozzle. Replace the fire extinguishers used at the pump and nozzle.

U-18. Remove the grounding cable from the aircraft. Remove the clip on the grounding connection, and reel up the grounding cable. Do not drag the cable clip across the ground. Guide the cable back onto the reel to prevent damage to the grounding system. If the refueling operation is over and the refueler's ground rod was used, pull the rod up and stow it in the refueler. Place the fire extinguisher in the refueler.

WARM REFUEL FOR AIRCRAFT

U-19. 'Warm Refuel' refers to performing standard "cold" aircraft refueling operations, but with the auxiliary power unit (APU) on the aircraft still running, and the rotor blades dormant.

U-20. The advantage to using this method is to efficiently allow the electrical components of the aircraft to remain active without full system shut down. Aircraft requiring open-port fueling will not be done using this technique without the aviation commander's authorization.

U-21. The aircraft radio communication can still be received, but the aircraft cannot transmit during active refuel.

U-22. Required personal protective equipment (PPE) must still be worn when preforming petroleum operations and the aircraft must be de-planed, with the exception of essential personnel, prior to fueling operations.

HOT REFUEL FOR AIRCRAFT

U-23. Start and operate the equipment in accordance with the appropriate TM to set the system in refueling mode.

U-24. Ensure the person manning the nozzle guides the aircraft into position using the signals described in ATP 3-04.94. Check with the pilot to ensure that all armaments are on SAFE.

U-25. Passengers must go to the designated passenger marshaling area. Marshalling area should be identified with a sign or some other authorized marking in accordance with unit SOP. Members of the crew, except the pilot, crew chief, or copilot who may remain at the controls if necessary, should deplane and assist with the refueling, or man fire extinguishers.

U-26. Position a 20 B:C at the fuel source and at each nozzle point. Carry the nozzle fire extinguisher out to the aircraft, and place it within reach of the aircraft fill port.

U-27. Ensure the pilot notifies his commander that he will be off the air during refueling. The pilot may monitor his radios during refueling, but he should never transmit. The crew chief and pilot may talk by intercom during refueling.

U-28. Ground the aircraft to an authorized ground point using a grounding cable. Also, ensure the refueler is grounded in the same manner.

U-29. Bond the nozzle to the aircraft in one of two ways. Either by inserting the bonding plug into the plug receiver or attaching the clip of the nozzle bonding cable to a bare metal part of the aircraft other than the antenna.

OPEN FILL PORT

U-30. After the nozzle is bonded to the aircraft, remove the dust cap from the nozzle and open the aircraft's fill port. Insert the fuel nozzle into the fuel port. Maintain contact with the fuel nozzle at all times. All fuel nozzles used to refuel aircraft must have a #100 mesh screen. Do not leave the nozzle unattended at any time during refueling. Stop the flow of fuel if there is any emergency at the refueling point.

CCR NOZZLE

U-31. Mate the CCR nozzle to the fill port. Pull back on the control handle latch, and then push the flow control handle up toward the aircraft into the FLOW position. If the aircraft is to be filled completely, watch the back of the nozzle. A red indicator will pop out of the back of the nozzle when the aircraft tank is full. Pull back on the flow control handle to move it into the NO FLOW position. Unlatch the nozzle.

OPEN-PORT NOZZLE REFUELING

U-32. Rapid refueling (hot) using the open-port nozzle is restricted to combat or vital training. The decision to use the open-port nozzle must be made by the aviation commander. The open-port nozzle is mated to the CCR nozzle. The end of the nozzle is placed in the aircraft fuel tank adapter. If used, set the CCR nozzle to FLOW. Squeeze the control handle to dispense fuel. Watch the fill port when filling the tank. As the tank nears full, ease up on the trigger and finish filling more slowly. When the tank is full, release the trigger. Move the flow control handle on the CCR nozzle to the NO FLOW position. Be sure that flow has stopped completely before removing the nozzle from the fill port.

D-1 NOZZLE REFUELING

U-33. Remove the dust cover from the end of the nozzle body. Grasp the handles and hold the nozzle in alignment with the aircraft refueling adapter. Press the nozzle body against the adapter and turn handles to the right until the end of the nozzle mates and locks to the aircraft refueling adapter. Rotate the control handle to the full OPEN position. The pilot will signal when the tank is full. To disconnect, rotate the control lever to the full CLOSED position. Grasp the handles and rotate the nozzle body to the left until it disconnects from the aircraft adapter.

