
Petroleum Supply Operations

APRIL 2022

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Preface

ATP 4-43 provides doctrinal guidance and direction for United States Army units conducting petroleum supply operations. The techniques provided in this publication are ways or methods that units can use to perform petroleum supply missions.

The principal audience for ATP 4-43 is personnel involved in the planning and execution of petroleum supply operations. It is also applicable to personnel assigned to operational commands and staffs and provides each 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 must ensure that their decisions and actions comply with applicable U.S., international, and in some cases host-nation laws and regulations. Commanders at all levels will ensure that their Soldiers operate in accordance with the law of armed conflict and the rules of engagement. (See FM 6-27/MCTP 11-10C.)

ATP 4-43 uses joint terms where applicable. Selected joint and Army terms and definitions appear in the glossary and the text. Terms for which ATP 4-43 is the proponent publication (the authority) are italicized in the text and are marked with an asterisk (*) in the glossary. Terms and definitions for which ATP 4-43 is the proponent publication 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, United States Army National Guard, and United States Army Reserve unless otherwise stated.

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Introduction

ATP 4-43 is the United States (U.S.) Army's reference for commanders, staff personnel, and Soldiers performing petroleum storage, distribution and quality surveillance operations. ATP 4-43 provides information on petroleum supply operations to include roles of the theater Army, field army, corps and division headquarters, the sustainment headquarters at echelon and Army unit capabilities to execute petroleum supply operations.

This version of ATP 4-43 reflects changes that occurred in force design, distribution management and materiel management since the 2015 edition and re-orientes ATP 4-43 to align with FM 3-0 and FM 4-0. Additions to this manual include information regarding planning activities, the distribution management and materiel management process, cold weather operations, and interoperability with NATO fuel distribution equipment. ATP 4-43 contains six chapters and eighteen appendices.

Chapter 1 provides a brief overview of petroleum supply operations and their role within the Army operational contexts; petroleum quality management, and general safety and environmental considerations.

Chapter 2 provides an overview of Army organizations at the theater, corps and division echelon and their roles in petroleum supply operations and Army unit capabilities to conduct petroleum supply operations explains the Army's organizational structure for petroleum supply.

Chapter 3 describes the operational art in sustainment. It explains the petroleum planning process across the Army operational contexts and by each echelon.

Chapter 4 describes the distribution management process for Army petroleum supply operations.

Chapter 5 provides the reader with a basic understanding of Army petroleum operations. This chapter includes accountability and distribution measures and the application of the various petroleum systems and equipment.

Chapter 6 surveys petroleum supply operations considerations for safety, environmental stewardship and protection, primarily for the commander and staff.

A new term is listed in the introductory table.

Introductory table. New Army terms

<i>Terms</i>	<i>Remarks</i>
offshore petroleum distribution system	Term added and defined.

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Chapter 1

Petroleum Operations Overview

Military forces require large quantities of bulk petroleum products to support combat operations. Military bulk petroleum operations require uninterrupted supply from the commercial supplier through the distribution network to the supported unit as far forward as required. Bulk petroleum operations involve requirements determination, resupply, storage, movement of bulk fuel, quality surveillance, accounting for the product and maintaining distribution equipment and facilities. The purpose of this chapter is to give an overview of the petroleum supply operations process.

PETROLEUM DEFINITION

1-1. For the purposes of this text, the term petroleum shall include not only the naturally derived product, but alternative, renewable, and synthetic fuels and their blends as well. Petroleum is divided into bulk petroleum and packaged petroleum:

- Class III (B) (bulk petroleum products) includes liquid petroleum product transported by various means (such as pipeline, hoseline, rail tank car, tank truck, barge, or tanker) and stored in tanks or containers having an individual fill capacity greater than 55 gallons.
- Class III (P) (packaged petroleum products) includes petroleum products and chemical products generally (lubricating oils, greases, and specialty items) that are normally packaged by the manufacturer and procured, stored, transported, and issued in containers of 55 gallon capacity or less. (An exception is that various-sized collapsible containers such as the 240 gallon totes or larger may also be considered packaged products.)

PETROLEUM SUPPLY DESCRIPTION

1-2. Petroleum supply operations involve the material management and distribution of petroleum to include receipt, storage, distribution, quality assurance and surveillance of bulk petroleum and packaged petroleum products. The petroleum materiel management mission requires continuous situational understanding to anticipate, synchronize, and direct bulk fuel in order to maximize combat power and enable freedom of action for supported units. Petroleum distribution management synchronizes materiel management with transportation (including pipelines and conduit) to move bulk fuel from the source of supply to the supported unit in accordance with the supported commander's priorities.

BULK PETROLEUM DISTRIBUTION

1-3. The bulk petroleum distribution system in a theater of operations is the network delivering bulk fuel to the supported units. The distribution system may consist of storage terminals, pump stations, pipelines, hoselines, class III supply points, tank vehicles, and rail tank cars. In a developed theater, the bulk distribution system may be similar to that of the undeveloped theater; however, a developed theater normally includes fixed facilities. While host nation support might be available in both undeveloped and developed theaters, Army bulk fuel planners should count on United States assets supplying the vast majority of its own bulk fuel needs.

- In the undeveloped theater, bulk petroleum is generally distributed using various temporary, rapidly employed systems. These systems include the *offshore petroleum distribution system (OPDS)*, a bulk petroleum transfer system used by offshore tankers to provide petroleum for storage in the beach support area, or for onward movement inland. It also includes the inland petroleum distribution system (IPDS), tactical petroleum terminals (TPT), host-nation

support facilities, assault hoseline system, petroleum tank vehicles, fuel system supply points (FSSP), the modular fuel system, contracted distribution assets, and other flexible systems.

- In the developed theater, bulk petroleum can be locally procured or received from ocean vessels at marine terminals and transferred by pipeline to tank farms. Petroleum managers may implement semi-permanent to permanent bulk petroleum storage facilities in this setting. The IPDS extends as far forward as practicable, and is then supplemented by other means of delivery such as barges, rail tank cars and tank vehicles.

1-4. When entering an undeveloped or developed theater of operations, the layout of petroleum distribution systems will be dependent on operational and mission variables. Theater level organizations, such as the theater Army and the theater sustainment command (TSC), are responsible for the assessment, development and planning of the petroleum distribution management process in a theater of operations, whether undeveloped or developed. Figure 1-1 illustrates a battlefield array of the distribution management process in the undeveloped and developed theater.

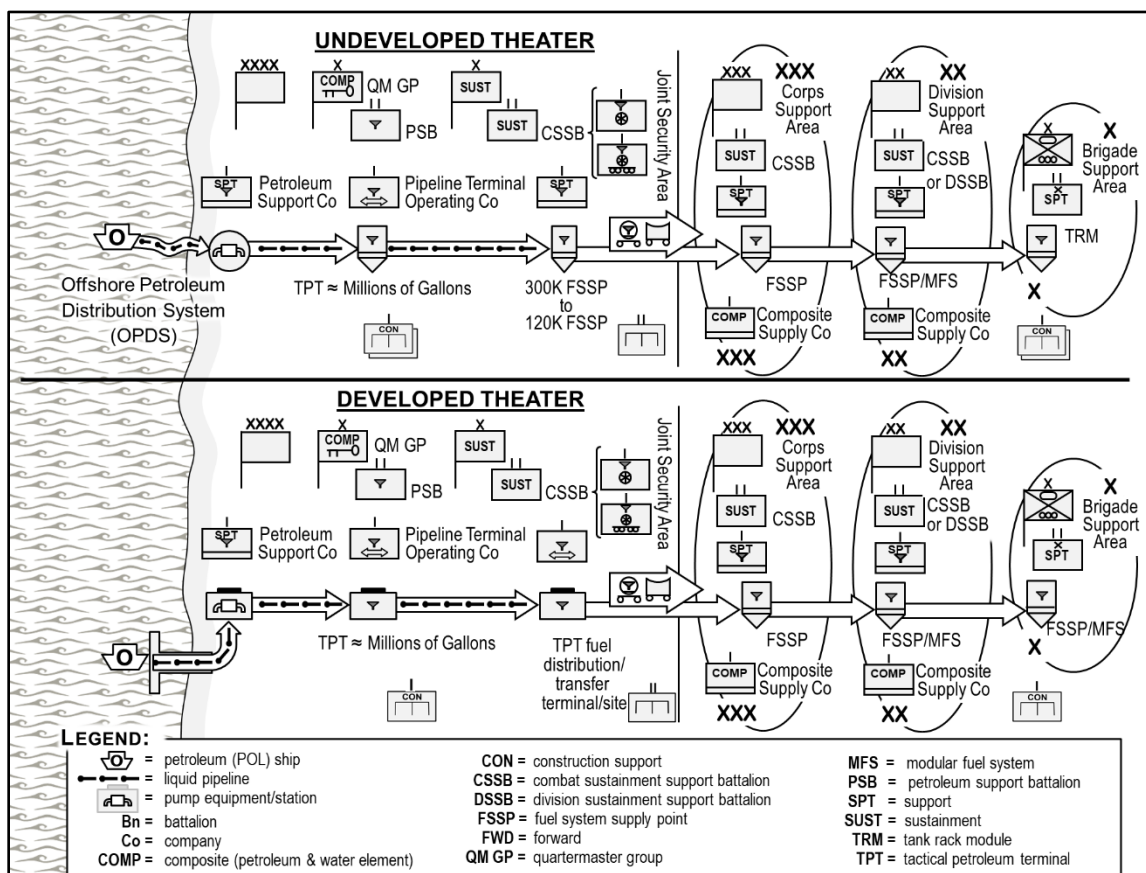


Figure 1-1. Undeveloped and developed theater

1-5. In accordance with JP 4-03, the Army provides:

- 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.
- Funding and maintenance for its 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. In an immature theater, this 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 inland to distribution centers and retail supply points.

1-6. To supplement its own petroleum force structure, the Army may use operational contract support in varying capacities. Operational contract support of the petroleum distribution network includes, but is not limited to, fixed storage facilities, bulk petroleum line haul and retail fuel support.

1-7. DOD directed the Services to standardize fuel usage, thereby minimizing the types of fuels required in joint operations. Jet propulsion fuel, type 8 (JP8), a kerosene-based jet fuel with similar properties to the commercial jet fuel Jet A-1 (with military additives), is the primary fuel for land-based air and ground forces. See MIL-DTL-83133K and DODM 4140.25, Vol. 1 for more information.

1-8. While the single fuel on the battlefield policy requires JP8 be used as the primary fuel in most scenarios, petroleum planners will have to plan for other types of fuels, such as diesel, motor gasoline and aviation gasoline, as the situation dictates. Refer to the DLA (Defense Logistics Agency) Energy Commodities Handbook and MIL-STD-3004-1A for more information.

1-9. The Defense Logistics Agency, Energy (DLA Energy) procures bulk fuel within the theater when possible. Host-nation sources of supply, such as commercial refineries, can shorten the lines of communication considerably and provide support that is more responsive. Tanker ships bring in bulk fuel not available in the theater. Ocean tankers are the most practical means of transporting bulk fuel across long distances; they are capable of providing over 10 million gallons in one load. In developed theaters, marine petroleum terminals receive and transfer bulk fuel by pipeline to tank farms. Pipelines and hoses extend as far forward as practical to reduce transportation requirements. Barges, rail tank cars, tankers, and aircraft provide other options for moving bulk fuel forward toward the point of need.

1-10. Pipeline is the most efficient means to transport fuel throughout the area of operations. Commercial pipelines are plentiful in many places in the world, including some less developed areas. The IPDS can supplement commercial pipelines or extend the reach of commercial pipelines, stand alone when commercial lines are not available, and be recovered and emplaced at a new location to meet changing operational demands. The least efficient, most costly, but most flexible means of support is via tanker truck.

CONCEPT OF PETROLEUM SUPPLY OPERATIONS

1-11. The concept of petroleum supply operations is an integrated process that links the operational requirements of petroleum products to the sustainment capabilities required to support demands. It focuses on when, where and how to provide petroleum products to forces in the theater via timely distribution methods. The basic petroleum-operating concept is to keep storage tanks full and distribute petroleum forward along open lines of communication. The availability of fuel depends on the location of the theater of operations. The Army provides its own multimodal integrated distribution system.

1-12. 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.

OVERVIEW OF PLANNING AT LEVELS OF WAR

1-13. Providing forces with the right fuel, in the right place, and at the right time requires planning to determine peacetime and wartime requirements, submit requirements, allocate product, establish or arrange for bulk storage, move products forward to and within the theater, ensure quality surveillance, issue and account for the fuel, and maintain distribution equipment and facilities.

1-14. Planning petroleum support in a theater of operations is challenging due to the huge tonnages involved, distribution distances, and the constant demand. Planners make maximum use of all possible sources of supply and distribution in order to establish the redundancies required to ensure continued mission support. Petroleum supply is planned and executed at all levels of warfare. 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 distribution management process. Strategic-level petroleum planners assist in the projection and long-term sustainment of the combatant commander's (CCDR) bulk petroleum requirements. They utilize the nation's industrial base to enhance the

CCDR's capabilities through the leveraging of strategic resources while maintaining flexibility in the face of a dynamic logistic environment.

- At the operational level, petroleum managers plan the support operations necessary to help maneuver commanders achieve strategic objectives within theaters or other operational areas. The sustainment of unified land operations requires a continuous link between the strategic and operational level. Petroleum planners face the challenges of getting the fuel into theater and integrating the capabilities from many providers who 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 three imperative capabilities critical to success: unity of effort, theater wide petroleum visibility, and rapid and precise response.

DISTRIBUTION MANAGEMENT

1-15. The Army employs the distribution management process to move petroleum from the source to the point of need. Distribution management includes materiel management and transportation management functions. It provides a consistent process whereby petroleum managers learn the things they need to do and the people they need to coordinate with to get the right fuel to the right place at the right time.

1-16. The process begins with planning for requirements and ends when an item is issued to the supported unit. Petroleum planners determine and validate materiel requirements (by commodity, quantity and priority) for distribution to units or locations, obtain materiel, and coordinate its distribution according to command priorities. Transportation managers allocate specific modes for specific commodities, by quantity and priority to coordinate distribution and routing to meet command priorities. Distribution managers use the information provided by the materiel management component to coordinate with the transportation component by commodity, quantity, priority, and recommended mode. Petroleum products, for inland support in a theater of operations, are requested from the TSC or an expeditionary sustainment command (ESC). Once the request is allocated, it is normally moved from the initial source in the joint security area, through the quartermaster petroleum group and operational level sustainment brigades to the tactical level brigade support battalion (BSB) or forward support company (FSC). Detailed information on distribution management exists in chapter 4 of this publication.

PETROLEUM SUPPLY OPERATIONS IN THE ARMY OPERATIONAL CONTEXTS

1-17. Army sustainment enables unified land operations by providing the support required to keep the Army, other Service, and allies engaged in operations across the operational environment (OE) as described in FM 4-0. Sustainment units supporting Army operations provide bulk fuel support within the operational contexts of competition, crisis, and conflict to ensure the combatant commander's freedom of movement, operational reach, and prolonged endurance.

OPERATIONAL ENVIRONMENT

1-18. The OE is a composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander (JP 3-0). An OE encompasses physical areas of the air, land, maritime, space and cyberspace domains; as well as the information environment (which includes cyberspace); the electromagnetic spectrum, and other factors. These factors include enemy, friendly, and neutral actors that are relevant to a specific operation. The OE involves interconnected influences from the global or regional perspective that impact on conditions and operations. ADP 3-0 and FM 3-0 describe the OE in detail.

1-19. A *threat* is any combination of actors, entities, or forces that have the capability and intent to harm United States forces, United States national interests, or the homeland (ADP 3-0). Threats exist in all domains and may include individuals, groups of individuals (organized or not organized), paramilitary or military

forces, nation-states, or national alliances. Threats are an inherent part of the OE. Sustainment commanders and staff must understand how current and potential threats organize, equip, train, employ, and control their forces. These leaders must continually identify, monitor, and assess threats as they adapt and change over time.

1-20. *Sustainment preparation of the operational environment* is the analysis to determine infrastructure, physical environment, and resources in the OE that will optimize or adversely affect friendly forces means for supporting and sustaining the commander's operations plan (ADP 4-0). It is a continuous shaping activity involving analysis to determine infrastructure, environmental, or resource factors in the OE that impact the Army's ability to sustain the commander's operations plan.

1-21. Petroleum supply operations in theater focus on continuous supply to meet the demand of the force and its equipment, enabling commanders to extend operational reach and prolong operational endurance. Planning for petroleum supply operations involves constant assessment and adjustments to the initial plan to adapt to a changing OE. In addition, the analysis of the OE includes determination of the infrastructure, physical environment and resources available in relation to petroleum supply support.

1-22. During large-scale combat against peer threats, friendly forces, including those conducting sustainment tasks, assume they are in contact and under observation in the space and cyberspace domains, as well as the information environment. In light of potential adversary capabilities, all fuel managers must be prepared to operate in denied, degraded and disrupted communication environments. FM 6-99 includes standardized report and message formats, including the Bulk Petroleum Allocation, Bulk Petroleum Requirements Forecast, and Bulk Class III Request and Forecast reports.

PETROLEUM SUPPLY OPERATIONS DURING COMPETITION

1-23. The Army conducts operations during competition to obtain geographic, informational, functional, and leadership positions of relative advantage across the land domain at the theater strategic and operational levels of warfare, to assist the joint force in deterring an adversary, and to contribute to alliance, coalition, or partner nation assurance activities. Army competition activities augment joint cooperation and, if required, position the Army to contribute to joint adversarial competition below armed conflict, and armed conflict. Army forces consistently compete in an attempt to keep relations with adversaries from escalating into a crisis or conflict. Examples of competition activities include setting the theater, military engagements, security cooperation, combined training and exercises, and sustainment preparation of the OE. Petroleum supply operations during competition focus on promoting organizational readiness and training.

1-24. Army units present in an area of operations during competition require reliable petroleum support. Effective petroleum support operations provide the operational commander the freedom of action, operational reach, and prolonged endurance necessary to shape the OE. To enable operations during competition, petroleum planners must work with planners at all levels to —

- Apply unity of command and effort to prepare the OE for transition.
- Leverage assured communication and enterprise capacity.
- Leverage commercial industry capacity to preserve force structure.
- Plan, synchronize, and integrate capabilities and capacities.
- Define and understand command and support relationships.
- Plan joint security operations and deterrent measures for the theater.
- Consider commercial infrastructure and alternate sources of supply
- Refine operation plans (OPLAN) and contingency plans (CONPLAN).
- Validate time-phased force deployment data (also called the TPFDD).
- Compile Joint services and Allied nations petroleum requirements.
- Identify engineer support requirements.
- Validate Army pre-positioned stock (APS) requirements.
- Determine sustainment and combat configured loads (IPDS sets, kits, outfits).
- Develop theater petroleum distribution plan.
- Develop theater quality surveillance plan.

- Identify over-the-shore requirements.
- Have simultaneity of effort across the warfighting functions.

1-25. Taking into consideration the level of host nation support and the ability to preposition petroleum stockpiles, petroleum planners determine and validate petroleum, oil, and lubricants (POL) requirements, and submit those to the Joint Petroleum Office (JPO) and DLA. They analyze the terrain of the area of operation (AO), which can have a significant effect on fuel consumption. They assess the shoreline, include water depth and tides, in preparation for possible over the shore operations. They identify and assess commercial infrastructure, including ports, airfields, and road networks. They identify alternative sources of supply, determine and configure combat loads, work with distribution and transportation managers to plan class III delivery, and participate in partner nation engagements and exercises.

PETROLEUM SUPPLY OPERATIONS DURING CRISIS

1-26. The Army conducts operations during crisis for two purposes. The first is to rapidly deploy Army forces to provide deterrence capability or, if necessary, compel an adversary to cease or reduce the actions that threaten U.S. national interests. The second reason the Army conducts crisis operations is to respond to a natural or humanitarian disaster that threatens the homeland or the stability of an ally or partner.

1-27. Operations during crisis may include mobilization, tailoring of forces and other pre-deployment activities; initial deployment into a theater and the development of mission-tailored requirements to support the commander's contingency operations. For petroleum operations planning purposes, this role consists of deployment planning operations that focus on requirements determination and allocation.

1-28. Units base their petroleum requirements on their projected mission and the supported commander's concept of the operation and intent. Maneuver unit operations sections and sustainment sections work to develop, refine and validate projected petroleum requirements. Petroleum managers may start exercising over-the-shore capabilities, commencing pipeline and fuel storage site construction, commencing the buildup of petroleum to reach the desired days of supply stockage objectives as determined by the combatant commander, and forward positioning fuel stocks.

1-29. To enable operations during crisis, petroleum planners must work with planners at all levels to —

- Determine the petroleum requirements.
- Provide class III support to units in theater.
- Refine concepts of support.
- Develop consumption estimates.
- Be prepared to support arriving, stationed and rotational forces simultaneously.
- Accelerate the rate and speed of assembly and integration of petroleum infrastructure and delivery.
- Understand acquisition and cross-servicing agreements (ACSA).
- Establish multiple ports of debarkation and distribution networks.
- Commence time-phased force deployment data flow.
- Mobilize component (often referred to as COMPO) 2 and 3 units.
- Activate regional DLA contracts.
- Exercise over-the-shore-capabilities.
- Deploy Army pre-positioned stocks (APS).
- Focus on building unit capabilities and days of supply while enabling reception, staging, onward movement and integration.
- Commence reception, staging, onward movement and integration
- Commence pipeline and fuel storage site construction.
- Identify inter and intra theater capability gaps.

PETROLEUM SUPPLY OPERATIONS DURING CONFLICT

1-30. During conflict, Army forces focus on the defeat and destruction of enemy ground forces as part of the joint team. The most violent and lethal level of conflict is large-scale ground combat operations conducted

against enemies with peer capabilities. As described in ADP 3-0, Army forces close with and destroy enemy forces in any terrain, exploit success, and break their opponent's will to resist. Army forces attack, defend, conduct stability tasks and consolidation of gains to attain national objectives. The ability to prevail in ground combat is a decisive factor in breaking an enemy's will to continue a conflict. Conducting large-scale combat operations corresponds to seize the initiative and dominate phases of joint operations.

1-31. When conflict operations commence, the commander immediately exploits friendly capabilities across multiple domains and the information environment to seize, retain and exploit the initiative. This involves the orchestration of many simultaneous unit actions in the most demanding of OEs. Operations during conflict require greater sustainment than other types of operations because of their higher operating tempo (OPTEMPO), greater lethality and significantly increased consumption of supplies and equipment. Based on the complex and chaotic nature of large-scale combat operations, sustainment commanders and their staffs will need to account for the characteristics of volume, lethality, precision and tempo during the operations process as they plan, prepare, execute and assess operations.

1-32. To enable operations during conflict, petroleum planners must work with planners at all levels to—

- Understand the concept of operation and scheme of maneuver.
- Understand the command and support relationships.
- Maintain situational awareness and understanding of the OE.
- Accurately determine fuel consumption demands and mitigate shortfalls.
- Conduct force protection through dispersion, signature management and network security.
- Conduct advanced planning to remain responsive as large-scale combat operations transition between offense, defense and consolidation of gains.
- Plan refuel-on-the-move (ROM) operations.
- Refine the class III (B) distribution plan.
- Estimate operational pauses and extended supply lines.
- Plan for forward arming and refueling point operations.
- Account for emergency resupply requirements.
- Secure critical infrastructure (pipeline, and bulk storage sites).
- Build theater days of supply.
- Exploit multimodal petroleum distribution options.
- Maximize resupply routes.
- Plan for transitioning between offense and defense and for consolidating gains.

1-33. Army forces consolidate gains made in combat to make enduring any temporary operational success and to set the conditions for a transition of control to legitimate civil authorities and a return to competition below armed conflict. Consolidation of gains is an integral and continuous part of armed conflict, and it is necessary for achieving success across the range of military operations. Army forces deliberately plan to consolidate gains continually during all phases of an operation. Army forces may conduct stability tasks for a sustained period over large land areas.

1-34. To enable operations to consolidate gains and return to competition below armed conflict, petroleum planners must—

- Balance the competing demands of fuel support to forces and stability tasks.
- Identify and acquire non-organic capability to enable stability operations.
- Anticipate requirements to close the joint operational area.
- Be prepared to transition from IPDS operations to contract operated.
- Manage inventory down to near zero and if necessary, sell the remaining fuel.
- Be prepared to transition to class III (B) distribution with civilian assets.

FUNDAMENTALS OF PETROLEUM QUALITY MANAGEMENT

1-35. Contaminated, comingled, or dirty fuels can damage expensive engines and cause the failure of critical combat missions. Quality management is the responsibility of every element that receives, stores, and issues

bulk fuel. Quality management includes two subsets - quality assurance and quality surveillance. Quality assurance determine if the bulk fuel producer or supplier complies with the required specifications detailed in the contract. Quality assurance takes place at the strategic level and is primarily a DLA Energy function. Quality surveillance ensures the on specification fuel provided to the Service is acceptable for the intended use until consumed. Quality surveillance is a Service task performed by qualified personnel using approved petroleum laboratories and test kits across the area of operations.

QUALITY ASSURANCE

1-36. Quality assurance is a planned and systematic pattern of all actions necessary to provide confidence that adequate technical requirements are established; products and services conform to established technical requirements; and satisfactory performance is achieved. For the Government, contract quality assurance is a method to determine if a supplier of products or services fulfilled its contract obligations pertaining to products or services provided. It includes all actions required to ensure the Government is receiving the proper products and services. By common usage, contract quality assurance responsibility is fulfilled when the product or service is accepted by the Government and the product no longer belongs to the contractor or the service is complete.

QUALITY SURVEILLANCE

1-37. Quality surveillance is the aggregate of measures (such as blending, stock rotation, and sampling) 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 takes place at the strategic, operational and tactical levels. Sediment, water, microbial growth, and commingled fuel may damage aircraft, ground vehicles, and fuel storage equipment. Contaminated or deteriorated fuel can cost lives, especially with aircraft.

1-38. A robust, detailed quality surveillance program ensures fuel used in military equipment is clean (clear) and bright and suitable for immediate use for its intended purpose. Quality surveillance applies to all petroleum products, and is the responsibility of all personnel who handle petroleum. Quality surveillance tests performed depend on where the bulk fuel is in the distribution network. The minimum quality surveillance tests required for each fuel type and location are provided in MIL-STD-3004-1A. Army specific quality surveillance guidance can be found within DA PAM 710-2-1 and AR 710-2. In addition to ensuring petroleum issued is suitable for use, quality surveillance provides insight into how well equipment and products are being maintained.

1-39. Daily quality surveillance of petroleum storage and distribution systems is essential to detect leaks, sabotage, damage, pilferage, unintended product comingling, contamination, and deterioration during storage. Qualified fuel handlers and petroleum laboratory specialists perform and supervise quality surveillance throughout the Army petroleum distribution network. Quality surveillance is the responsibility of every element in the distribution network that receives, stores, and issues bulk fuel.

1-40. Quality surveillance and sampling of bulk fuel is necessary to ensure that quality products are supplied. Fuel handlers and petroleum laboratory specialists personnel take samples of products for testing as follows:

- Upon receipt.
- Daily prior to use.
- When requested by petroleum offices.
- Bulk fuel stored for six months or more. Refer to AR 710-2 and MIL-STD-3004-1A.
- The quality of fuel is questioned or it cannot be classified.
- A filter separator is first placed in service after the filter-coalescer elements have been changed and within 30 days from the date last sampled from that filter separator.
- It is reasonably suspected that an aviation fuel may be contaminated or commingled.
- Commercial deliveries of bulk fuel. Refer to DA PAM 710-2-1 and MIL-STD-3004-1A.

1-41. Petroleum laboratories routinely test fuel at class III supply points for deterioration or contamination during storage. A series of testing procedures ensures that bulk fuel is of the highest quality, meets the required performance standards, and is usable for its intended purpose. Providing fuel within required

specifications requires checks at the point of receipt, during storage, and prior to issuing to the supported units. If bulk fuel is found unsuitable, the United States Army Petroleum Center (USAPC) makes recommendations for product disposition.

1-42. The Quality Surveillance Program (see AR 710-2) is used to monitor the condition of fuel from point of receipt until it is consumed. In addition to ensuring that all petroleum issued to supported units is suitable for its intended use, quality surveillance provides day-to-day information on how well equipment and products are maintained. AR 710-2, DA PAM 710-2-1, and MIL-STD-3004-1A dictate the testing frequency and the testing methods for bulk products in transit and in storage.

GENERAL SAFETY AND ENVIRONMENTAL CONSIDERATIONS

1-43. Bulk petroleum handlers adhere to safety guidelines in equipment technical manuals (TM) to prevent death or severe injury during transportation, installation, operation, and recovery of bulk petroleum and its equipment. Environmental stewardship measures apply to petroleum storage and distribution operations.

SAFETY IN PETROLEUM OPERATIONS

1-44. Users are more likely to handle and store petroleum products safely if they understand and respect the unique safety hazards such products present. Chapter 6 of this publication gives bulk petroleum receipt, storage, and issue safety techniques to include safety 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 that bulk fuel managers and handlers must consider and alleviate during those processes.

1-45. Safety training is the key to preventing accidents. Safety training starts during the Soldier's initial entry training and continues throughout their military service. Supervisors ensure all fuel handlers know about petroleum and the safety principles for handling and using petroleum products. In addition, handlers learn thoroughly self-care techniques, fire prevention, first aid, and emergency safety procedures.

1-46. The United States Army Tank-automotive and Armaments Command (TACOM) and the U.S. Army Quartermaster School have websites to assist with safety and health in petroleum operations. Petroleum handling personnel should frequently search the USAPC, TACOM Unique Logistics Support Applications (also known as TULSA), and U.S. Army Quartermaster School Petroleum and Water Department websites for updates and messages regarding safety and health in petroleum operations.

ENVIRONMENTAL STEWARDSHIP MEASURES

1-47. The Army has the task of mitigating the effect on the environment of its operations. Without strict adherence to proper safety and environmental practices, petroleum operations can result in an adverse impact on the environment. Leaders and Soldiers in these units need to follow safe, legal environmental practices to the maximum reasonable extent practicable under the operational circumstances. This will protect the health of those around them and prevent long-term environmental damage. Petroleum managers make every effort to adhere to the following stewardship principles:

- Apply appropriate risk management procedures.
- Comply with installation environmental policies, unit standard operating procedures (SOPs) and environmental laws and regulations, and Army policy.
- Maintain a clean and safe work area.
- Use required safety equipment when handling hazardous materials.
- Report spills and other violations.
- Conserve resources.

1-48. At a minimum, unit environmental compliance in petroleum supply operations programs cover—

- Hazardous materials management in accordance with DA PAM 710-7.
- Hazardous waste management in accordance with the U.S. Army Environmental Command and the Resource Conservation and Recovery Act.

- Hazard Communications in accordance with DODI 6050.05 and AR 385-10.
- A spill prevention, control and countermeasure plan. This plan identifies fuel storage locations therefore, potential spill sites and those measures taken to prevent a spill from occurring.
- A spill contingency plan that 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.
- Personnel at all levels are expected to comply with installation environmental policies, unit SOPs, ARs, and environmental laws and regulations.

ADDITIONAL CONSIDERATIONS

1-49. Additional considerations include maintaining proper accountability and security of petroleum products.

PETROLEUM PRODUCTS INVENTORY

1-50. The primary goal of petroleum distribution is to initiate an uninterrupted flow of on-specification fuel with ground lines of communication as far forward as possible. Theft of fuel exacts operational and financial risks.

1-51. The petroleum commodity is subject to fraud, waste and abuse if not accounted for and handled properly. Automating fuel systems, sound accounting practices, accurate quality surveillance, frequent physical inspections and auditing, establishing responsibility and good stewardship make fuel accountability effective and less subject to fraudulent activities.

1-52. Petroleum accountability is the responsibility of all Soldiers and personnel. However, supervisors, noncommissioned officers (NCO) and officers are ultimately responsible for ensuring proper accountability of petroleum products is maintained. Commanders instill in their unit personnel the sense of responsibility for exercising 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, and balances on hand or in use.

1-53. DOD fuel is purchased and owned at the national level by DLA Energy. The fuel when owned by DLA Energy is known as capitalized fuel. When the Army purchases fuel, it is subject to Army accountability, handling, and storage policies. The Army is adopting DOD inventory management practices to seamlessly interconnect capitalized and non-capitalized fuel accounts.

- Capitalized fuel is owned by the Defense-Wide Working Capital Fund while in storage tanks, servicing vehicles and ships until the point of sale. The DLA division of the Defense-Wide Working Capital Fund assumes management responsibility and ownership (title) for inventories financed from other DOD appropriations or funds, without reimbursement except as stipulated in UFC 3-460-01 (DODM 4140.25, Vol. 1). DODM 4140.25 Vol. 6, provides overarching guidance for the accountability of capitalized petroleum products. DLA Energy provides additional guidance in its policies.
- Non-capitalized fuel is owned by the Services while in storage tanks, servicing vehicles, and ships until the point of issue. The Services assume management responsibility and ownership (title) for inventories financed from the Services appropriated funds (DODM 4140.25, Vol. 1).

1-54. In simplified terms, DLA Energy owns the fuel in capitalized accounts, and the Army owns the fuel in non-capitalized accounts. The vast majority of Army fixed bulk fuel operations are capitalized; most tactical, unit level operations are not capitalized. DLA accounts for its fuel to the nearest 0.25%; Army-owned fuel is accounted for to the nearest 0.50%.

1-55. Personnel storing or transferring bulk fuel 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.

1-56. Units are responsible for all petroleum issued to them for consumption as part of their basic or operational load. Units ensure protection, maintain control, and maintain audit trails on all fuel issued and received for the current fiscal year of issue, plus three prior years. Unit commanders responsible for storing and issuing fuels designate in writing a responsible individual to maintain control of all fuels and to provide an audit trail. Aggressive management policies and procedures will assist in the prompt and accurate identification of shortages or overages. Refer to AR 710-2 and DA PAM 710-2-1 for detailed bulk petroleum accounting procedures of Army-owned product.

SAFEGUARDING PETROLEUM

1-57. 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. Unit commanders are responsible for devising 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.
- Permit only one-way traffic.
- 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.
- Physically look into tank trucks prior to leaving the supply point.
- Establish methods to compare the documented loaded quantity of fuel to the physical quantity of fuel received.

1-58. Petroleum bulk fuel transport vehicles not under the surveillance of the operator or a dedicated guard force will have —

- Locked hatch covers where possible
- Locked manifold access doors
- Each manifold valve secured with a transportation seal, if a manifold access door cannot be locked
- Approved padlocks as specified in non-sparking brass for safety, if available.

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Chapter 2

Petroleum Supply Organizational Structure

Chapter 2 provides an overview of the joint and strategic-level organizations and Army units that conduct petroleum supply operations. This chapter provides a description of the role of Army headquarters at echelon (theater, corps and division) for petroleum supply operations. Chapter 2 also provides a brief description of each unit, its role and its capabilities.

SECTION I – JOINT AND STRATEGIC LEVEL ORGANIZATIONS

2-1. Joint and strategic organizations involved in petroleum supply operations include the United States Transportation Command (USTRANSCOM), DLA, United States Army Materiel Command (USAMC) and geographic command commands (GCC). 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 geographic combatant command level and ends with the TSC at the operational level of petroleum support. Coordination with the JPO, the theater Army, the United States USTRANSCOM, 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.

UNITED STATES TRANSPORTATION COMMAND

2-2. USTRANSCOM is the functional combatant command responsible for providing and managing strategic common-user airlift, sealift, and terminal services worldwide. The USTRANSCOM mission includes planning for and providing air, land, and sea transportation of fuels for DOD during all operational contexts.

2-3. Combatant commands, service components, and DLA Energy coordinate with USTRANSCOM to move petroleum assets outside of the operational area.

2-4. USTRANSCOM's major subordinate commands include Air Mobility Command as its Air Force component command, Military Sealift Command as its Navy component command, and the Military Surface Deployment and Distribution Command (also known as SDDC) as its Army Service component command. Military Sealift Command operates vessels that sustain our warfighting forces and deliver specialized maritime services in support of national security objectives. The Military Sealift Command provides petroleum capability through the OPDS. When commercial facilities are not available, are damaged, or inadequate, the OPDS can hook up to commercial and military oceangoing tankers to provide an effective alternative method for providing high volumes of fuel to the shore.

2-5. The Joint Petroleum Office, USTRANSCOM, represents Commander, USTRANSCOM, on all petroleum-related issues: Key duties and responsibilities of the USTRANSCOM JPO include —

- 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.
- Oversee and validate all fuel data reporting by Army Materiel Command and Military Sealift Command.
- Assist combatant commanders on establishing their fuel-related priorities.

- Coordinate with other JPOs to de-conflict requirements.

DEFENSE LOGISTICS AGENCY

2-6. DLA is the primary DOD logistics provider for supply classes I, II, III, IV, VI, VII and IX. DLA Energy is a major subordinate command of DLA and is the primary source for class III bulk petroleum supplies. DLA supports each GCC, often by co-locating a DLA regional command with the sustainment headquarters (typically the TSC or ESC). DLA regional commands are the focal point for coordinating DLA activities throughout the area of responsibility (AOR) and reach back to other DLA elements in CONUS for logistics solutions.

2-7. In accordance with DODD 5101.8E, DLA Energy —

- Serves as the class III (B) executive agent responsible for providing contracted fuel support across all services and combatant commands in permissive and semi permissive environments.
- Manages the bulk petroleum distribution network from the refinery to the supported and supporting unit.
- Obtains bulk fuel locally within the theater, when possible.

2-8. DLA Energy uses Accountable Property System as its automated conduit to manage any location where the fuel is owned by DLA Energy. These locations are known as capitalized locations or Defense Fuel Support Points. Defense Fuel Support Points receive, store, and issue capitalized fuel. Capitalization refers to ownership. Capitalized fuel is managed and owned by DLA Energy from refinery to delivery to an Army unit who is required to reimburse the Defense-Wide Working Capital Fund for the fuel it received. Fuel purchased from DLA Energy and owned by the Services is non-capitalized.

2-9. The DLA Energy bulk fuels commodity business unit acts as the principal advisor and assistant to the Director, DLA Energy and the deputy director of operations in directing the accomplishment of mission responsibilities. These responsibilities are to provide —

- Worldwide support of authorized activities in the areas of contracting, distribution, transportation.
- 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, bulk fuel additives, and crude oil.

2-10. The direct delivery fuels commodity business unit acquires and manages ground, aviation, and ship propulsion fuels delivered directly to the requiring Service from commercial vendors. DLA Energy is responsible for quality assurance and on-specification delivery of all bulk petroleum products procured and distributed through the distribution management process. During large-scale combat operations, DLA cannot be expected to deliver fuel forward of the rear boundary of the corps support area.

UNITED STATES ARMY MATERIEL COMMAND

2-11. The USAMC is the Army's materiel integrator providing national-level sustainment, acquisition integration support, contracting support, and selected logistics support to Army forces. It also provides related common support to other Services, multinational, and interagency partners (FM 4-0). USAMC is responsible for developing fuel burn rates for Army equipment.

2-12. USAMC is the Army's executive agent for the APS program. USAMC is responsible for APS management, equipment modernization planning and current operations. The APS comprises five land and sea-based categories: unit sets, operational project stocks, sustainment stocks, war reserve stock, and activity sets.

UNITED STATES ARMY PETROLEUM CENTER

2-13. The USAPC supports Army needs on most petroleum-related topics and actively interacts with all parties within the military petroleum community. USAPC has three core areas of expertise: petroleum operations (tactical and garrison), petroleum infrastructure, and quality surveillance.

2-14. In accordance with AR 710-2, USAPC will—

- Act as the Army Service control point in accordance with DOD 4140.25, Volume 1. Service control points established by military Services 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).

2-15. USAPC will execute the following programs (for more information see AR 710-2):

- Petroleum operations.
 - Army petroleum help desk.
 - Petroleum Technical Assistance Program.
 - Army fuel consumption requirements validation.
- Petroleum infrastructure.
 - Engineering Technical Review Program.
 - Army Sustainment, Restoration and Modernization Program.
 - Army Petroleum Military Construction Program.
 - Army Fuel Facility Optimization Program.
- Quality.
 - Army Quality Surveillance Program.
 - Petroleum Laboratory Certification Program.
 - Air Pollution Abatement Program.
- Laboratory support.

2-16. During major contingencies, USAPC serves as a collaborative partner that provides technical assistance in requirements determination and validation. The GCC JPO typically works directly with DLA Energy with USAPC providing assistance as needed.

2-17. Additional functions of the USAPC include, but are not limited to:

- Providing technical assistance and readiness assessments.
- Managing sustainment, restoration, and modernization requirements for Army capitalized facilities and provide engineering support for those projects.
- Providing technical expertise for installation and operation of tactical bulk petroleum handling systems and automated fuel management systems.

GEOGRAPHIC COMBATANT COMMAND

2-18. The GCC 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. The operations directorate of the joint staff (J-3) is responsible for developing the GCC concept of operations, which will drive fuel requirements within the assigned geographic or functional area of operations. The logistics directorate of the joint staff (J-4) at the GCC plans for the execution of petroleum support for the AOR. The J-4 has responsibilities to develop, project and validate petroleum requirements in support of the J-3's concept of operations.

2-19. The CCDR is ultimately responsible for ensuring the theater has all petroleum support capability required to meet the CCDR's objectives. The JPO discharges the responsibility. 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. To support the management of the inland petroleum distribution mission of the Army to support the joint force, the JPO can designate an area within the joint operational area (JOA) as requiring a subarea petroleum office (SAPO) and request the Services to provide personnel to staff the office. The SAPO is responsible for execution of multi-service and coalition partner petroleum support.

2-20. 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 combatant commands, subordinate unified commands, and joint task forces. Joint forces can be established on either a geographic area or functional basis. Further information on combatant commands and joint force command is located in JP 1.

JOINT PETROLEUM OFFICE

2-21. The JPO executes petroleum responsibilities for the combatant commander and if needed, establishes one or more SAPOs.

2-22. The JPO collaborates with DLA Energy, Service components, SAPO, USAPC, the TPC, and quartermaster petroleum groups 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.

2-23. The JPO 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.

2-24. 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, petroleum military construction project planning includes the U.S. Army Corps of Engineers and the USAPC. Close coordination between the JPO, responsible host-nation agencies, and Service components 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.

2-25. At the direction of the GCC, the theater Army provides forces, tasks, and designates one or more SAPOs, as subordinate offices, to the JPO to perform petroleum planning and execution in an area of operations or joint operations area for which the JPO is responsible. SAPOs—

- Plan and execute the petroleum logistics support requirements.
- Maintain visibility of the bulk fuel supply distribution situation and facilitate resolution of fuel related problems.
- Document and verify fuel deliveries to Service components and supporting commands.
- Consolidate and forward bulk fuel requirements to the JPO with a copy furnished to USAPC.
- Oversee quality surveillance for all bulk fuel in the JOA.
- Forward receipt documents to the appropriate DLA Energy element.

2-26. Key responsibilities of the JPO and SAPO are further discussed in JP 4-03.

SECTION II – THEATER ECHELON ARMY ORGANIZATIONS AND CAPABILITIES

2-27. The purpose of this section is to describe the role of Army organizations at the theater echelon and Army unit capabilities to conduct petroleum supply operations.

2-28. Theater petroleum operations begin with planning and coordination at the strategic level with the combatant commander and at the theater Army level. Theater-level petroleum planners coordinate 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 ESC. Theater distribution is executed by the petroleum group at the operational level and below. The TPC and petroleum liaison detachments support Army planning and

operations at the theater Army, TSC, ESC levels and below. Figure 2-1 shows a layout of the echelons of bulk petroleum distribution in theater.