RECOVERY

U-34. Replace the cover of the aircraft fill port and put the dust cap back on the nozzle. Unplug the nozzle bonding plug or release the bonding clip. Carry the nozzle back to the hanger. Do not lay it or drag it across the ground. Release the grounding cable clip from the aircraft. Take the fire extinguisher back to a position near the nozzle hanger. Have the aircrew and passengers reboard the aircraft.

COLD REFUEL FOR GROUND EQUIPMENT

U-35. Cold refuel for ground equipment is very similar in procedures to the cold refueling of aircraft recorded above. In instances where aircraft is mentioned above, replace aircraft with equipment.

Appendix V

AVGAS Considerations

This appendix discusses the considerations when storing, handling and procuring AVGAS.

AVGAS

V-1. DLA Energy is responsible for the procurement, contracting and international fuel agreement for avgas. USAPC provides units with support involving avgas contamination and specification requirements.

PROCUREMENT

V-2. Avgas operations require unique infrastructure and equipment to ensure product quality and availability. It is critical that assigned personnel be involved in the initial planning site surveys and implementation of avgas operations. At locations where multi-service, multi-national and other U.S. agencies), a Memorandum of Understanding (MOU) will be executed between the various fuels organizations. A lead fuels function/agency will be designated to coordinate avgas requisition, receipt, storage and quality control to eliminate redundancy. The MOU will be coordinated with the JPO.

V-3. When determining requirements units must plan for product rotation to occur at a minimum every 90 days to maintain product quality.

V-4. For new avgas requirements, the requesting unit will submit a DLA Energy Requirements Worksheet in accordance with ASTM International D910, *Standard Specification for Aviation Gasolines* through COCOM ASCC to JPO for validation/submission to DLA Energy. All requirements worksheets will have the special requirements line annotated with "Fuel must conform to ASTM International D910."

STORAGE AND HANDLING

V-5. Every effort must be made to ensure avgas infrastructure (fixed or tactical) meets specifications, standards and criteria to ensure safe operations and to maintain fuel quality.

V-6. Portable fuel storage tanks or self-contained aboveground tanks (SCAT) are preferred due to construction costs and ease of installation. If used, SCATs must be designed to meet operational, safety, environmental pressure relief, fire, electrical and filtration requirement. The tanks must be maintained and operated in accordance with UFC 3-460-03, *O&M: Maintenance of Petroleum Systems*.

V-7. Procured or installed SCAT systems must meet minimum design and construction requirements of UFC 3-460-01, NFPA 30, *Flammable and Combustible Liquids Code*, UL Standard 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, UL Standard 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids,* UL Standard 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids* or international equivalent. Spacing, tank capacity restrictions and spill containment restrictions shall conform to UFC 3-460-01 and NFPA 30.

V-8. Procured or installed SCAT systems must meet minimum emergency venting/pressure relief requirements of API 2000, *Venting Atmospheric and Low-pressure Storage Tanks*, UL Standard 142, STI SP001, *Standard for Inspection of Aboveground Storage Tanks*, NFPA 30, or international equivalent. These requirements must be met to prevent loss of vapor pressure and to include provisions for emergency venting.

V-9. All containers storing avgas must be covered or shaded to protect minimize the environmental impacts and maintain product quality due to sunlight.

V-10. Collapsible fabric fuel tanks or bulk fuel vehicles should not be used for long term dormant storage of avgas due to possible off-specification of product as a result of vapor pressure loss. The collapsible fabric fuel tank must meet MIL-PRF-32233, *Tanks Collapsible, 3,000, 10,000, 20,000, 50,000 & 210,000 US Gallons Fuel*, requirements for avgas storage.

> **WARNING**
>
> **Collapsible fabric fuel tanks over 10,000 gallon capacity should not be used for avgas storage to ensure timely stock rotation.**

V-11. 55-gallon metal drums storing avgas must be stored by batch number and issued on a first in, first out basis. Drums will be stacked horizontally (on sides), not more than three high, bottom-to-bottom with bungs and vents in a vertical (3 and 9 o'clock) position facing outward. Drums must be placed on dunnage with proper blocking and bracing as necessary.

V-12. When servicing aircraft, equipment/vehicles of transferring fuel from drums, ensure equipment is grounded/bonded as with the procedures in aircraft fuel servicing.

PRODUCT QUALITY

V-13. See section on quality surveillance in this chapter for product quality concerning avgas.

EQUIPMENT

V-14. Infrastructure and equipment markings shall be in accordance with MIL-STD-161G, Identification Methods for Bulk Petroleum Products Systems/Including Hydrocarbon Missile Fuels.

V-15. The following list of refueling equipment is authorized and recommended for avgas use. The use of commercial or non-standardized Army refueling equipment should only be considered when equipment is not available and must be approved by USAPC.

- Forward area refueling equipment.
- Advanced aviation fuel refueling system.
- Collapsible coated fabric tanks.
- Seal drums (blivets).
- Elbow coupler valve.
- M978, HEMTT tank truck.
- Tank rack module.

Appendix W

Volume Correction of Collapsible Fabric Fuel Tanks

This appendix describes techniques used for volume correction in collapsible fabric fuel tanks. There are two steps to determining daily physical inventory, gauging the bag and correcting the inventory to 60o F.

W-1. Method for obtaining a sample from a collapsible fuel tank to perform volume correction:

- Gauge the fuel bag from the reference point IAW TB 10-5430-253-13 and record the measurement. Do not forget to subtract the documented distance between the cord and the fuel bag surface to an accurate gauge.
- Correct the inventory from the strapping chart to 60°F using the volume correction factors referenced in Tables 5B & 6B of ASTM International D1250 by:
- Displace twice the amount of product contained upstream of the filter separator.

W-2. To determine the quantity of fuel in the hoses from the collapsible fuel tank to the filter separator:

- Count the number of hoses from the bag to the F/S.
- Using the charts below determine the quantity of fuel in the hoses.
- Begin recirculation of fuel and displace twice the amount of fuel in the hoses from the collapsible fuel tank to the filter separator. This will ensure the sample is representative of the product in the bag to be volume corrected.

W-3. Take the sample downstream of F/S from sampling probe to obtain observed API and Temperature.

W-4. Perform the API gravity test and record the observed API gravity and observed temperature. Correct the API gravity to 60°F. using ASTM International table 5b.

W-5. When doing volume correction on collapsible fuel tanks, the observed temperature (from the API gravity test) will also be used as the tank temp to determine the volume correction factor.

W-6. Take the observed temperature and the corrected API gravity and use ASTM International table 6b to determine the volume correction factor.

W-7. Multiply the volume correction factor by the strapping chart volume to determine the volume corrected physical inventory.

W-8. Volume correction of daily physical inventory of tactical fuel sites can be time consuming if you try to volume correct each individual fuel bag, especially for larger sites. To alleviate this issue operators are authorized to (using the procedures mentioned above) use the observed temperature and API gravity of the issue fuel bag (or fuel bags if more than one fuel type is present) as the “site” observed temperature and API gravity readings. This means that if you have an observed API gravity reading of your JP8 issue fuel bag of 47.1 and an observed temperature of 80°F, once you correct the API gravity using Table 5b to 45.2 and determine your volume correction factor (Table 6b) to be 0.9897, you use this volume correction factor to correct the physical inventories of all your other JP8 fuel bags.

W-9. See appendix P, Recirculation for working and burst pressure as well as the amount of fuel in the hose by type.

Note: The 350 GPM pump holds approximately five gallons. The 350 GPM filter separator holds approximately 60 gallons.

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Appendix X

Procedures for Loading and Unloading Tank Cars

PROCEDURES FOR LOADING TANK CARS

X-1. The procedures for loading tank cars are described below.

SAMPLING AND GAUGING

X-2. Take a sample of the product and gauge the tank in accordance with the sampling and gauging procedures listed previously in this chapter. Resolve all discrepancies before loading the product.

INSPECTING LOADING EQUIPMENT

X-3. Inspect pumps, hose, pipelines, and manifolds to see that they are in good working condition and clean.

SPOTTING TANK CAR

X-4. Spot a tank car by using the following procedures.

- Make sure the track rails are properly bonded and grounded. Ensure that cable connections are secure and make bare metal-to-metal contact.
- Position the tank car so that there will be no unnecessary strain on the hose connections.
- Set the brakes and block the wheels of the tank car to keep it from moving during loading operations. Set and lock derails.
- Place STOP--TANK CAR CONNECTED signs between the rails at least 25 feet and preferably 50 feet ahead of and behind the tank car or group of tank cars. Place the signs so that they can be seen by switch crews on the main line next to the spur track. The signs should be at least 12 by 15 inches with black letters on a yellow background. The word STOP should be in 4-inch letters. The words TANK CAR CONNECTED should be in 2- inch letters.
- Place at least two fire extinguishers near the tank car where they will be in easy reach.
- If there is no permanent ground rod, drive a 4- to 5-foot iron rod into the ground beside the tank car. Attach a ground wire between the tank car and the rod. Soak the ground around the rod with water.
- If a tank car manifold is used, bond it to the tank car shell.
- When several rail cars are awaiting service, position cars with like products together.
- Place NO SMOKING signs in the area where they can be easily seen.