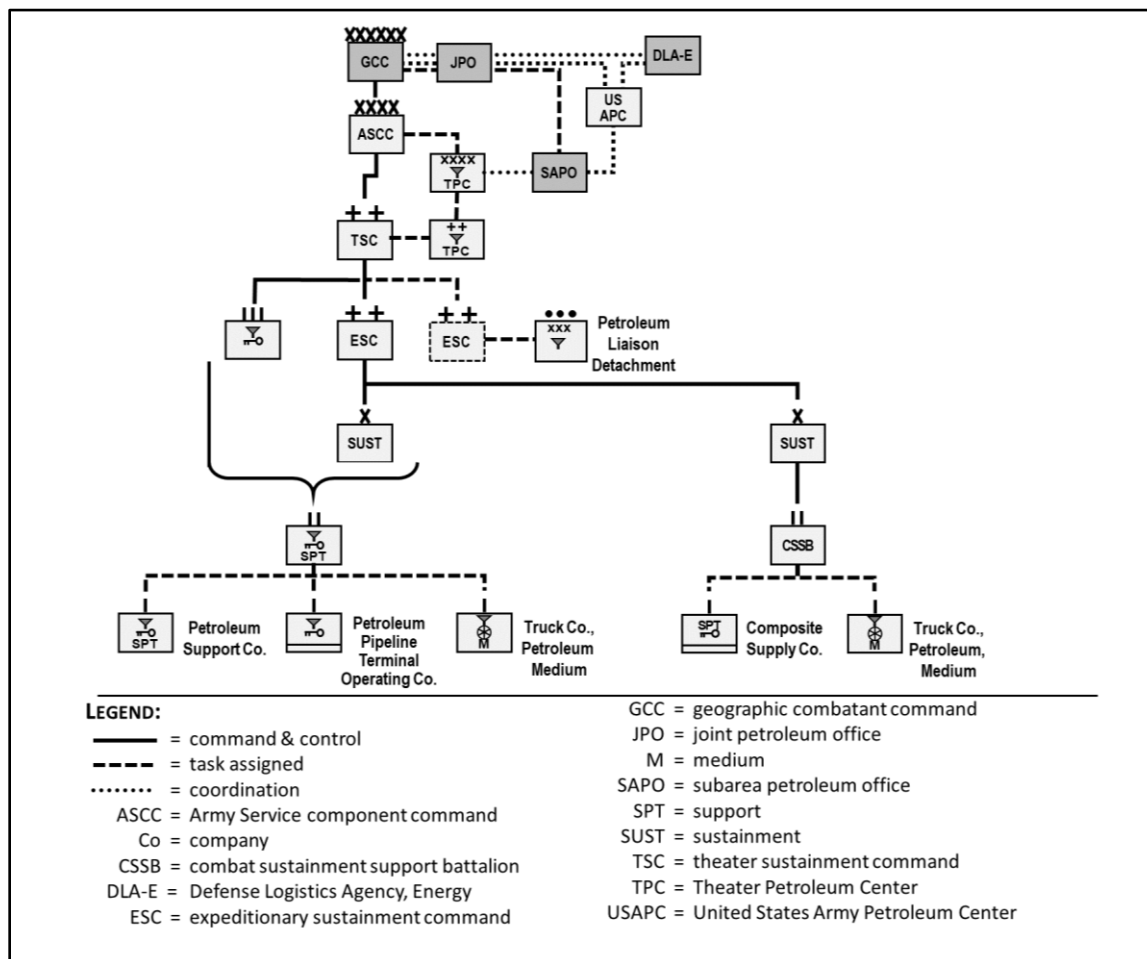


Figure 2-1. Echelons of bulk petroleum distribution in theater

THEATER ARMY

2-29. The theater Army is the highest echelon Army headquarters in an AOR. The theater Army is responsible for training, equipping, and sustaining forces as outlined in the appropriate service-specific subtitle of 10 USC. The theater Army is the Army Service component command for each geographic combatant command. The theater Army is responsible for making recommendations to the joint force commander on the use of Army forces within a combatant commander's AOR.

2-30. The theater Army conducts administrative and select operational activities (theater opening, reception, staging, onward movement and integration; Army support to other Services, and common-user logistics for multiple tasks including fuel distribution and transportation) to allow the field army to focus on tactical operations. The theater Army's senior sustainment headquarters is the assigned TSC.

2-31. Embedded within the theater Army are staff elements which provide oversight of petroleum and water supply, storage, reporting, and health safety within the AOR. The assistant chief of staff, operations (G-3) is responsible for developing the theater Army concept of operations, which will drive fuel requirements. The assistant chief of staff, logistics (G-4) staff is the primary staff concerned with petroleum and water requirements determination. Theater level petroleum and water situational awareness occurs between the theater Army and the theater level logistics headquarters. The TPC or petroleum liaison detachments may be assigned or attached to the theater Army G-4 to support planning and operations at the theater level.

THEATER PETROLEUM CENTER

2-32. The TPC serves as the senior Army petroleum advisor to the geographic and functional combatant commands. The TPC provides strategic through operational planning support to geographic or functional combatant commands, the theater Army, corps, and TSC. The TPC conducts liaison support with DLA Energy, the Army Petroleum Center, the JPO, SAPO, and other partners as needed. The TPC is allocated one per theater Army supporting a GCC, or in the TSC when their capabilities to plan and execute petroleum operations are exceeded.

2-33. The TPC serves as the linkage between petroleum partners by providing liaison support between DLA Energy, USAPC, JPO, theater Army, corps, TSC and ESC, petroleum groups and the SAPO as needed. The TPC serves as the senior theater Army petroleum advisor to the geographic and functional combatant commands. The TPC is normally assigned or attached to a theater Army, TSC, or corps. The TPC may also be attached to a geographic combatant command when supporting the JPO mission as the Army's Service component representative.

2-34. The TPC has a worldwide mission focus and responsibility. Based on requirements and resources available, the TPC supports all theaters of operations simultaneously and refines its focus as conditions require. In this capacity, the TPC interfaces with DOD strategic partners throughout the globe in accordance with operational needs.

2-35. The TPC—

- Assists combatant commands, theater armies, TSC, and corps with development of bulk petroleum and alternative fuels policies, procedures, and guidelines.
- Assists combatant commands, theater Armies, TSC, and corps with development and validation of OPLAN and CONPLAN.
- Provides theater level expertise, augmentation, management, and recommendation to the JPO and G4 during planning and support to Defense Support of Civil Authorities events.
- Synchronizes OPLAN and CONPLAN petroleum requirements at the theater Army and TSC level.
- Validates time phased force deployment data, for petroleum support units and command and control elements at the theater Army level and below.
- Determines transportation (intra and inter-theater) requirements and methodology for multimodal distribution network movement of bulk petroleum and alternative fuels from the point of receipt of product from DLA Energy forward.
- Conducts multimodal distribution network and storage capabilities assessments of host nation, allied and partner nations in concert with strategic and operational partners.
- Supports a JPO as the Army's Service component representative when required.
- Acts as or supports a SAPO as the Army's Service component representative when required.
- When supporting as a JPO or SAPO the TPC communicates and synchronizes bulk petroleum and alternative fuels requirements, resources and plans between operational and strategic levels.
- Develops, synchronizes and monitors quality surveillance plans, policies, procedures and guidelines from the point of receipt of energy products from DLA Energy forward in an OE.
- Provides bulk potable water planning support at the TSC or above level as required.
- Provides coordination and synchronization guidance for Total Force's petroleum liaison detachments.

QUARTERMASTER PETROLEUM LIAISON DETACHMENT

2-36. Each quartermaster petroleum liaison detachment is assigned to support a TSC, ESC, petroleum and water group, or transportation brigade expeditionary (TBX). The quartermaster petroleum liaison detachment is similar to the TPC and provides the same capabilities of the TPC on a smaller scale.

2-37. Each detachment serves as the Army petroleum advisor for operational planning support to the TSC, ESC, and quartermaster petroleum group. The team conducts liaison support with DLA Energy, the USAPC, the JPO, the SAPO, the Theater Petroleum Center and other partners as needed. The team supports a

designated region as a SAPO when designated by the GCC. JPO. It provides bulk potable water planning support at the TSC or ESC level as required. In addition, the quartermaster petroleum liaison detachment —

- Executes liaison, synchronization and coordination for bulk petroleum and alternative fuels support for U.S. forces, allies, coalition partners, host nations, governmental and as directed nongovernmental partners at the corps level and below.
- Provides theater level expertise, augmentation, management, and recommendation to the JPO and G4 during planning and support to Defense Support of Civil Authorities events.
- Can be attached to a petroleum group as a plans and operations center when the group has one or more petroleum support battalions (PSB) or multiple petroleum support companies (PSC) such as pipeline terminal operating or assault hoseline assigned. It provides support, plans, validates requirements and assists in the development of the concept of support.
- Supports the theater port opening mission of the transportation brigade (expeditionary) when assigned. It provides planning, coordinating and operations support to the TBX when the bulk petroleum portion of the mission exceeds staff capabilities.
- Receives coordination and synchronization guidance from the TPC through its chain of command.

THEATER SUSTAINMENT COMMAND

2-38. The TSC is the senior sustainment headquarters commanding and controlling task organized sustainment units while supporting joint operations through all of the Army's operational contexts across the supported AO in support of the theater Army.

2-39. The TSC provides sustainment support to Army, joint, and multinational forces in support of unified land operations. As the materiel manager for a geographic area of responsibility, the TSC provides operational oversight for bulk petroleum. A TSC may command one or more ESCs as required. The theater's quartermaster petroleum group is usually assigned directly to the TSC.

2-40. The TSC staff assists the theater Army G-4 with information required to complete the theater Army operations order (OPORD). The TSC commander may coordinate with strategic providers for support as directed by the theater Army commander.

2-41. The TSC commander and staff responsibilities for sustainment plans and operations are shown below. These are not in priority order and are not all-inclusive:

- Coordinate with the theater commander and staff to understand the theater Army mission.
- Develop and disseminate an OPORD to subordinate units. This OPORD contains a concept of operations that specifies tasks for subordinate units and clearly delineate command and support relationships as specified in the theater Army OPORD.
- Develop sustainment estimates to determine adequacy of the current operations concept and make changes to the concept as required.
- Communicate critical sustainment requirements in priority order to the higher headquarters.
- Identify and communicate critical capability shortfalls to the theater Army commander and staff.
- Develop the theater's quality surveillance plan.
- Provide recommendations for sustainment unit placement to the theater Army staff.
- Provide logistics status reports (LOGSTAT) reports to the theater Army staff in accordance with the theater Army reporting SOP.
- As directed by the theater Army commander or G-4, coordinates support from strategic providers in accordance with the theater Army support priorities.
- Maintain the theater's common operational picture (COP) for fuel supplies and status.

2-42. The TSC has an organic distribution management center (DMC) with a fuel and water branch. The fuel and water branch manages bulk class III and water distribution throughout the AOR by using military, contracted, and locally procured capability assets. It coordinates with other branches in the DMC as well as with strategic partners such as DLA Energy to monitor and manage theater stocks. The fuel and water branch also works with the U.S. Army Petroleum Center to ensure the distribution plan is accurate and can be supported. The Army normally manages overland petroleum support, including inland waterways, to U.S.

land-based forces of all DOD components. This branch coordinates with theater petroleum center representatives, the JPO, subarea petroleum office, and DLA Energy to plan, coordinate, and oversee all phases of bulk petroleum procurement and support for U.S. forces and other organizations in an AOR. The staff coordinates petroleum operations and monitors quality surveillance resources and testing results in the AOR. The TSC may require the TPC or a petroleum liaison detachment to be attached or assigned to support its petroleum and water planning in most environments. The petroleum liaison detachment acts as the future plans cell for bulk fuel and water for the TSC when assigned in a supporting role to the TSC. There is also a theater POL lab detachment.

2-43. The TSC petroleum officer plans a theater wide petroleum distribution system in support of the GCC 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 TPC, petroleum group, and petroleum liaison detachments are designed to support theater planning and execution of petroleum and water operations. They are assigned to the TSC to provide planning, synchronization and coordination for initial entry plans and events at the 30-day planning horizon and beyond.

- The TSC petroleum officer coordinates with other key staff members, senior, adjacent, and subordinate, as well as the USAPC to ensure the distribution plan is accurate and supportable. Distribution, engineer, G-3, assistant chief of staff, plans (known as the G-5) and other sections may need to assist in the synchronization of the plan and coordination. The petroleum and water section concentrates on requirements and operations within the 30-day planning horizon.
- 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 AR 710-1 and AR 710-3.
- 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.

2-44. The TSC executes its petroleum distribution mission through the use of modular forces, to include the ESC, petroleum group, sustainment brigade, the PSB, and PSCs. Figure 2-2 depicts the staff sections within the TSC DMC.

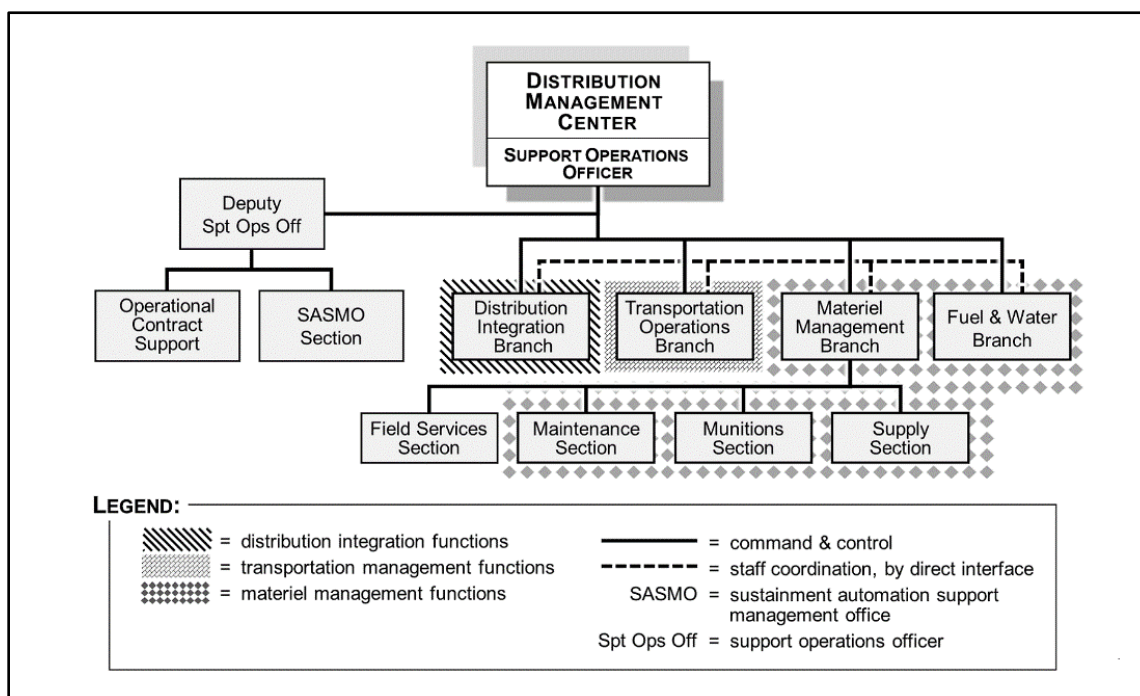


Figure 2-2. Theater sustainment command, distribution management center

EXPEDITIONARY SUSTAINMENT COMMAND

2-45. The ESC is the senior sustainment headquarters commanding and controlling task organized sustainment units executing operational area opening, distribution, sustainment, and operational area closing in support of Army forces or a joint task force (JTF). Whereas the TSC looks across an entire AOR, the ESC focuses on an operational area within an AOR, synchronizing sustainment operations in support of Army forces or a JTF conducting unified land operations.

2-46. The ESC, if employed, manages petroleum supply and distribution within an assigned area of operations. The ESC provides a similar support structure as the TSC, but lacks some of the depth and capabilities of the TSC. If a TSC is not in theater, the ESC will fulfill the role of senior sustainment commander but may require additional staff elements, a planning section for example.

2-47. Like the TSC, the ESC has a DMC. The DMC staff is depicted in figure 2-3. The DMC is headed by the support operations (SPO) officer and is a coordinating staff section. The DMC includes a deputy SPO officer, the operational contract support section, and sustainment automation support management office sections. The ESC DMC is the principal staff section for coordinating sustainment across an operational area. The DMC is responsible for sustaining the force through its three branches: distribution integration branch (DIB), the material management branch and the transportation operations branch. The staff focuses on detailed planning for operational area opening, distribution, sustainment, and operational area closing operations

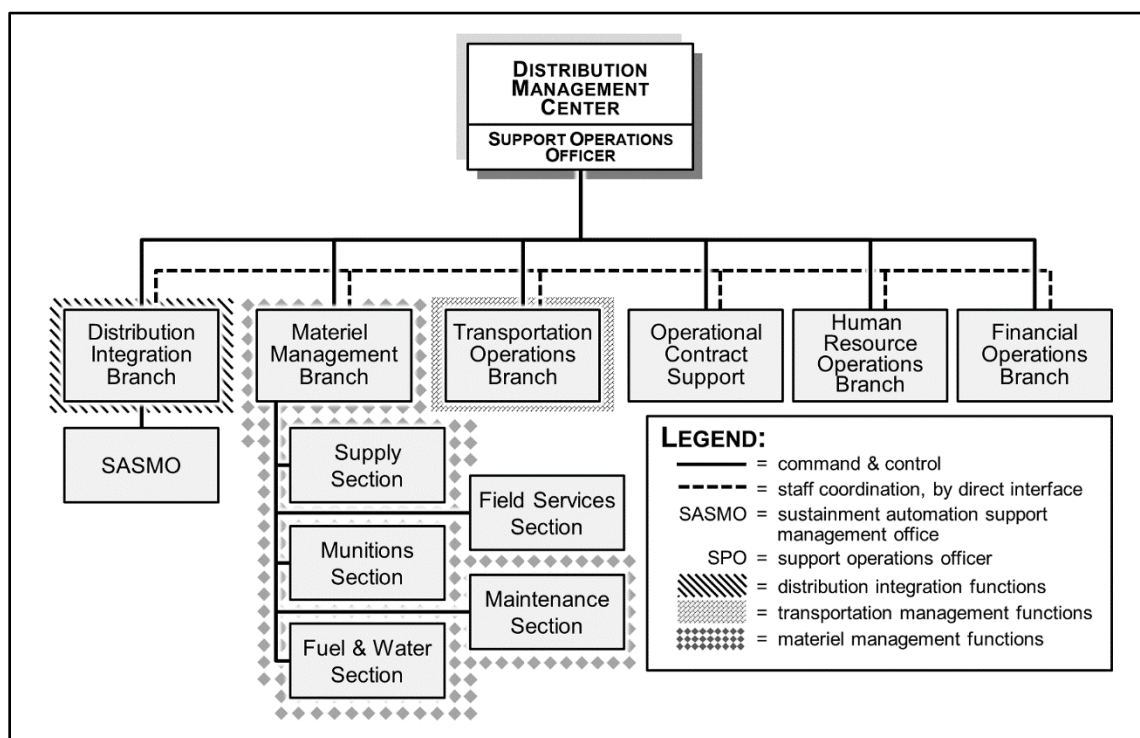


Figure 2-3. Expeditionary sustainment command, distribution management center

2-48. Within the materiel management branch is the fuel and water section. The fuel and water section plans and coordinates petroleum support with subordinate sustainment brigades or other subordinate headquarters as necessary. The fuel and water section is tasked to manage and account for theater bulk petroleum. It also coordinates tactical petroleum operations and quality surveillance of bulk petroleum in the theater. This organization plans distribution of bulk fuel forward into the corps support area based on a combination of available storage, distribution assets, and anticipated customer demands. The petroleum liaison detachment acts as the future plans cell for bulk fuel and water when assigned to the ESC.

QUARTERMASTER GROUP (PETROLEUM AND WATER)

2-49. The petroleum group is normally attached to a TSC. The petroleum group supports a theater Army in establishing, managing and conducting petroleum and water operations.

2-50. In a set the theater or early entry mission set, the petroleum group is responsible for planning and providing command and control of the theater petroleum and water units assigned to build theater stocks, distribution systems, and quality surveillance support structure.

2-51. This unit provides—

- Command, control, planning, and supervision of bulk petroleum and bulk potable water supply, storage, multimodal distribution networks and quality surveillance and water purification, storage and distribution in support of unified land operations.
- Planning of 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 other Services and host nations for coordination of the allied pipeline and multimodal distribution system.
- Planning and execution of the theater's petroleum quality surveillance plan.

2-52. The group has a support operations (SPO) section that coordinates, manages, and synchronizes all bulk petroleum in the theater or corps. The size of the current petroleum group staff limits it to planning current operations. It requires a petroleum liaison detachment attached as a future plans team to coordinate support requirements for missions in theater greater than 30 days ahead. Figure 2-4 shows the current structure of a quartermaster group (petroleum and water).

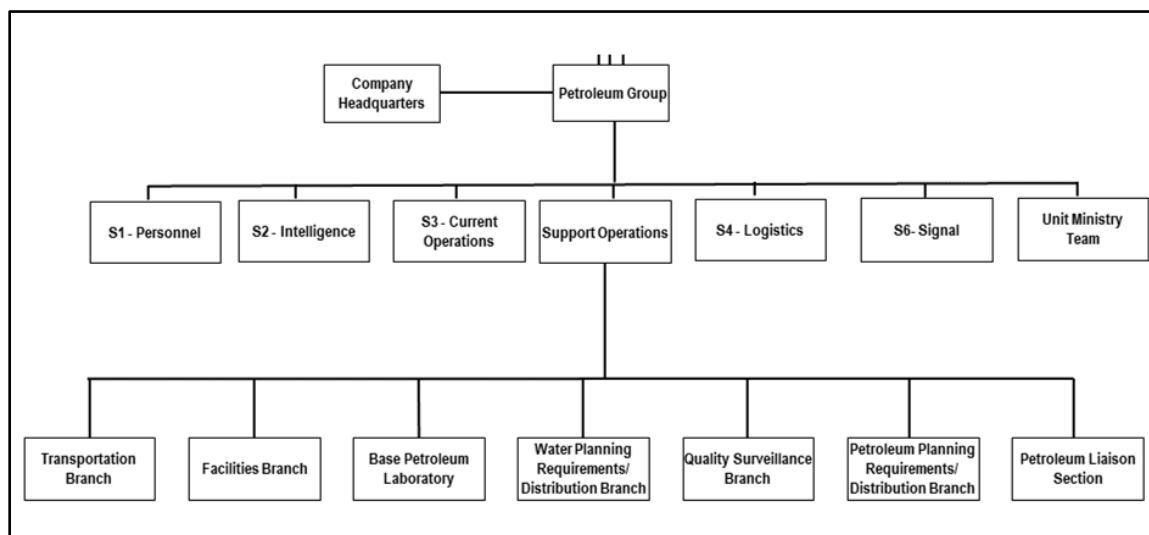


Figure 2-4. Quartermaster group (petroleum and water)

2-53. This unit is dependent on external support for—

- Area signal support.
- Engineering, construction, rehabilitation, and maintenance of military and civilian conduit and pipelines, storage and distribution facilities and petroleum facilities.
- Security forces required to protect petroleum terminals and other facilities from guerilla activity, destruction, sabotage and pilferage.

2-54. Coordination is required with the transportation brigade (expeditionary) during port opening and theater opening operations where bulk petroleum is distributed over the shore or through TBX areas of responsibility.

2-55. This organization is programmed to become the theater petroleum and water group (TPWG) by 2025. The TPWG will have a more robust planning cell and ability to track petroleum and water distribution. More information and a diagram of the projected TPWG force structure is located in appendix R.

TRANSPORTATION BRIGADE (EXPEDITIONARY)

2-56. The TBX is an early-entry brigade that supports a theater Army in managing and conducting seaport operations. The TBX can be attached to a TSC or ESC and is the expert on the execution of port operations and management.

2-57. The TBX provides command and control for seaport operations and provides command for Army transportation terminal battalions, seaport operations companies and Army watercraft units deployed to support the GCC. During early-entry operations a petroleum liaison detachment is attached to the TBX team to support the planning of port opening for port and over the shore petroleum and potable water operations in support of the theater plan. The petroleum liaison detachment supports the TBX by planning early-entry petroleum and water operations and requirements for the theater and supports the building of theater stocks, distribution networks to include OPDS, beach terminal operations, in-land petroleum distribution system, flexible hoseline systems, storage sites and initial quality surveillance program. The petroleum liaison detachment assigned to the TBX is responsible for coordinating with the petroleum group and other agencies.

THEATER MOVEMENT CONTROL ELEMENT

2-58. The theater movement control element is assigned to a TSC or ESC to manage movement control planning by use of movement control, intra-theater operations, inter-theater operations, and theater container management. The theater movement control element assists petroleum support operations by determining optimal supply routes.

THEATER PETROLEUM LAB DETACHMENT

2-59. The theater petroleum lab detachment performs quality surveillance on aviation turbine fuel and diesel fuel for properties associated with identification and acceptance at destination, properties likely to be affected by transportation, and characteristics susceptible to deterioration due to age, environmental, or storage conditions in accordance with MIL-STD-3004-1A for the theater. It is normally assigned one per theater as testing requirements dictate. The theater petroleum lab tests contracted or other outsourced fuel before that fuel moves forward into theater.

2-60. The theater petroleum lab detachment is assigned to a TSC or an ESC supporting a field army. Its equipment includes two Petroleum Quality Analysis Systems-Enhanced (PQAS-E). This unit has 100% of its table organization and equipment items transported in a single lift using organic equipment.

SECTION III - OVERVIEW OF OPERATIONAL AND TACTICAL LEVEL SUPPORT

2-61. The purpose of this section is to describe the role of Army organizations at the operational and tactical level and Army unit capabilities to conduct petroleum supply operations.

FIELD ARMY

2-62. A field army may or may not be constituted. When constituted, a field army focuses on the threat to successfully compete, deter, and if necessary, prepare for and transition to combat operations as a land component command. A field army's focus is on tactical operations while the theater Army conducts largely administrative and operational activities. A field army is task ordered by the theater Army until the joint force commander takes command.

2-63. The Army constitutes a field army in theaters where large-scale ground combat is possible. Its primary purpose is to prevent and if necessary, prevail in large-scale ground combat against peer or near-peer adversaries. It also enables effective competition against such threats below the threshold of armed conflict. A field army exercises command and control of two or more corps. A field army is tailored in its capability and capacity as determined by mission and operational variables (FM 4-0).

2-64. Fundamentally, a field army headquarters is staffed and equipped to perform three roles:

- Army component and ARFOR for a subordinate unified commander.
- Joint force land component headquarters (with augmentation) for large-scale ground combat operations.
- JTF headquarters (with augmentation) for crisis response and limited contingency operations.

2-65. An ESC may be attached to the field army. The ESC is responsible for synchronizing and integrating operations at the field army echelon. The ESC DMC fuel and water staff supports the field army staff planning petroleum supply operations.

2-66. The ESC advises the field army staff on issues regarding task organization, sustainment capabilities, and risk. In coordination with the field Army G-4, it maintains the sustainment running estimate and take actions to mitigate shortfalls. The ESC and its subordinate task organized sustainment units normally have a general support relationship with units in their geographic area. For more information on the ESC, see ATP 4-94.

CORPS

2-67. A corps is normally the senior Army headquarters deployed to a joint operational area. The corps is designed to control the operations of two to five divisions. During large-scale ground combat, the corps operates as a tactical headquarters tailored to support the operation. The corps will normally have multiple attached subordinate divisions as well as an assigned ESC, and other supporting brigades. The ESC is the corps' command headquarters for sustainment within its operational area. The corps' G-4 staff will coordinate with the ESC to execute sustainment operations. The ESC normally provides general support with units in local proximity.

2-68. The corps G-3 develops the corps concept of operations. The G-3 concept of operations drives fuel requirements. The corps G-4 has responsibilities to develop, project and validate petroleum requirements in support of corps operations, as well as receive, consolidate, monitor, and communicate petroleum and water support requirements through support channels during operations. However, the actual function of providing logistical support to facilitate petroleum supply operations on the battlefield remains with the sustainment organizations. Petroleum distribution management and materiel management is performed by ESC headquarters.

EXPEDITIONARY SUSTAINMENT COMMAND

2-69. The corps' assigned ESC is responsible for synchronizing and integrating sustainment operations at the corps echelon. The ESC DMC fuel and water staff supports the corps staff planning petroleum supply operations. The corps' ESC and its subordinate task-organized petroleum support units provide general support for all units in corps area of operations as directed by the corps commander. The ESC assists the corps sustainment cell with planning and coordinating petroleum support.

2-70. The corps' ESC commands and controls all assigned and attached sustainment units in an operational area as directed by the corps commander. A task-organized ESC assigned to a corps normally includes enablers that include a corps logistics support element, petroleum group, movement control battalion, and a sustainment brigade task organized with combat sustainment support battalions (CSSB) to support sustainment operations. The ESC plans for near term operations and synchronizes operational-level sustainment operations to meet the current operations. The corps' ESC is dependent on the corps staff and an attached petroleum liaison detachment for long-range planning capability.

SUSTAINMENT BRIGADE

2-71. At the field army echelon, sustainment brigades provide command and control for combat sustainment support battalions and other functional sustainment battalion and conduct support operations for units operating at the field army echelon. At the corps echelon, sustainment brigades provide command and control for combat sustainment support battalions and other functional sustainment battalions and conduct support operations for units operating at the corps echelon.

2-72. The sustainment brigade, in coordination with the TSC or ESC, is responsible for providing bulk petroleum and packaged petroleum product management to supported forces and support to multinational forces based on memorandums of agreement and ACSA. In addition, the sustainment brigade provides general support to the aviation support battalion (ASB), the BSB, and to forward support companies as required. The sustainment brigade is responsible for quality surveillance and liaison with the supported forces.

2-73. The sustainment brigade contains a SPO section. Figure 2-5 shows the organization of the SPO section. The SPO is the principal staff office responsible for coordinating sustainment for all units within the sustainment brigade's assigned operational area. Within the SPO's materiel management branch is a fuel and water branch. The fuel and water branch plans and coordinates bulk fuel support for supported units within the sustainment brigade's support area. For more information on the sustainment brigade, see ATP 4-93.

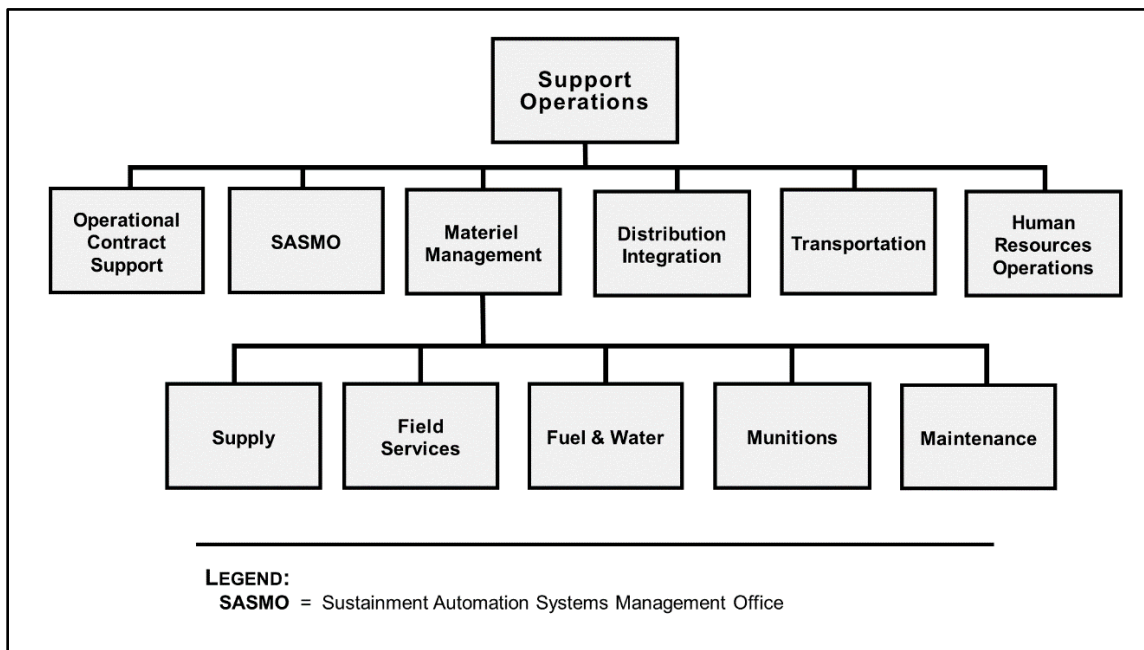


Figure 2-5. Sustainment brigade support operations staff organization

COMBAT SUSTAINMENT SUPPORT BATTALION

2-74. The CSSB is a multifunctional logistics headquarters with the flexibility to control and synchronize execution of all logistics functions. At the field army and corps echelons, CSSBs may be attached to the sustainment brigades to provide sustainment to Army forces and unified action partners conducting operations across a multi-domain extended battlefield. At the corps echelon, the CSSB is the sustainment brigade's primary means to accomplish its support mission. The CSSB synchronizes and executes logistics support to functional brigades and multifunctional support brigades attached to the field army and corps.

2-75. The CSSB is task organized by its higher headquarters to meet specific mission requirements; it contains an organic headquarters and headquarters company and up to six attached companies. Task-organized CSSBs normally include a composite supply company, support maintenance company, modular ammunition company, palletized load system truck company and inland cargo transfer company. The CSSB may have petroleum units attached based on the mission and capability required.

2-76. The CSSB synchronizes and executes logistics support to functional brigades and multifunctional support brigades attached to the corps. CSSBs operate in various locations to include the joint security area and corps support area. In some instances, CSSB may operate in the division consolidation or support area as required. Figure 2-6 shows the wire diagram structure of a notional CSSB. Figure 2-7 shows the placement of a CSSB on the battlefield.

Combat Sustainment Support Battalion

- **Role:** The role of the CSSB is to exercise command and control for task organized companies, teams, and detachments executing logistics operations.
- **Capability:** The CSSB controls and synchronizes the logistics operations of up to six functional companies.
- **Parent:** Sustainment brigade.
- **Command relationship:** Normally attached to sustainment brigade, it may change based on mission requirements.
- **Support relationship:** General support to all units in its area, unless otherwise directed.
- **Span of operations:** Rear of the theater support area up to the field trains.
- **Mobility:** Varies depending on which units are attached.

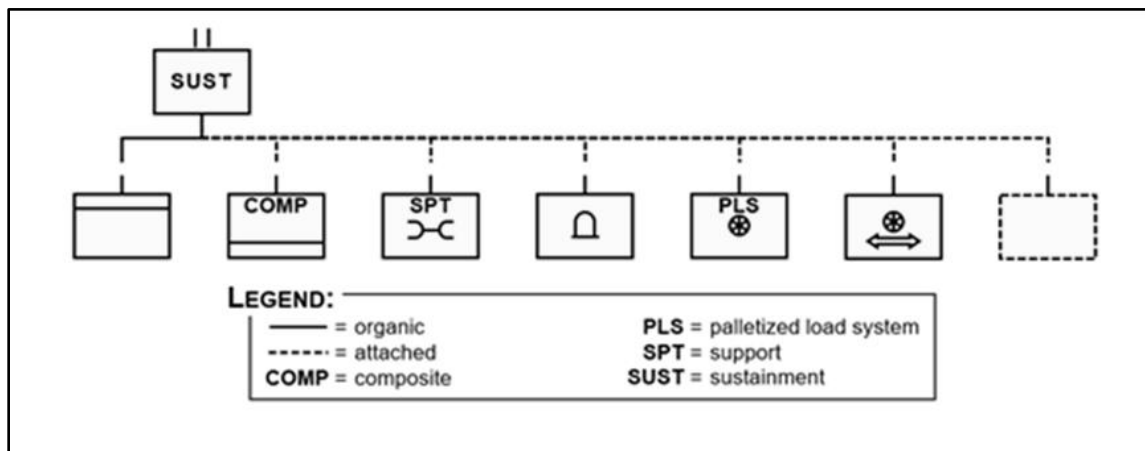


Figure 2-6. Combat sustainment support battalion configuration

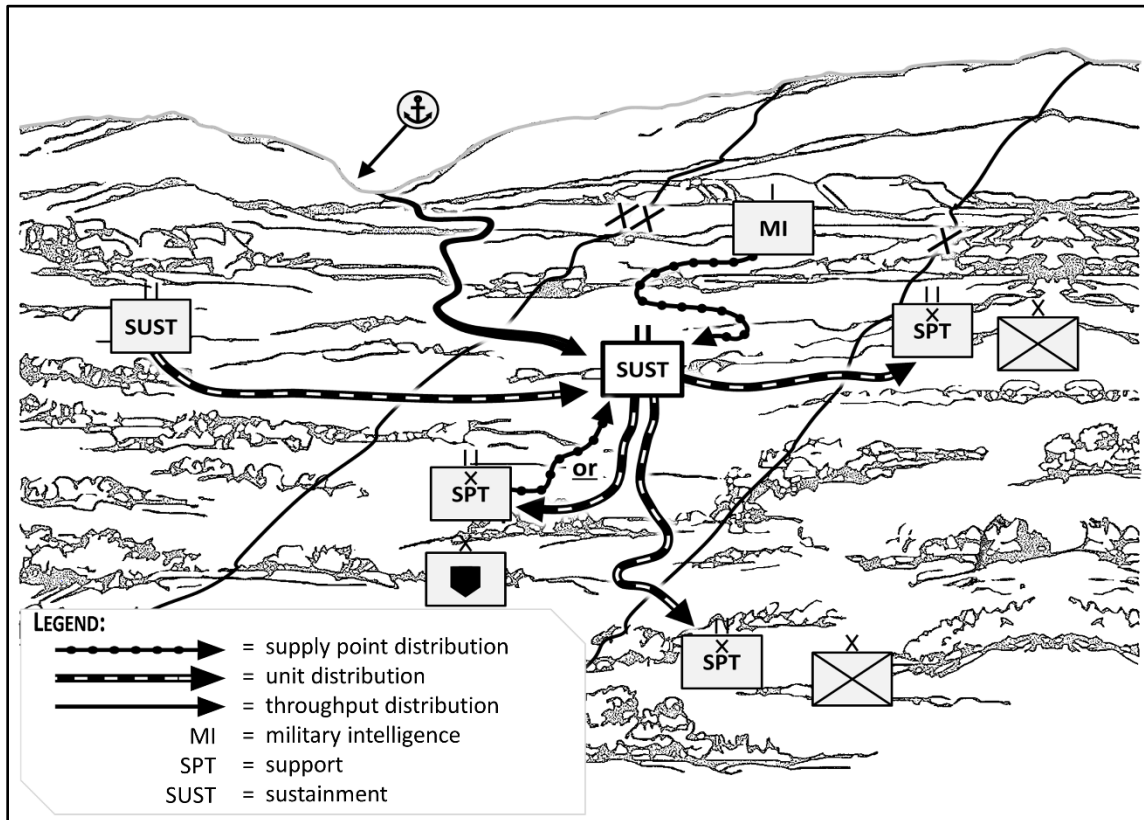


Figure 2-7. Notional battlefield array for combat sustainment support battalion

DIVISION

2-77. The division is the tactical unit of execution for a corps. Like a corps, the division is both a headquarters and a formation. The role of the division is to serve as a tactical headquarters commanding brigades. The capabilities of the division are determined based on the direction of the corps and the subordinate units assigned or attached to the division. The division has an assigned sustainment brigade. The division staff coordinates with the sustainment brigade to provide direct support to all subordinate units. The sustainment brigade and other subordinate units rely on the division staff for long-range planning.

2-78. The division assistant chief of staff, G-4 has responsibilities to develop, project, and validate petroleum and water requirements in support of operations, as well as receive, consolidate, monitor, and communicate petroleum and water requirements through support channels during operations. However, the actual function of providing logistical support to facilitate petroleum supply operations on the battlefield remains with the sustainment organizations. Petroleum distribution management and materiel management is performed by the sustainment brigade headquarters.

DIVISION SUSTAINMENT BRIGADE

2-79. The division sustainment brigade (DSB) is assigned to a division. The DSB connects the strategic and operational plans and requirements with the tactical level units at division and below who execute those plans.

2-80. The DSB commander is the sustainment coordinator for the division and is the primary senior advisor regarding sustainment to the division commander and the deputy commanding general (support). The commander is responsible for the integration, synchronization, and execution of sustainment operations at echelon. The DSB employs sustainment capabilities to create desired effects in support of the division commander's objectives. The DSB role as the sustainment coordinator does not replace the division G-4's

role as the division sustainment planner responsible for developing the sustainment support concept based on the division G-3's operations concept.

2-81. Petroleum distribution management responsibilities with the SPO section are the same as at the sustainment brigade, except that it supports units within the division sustainment area.

DIVISION SUSTAINMENT SUPPORT BATTALION

2-82. The division sustainment support battalion (DSSB) is employed using various task-organizations as shown in figure 2-8. The DSSB is a renamed CSSB that is organic to a DSB. The DSSB and its subordinate units must be able to move and displace at the pace of large-scale ground combat operations. The DSSB commands and controls all organic, assigned, and attached units. As directed by the DSB commander, the DSSB conducts maintenance, transportation, supply, field services, and distribution. DSSBs organic to DSBs supporting divisions have an organic composite supply company, composite truck company, and support maintenance company. Other capabilities are task organized by the division commander in accordance with requirements. The DSSB synchronizes and executes logistics support to brigade combat teams (BCTs) and multifunctional support brigades attached to the division.

Division Sustainment Support Battalion

- **Role:** The role of the DSSB is to command and control tactical units executing logistics operations.
- **Capability:** The DSSB controls and synchronizes the logistics operations of four organic companies and up to two additional companies as task organized by the division.
- **Parent:** Division sustainment brigade.
- **Command relationship:** Organic to the division sustainment brigade.
- **Support relationship:** General support to all units in its division area of operations.
- **Span of operations:** Division rear to brigade support area.
- **Mobility:** Capable of 71% mobility in one lift using organic assets.

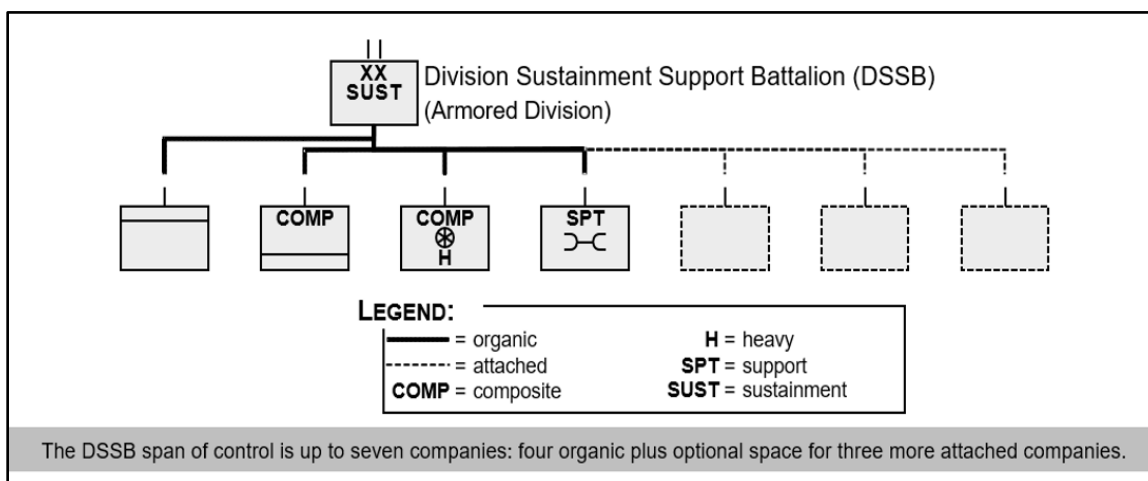


Figure 2-8. Division sustainment support battalion for an armored division

ECHELONS ABOVE BRIGADE FUNCTIONAL UNITS

2-83. DSSBs, CSSBs and functional battalions such as the PSB below are task organized with composite and functional sustainment companies, teams, and detachments. The following paragraphs are a summary of sustainment capabilities that may be task organized to a logistics battalion. These units have specific fuel support capabilities and execute complex operations.