REMOVING DOME COVER

X-5. Stand on the windward side of the dome when releasing internal pressure or when removing the dome cover. Remove the dome cover as follows.

- Clean all dirt from around the dome cover.
- Raise the safety valve on the dome to see if there is pressure in the tank. Reduce any pressure in the tank by keeping the safety valve open.
- Remove the padlock or seal that secures the dome cover.
- Loosen the dome cover slowly to permit any remaining pressure to escape through vents in the cover. If the tank car has a screw cover, place a bar between the cover lug and the dome knob. Unscrew the cover two complete turns or until the vent openings are exposed. If the car has a hinge-and-bolt dome cover, loosen the nuts enough to release internal pressure.
- Remove the dome cover.

INSPECTING TANK CAR

X-6. Inspect the tank car to determine if it is suitable to receive the product. Follow these steps.

- Make sure that the product last carried in the tank is the same product that is to be transferred to the tank. If the product is not the same, follow the procedures in MIL-STD-3004.
- Inspect the inside of the tank visually from the outside through the dome to make sure it is clean. If there is rust, sand, scale, dirt, or residue, the tank must be cleaned before it is filled. Only authorized persons familiar with procedures for cleaning tanks should enter the tank.
- Look for any foreign objects, such as tools, bolts, or old tank car seals that may have fallen into the tank. Such objects should be removed only by authorized persons. Some objects may not contaminate the product; inspect the tank for residual product. Any residual product must be removed before the tank is filled.
- Inspect the inside and outside of the tank visually from the outside to make sure there are no holes, cracks, leaks, or loose plates. See that the tank is properly mounted to the under frame and that the tank is safe and roadworthy.
- Inspect the dome, dome cover, and safety valve to make sure they work and are in good condition. Make sure that the vent holes in the dome cover are open and clean.
- Make sure the bottom outlet chamber is serviceable.
- Ensure that the outlet valve seats and seals properly. Place a container under the bottom outlet chamber to catch drainage. It should stay there until the transfer is complete. Open and close the outlet valve several times with the valve rod handle or hand wheel located in the dome. If the valve does not seat properly, replace the valve gasket or repair the valve. In an emergency, load the tank car without repairing the outlet valve. However, report it so that personnel at the installation receiving the tank car will unload it through the dome. The valve should then be repaired as soon as possible. When the outlet valve is operating, close it.
- If necessary, tank cars may be flushed with a small amount of the product to be loaded. This will remove traces of previous product, rust, and scale from the outlet sump.

BOTTOM OUTLET LOADING

X-7. Tank cars should always be loaded through the bottom outlet. This prevents vapor loss. It also reduces static electricity and the chance of product contamination.

X-8. Make sure the outlet valve is seated before removing the bottom outlet cap. Remove the bottom outlet cap with the tank car wrench. If the cap does not unscrew easily, tap the cap lightly in an upward direction with a wooden mallet or block. Let any product in the outlet chamber drain into the drainage container. Open the outlet valve to allow any residual product to drain into the container. Close the outlet valve, but do not replace the outlet cap until the car is completely loaded. Dispose of any product in the container, and place it back under the outlet valve.

X-9. Precautions and procedures for loading a tank car through the bottom outlet are as follows:

- Place a pumping unit at least 50 feet from the tank car.
- Make sure the pumping unit is properly grounded.
- Make sure that the supply container is properly grounded and vented.
- Make sure the hoseline connections are not laid on the ground without a dust cap or plug. It could result in contamination of product.
- Connect the pump suction line to the outlet of the supply container.
- Attach the tank car elbow or Gossler coupling to the tank car outlet. Connect the pump discharge hose to either the elbow or the coupling. The tank car elbow is a part of the tank car loading facility and the FSSP.
- Station someone on the windward side of the dome to signal when the full mark is reached.
- Open the following valves before starting the pump:
- Outlet valve of the supply container.
- Pump valves necessary to permit flow through the pump.

- Tank car bottom outlet valve.
- Manifold valves, when a manifold is used.
- Start the pump following these precautions and steps.
- If spills occur while loading, stop the pump and cover the area with a blanket of foam from a foam fire extinguisher. If there is no foam fire extinguisher in the area, cover the spill with sand or dry earth. Remove contaminated earth and dispose of it according to current regulations.
- If sparks are seen while the car is being loaded, stop the pumps at once and check all bonding and grounding connections. All connections should have bare metal-to-metal contact.
- If the bad connection cannot be found, check the power equipment in the area for stray current. Correct any faulty condition.
- In the event of enemy attack, electrical storm, or fire, stop the transfer operation. Disconnect the pump discharge hose and tank car elbow. Replace the bottom outlet. If time permits, move the car out of the danger zone, set the brakes, and ground the car.
- In case of a fire at a hinged dome, stop loading and close the dome. In case of a fire at a screw dome, throw a wet tarpaulin or blanket over the dome or use a carbon dioxide or foam fire extinguisher.
- If the loading operation is stopped for any reason, disconnect the pump discharge hose.
- Check the contents of the tank often to avoid overfilling. However, never put your head in the dome.
- When the product level is near the full mark in the tank car, signal the pump operator to reduce pump speed and get ready to stop the pump. When a loading system that has a control valve is used, reduce the product flow by partially closing the valve. If the tank does not have a full mark, load the tank until the product reaches the top of the shell. When the tank is full, stop the pump, close all the valves, and disconnect the pump discharge hose.

DOME LOADING

X-10. A tank car should be loaded through the dome only when bottom loading is not possible. If the tank car must be loaded through the dome, follow these steps.

- Place a pumping unit at least 50 feet from the tank car. Make sure the pumping unit is properly grounded.
- Make sure the supply container is properly grounded and vented.
- Make sure the hoseline connections are not laid on the ground without a dust cap or plug. This could result in contamination of product.
- Connect the pump suction line to the outlet of the supply container.
- Put the end of the loading hose or drop tube through the dome of the tank until it almost touches the bottom of the tank. Bond the hose or drop tube to the tank. Make sure the end of the loading hose or drop tube remains submerged in the product in the tank during loading. If the hose or tube does not extend far enough into the tank, product will splash and vaporize. Splashing also causes static electricity. Make sure there is no strain on the hose that would cause it to move or
- Open the following valves before the pump is started:
- Outlet valve of the supply container.
- Pump valve to allow flow through the pump.
- Loading rack outlet valve when a loading rack is used.
- Manifold valves when a manifold is used.
- Make sure all the connections are secure, and start the pump following these precautions and step.
- Check for leaks at the bottom outlet when product starts to flow into the tank. If there are leaks, stop the pump and try to seat the bottom outlet valve by turning the valve rod handle clockwise. If the leak continues, stop loading, recover the product from the tank, and clean up any spills.
- If spills occur while loading, stop the pump and cover the area with a blanket of foam from a foam fire extinguisher. If there is no foam fire extinguisher in the area, cover the spill with sand or dry earth. Dispose of contaminated earth according to current regulations.

- Stop the pumps at once and check all bonding and grounding connections if sparks are seen while the product is being loaded. All connections should have bare metal-to-metal contact. If the bad connection cannot be found, check the power equipment in the area for stray current. Correct any faulty condition.
- Stop the transfer operation in the event of enemy attack, electrical storm, or fire. Then disconnect the pump discharge hose and tank car elbow, and replace the bottom outlet cap. If time permits, move the car out of the danger zone, set the brakes, and ground it.
- Stop loading and close the dome if there is a fire at a hinged dome. In case of a fire at a screw-type dome, throw a wet tarpaulin or blanket over the dome or use a carbon dioxide or a foam fire extinguisher.
- Remove the hose or drop tube from the tank if loading is stopped for any reason.
- Check the contents of the tank often to avoid overfilling. However, never put your head in the dome.
- Signal the pump operator to reduce pump speed, and get ready to stop the pump when the product level is near the full mark in the tank car. When using a loading rack or other system that has a control valve, reduce the product flow by partially closing the valve. If the tank does not have a full mark, load the product until it reaches the top of the tank shell. When the tank is full, stop the pump and close all the valves. Carefully remove the loading hose or drop tube from the tank to avoid spills.