PETROLEUM SUPPORT BATTALION

2-84. The petroleum support battalion (PSB) provides command and control over assigned or attached petroleum pipeline and terminal operating companies, petroleum support companies, transportation medium truck companies (petroleum), assault hoseline teams and petroleum lab teams in order to plan, establish, and operate as part of the multimodal bulk petroleum storage and distribution network.

2-85. The PSB provides command and control for units conducting theater bulk petroleum storage and distribution, port terminal operations, and petroleum pipeline operations. The battalion commander and staff direct the operation of petroleum port terminal and storage facilities, supervise a program for quality surveillance of petroleum products, and operate a mobile petroleum products laboratory.

2-86. The PSB is comprised of three to five attached companies – a combination of PSCs, transportation medium truck companies (petroleum), and 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). The PSB, normally attached to a sustainment brigade, also operates bulk and retail supply point distribution, and executes over-the-shore POL storage requirements.

2-87. The PSB serves as the petroleum operational link in its specified AO. The PSB operates a central dispatching and scheduling agency to ensure direct flow of bulk petroleum through the IPDS. 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. It distributes bulk fuel to sustainment brigades and brigade combat teams as required.

2-88. The S-3 is responsible for operations of the PSB. The plans officer is responsible for futures planning for the PSB. The logistics staff officer (S-4) is responsible for sustainment of the PSB. The SPO section is responsible for coordinating bulk petroleum movement in the PSB's AO.

2-89. The PSB receives bulk petroleum via pipeline, rail, or transport vehicle from terminals operated by a petroleum pipeline and terminal operating company. The PSB 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, and assault hoseline to distribute bulk fuels. Figure 2-9 shows a task organized PSB.

- Petroleum Support Battalion**
- **Role:** Provide command and operational control for theater bulk petroleum storage & distribution; port terminal operations, and petroleum pipeline operations.
 - **Capability:** Three to five companies.
 - **Parent:** Sustainment brigade or QM petroleum group.
 - **Command relationship:** Normally attached to sustainment brigade; may change based on mission requirements.
 - **Support relationship:** General support to all units in its area, unless otherwise directed.
 - **Span of operations:** Rear of the theater support area up to the field trains.
 - **Mobility:** Capable of 50% mobility in one lift using organic assets.

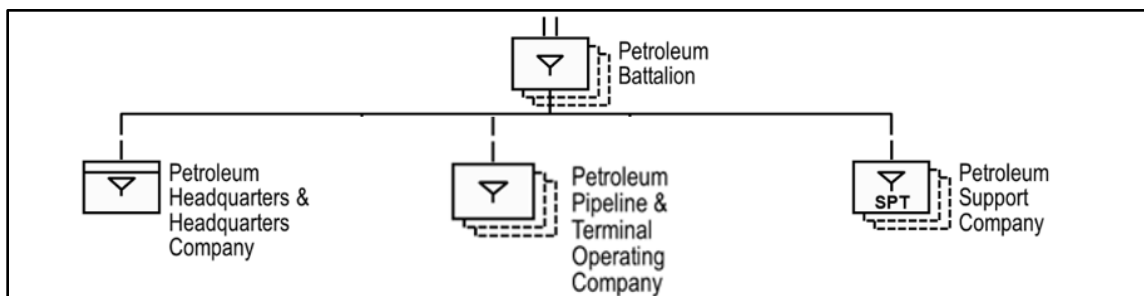


Figure 2-9. Petroleum support battalion

PETROLEUM PIPELINE AND TERMINAL OPERATING COMPANY

2-90. The petroleum pipeline and terminal operating company's mission is to operate petroleum pipeline and terminal facilities for receipt, storage, issue, and distribution of bulk petroleum products in support of unified land operations. The petroleum pipeline and terminal operating company is normally attached to a PSB. In some circumstances, such as a theater opening, it may be attached to a CSSB. It typically has a general support relationship to supported units. Figure 2-10 shows a task organized petroleum pipeline and terminal operating company.

2-91. Core capabilities of a petroleum pipeline and terminal operating company include—

- Operate fixed terminal facilities for storage of up to 21,000,000 gallons (500,000 barrels) of bulk petroleum. Normally consists of two tank farms, each with a capacity of up to 10,500,000 gallons (250,000 barrels) or operates a tactical petroleum terminal with a storage capability of up to 3,780,000 gallons (90,000 barrels).
- Operate five pump stations and up to 75 miles (125 km) of IPDS for distribution approximately 720,000 gallons per day (based on flow rate of the TPT's 600 gallons-per-minute pump operating 20 hours per day). The operations of pipeline or hoseline goes 24 hours per day (20 hours of pumping and four hours of maintenance).
- Operate facilities for shipment of bulk product by coastal tanker, barge, rail and tank trucks.
- Maintain a prescribed reserve of bulk product for the theater.
- Operate a FSSP for bulk petroleum issue operations.
- Install and operate up to eight km (five miles) of assault hoseline to connect large volume consumers such as hospitals or airfields.
- Provide limited over-the-road transportation of bulk fuel with two 5,000 gallon fuel trucks.

2-92. The petroleum pipeline and terminal operating (PPTO) company provides technical assistance to engineer companies for construction, repair, and rehabilitation of pipelines, fixed and temporary terminals, and other fuel sites and pump stations. The PPTO company is dependent upon external engineer support for clearing the pipeline route, building-crossing structures, installing pump stations and intermediate storage facilities. The engineers will also be responsible for pressure-testing of each completed section prior to handing it over for operation to the PPTO company.

2-93. The PPTO company is dependent on military police support for security.

Petroleum Pipeline and Terminal Operating Company

- **Role:** Serves as the petroleum operational link in its specified area of operations.
- **Capability:** Oversees the operation and maintenance of military distribution system of up to 75 miles of petroleum pipeline and the transportation of class III (B). Provides bulk and retail supply point distribution, when required. Provides quality surveillance for bulk fuel in its AO.
- **Parent:** Petroleum support battalion.
- **Command relationship:** Attached.
- **Support relationship:** General support to Army forces.
- **Span of operations:** Operates at the operational level of warfare throughout the AOR.
- **Mobility:** Capable of 50% mobility in one lift using organic assets.

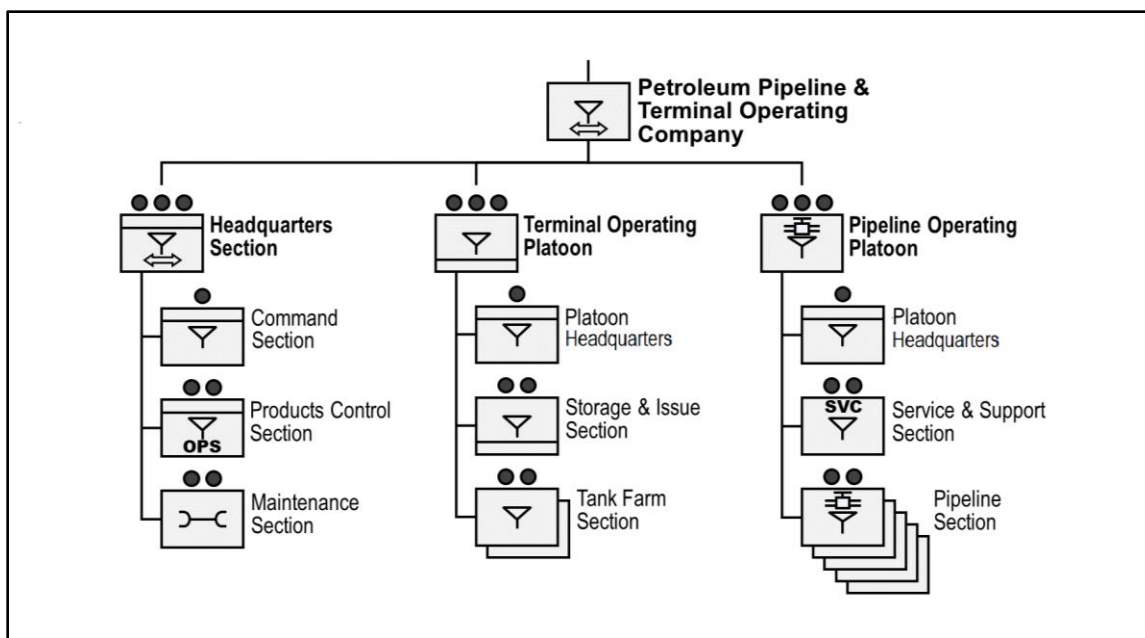


Figure 2-10. Petroleum pipeline and terminal operating company task organization

TRANSPORTATION MEDIUM TRUCK COMPANY (PETROLEUM)

2-94. The medium truck company's (petroleum) mission is to provide transportation for the movement of bulk petroleum products through the use of tractors with associated semi-trailer tanks. This company is normally attached to a CSSB, DSSB, or PSB. This company is employed in line haul operations, primarily in the corps or division area of operations. It is dependent upon improved roads to complete its mission of providing bulk fuel distribution.

2-95. The medium truck company (petroleum) is authorized 60 tractors. For every tractor assigned, there is one semi-trailer tank assigned, either one of 7,500 gallons or 5,000 gallons.

2-96. There are three types of medium truck companies (petroleum), each corresponding to one of the three variants of the semi-trailer tank:

- A 7,500 gallon line haul truck company, which uses the M1062 7,500 gallon tanker.
- A 5,000 gallon line haul truck company, which uses the M967 5,000 gallon tanker.
- A 5,000 gallon tactical truck company, which uses the tactical version of the M967.

2-97. Figure 2-11 on page 2-20 shows the task organization of a medium truck company (petroleum). The task organization is the same regardless of which capacity trailers the company is using.

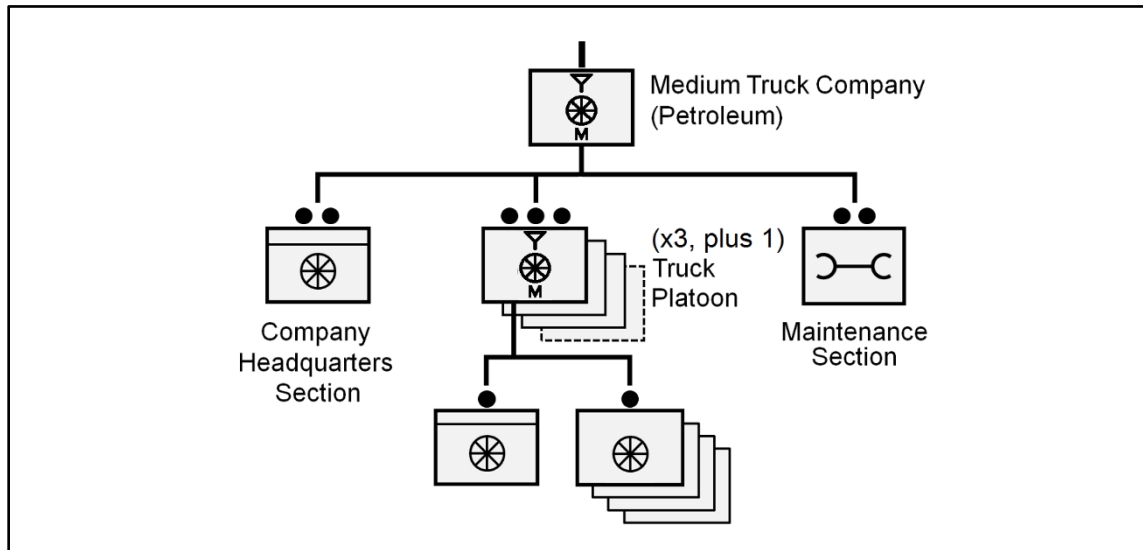


Figure 2-11. Medium truck company (petroleum)

2-98. The bulk fuel distribution system (BFDS) is programmed to replace the M1062 and the M967 tankers used by the line haul truck companies by 2025. There will then be only one type of line haul truck company. The tactical fuel distribution system (TFDS) will replace the M967 tankers used by the tactical truck company.

2-99. When the medium truck company petroleum (7,500 gallons) has 100% of its 60 assigned vehicles available with their trailers filled to their maximum capacity, the unit can provide a one-time lift capability for bulk fuel of 450,000 gallons. Upon the one-for one switchover from the M1062 to the BFDS, the unit will be able to provide a one-time lift capability of 492,000 gallons.

2-100. When either medium truck company petroleum (5,000 gallons) has 100% of its 60 assigned vehicles available with their trailers filled to their maximum capacity; the unit can provide a one-time lift capability for bulk fuel of 300,000 gallons. Upon switchover to the BFDS, the line haul unit will be able to provide a one-time lift capability of 492,000 gallons. Upon switchover to the TFDS, the tactical unit will still have a one-time lift capacity of 300,000 gallons.

PETROLEUM SUPPORT COMPANY

2-101. The petroleum support company (PSC) receives, stores, and transfers bulk petroleum, providing wholesale and area support, and limited distribution.

2-102. The PSC 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 PSB, the company is employed throughout the echelon above brigade area to provide wholesale and retail fuel support and limited distribution at operational and tactical levels.

2-103. Elements of the company may operate in the brigade support area and can be attached to any of the companies of the CSSB with a sustainment brigade for tailored support. Normally, there is one per PSB, but there may be more, based on stated requirements. Two 800,000-gallon FSSP are allocated from Army pre-positioned stocks for each platoon of the PSC upon opening or theater distribution missions.

2-104. The PSC can be comprised of petroleum support platoons, an assault hoseline augmentation team, and a pipeline-operating platoon.

2-105. Figure 2-12 on page 2-22 shows a PSC with an assault hoseline team and pipeline operating platoon. A standard PSC is configured the same way, but without the hoseline team or the pipeline operating platoon. The petroleum support platoons can be configured with 50,000 gallon or 210,000 gallon bags.

Petroleum Support Company

- **Role:** To receive, store, and transfer bulk petroleum, provide wholesale and area support, and limited distribution.
- **Capability:** Receipt & issue 400,000 gallons class III(B) per day. Store 1.8M gallons per day. Distribute 75K gallons per day.
- **Parent:** Petroleum support battalion.
- **Command relationship:** Normally assigned to a CSSB, or as an echelon above brigade asset in an area of operations.
- **Support relationship:** Area support to all units in its area, unless otherwise directed.
- **Span of operations:** Throughout the echelons above brigade area elements may operate in the brigade support area.
- **Mobility:** Headquarters and assault hoseline section capable of 50% mobility in one lift using organic assets. Pipeline platoon capable of 100% mobility in one lift using organic assets.

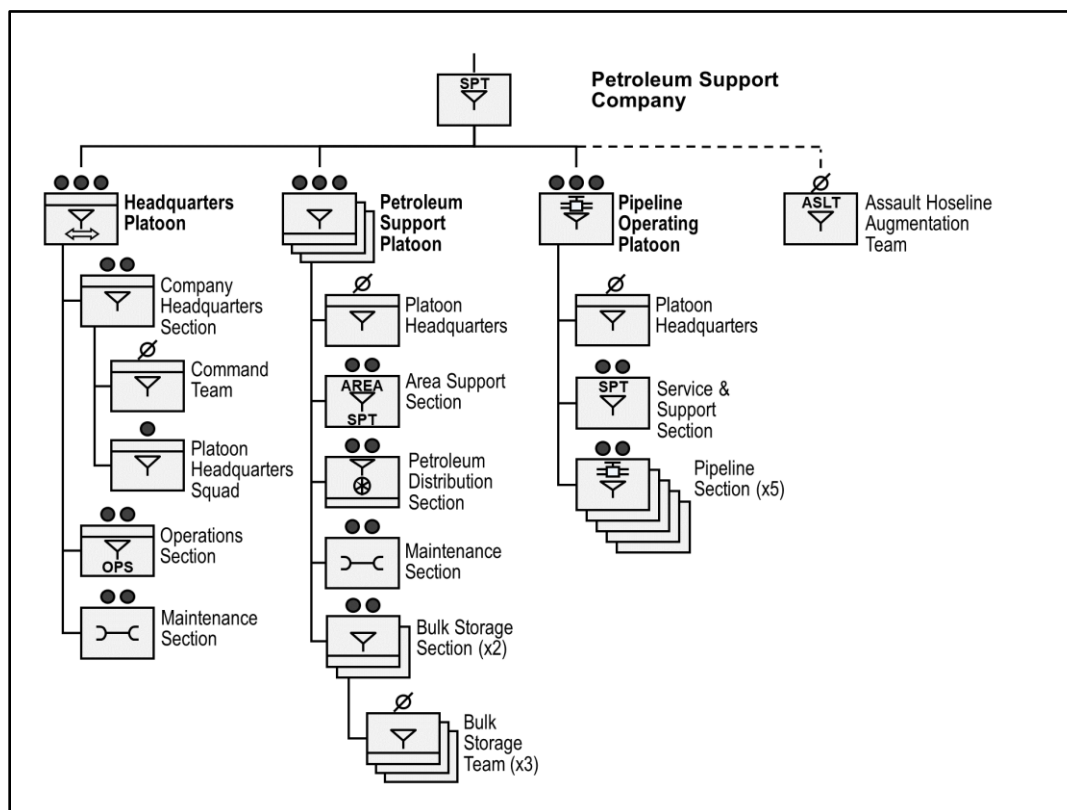


Figure 2-12. Petroleum support company

2-106. When the company is equipped with two 300,000 gallon FSSPs and one 120,000 gallon FSSP per platoon, it can:

- Operate 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.
- Receive and issue at each storage facility of up to 420,000 gallons of bulk petroleum for a combined total of 1.2 million gallons per day, using 20,000-gallon bags.
- 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 is able to—
 - 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.

2-107. When the company is equipped with two 800,000 gallon FSSPs and one 120,000 gallon FSSP per platoon, it can:

- Operate 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.
- Receive and issue at each storage facility of up to 720,000 gallons 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.

2-108. The PSC has sampling capability but will need external laboratory support for testing. The operations section coordinates with higher headquarters for external laboratory support. Figure 2-13 shows a notional PSC arrayed on the battlefield.

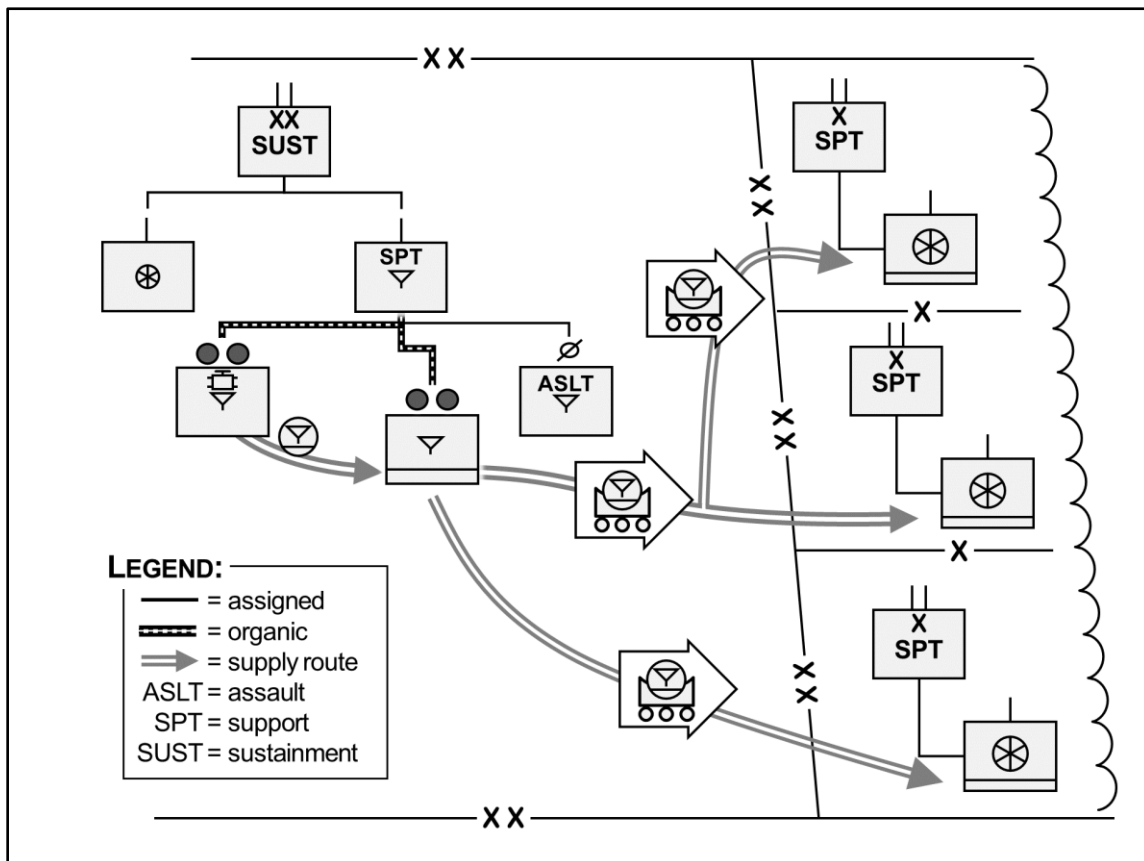


Figure 2-13. Petroleum support company battlefield array

2-109. The PSC is capable of operating a fuel storage facility connecting into pipeline systems, operating bulk fuel railheads, and fixed class III installations as required.

COMPOSITE SUPPLY COMPANY

2-110. The role of the composite supply company is to provide general supply, petroleum and water support to the division or corps rear area and supported units. A composite supply company can be part of a task organized CSSB supporting corps and division headquarters, multifunctional or functional support brigades, or assigned to a DSSB supporting brigade combat teams. A composite supply company is normally employed in the brigade and division area of operations.

2-111. The composite supply company provides petroleum quality surveillance, storage and distribution to the division or corps rear area as well as area support to units operating in the division 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.

Composite Supply Company

- **Role:** To provide class I perishable & semi-perishable supply, retrograde support, petroleum supply, water supply support, shower and laundry services to supported units.
- **Capability:** Can receive, store & issue up to 540,000 gallons class III (B) per day.
- **Parent:** Division sustainment support battalion or combat sustainment support battalion.
- **Command relationship:** Assigned to DSSB. Attached to CSSB.
- **Support relationship:** General support to units within area of operations.
- **Span of operations:** Corps support area as far forward as brigade support area.
- **Mobility Index:** Capable of 48% mobility in one lift using organic assets.

Current Structure

2-112. The composite supply company includes 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 2-14. Figure 2-15 shows a composite supply company arrayed on the battlefield.

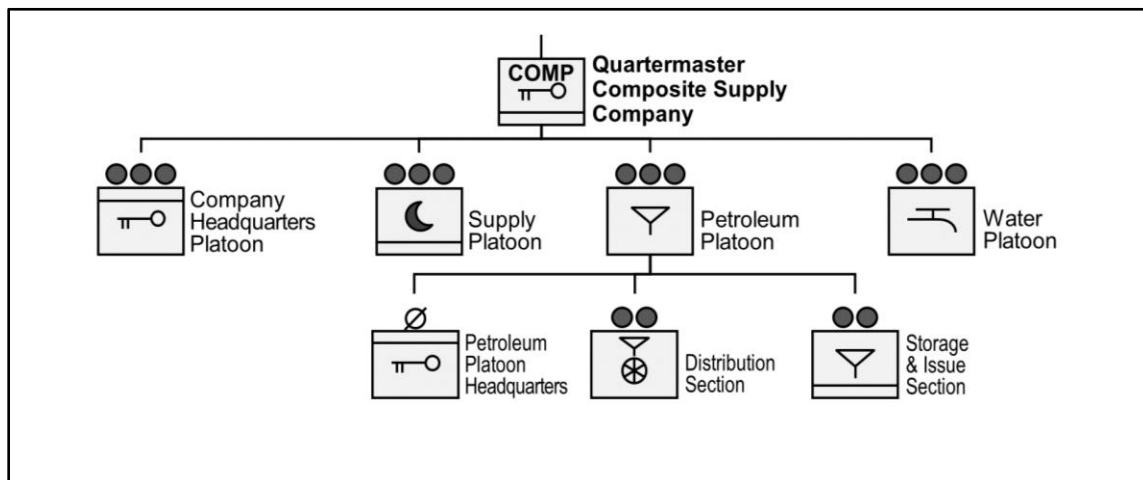


Figure 2-14. Quartermaster composite supply company

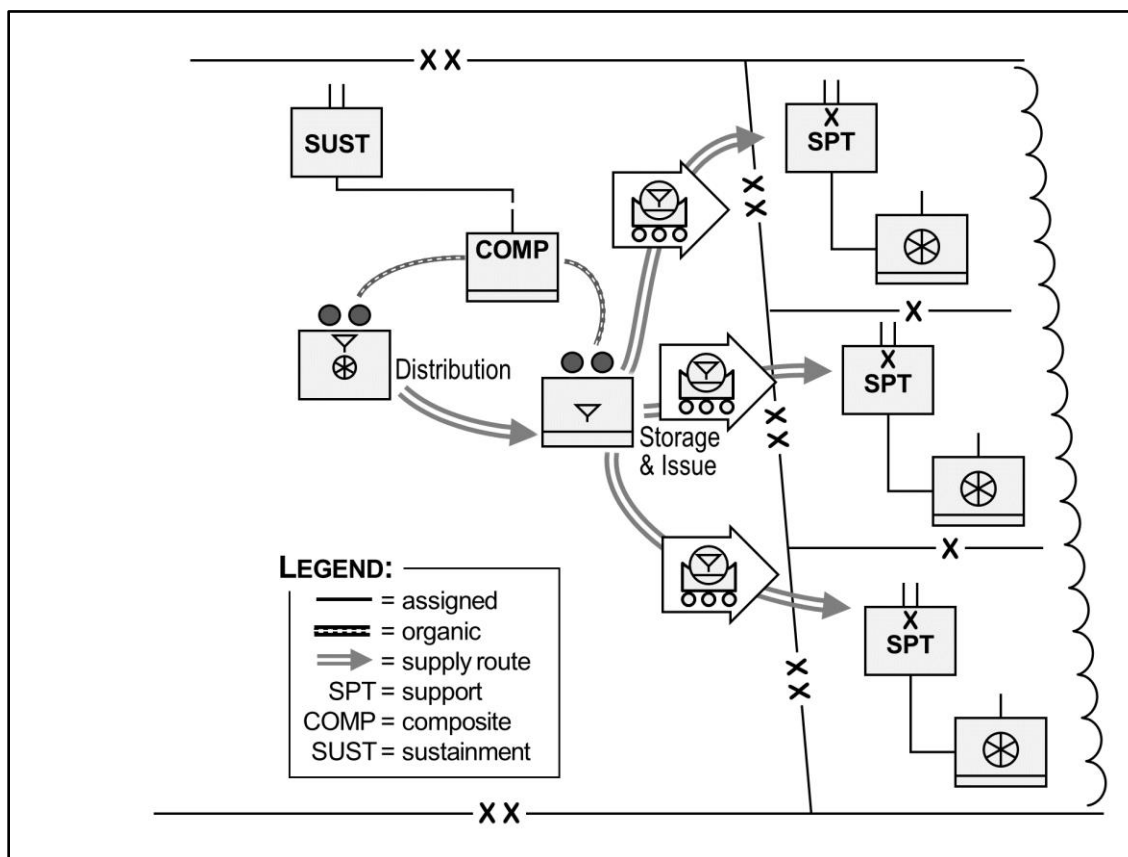


Figure 2-15. Quartermaster composite supply company battlefield array

2-113. The composite supply company requires assets from the composite transportation company or other transportation units to distribute mobile fuel storage systems.

2-114. 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.

2-115. 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 gallon) and 6 x 2,500 gallon heavy expanded mobility tactical truck (HEMTT) fuel trucks and 20 x 2,500 gal modular fuel tank racks (65,000 gallon) on palletized load system (PLS) trailers. The section is capable of augmenting BCTs with modular fuel system, but capability is reduced when tank racks are no longer used for distribution. The additional modular fuel system tank racks and PLS trailers in this section may be used by the composite truck companies for petroleum distribution. The section includes forward area refueling equipment (FARE) capable of up to two aircraft refuel points.

2-116. The PQAS-E, which resides in the composite supply company's fuel platoon headquarters section, provides direct support quality surveillance and testing capabilities to the corps or division and on an area basis as well as provides quality surveillance and control measures for fuel being stored and distributed by the platoon.

Future Structure

2-117. The composite supply companies will change into 3 different variants between 2022 and 2025:

- Composite supply company (division), assigned to a DSSB.

- Composite supply company (corps), assigned to a CSSB.
- Composite supply company (the original version –the National Guard composite supply companies will stay this way).

2-118. The division composite supply companies are scheduled to change to lettered companies (A Company) under the DSSB by 2022, with table organization and equipment item to follow between 2022 and 2025. The corps versions are scheduled to change in 2025. Both the corps and division composite supply companies will have 12 5,000 gallon tankers, 26 HEMTT tankers, 40 tank rack modules (TRM), seven HEMTT load handling systems (LHS) and 33 PLS trailers upon conversion.

PIPELINE OPERATING PLATOON

2-119. The pipeline operating platoon establishes the early entry petroleum receipt capability at the beach termination unit (BTU) connected to the offshore petroleum distribution system.

2-120. The pipeline operating platoon can operate up to 45 miles of petroleum pipeline or conduit for the distribution of bulk petroleum products. It maintains pipeline and conduit operations via linkage between tank farms and other elements of the multimodal storage and distribution system. The platoon assumes operations of pipeline and conduit systems once engineers construct and test system for leakage.

2-121. The platoon is organized with a pipeline operating platoon headquarters, pipeline maintenance section, and three 15-mile pipeline sections capable of employing up to 45 miles (72 km) of pipeline, three pump station each 15-mile section, and 5 miles (8 km) of assault hose line as required. When the early entry fluid distribution system (E2FDS) is fielded, the platoon will be retrofitted to operate up to 25 miles of E2FDS conduit.

2-122. This platoon provides movement of approximately 720,000 gallons of bulk petroleum per day (20 operational hours and four hours set aside for maintenance) by pipeline.

2-123. This unit is dependent upon —

- Appropriate elements of corps or theater for religious, legal, force health protection, finance, personnel and administrative services, and logistics.
- PSC headquarters for administration, logistics, field maintenance, maintenance supervision, and unit supply.
- Operations section for operational control of the platoon.
- Appropriate field maintenance elements in an area where water support platoon is attached, for common maintenance item support. The platoon has an organic maintenance section with mechanic level tool boxes and prescribed load list or The Army Maintenance Management System capabilities.
- The support unit for the prescribed load list, The Army Maintenance Management System, and vehicle recovery, when attached away from its company's headquarters maintenance section.
- The field feeding company or supported BCT for field feeding support.
- External engineer support for the IPDS - clearing the pipeline route, building-crossing structures, installing pump stations and intermediate storage facilities, and pressure-testing of each completed section.
- The composite truck company (heavy) for transportation of pipeline and conduit, pumps, and all other associated equipment for the establishment of the pipeline and conduit mission.

Pipeline Operating Platoon

- **Role:** To establish linkage between tank farm and high volume users.
- **Capability:** Can distribute 720,000 class III (B) per day.
- **Parent:** Petroleum support company.
- **Command relationship:** Modular organization assigned to a PSC.
- **Support relationship:** General support to units within area of operations.
- **Span of operations:** Throughout the echelons above brigade area. Normally located in the theater support area or port.
- **Mobility Index:** Capable of 50% mobility in one lift using organic assets.

TACTICAL LEVEL ORGANIZATIONS

2-124. Tactical level distribution occurs in the theater of operations. Petroleum support at the tactical level is linked from the CSSB or DSSB through the BSB and FSC to the maneuver end user. The tactical level organizations are described below.

BRIGADE SUPPORT BATTALION

2-125. The BSB provides support to its parent brigade. BSBs are organic to the brigade combat team, and select multifunctional support brigades. 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 FSCs with maneuver and fires battalions. Figure 2-16 shows a task organized BSB.

2-126. BSBs without FSCs, such as a maneuver enhancement brigade BSB, provide sustainment by task organizing logistics assets to support specific units and missions based on OE considerations. The type of support varies by battalion based upon the situation and support requirements. The BSB will also provide area support within the limits of their capabilities to other elements operating in the brigade AO. See figure 2-17 on page 2-28 to see echeloned support from the CSSB through the BSB arrayed on the battlefield.

Brigade Support Battalion

- **Role:** The BSB provides logistics and Army Health System support to a brigade combat team.
- **Capability:** The BSB is an expeditionary multifunctional logistics battalion with integrated Army Health System support capable of operating at the tactical level in an assigned AO in support of a BCT.
- **Parent:** Brigade combat team.
- **Command relationship:** Organic to a BCT.
- **Support relationship:** N/A – A support relationship is not required because the BSB is organic to the BCT.
- **Span of operations:** Brigade combat team area of operations.
- **Mobility Index:** Requires between 60-85% mobility in one lift using organic assets.

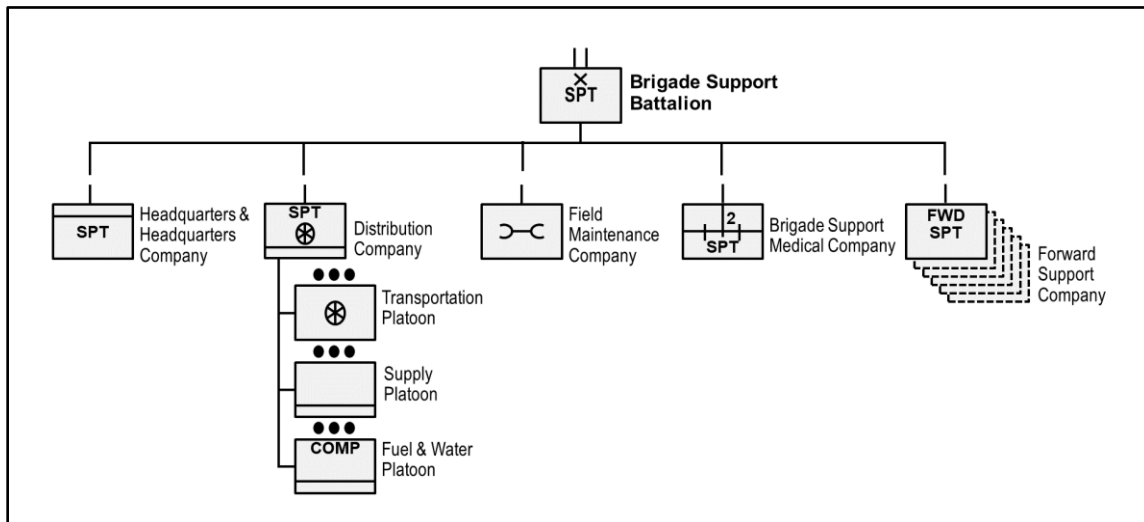


Figure 2-16. Brigade support battalion

2-127. The BSB contains a SPO section that assists in petroleum planning. 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 DSB. The BSB, brigade staff, and the DSB considers 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 conducts complete coordination with the forward support companies and the brigade to ensure a complete understanding of the non-mobile storage support capability and requirements. Table 2-1 on page 2-29 shows

the fuel equipment, distribution capability and mobility index of various BSB units. For additional information about the BSB, see ATP 4-90.

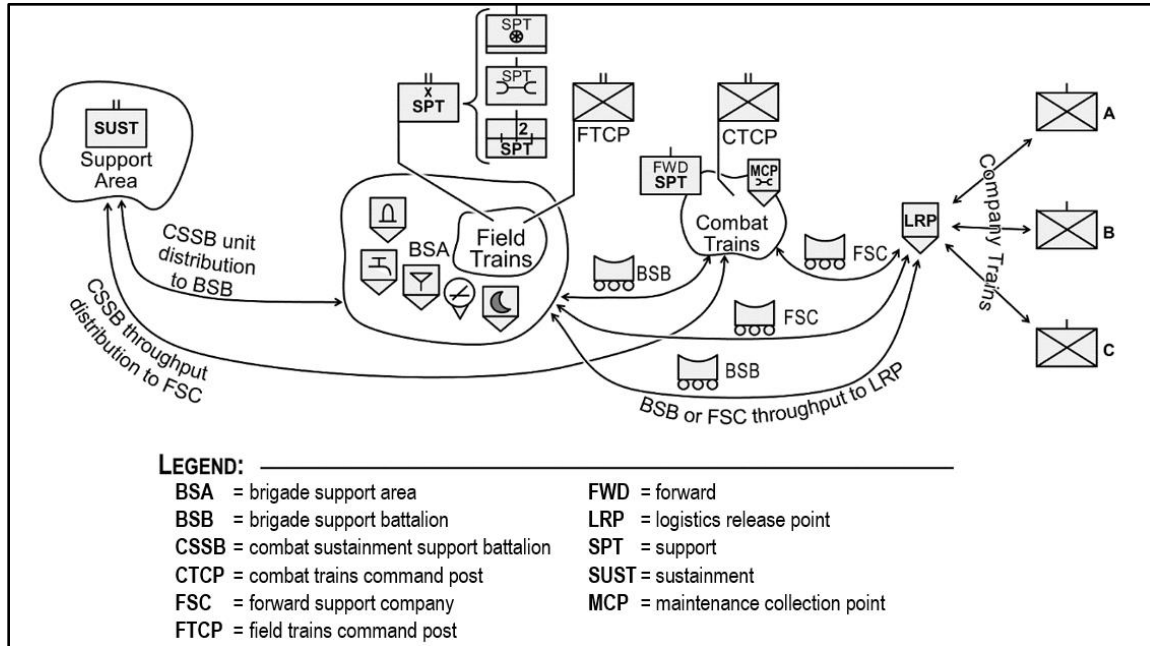


Figure 2-17. Notional battlefield array of a brigade support battalion

Table 2-1. Brigade support battalion unit distribution equipment, petroleum distribution capability (in gallons) and mobility index percentage

<i>Battalion</i>	<i>Unit</i>	<i>Equipment</i>		<i>Distribution Capability (in gallons)</i>	<i>Mobility Index Percentage</i>
Brigade Support Battalion, Infantry Brigade Combat Team (IBCT)	Distribution Company	1 FARE 2 HTARS 5 HEMTT	2 TRM 2 PLS	25,000	68%
	FSC, Brigade Engineer Battalion	3 HEMMT 3 TRM	3 PLS	15,000	77%
	FSC, Cavalry Squadron	4 TRM 4 PLS		10,000	90%
	FSC, Infantry Battalion (x 3 in BSB)	4 TRM 4 PLS (All x 3 in BSB)		10,000 (x 3 in BSB)	96%
	FSC, Field Artillery Battalion	4 TRM 4 PLS		10,000	89%
Brigade Support Battalion, Stryker Brigade Combat Team (SBCT)	Distribution Company	2 FARE 2 HTARS 10 HEMTT	10 TRM 10 PLS	50,000	85%
	FSC, Brigade Engineer Battalion	2 HEMTT 2 TRM	2 PLS	10,000	79%
	FSC, Cavalry Squadron	2 HEMTT 2 TRM	2 PLS	10,000	97%
	FSC, Infantry Battalion (x3 in BSB)	2 HEMTT 2 TRM (All x 3 in BSB)	2 PLS	10,000 (x 3 in BSB)	97%
	FSC, Field Artillery Battalion	2 HEMTT 2 TRM	2 PLS	10,000	86%
Brigade Support Battalion, Armored Brigade Combat Team (ABCT)	Distribution Company	2 HTARS 18 HEMTT	18 TRM 18 PLS	90,000	68%
	FSC, Brigade Engineer Battalion	3 HEMTT 3 TRM	3 PLS	15,000	91%
	FSC, Cavalry Squadron	6 HEMTT 6 TRM	6 PLS	30,000	98%
	FSC, Mechanized Infantry Battalion	6 HEMTT 6 TRM	6 PLS	30,000	99%
	FSC Armored Battalion (x2 in BSB)	6 HEMTT 6 TRM (All x 2 in BSB)	6 PLS	30,000 (x2 in BSB)	100%
	FSC, Field Artillery Battalion	3 HEMTT 3 TRM	3 PLS	15,000	89%
LEGEND: BSB = brigade support battalion FARE = forward area refueling equipment FSC = forward support company HEMTT = heavy expanded mobility tactical truck HTARS = HEMTT tanker aviation refueling system PLS = palletized load system TRM = tank rack module					

BSB DISTRIBUTION COMPANY

2-128. The distribution company provides fuel receipt, storage, and distribution in support of a brigade combat team. The fuel section receives, temporarily stores, and issues bulk petroleum to the forward support companies within the brigade combat team using HEMTT tankers and modular fuel system tank racks. The BSB's distribution capacity is based on the type of BCT it supports. See the unit authorization documents for equipment and personnel authorizations. Figure 2-18 shows a notional BSB distribution company.

2-129. The section has no static storage capability, which allows it the ability to displace whenever necessary.

BSB Distribution Company

- **Role:** The BSB distribution company plans, directs, and supervises supply distribution in support to a brigade combat team or multifunctional brigade.
- **Capability:** The distribution company manages the distribution of supplies to the brigade and provides distribution capability for all classes of supply.
- **Parent:** Brigade support battalion.
- **Command relationship:** Organic to a brigade support battalion.
- **Support relationship:** General support to the BSB and BCT.
- **Span of operations:** Brigade combat team area of operations.
- **Mobility Index:** Distro companies supporting an IBCT or ABCT require 68%-mobility in one lift using organic assets. The distro company supporting an SBCT requires 85%.

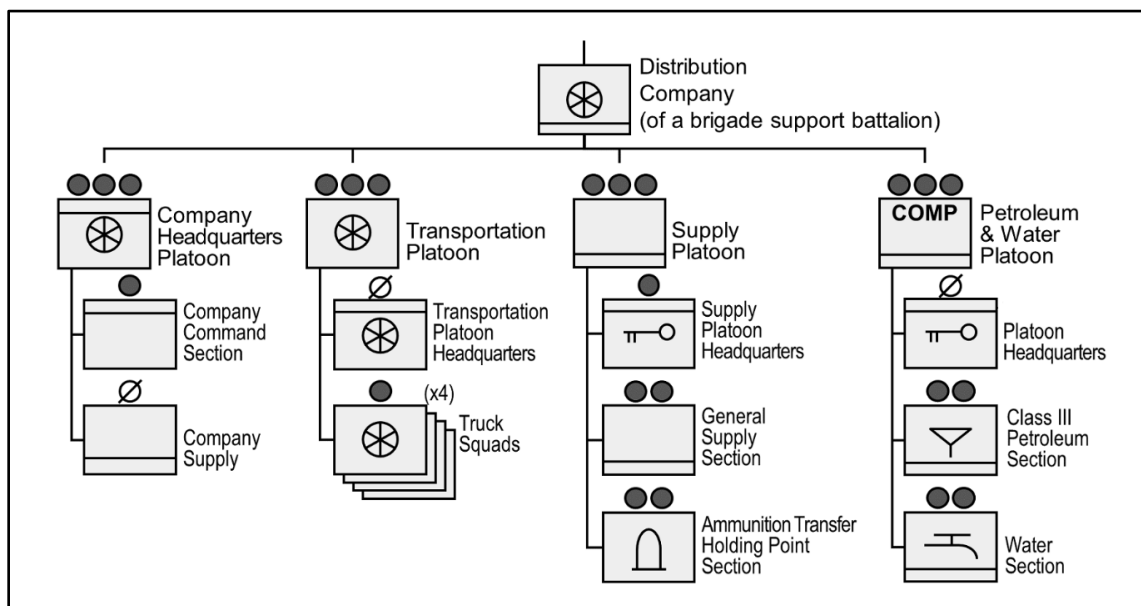


Figure 2-18. Notional brigade support battalion distribution company

FORWARD SUPPORT COMPANY

2-130. The FSC provides support to its habitual supported battalion. The FSC will have a petroleum section capable of receiving, mobile storage and issuing petroleum to its supported battalion. It also provides refueling options for any BCT unit 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.

2-131. The FSC's deployment and distribution capacity is based on the type of battalion it supports. FSCs are organic to the helicopter battalion, whereas BSB FSCs are organic to the BSB. See the unit authorized documents for equipment and personnel authorizations. See Figure 2-19 to see a notional FSC. Figure 2-20 on page 2-32 shows a notional FSC field site.

Forward Support Company

- **Role:** The FSC provides logistics in direct support to its specific supported battalion.
- **Capability:** The FSC provides field feeding, bulk fuel, general supply, ammunition, and field-level maintenance in direct support of a supported battalion.
- **Parent:** BSB; for aviation FSC, parent is the helicopter battalion.
- **Command relationship:** Ground-based FSCs organic to a BSB; may be attached or OPCON to its supported battalion for a limited duration. Aviation FSCs are organic to a helicopter battalion.
- **Support relationship:** Direct support to its specific maneuver battalion; general support to other units in the BCT; general support to others on a limited basis by exception.
- **Span of operations:** Brigade combat team area of operations from the BSAs to the forward line of troops.
- **Mobility Index:** Requires between 77-100% mobility in one lift using organic assets.

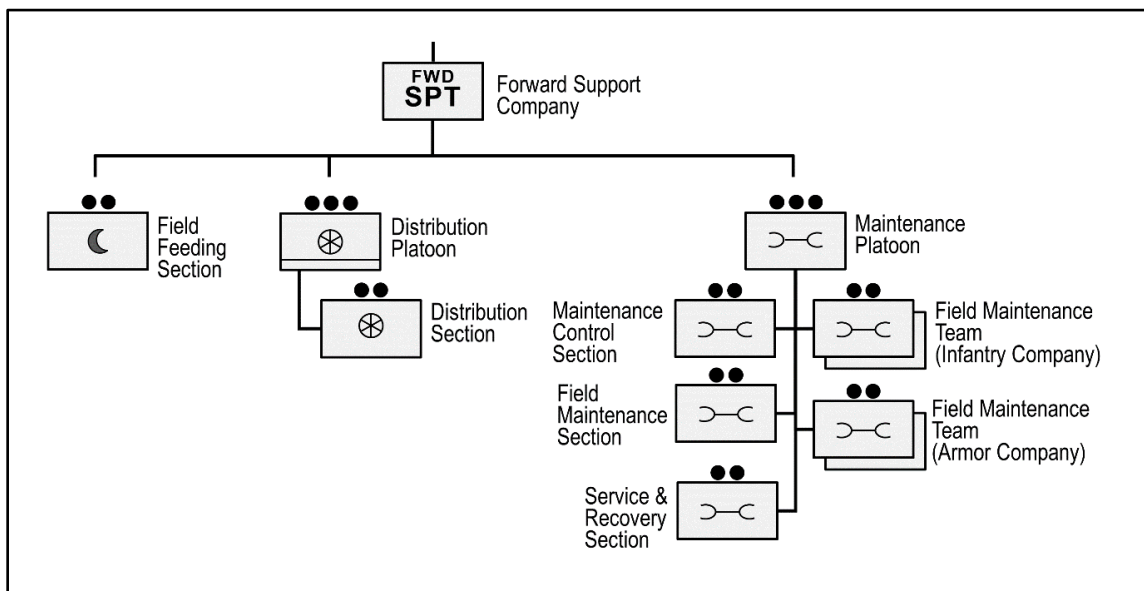


Figure 2-19. Notional forward support company

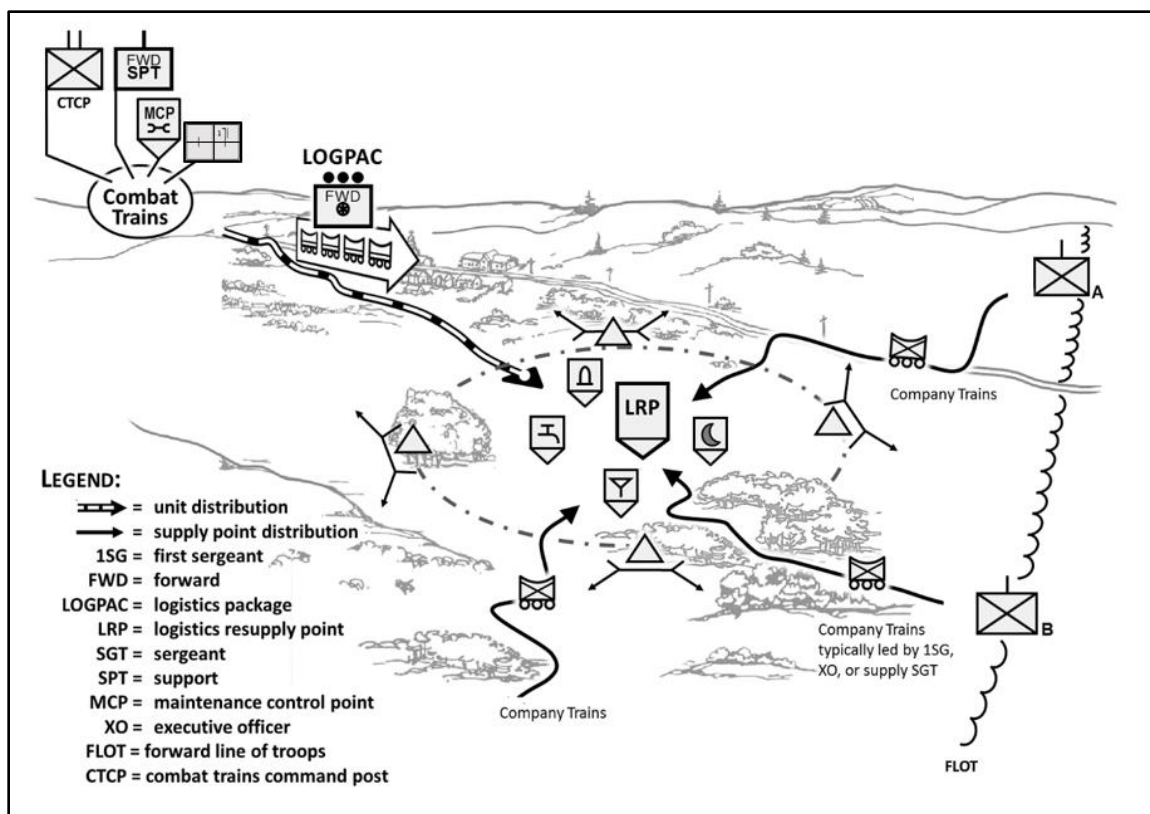


Figure 2-20. Field site of forward support elements

AVIATION SUPPORT BATTALION

2-132. The ASB is organic to a combat aviation brigade (CAB), an expeditionary combat aviation brigade (ECAB), and a theater aviation brigade. There are three primary differences between a BSB and an ASB:

- Instead of a separate medical company, the ASB has a medical platoon assigned to the HHC.
- The forward support companies are assigned to the helicopter battalions in the brigade.
- A signal company is added.

2-133. The ASB performs the following tasks:

- Ground vehicle and aviation maintenance and recovery operations.
- Signal and network security to the CAB for command and control.
- Aviation and ground sustainment operations for the aviation brigade, including refueling operations.
- Distribution management operations within the aviation brigade.
- Petroleum laboratory support for the CAB and the ECAB.

2-134. The ASB provides distribution management operations within the aviation brigade. The ASB conducts aviation and ground sustainment operations for the aviation brigade, including the planning and execution of forward arming and refueling points. An organic aviation maintenance company and FSC provide additional sustainment to aviation battalions and squadrons.

2-135. The ASB consists of four companies: a headquarters and support company, a distribution company, an aviation support company, and a brigade signal company. In addition, each aviation battalion has an organic aviation FSC.

2-136. The ASB is optimized to support the CAB's forward support companies or troops, aviation maintenance companies or troops, the brigade's headquarters company and the Gray Eagle Company, if applicable. The ASB can establish a brigade support area in an austere area or on a properly surveyed existing airfield. Figure 2-21 depicts an aviation support battalion in support of a combat aviation brigade. Table 2-2 on page 2-34 shows the distribution capability and mobility index of ASB units.

Aviation Support Battalion

- **Role:** The ASB provides logistics to a combat aviation brigade, expeditionary combat aviation brigade, and theater aviation brigade.
- **Capability:** The ASB is an expeditionary multifunctional logistics battalion capable of operating at the tactical level in an assigned AO in support of an aviation brigade.
- **Parent:** Aviation brigade.
- **Command relationship:** Organic to an aviation brigade.
- **Support relationship:** N/A – A support relationship is not required because the ASB is organic to the aviation brigade.
- **Span of operations:** Aviation brigade area of operations.
- **Mobility Index:** Requires between 75%-100% mobility in one lift using organic assets.

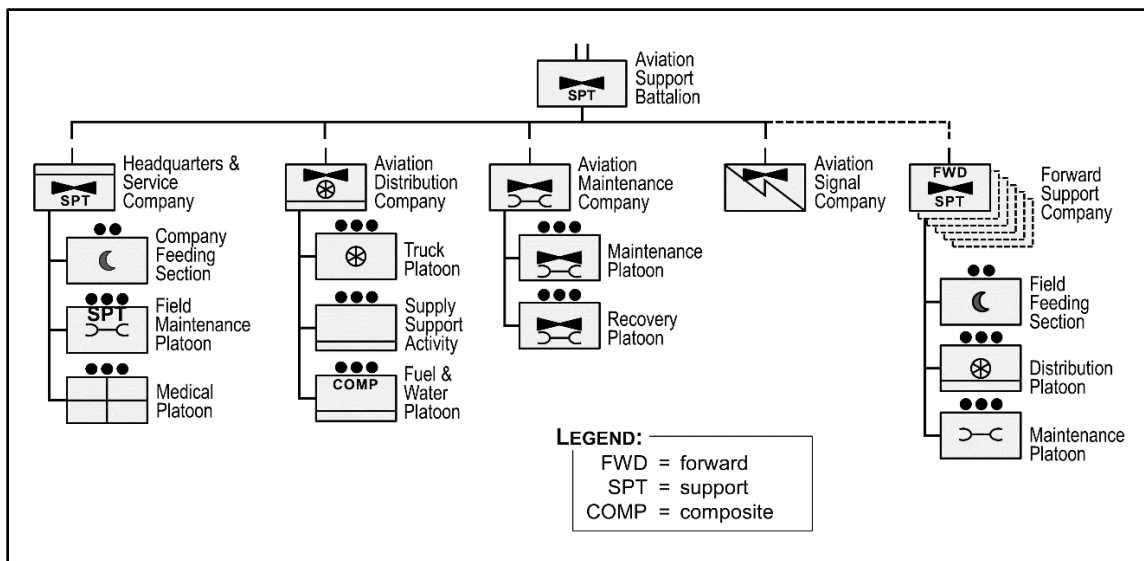


Figure 2-21. Aviation support battalion task organization in a combat aviation brigade

Table 2-2. CAB & ECAB aviation support battalion unit petroleum distribution equipment, distribution capability (in gallons), and estimated mobility rating

<i>Battalion</i>	<i>Unit</i>	<i>Equipment</i>	<i>Distribution Capability (in gallons)</i>	<i>Mobility Index Percentage</i>
Aviation Support Battalion, Combat Aviation Brigade (CAB)	Headquarters & Service Company	None.	0	75%
	Distribution Company	1 120K FSSP 4 M969 Tanker 2 AAFARS 4 MTV Tractor 2 HTARS 6 PLS 1 PQAS-E 6 TRM	50,000	75%
	Forward Support Company, General Support Aviation Battalion	2 AAFARS 6 TRM 5 HTARS 6 PLS 22 HEMTT	70,000 (Can operate up to 3 FARP)	100%
	Forward Support Company, Assault Battalion (UH-60)	1 AAFARS 6 PLS 1 HTARS 6 TRM 11 HEMTT	42,500 (Can operate up to 3 FARP)	100%
	Aviation Support Company, Aviation Support Battalion	2 HEMTT	5,000 (Used for removing fuel for aircraft maintenance).	50%
	Forward Support Company, AH-64	2 AAFARS 3 TRM 3 HTARS 3 PLS 8 HEMTT	27,500 (Can operate up to 3 FARP)	100%
	Forward Support Troop, Armored Reconnaissance Squadron	2 AAFARS 3 TRM 3 HTARS 3 PLS 8 HEMTT	27,500 (Can operate up to 3 FARP)	100%
Aviation Support Battalion, Expeditionary Combat Aviation Brigade (ECAB)	Headquarters & Service Company	None	0	75%
	Distribution Company	1 120K FSSP 4 M969 Tanker 2 AAFARS 4 MTV Tractor 2 HTARS 6 PLS 1 PQAS-E 6 TRM	50,000	100%
	Forward Support Company, General Support Aviation Battalion	2 AAFARS 8 TRM 6 HTARS 8 PLS 27 HEMTT	87,500 (Can operate up to 3 FARP)	100%
	Forward Support Company, Assault Battalion (UH-60) (x2)	11 HEMTT 6 TRM 6 PLS 2 HEMTT (All x 2)	42,500 (x2) (Each FSC can operate up to 3 FARPs)	100%
	Aviation Support Company, Aviation Support Battalion	2 HEMTT	5,000 (Used for removing fuel for aircraft maintenance).	50%

Table 2-2. CAB & ECAB aviation support battalion unit petroleum distribution equipment, distribution capability (in gallons), and estimated mobility rating - *continued*

LEGEND:

AAFARS = Advanced Aviation Forward Area Refueling System	FSSP = fuel system supply point
AH-64 = Apache helicopter	HEMTT = heavy expanded mobility tactical truck
BSB = brigade support battalion	HTARS = HEMTT tanker aviation refueling system
FARE = forward area refueling equipment	MTV = mobile tactical vehicle
FARP = forward arming and refueling point	UH-60 = Black Hawk helicopter
FSC = forward support company	

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Chapter 3

Planning for Petroleum Support Operations

Planning is the art and science of understanding a situation, envisioning a desired future, and laying out effective ways of bringing that future about (ADP 5-0). Army leaders plan to create a common vision among subordinate commanders, staffs, and unified action partners for the successful execution of operations. In order to help extend operational reach and prolong operational endurance, petroleum planners must understand the operational environment and commander's intent, make plans and direct actions to synchronize petroleum operations to achieve unit objectives across the operational environment. This chapter describes petroleum operations planning.

THE PLANNING PROCESS

- 3-1. Planning helps commanders create and communicate a common vision to and between their staffs, subordinate commanders, and unified action partners. Planning results in a formal plan and orders synchronize the action of forces in time, space, and purpose to achieve objectives and accomplish missions.
- 3-2. Planning is both a continuous and cyclical activity of the operations process. While planning may start as an iteration of the operations process, planning does not stop with the production of an order. Planning may be highly structured, involving the commander, staff, subordinate commanders, and others to develop a fully synchronized plan or order. Planning may also be less structured, involving a platoon leader and squad leaders rapidly determining a scheme of maneuver for a hasty attack.
- 3-3. A product of planning is a plan or order—a directive for future action. Planning helps leaders—
 - Understand and develop solutions to problems.
 - Anticipate events and adapt to changing circumstances.
 - Task-organize the force and prioritize efforts.
- 3-4. The defining challenges to effective planning are uncertainty and time. Planning provides an informed forecast of how future events may unfold. It entails identifying and evaluating potential decisions and actions in advance to include thinking through consequences of certain actions. Planning involves thinking about ways to influence the future as well as how to respond to potential events. Put simply, planning is thinking critically and creatively about what to do and how to do it, while anticipating changes along the way.
- 3-5. A key aspect of planning is organizing the force for operations. Through task organization, commanders establish command or support relationships and allocate resources to weight the decisive operation or main effort. In addition to task organizing, commanders establish priorities of support. Priorities of movement, fires, sustainment, protection, and information all illustrate priorities of support that commanders use to weight the decisive operation, or the main effort in phased operations.
- 3-6. Effective petroleum operations require making detailed plans using the military decision-making process. Figure 3-1 on page 3-2 provides an overview of the military decision-making process. See FM 6-0 for additional information on the military decision-making process.

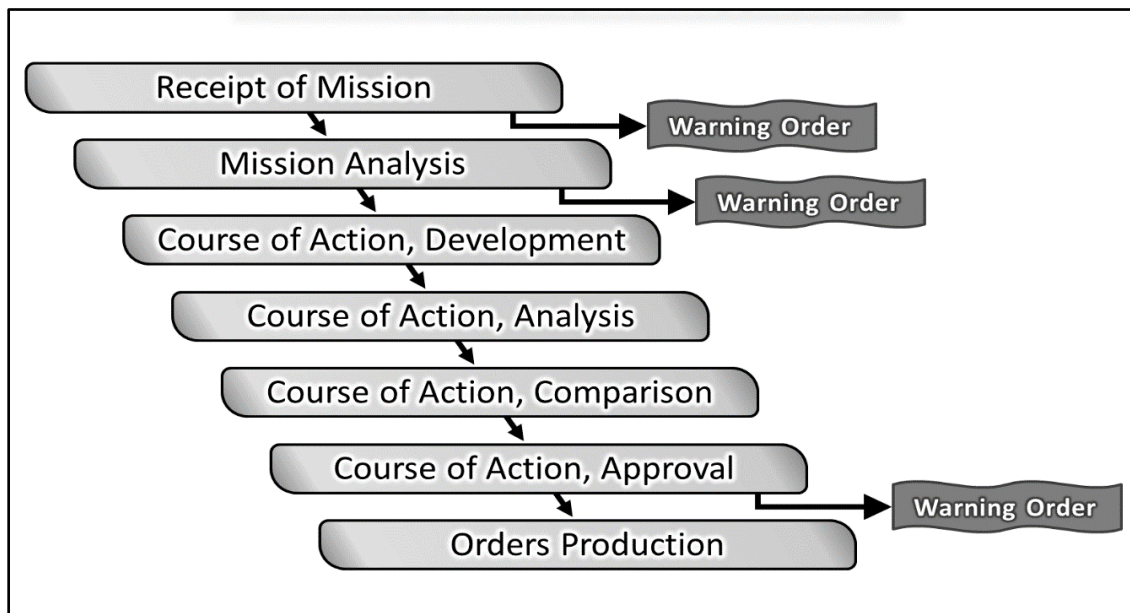


Figure 3-1. Military decision-making process

3-7. Petroleum supply planning falls into two basic categories—logistics and operational.

- Logistics planning requires the translation of such factors as troop strengths, numbers and types of fuel-consuming equipment and vehicles, and tactical objectives into specific fuel requirements and distribution plans. Planning of this nature begins well in advance of actual operations. This planning insures that products, distribution facilities, and operating units and personnel will be available when needed.
- Operational planning includes planning for reaching the rated capacity of the distribution system and for maintaining that capacity to meet requirements placed upon it. This planning occurs during operations. Revisions may be necessary because of tactical developments, losses in handling capacity due to enemy action, and other factors that keep the system from operating as planned.

OPERATIONAL ART IN SUSTAINMENT

3-8. Army commanders, both maneuver and sustainment, use operational art to develop a vision of how to establish conditions that accomplish petroleum support. Commanders and staffs use operational art to develop strategies and operations to organize and employ tactical forces. Using their collective skill, knowledge, experience, creativity, and judgment, commanders and staffs integrate ends, ways, and means while accepting and accounting for risk. Army commanders use operational art to pursue strategic objectives through the arrangement of petroleum support units in time, space, and purpose. Operational art is what allows commanders to translate their operational approach into a clear and concise concept of operations that is disseminated in an OPORD.

3-9. The Army design methodology can be used to shape an operational approach. Through this methodology, commanders and staffs gain an understanding of the current state of the OE to include current conditions. It allows them to envision a desired end state that must be achieved; identify problems that will prevent achieving the end state; and then develop a broad, general plan to solve the problems. From this point, commanders use the military decision-making process to develop a detailed plan which includes a concept of operations.

3-10. Maneuver and sustainment commanders use the elements of operational art to understand the OE and to develop a concept of operations. These elements are used selectively in any operation as required and may not all apply at all levels of warfare. The elements are —

- End state and conditions.

- Center of gravity.
- Decisive points.
- Lines of operation and lines of effort.
- Tempo.
- Phasing and transitions.
- Culmination.
- Operational reach.
- Basing.
- Risk.

3-11. Commanders consider these elements in planning. With proper consideration, each element can be used to develop a concept of operations that synchronizes and integrates petroleum supply operations with the other warfighting functions. Examples of how this can be done are shown below:

- Determine the required petroleum support capability and where it must be located in order to achieve the desired end state.
- Establish desired conditions such as required quantities of supplies or operational readiness rate.
- Identify the components of the sustainment support structure such as supply storage and distribution that are critical and could cause failure if destroyed. Apportion protection to the sustainment assets as required.
- Analyze the effects of petroleum support in allowing a commander to reach decisive points. An example might consist of analyzing the bulk fuel status and determining if the status is adequate to reach the point.
- Analyze how petroleum support affects movement and maneuver, fires, and protection. Furthermore, commanders should determine if sustainment support is a line of effort required to establish the desired end state.
- Analyze how petroleum will affect the desired tempo of the operation and if projected petroleum levels will allow maneuver forces to maintain a higher tempo than the enemy. Understanding the status of class III (B) is critical to controlling the tempo since fuel directly impacts movement and maneuver. Commanders must also ensure the maneuver tempo does not outpace the petroleum support.
- Analyze the effect petroleum has on completing the current phase of an operation and transitioning to the next phase. The commander and his staff should use bulk fuel estimates to determine if the support concept is achieving the desired results in terms of the operational objectives. Identify the changes to the plan and the specific support required to complete the phase.
- Commanders must always know the point at which the operation will culminate due to petroleum limitations or inadequate bulk fuel support. A shortage of bulk fuel may cause the operation to culminate sooner than planned and be unable to complete the assigned mission. Sustainment commanders and staffs should be able to determine the culmination point and communicate it to the maneuver commander for consideration. This information can be used to plan a deliberate transition from offense to defense.
- Operational reach is closely tied to culmination since the culmination point is normally the limit of a unit's operational reach. Fuel support, supply, maintenance, personnel replacements, and medical support all directly affect endurance and the ability to employ combat power for extended periods.
- Commanders should consider what types of basing, such as an intermediate staging base or temporary base camps, are required to execute sustainment support. This includes proper positioning, command and control, dispersion, and protection, required to control the bases.
- Determine the amount of risk to accept when committing sustainment forces. Commanders balance the risk with the potential favorable outcome. As an example, a commander might commit an entire fleet of tactical fuel vehicles to reach a decisive point in the operation but must accept the fact that doing so may jeopardize future operations if the fuel assets are destroyed by enemy action.

PETROLEUM PLANNING IN THE ARMY OPERATIONAL CONTEXTS

3-12. Petroleum planners must be able to adapt to the changing requirements of the theater to maintain effective fuel support. Tasks during each role are often continuous and do not stop when tasks or operations in another role begin.

3-13. Each operational context demands that Army units maneuver, and all forms of maneuver other than walking require fuel. In most cases, host-nation support will be either unavailable or insufficient to adequately fuel Army units. Successful petroleum planning is dependent on regularly and accurately determining demand for all petroleum products.

Critical Fuel Planning Tasks

In any operational context and at any echelon, petroleum planners must accomplish the following tasks:

- **Determine Requirements.** This is the key to POL planning. Determining requirements is the foundation for all other POL planning.
- **Cross-reference the supporting unit structure and mission vs. usage data.** The time-phased force deployment data (TPFDD) has the structure. For usage data, consult OPLOG Planner and historical data.
- **Determine the Capabilities Required to Fulfill The Need.** Use the Force Management System Website (FMSWeb).
- **Build the Concept of Support**

PETROLEUM PLANNING IN OPERATIONS DURING COMPETITION

3-14. Army operations during competition help set the conditions for successful execution of strategic plans. Examples of competition activities include setting the theater, military engagements, security cooperation, combined training and exercises, and sustainment preparation of the OE. Advance petroleum analysis, planning, preparation and coordination are critical to successful petroleum support operations.

3-15. Petroleum supply preparation of the OE is a continuous activity involving analysis to determine infrastructure, environmental, or resource factors in the OE that impact petroleum units' ability to sustain a commander's OPLAN.

3-16. Petroleum supply operations supporting maneuver unit competition operations center on promoting organizational readiness and training. This results in effective training programs, relevant command supply discipline programs, and increased materiel management effectiveness. Standard battle rhythm events, such as brigade logistics synchronization meetings, sustainment readiness reviews, and theater logistics working groups help tracking readiness and prioritizing efforts. Senior leaders reinforce and verify sustainment practices by conducting rigorous emergency deployment readiness exercises and conducting periodic logistics terrain walks.

3-17. During competition operations, petroleum planners are looking at different AORs and determining what capabilities exist there that they can access both early on and long term.

3-18. Planners consider over the shore requirements, capabilities, and capacity. They assess shores and beaches to include depth and tides for over the shore operations.

3-19. Planners assess the host nation's climate and terrain and how those factors affect the amount of use and ease of delivery of petroleum.

3-20. During competition operations, sustainment planners negotiate agreements with host nations for provision of fuel and other products and services. The acquisition and cross-servicing agreement (ACSA) regulates agreements with eligible countries and international organizations. ACSAs are applicable worldwide to acquire logistics support, supplies, and services directly from or provide them to a foreign government or organization. ACSA authority is usually exercised by the unified combatant commands. (See DODD 2010.9 and CJCSI 2120.01D. Potential host nation agreements may address labor support arrangements for port and terminal operations, use of available transportation assets in country, access to bulk petroleum distribution and storage facilities, possible bulk fuel and barrier materiel supply, and provision of field services. Petroleum planners, usually in the JPO, determine—

- What potential shortfalls exist and how quickly enough support can be brought forward.

- What pre-positioned stocks (both Army prepositioned stock and Army prepositioned stock afloat) are readily available.
- What units they need to bring into theater and when during the force flow to bring them in order to support anticipated consumption rates.

3-21. The JPO conducts the overall planning of petroleum logistics support, Based on the inventory management plan, the JPO —

- Identifies the petroleum inventory levels needed to support operating stocks requirements and pre-positioned war reserve requirements,
- Specifies the amount of petroleum product, by location, held to cover requirements.

3-22. Petroleum distribution planning is a key function of strategic and operational level petroleum planners in operations during competition. The facilities branch of the quartermaster group (petroleum and water) continues planning the development, design and construction of the petroleum distribution system and storage facilities based on the operational plan of the theater commander. It conducts evaluation of host-nation petroleum systems and plans for the development, rehabilitation, and extension of host-nation petroleum systems and storage facilities based on the OPLAN of the theater commander. The quartermaster group (petroleum and water) also coordinates construction, rehabilitation, and maintenance requirements of petroleum facilities with the engineer command.

3-23. The use of existing commercial pipelines, military pipelines, assault hoselines, contracts and bulk fuel and water agreements are all leveraged to provide bulk fuel and water. Planners at the JPO and DLA Energy work with other nations to develop ACSAs, contingency sites, fuel exchange agreements, and a quality surveillance-testing program on mission-critical fuel products. DLA establishes contracts with local vendors in the absence of pre-established agreements with nations in the AOR.

3-24. Other important planning considerations for petroleum planners in operations during competition include—

- Distribution capacity to include infrastructure, ports, and airfields.
- Types of fuel required.
- Ability to procure fuel additives in the event acceptable commercial jet fuel is provided to meet demand.
- Basic load requirements.
- Pre-positioned war reserve stocks.
- Transporting capacity.
- Appropriate storage capacity and appropriate locations for storage.
- Quality surveillance capability.
- Capabilities and limitations of host-nation support.
- Host-nation equipment interoperability with Army petroleum systems. (For example, North Atlantic Treaty Organization [NATO]) nations may use different couplers and adapters.)
- Capabilities and limitations of contractor support.
- Requirements for Army support to other services.
- Pertinent host-nation environmental regulations.
- Hazardous waste and material spill prevention procedures.

3-25. In this operational context, echelons above brigade should have a quartermaster petroleum liaison detachment OPCON to them to conduct futures planning for fuel support. The SPO fuel and water branch concentrates on more immediate needs.

PETROLEUM PLANNING IN OPERATIONS DURING CRISIS

3-26. Operations during crisis are characterized by actions to protect friendly forces and indicate the intent to execute subsequent phases of a planned operation. With the transition from competition to crisis, the theater Army shifts to refining CONPLANS and preparing estimates for land power based on GCC guidance.

3-27. Concurrent with actions intended to confront and deter an adversary, the theater Army commander sets the theater to enable land power to exert its full capabilities. This includes extending the existing signal and network infrastructure to accept the land component and its supporting units. Enabling landpower may include negotiation and contracting through the GCC with adjacent nations to establish tactical staging bases and realignment of security cooperation efforts based on emerging threats. The theater Army requests forces to conduct prevent activities and employs theater-level units required to support prevent activities.

3-28. Petroleum operations in support of operations during crisis continue to emphasize enhanced operational readiness, but also extend to projecting fuel assets forward. Planners involved in setting the theater plan for adequate petroleum infrastructure, supply and distribution networks to ensure the combatant commander is able to support the force as a credible threat. This includes planning for and synchronizing the arrival and deployment of petroleum assets in the Army Reserve and National Guard components that are likely to be mobilized.

3-29. In conjunction with the geographic combatant command staff and interagency partners, the theater Army identifies locations to develop or improve bases and base camps, in the joint operational area for sustainment, protection and infrastructure development, to include inland petroleum pipeline operations and land transportation.

3-30. The theater Army develops a theater logistics analysis as part of setting the theater. The TSC contributes to this analysis by completing a sustainment preparation of the OE. *Sustainment preparation of the operational environment* is the analysis to determine infrastructure and resources in the OE that will optimize or adversely impact friendly forces' means for supporting and sustaining the commander's operation plan. (ADP 4-0). Included in this analysis is an assessment of whether any required items, including bulk petroleum, are available in country, and information on transportation assets, including petroleum pipelines. The TSC, ESC, and sustainment brigade continuously verify and refine sustainment plans during operations during crisis. One of the first variables sustainment planners consider in this context is the entry into theater. The conditions of entry vary widely, from an operational area in which friendly host-nation country military and law enforcement agencies have control, intent and capability to assist U.S. operations that a unit intends to conduct (known as a permissive environment) to a forcible-entry into a contested environment.

3-31. In preparation of setting the theater, the theater Army G-3 creates the concept of operations. Fuel planners (TPC and TSC) with the theater Army come up with logistical concept of support for fuel & water, using the G-3s' operational concept, proposed time-phased force deployment data, and Operational Logistics (OPLOG) Planner. Then, as the executive authority for fuel in theater, they collect requirements from service component partners (Navy, Air Force, Marines). They consult with USAPC and DLA Energy to ensure that what is asked for is within the strategic scope. TPC helps validate then passes the validated requirement to the JPO so JPO can validate the strategy is approved by the combatant command. It is USAPC and DLA Energy that validate the requirement is strategically supportable.

3-32. The phases of a forcible entry operation are (1) preparation and deployment, (2) assault, (3) stabilization of the lodgment, (4) introduction of follow-on forces, and (5) termination or transition operations. Sustainment of these operations is normally divided into three echelons during deployment: assault, follow-on and rear echelons. Sustainment of early operations focuses on supply and distribution. In some instances, the assault force leverages resupply by air including planned resupply, immediate airdrop resupply, and emergency airdrop resupply requests. The assault force is typically supported by both organic and external elements organized to distribute supplies, including fuel and forward lines of communications (LOC). The exact organization and disposition of the assault and follow-on sustainment elements is a function of the assault force's mission and anticipated follow-on operations.

3-33. Bulk petroleum makes up the majority of the tonnage moved into a theater of operations. Pipelines are the most economical and rapid means of transporting large quantities of fuel between two points. Fuel planners and engineers within the quartermaster petroleum group collaborate with the theater engineer command to plan the construction of the IPDS.

3-34. Quartermaster units rely on engineer units for site preparation and construction of the IPDS. The quartermaster group (petroleum and water) is responsible for ordering the required pipeline construction materials and coordinating the movement of the materials to the construction staging areas along the proposed

pipeline route. Engineers determine the tentative pipeline route, install the aluminum pipeline and pump stations.

3-35. The horizontal construction engineers are responsible for clearing the pipeline route, building-crossing structures, installing pump stations and intermediate storage facilities. They will also be responsible for pressure testing of each completed section to maintain constant pressure for the stipulated period of time prior to handing it over for operation to the PPTO company.

3-36. Among the activities planned by petroleum planners are:

- Validating the OPLAN class III (B) requirements for the Army.
- Commencing the time-phased force deployment data flow and buildup of days of supply stockage objective.
- Forward positioning fuel stocks.
- Activating the fuel quality surveillance plan.
- Securing border nations supply routes.
- Commencing pipeline and fuel storage site construction.
- Securing critical POL infrastructure.

3-37. In addition, petroleum planners consider—

- Basic load requirements.
- Transporting capacity.
- Bulk fuel service providers.
- Package fuel service providers.
- Provider's capabilities and limitations.
- Procedures necessary to acquire support.
- Required coordination.
- Hazardous waste and material spill prevention procedures.

PETROLEUM PLANNING IN OPERATIONS DURING CONFLICT

3-38. In operations during conflict, Army forces help joint force commanders gain and maintain the initiative, defeat enemy forces on the ground, control territory and populations, and consolidate gains to establish conditions for a political settlement. Commanders rely on quartermaster operations to provide initial and sustained combat power. During combat operations, logisticians provide the right supplies at the right time and location enabling the force to shoot, move, and communicate and stay in the fight. During combat operations, logisticians will be in the same complex environment operating in austere conditions, often without adequate pipeline support. In that case, SPO officers will coordinate petroleum operations by rail or more likely by truck delivery. Aerial petroleum support is restricted to emergency situations.

3-39. The demand for petroleum will surge during large-scale combat operations. The number of deployed personnel, equipment, and vehicles is at its highest in this operational context and it will require a robust and adaptable petroleum support network to maintain sustainability, endurance, and OPTEMPO. Massing bulk fuel and arraying it on the battlefield enables the commander to support the main effort. Commanders who enable materiel management processes and functions provide a greater number of supplies at the point of need.

Note: The Army currently faces a significant challenge in bulk fuel line haul distribution capacity and in bulk fuel tactical distribution capacity. A fix is on the horizon as the Army brings new, larger capacity tankers into the force. Meanwhile, petroleum planners do not have the luxury of significantly overestimating fuel requirements in order to eliminate any possibility of a fuel shortage on hand. A significant overestimation of fuel requirements in one area of the battlefield will lead to fuel tankers being used inefficiently and unnecessarily exposed to deep enemy fires, and to likely fuel shortages elsewhere on the battlefield. Armies in theater will need to maximize the precision of their fuel requirement estimates and the efficiency of their transportation planning. Accurate requirements determination and robust requirements validation are vital to maximizing the efficiency of fuel delivery and extending the supported commander's endurance and operational reach.

3-40. During periods of degraded communications, petroleum supply operations continue. Planners devise CONPLANS and have them in place to push petroleum to the combat force in situations where they have limited knowledge, information or understanding of the tactical situation. Petroleum supply operations also continue in chemical, biological, radiological and nuclear (CBRN) environments. Commanders and staff must train and prepare to continue operations under periods of degraded communication and in CBRN environments.

3-41. Considerations for petroleum planners before and during large-scale combat operations include —

- Determine fuel stockage levels for all supported fuel supply points, based on commander's guidance.
- Determine fuel requirements to support current and future operations.
- Receive, validate and fill requisitions from supported fuel supply points by cross leveling from other fuel supply points or by throughput from higher sources of supply.
- Progress of fuel shipments to and between supported fuel supply points.
- Receive, validate, consolidate, package, and forward daily fuel status reports from supported fuel supply points.
- Develop and recommend fuel management policy for the supported area of operation.
- Refine OPLAN and CONPLAN stockage objective.
- Validate early entry petroleum requirements.
- Identify regionally aligned forces participation.
- Determine logistics over-the-shore (LOTS) requirements.
- Identify inter and intra theater capabilities.
- Determine and implement quality surveillance practices.

Defensive Operations

3-42. A *defensive operation* is an operation to deter or defeat an enemy attack, gain time, economize forces, and develop conditions favorable for offensive or stability operations (ADP 3-0). In defensive operations, sustainment commanders and staffs seek to understand, balance, and be prepared to take calculated risks to ensure sustainment of the operations force. Among the risk considerations during defensive operations is the question of whether sufficient quantities of class III are being maintained in the forward area to provide fuel for the security force. Sustainment commanders plan for mobility and transportation support to units fighting over a dispersed area in a static area, defense and in a dynamic mobile or retrograde defense. They plan for troop transportation assets to support the retrograde operation. Commanders and staffs build stocks of bulk petroleum to prepare to transition to offensive operations.

3-43. Additional special considerations include—

- Increases in unmanned aircraft delivery of supply items (class III [B], V, and IX repair parts) to increase during defensive operations. Unmanned aircraft systems often require Jet Fuel or aviation gasoline (avgas). This requirement must be included in LOGSTAT reporting, requisitioning, storage, and distribution.

- Prepare a primary, alternate, contingency and emergency communications plan to ensure effective personnel asset visibility and logistics status report delivery.
- Continue to build the days of supply objective.
- Plan for emergency petroleum resupply.
- Plan for diesel fuel for smoke.
- Plan for operations in a CBRN environment. Support push/pull re-supply operations.
- Identify forward arming and refueling point (FARP) requirements.
- Secure critical petroleum infrastructure.
- Retrograde operations generally require more class III supply than during the other defensive tasks. Increased supply of bulk fuel and ammunition combine to increase the demand for transportation assets and space on main supply routes. For example, CSSBs or DSSBs may need to provide support to BCT units when the BSB is in retrograde movement.

Offensive Operations

3-44. An offensive operation is an operation to defeat or destroy enemy forces and gain control of terrain, resources, and population centers (ADP 3-0). The intent of the offense is to impose the commander's will on the enemy. Commanders may conduct offensive operations in order to—

- Dislocate, isolate, disrupt, and destroy enemy forces.
- Seize key terrain.
- Deprive the enemy of resources.
- Refine intelligence.
- Deceive and divert the enemy.
- Provide a secure environment for stability tasks.

3-45. There are four offensive operations conducted during large-scale combat operations: movement to contact, attack, exploitation, and pursuit. These offensive operations and their associated tactical mission tasks enable commanders to impose their will on the enemy and deprive the enemy of resources, seize decisive terrain, deceive or divert the enemy, develop intelligence, or hold an enemy position. Sustainment commanders and their staffs prepare to support each offensive task. Sustainment determines the depth, duration and endurance of Army operations, plays a key role in enabling decisive action. Operational and sustainment planners at each echelon work closely to synchronize sustainment support to allow commanders the freedom of action to maneuver and provide extended operational reach for the offense.

3-46. Offensive operations involve an intense OPTEMPO, requiring sustainers to continually update their running estimates to anticipate friction points on the battlefield. Sustainers need to be able to accurately envision the offensive operation in time and space to accurately forecast operational requirements.

3-47. Sustainment of offensive operations is a high-intensity process. Sustainment commanders and staffs plan for increased requirements in bulk petroleum to sustain the pace and tempo of operations. Planners forecast increased consumption of petroleum to support offensive operations. Planners ensure adequate transportation assets are available to move petroleum to the point of need.

3-48. Plan for all sustainment functions required to build combat power. Preposition bulk fuel as far forward as the tactical situation permits.

3-49. Bulk petroleum represents the single largest commodity by volume in the conduct of large-scale combat operations. Expect high demand for petroleum to support the offensive preparation efforts. Ensure adequate transportation assets are available to move the required tonnage. Fast-paced offensive operations may require sustainment commanders to prepare push packages of critical supplies including bulk fuel to support maneuver forces during degraded communications.

3-50. Sustainment forces anticipate longer lines of communication, potential degraded communications, bypassed enemy forces, and movement restrictions during offensive operations. These factors are considered in all distribution management and movement control plans. Further special planning considerations for offensive operations include—

- Plan for support to special operations forces at all echelons.

- Consider weighting the main offensive effort by prepositioning class III (B) stocks centrally and well-forward.
- Plan for increased consumption of fuel and ammunition by aviation brigades. Plan support to attack helicopter operations at all echelons. This includes planning for jet fuel and placement of FARPs.
- Anticipate increased time needed to execute bulk petroleum delivery as distances increase.
- Coordinate with movement control units for road usage or de-confliction during offensive operations. Commanders identify main and alternate movement routes.
- Plan and prepare for supporting consolidation of gains and security of the support area. Maneuver commanders will assign a consolidation area to a BCT or division as an area of operations. Those forces will clear their AOs of stay behind forces and bypassed enemy units to ensure friendly freedom of action as their parent unit continues to advance.
- Plan for refuel on the move operations.
- Plan for FARP operations.
- Plan for consolidating gains.
- Estimate operational pauses and extended supply lines.
- Sustain maneuver units class III (B) requirements.

Consolidating Gains

3-51. Army forces consolidate gains to make enduring any temporary operational success and set the conditions for a sustainable environment, allowing for a transition of control to legitimate civil authorities and a return to competition below armed conflict. During operations to consolidate gains, petroleum support priorities continue to focus on support to maneuver forces in following through on combat operations – setting the defense, restoring combat power, and preparing for continued operations to destroy remaining enemy forces. However, as the area becomes more stable and security increases, petroleum supply operations include actions to restore combat power.

3-52. Combat operations may damage or destroy existing roads, bridges, canals, airfields, port facilities, and rail systems. Sustainment forces coordinate with engineer elements for repair or replacement of LOC. Petroleum planners plan for multiple modes of resupply.

3-53. Petroleum planners at all levels continue to conduct petroleum planning to provide and sustain combat power. Combat operations may still be ongoing even as neighboring units are conducting humanitarian support and stability operations. Assets may also be used to prepare units, equipment, and vehicles for redeployment.

3-54. To enable operations to consolidate gains and enable a transition back to competition below armed conflict, petroleum planners—

- Balance the competing demands of fuel support to forces and stability tasks.
- Provide fuel support to Army units that are temporarily located in an area or are being retrograded.
- Prepare to support interagency and nongovernmental organization operations, which often will rely on the Army for fuel support.
- Synchronize and integrate unity of effort with other government agencies and nongovernmental organizations in their efforts to help host nations.
- Identify and acquire non-organic capability to enable stability operations.
- Anticipate requirements to close the joint operational area, including planning for the dismantling and removal of all equipment and class III(B) retrograde and disposal.
- Transition to fuel support with civilian assets if possible.
- Identify equipment reset.
- Prepare for future offensive operations.