FOLLOW-UP PROCEDURES

X-11. Certain follow-up procedures must be performed after a tank car is loaded. They are as follows:

- Allow the product to stand for at least 15 minutes so that suspended water or sediment can settle.
- Gauge and sample the contents of the tank. Take the temperature of the product, volume correct the quantity, and record the data. Keep the sample for reference until the tank is delivered.
- Drain any water or sediment from the tank.
- Compare the amount of the product issued from storage tanks with the amount loaded on the tank cars after the daily closing gauges are taken. Report excessive loss to the proper authority.
- Replace the bottom outlet cap. Close and lock the dome cover when the tank car is full of product.
- Place an approved identification seal on the dome cover. If the seal is in place, the receiver is assured that no one has tampered with the car. Record the seal marking on all the shipping papers.
- Remove the drainage tub from under the bottom outlet. Properly dispose of any product that is in the tub.
- Remove any DANGEROUS-EMPTY signs, and replace them with FLAMMABLE signs.
- Disconnect the grounding wire from the tank car. Remove the derails, if used, and remove the TANK CAR CONNECTED signs.
- Release the brakes, and move the car from the transfer area.

PROCEDURES FOR UNLOADING TANK CARS

X-12. Certain procedures must be followed before tank cars are unloaded. The procedures to follow are given below:

INSPECTING RECEIVING CONTAINERS

X-13. When inspecting receiving containers, you will need to follow certain procedures. These procedures are as follows:

- If the product in the tank car is to be transferred to a tank truck or semitrailer, inspect the vehicle tanks as you would tank car tanks.
- If the product in the tank car is to be transferred to storage tanks, make sure the storage tanks are suitable to receive the assigned product.

- If a receiving tank already has product in it, gauge and sample the tank contents. Make sure there is enough outage in the tank to receive the product. Visually inspect the sample to make sure the product in the receiving tank is the same as the product in the tank car. If there is any doubt, have tests made to verify the grade and quality of the product before mixing it with a new product. Gauge the tank again, and record the data.
- Make sure that the receiving tank is grounded and vented.

INSPECTING UNLOADING EQUIPMENT

X-14. Inspect pumps, hose, pipelines, and manifolds to see that they are clean and in good operating condition. When possible, use equipment to handle only one product. If more than one product must be handled by the same equipment, make sure all previous product in it is thoroughly drained before new product is pumped.

SPOTTING TANK CAR

X-15. A number of procedures are performed when spotting a tank car. These procedures are described in Section II. In addition, the following procedures apply to loading tank car.

- Make sure the tank car is in the right place by comparing the car and seal numbers with those on the shipping papers. Make sure the seals and locks are intact. Notify the proper authority if cars arrive with broken seals or locks. If there is an emergency and the tank car is needed immediately, unload the tank car but do not use the product until it has been tested.
- Pry the seals loose, and remove the dome cover. If the safety valve is not working, high pressure may develop in the tank car in hot weather. If time permits, relieve the pressure by letting the car cool overnight. Relieving the pressure by venting allows product to vaporize. It also causes a fire hazard.

TANK CAR INSPECTION

X-16. A number of procedures must be followed when inspecting a tank car. Follow these steps.

- Inspect the tank car for leaks through the shell and the bottom outlet. If there are any signs the car is leaking, schedule it to be unloaded at once. Place containers to catch leaking product, and clean up any spills.
- Gauge and sample the contents of the tank car, and check the sample for appearance and color. Take the temperature of the product, volume correct the quantity, and record the data. Slowly drain any water in the tank through the bottom outlet. After the water is removed, gauge the contents again, volume correct the quantity, and record the data. Fuel that is cloudy or off color may be contaminated. Any questionable product should be thoroughly tested before it is unloaded.
- Make sure the bottom outlet chamber is in good condition and the outlet valve is working properly (if it is used for unloading). In cold weather, water in the tank may freeze around the outlet valve and cause it not to work. To free the frozen valve, apply steam, hot water, or hot cloths to the outlet chamber. A hot air duct tent heater or a slave kit may be used by trained personnel, when authorized, to thaw the outlet. Let the valve thaw in the warm part of the day, when possible.

SAFETY PRECAUTIONS

X-17. A tank car should be unloaded through the bottom outlet. The tank car may be unloaded through the dome only when it is impossible to unload it through the bottom outlet. When unloading a tank car through either the bottom outlet or the dome, follow these safety precautions:

- If spills occur while unloading, stop the pump and cover the area with a blanket of foam from a foam fire extinguisher. If there is no foam fire extinguisher in the area, cover the spill with sand or dry earth. Dispose of contaminated earth according to current regulations.
- If sparks are seen while the car is being unloaded, stop the pumps immediately and check all bonding and grounding connections. All connections should have bare metal-to-metal contact. If

the bad connection cannot be found, check the power equipment in the area for stray current. Correct any faulty condition.