PLANNING CONSIDERATIONS BY WARFIGHTING FUNCTIONS

3-55. Throughout operations, Army leaders face various problems, often requiring unique, creative solutions. Planning provides an informed forecast of how future events may unfold. It entails identifying and evaluating potential decisions and actions in advance to include thinking through consequences of certain actions. Planning involves thinking about ways to influence the future as well as how to respond to potential events.

3-56. Planning considerations listed below are an example of what sustainment planners may take into account during defense operations. This list is not all-inclusive. Considerations will vary for individual operations. The list is common planning considerations for all defense tasks. If a defense task has a special consideration, it is indicated in the list.

3-57. Command and control planning considerations include, but are not limited to, the following:

- Assess petroleum operations task organization frequently to ensure it is adequate and positioned properly to support the mission. Plan for replacement of fuel lost to enemy action.
- Expect enemy attacks on space and cyberspace domains to include the electromagnetic spectrum that will degrade communications and digital information transmission.
- Expect highly adverse impacts on satellite communications, positioning, navigation, timing, information collection, internet operations, and radio communications.
- Development and execution of primary, alternate, contingency, and emergency communications plans is critical.
- Identify petroleum forces that will support the defense reserve force in all types of defense tasks. Commanders will determine what risk is acceptable in attaching sustainment units to the reserve.
- Understand how terrain may limit or degrade communications and force the use of retransmission stations. This is important for combat service support automated information system interface or very small aperture terminal operations.
- Assess petroleum unit task organization frequently to ensure it is adequate and positioned properly to support the sustainment mission. Plan for replacement of petroleum units that become combat ineffective due to enemy actions.

3-58. Intelligence planning considerations include—

- Understand the threat capability and probable courses of action. This aids in planning unit protection operations. Understand how enemy threat may impact petroleum operations.
- Understand the OE through analysis of all operational variables and further refinement through analysis of the mission variables. Understand how each variable may impact sustainment operations. Understand the impact the theater's form of inclement weather may have on petroleum operations. Snow, rain, hail, extreme heat, wind, hurricanes, tornadoes and typhoons each may significantly impact petroleum operations, but they do so in different ways.

3-59. Movement and maneuver planning considerations include the following:

- Understand and anticipate how terrain, defense obstacles, fire support coordination measures, movement restrictions, and terrain will affect rates of petroleum consumption and methods of petroleum distribution. These factors must be considered in all distribution management and movement control plans.
- Expect bulk fuel support elements to operate outside the unit boundaries and beyond the forward line of troops while supporting covering, guard, screening forces, counter and spoiling attack forces. Sustainment units must understand operational control measures to include passage of lines with maneuver forces in perimeter defense.
- Tasking of and coordination with movement control units for road usage or de-confliction during retrograde operations. This is critical to ensure the retrograde is not hindered by uncoordinated or conflicting unit movement on available routes. Commanders must identify main and alternate movement routes.
- Expect increase in unmanned aircraft system resupply items (fuel, ammunition, repair parts) to increase during defense operations. A special consideration is unmanned aircraft systems often require jet fuel or avgas. This requires avgas to be included in LOGSTAT reporting, requisitioning, storage, and distribution.

- Expect demand for bulk petroleum to surge during offensive operations.
- Plan for diesel fuel for obscuration smoke during offensive operations.
- Plan for support to attack helicopter operations at the BCT level. This includes planning for fuel, maintenance, munitions, and placement of forward arming and refueling points.
- Prepare to conduct refuel on the move operations.

3-60. Fires planning considerations include—

- Forecast increased consumption of long range and precision munitions for BCT and corps fires units. Anticipate frequent and rapid relocation of fires units and allocate fuel supply to ammunition transportation assets accordingly.
- Fires units are widely dispersed and will require petroleum distribution to several forward locations.
- Class III(B) - estimate 1,756 gallons per field artillery battalion per day. However, this doesn't take dispersion of corps high mobility artillery rocket system force into consideration.

3-61. Sustainment planning considerations include—

- Plan for execution of bulk fuel support at all echelons.
- Ensure adequate ullage to receive fuel is available when distributing fuel. Failure to reorganize available storage may tie up available fuel assets.
- Prioritize main effort petroleum support for all operations. Plan for all bulk fuel support functions required to build combat power. Preposition class III as far forward as the tactical situation permits. Consider the use of mission configured loads. Balance forward positioning of resupply and rapid mobility.
- Plan for fuel support for heavy equipment transportation assets required for movement of heavy equipment, supplies, vehicles and personnel during the retrograde operation.
- Coordinate with the supporting CSSB to provide support to BCT units when the BSB is in retrograde movement.

3-62. Protection planning considerations include—

- Plan for adequate cover and concealment measures of bulk fuel supply assets to prevent detection by enemy forces.
- Plan for adequate dispersion of fuel stocks to mitigate effects of long-range fires and attack aircraft.
- Plan for pipeline bulk fuel storage site security and patrols of main pipeline routes.
- Plan for adequate convoy security for convoys supporting the mobile defense. This may be from internal sources or from coordinated external sources.
- Plan for CBRN conditions. This includes protecting equipment and supplies from contamination where possible, training to operate in individual protective equipment, and planning for additional resources needed, such as non-potable water and chemical defense equipment, when operating in CBRN conditions.

PETROLEUM PLANNING BY ECHELON

3-63. Effective planning for petroleum supply is critical for mission success in each operational context. Petroleum is a limiting factor for operational reach and operational endurance. Bulk petroleum planners identify and track the changing requirements and allocate resources to mitigate shortfalls and increase efficiency.

3-64. Petroleum support planning and execution at each echelon, from the theater Army forward to the battalion, is a collaborative process between the sustainment headquarters and the supported unit that requires direct involvement of commanders and staffs. Both headquarters have distinct roles in the planning and execution of petroleum support. The supported unit staff develops a concept of sustainment that clearly identifies the supported unit requirements by organization. Based on this information the sustainment unit staff develops a concept of operations to execute support to meet the supported unit's petroleum requirements.

3-65. Petroleum planners at the operational level forecast fuel requirements weeks or months ahead, while tactical-level petroleum managers are focused on more immediate fuel needs. Table 3-1 shows the different planning horizons at each echelon. A planning horizon is a point in time commanders use to focus the organization's planning efforts to shape future events (ADP 5-0). These timelines are not fixed and may be changed as conditions warrant.

Table 3-1. Notional petroleum planning time horizons by echelon

<i>Echelon</i>	<i>Time Horizon</i>
Geographic combatant command	180 days
Joint force land component commander and theater sustainment command	30 days
Expeditionary sustainment command (attached to a theater sustainment command)	14 days
Expeditionary sustainment command (attached to corps)	96 hours
Sustainment brigade	48 to 72 hours
Division sustainment brigade	24 to 48 hours
Combat sustainment support battalion and division sustainment support battalion	24 hours

3-66. The operational headquarters above brigade will typically consist of a theater Army, a field army (if constituted), Army corps, and a division headquarters. As the headquarters organizations providing command and control to various subordinate commands within the force, they must be fully aware of fuel requirements and statuses of subordinate organizations. These headquarters integrate fuel support into all planning and effectively communicate, coordinate, and cooperate with the various sustainment headquarters and support organizations. These headquarters are key to establishing fuel requirements and forecasting future demand.

3-67. Within the operational headquarters are the G-3 and G-4 staffs, or S-3 and S-4 for a brigade or battalion. These staffs communicate to subordinate organizations through an operations order. The G/S-3 devises a concept of operations; the G/S-4 staff is involved in the development of that concept, being available to provide information about sustainment abilities.

3-68. The G/S-4 staff develops a concept of sustainment and the sustainment annex of the operations order. G/S-4 staffs develop an estimate for petroleum consumption based on the size of the force, length of the operation and other factors. The G/S-3 staff writes the mission requirements, tasks, and task organization of subordinates in the operations order. The concept of sustainment is developed by the G/S-1 and G/S-4. It is a written and graphical representation of how the unit will employ sustainment assets to support the commander's concept of operations. The supporting unit SPO officer may assist the maneuver staff in developing the sustainment concept but is not responsible for it. Figure 3-2 on page 3-14 shows some of the different responsibilities of the G-4/S-4 (both supporting and supported unit) and the supporting unit SPO.

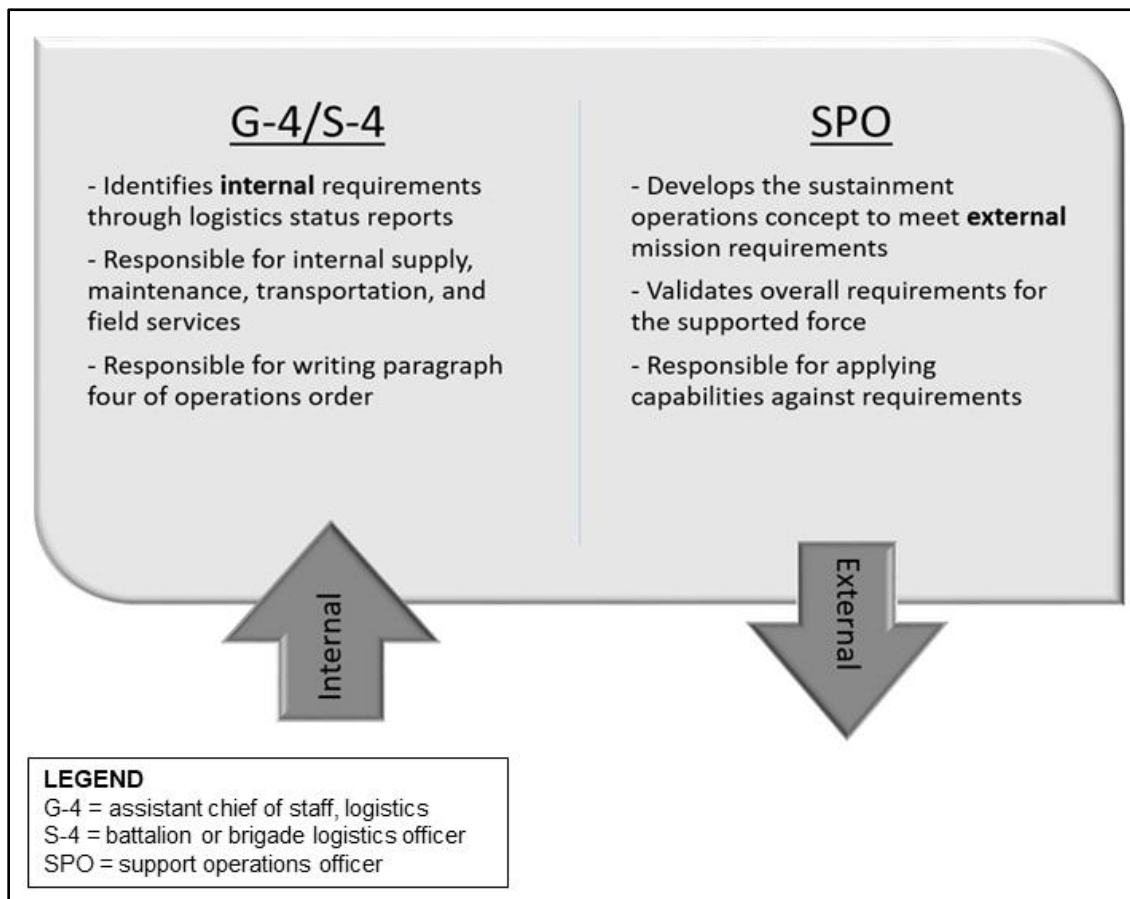


Figure 3-2. G-4, S-4 and support operations responsibilities

Note: The concept of sustainment and the concept of operations to execute sustainment support (sometimes referred to as a “concept of support”) are two different things. The concept of sustainment is found in Paragraph 4 of the supported unit’s OPORD. The concept of operations to execute sustainment support, is a supporting unit’s plan to execute support to the supported unit. For example, a brigade S-4 is responsible for the brigade’s concept of sustainment, which will be in Paragraph 4 of the BCT OPORD. The BSB SPO is responsible for the BSB’s concept of support for the brigade, which is part of the BSB’s OPORD.

3-69. The concept of sustainment identifies sustainment requirements and priorities of support by unit and sustainment elements for all phases of an operation or mission. It includes times, based on the initial plan, as to when the supporting unit will push logistics packages (LOGPAC) to the maneuver units. It also includes information on supported unit mobility requirements. The concept of sustainment is captured in paragraph 4 and Annex F of the maneuver unit operations order. Paragraph 4 includes sub-paragraphs identifying requirements and priorities for each sustainment element, logistics: Army Health System, personnel services, and financial management. Petroleum support falls under logistics.

3-70. If additional information is required, it is included in annex F. Annex F describes in further detail mission specifics such as maintenance, recovery, transportation, supply, field services, distribution, contract support, integration, mortuary affairs, human resources support, financial management, legal support, religious support, band operations and Army Health System support. The concept of sustainment is disseminated to the supporting unit in the supported unit OPORD.

3-71. The supporting unit receives the supported unit OPORD and begins the operations process. The supporting unit commander and staff use the Army military decision-making process to develop the concept of operations to execute sustainment support to meet the supported unit requirements described in the supported unit operations order. The supporting unit commander and staff conduct mission analysis to develop a thorough understanding of the supported unit commander's intent, mission and desired end state. The supporting unit commander restates the supporting unit mission to include his intent, guidance and desired end state.

3-72. The SPO officer and the supporting unit S-3 ensure that sustainment planning is synchronized with the supported unit operations concept and across all warfighting functions. This is critical to ensure the concept of sustainment tasks will not conflict with, hinder, or be hindered by supported unit operations or control measures. Continuous coordination between the DMC/SPO and the supported unit S-4 throughout the planning process is necessary to maintain awareness of changes in the supported unit operations concept.

3-73. The supporting unit order uses the standard five-paragraph format with Paragraph 3, Execution, providing the details of the concept of operations. This describes the manner in which subordinate units cooperate to accomplish the sustainment mission and establishes the sequence of actions the supporting units will use to achieve the end state. It identifies the tasks to be executed (to include the supply, maintenance, and distribution of bulk fuel), a time and location for execution, and the subordinate units responsible for each task.

3-74. The supporting unit SPO and operations officer remain alert for supported unit task organization changes to make recommendations to the supported unit on shifting petroleum support capability from one sustainment unit to another. This is especially critical in supporting the main effort.

3-75. During the planning process, the supporting unit SPO identifies sustainment capability gaps and shortfalls and coordinates with higher sustainment headquarters for mitigation. Coordination may include the need for bulk fuel storage and distribution. The concept of operations also includes requirements to coordinate with the higher sustainment headquarters for bulk petroleum replenishment. Ideally, it identifies times when and where the higher sustainment echelon is expected to deliver bulk fuel. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-76. The supporting unit operations officer publishes the OPORD, which tasks subordinate units to execute the concept of operations. Once execution begins, the supporting unit operations officer monitors and controls the current operations. The SPO section (or at the TSC or ESC level, the attached petroleum liaison detachment) focuses on future operations to ensure the supporting unit is postured to execute sustainment operations to maintain supported unit momentum.

3-77. Sustainment headquarters allocate resources in order to meet operational requirements and priorities for fuel support. It is imperative that the operational and sustainment headquarters maintain close coordination and cooperation with each other to ensure complete understanding of the OE, support priorities, and fuel support capabilities. The concept of operations should not be made in a vacuum without a keen understanding of the logistical requirements involved. Sustainment headquarters develop an operations order based on the analysis of the operations order from the operational headquarters. The concept of operations within the sustainment operations order describes how subordinate units execute tasks in support of the mission.

THEATER SUSTAINMENT COMMAND

3-78. The TSC is responsible for supply planning, forecasting and establishing supply stock levels at each support echelon to meet mission requirements. The TSC may be task organized with ESCs, sustainment brigades and functional logistics organizations supporting unified land operations. The TSC headquarters conducts planning as part of operations during competition and crisis.

3-79. The theater Army G-3 is responsible for supervising planning for the theater. The G-3 coordinates with the G-4 while planning to ensure the maneuver element of the operation is logistically supportable.

3-80. In the theater Army operations order or operation plan, the G-4 prepares annex F (Sustainment), annex P (Host Nation Support) and annex W (Operational Contract Support). See FM 6-0 for more information regarding operations order formats.

3-81. The theater Army issues an order to the TSC with a concept of operations. Based on the requirements of the operational concept, the TSC commander plans for theater distribution. This includes positioning of petroleum units in support of the operational concept. All of this is included in the TSC order prepared by the G-3, and issued by the commander to subordinate units describing their support tasks, and informs the G-4's sustainment annexes referenced in previous paragraph.

3-82. The fuel and water branch staff plans, recommends resourcing, monitors and analyzes fuel and water support in the AOR. TSC plans are informed by the plans of the theater Army and the whole maneuver force. The size and arrangement of the force are considerations for how much fuel is required and the size and layout of the distribution network. The JPO sets the theater stockage objective, including a goal for the number of days of supply to be on-hand. The stockage objective is not fulfilled immediately, but is built up over time. The JPO also determines the timeline for which the days of supply are completed.

3-83. The DIB plans distribution of fuel and water forward into the support area based on a combination of available storage, distribution assets, and anticipated customer demands. The branch provides theater on-hand visibility and recommends priority of issue.

3-84. The fuel and water branch manages bulk class III and water distribution throughout theater by using military, contracted and locally procured capability assets. It coordinates with other branches in the DMC as well as strategic partners like DLA Energy to monitor and manage theater stocks. DLA manages overland petroleum support, including inland waterways, to U.S. land-based forces of all DOD components.

3-85. This branch coordinates with the TPC representatives, the JPO, the SAPO, and DLA Energy to plan, coordinate, and oversee all phases of bulk petroleum support for U.S. forces and other organizations in an AOR. This branch also manages and accounts for bulk petroleum in the AOR. The staff coordinates petroleum operations and monitors quality surveillance resources and testing results in the theater. The TSC's focus is on operations more than 30 days in the future.

3-86. Examples of tasks the fuel and water branch accomplishes are listed below.

- Monitors and assesses petroleum operations for impact on future operations.
- Prepares petroleum and water operations requirements for major operations and battles.
- Analyzes and recommends resolutions for all issues involving fuel and water.
- Validates requirements being considered for local resupply.

EXPEDITIONARY SUSTAINMENT COMMAND

3-87. An ESC can be employed in any of three ways: attached to a TSC, attached to a field army, or assigned to a corps.

3-88. When the ESC is attached to the TSC in support of the theater Army—

- The ESC conducts planning similar to a TSC, but its focus is upon a joint area of operations. One of the primary roles of the ESC is supply planning, forecasting and establishing supply stock levels at each support echelon to meet mission requirements.
- The TSC issues an order to the attached ESC with a concept of support. Based on the requirements of the plans for theater distribution, the DMC prepares and the ESC commander issues a concept of support. This includes positioning of petroleum units in support of the operational concept. All of this is included in the ESC concept of support prepared by the ESC G-3 (with extensive coordination from the DMC), and issued by the commander to subordinate units describing their support tasks, and informs the theater Army G-4's sustainment annexes.

3-89. When the ESC is attached to a field army—

- The field army issues an order to the ESC with a concept of operations. Based on the requirements of the operational concept, the ESC commander plans for fuel distribution in the JOA. This includes positioning of petroleum units in support of the operational concept. All of this is included

in the ESC order prepared by the G-3, and issued by the commander to subordinate units describing their support tasks, and informs the field Army G-4's sustainment annexes.

- The fuel and water section plans, recommends resourcing, monitors and analyzes fuel and water support in the AOR. ESC plans are informed by the plans of the field army. The size and arrangement of the force are considerations for how much fuel is required and the size and layout of the distribution network. The ESC also sets the stockage objective for the field army (in accordance with the theater stockage objective set by the TSC), including a goal for the number of days of supply to be on-hand. The stockage objective is not fulfilled immediately, but is built up over time. The TSC also determines the timeline for which the days of supply are completed.

3-90. When the ESC is assigned to a corps—

- The corps G-3 develops a concept of operations. The G-4 will coordinate with the ESC to execute sustainment operations in support of the G-3's concept. The ESC normally provides general support with units in local proximity. The G-4 has responsibilities to develop, project and validate petroleum and water requirements in support of operations, as well as receive, consolidate, monitor, and communicate petroleum and water support requirements through support channels during operations.
- The corps level ESC plans for the next operation to be carried out in the forthcoming 72-96 hours. LOGSTAT and other data that is collected by the sustainment brigades is passed up to the ESC for analysis. Some general considerations by the ESC include—
 - Changes to anticipated consumption rate.
 - Any incident or change having significant impact to the operational capability of a logistics unit.
 - Any incident or change having significant impact on the logistical posture of any tactical unit.
- The fuel and water section plans, recommends resourcing, monitors and analyzes fuel and water support in the corps AOR. ESC plans are informed by the plans of the corps. The size and arrangement of the force are considerations for how much fuel is required and the size and layout of the distribution network.

3-91. Regardless of the manner in which the ESC is employed, the DIB plans distribution of fuel and water forward into the support area based on a combination of available storage, distribution assets, and anticipated customer demands. The branch provides theater on-hand visibility and recommends priority of issue.

3-92. The ESC petroleum detachment's planning focus depends on whether it is attached to a TSC tasked with supporting operations or assigned to a corps supporting the tactical fight. If supporting at the operational level, its focus is generally on fuel supply more than two weeks in the future. If supporting at the tactical level, its focus is on operations approximately 96 hours in the future.

QUARTERMASTER PETROLEUM GROUP

3-93. The group is normally attached to a TSC. More than a third of the group works in the support operation section, which is dedicated entirely to petroleum and water.

3-94. The group may receive an operations order from the TSC or ESC. However, its planning normally starts when it sees the theater Army's OPLAN. The group plans the development, design, and construction of the tactical petroleum distribution and storage facilities based on the theater commander's OPLAN. The group provides operational planning for the development, rehabilitation, and extension of host nation petroleum systems and storage facilities based on the theater commander's OPLAN and in coordination with the JPO.

3-95. The petroleum plans, requirements and distribution branch —

- Plans the distribution of petroleum supplies on the battlefield. The section determines subordinate units' resupply requirements and forwards them to the fuel and water branch of the TSC or ESC DMC.
- Maintains petroleum requirements estimates and operation records.
- Works with the facilities section for operations of the pipeline and terminal system.

3-96. The facilities section develops and prepares plans for the construction of the IPDS, theater water distribution system, and selected operational projects in coordination with the TSC or ESC's fuel and water branch and the theater engineer command. It plans in anticipation of complying with all applicable federal, state, local, and host-nation laws.

3-97. The transportation section, under the direction of the freight movements officer, develops wartime plans for programming the movement of bulk petroleum and water by means other than the pipeline (such as rail, inland barge, trucks.). The section coordinates with the theater movement control element for movement of the International Organization for Standardization (ISO) containers and components of the IPDS.

PETROLEUM SUPPORT BATTALION

3-98. The PSB receives orders from its higher headquarters, either the sustainment brigade or the quartermaster petroleum group. Its attached companies are the executors of the group's distribution plan. The S-3 is responsible for internal operations of the PSB. The SPO section plans for external support, including theater storage and theater flow of bulk petroleum. The SPO section coordinates for the use of fuel tankers, pipeline, hoseline and, when feasible, rail cars, barges, civilian contractor assets and host-nation assets to distribute bulk fuels. The SPO section is responsible for coordinating bulk petroleum movement in the PSB's AO in accordance with the group's distribution plan. The plans officer is responsible for futures planning for the PSB.

3-99. The PSB SPO section plans and prepares a draft order for the S-3, who issues orders to the PSB's —

- Petroleum support companies regarding receiving and storing bulk petroleum, to include meeting days of supply requirements. When required, the battalion will issue orders to provide bulk and retail supply point distribution.
- Petroleum pipeline and terminal companies regarding the construction and operation of pipelines and terminals to include on order, bulk supply point distribution.
- Transportation medium truck companies regarding distribution and transferring of bulk petroleum to direct support supply units.

3-100. The battalion also provides technical and operational supervision for the storage and distribution of petroleum products within its specified area of operations. It operates as a central dispatching agency to schedule and direct the flow of bulk petroleum through the petroleum pipeline. It receives daily pumping and transportation reports from its subordinate units that inform the SPO's next planning iteration.

SUSTAINMENT BRIGADE (IN SUPPORT OF A CORPS OR FOR THEATER OPENING OR THEATER DISTRIBUTION)

3-101. The sustainment brigade in support of a corps connects the strategic and operational plans and requirements with the tactical level units at division and below who execute those plans. The time horizon of sustainment brigade planning does not usually extend beyond 72 hours; it is concerned with completing the current mission. ESC plans for the next operation are translated into daily requirements and plans by the sustainment brigade.

3-102. The brigade SPO section plans and coordinates external support operations. The brigade SPO section aggregates all supported units requirements and determines the overall requirement. The brigade support operations section balances external sustainment support requirements with the brigade's sustainment capabilities. If shortfalls are unable to be addressed by assets contained within the sustainment brigade, then the sustainment brigade SPO relays a request for support to the appropriate higher echelon, usually the ESC.

3-103. The sustainment brigade requires the LOGSTAT reports from all subordinate tactical units. LOGSTAT reports include the amount of fuel on-hand, and a projected amount that the unit is expected to have over the next 24, 48, and 72 hours.

3-104. Brigade standard operating procedures define LOGSTAT format, report time, and analog and digital redundancy requirements. It is most effective to coordinate with the ESC G-4 to agree on a uniform date time stamp on all subordinate LOGSTAT reports. This requirement allows for an accurate snapshot of stockage levels by minimizing the uncertainty caused by anticipated deliveries or recounted supplies. The SPO and

S-4 staff sections within the sustainment brigade are able to calculate a more up-to-the-minute report by factoring in scheduled deliveries, consumption rates, and production.

3-105. The SPO section conducts commodity management of general supplies including petroleum. The materiel management branch determines requirements and recommends priorities for the allocation and distribution of supplies. It monitors the requisition of commodities and makes recommendations for the redistribution within the brigade's assigned area. It maintains visibility of on-hand and in-transit supply stocks using automated logistics systems. The SPO fuel and water section maintains the fuel common operating picture of on-hand balances, product within the distribution system, and due-in product out to a minimum of three days with an objective of ten days out.

3-106. The general supply section within the material management branch controls, manages, and directs the receipt, storage, and distribution of class I, II, III (packaged), IV, and IX supplies to supported units within the sustainment brigade's area of operations. The branch's fuel and water branch controls and manages the bulk fuel and water supply to supported units. It also directs the receipt, storage, inspection, testing, quality, issue, distribution, and accountability of the bulk fuel and water stocks for the sustainment brigade's area of operations.

COMBAT SUSTAINMENT SUPPORT BATTALION

3-107. The CSSB executes the distribution plan developed by the sustainment brigade. The CSSB commander, upon receiving the distribution plan from the sustainment brigade, develops the commander's intent that conveys a clear image of the operation's purpose, key tasks, and the desired outcome. The CSSB's subordinate units are typically geographically dispersed across its assigned support area. Delivering the commander's intent face-to-face to all subordinate commanders at the same time may not be possible. Sustainment operations require the CSSB to adapt to the changes in the OE and changes to missions of supported units. By understanding the commander's intent and the overall common objective, subordinates are able to adapt to rapidly changing situations and exploit fleeting opportunities.

3-108. The CSSB SPO analyzes its supported units' requirements. The supported units' logistics staff officers determine their unit's petroleum requirements. The CSSB SPO section aggregates and analyzes those requirements to determine the CSSB's support requirements. The SPO officer considers the mission, running estimates and unit requirements, and balances them with professional experience and judgement to synchronize support and to anticipate changes to the support plan.

3-109. Once the supported units submit their requirements, the SPO section compares them to the estimate and adjusts accordingly. The SPO section assesses the task organized CSSB capabilities against requirements. Support requirements that exceed the capabilities of the CSSB are communicated to the sustainment brigade for coordination. They consider the following—

- What logistics resources are available (within the battalion, within the sustainment brigade and in the operational area)?
- Where are logistics resources located?
- When are logistics resources available?
- How can logistics resources be made available?

3-110. On occasion, the CSSB is tasked with area support. The CSSB SPO officer uses guidance from the sustainment brigade SPO officer. The SPO officer coordinates with the battalion S-3 to ensure awareness of units transiting the area. The SPO officer reviews the task organization and available orders to determine supported units over time. Task organizations are fluid as the organization transitions through different phases of the operation. Likely supported units include—

- Field artillery brigade.
- Military police brigade.
- Engineer brigade.
- Protection brigade.
- Explosive ordnance disposal companies.
- Medical units.
- Companies and platoons detached from parent unit.

- Joint service and multinational units operating in the support area.
- Special operations forces.
- Units transiting the area.

DIVISION SUSTAINMENT BRIGADE

3-111. The division assistant chief of staff, personnel (known as the G-1) and G-4 develop the division concept of sustainment. It is a written and graphical representation of how the division will employ sustainment assets to support the division concept of operations. The DSB SPO may assist the division staff in developing the sustainment concept but is not responsible for it.

3-112. The division concept of sustainment identifies sustainment requirements and priorities of support by unit and sustainment element for all phases of an operation or mission. It includes times, based on the initial plan, as to when the BSB will push LOGPACs to the maneuver units. Knowing LOGPAC times helps the BSB and maneuver units know when to attempt to make contact even in periods of degraded communications, and it gives the DSSB a sense of the optimal time to push supplies forward to the BSB. The division concept of sustainment also includes information on division mobility requirements. The concept of sustainment is captured in paragraph 4 and annex F of the division OPORD. The concept of sustainment is disseminated to the DSB in the division OPORD.

3-113. The DSB commander receives the division OPORD and begins the operations process. The DSB commander and staff use the Army military decision-making process to develop a concept of operations to execute sustainment support to meet the division requirements described in the division order. The DSB commander and staff conduct mission analysis to develop a thorough understanding of the division commander's intent, the division mission, and desired end state. The DSB commander restates the DSB mission to include his intent, guidance and desired end state.

3-114. The SPO officer develops the concept of support. The SPO officer and the DSB S-3 ensure that sustainment planning is synchronized with the division operations concept and across all warfighting functions. This is critical to ensure the concept of sustainment tasks will not conflict with, hinder, or be hindered by division operations or control measures. Continuous coordination and communication between the SPO officer and division G-4 throughout the planning process are necessary to maintain awareness of changes in the division operations concept.

3-115. The DSB order uses the standard five-paragraph format with Paragraph 3, Execution, providing the details of the concept of operations. This describes the manner in which subordinate units cooperate to accomplish the sustainment mission and establishes the sequence of actions the DSB units will use to achieve the end state. It identifies the tasks to be executed, (such as supply, distribution, Army Health System, maintenance, and recovery), a time and location for execution, and the subordinate units responsible for each task.

3-116. The brigade SPO section plans and coordinates external support operations. The sustainment brigade SPO section aggregates all supported units requirements and determines the overall requirement. The SPO's fuel and water section maintains the common operational picture for bulk fuel and water. The SPO section balances external sustainment support requirements with the brigade's sustainment capabilities. If shortfalls are unable to be addressed by assets contained within the sustainment brigade, then the sustainment brigade SPO officer relays a request for support to the appropriate higher echelon, usually the ESC.

3-117. The sustainment brigade requires the LOGSTAT reports from all subordinate tactical units. LOGSTAT reports include the amount of fuel on-hand, and a projected amount that the unit is expected to have over the next 24, 48, and 72 hours.

3-118. Brigade standard operating procedures define LOGSTAT format, report time, and analog and digital redundancy requirements. It is most effective to coordinate with the division G-4 to agree on a uniform date time stamp on all subordinate LOGSTAT reports. This requirement allows for an accurate snapshot of stockage levels by minimizing the uncertainty caused by anticipated deliveries or recounted supplies. The SPO and S-4 staff sections within the sustainment brigade are able to calculate a more up-to-the-minute report by factoring in scheduled deliveries, consumption rates, and production.

3-119. The concept of operations also includes requirements to coordinate with the ESC for supply replenishment. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-120. The DSB S-3 publishes the operations order that tasks subordinate units to execute the concept of operations. Once execution begins, the DSB S-3 monitors and controls the current operations. The SPO section focuses on future operations to ensure the DSB is postured to execute sustainment operations to maintain the division's momentum.

DIVISION SUSTAINMENT SUPPORT BATTALION

3-121. The DSSB commander receives the DSB OPORD and begins the operations process. The DSSB commander and staff use the military decision-making process to develop a concept of operations to execute the DSSB's sustainment mission as described in the DSB order. The DSSB commander and staff conduct mission analysis to develop a thorough understanding of the DSB commander's intent, the BCT mission, and desired end state. The DSSB commander restates the DSB mission to include his intent, guidance and desired end state.

3-122. The DSSB operations order uses the standard five-paragraph format with Paragraph 3, Execution, providing the details of the concept of operations. This describes the manner in which subordinate units cooperate to accomplish the sustainment mission and establishes the sequence of actions the DSSB units will use to achieve the end state. It identifies the tasks to be executed, a time and location for execution, and the subordinate units responsible for each task.

3-123. During the planning process, the SPO section identifies any sustainment capability gaps and shortfalls and coordinates with the DSB for mitigation. Coordination may include the need for field services, bulk fuel storage and distribution, water purification, bulk water storage and distribution, general supply, transportation, and mortuary affairs support. The concept of operations also includes requirements to coordinate with the BSB for supply replenishment. Ideally, it identifies times when and where the DSB is expected to deliver supplies. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-124. The DSSB commander publishes the OPORD that tasks subordinate units to execute the concept of operations. Once execution begins, the commander monitors and controls the current operations. The DSSB commander and staff constantly conducts distribution management to integrate supplies with available transportation assets and control the movement of these according to the distribution plan.

3-125. The DSSB executes the distribution plan developed by the DSB. The DSSB SPO section continues to analyze its supported units' requirements. The supported units' logistics staff officers determine the unit's petroleum requirements. The DSSB SPO section aggregates and analyzes those requirements to determine the DSSB's support requirements. The SPO operations cell maintains the logistics common operational picture for bulk fuel and water. The SPO officer considers the mission, running estimates and unit requirements, and balances them with professional experience and judgement to synchronize support and to anticipate changes to the support plan.

3-126. Once the supported units submit their requirements, the SPO section compares them to the estimate and adjusts accordingly. The SPO section assesses DSSB capabilities against requirements and communicate support requirements that exceed the DSSB's capabilities to the DSB for coordination. They consider—

- What logistics resources are available (within the battalion, within the sustainment brigade and in the operational area).
- Where logistics resources are located.
- When logistics resources are available.
- How logistics resources can be made available.

3-127. The SPO section must be thorough when identifying support relationships with supported units. A DSSB with a direct support relationship to a division or a BCT reviews the task organization of the supported unit paying special attention to the enabling units. The task organization will change as the supported unit

transitions through phases of the operation. The supported units' priority of support may change. For example, a brigade transitioning from the main effort to the supporting effort. The division G-4 or the brigade S-4 communicates requirements to the DSSB SPO. The DSSB SPO analyzes the situation ahead of time so they can be prepared for possible changes to task organization and associated support requirements.

3-128. A DSSB can also be tasked with area support. The DSSB SPO officer uses guidance from the DSB SPO and coordinates with CSSBs that may be located in the same area. The SPO coordinates with the battalion S-3 to ensure awareness of units transiting the area. The SPO reviews the task organization and available orders to determine supported units over time.

3-129. To reduce the possibility of any friction between the support operations and the S-3 staffs, the commander provides clear guidance on duties, time horizons and mission hand off. The current operations integration cell time horizon is usually anything under 24 hours. The commander may determine to expand or contract the time window.

BRIGADE SUPPORT BATTALION

3-130. The BCT S-3 develops the BCT concept of operations. The BCT concept of sustainment is developed by the BCT personnel staff officer (S-1) and S-4. It is a written and/or graphical representation of how the BCT will employ sustainment assets to support the BCT concept of operations. The BSB SPO may assist the BCT staff in developing the sustainment concept but is not responsible for it.

3-131. The BSB receives the BCT OPORD and begins the operations process. The BSB commander and staff use the Army military decision-making process to develop a concept of operations to execute sustainment support to meet the BCT requirements described in the BCT order. The BSB commander and staff conduct mission analysis to develop a thorough understanding of the BCT commander's intent, the BCT mission, and desired end state. The BSB commander restates the BSB mission to include his intent, guidance and desired end state.

3-132. The BSB SPO officer and the BSB S-3 ensure sustainment planning is synchronized with the BCT operations concept and across all warfighting functions. This is critical to ensure the concept of sustainment tasks will not conflict with, hinder, or be hindered by BCT operations or control measures. Continuous coordination and communication between the SPO and BCT S-4 throughout the planning process are necessary to maintain awareness of changes in the BCT operations concept.

3-133. The BSB order uses the standard five-paragraph format with Paragraph 3, Execution, providing the details of the concept of operations. This describes the manner in which subordinate units cooperate to accomplish the sustainment mission and establishes the sequence of actions the BSB units will use to achieve the end state. It identifies the tasks to be executed, (such as supply, distribution, Army Health System, maintenance, and recovery), a time and location for execution, and the subordinate units responsible for each task.

3-134. The BSB SPO officer and S-3 remain alert for BCT task organization changes to make recommendations to the BCT commander on shifting logistics capability from one FSC to another. This is especially critical in supporting the main effort. It may be necessary to move capability, such as field maintenance and recovery, from one FSC to another to support the main effort battalion.

3-135. During the planning process the BSB SPO section identifies sustainment capability gaps and shortfalls and coordinates with the DSB for mitigation. Coordination may include the need for field services, bulk fuel storage and distribution, water purification, bulk water storage and distribution, general supply, transportation, and mortuary affairs support. The concept of operations also includes requirements to coordinate with the DSB or DSSB for supply replenishment. Ideally, it identifies times when and where the DSSB is expected to deliver supplies. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-136. The BSB S-3 publishes the OPORD that tasks subordinate units to execute the concept of operations. Once execution begins, the BSB S-3 monitors and controls the current operations. The SPO focuses on future operations extending 24 to 48 hours to ensure the BSB is postured to execute sustainment operations to maintain the BCT momentum.

3-137. The SPO normally develops a sustainment synchronization matrix to graphically display which support functions are executed when and where during a mission. This matrix ensures all sustainment functions to be executed and units to be supported (including time and location) during a mission are accounted for. It also ensures there are no conflicts in support. The synchronization may be provided to the BCT S-4 for inclusion in annex F of the BCT operation order. The BSB S-3 includes the synchronization matrix as a tab to annex C, operations, of the BSB operation order. The BSB SPO section uses the logistic status reports and running estimates to update the synchronization matrix for future operations.

3-138. A sustainment overlay is a graphic representation of the locations of sustainment units, support areas, MSRs, alternate supply routes, transportation facilities, unit boundaries, control measures, supply points, maintenance collection points, mortuary affairs collection points, ambulance exchange points, and others. A sustainment overlay accompanies an operations order and can be distributed throughout the BCT. The logistics planners of the BSB and BCT must synchronize the sustainment overlay with the operations overlays from the other warfighting functions to build a complete common operational picture for the BCT. The BSB sustainment overlay is captured in annex C appendix 2 of the operation order.

3-139. Staffs maintain running estimates throughout the operations process to help commanders in the exercise of command and control. An estimate may be needed at any time, so running estimates are developed, revised, updated, and maintained continuously. Fuel planners develop running estimates from historical consumption data, OPLOG Planner, Quick Logistics Estimation Tool (QLET), and the military decision-making process. The running estimate helps the staff to track and record pertinent information and provide recommendations to commanders. Running estimates represent the analysis and expert opinion of each staff element by functional area.

3-140. The BSB S-3 and S-4 focus their staff section's running estimate on the BSB's internal operations. The SPO section's logistics running estimate is externally based. The SPO section's running estimate incorporates external sustainment factors as they relate to the requirements, capabilities, and shortfalls of the sustainment for the BCT.

3-141. Sustainment planners, the BSB SPO, and the S-3 use logistics running estimates to recommend changes to the current operation when it is obvious the operation is not unfolding according to plan.

3-142. The BCT XO routinely conducts a brigade logistics synchronization meeting. Attendees may include the BCT S-4, FSC commanders, BSB SPO section and maneuver battalion S-4s as well as any supporting sustainment EABs coordinating staff. Attendees consider current orders, logistics reports, sustainment synchronization matrix, commander's guidance and other pertinent information. Meeting products include warning orders, SPO guidance and updated calendars, synch matrices, and logistics posture.

BSB DISTRIBUTION COMPANY

3-143. The BSB distribution company's role is to provide supply distribution to the BCT executing missions in each of its operational contexts. It executes a combination of supply and transportation functions to accomplish supply replenishment to support defensive operations. The BSB distribution company plans, directs, and supervises supply distribution in support of a brigade combat team to ensure that anticipatory replenishment is executed in accordance with the support concept.

3-144. The distribution company commander receives the BSB OPORD and begins troop leading procedures. The distribution company commander uses Army troop leading procedures to develop a concept of operations to execute the distribution company's sustainment mission as described in the BSB order. The distribution company commander and staff conduct mission analysis to develop a thorough understanding of the BSB commander's intent, the BCT mission, and desired end state. The distribution company commander restates the BSB mission to include his intent, guidance and desired end state.

3-145. The distribution company order uses the standard five-paragraph format with Paragraph 3, Execution, providing the details of the concept of operations. This describes the manner in which subordinate elements cooperate to accomplish the sustainment mission and establishes the sequence of actions the platoons will use to achieve the end state. It identifies the tasks to be executed, a time and location for execution, and the subordinate units responsible for each task.

3-146. During troop leading procedures, the company executive officer identifies any sustainment capability gaps and shortfalls and coordinates with the BSB for mitigation. Coordination may include the need for field services, bulk fuel storage and distribution, water purification, bulk water storage and distribution, general supply, transportation, and mortuary affairs support. The concept of operations also includes requirements to coordinate with the BSB for supply replenishment. Ideally, it identifies times when and where the BSB is expected to deliver supplies. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-147. The distribution company commander publishes the OPORD that tasks subordinate elements to execute the concept of operations. Once execution begins, the commander monitors and controls the current operations. The distribution company commander and key leaders constantly conducts distribution management to integrate supplies with available transportation assets and control the movement of these according to the distribution plan.

FORWARD SUPPORT COMPANY

3-148. The role of the FSC is to provide direct support to a specific supported battalion. For a limited duration, the FSC, may be attached to the supported battalion or placed under operational control of the supported battalion. Petroleum planners should consider the different capabilities of FSCs during planning to ensure the right support is allocated for the mission. The FSC provides logistics support that is organized specifically to meet the supported commander's needs. The FSC commander receives technical logistics oversight and mentoring from the BSB commander, and maintains a relationship with the BSB SPO section. The BSB communicates the concept of support through the SPO section to the FSC commander.

3-149. The FSC commander receives the BSB OPORD and begins troop leading procedures (Aviation FSCs receive the aviation battalion OPORD and begins troop leading procedures). The FSC commander and staff use Army troop leading procedures to develop a concept of operations to execute the FSC's sustainment mission as described in the BSB order. The FSC commander and staff conduct mission analysis to develop a thorough understanding of the BSB commander's intent, the supported battalion's mission, and desired end state. The FSC commander restates the BSB mission to include his intent, guidance and desired end state.

3-150. During the planning process, the company executive officer identifies any sustainment capability gaps and shortfalls and coordinates with the BSB for mitigation. Coordination may include the need for field services, bulk fuel storage and distribution, water purification, bulk water storage and distribution, general supply, transportation, and mortuary affairs support. The concept of operations also includes requirements to coordinate with the BSB for supply replenishment. Ideally, it identifies times when and where the BSB is expected to deliver supplies. Additional order products supporting the concept of operations such as operation overlays, execution matrices, movement control tables, and traffic control overlays may be included in annex C as appendices or tabs.

3-151. The FSC commander publishes the OPORD that explains how the FSC will execute the concept of operations and tasks subordinate elements. Once execution begins, the commander monitors and controls the current operations. The FSC commander and key leaders constantly conduct distribution management to integrate supplies with available transportation assets and control the movement of these according to the distribution plan.

PETROLEUM PLANNING TOOLS

3-152. Using guidelines and planning factors, bulk petroleum planners determine the quantities of bulk petroleum needed to support an operation. Logistics planning data include a variety of information, such as consumption rates, reference data, and planning factors. The strategic, operational and tactical levels use Army logistics planning data and factors to estimate the amount and type of efforts required for a given operation.

3-153. Units forecast each class of supply using logistics planning factors. A planning factor (rate, ratio, length of time) is a multiplier used to estimate the amount and type of effort involved in an operation. Population based planning factors have three variables: weight of the class of supply for a given period, population supported during the same time frame, and estimated number of days for the operation or mission.

Equipment based planning factors take into account equipment usage profiles for each fuel burning line identification number, commonly referred to as an LIN, in each operation.

3-154. Historical data, if appropriate data is available, may lead to the most accurate forecasts. In the absence of historical data, bulk petroleum planners use QLET, or most often, OPLOG Planner, to compute fuel requirements. In addition, a simple gallons-per-person-per-day estimate may be used early in developing requirements for an unknown force makeup; this method is seldom used below theater level.

FUEL CONSUMPTION ESTIMATES

3-155. Fuel consumption estimates or requirements are the key to designing an effective petroleum distribution system to support the theater. At theater level, fuel consumption estimates are the basis for acquiring theater petroleum tankage and for allocating supply stockage levels throughout the theater. At theater Army level, fuel consumption estimates are used to establish priorities for distribution and construction.

3-156. At lower echelons fuel consumption estimates are the basis for resupply. Theater fuel consumption estimates must be accurately determined to develop realistic plans in support of operational forces. Requirements are needed for operating Army units, Air Force, allies and other large-volume consumers by location and time period. Determining the requirements allows the planner to determine such specifics as the number and types of tanker unloading facilities and the number of rail tank cars, tank vehicles, tanker aircraft, barges, and other bulk petroleum distribution equipment needed.

3-157. Fuel consumption must be estimated as soon as the situation and 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 and aircraft in each phase of the operation are essential in the initial determination of petroleum requirements. Some of the resources used to compose consumption fuel estimates are historical data, OPLOG Planner and Integrated Consumable Item Support (ICIS) system on the Secret Internet Protocol Router Network (also called SIPRNET) for use by all JPOs.

INTEGRATED CONSUMABLE ITEM SUPPORT SYSTEM

3-158. The ICIS system is a decision support system that takes time-phased force and deployment data (such as Department of Defense deployment plans) and calculates the ability of the Defense Logistics Agency, the warehousing unit of the Department of Defense, to support those plans. For fuel supply points and echelons above brigade fuel planners, ICIS is the system of record for petroleum usage, demand and requirements. Integrated consumable item support can calculate for the planned deployment supply and demand curves for over two million individual items, including petroleum, oil and lubricants, stocked by DLA in support of deployment. ICIS requires Secret Internet Protocol Router Network capabilities.

OPERATIONAL LOGISTICS PLANNER

3-159. Stockage and resupply requirements for a theater can be determined using LOGSTAT, command guidance, unit standard operating procedures and OPLOG Planner.

3-160. OPLOG Planner is an interactive stand-alone tool that assists commanders and staff in developing a sustainment estimate. The planner is updated annually with the DA G-4 approved logistics planning rates and the standard requirements codes reflecting the equipment and personnel found in the objective tables of organization and equipment designed by Training and Doctrine Command and maintained by the U.S. Army Force Management Support Agency. Sustainment planners answer a series of questions about mission, enemy, terrain, weather, troops, time available, civil considerations and task organizations to generate a supply estimate for each class of supply.

3-161. OPLOG Planner is used in petroleum planning to estimate the amount and type of fuel required for a contemplated operation. The estimate is based on equipment factors such as burn rate, usage profile, OE, duration and number of items. The Army Materiel Command is the component responsible for developing class III fuel burn rates for Army equipment. All reports are easily exportable in multiple formats for ease in staff planning, analysis and chart making. Petroleum planners can gain access to OPLOG Planner by

contacting the Combined Arms Support Command (CASCOM) Planning and Development Branch website at the link provided in the reference section of this publication.

QUICK LOGISTICS ESTIMATION TOOL

3-162. QLET is a lighter, quicker version of OPLOG Planner and provides requirements for one or multiple standard requirements codes (SRCs) for each class of supply. Although not as detailed as OPLOG Planner, users can select the SRCs, joint phase, climate, and platform requirements and the tool provides a logistics estimate. It determines the total weight, short tons, gallons, pallets, and platforms from the SRCs chosen.

3-163. The Headquarters, Department of the Army G4 has given the CASCOM Planning and Development Branch the responsibility for updating QLET periodically. Petroleum planners can gain access to QLET by contacting the CASCOM Planning and Development Branch website located in the references section of this publication.

FORCE MANAGEMENT SYSTEM WEBSITE (FMSWeb)

3-164. The Force Management System Website (FMSWeb) is maintained by the U.S. Army Force Management Support Agency; the website address is provided in the references section of this publication. Planners can use FMSWeb to help determine their capabilities. FMSWeb provides basis of issue, table of organization and equipment; modified table of organization and equipment (MTOE), common tables of allowance, table of distribution and allowances, and joint tables of allowance. The MTOE is likely to be the most up-to-date for determining capabilities. Users can search for unit data by name, unit identification code, or standard requirements code.

PETROLEUM PLANNING CONVERSION FORMULAS

3-165. Bulk fuel information may arrive in a measurement quantity that petroleum planners may need to convert into a more useful form. The following are used in computing weight or quantity conversions.

Converting Between Specific Gravity and American Petroleum Institute Gravity

3-166. Petroleum planners convert American Petroleum Institute (API) gravity to specific gravity by using the following formula: $141.5 / (\text{API} + 131.5) = \text{specific gravity}$.

3-167. Petroleum planners convert specific gravity to API gravity by using the following formula: $(141 / \text{specific gravity}) - 131.5 = \text{API gravity}$.

Converting Between Pounds and Gallons

3-168. When issuing fuel to an aircraft, the quantity provided by the flight crew most likely will be in pounds of fuel requested.

3-169. To convert from the quantity in pounds to the quantity in gallons:

- Step 1. Convert API gravity to specific gravity.
- Step 2. Multiply the weight of one gallon of water (8.33 lbs.) by the specific gravity of the fuel.
(8.33 lbs. x specific gravity = weight 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 number of pounds/weight of one gallon of fuel = total gallons).

3-170. To convert from the quantity in gallons to the quantity in pounds:

- Step 1. Convert API gravity to specific gravity.
- Step 2. Multiply the weight one gallon of water (8.33 lbs.) by the specific gravity of the fuel.
(8.33 lbs. x specific gravity = weight of one gallon of fuel)
- Divide the weight of the entire load of fuel by the weight of one gallon of fuel.
(Total number of gallons x weight of one gallon of fuel = total pounds.)

Flow Conversion Table

3-171. The flow conversion table is a tool developed to assist the petroleum planner in calculating the rate of flow of petroleum products under various units of measurement. Table 3-2 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 rates of flow.

Table 3-2. 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	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	34.2857
	barrels per	1.4286
	barrels per	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

PETROLEUM PLANNING FACTOR TABLES

3-172. Table 3-3 on page 3-28 shows the fuel consumption rate for select vehicles in the Army inventory for one hour of operation. The table provides fuel historic averages for fuel consumption while the particular vehicle sits idle with the engine running, driving cross-country over uneven terrain, and on hard paved roadway surfaces.

Table 3-3. Vehicle fuel capacity by gallons and consumption by gallons per hour

<i>Vehicle</i>	<i>Tank Capacity</i>	<i>Idle</i>	<i>Cross-Country</i>	<i>Road</i>
M1A2	496	12.8	61.9	59.1
M2 or M3	175	1.4	19.1	18.8
M113	95	1.0	7.9	8.0
M88	400	3.5	42.9	40.9
M9 ACE	134	1.4	12.6	9.3
M109A6	133	1.4	18.9	18.5
MLRS	175	1.4	18.3	18.2

3-173. Table 3-4 depicts the fuel capacity and average consumption rates for helicopters that may need fuel in a FARP.

Table 3-4. Average fuel consumption rates for Army helicopters

<i>Helicopter</i>	<i>Capacity (in gallons)</i>	<i>Consumption rate of JP8 (gallons per hour)</i>
AH-64D/E	370	175
CH-47D/F	1,030	514
UH-60A/L/M	362	175
UH-72A	225	80

3-174. Table 3-5 shows the fuel consumption planning factors from the CASCOM Planning Data Branch. This is not an exhaustive list. Petroleum planners will need to consider the fuel consumption of all units involved in an operation. For current bulk petroleum estimates, consider OPLOG Planner and unit historical data.

Table 3-5. Estimated daily fuel consumption planning factors

<i>Unit Type</i>	<i>Personnel</i>	<i>Maximum Fuel (in gallons)</i>	<i>Average Fuel (in gallons)</i>
Combat Aviation Brigade (Medium)	2,719	134,338	93,929
Combat Aviation Brigade (Heavy)	2,754	142,591	102,424
Aviation Attack/Recon Battalion (AH-64)	403	18,822	14,224
Brigade Engineer Battalion (ABCT)	443	12,513	11,909
Brigade Engineer Battalion (IBCT)	422	5,826	5,517
Brigade Engineer Battalion (SBCT)	468	6,500	5,954
Field Artillery Battalion Comp (3x6) (IBCT)	553	3,554	3,533
FA Battalion, 155Towed (SBCT) (3x6)	373	2,661	2,661
FA Battalion 155 Self-Propelled (ABCT)	315	4,759	4,759
FA Battalion, High Mobility Artillery Rocket System (HIMARS)	240	1,756	1,756
FA Battalion, Multiple Launcher Rocket System (MLRS)	232	2,309	2,309
Infantry Battalion (IBCT)	699	2,550	1,905
Infantry Battalion (IBCT) (Airborne)	699	2,144	1,580
Infantry Battalion (SBCT)	698	4,303	2,726
Combined Arms Battalion (ABCT) (2 Mechanized / 2 Armor)	632	26,310	14,880
Cavalry Squadron (SBCT)	418	5,382	2,518
Cavalry Squadron (ABCT)	428	8,970	3,735

Table 3-5. Estimated daily fuel consumption planning factors - continued

<i>Unit Type</i>	<i>Personnel</i>	<i>Maximum Fuel (in gallons)</i>	<i>Average Fuel (in gallons)</i>
Cavalry Squadron (IBCT)	372	4,811	2,241
Brigade Support Battalion (SBCT)	953	11,859	9,088
Brigade Support Battalion (ABCT)	1,371	25,463	21,255
Brigade Support Battalion (IBCT)	882	10,458	8,320
SBCT	4,497	39,208	29,964
IBCT	3,458	25,839	21,380
ABCT	3,800	100,384	65,039
LEGEND: ABCT = armored brigade combat team IBCT = infantry brigade combat team SBCT = stryker brigade combat team			

Note: Table based on modified table of organization and equipment current at date of publication.

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Chapter 4

Distribution Management and Materiel Management Process

The Army distribution management process integrates and synchronizes the functions of materiel management and transportation, in accordance with command priorities, to ensure petroleum moves from the source of supply to the point of need. Effective petroleum distribution allows commanders to enjoy freedom of movement, extend operational reach, and maintain an operational pace the enemy cannot match. Bulk petroleum distribution in a theater of operations begins with understanding the fuel requirement. Based on the requirement, commanders ensure adequate fuel, storage and distribution capability are in place.

4-1. Distribution management is a process that includes materiel management and transportation management functions. It provides a consistent process whereby petroleum managers can know the things they need to do and the people they need to coordinate with to get the right item (in this case, bulk fuel) to the right place at the right time.

4-2. For petroleum planners, the process begins with planning for requirements and ends when the right fuel is issued to the end user. Petroleum planners determine and validate fuel requirements (by quantity and priority) for distribution to units or locations, obtain the fuel, and coordinate its distribution according to command priorities.

4-3. Transportation managers allocate specific modes for bulk petroleum along with other commodities, by quantity and priority to coordinate distribution and routing to meet command priorities. Distribution managers use the information provided by the materiel management component to coordinate with the transportation component by commodity, quantity, priority, and recommended mode.

- The materiel management component of the distribution process—
 - Is executed by the materiel management branch of the DMC within the TSC and ESC and by the supply and services section within the support operations branch of the DSB and sustainment brigade.
 - Is executed in the SPO section of the CSSB, DSB, and BSB support operations section.
- The transportation component of the distribution process—
 - Is planned in the TSC and ESC transportation operations branch of the DMC.
 - Is executed in the sustainment brigade, DSB, CSSB, DSSB and BSB support operations section.
- The distribution integration component of the distribution process—:
 - Is executed in the TSC, ESC, and sustainment brigade integration branch of the DMC.
 - Is executed by the CSSB, DSSB and BSB support operations section.

DISTRIBUTION MANAGEMENT FUNCTIONS

4-4. Distribution management synchronizes and optimizes transportation, its networks, and materiel management with the warfighting functions to move personnel and materiel from origins to the point of need in accordance with the supported commander's priorities.

4-5. Petroleum distribution management occurs at all echelons from the TSC down to the FSC. Distribution management functions include the following:

- Transportation feasibility determines if the capability exists to move required quantities of bulk fuel from the point of origin to the final destination within the time required. If transportation is not feasible, transportation planners report this fact to the petroleum planners.
- Prioritization ensures bulk fuel to be distributed is organized and queued in order of priority as determined by the command. Priority is expressed as both commodity and unit priority.
- Mitigation of shortfalls links materiel management to transportation in terms of commodity, quantity, and priority. It ensures that adequate transportation assets are identified and obtained against the requirement deficiency.
- Synchronization ensures that distribution is synchronized with transportation operation cycles to ensure modes with sufficient capacity are available when commodities are positioned for movement. It also synchronizes distribution with operational tasks, phases, and objectives.
- Visibility provides the petroleum planners with visibility of bulk fuel that is queued, prioritized, and has transportation allocated for movement. Unlike with other commodities, units do not maintain automated in-transit visibility with bulk petroleum. Maintaining bulk petroleum visibility is a manual process.
- Distribution integrates the logistics functions of transportation and supply. It is dependent on materiel management and movement control. The operational process of synchronizing all elements of the logistics system to deliver the “right things” to the “right place” at the “right time” to support the commander.
- Redistribution reallocates excess materiel to other locations in theater using all transportation assets available. Managers may use excess bulk fuel in theater to fill shortages and meet operational requirements.

MATERIEL MANAGEMENT FUNCTIONS

4-6. Materiel management is the continuous situational understanding, planning, and execution of supply and maintenance capabilities to anticipate, synchronize, and direct all classes of supply to maximize combat power and enable freedom of action in accordance with the supported commander's priorities. Sustainment planners, commanders, and Soldiers act as materiel managers when acting in roles that execute materiel management functions.

4-7. Petroleum materiel management is anticipatory and flexible to meet unforeseen and unexpected fuel requirements that arise during large-scale combat operations. Bulk fuel planners and managers focus on equipping the forces by satisfying supply requirements as quickly and efficiently as possible.

4-8. Materiel management of bulk petroleum is executed through the following functions. These functions may be executed entirely or in part based on operational and mission variables.

- Supply planning forecasts and establishes bulk fuel stockage levels at each support echelon to meet mission requirements. It is a translation of an operating force's composition into specific supply requirements. Planning ensures that adequate bulk petroleum and transportation assets are available.
- Requirements determination is the understanding and determination of a supply requirement to support an operating force. It aids petroleum planners in defining priorities of support. It is based upon requirements communicated from operating forces and forecasted by sustainment organizations supporting these forces.
- Requirements validation is critical to avoid excess petroleum and to avoid misuse of logistics transportation and maintenance assets. Petroleum managers validate and prioritize available logistics assets against an established or forecasted requirement. Requirements validation ensures that no requests for bulk petroleum support are passed to a higher headquarters until it is determined on-hand supply is insufficient to meet the requirement. It also includes establishing controlled rates of supply if necessary.
- Resupply is obtaining bulk fuel to meet operational requirements. It includes the requisition process, contracting, and local purchase.
- Funds management includes contracting officers with warrant authority and finance officers, managing the obligation of funds in support of bulk fuel supply operations.

- Storage includes fuel site management, receiving, storing, issuing, securing, inventory management, and accounting for fuel. Storage locations include fixed facilities, collapsible fuel tanks, tankracks, tankers and other available, acceptable fuel containers.
- Stock control involves maintaining proper location and identification of materiel. Petroleum managers need correct identification and location of all bulk fuel under their control.
- Supply is providing all items necessary to equip, maintain, and operate a military command. For fuel, it involves requesting, receiving, storing, maintaining, issuing, and establishing accountability of all class III (B) required to execute a unit's assigned mission.
- Maintenance includes all actions necessary for quality surveillance of class III (B).
- Asset visibility includes petroleum planners working to determine location, movement, status, and identity of class III (B) assets, and enabling improved decision making on sources of support and prioritization.
- Vertical and horizontal reporting of asset status is a critical component of asset visibility, requirements determination, and requirements validation. It occurs at all echelons with the frequency and commodities to be reported determined by the command. LOGSTAT and Bulk Petroleum Contingency Reports (often referred to as JCS REPOL) are a critical part of ensuring timely bulk fuel supply. REPOL stands for "reporting emergency petroleum, oils, and lubricants", but is generally meant to refer to bulk fuel status reports.
- Retrograde of material is an Army logistics function of returning materiel from the owning or using unit back through the distribution system to the source of supply, directed ship-to location, or point of disposal (ATP 4-0.1). Rather than retrograding, fuel managers typically manage the inventory down to zero.
- Disposal is the systematic removal of materiel that is uneconomically repairable or obsolete. It is accomplished through the process of transferring, donating, selling, abandoning, or destroying materiel. It is normally directed through program management channels but may also be a command decision if the OE dictates. Fuel will generally be regraded or sold.

4-9. Materiel management addresses all internal and external logistical processes, information, and functions necessary to satisfy an operational supply requirement. The primary objective for petroleum materiel management is to provide effective and efficient supply support to meet operational requirements. Effective petroleum materiel management provides the commander with greater situational awareness, informs decision making, and enhances control and flexibility.

TRANSPORTATION MANAGEMENT FUNCTIONS

4-10. Transportation is a logistics function that includes movement control and associated activities to incorporate military, commercial, and multinational motor, rail, air, and water mode assets in the movement of units, personnel, equipment, and supplies in support of the concept of operations. Transportation functions for petroleum include the following:

- Intermodal operations is the process of using multiple modes (air, sea, highway, rail and pipeline) and conveyances (truck, barge, pallets, containers) to move troops, fuel, supplies, and equipment through expeditionary entry points and the network of specialized transportation nodes to sustain land forces.
- Mode operations is the execution of movements using various conveyances (truck, lighting, rail car, aircraft) to transport cargo (ADP 4-0).
- Movement control (Army) is the dual process of committing allocated transportation assets and regulating movements according to command priorities to synchronize distribution flow over lines of communications to sustain land forces (ADP 4-0). Petroleum planners determine and plan for fuel items that need be shipped.
- Allocation involves the distribution of limited forces and resources for employment among competing requirements.
- Coordination includes interfacing with organizations that participate directly or indirectly with the movement of fuel. Coordination extends to joint and multinational forces, host nation, contractors, and non-government agencies.

- Routing is the process of scheduling and directing movements on the lines-of-communication to prevent conflict and congestion.
- In-transit visibility is the ability to track the identity, status, and location of Department of Defense units, and non-unit cargo and passengers; patients, and personal property from origin to consignee or destination across the range of military operations. Fuel planners use their knowledge of the location and amounts of fuel in transit to plan additional shipments.

DISTRIBUTION MANAGEMENT AND MATERIEL MANAGEMENT PROCESS FOR PETROLEUM

4-11. Distribution management and materiel management functions are linked. Bulk petroleum support is primarily a materiel management process. Figure 4-1 depicts the distribution management process. It is important to understand the functions are carried out continuously and often simultaneously, through multiple iterations. For example, supported units determine new requirements at regular intervals depending on changes in the mission variables (for example, numbers of troops, OPTEMPO, storage capacity, priorities for support, operational readiness rates for distribution assets, and accessibility of lines of communication to name a few).

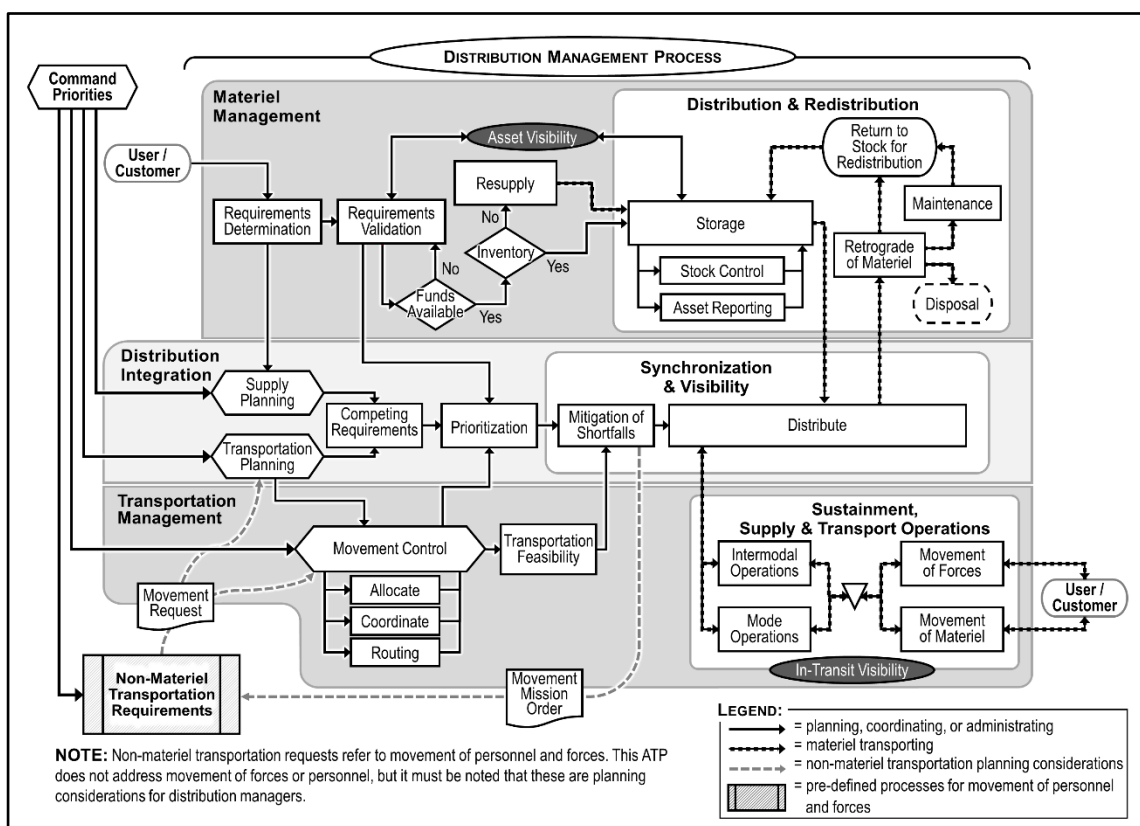


Figure 4-1. Distribution management process

REQUIREMENTS DETERMINATION

4-12. Requirements and command priorities initiate the petroleum management process. For example, LOGSTAT reports that show a fuel shortage are a source of requirements. An operations order will also contain requirements.

Consumption Estimates

4-13. Fuel consumption estimates or requirements are the foundation to effective petroleum distribution planning and establishment of an effective distribution network to support the end user in theater. In conducting operations in theater, all units estimate fuels requirements and the necessary delivery frequency to ensure an end user has a continuous supply.

4-14. Accurate theater fuel consumption estimates enable petroleum planners to develop realistic plans in support of operational forces. At theater level, fuel consumption estimates are the basis for acquiring theater petroleum tankage and for allocating supply stockage levels throughout the theater. Determining the requirements allows the planner to synchronize resupply and determine such specifics as the amount of assets required to support the mission. At echelons above brigade level, fuel consumption estimates are used to establish priorities for distribution. At lower echelons, fuel consumption estimates are the basis for resupply.

4-15. Fuel consumption is estimated as soon as the situation and conditions permit so that it can be balanced against known capabilities and coordinated with other supply and transportation support requirements. The number of major items of fuel consuming equipment and vehicles and aircraft in each phase of the operation is essential in the initial determination of petroleum requirements. In addition, there are minimum timelines set by DLA Energy for the establishment of contracts.

4-16. Petroleum planners obtain and employ the best fuel consumption estimates available. At the company level, executive officers are normally responsible for this task. At battalion-level and above, the S-4 is responsible for compiling and forwarding this information. Some resources used to generate consumption fuel estimates are historical data, which is the most accurate source; OPLOG Planner, and integrated consumable item support on the Secret Internet Protocol Router employed by all GCC JPOs. Class III(B) consumption is often expressed in gallons per hour.

Forecasting Process

4-17. Petroleum supply points submit a daily status report containing quantities received, issued, and on-hand. Petroleum planners use the daily status reports to forecast bulk fuel requirements.

4-18. Army bulk fuel accountability and forecasting is a manual process. The process goes from the tactical through the operational to the strategic level. Each level prepares and submits accountability documents through the chain of command and petroleum management channels. See DA PAM 710-2-1 for in-depth information on how to fill out the appropriate accountability documents.

4-19. Petroleum managers communicate along command channels and technical channels to ensure that supported units receive on-specification bulk petroleum. The command channel involves the petroleum units within the Army while the technical channel includes joint and Army organizations.

4-20. Command and technical channels incorporate a two-way flow of information to ensure the petroleum terminals receive the most current guidance and to inform the command or suppliers of real or potential problems in the field. Army bulk petroleum planners work closely with DLA Energy to ensure that petroleum units can deliver fuel to supported units in a timely manner. Bulk fuel is distributed based on priorities established by the commander and will be determined in response to forecasted requirements and status reports. Unit S-4s and when applicable, SPO sections forecast requirements based on the type and quantity of fuel on-hand. Further coordination with S-2s and S-3s is essential to forecast requirements based on the probable level of activity for the next 72-hour period. Initial forecasts can be based on consumption data for periods of similar operations.

4-21. The JPO submits requirements to DLA Energy. It also collaborates with Service components, SAPO, Army Petroleum Center, and the TPC. Together, they plan, coordinate, and oversee all phases of bulk petroleum support for U.S. forces and other organizations employed or planned for possible employment in the theater. The JPO ensures all participants, to include the Services, allies, coalition partners, and supporting commands coordinate their requirements to maximize the fuel support capability for effective theater-wide support.

REQUIREMENTS VALIDATION

4-22. Units pass forecasted requirements through S-4 channels to petroleum planners in the SPO section, who manage distribution in coordination with movement control and supply elements. Petroleum planners provide allocations based on priorities provided by operations planners. The approved allocations are provided to the movement control managers.

4-23. The support operations staff at each echelon compares the collected fuel requirements to the capabilities of that echelon's supporting units. Planners validate and prioritize available petroleum against an established or forecasted requirement. Every echelon is responsible for knowing the requirements of its supported units. They should know if that requirement is supportable or what gap if any exists and how to meet that gap to meet the supported unit's request. If the staff determines on-hand assets are insufficient to meet the requirement, then it passes a request for fuel support to its higher headquarters. Requirements validation helps ensure requests are realistic and supportable, helps avoid accruing more petroleum than can be stored, and helps avoid misuse of logistics transportation and maintenance assets. Requirements validation also includes establishing controlled rates of supply, if necessary.

FUNDS MANAGEMENT

4-24. Supported units receiving bulk petroleum use their Department of Defense activity address code, known as a DODAAC, and its unit identification code to purchase fuel. The dispensing unit enters the amount of issue and date of issue into the contact log it is required to maintain. For additional information on the regulatory requirements for fuel purchases, consult AR 710-2.

PROCUREMENT

4-25. The supported unit S-4 coordinates a bulk fuel issue schedule with the supporting SPO section. Supported units pick up fuel in organic refueling vehicles, and an authorized unit representative signs for quantities received. A convoy support center may be set up along a main supply route to issue fuel to vehicles on the road. A receiving agent signs for these issues.

4-26. The SAPO submits bulk fuel requirements through JPO for processing to DLA Energy to obtain sourcing for DOD, local commercial or host government resources using DLA Energy contracts or service or country replacement-in-kind agreements. When coordinated, DLA Energy throughputs bulk fuel to forward petroleum supply stocks points and supported units. This is done in emergencies either through pre-positioned stocks or DLA Energy theater support contracts after sources are inspected and approved.

Logistics Over the Shore

4-27. Logistics over-the-shore is the loading and unloading of ships in an austere environment or without deep draft capable fixed port facilities. LOTS operations include all processes from in-stream discharge through the off-loading, and arrival of equipment and cargo and supplies at the inland staging and marshalling areas.

4-28. LOTS operations use pipelines and hoses to offload tankers at undeveloped ports into TPTs operated by the PPTO. LOTS operations provide a critical capability for bringing equipment, cargo and supplies into theater with degraded or austere port facilities, or it can be used to bypass enemy anti-access or area denial efforts. Logistics over-the-shore can also supplement existing port facilities. LOTS provide the combatant commander the option to choose which off-load locations to use, such as bare beach, austere port, or a damaged fixed port. Using LOTS allows for cargo to be delivered and off-loaded closer to the point of need. LOTS enablers will allow them to create pier facilities, conduct salvage, or provide floating crane support capabilities alongside ships and fixed facilities.

4-29. Using a variety of Army watercraft systems, the Army can conduct its own LOTS operation or, it can operate in conjunction with the Navy in a joint logistics over-the-shore operation. The petroleum support battalion directs the operation of petroleum port terminal facilities and storage facilities. Transportation medium support companies transport bulk petroleum inland. See ATP 4-15 for more information about Army logistics over the shore operations.

Waterfront Operations

4-30. Waterfront operations include the discharging and receiving of fuel through distribution from the vessel offshore through the flexible pipe of the offshore petroleum distribution system (OPDS) to the BTU. The Army then assumes responsibility at the outlet side of the BTU. More information on waterfront operations can be found in chapter 5 of this publication.

4-31. Piers and wharves are permanent structures built in protected harbors. They are built using timber, concrete or steel. Vessels dock at least 50 feet from any vessel unloading bulk cargo unless the depot officer or supervisor and the master of the vessel transferring cargo agree to an exception.

4-32. Existing loading and unloading facilities in a developed theater may also require self-elevating piers and pipeline jetties.

- A self-elevating pier is a steel barge that must be towed into place. It has jacks, caissons, and machinery that raise the pier above the water to form a working platform.
- 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 to provide a walkway with a 40 by 70 foot working platform at the tanker end.

4-33. 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.

4-34. The inspectors review the loading plans and consider bulkheads, lines, tank capacities, and trim.

4-35. Shore operators ensure that precautions are taken against fire, product contamination, and safety hazards. The ship's officer and the responsible shore authority coordinate all loading plans.

STORAGE

4-36. Once a unit procures bulk petroleum, it stores it. Storage is the initial step in distribution and redistribution. The term storage does not imply the use of fixed facilities; bulk petroleum is normally stored in collapsible bags, tanks, blivets, and trucks. The theater support area is where bulk fuel units establish the theater stocks, as well as storage and distribution capabilities.

4-37. Distribution management and materiel management functions are linked. Once petroleum is distributed from one unit to another, the receiving unit then stores the petroleum, carries out quality surveillance, stock control, LOGSTAT reporting, and so on. Additionally, distribution functions rely on the conduct of transportation functions. Transportation planners allocate adequate resources, coordinate pick-up and delivery, and determine the route of delivery to the supported unit.

Stock Control and Reporting

4-38. The functions of inventory accounting (the petroleum equivalent of stock control) and reporting ensure that bulk petroleum is properly stored, organized, and accounted for, ensuring higher echelons have clear visibility of what bulk petroleum is available, which assists in the next iteration of bulk petroleum supply planning.

4-39. Management and accountability is executed through the Accountable Property System and REPOL reports by the Defense Fuel Support Points (for capitalized fuel), as well as DA Forms, LOGSTAT and REPOL reports (for non-capitalized fuel).

4-40. Responsible officers are primarily responsible for supervising and managing the receipt, storage and distribution of bulk or packaged petroleum products. The petroleum system technician (923A) serves in key staff positions at multiple echelons of Army commands that determine requirements for bulk fuel storage and distribution. The petroleum systems technician develops and monitors unit quality surveillance, bulk fuel management and accounting procedures; and environmental programs, and advises unit activity engaged in petroleum operations in accordance with Army regulations.

4-41. The petroleum supply specialist (92F) monitors bulk petroleum storage and distribution assets and capabilities. Petroleum supply specialists are licensed operators of pump and filtration systems that simultaneously deliver fuel to storage tanks, mobile tanker trucks, and semitrailers; and receive fuel into bulk storage and discharge fuel through tactical hoseline systems. Petroleum supply specialists design, operate, and retrieve hose line systems and equipment used for tactical retail mobile operations. When required, petroleum supply specialists operate material handling equipment that are associated with assembly of tactical petroleum terminal or fuel system supply points.

4-42. The petroleum inventory control specialists, referred to as accountants, maintain the unit's stock status on a 24-hour basis. Accountants maintain inventory control and location records of bulk petroleum products and processes requisitions, requests, and turn-in documents.

4-43. The JPO submits two key joint petroleum web-based contingency reports.

- The Bulk Petroleum Contingency Report, commonly referred to as JCS REPOL, provides the joint staff, joint services, and DLA Energy with summary information on bulk petroleum inventories, a damage assessment for bulk petroleum distribution systems, and other strategic information pertaining to bulk petroleum support posture at specific bases, posts, locations, or forward operating bases. During contingencies, a REPOL may be submitted as frequently as daily from all fuel points within the GCC. The JPO or SAPO consolidates the information to develop the REPOL for submission to the joint staff and supporting combatant commanders using the Joint Chiefs of Staff web-based REPOL application.
- The Bulk Petroleum Capabilities Report, commonly referred to as POLCAP, provides the joint staff, joint services, and DLA Energy with an assessment of bulk petroleum support capabilities for contingency requirements in a specific theater. (JP 4-03)

Quality Surveillance

4-44. Quality surveillance 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. Units conduct quality surveillance as part of receipt, issue, transfer, storage and maintenance operations. For more information on quality surveillance, see appendix L.

SUPPLY

4-45. In the supply function, supporting units providing all items necessary to equip, maintain, and operate a military command. It involves requesting, receiving, storing, issuing, maintaining, and establishing accountability of the petroleum required to execute a unit's assigned mission.

4-46. There are several ways to distribute bulk petroleum products into and within a theater of operation. The major methods of distribution used by the Army for planning purposes are over the shore supply, petroleum pipeline and terminal operations, fuel system supply point operations, refuel on the move and aircraft refueling.

4-47. Army units conduct three methods of petroleum supply replenishment in an OE, unit distribution, supply point distribution and throughput distribution:

- When unit distribution is used, the supported unit receives petroleum in its area. The logistics release point, established by the supported unit, may be any place on the ground where unit vehicles can receive fuel.
- Supply point distribution requires the supported unit to move to a supply point to pick up supplies. The supply point issues materiel to the supported unit that transports their supplies back to the unit with organic transportation.
- Throughput distribution bypasses one or more intermediate supply echelons in the supply system to avoid multiple handling. Throughput is not automatic. It must be specified in appropriate plans and coordinated. For more information on throughput distribution, see ATP 4-11.

Pipeline and Terminal Operations

4-48. The Army conducts petroleum pipeline operations using the IPDS. The IPDS is used to interface with an existing fuel source, such as a refinery, or with the offshore petroleum distribution system. The IPDS consists of —

- Tactical petroleum terminals (consisting of fuel units and pipeline connection assemblies).
- Pipeline pump stations.
- Pipeline support equipment.
- 5-mile pipeline sets.

4-49. Terminal operations may include tactical or fixed facilities.

4-50. Planning and execution at the theater consolidation area is managed within the theater support area by the TSC. The TSC DMC provides operational oversight for bulk petroleum through the fuel and water office's petroleum section.

4-51. The quartermaster petroleum group, normally attached to the TSC, operates within the theater area of operations for distribution of petroleum in the theater. The group, working with the theater engineer command, TSC, and theater Army, is responsible for planning and developing the IPDS. This organization plans the development, rehabilitation, and extension of host nation petroleum systems and storage facilities based on the operation plan of the theater commander.

4-52. Petroleum support battalions provide administrative, technical and operational supervision over assigned or attached petroleum pipeline and terminal operating companies, petroleum support companies and transportation medium truck companies (petroleum). Petroleum support battalions utilize their array of fuel units to establish the bulk fuel foundation for the theater of operation.

4-53. Operational bulk fuel units move the petroleum from the sea port of debarkation to the rear of the corps support area, including the following:

- Petroleum pipeline and terminal operating companies operate up to 75 miles of pipeline for distribution of 720,000 gallons per day (based on a 600 gallons per minute [GPM] pump operating for 20 hours per day) and one tactical petroleum terminal. The PPTO company's terminal operating platoon sets up and operates the tactical petroleum terminal which can receive and hold up to 3.78 million gallons of petroleum.
- The PSC can be configured with 50,000 gallon or 210,000 gallon bags. Each platoon within the company can establish and operate four refueling points using one Advanced Aviation Forward Area Refueling System (AAFARS) for transitory aircrafts.
- Assault hoseline teams are augmentation teams that establish and maintain 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 2.5 miles per hour. The team can provide a total of 10 miles of hoseline.
- The most expensive, but most flexible mode of transportation for bulk fuel is by truck. The medium truck company (petroleum) is the major transportation asset for moving bulk fuel across the battlefield. This unit may be equipped with 7,500 gallon tankers or 5,000 gallon tankers. Medium truck companies (petroleum) provide reach capabilities if pipeline is unavailable. When pipeline is available, truck companies provide extended distribution.

4-54. The tactical environment begins at the rear of the corps support area and moves forward to the forward line of own troops. An ESC operates the corps support area within the corps consolidation area. The ESC DMC's fuel and water branch plans and manages theater bulk petroleum. It also coordinates tactical petroleum operations and quality surveillance of bulk petroleum in the theater.

4-55. The DSBs and DSSBs in the division consolidation area are the main echelon of support for the divisions. The DSB and DSSB SPO supply and services branches manage fuel through LOGSTAT reporting from within their respective support areas.

4-56. The BSB SPO section manages fuel requirements for its supported BCT and any other units augmenting the BCT. The FSCs along with their supported S-4s and tactical unit executive officers and first sergeants play a key role in providing accurate LOGSTATS for bulk fuel usage.

Bulk Fuel Supply Points

4-57. Bulk petroleum is normally delivered to the class III supply point in 5,000 gallon and 7,500 gallon tank semitrailers; however 2,500 gallon 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.

4-58. Platoons from PSCs normally run bulk fuel supply points, although composite supply companies and PPTO companies may operate sites. 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.

4-59. The petroleum officer, normally a platoon leader, commands or exercises staff responsibility for units engaged in petroleum and water operations. The class III platoon leader is responsible for accountability of personnel and assigned equipment. Petroleum officers serve in staff positions requiring petroleum and water experience. The petroleum officer directs acquisition, storage, inspection, testing, issue and distribution of petroleum and water products. Petroleum officers determine bulk and packaged petroleum products and water requirements, storage space requirements, distribution system requirements, and quality surveillance requirements. The petroleum officer recommends locations for petroleum and water pipe-line and hoseline routes, terminals supply points, and depots; advises on water and bulk petroleum distribution system. The platoon leader develops and maintains a clear understanding of storage plans, policies and procedures. Platoon leaders are responsible for accountability of personnel and assigned equipment.

4-60. The bulk fuels accountable officer, normally a warrant officer, supervises the overall class III supply point operation, mobile filling station sites, bulk storage facilities and tank farms. Petroleum supply point accountable officers are responsible for the layout of the supply point as well as the operations involved in the receipt, storage, and issue of petroleum. Accountable officers develop local policy guidance; periodically review all operating procedures; and execute corrective actions. Accountable officers direct the preparation of reports and maintenance of records pertaining to petroleum accounting and distribution operations. The accountable officer ensures that petroleum operations adhere to applicable environmental policies, procedures, laws and regulations. Specific to mobile laboratory operations, the accountable officer ensures the commander is advised of quality surveillance problem areas.

4-61. The section chief is responsible for—

- Supervising and controlling class III(B) section operations and personnel.
- Day-to-day supervision and coordination to ensure mission accomplishment.
- Assigning duties and planning and managing the functioning of the fuel supply point.
- Ensuring that fuel stocks are safe from weather, animals, or any other factors that may spoil the stock.
- Ensuring supply point personnel follow the health and safety requirements and standards.
- Implementing policies, procedures, and priorities.
- Developing and implementing plans of action to alleviate problems as necessary.
- Developing and implementing training to include cross training for all personnel.
- Preparing reviews and submits required reports for the accountable officer's approval.
- Assisting the platoon sergeant as needed.

4-62. For capitalized fuel sites, the defense fuel support points execute management and accountability through the Fuels Manager Defense automated system, as well as LOGSTAT reports. Once units receive fuel, they continue to maintain running estimates to have an accurate picture of how much fuel they will require. They will forward requirements to higher headquarters and the petroleum distribution management and materiel management process begins again. In fact, the process is always going.

4-63. Detailed information on the conduct of bulk fuel supply points is contained in appendix D of this publication.

Refuel on the Move

4-64. The Army's maneuver force depends on fuel to sustain it on the battlefield. Army vehicles may need to be refueled without returning to a supply point. It may need large amounts of fuel in a timely fashion while it is moving in order to maintain OPTEMPO, freedom of movement and prolonged endurance. Refuel on the move is a technique to solve this problem.

4-65. Although ROM can be tailored to other tactical situations, its two primary purposes are to —

- Provide a timed allotment or specific quantity of fuel for operational formations or convoy movements to extend maneuverability to reach the intended destination when complete refueling operations are either not practical or unnecessary.
- Provide fuel between engagements to extend the time U.S. forces can spend on the objective.

4-66. For a detailed explanation of refuel on the move operations, see chapter 5.

Forward Arming and Refueling Point

4-67. The CAB aircraft are resupplied with class III by the ASB or CAB FSC's distribution platoon. A FARP is a temporary location, event, or mission that is organized, equipped, and deployed as far forward, or widely dispersed, as tactically feasible. The FARP provides fuel and ammunition necessary for the sustainment of aviation maneuver units during decisive operations.

4-68. FARPs are normally employed in support of aviation operations when the distance covered or endurance requirements exceed normal capabilities of the aircraft. FARPs may be employed during rapid advances when field trains are unable to keep pace. The primary fuel systems employed to support FARP operations are the HEMTT tanker and the AAFARS. The AAFARS is used for FARP locations where time or distance does not allow use of the HEMTT tanker. For more information on FARPs, refer to ATP 3-04.17.