- In case of enemy attack, electrical storm, or fire, stop the transfer operation. Disconnect the pump suction hose and tank car elbow, and replace the bottom outlet cap or remove the drop tube or hose. If time permits, move the car out of the danger zone, set the brakes, and ground the car.
- In case of a fire at a hinged dome, stop unloading and close the dome. In case of a fire at a screw-type dome, throw a wet tarpaulin or blanket over the dome or use a carbon dioxide or a foam fire extinguisher.
- If loading is stopped for any reason, disconnect the pump suction hose or remove the hose or drop tube from the tank.

BOTTOM OUTLET UNLOADING PROCEDURES

X-18. Certain procedures must be followed to unload a tank car through the bottom outlet. These procedures are as follows:

- Place the pump at least 50 feet from the tank car. Ground the pump.
- Measure the diameter of the bottom outlet of the tank to make sure the connection can be made with available adapters.
- Turn the valve rod handle or hand wheel clockwise to make sure the outlet valve is seated. Place a drain tub under the bottom outlet, and leave it there until the operation is completed.
- Loosen the bottom outlet cap one or two turns. This permits product trapped in the outlet chamber to run into the drain tub. If the cap does not unscrew easily, tap it lightly in an upward direction with a wooden mallet or a block. Do not unscrew the cap completely. If flow from the outlet does not slow down after about 15 seconds, the outlet valve is not seated properly. In such a case, tighten the outlet cap and try to seat the valve properly. Unload the tank car through the dome if the valve cannot be seated. When drainage from the outlet slows to a drip, remove the outlet cap.
- Attach the tank car elbow or Gossler coupling to the tank car outlet. Use the necessary adapters, and connect the pump suction line to the tank car elbow or the coupling.
- Connect the pump discharge line to the inlet of the receiving container.
- Dispose of drainage collected in the drainage tub, and put the tub back in place.
- Place the dome cover over the manhole by propping it up with a block of wood under the edge. This allows air to enter the tank as the product is unloaded.
- Open the bottom outlet valve when all connections are secure.
- Open the proper valves in the line, and start the pump.
- Watch for leaks around all connections when the product starts to flow. If there are leaks, stop the pump and make repairs before starting the pump again.
- Wait until the entire product has been unloaded from the tank. Let the pump drain the suction line, and then stop the pump. When the suction line is empty, the engine speed will increase noticeably.
- Close the inlet valve of the receiving container immediately after shutting down the pump so that product will not drain back into the line.

DOME UNLOADING

X-19. Certain considerations must be followed when unloading a tank car through the dome. These considerations are as follows:

- Place the pump at least 50 feet from the tank car. Ground the pump.
- Place a drainage tub under the bottom outlet.
- Put the end of the unloading hose through the tank dome until it almost touches the bottom of the tank. Keep the hose below the surface of the product until the tank is completely unloaded.
- Connect the pump discharge line to the inlet of the receiving container.
- Place the dome cover over the manhole so that it rests against the hose and allows enough space for venting. Open the proper valves in the line, and start the pump.

- Watch for leaks around all connections when the product starts to flow. If there are leaks, stop the pump and make repairs before starting the pump again.
- Wait until the entire product has been unloaded from the tank car. Let the pump drain the suction line, and then stop the pump. When the suction line is empty, the engine speed will increase noticeably.
- Close the inlet valve of the receiving container immediately after shutting down the pump so that the product will not drain back into the line.
- Remove the bottom outlet cap, if possible, and drain the product from the outlet chamber into the drainage tub.

FOLLOW-UP PROCEDURES

X-20. Certain follow-up procedures must be performed after a tank car is unloaded. These procedures are as follows:

- Make sure the tank car is completely empty.
- Gauge and sample the product in the receiving tank, volume correct the quantity, and record the data. Compare the amount of the product delivered to the receiving tank with the amount of the product taken from the tank car. Report excessive loss to the proper authority. Allow enough time for water and particles to settle in the receiving tank. Drain the water from the receiving tank, gauge the contents again, and record the data.
- Remove the unloading hose or drop tube from the tank car.
- Close and unlock the dome cover. Remove the drainage tub, and discard any product in the tub. If the tank car has FLAMMABLE signs, replace them with DANGEROUS EMPTY signs. Disconnect the ground wire from the tank car, and remove the derails, if used.
- Remove the TANK CAR CONNECTED signs.
- Release the brakes, and move the car from the transfer area.