RETROGRADE AND DISPOSAL

4-69. In normal circumstances, once petroleum has been supplied to the using unit, it is not typically retrograded. Petroleum stocks are managed down to avoid waste. Petroleum disposal falls under Environmental Protection Agency, local, or host-nation regulation and will usually require some form of permit. Disposition of off specification product should be provided by USAPC. For more detailed information on the recovery, recycling, and disposal of petroleum products, see AR 710-2.

DISTRIBUTION MANAGEMENT BY ECHELON

4-70. Reliable distribution management relies on effective communication within units and between echelons ranging from the theater-level down to the company. The following is a review of the roles and duties of bulk fuel planners and managers throughout the theater.

THEATER SUSTAINMENT COMMAND

4-71. The TSC links distribution management and materiel management executed at the combatant command J-4 and plans directorate of a joint staff (known as the J-5) strategic level of warfare with the operational level force. The TSC works in concert with DA G-4, USTRANSCOM and USAMC to ensure AOR petroleum requirements are aligned with national capabilities and resources to achieve strategic objectives. DLA Energy is focused on global distribution management, linking the economic base (people, resources, industry) to military operations. The TSC works with its strategic partners on determining realistic, supportable, resource requirements; acquiring, packaging, managing, and positioning supplies, and coordinating with the ESC for movement of materiel into, within, and out of the theater.

4-72. The TSC supports the theater Army sustainment cells with planning and coordinating theater-wide petroleum distribution. The TSC maintains a theater-wide focus participating in and coordinating with the applicable joint logistics boards, centers, and bureaus responsible for resolving issues concerning competing priorities and the allocation of constrained resources. The TSC coordinates with the JPO, SAPO, unit support operations, the TPC, associated petroleum liaison detachments, and supported J-4 or G-4s. The TSC executes

the sustainment concept of support for planning and executing sustainment-related support to the AOR for all of the Army operational contexts.

4-73. If an ESC is not deployed within the theater of operations, the TSC will expand its reach to encompass the operational level of warfare. If the ESC is deployed without a TSC, it assumes the material management duties of the TSC.

Distribution Management Center

4-74. The DMC examines current operations to ensure success in achieving the effects the combatant commander desires on the battlefield. It coordinates and synchronizes the movement of fuel within the AOR, and coordinates and synchronizes movements with unified action partners and ESCs in the AOR entering and exiting the theater. The DMC is headed by the support operations officer and is a coordinating staff section unique to TSCs and ESCs. The DMC includes the SPO officer, a deputy SPO officer, the operational contract support section, and a Sustainment Automation Support Management Office section. It also includes a DIB, materiel management branch, fuel and water branch and transportation operations branch.

4-75. The key staffs within the TSC for petroleum support include the DIB, the materiel management branch, and the transportation operations branch. Figure 2-3 on page 2-9 shows the organizational structure within the TSC.

4-76. Specific functions of the TSC DMC are listed below. The TSC—

- Establishes and maintains the sustainment common operational picture.
- Develops, coordinates and manages the theater distribution plan for bulk petroleum.
- Manages transportation operations to include (mode, terminal and movement control) and common-user land transportation support.
- Provides materiel management for bulk petroleum.
- Integrates operational contract support into sustainment operations.
- Coordinates external petroleum support requirements for supported units.
- Synchronizes petroleum support requirements to ensure they remain consistent with current and future operations.
- Plans, monitors petroleum support operations and makes adjustments to meet support requirements.
- Coordinates with other operational and sustainment petroleum staff at each echelons.
- Prepares and distributes the external petroleum support SOP that provides guidance and procedures to supported units.
- Accounts for receipt of petroleum into theater and distribution in theater through the system of record.
- The POL detachment coordinates future petroleum and water plans up to 30 days out.
- The TPC coordinates future petroleum and water plans beyond 30 days.

Fuel and Water Branch

4-77. The fuel and water branch executes materiel management of fuel and water. The fuel and water branch ensures petroleum supply is available for distribution throughout theater. It coordinates with other branches in the DMC as well as strategic partners to monitor and manage theater stocks. The fuel and water branch is responsible for the logistics COP for fuel and water.

4-78. The fuel and water branch plans and coordinates petroleum support with subordinate organizations. The attached quartermaster petroleum liaison detachment concentrates on futures planning (generally more than 30 days out at the TSC, more than two weeks out at an operational level ESC, or more than five days at an ESC supporting tactical operations). Fuel system repair parts are procured through USAMC from commercial businesses.

4-79. The Army normally manages overland petroleum support, including inland waterways, to U.S. land-based forces of all DOD components. This branch coordinates with the TPC representatives, the JPO, the SAPO, and DLA Energy to plan, coordinate and oversee all phases of bulk petroleum support for U.S. forces

and other organizations in an AOR. This branch also manages and accounts for bulk petroleum in the AOR. The staff coordinates petroleum operations and monitors quality surveillance resources and testing results in the theater.

4-80. The fuel and water branch conducts extensive supply planning. It forecasts and establishes petroleum stock levels at each support echelon to meet mission requirements. It will coordinate and respond to the geographic combatant command lead service common-use-logistics designation, TPC, and multinational force logistics directives. Branch staff will coordinate with GCC and theater Army G-4 planners to establish the theater defense fuel support points as well as projected subordinate class III storage points in accordance with the OPLAN or OPORD. The staff is responsible for preparing guidance for the class III portion of support plans, base development plans, and troop basis for future operations with emphasis on initial fueling and refueling operations. It will issue class III directives to expeditionary and sustainment brigades specifying unit support assignments.

4-81. The fuel and water branch determines fuel requirements in theater. It will forecast long-range materiel requirements, facilities, materials, and equipment needed to install and operate the petroleum distribution system. The attached POL detachment takes the time phased force deployment data established by the command, and using OPLOG Planner and historical data if applicable, determines fuel requirements in theater. Then overlaying those results with FMSWeb, which shows quartermaster capabilities, the POL detachment determines the size class III sustainment activity required to perform distribution tasks at each level of supply (theater and below). The TPC then assists in validating the requirement.

4-82. Branch staff, in coordination with the TPC, also plan for non-Army requests. For example, aviation units are by far the largest consumers of bulk petroleum, and that coalition units often will depend on U.S. forces for fuel support. Furthermore, branch staff plan for additional non-standard fuel types, such as jet propulsion fuel, type 5 (JP5), F-24, and F-76.

4-83. While conducting supply planning, fuel and water staff coordinates with—

- GCC and theater Army G-3 planners for operational timelines.
- GCC and theater Army G-4 planners for equipment density, allied and host nation support density lists, and equipment arrival and departure timelines.
- Subordinate class III planners for fuel requests and consumption rate forecasts.
- USAPC, SAPO, and JPO for throughput capability.

4-84. The fuel and water branch validates theater fuel requirements. It establishes the theater petroleum operating concept and the basic stockage concept. To assist in validating requirements, the staff coordinates with—

- GCC and theater Army G-3, assistant chief of staff, plans; TPC, and USAPC to validate the class III distribution plan and methods.
- Theater Army for inspection procedures, quality assurance and quality surveillance program details and compliance requirements related to receiving, storing, and distribution of class III.
- Subordinate class III planners to determine pipelines, hoses, bladders, barges, rail cars, tank trucks and aircraft requirements. It also directs subordinates to establish their refueling plans, and to prepare issue schedules.

4-85. Upon completion of the fuel management process, branch staff assists in procuring additional bulk fuel, including the requisition process, cross-leveling, contracting, invoking ACSAs, and local purchase where applicable. The staff coordinates with and passes requirements to the theater Army, SAPO, or JPO. The staff tracks performance measures that indicate how well the distribution network is responding to identified requirements. The staff conducts bulk petroleum manager review file oversight, and reviews business workplace messaging.

4-86. TSC petroleum planners provide direction for receiving storing and issuing fuel in accordance with theater Army priorities, but the actual handling of fuel is accomplished at the tactical level. The branch staff determine theater stockage levels, the build plan to get the theater up to that level, and the priority of support. The petroleum manager is also responsible for inspecting, enforcing and reporting status of sampling for the quality assurance and quality surveillance programs.

4-87. The fuel and water branch assists in stock control by compiling the daily stockage reports from each subordinate unit, and establishing policies and procedures for consumption accountability.

4-88. The fuel and water branch maintains visibility on the assets under its control, by accounting, maintaining stock status, maintaining in-transit visibility status reporting and inventory actions. The fuel and water branch—

- Compiles daily terminal inventory reports, maintains daily pumping schedules for the forecasted week, and compiles the monthly pipeline schedule.
- Monitors terminal and fuel points for shortages, excess and stockage.

4-89. Branch staff provide vertical and horizontal reporting of those assets by—

- Providing the complete terminal inventory reports to the JPO daily.
- Providing a weekly terminal message report to DLA Energy.
- Monitoring and compiling input station, pump station and take-off receiving station reports.
- Monitoring terminal and refuel point critical equipment readiness rates.

4-90. The fuel and water branch directs class III distribution in accordance with the petroleum distribution network layout (OPDS, pipeline, tanker-truck, air). It coordinates with DIB planners for transportation requirements in accordance with the distribution plan, and assists in expediting critical and special fuel requests. The fuel and water branch monitors terminal and fuel points for shortages, excess and stockage, issues cross leveling notices, and redirects flow and transportation of inbound fuel as needed.

4-91. The branch staff coordinates with USAPC to establish in theater reclamation and defueling procedures, and to establish in-theater Army owned class III product disposition instructions.

Distribution Integration Branch

4-92. The DIB queues bulk fuel to be moved in accordance with the materiel management priority and ensures transportation modes with adequate haul capacity are allocated to distribute the materiel. The branch provides theater on-hand visibility and recommends priority of issue.

4-93. The DIB coordinates and synchronizes the movement of fuel into and out of the AOR. The DIB develops the distribution plan in collaboration with the G-3. It synchronizes and integrates materiel and transportation requirements into distribution actions supporting operational-level sustainment support throughout the AOR. The DIB relies on coordination and information exchange between the materiel management, fuel and water, and transportation operations branches. The DIB normally includes a petroleum NCO, a senior NCO transportation supervisor and a senior materiel management NCO to assist with bulk fuel scheduling and synchronization.

4-94. The DIB plans and synchronizes distribution operations in the theater distribution network to include visibility and capacity management. The primary functions of the distribution plans and integration branch include —

- Create the theater distribution plan including the petroleum distribution network.
- Compare theater distribution operations with the theater Army's concept of operations to ensure they are synchronized and executed according to the theater Army commander's priorities.
- Monitor and assess petroleum operations for impact on future operations.
- Compare supported unit fuel requirements and consumption rates with bulk fuel distribution capabilities.
- Coordinate with the transportation section to ensure motor and rail.
- Track bulk fuel deliveries to their final destination.

Transportation Branch

4-95. The transportation operation branch executes the controlling function for the physical movement of bulk petroleum. The TSC DMC manages all facets of transportation; enforces priorities for transportation; established by the theater Army and the supported combatant commander; considers all modes of transport

to include inland surface transportation (pipeline, rail, road, inland waterway); sea transport (coastal and ocean), and air transportation; and maintain visibility of distribution assets

4-96. The transportation operations branch supports the DMC's planning efforts for OPLANs, CONPLANs, and major operations by providing estimates, requirements, assessments and any additional information the DIB may require to support multiple planning efforts. They develop theater highway regulation, traffic circulation, and maneuver and mobility support plans. The branch manages all facets of transportation information related to coordinating, and evaluating all methods of transportation movement control and logistic support. Additional examples of transportation operations branch responsibilities are —

- Create the movement program for inclusion to the theater distribution plan.
- Track the implementation of the movement program executed by the movement control battalion to ensure compliance.
- Manage transportation operations to include (mode, terminal and movement control) and common-user land transportation support.
- Monitor and assess transportation operations for impact on future operations.

4-97. The transportation operations branch provides staff supervision of all allocated transportation assets and coordinates directly with the movement control battalion. In the absence of the TSC, they coordinate with joint and strategic partners to synchronize deployment and distribution efforts; and optimize distribution within the JOA by employing all transportation modes available.

Command Post Operations

4-98. Command post operations provide the commanders a means to execute continuous close coordination, synchronization, and information sharing across staff sections. Command post operations performed by the TSC include the development and use of a joint fuel coordination board, various movement boards, a logistics synchronization matrix, and a common operational picture for logistics.

Joint Fuel Coordination Board

4-99. The TSC will participate in or may lead a joint fuel coordination board. The joint fuel coordination board is the key fuel coordination point for the theater. The joint fuel coordination board is a recurring meeting of other Services, coalition partners if applicable, and stakeholder personnel to synchronize bulk fuel logistics across the participating Services. It identifies current and predicted critical class III shortfalls, sets petroleum support priorities, provides petroleum support guidance, and highlights bulk fuel issues requiring coordination with joint staff, other GCCs or partner nations.

4-100. When TSC leads the board, it is hosted by the SPO and organized by the petroleum liaison detachment. At the TSC level, the TPC or attached petroleum detachment hosts the TSC Joint Fuel Coordination Board. Members of the board often include representatives of—

- DMC fuel and water branch.
- Distribution integration branch.
- DMC transportation operations branch.
- ESC liaison.
- Theater Army G-4 liaison.
- Petroleum group liaison.
- Theater-level petroleum liaison detachments.
- Joint Partners in the operational area (USAF, USMC, USN).
- Special operations liaison.
- Coalition forces liaisons.
- DLA.
- JPO.
- United States Army Petroleum Center.

Movement Boards

4-101. Movement boards manage transportation policies, priorities, status of LOC, convoy protection, synchronization, and transportation assets allocation to support theater distribution operations. In the event that an ESC is not in theater, the TSC will establish movement boards.

Logistics Synchronization Matrix

4-102. The TSC logistics synchronization matrix tells supported units what they will receive, when they will receive it, and the method of delivery. It also enables the TSC commander, the support operations officer, and the staff to identify and deconflict potential problems. The synchronization matrix changes as requirements and operations change, and is shared every time it is updated.

Common Operational Picture

4-103. Logisticians develop a logistics common operational picture (COP). The common operational picture is a display of relevant information within a commander's area of interest tailored to the user's requirements and based on common data and information shared by more than one command (ADP 6-0). Ideally, the common operational picture is automated, requiring minimal manipulation by command posts. The fuel and water branch of each organizational level is responsible for developing and maintaining the fuel and water elements of the logistics COP. The TSC DMC fuel and water branch is responsible for the logistics COP for fuel and water in the TSC.

EXPEDITIONARY SUSTAINMENT COMMAND

4-104. The ESC is the primary sustainment headquarters focused on executing materiel management at the operational level of warfare within a theater or area of operations. If an ESC is not deployed within the theater of operations, the TSC will expand its focus to encompass the operational level of warfare. If the ESC is deployed without a TSC, it assumes the materiel management duties of the TSC. Materiel management at the operational level involves resupply, storage, protection, maintenance, stock control, retrograde, and disposal of supplies. Petroleum planners seek to understand the joint force commander's requirements and priorities for supporting combat operations. Materiel managers at the operational level play an integral role in linking strategic resources to tactical requirements.

4-105. The ESC coordinates with the TSC, joint task force J-4, or theater Army G-4 to establish petroleum storage and distribution points specified in the OPLAN and operations order. The ESC provides input to the TSC or theater Army commander on bulk fuel operations, capabilities, and options to mitigate shortfalls. The ESC priorities are informed by those of the theater Army G-4 and TSC, and passed on to subordinate units. The ESC issues directives to subordinate sustainment brigades and specifies unit support relationships.

Distribution Management Center

4-106. The ESC DMC coordinates all facets of transportation including the effective use of air, land, and sea transportation assets. It also enforces priorities for air, land, and water transportation, both sea and inland waterways, established by the supported commander. The ESC transportation operations may be categorized into three operations: inter-theater operations, intra-theater operations, and container operations.

4-107. The ESC support operations officer directs the DMC and advises the commander on support requirements versus support assets available. The DMC manages petroleum distribution through the fuel and water branch, the DIB, and the transportation branch.

Fuel and Water Branch

4-108. The fuel and water branch is responsible for executing materiel management of petroleum in its supported AO. It calculates projected consumption rates, receives actual consumption rates from subordinate units in the supported AO, and compares the projections and actual rates to determine requirements. These requirements are validated with those generated from the TSC. The DMC also maintains visibility across the distribution network within the ESC's supported AO. When discrepancies or shortfalls are identified, the fuel and water branch staff relays them to the TSC where decisions are made on further petroleum support.

4-109. The ESC fuel and water branch conducts extensive fuel supply planning and coordination with subordinate organizations. Section staff coordinate with TSC and JTF J-4 planners to establish the JOA Defense Fuel Support Points as well as projected subordinate class III storage points in concert with the OPLAN or OPORD. They prepare guidance for the class III portion of support plans, base development plans and troop basis for future operations with emphasis on initial fueling and refueling operations. The staff issues class III directives to sustainment brigades specifying unit support assignments and establishes the contingency stock levels.

4-110. The ESC fuel and water branch assists with requirements determination. It forecasts long-range petroleum requirements, facilities, materials, and equipment needed to install and operate the petroleum distribution system. The section staff coordinates with—

- TSC and JTF J-3 planners for operational timelines.
- TSC and JTF J-4 planners for equipment density, allied and host nation support density lists, and equipment arrival and departure timelines.
- TSC for fuel that is under operational control of the Army but owned by DLA Energy for accounting and quality surveillance procedures.
- Subordinate class III planners for fuel requests and consumption rate forecasts.

4-111. The fuel and water branch determines—

- The petroleum distribution network layout in accordance with undeveloped and developed JOA capabilities.
- The size of class III sustainment activity required to perform distribution tasks at each level of supply (JOA and below).
- Host nation and non-Army equipment requirements, and plans for additional non-standard fuel types, such as JP5, F-24, and F-76.

4-112. The ESC's fuel and water branch validates theater fuel requirements. It establishes the JOA petroleum operating concept and the basic stockage concept. It directs subordinates to establish their refueling plans in accordance with their support designation (direct, general, or area), and to prepare issue schedules.

4-113. To assist in validating requirements, the staff coordinates with—

- TSC and JTF J-3 and plans directorate of a joint staff to validate the class III distribution plan and its methods.
- TSC and JTF J-4 for inspection procedures, quality assurance and quality surveillance program details and compliance requirements related to receiving, storing and distributing class III.
- Subordinate class III planners to determine pipelines, hoses, bladders, barges, rail cars, tank truck, and aircraft requirements.

4-114. Upon completion of the fuel management process, section staff assists in procuring more bulk fuel, by coordinating with and passing requirements to the TSC. It provides operational oversight for bulk petroleum operations in its supported AO. It tracks performance measures that indicate how well the distribution network is responding to identified requirements. It conducts bulk petroleum manager review file oversight, and review business workplace messaging in its AO.

4-115. ESC petroleum planners provide direction for receiving, storing and issuing of JOA fuel stocks in accordance with JTF support priorities. It coordinates with TSC for procedures in the event that fuel is received in a non-standard manner. Petroleum planners establish business rules for reporting and forecasting subordinate consumption rates, and recommends policies, priorities, allocations and criteria for priority requests. They are also responsible for inspecting, enforcing and reporting status of sampling for the quality assurance and quality surveillance programs, and ensures that fuel points operate in accordance with safety and environmental procedures.

4-116. The fuel and water compiles the daily stockage reports from each subordinate unit, monitoring the fuel point and storage excess posture, and ensuring compliance with directives related to sampling, quality assurance, safety, environmental and distribution operations. It establishes policies and procedures for consumption accountability. The fuel and water branch maintains visibility on the assets under its control, by accounting, maintaining stock status, maintaining ITV, status reporting and inventory actions.

- 4-117. The fuel and water branch provides vertical and horizontal reporting of those assets by —.
- Maintaining the ESC's logistics COP for fuel and water.
 - Providing the complete terminal inventory reports to the JPO daily.
 - Providing a weekly terminal message report to DLA Energy.
 - Monitoring and compiling input station, pump station and take-off receiving station reports.
 - Monitoring terminal and refuel point critical equipment readiness rates.
- 4-118. It coordinates with DIB planners for transportation requirements in accordance with the distribution plan, and assists in expediting critical and special fuel requests. The fuel and water branch staff monitors terminal and fuel points for shortages, excess and stockage, issues cross-leveling notices, and redirects the flow and transportation of inbound fuel as needed. It submits theater movement requests to the DIB for movement of fuel to fill immediate shortages from existing fuel points within the JOA.
- 4-119. The ESC DMC directs class III issue to all identified JOA class III points. It coordinates with the TSC for sampling, laboratory testing, quality assurance and surveillance programs.
- 4-120. The branch section coordinates with the TSC to establish JOA-wide —
- Reclamation and defueling procedures and Army owned class III product disposition instructions.
 - Army-owned class III product disposition instructions.
 - DLA Energy-owned class III product disposition instructions.

Distribution Integration Branch

- 4-121. The DIB coordinates and synchronizes the movement of fuel in supporting an AO or JOA. The DIB develops the distribution plan in collaboration with the G-3. The branch integrates materiel and transportation requirements into distribution actions supporting operational-level sustainment support throughout the AO or JOA. The DIB relies on coordination and information exchange between the fuel and water branch and transportation operations branch to synchronize and integrate the allocation of resources for movement of petroleum.
- 4-122. DIB staff members require a complete understanding of the distribution network to optimize capabilities and task subordinate organizations in support of on-going and future operations. The DIB plans and synchronizes distribution operations in the theater distribution network to include visibility and capacity management. The primary functions of the distribution plans and integration branch are listed below.
- Compare distribution operations with the supported commander's concept of operations to ensure they are synchronized and executed according to the supported commander's priorities.
 - Manage petroleum flow within the AO or JOA; coordinate with forward storage areas, BSBs, and sustainment brigades regarding class III resupply.
 - Maintain a common operational picture for bulk fuel.
 - Queue the bulk fuel to be moved in accordance of priority.
 - Coordinate with the transportation section to ensure motor and rail assets are available to support class III movement requirements. Distribution managers provide the transportation component with commodity, quantity, priority, and recommended mode.
 - Compare supported unit requirements with distribution capabilities and track petroleum to its final destination.
 - Monitor and assess petroleum operations for impact on future operations.

Transportation Branch

- 4-123. The transportation branch's role in petroleum distribution includes maintaining visibility of distribution assets within the distribution network. The branch directs cross-leveling of distribution assets and executes the controlling function for physical movement. In the absence of the TSC, they coordinate with joint and strategic partners. The branch coordinates with contracted transportation providers, mode operators, and supported unit. They also coordinate common-user land transport assets, both U.S. and host nation, and liaise with host nations for contracted assets.

4-124. The transportation branch coordinates directly with the movement control battalion. The transportation operations branch directs the distribution of transportation resources to meet the fuel and water requirements and optimize distribution flow through its movement plan. The transportation operations branch coordinates with contracted transportation providers, mode operators, and supported units.

Command Post Operations

4-125. Command post operations provide the commanders a means to execute continuous close coordination, synchronization, and information sharing across staff sections. Similar to the TSC, ESC command post operations include the development and use of a joint fuel coordination board, various movement boards, a logistics synchronization matrix, and a common operational picture for logistics. These boards are where most of the transportation coordination takes place, linking loads to modes.

Joint Fuel Coordination Board

4-126. The ESC participates in a joint fuel coordination board hosted by the TSC or TPC. The joint fuel coordination board is a recurring meeting of representatives of all Services, coalition partners if applicable, and stakeholder fuel personnel to synchronize bulk fuel logistics across the participating services. It identifies current and predicted critical class III shortfalls, sets petroleum support priorities, provides petroleum support guidance, and highlights bulk fuel issues requiring coordination with joint staff, other GCCs or partner nations.

4-127. When the ESC leads the board, it is hosted by the petroleum detachment. Attendees typically include representatives of the fuel and water branch, transportation operations branch, DIB, liaisons from one level up, the TSC, and one level below, normally whatever sustainment brigades are within the ESC's supported AO; representatives from other Services, special operations, coalition partners, DLA Energy, JPO, and USAPC.

Movement Boards

4-128. Movement boards manage transportation policies, priorities, status of LOC, convoy protection, synchronization, and transportation assets allocation to support theater distribution operations.

4-129. The movement synchronization board synchronizes the execution of movement priorities across the AO. The transportation mobility officer in charge leads the board. Attendees may include the sustainment brigades, AFSB, CSSB, movement control teams and the transportation battalion SPO. The board is held as determined by the ESC commander's battle rhythm.

4-130. The movement allocation board uses the outputs from the movement synchronization board to finalize movement allocation (mode, load, route and security) 96 hours before execution with sustainment brigades and subordinates. Attendees may also include representatives from the sustainment brigade SPO section, movement control battalion, CSSBs and movement control teams. The movement control battalion leads the board.

Logistics Synchronization Matrix

4-131. The ESC logistics synchronization matrix tells supported units what they will receive, when they will receive it, and the method of delivery. It also enables the ESC commander, the support operations officer, and the staff to identify and de-conflict potential problems. The synchronization matrix changes as requirements and operations change and is shared every time it is updated.

Common Operational Picture

4-132. ESC logisticians develop a common operational picture as required. The ESC COP is normally developed and maintained by the current operations cell. The ESC COP will likely be similar to the TSC COP with additional information the ESC commander requires. The DMC provides updated information to current operations for their use in updating the COP.

QUARTERMASTER PETROLEUM GROUP

4-133. The quartermaster petroleum group is normally assigned to a TSC. On order, this unit provides command and control, planning, liaison, and supervision of the supply, distribution, quality surveillance, and storage of bulk petroleum for a theater of operations. The quartermaster petroleum group contains the PSBs that are going to execute the transfer of bulk petroleum from the theater area to the corps support area.

Current Operations S-3 Section

4-134. The petroleum group receives orders from its TSC or ESC and prepares the group commander's OPORD for its subordinate units. The S2/S3 officer exercises staff supervision over all intelligence, security and defense activities. The petroleum operations sergeant assists the S2/S3 with planning to ensure security of the pipeline distribution system. An attached petroleum liaison detachment helps plan future operations.

S-4 Section

4-135. The S-4 section plans, coordinates and supervises organizational supply, maintenance, and food service activities for subordinate units. The S-4 officer is responsible for the execution of the command operating budget.

Support Operations Section

4-136. The SPO maintains the logistics COP for fuel and water for their area of responsibility. The SPO section coordinates, manages, and synchronizes all bulk petroleum and water in the theater or corps. The SPO section provides the group commander with information on current petroleum and water operations. The section is responsible for:

- Development of the concept of the operations for OPORDs and OPLANs.
- Coordination with host-nation support organizations in bulk petroleum and water support elements.

4-137. The SPO plans, requirements, and distribution section is responsible for materiel management and distribution management. The section consists of a plans officer, a petroleum distribution sergeant, a petroleum distribution supervisor and two inventory control specialists. The plans officer is responsible for formulating plans for receipt, storage, and distribution of bulk petroleum products, and coordinating these plans with the command and the area petroleum office.

4-138. The section determines subordinate resupply requirements, and coordinates and directs bulk delivery. This section maintains estimates, records, writes OPORDs, collects inventory and pumping reports, and monitors operations of the pipeline and terminal system.

4-139. The SPO plans, requirements and distribution staff and facilities branch work together on operations of the pipeline and terminal system. Dispatchers from the PSB send daily pumping reports. Reports and logistical plans provided by higher headquarters determine petroleum requirements and distribution. The branch reviews inventory results and forwards them to the fuel and water branch of the TSC.

4-140. The SPO facilities branch consists of a field grade facilities and contract construction management engineer (pipeline) officer, a senior NCO senior construction supervisor, an enlisted plumber and pipefitter, and an enlisted technical engineer specialist. The facilities branch develops and prepares plans for the IPDS, the tactical water distribution system, and selected operational petroleum and water projects. It is responsible for pipeline design, construction, maintenance, expansion and inspection. It coordinates with the engineering command.

4-141. The liaison section, led by a senior NCO petroleum supply sergeant, provides direct coordination channels between supported units (Army, Air Force, Marine Corps and Navy forces ashore), host-nation activities and the petroleum plans, requirements, and distribution branch of the petroleum group. It tracks key construction and rehab projects.

4-142. The quality surveillance and safety branch establishes and supervises petroleum quality surveillance and safety.

4-143. The transportation branch provides transportation management. It directs, coordinates and supervises the movement (other than by pipeline) of bulk petroleum and water. A company grade freight movements officer supervises the branch operations.

SUSTAINMENT BRIGADE

4-144. The sustainment brigade executes distribution management and materiel management as directed by the sustainment command and as part of the theater wide distribution process. The focus of the sustainment brigade is to provide oversight executing current sustainment objectives through units at the tactical level. The sustainment brigade supporting the ESC likely has at least one PSB to execute the transfer of bulk petroleum from the port of entry to the corps support area.

4-145. The sustainment brigade conducting theater distribution tasks is organized with CSSBs that are further task organized with functional petroleum support and transportation units. These units are organized to operate multimodal distribution hubs and maintain visibility of the bulk fuel distribution system. The sustainment brigade may participate in the ESC-led movement board to manage transportation policies, priorities, LOC status, convoy protection, and synchronization and transportation assets allocation to support theater distribution operations. The sustainment brigade and its subordinate units are going to receive fuel in the corps support area and either distribute it in the corps support area or transport it forward into the division support area.

Brigade S-3

4-146. The sustainment brigade S-3 synchronizes and integrates sustainment operations with all warfighting functions across the current operations and future operations planning horizons. The S-3 integrates current and future operations with the plans integrating cells in accordance with the commander's intent and planning guidance.

4-147. The sustainment brigade S-3 coordinates with supported units to synchronize future operations and the transition from future operations to the current operation without loss of momentum or unit integrity. It plans for and synchronizes staff mission planning, course of action development, rehearsals, operational planning, and after action reviews.

Brigade S-4

4-148. The sustainment brigade S-4 is the principal staff officer for internal sustainment and readiness. Primary tasks include sustainment operations and plans, supply, maintenance, transportation, and field services. The S-4 also provides staff oversight of food services, and oversees the deployment and redeployment of brigade and subordinate units. The S-4 also compares LOGSTAT reports received from the division S-4 with the LOGSTAT reports from the subordinate units.

Support Operations Section

4-149. The SPO section plans and coordinates support operations by balancing external sustainment requirements with unit capabilities. The SPO section conducts distribution operations, maintenance management, and management of general supplies, including water. The SPO organization includes a supply and services branch, which is concerned with the resupply and storage of bulk petroleum water, and the DIB that matches transportation assets with bulk fuel resources to maintain supply levels at supported locations.

4-150. The materiel management branch determines requirements and recommends priorities for the allocation and distribution of supplies. It monitors resupply of commodities and makes recommendations for distribution and redistribution within the brigade's assigned support area.

4-151. The materiel management branch's fuel and water branch controls and manages the issue of water to supported organizations. It directs the receipt, storing, inspection, testing, quality, supply, and accountability of the bulk fuel and water stocks for the operational area. The fuel and water branch is responsible for executing materiel management of bulk fuel; it contains one warrant officer and three NCOs dedicated to managing fuel supply.

4-152. The DIB plans, coordinates, and synchronizes distribution operations. The DIB consolidates distribution requirements from all sections of the SPO section, deconflicts competing requirements, prioritizes support and movement, and creates the distribution plan. The distribution plan describes how sustainment flows from the sustainment brigade to supported units. This branch plans and maintains visibility of the execution of distribution plan in accordance with the concept of support. It synchronizes operations within the distribution system to maximize throughput from the production sites to the supported units.

4-153. The DIB coordinates with the subordinate CSSB staff to determine transportation feasibility. If the CSSB cannot accomplish the required bulk fuel distribution using organic assets, the sustainment brigade allocates or requests the necessary resources.

4-154. The sustainment brigade may participate in ESC led movement boards. These boards manage transportation policies, priorities, status of LOC, convoy protection, synchronization and transportation assets allocation in support of theater distribution operations.

4-155. The SPO maintains the logistics COP for fuel and water for their area of responsibility. The SPO section compiles the LOGSTAT reports from the attached CSSBs into a zero balance report. The zero balance report summarizes all on-hand, due-in, and due-out bulk fuel, water stockage and deliveries. With this information, the SPO officer can assess and ensure appropriate levels of effectiveness, identify and mitigate shortfalls, and plan for near-future operations. If the sustainment brigade cannot meet the gaps, this is reported to the appropriate higher headquarters.

PETROLEUM SUPPORT BATTALION

4-156. The PSB receives its orders from the sustainment brigade, or on occasion, from the quartermaster petroleum group. The PSB supports theater bulk petroleum storage (meeting days of supply requirements) and distribution in accordance with the bulk petroleum distribution plan developed by the quartermaster petroleum group. The PSB receives bulk petroleum via pipeline, rail, or transport vehicle from terminals operated by a petroleum pipeline and terminal operating company. The battalion contains the units that actually execute the distribution of petroleum from the port of entry forward to the corps support area. If the situation dictates, battalion units can go forward of the corps support area, but under normal conditions, the battalion is going to transfer the fuel to the sustainment brigade petroleum units.

4-157. The battalion's petroleum operations branch is responsible for distribution, materiel and transportation management. It operates a central dispatching agency to schedule and direct the flow of bulk petroleum through multi-product pipelines and coordinates the movement of bulk petroleum products by barge, rail, and truck.

4-158. The battalion may store a portion of theater petroleum reserve stocks. The battalion supervises the quality surveillance of the petroleum products in their area of responsibility.

4-159. The battalion distributes to echelons above brigade POL units and may go as far forward as brigade support areas when required. The battalion supervises the operation and maintenance of the military petroleum distribution system or part of a system determined by geographic needs.

4-160. The battalion issues operations orders and provides command and control for its assigned PPTOs, PSCs and transportation medium truck companies (petroleum). Petroleum support battalions utilize their array of fuel units to establish the bulk fuel foundation for the theater of operation.

COMBAT SUSTAINMENT SUPPORT BATTALION

4-161. The CSSB is task organized with functional companies and other subordinate units to conduct tactical level supply. The CSSB and organic subordinate units conduct distribution management and materiel management functions to execute the distribution plan that is provided by the sustainment brigade. The staff sections at the CSSB and below are smaller than those in higher echelons and focus on the execution of the distribution integration process. They depend on those higher echelons for the extensive, long-term planning.

4-162. The CSSB, when task organized to conduct theater distribution, depends on the sustainment brigade to conduct distribution planning and integration. CSSB transportation assets are used to execute distribution and conduct resupply and replenishment missions.

4-163. Unit distribution is the routine method the CSSB uses to support the BCT. The CSSB transports supplies to the BSB's distribution company.

4-164. The CSSB may conduct throughput distribution when tasked with the theater distribution mission. An example of throughput distribution is the CSSB distributing supplies directly to an FSC, bypassing the BSB's distribution company.

Battalion Coordinating Staff

4-165. The S-3 receives input from the battalion SPO and synchronizes and prioritizes the battalion's lines of effort. The S-3 and the SPO section create the battalion's concept of operations, which expands on the commander's intent. The concept of operations clearly describes how subordinate units cooperate and establishes a specific sequence of actions to achieve the desired end state.

4-166. The S-4 coordinates the strategic and operational deployment. The S-4 is focused on internal requirements, supply functions, and generating the internal LOGSTAT report.

Support Operations Staff

4-167. The SPO section is responsible for synchronizing logistics operations to maximize efficiencies and ensure priorities are executed in accordance with published orders. When tasked with area support, the SPO section develops the concept of operations for their designated portion of the support area.

4-168. The SPO supply and field services staff is responsible for distribution and materiel management. The transportation function, consisting of a transportation officer, movements supervisor and movements NCO, is responsible for transportation management.

4-169. The SPO supply and field services staff forecasts and establishes supply stock levels to meet mission requirements. It coordinates with sustainment brigade planners to—

- Set the contingency stockage levels.
- Set disposition directives for residual disposal.
- Establish the AO fuel points in compliance with the OPLAN or OPORD.
- Determine area or unit support assignment and customer base.

4-170. The CSSB SPO assists in requirements determination. The SPO forecasts long-range materiel requirements, facilities, materials, and equipment needed to operate assigned FSSPs and plans for additional non-standard fuel types (such as JP5, F-24, or F-76).

4-171. The SPO coordinates with sustainment brigade planners for—

- Operational timelines.
- Equipment density, allied and host nation support density lists, and equipment arrival and departure timelines.
- Accounting and quality surveillance procedures, and safety and environmental mitigation requirements.
- Determining methods of class III delivery and the size of class III sustainment activity required to perform distribution tasks.

4-172. The SPO coordinates with sustainment brigade fuel planners and customer class III fuel planners for fuel requests, area support and consumption rate forecasts. It coordinates with the sustainment brigade SPO for throughput capability.

4-173. The SPO validates the requirement for retail fuel support, including—

- Space availability for distribution and storage methods.
- External support commodities needed to support the distribution system (for example, security, engineer support).
- Refuel plans in accordance with its support designation (direct, general, area).

4-174. To assist in validating requirements, the SPO section coordinates with the sustainment brigade for inspection procedures, quality assurance and quality surveillance program details, and compliance requirements related to receiving, storing, and distribution of class III. It then prepares issue schedules.

4-175. To assist in the resupply of bulk fuel, the SPO coordinates with and passes requirements to the sustainment brigade, provides operational oversight for bulk petroleum, and performs fuel recovery, defueling and inspection of retrograded class III.

4-176. The CSSB's attached PSC or composite supply company plays a major role in the handling and storage of bulk petroleum. Its tasks include—

- Establish the class III storage and retail fueling point as directed by the sustainment brigade. This will be done by the attached PSC.
- Receive, store and issue petroleum in accordance with sustainment brigade directives and support priorities.
- Coordinate with the sustainment brigade for procedures in the event that fuel is received in a non-standard manner.
- Provide operations supervision over retail fuel and refueling activities.
- Provide, maintain, and operate all fuel equipment at the retail point.
- Ensure that retail fuel points receive and issue the appropriate product in accordance with safety and environmental procedures.
- Report customer consumption rates.
- Inspect, enforce, and report status of sampling, quality assurance and surveillance programs.
- Provide BCT storage augmentation using 5,000-gallon tankers, HEMTT tankers with modular fuel system, and PLS trailers.

4-177. The CSSB SPO supply and field services staff, working with its petroleum support company and composite supply company, maintains stock control over its supply of bulk petroleum. It will—

- Establish class III FSSPs in accordance with the sustainment brigade fuel distribution plan.
- Compile the daily stockage reports from each customer.
- Report storage excess posture and consumption accountability.
- Follow and operate the sampling, quality assurance, safety, environmental and distribution operations.

4-178. The attached PSC will issue class III in accordance with the issue plan and customer requests.

4-179. The CSSB also plays a major role in bulk fuel distribution through its petroleum support company. It is responsible for delivering and issuing class III in accordance with sustainment brigade directives, which it does through its PSC, or for smaller deliveries, through its composite supply company. The attached PSC will issue class III in accordance with the issue plan and customer requests. It may distribute fuel through a supply point, transfer it to a BSB or conduct throughput distribution straight to an FSC. It determines logistics release points, expedites critical and special fuel requests, and monitors FSSP overdue deliveries to ensure they are being resolved promptly and effectively. It may conduct redistribution by providing transportation assets for movement of class III between customers as directed by the sustainment brigade. The SPO monitors and reports any critical or immediate fuel shortages or overages.

4-180. The SPO reports on its bulk fuel assets. The SPO supply and services staff will—

- Prepare daily inventory reports and forward them to the sustainment brigade.
- Compile and forward class III stockage reports to the sustainment brigade.
- Compile and report customer requests, on-hand inventories, and retail usage statistics to the sustainment brigade.
- Maintain FSSP critical equipment readiness rates.

4-181. The CSSB SPO supply and field services staff redistributes bulk petroleum, reallocating excess materiel or sending to other locations in theater to fill shortages using all transportation assets available. It monitors and reports any critical or immediate fuel shortages or overages. It provides transportation assets for movement of class III between customers as directed by the sustainment brigade.

4-182. The CSSB SPO supply and field services conduct retrograde support by performing reclamation and defueling operations, and dispose of Army-owned class III in accordance with theater disposition instructions. It will coordinate with the sustainment brigade OCS staff section for contracted support of waste removal and fuel disposition, if available.

Petroleum Units

4-183. The petroleum support company receives, stores, and distributes bulk petroleum. The company supports all units in its assigned support area. It is capable of both unit and supply point distribution. The company is modular and may be composed of a varying number of petroleum support platoons, an attached petroleum quality analysis team and an attached assault hoseline team. The basic building block is the petroleum support platoon. Each petroleum support platoon has non-mobile fuel storage and issue, and a small mobile distribution capability. The mix and quantity of platoons depends on supported units.

4-184. Petroleum quality analysis teams primarily support aviation support battalions but a variant of this team may be assigned or attached to the PSC. The team operates a petroleum laboratory and performs complete specification and quality surveillance of petroleum products received from supported units' requirements.

4-185. The assault hoseline augmentation team operates and maintains the assault hoseline system to establish and maintain linkage between petroleum tank farms and high volume users. This unit is most likely to be used near air or sea hubs or distribution nodes with very high traffic volume.

TACTICAL DISTRIBUTION MANAGEMENT

4-186. The sustainment brigade, the CSSB, DSSB, and BSB are the primary sustainment headquarters focused on executing materiel management at the tactical level of warfare within an area of operations. Petroleum managers at this level provide class III support to combat forces conducting battles and engagements. Based on the supported commander's priorities and anticipated requirements, petroleum materiel managers ensure responsive class III replenishment to combat forces. Tactical units submit LOGSTAT reports to inform the higher levels of sustainment regarding consumption rates and forecasted requirements for petroleum.

DIVISION SUSTAINMENT BRIGADE

4-187. The DSB operates similarly to any other sustainment brigade. The DSB and its subordinate units assigned to a division provide direct support to all assigned and attached units in an operation area as directed by the division commander. The sustainment brigade provides general support logistics, including class III support, to non-divisional forces operating in the division AO.

Brigade S-3

4-188. The DSB S-3 synchronizes and integrates DSB sustainment operations with all warfighting functions across the current operations and future operations planning horizons. The S-3 integrates current and future operations with the plans integrating cells in accordance with the commander's intent and planning guidance. The sustainment brigade S-3 coordinates with supported units to synchronize future operations and the transition from future operations to the current operation without loss of momentum or unit integrity. Plans for and synchronizes staff mission planning, course of action development, rehearsals, operational planning, and after action reviews.

Brigade S-4

4-189. The DSB S-4 is the principal staff officer for internal sustainment and readiness. The S-4's primary tasks include sustainment operations and plans, supply, maintenance, transportation, and field services. The S-4 also provides staff oversight of food services, and oversees the deployment and redeployment of brigade and subordinate units. The S-4 also compares LOGSTAT reports received from the division G-4 with the LOGSTAT reports from the subordinate units.

Support Operations Staff

4-190. The SPO section is responsible for external sustainment and readiness. The SPO section plans and coordinates support operations by balancing external sustainment requirements with unit capabilities. The staff conducts distribution operations, maintenance management, and management of general supplies including petroleum. The SPO includes a supply and services branch that is concerned with the resupply and storage of petroleum and the DIB, which matches transportation assets to move petroleum to supported units.

4-191. The supply and services branch conducts materiel management and plans and coordinates field service support. This branch determines requirements and recommends priorities for the allocation and distribution of supplies. It monitors resupply of commodities and makes recommendations for redistribution within the brigade's assigned support area. It maintains visibility of on-hand stock and in-transit supply stocks using automated logistics systems.