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Glossary

SECTION I – ACRONYMS AND ABBREVIATIONS

ADRP	Army doctrine reference publication
BCT	brigade combat team
BSB	brigade support battalion
CSSB	combat sustainment support battalion
DA	Department of the Army
DA Pam	Department of the Army pamphlet
DLA	Defense Logistics Agency
DOD	Department of Defense
DOS	days of supply
ESC	expeditionary sustainment command
FARE	forward area refueling equipment
FM	field manual
FSSP	fuel system supply point
GPM	gallons per minute
IPDS	inland petroleum distribution system
ISO	international standards organization
JP	joint publication
JP5	jet propulsion fuel-type 5
JP8	jet propulsion fuel-type 8
JPO	joint petroleum office
METT-TC	mission, enemy, terrain and weather, troops and support available, time available and civil considerations
MIL-STD	military standard
OPDS	offshore petroleum discharge system
POLCAP	petroleum capabilities
REPOL	reporting emergency petroleum, oils, and lubricants
ROM	refuel on-the-move
SAPO	sub-area petroleum office
TM	technical manual
TPT	tactical petroleum terminal
TSC	theater sustainment command

SECTION II – TERMS

area of operations

An operational area defined by the joint force commander for land and maritime forces that should be large enough to accomplish their missions and protect their forces. Also called AO. See also area of responsibility; joint operations area; joint special operations area. (JP 3-0)

area of responsibility

The geographical area associated with a combatant command within which a geographic combatant commander has authority to plan and conduct operations. Also called AOR. See also combatant command. (JP 1)

brigade combat team

A combined arms organization, consisting of a brigade headquarters, at least two maneuver battalions, and necessary supporting functional capabilities. (ADRP 3-90)

combatant command (command authority)

Nontransferable command authority, which cannot be delegated, of a combatant commander to perform those functions of command over assigned forces involving organizing and employing commands and forces; assigning tasks; designating objectives; and giving authoritative direction over all aspects of military operations, joint training, and logistics necessary to accomplish the missions assigned to the command. Also called COCOM. See also combatant command; combatant commander; operational control; tactical control. (JP 1)

direct support

A mission requiring a force to support another specific force and authorizing it to answer directly to the supported force's request for assistance. Also called DS. See also close support; general support; mission; mutual support; support. (JP 3-09.3)

host nation

A nation which receives the forces and/or supplies of allied nations and/or NATO organizations to be located on, to operate in, or to transit through its territory. Also called HN. (JP 3-57)

inland petroleum distribution system

A multi-product system consisting of both commercially available and military standard petroleum equipment that can be assembled by military personnel and, when assembled into an integrated petroleum distribution system, provides the military with the capability required to support an operational force with bulk fuels. The inland petroleum distribution system is comprised of three primary subsystems: tactical petroleum terminal, pipeline segments, and pump stations. Also called IPDS. (JP 4-03)

joint force commander

A general term applied to a combatant commander, subunified commander, or joint task force commander authorized to exercise combatant command (command authority) or operational control over a joint force. Also called JFC. See also joint force. (JP 1)

joint logistics over-the-shore operations

Operations in which Navy and Army logistics over-the-shore forces conduct logistics over-the-shore operations together under a joint force commander. Also called JLOTS operations. See also joint logistics; logistics over-the-shore operations. (JP 4-01.6)

Military Sealift Command

A major command of the United States Navy reporting to Commander Fleet Forces Command, and the United States Transportation Command’s component command responsible for designated common-user sealift transportation services to deploy, employ, sustain, and redeploy United States forces on a global basis. Also called MSC. See also transportation component command. (JP 4-01.2)

Offshore Petroleum Discharge System

Provides bulk transfer of petroleum directly from an offshore tanker to a beach termination unit located immediately inland from the high watermark. Bulk petroleum then is either transported inland or stored in the beach support area. Also called OPDS. (JP 4-03)

operation plan

Any plan for the conduct of military operations prepared in response to actual and potential contingencies.(JP 5-0)

operational control

The authority to perform those functions of command over subordinate forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction necessary to accomplish the mission. Also called OPCON. (JP 1)

operational environment

A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. Also called OE. (JP 3-0)

theater of operations

An operational area defined by the geographic combatant commander for the conduct or support of specific military operations. Also called TO. See also theater of war. (JP 3-0)

unified command

A command with a broad continuing mission under a single commander and composed of significant assigned components of two or more Military Departments that is established and so designated by the President, through the Secretary of Defense with the advice and assistance of the Chairman of the Joint Chiefs of Staff. Also called unified combatant command. See also combatant command; subordinate unified command. (JP 1)

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06 August 2015

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