4-192. The supply and services branch's fuel and water branch controls and manages the bulk fuel supply to supported organizations. It directs the receipt, storage, inspection, testing, quality, supply, and accountability of the bulk fuel for the operational area. The SPO maintains the logistics COP for fuel and water for their area of responsibility.

4-193. The DIB plans, coordinates, and synchronizes distribution operations. The DIB consolidates distribution requirements from all sections of the SPO section and creates the distribution plan. The distribution plan describes how sustainment flows from the sustainment brigade to supported units. This branch plans and maintains visibility of the execution of distribution plan in accordance with the concept of support. It synchronizes operations within the distribution system to maximize throughput from the production sites to the supported units.

4-194. The SPO's transportation operations section develops the movement plan to support the distribution plan by balancing transportation capabilities with petroleum transportation requirements in coordination with the movement control team. The DIB assists by coordinating with the subordinate DSSB staff to determine transportation feasibility. If the DSSB cannot accomplish its petroleum distribution mission using organic assets, the transportation operations section works with its higher headquarters at ESC or corps to identify and allocate the necessary transportation resources.

4-195. The SPO section compiles the LOGSTAT reports from the attached CSSBs into a zero balance report. The zero balance report summarizes all on-hand, due-in, and due-out materiel stocks and deliveries. With this information, the SPO can assess and ensure appropriate levels of effectiveness, identify and mitigate shortfalls, and plan for near-future operations. If the gaps cannot be met by the sustainment brigade it is reported to the appropriate higher headquarters.

4-196. The DSB may participate in ESC-led movement boards. These boards manage transportation policies, priorities, status of LOC, convoy protection, synchronization and transportation assets allocation in support of theater distribution operations.

DIVISION SUSTAINMENT SUPPORT BATTALION

4-197. The DSSB is organic to a DSB. The DSSB and organic subordinate units conduct distribution management and materiel management functions to execute the distribution plan provided by the DSB. The staff sections at the DSSB and below are smaller than those in higher echelons and focus on the execution of the distribution integration process. They depend on those higher echelons for the extensive, long-term planning.

4-198. Unit distribution is the routine method the DSSB uses to support the BCT; the DSSB transports supplies to the receiving unit's area for distribution. The DSSB delivers supplies to the BSB's distribution company.

4-199. The DSSB may conduct throughput distribution. For example, a DSSB may deliver fuel directly to an FSC, bypassing the BSB's distribution company.

Battalion Coordinating Staff

4-200. The DSSB S-3 is responsible for the overall conduct of the deployment process. The S-3 receives input from the battalion SPO section and synchronizes and prioritizes the battalion's lines of effort. The S-3 and the SPO section create the battalion's concept of operations, which expands on the commander's intent. The concept of operations clearly describes how subordinate units cooperate and establishes a specific sequence of actions to achieve the desired end state.

4-201. The S-4 coordinates the strategic and operational deployment. The S-4 is focused on internal requirements, supply functions, and generating the internal LOGSTAT report. The S-4 determines supply requirements and coordinates the resupply and storage of supplies and equipment. The S-4 also conducts funds management.

Support Operations Section

4-202. The SPO section is responsible for synchronizing logistics operations to maximize efficiencies and ensure priorities are executed in accordance with published orders. When tasked with area support, the SPO section develops the concept of operations for their designated portion of the support area.

4-203. The SPO supply and field services function is responsible for distribution and materiel management. The transportation function is responsible for transportation management.

4-204. The DSSB SPO section assists in requirements determination, including forecasting long-range materiel requirements, facilities, materials, and equipment needed to operate assigned FSSP and plans for additional non-standard fuel types (for example, JP5, F-24 or F-76). The SPO supply and field services staff forecasts and establishes supply stock levels to meet mission requirements. It coordinates with DSB planners to—

- Set the contingency stockage levels.
- Set disposition directives for residual disposal.
- Establish the AO fuel points in compliance with the OPLAN or OPORD.
- Determine area or unit support assignment and customer base.

4-205. The SPO coordinates with DSB planners for—

- Operational timelines.
- Equipment density, allied and host nation support density lists, and equipment arrival and departure timelines.
- Accounting and quality surveillance procedures and safety and environmental mitigation requirements.
- Determining methods of class III delivery and the size of class III sustainment activity required to perform distribution tasks.

4-206. The SPO section coordinates with DSB fuel planners and customer class III fuel planners for fuel requests, area support and consumption rate forecasts. It coordinates with the DSB for throughput capability.

4-207. The SPO section validates the requirement for retail fuel support, including—

- Space availability for distribution and storage methods.
- External support commodities needed to support the distribution system (for example, security, and engineer support).
- Refuel plans in accordance with its support designation (direct, general, area).

4-208. To assist in validating requirements, the staff coordinates with the DSB for inspection procedures, quality assurance and quality surveillance program details, and compliance requirements related to receiving, storing, and distribution of class III. It then prepares issue schedules.

4-209. To assist in the resupply of bulk fuel, the SPO officer coordinates with and passes requirements to the DSB, provides operational oversight for bulk petroleum, and performs fuel recovery, defueling and inspection of retrograded class III.

4-210. The DSSB's organic composite supply company or (if attached) PSC plays a major role in the handling and storage of bulk petroleum. Its tasks include—

- Establish the class III storage and retail fueling point as directed by the sustainment brigade. This will be done by the attached PSC.
- Receive, store and issue stocks in accordance with sustainment brigade directives and support priorities.
- Coordinate with the sustainment brigade for procedures in the event that fuel is received in a non-standard manner.
- Provide operations supervision over retail fuel and refueling activities.
- Provide, maintain, and operate all fuel equipment at the retail point.
- Ensure that retail fuel points receive and issue the appropriate product in accordance with safety and environmental procedures.
- Report customer consumption rates.
- Inspect, enforce, and report status of sampling, quality assurance and surveillance programs.
- Provide BCT storage augmentation using 5,000 gallon tankers, HEMTT tankers with modular fuel system and PLS trailers.

4-211. The DSSB SPO supply and field services staff, working with its PSC (if attached) and composite supply company, maintains stock control over its supply of bulk petroleum. It will—

- Establish class III FSSPs in accordance with the sustainment brigade fuel distribution plan.
- Compile the daily stockage reports from each customer.
- Report storage excess posture and consumption accountability.
- Follow and operate the sampling, quality assurance, safety, environmental and distribution operations.

4-212. The DSSB also plays a major role in bulk fuel distribution through its composite supply company or (if attached) PSC. It is responsible for delivering and issuing class III in accordance with DSB directives, which it does through its PSC, or for smaller deliveries, through its composite supply company. It may distribute fuel through a supply point, transfer it to a BSB or conduct throughput distribution straight to an FSC. It determines logistics release points, expedites critical and special fuel requests, and monitors FSSP overdue deliveries to ensure they are being resolved promptly and effectively. It may conduct redistribution by providing transportation assets for movement of class III between customers as directed by the DSB. The SPO monitors and reports any critical or immediate fuel shortages or overages.

4-213. The SPO section reports on its bulk fuel assets. The SPO supply and field services staff will —

- Prepare daily inventory reports and forward them to the DSB.
- Compile and forward class III stockage reports to the DSB.
- Compile and report customer requests, on-hand inventories, and retail usage statistics to the sustainment brigade.
- Maintain FSSP critical equipment readiness rates.

4-214. The DSSB SPO supply and field services staff redistributes bulk petroleum, reallocating excess materiel or sending to other locations in theater to fill shortages using all transportation assets available. It monitors and reports any critical or immediate fuel shortages or overages. It provides transportation assets for movement of class III between customers as directed by the sustainment brigade.

4-215. The DSSB SPO supply and field services staff would coordinate with a petroleum services company or composite supply company to conduct retrograde support such as reclamation and defueling operations, and disposition of Army-owned class III in accordance with theater disposition instructions. It will coordinate with the sustainment brigade OCS staff section for contracted support of waste removal and fuel disposition, if available.

BRIGADE SUPPORT BATTALION

4-216. The BSB provides logistical support to a BCT. The BSB plans, coordinates, synchronizes and executes petroleum supply operations in support of brigade operations. Staff sections within the BSB are much smaller than those in echelons above brigade headquarters. The BSB commander studies the supported commander's operational plan and then executes support so that the supported brigade maintains freedom of action and operational endurance.

BSB Support Operations

4-217. The BSB SPO section is responsible for planning and coordinating petroleum resupply operations for the FSCs and from the sustainment brigade to the BSB distribution company. The brigade S-4 consolidates and prioritizes fuel requirements for the BCT. The SPO officer coordinates with the BCT S-4 and sustainment brigade planners to set the contingency stockage levels, establish fuel points in compliance with the OPLAN and OPORD and set disposition directives for residual disposal.

4-218. The SPO straddles mid-range to short range planning and execution. SPO supply and field services function is responsible for distribution and materiel management. The SPO transportation function is responsible for transportation management. The SPO balances fuel distribution requirements against fuel distribution capabilities and develops movement plans to support distribution operations for the brigade. The SPO identifies capabilities required to meet mission requirements that exceed the capacity of the BSB. The brigade S4 requests additional fuel distribution capabilities to meet mission requirements. The SPO determines and understands the logistics requirement to support its operating force. It will—

- Coordinate with the brigade S-3 and S-4 for operational timelines.
- Coordinate with the brigade S-4 for supported equipment density, allied and host nation support density lists, and equipment arrival and departure timelines.
- Coordinate with the supported battalions for fuel requests, area support and consumption rate forecasts.
- Forecast, with the brigade S-4, long-range materiel requirements, facilities, materials, and equipment needed to operate assigned FSSP.
- Plan for additional non-standard fuel types (for example JP5, F-24, or F-76).
- Coordinate with DSB and DSSB planners for accounting and quality surveillance procedures.
- Coordinate with DSB to determine methods of class III delivery and safety and environmental mitigation requirements.
- Coordinate with BSB and DSSB for throughput capability.

4-219. To validate and prioritize available class III assets, the BSB SPO will —

- Validate the requirement for retail fuel support.
- Coordinate with the DSB for inspection procedures, quality assurance and quality surveillance program details and compliance requirements related to receiving, storing and distribution of class III.
- Validate space availability for distribution and storage methods.
- Validate external support commodities needed to support the distribution system (for example, security, and engineer support).
- Validate refuel plans in accordance with support designation (direct, general, area).
- Prepare issue schedules.

4-220. The BSB executes management of all class III in its area of operations. To procure bulk petroleum and supplies to meet operation requirements, the BSB will coordinate with and pass requirements to the DSB.

4-221. Once bulk petroleum is procured, the BSB arranges to organize, sort, store and safeguard it. The BSB fuel section has no static storage capability. (The ASBs do have static storage capability through its distribution company's 120,000-gallon capacity FSSP.) The BSB requires non-mobile storage of petroleum to be able to provide petroleum support to the brigade as required to support the mission. The BSB support operations officer requests the non-mobile storage assets from the DSB.

4-222. The BCT XO routinely conducts a brigade logistics synchronization meeting. Attendees include the BSB SPO officer and section staff, BCT S-4, FSC commanders, medical planners, support and maneuver battalion S-4s, as well as any supporting sustainment echelon above brigade coordinating staff. Attendees consider current orders, logistics reports, commander's guidance, and other pertinent information.

4-223. The BSB establishes the class III storage and retail fueling point as directed by the sustainment brigade and coordinates with the DSB or DSSB for procedures in the event that fuel is received in a non-standard manner. The BSB will receive, store and issue stocks in accordance with brigade S-4 and sustainment brigade directives and support priorities. It provides, maintains, and operates all fuel equipment at the retail point, supervises retail refueling operations, reports customer consumption rates, and inspects, enforces, and reports status of sampling, quality assurance and surveillance programs.

4-224. The BSB, through its distribution company's petroleum section or forward supply company issues class III in accordance with the issue plan and customer requests. The BSB accounts for and reports on the petroleum under its control.

4-225. The BSB distributes bulk petroleum through its distribution company. Distribution integrates the logistics functions of transportation and supply. It is dependent on movement control and other materiel management tasks. SPO supply and field services section balances fuel distribution requirements against fuel distribution capabilities and develops movement plans to support distribution operations for the brigade. The BSB—

- Delivers and issues class III in accordance with brigade S-4 priorities and supported battalion requests.
- Provides or coordinates with the brigade S-3 and sustainment brigade for in-transit security and tamper seals for trucks containing class III.
- Determines logistics release points.
- Expedites critical and special fuel requests.
- Monitors FSSP overdue deliveries to ensure they are being resolved promptly and effectively.

4-226. BSB SPO's supply and field services section determines the redistribution of bulk petroleum as necessary, reallocating excess materiel or sending petroleum to other locations in theater to fill shortages using all transportation assets available. The supply and field services branch monitors and reports any critical or immediate fuel shortages or overages. It provides transportation assets for movement of class III between customers as directed by the sustainment brigade.

4-227. The BSB SPO's supply and field services section conducts retrograde support by planning for reclamation and defueling operations, and the disposal of Army-owned class III in accordance with theater disposition instructions. It will coordinate with the sustainment brigade OCS staff section for contracted support of waste removal and fuel disposition, if available.

BSB Distribution Company

4-228. The BSB distribution company, often referred to as the Alpha Company, is responsible for fuel distribution to the brigade. The key distribution and petroleum managers in the distribution company include the commander, executive officer, fuel and water platoon leader and supervisory NCOs.

4-229. The fuel and water platoon executes fuel distribution operations. The fuel section receives, temporarily stores and issues petroleum to the BCT.

4-230. The distribution company conducts replenishment operations in two ways; supply point distribution in which the FSC comes to the distribution company supply point to conduct refueling; and unit distribution where the distribution company delivers to the FSCs. The distribution company receives bulk petroleum from the supporting sustainment brigade with the capability to store bulk fuel and issues it to units within the BSA and the FSCs through its fuel and water platoon.

Forward Support Company

4-231. The FSC is the forward most logistics unit responsible for the distribution and supply of bulk fuel to maneuver units. The key distribution and petroleum managers in the FSC are the commander, executive

officer, and supervisory NCOs. The FSC commander coordinates with the supported battalion S-4, executive officer, and maintains a relationship with the BSB SPO in order to understand the BSB commander's brigade logistics support plan. The S-4 is the logistics planner for the battalion and creates the battalion's sustainment COP. The FSC commander is the executor of the S-4's plan.

4-232. The distribution platoon leader leads the platoon overseeing LOGPAC operations, and manages the distribution of supplies, including bulk fuel, coming from or passing through the FSC in support of the supported battalion's units. The distribution platoon provides fuel to the supported battalion as part of its replenishment operations.

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Chapter 5

Petroleum Operations

Bulk petroleum requires special handling and storage. Bulk petroleum operations require uninterrupted supply from the commercial supplier down to the tactical level as far forward as required. This chapter outlines procedures for proper receipt, accounting, storage, quality surveillance, and distribution of petroleum.

SECTION I – STOCK CONTROL AND REPORTING

5-1. 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 in all Army operational contexts.

5-2. 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.

5-3. Whether a Service is holding wholesale or retail bulk fuel stocks, certain rules of accounting apply to all Services.

ACCOUNTABILITY

5-4. 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 PAM 710-2-1 for detailed bulk petroleum accounting procedures. In addition, DODM 4140.25, Volume 2 covers the requirements and procedures for the accountability of petroleum products.

5-5. 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 responsible to ensure proper accountability of petroleum products is maintained.

5-6. 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.

5-7. 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 PAM 710-2-1.

5-8. 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

5-9. The Army is adopting DOD inventory management practices to seamlessly interconnect capitalized and non-capitalized fuel accounts.

5-10. A non-capitalized account is an account where the fuel is owned by the Army.

5-11. In capitalized accounts, DLA Energy owns the product stored and dispensed from Army facilities/equipment.

5-12. The vast majority of Army fixed bulk fuel operations are capitalized; most tactical, unit level operations are not capitalized.

INVENTORY PROCEDURES

5-13. For inventory procedures pertaining to bulk petroleum and packaged products refer to AR 710-2 and DA PAM 710-2-1.

MEASUREMENT

5-14. Accurate measurement is a critical function for proper petroleum accountability and stock control. Proper measurement procedures are outlined below.

GAUGING

5-15. 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.

5-16. Special equipment is needed to measure bulk petroleum. This equipment is given below.

5-17. 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.

5-18. 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.

5-19. 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.

5-20. 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.

5-21. 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.

5-22. 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.

5-23. 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, ASTM International Tables 5B and 6B. The test provides the user with an indication of product type to identify the fuel type and a volume correction factor.

5-24. 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.

5-25. 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.

5-26. 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.

5-27. Innage and outage gauging tapes and bobs are usually used for large, fixed storage tanks. Considerations for use are as follows:

5-28. 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.

5-29. 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.

5-30. 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.

5-31. 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 two to three 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 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 gauge is 6 feet 1¾ inches. To convert the outage gauge to innage gauge, subtract the outage gauge from the reference height of the tank.

5-32. 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.

5-33. 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.

5-34. 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

5-35. 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.

5-36. 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

5-37. 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

5-38. From the tank capacity table, find the total measured quantity corresponding to the product gauge.

Bottom Sediment and Water

5-39. 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

5-40. 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

5-41. Do volume calculations in accordance with AR 710-2. Capacity tables or 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

5-42. To determine the net quantity of product, multiply the net quantity of product (uncorrected) by the proper volume correction factor.

SECTION II – RECEIPT, STORAGE, AND DISTRIBUTION OVERVIEW

5-43. This section provides an overview of receipt, storage and distribution procedures.

RECEIPT

5-44. 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.

5-45. 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.

5-46. 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.

5-47. 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.

5-48. 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.

5-49. 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

5-50. 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.

5-51. 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.

5-52. 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.

5-53. There are several practices petroleum supply specialists should always follow when storing bulk petroleum:

- Implement all environmental, safety and health considerations to properly store bulk fuel.
- Use a separate handling system for each type of petroleum product.
- Install a filter separator 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.
- Drain any water in your collapsible tanks through the drain fitting assembly.
- 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.
- 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.

- 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

5-54. 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. The technical reference for circulation of fuel is Technical Advisory Message 11-001.

5-55. 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.

5-56. 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.

5-57. Perform quality surveillance and quality assurance procedures as required.

DISPOSAL OF EXCESS OR CONTAMINATED PRODUCTS

5-58. 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.

5-59. 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.

5-60. Report excess bulk petroleum in excess of 500-gallons or more and excess 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, national stock number (NSN) or product code, quantity, location, most recent laboratory test results, and reason for the excess.

5-61. 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

5-62. 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.

CONSIDERATIONS

5-63. 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.

5-64. 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.

5-65. Ensure all environmental, safety and health considerations have been implemented before, during and after operations.

5-66. Ensure proper issuing documentation is completed in accordance with AR 710-2 and DA PAM 710-2-1.

PRELIMINARY PROCEDURES

5-67. There are a number of preliminary considerations you should take before issuing bulk petroleum from your class III supply point.

Prepare Issue Schedule

5-68. 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 be 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

5-69. 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.

5-70. Fuel dispensing equipment must be recirculated (flushed) through the 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 or particulates.

Spotting the Transporter

5-71. 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.

5-72. Position the receiving and dispensing platforms on as level, equally elevated terrain as possible.

Inspecting the Transporter

5-73. 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-3004-1A. 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. Chapter 3 has a conversion chart for procedures that should be followed when changing products in tank cars and tank trucks.

METHODS OF DISTRIBUTION

5-74. 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.

SECTION III – PETROLEUM PIPELINE OPERATIONS

5-75. 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

5-76. Tactical petroleum terminals are located in the area they are to conduct supply. The general location is designated by the petroleum planners 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.

5-77. Usually as part of the Army's operations during competition, the facilities branch of the quartermaster group SPO preselects a specific site or desired area to set up the TPT using aerial or ground reconnaissance. There is no ideal site. 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.
- The ability to hold the equipment and roadways needed. Compromise and rearrangement of equipment will often be necessary.
- Ground that is 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.

- Access to existing road systems capable of carrying the traffic anticipated. If there is not access to that road system, the facilities branch arranges for the construction of a new road to connect to the road system.
- Availability of water. The operation must have water available for safety reasons even if it must be hauled to the site. Water is essential for the charging of the dry chemical/aqueous film forming foam, commonly known as AFFF, wheel-mounted fire extinguisher. It is also needed for general fire protection and personnel safety.

5-78. As part of the concept of operations, the theater Army G-3 is responsible for tasking the theater engineer command to construct TPTs. The engineer units tasked to the construction site 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 raids are relatively easy to defend against. TPT fuel units should never be located in drainage areas above critical installations.

5-79. Planners will locate TPTs 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 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.

5-80. 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 should be based on this final layout.

SITE PREPARATION

5-81. 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.

ROAD

5-82. Road must be fully compacted and have good drainage. If at all possible, they have at least a surface of gravel or crushed rock.

TANK PAD AND BERM CONSTRUCTION

5-83. Proper tank pad and berm construction provides for efficient 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 one 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 are 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 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

5-84. 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, the site supervisor will ensure it is 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

5-85. 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.

5-86. The petroleum officer is the supervisor of the control section. The petroleum officer has the duty to —

- Monitor the work, coordinate with higher headquarters, and make 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.
- Obtain or develop pumping schedules for transfer, storage, and delivery. Personnel under the officer's supervision make the hourly pumping and delivery report to the chief dispatcher of the petroleum operating unit.
- 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 operations orders; and detect line breaks, leakage, and other problem areas.

5-87. The section chief supervises the installation, operation, and maintenance of petroleum storage facilities. They also supervise and control the tank farm section personnel.

5-88. The petroleum inventory control specialist assists the section chief in coordination of tank farm operations and maintenance. The specialist maintains 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.

5-89. The petroleum heavy vehicle operator operates vehicles used to support the hoseline outfit equipment and evacuate fuel products.

5-90. The petroleum supply specialist operates and maintains the TPT, FSSP, or other service or civilian equipment as required. The petroleum supply specialist also completes the appropriate receipt and shipping documents that are 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, hoseline, 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

5-91. 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.

5-92. Figure 5-1 shows a typical TPT layout. It has been arranged to make full use of the transfer hoses 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.

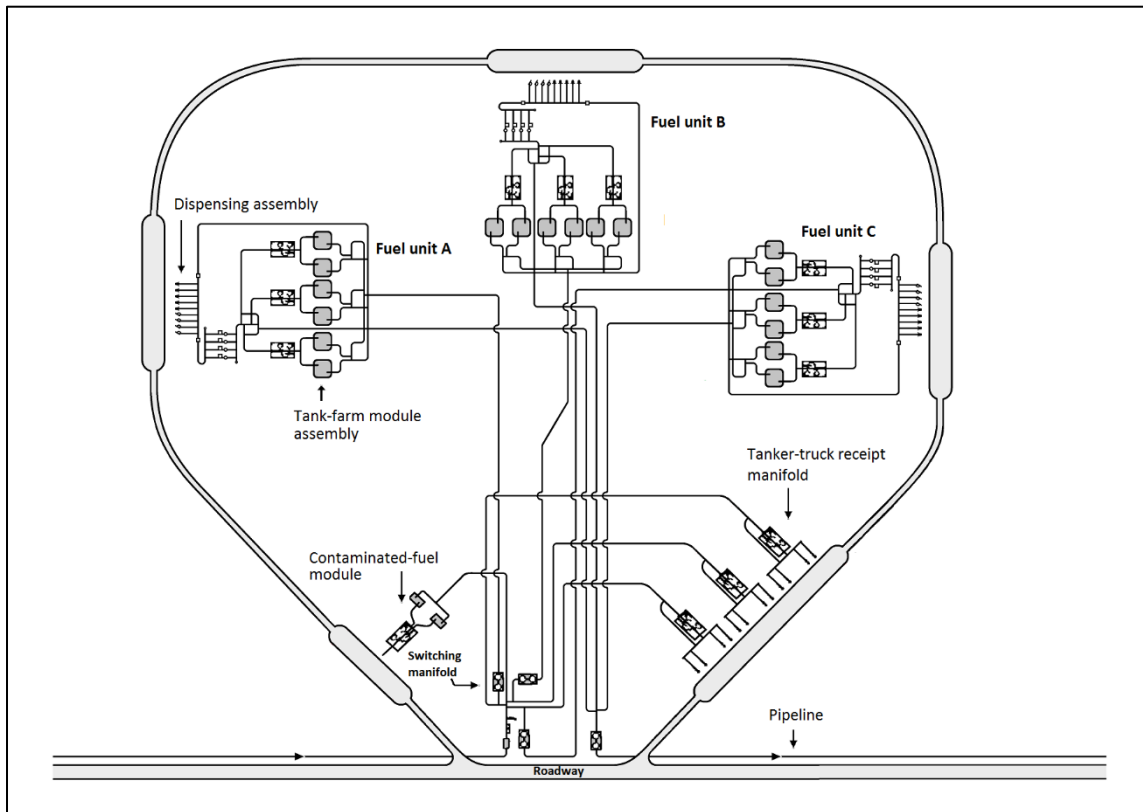


Figure 5-1. Typical tactical petroleum terminal (TPT) layout

5-93. Access is 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.

5-94. 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. Supervisors ensure that all personnel 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

5-95. Line operations are the control, planning for, organization, coordination, and direction of the pipeline and terminal operations. Line operations are normally conducted by the petroleum pipeline and terminal operations company.

PLANNING

5-96. 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.

ORGANIZATION

5-97. The pipeline operating platoon leader organizes the operations to provide bulk fuel to serviced units and to ensure the platoon operations interface with those of the larger system. It is essential that operations are organized so that Soldiers know what is expected of them and they can perform their duties with confidence.

COORDINATION

5-98. 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. The platoon leadership schedules work to maximize the efficient employment 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.

DIRECTION

5-99. Pipeline systems, terminal design, product demands, and the nature of each receipt or issue of product determine specific operating procedures. However, all terminals follow certain rules and procedures to foster efficient operation and safety.

5-100. Determining the flow rate and units of measurement in pipeline and hoseline operations is required during pipeline operations. The units of measurement can be barrels, gallons, or liters depending on the area of operations and the organizations involved in the distribution chain.

5-101. Pipeline and terminal units cross-train their personnel 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 and understand complete operational instructions. Personnel should receive training on how to anticipate emergencies so that they can cope with various situations.

OPERATIONAL CONSIDERATIONS

5-102. Listed below are general operating considerations that should be followed.

- 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.
- 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. Keep in close touch with the dispatcher so as to keep from overfilling or rupturing a storage tank.
- Pipeline operations hydraulics is a consideration that is addressed in appendix H of this publication.

RECEIPT OF PRODUCT

5-103. 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.
- 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 fuel into a 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.

ISSUE OF PRODUCT

5-104. 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-3004-1A.

INTRA-TERMINAL TRANSFERS

5-105. 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

5-106. 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.

TERMINAL RECORDS AND REPORTS

5-107. Terminal or pipeline managers determine reporting requirements and what information is required. The format used is generally a daily report often informally referred to as a REPOL. This is not to be confused with the Bulk Fuel Contingency Report submitted by the JPO, often referred to as a JCS REPOL. Listed below are examples of such reports.

Class III Status Report

5-108. Each terminal in the pipeline maintains a class III status report. 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

5-109. 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.

5-110. 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.

TESTING OPERATIONS

5-111. 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

5-112. 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 chief dispatcher. Pump stations are informed of the expected arrival time of scrapers that may be in the line.

OPERATION REPORTS

5-113. Operation reports cover hourly pumping and delivery data from the various pipeline pump stations. These reports are sent to the chief 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 gallons pumped and gallons 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

- 5-114. An input station provides various data to the dispatcher. The data includes—
- 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

- 5-115. A pump station provides various data to the dispatcher. This data may include—
- Suction pressure.
 - Discharge pressure.
 - Engine RPM.
 - API gravity (if multi-product).

Takeoff Receiving Station Report

5-116. A takeoff station provides various data to the dispatcher. The data includes—

- 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.

SCHEDULING

5-117. 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.

5-118. 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

5-119. 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 5-2 provides an example of a typical consumption graph.

5-120. 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.

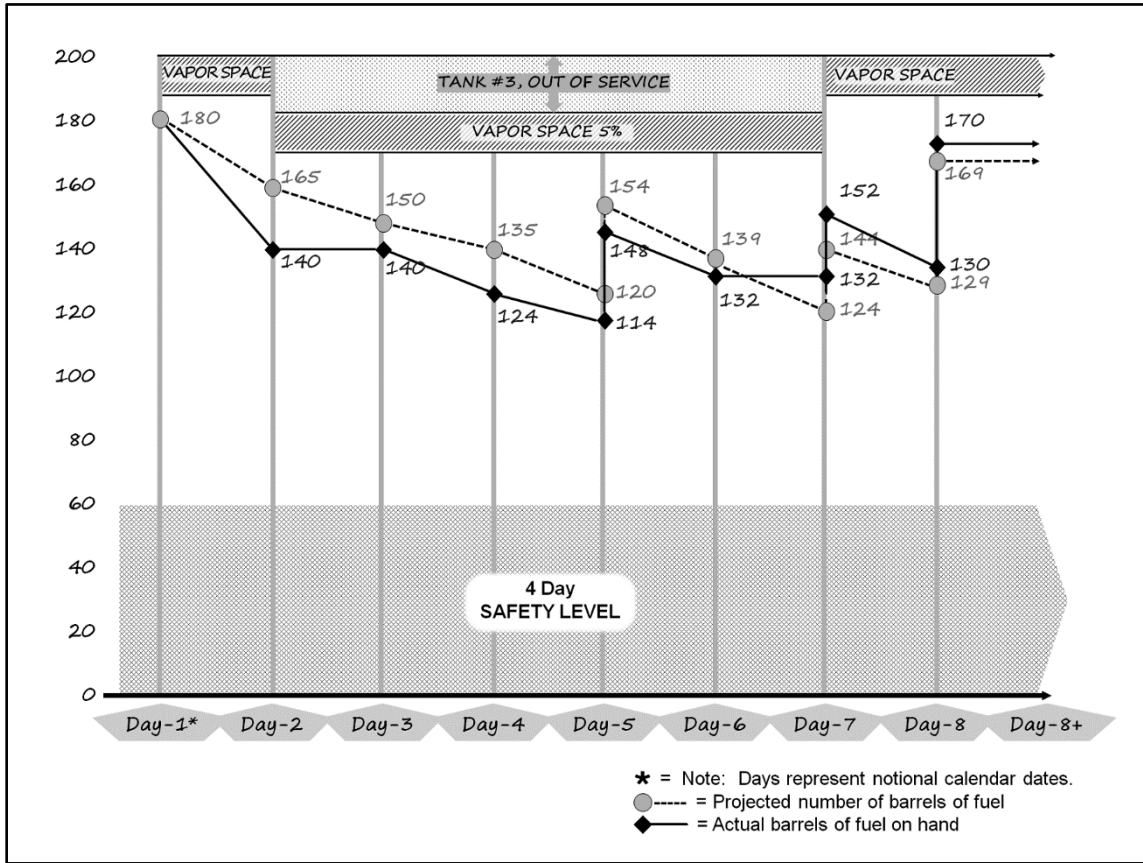


Figure 5-2. Consumption graph

5-121. 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

5-122. The monthly pipeline schedule as shown in figure 5-3 on page 5-20 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 that 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 the flow is plotted correctly. Information on this graph is given below.

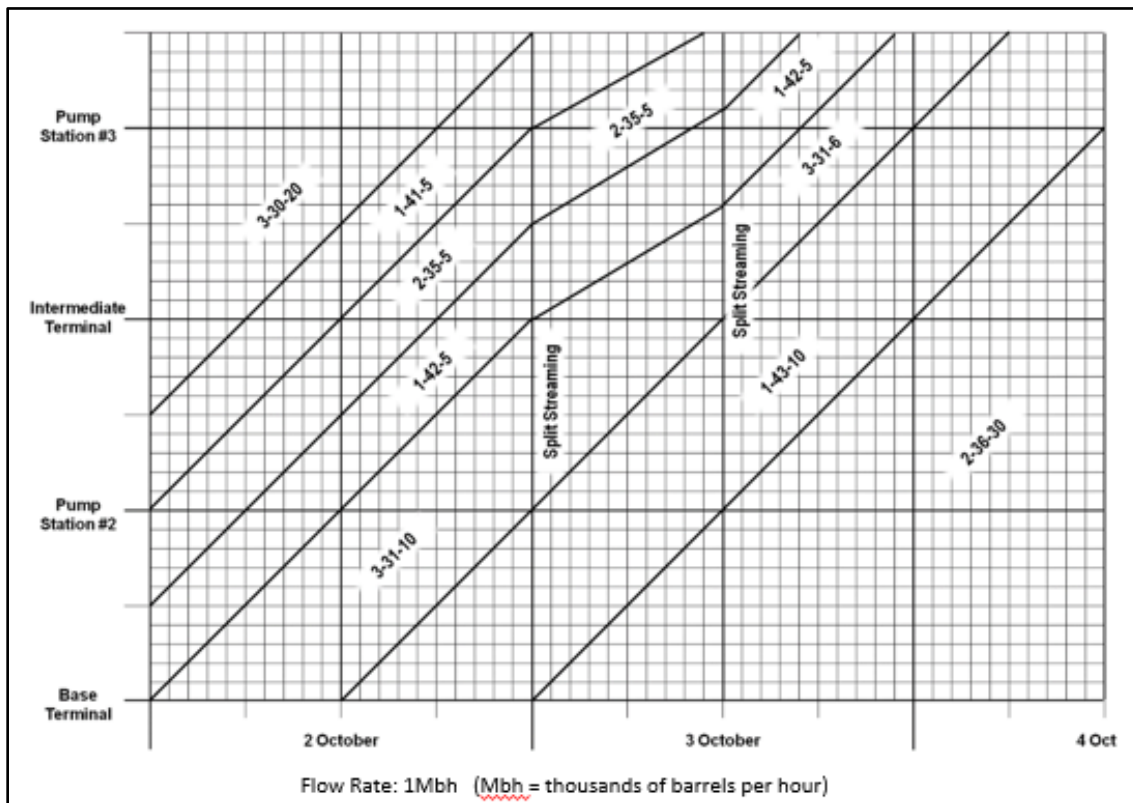


Figure 5-3. Monthly pipeline schedule

- 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

5-123. 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 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 IN A MULTI-PRODUCT PIPELINE

5-124. 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.

5-125. 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.

5-126. 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 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

5-127. 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. In addition, 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

5-128. 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

5-129. 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 motorized gas 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

5-130. 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 motorized gasoline and JP8. There may be little difference, as between DF-1 and DF-2.
- 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.

BATCH RESIDUES

5-131. After deliveries and in idle pumps or stations after shutdowns, fuel stays in delivery lines, dead ends of pipes, and manifolds. IPDS pipes hold 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 200 to 250 gallons 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

5-132. There may be times when product cuts are needed. A number of factors must be considered when making such cut.

DETERMINING THE CUT

5-133. 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

5-134. 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

5-135. 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

5-136. 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

5-137. 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

5-138. 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

5-139. Information recorded in the daily pumping record includes the following:

- 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 suction pressures, discharge pressures, and revolutions per minute are recorded to show any problems. Revolutions per minute should be the same for all pumps operating properly.
- 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

5-140. 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 the dispatcher prepares and posts the daily pumping record.

5-141. Batch changes, showing time of first and final change (gravity or color) and rate of flow, are posted in the remarks section.

5-142. Discharge pressures should be monitored closely. Any drop in discharge pressure could be the result of a line tap or break.

5-143. 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

5-144. 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. Figure 5-4 shows an example of a graphic progress chart.

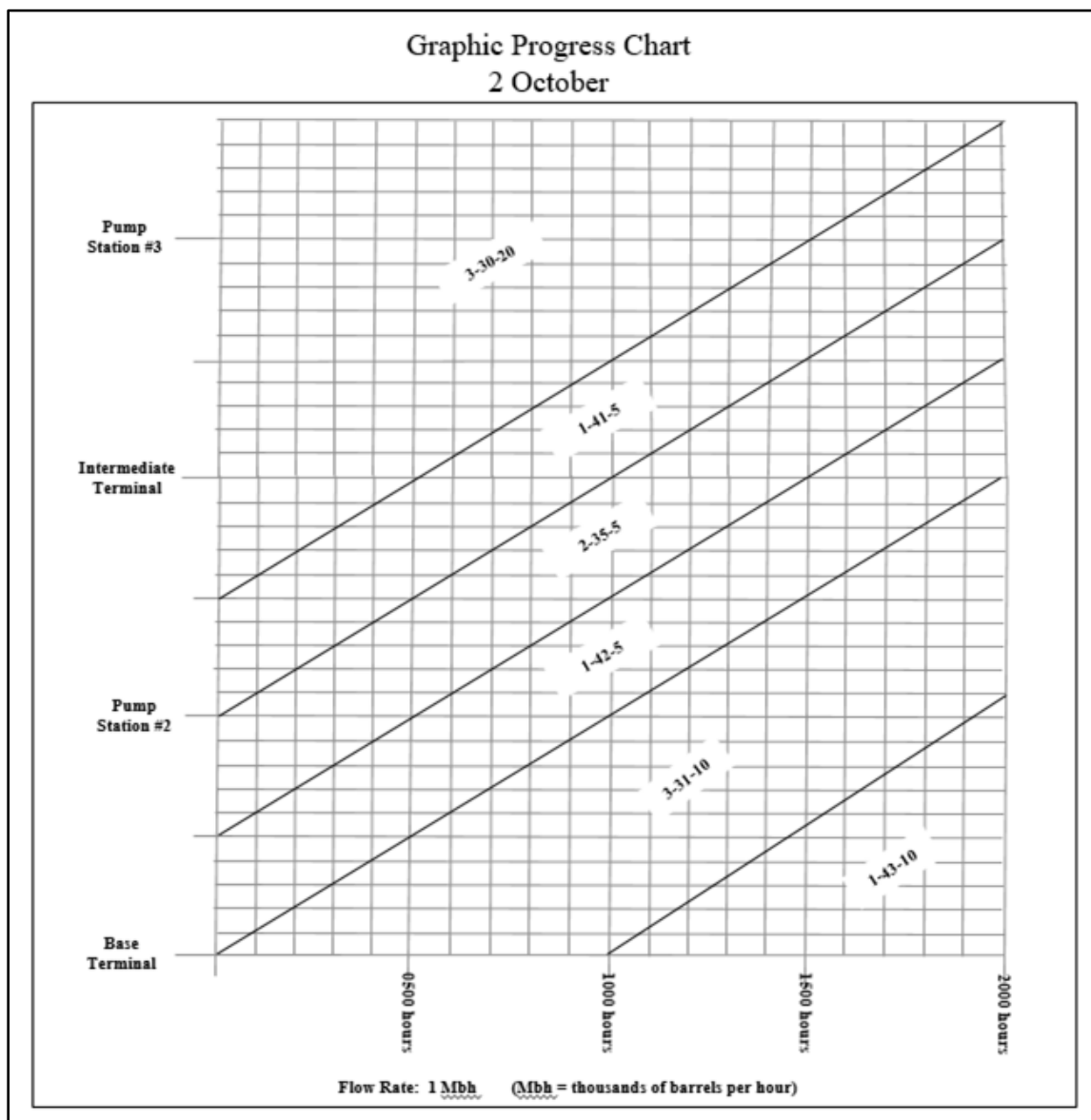


Figure 5-4. Sample graphic progress chart

Preparation

5-145. 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

5-146. 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

5-147. There is no set format for the daily pumping order. General guidelines for preparing the order are listed below.

5-148. 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 IV - BULK FUEL SUPPLY POINTS

5-149. 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

5-150. One of the most important tasks associated with managing a class III supply point is employment of its qualified personnel. Petroleum managers consider the following when determining personnel requirements:

- The number of personnel needed for a specific operation.
- The placement of each Soldier in relation to the equipment.
- The tasks each Soldier is given to perform.

5-151. It is important that personnel at the class III supply point receive specific tasks, but their assignments should also be flexible. For example, 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, improve the firewalls around the collapsible tanks, and perform operator and organizational maintenance on the equipment in the supply point.

5-152. Supervisors of the class III supply point—

- Conduct map or site recon and select a direct, efficient route, which is free of obstacles.
- Develop site diagram, operational procedures, and site SOP.
- 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 and 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 and 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 tankers and their paperwork prior to receipt or issue.
- 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 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 loss or gain 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 or TMs.
- Supervise retrieval and packing of class III supply point according to unit SOP and appropriate FMs or TMs.
- Supervise handling of 500-gallon fuel drums. Refer to appropriate field manual 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. In some situations, you will have to augment personnel.

LAYOUT

5-153. After selecting the specific site(s) for the class III supply point, the site leader develops a flow plan for the most efficient and effective use possible, with the goal of simplifying the process and minimizing the handling of products and containers as much as possible. The flow plan identifies steps that 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, the site leader considers the location of bulk storage, packaged product storage, the flow of traffic and access points through the supply point. Under normal circumstances, they allow only one-way traffic through the supply point. The site leader studies and draws out the area, and makes up a flow plan before the supply point moves to the new location.

OPERATION

5-154. 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.
- AAFARS operations.
- Tactical petroleum terminal operations.

5-155. Bulk petroleum is normally delivered to 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. In addition, 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. Regardless of the method of delivery, bulk fuel planners and handlers follow the same safety procedures and environmental compliance measures as outlined in chapter five of this publication.

5-156. Petroleum supervisors 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 are identified and synchronized with other tasks.

5-157. Inspections are the key to finding out how well the class III supply point is performing. Inspections provide firsthand information on how the equipment and products are maintained from day to day. Inspections enable 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. Supervisors inspect—

- Collapsible tanks and hoses.
- Operating equipment.
- Firefighting equipment and drainage facilities.
- Storage area to ensure it is free of trash, weeds, or other combustible material.

5-158. In addition, supervisor surveys the traffic control system often to ensure that traffic is routed efficiently. The supervisor removes unnecessary equipment in the area that hinders traffic movement or access to firefighting equipment.

FUEL SYSTEM SUPPLY POINT

5-159. When selecting the FSSP site, planners consider—

- Cover and concealment.
- Road networks.
- Dispersion factors.

- Terrain.
- Site preparation requirements.

5-160. Planners normally 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. Among the planning considerations for site selection are—

- Ease in loading or unloading trucks and refuel vehicles without leaving the road network in the supply point.
- 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 120,000 or 300,000-FSSP, the inlet/outlet of the collapsible tanks are no more than 60 feet apart. For the 800,000-gallon 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.

5-161. An FSSP is normally emplaced and operated by a platoon from the PSC or composite supply company. Each platoon has a platoon leader, a warrant officer as petroleum systems technician, and a platoon sergeant.

5-162. The site preparation includes a layout for the major items of equipment in the FSSP that include the collapsible tanks, the pumps, and the filter separators.

5-163. The engineers slope the tank sites gently toward the manifold end to help drain the tanks when they are removed. The site for each tank is sloped no more than one degree in the direction of the tank's suction port. Then they build a firewall around each tank, making it large enough to hold the contents of the tank and one foot of freeboard. Table 5-1 shows the berm dimensions required to protect the various sizes of collapsible fabric fuel tanks in the Army's inventory. Further information on berm size can be found in TB 10-5430-253-13.

Table 5-1. Berm dimensions for collapsible fabric fuel tanks

<i>Collapsible fabric fuel tank size</i>	<i>Tank dimensions (dry)</i>	<i>Berm dimensions (outside)</i>
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

5-164. 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 = berm height [minus (-)] freeboard.

5-165. When handling two types of fuel (for example, JP8 and motor gasoline), separate systems are required. One FSSP may be divided depending on the storage requirement however, if the FSSP is divided, additional equipment (such as pumps or filter separators) may be required.

5-166. Supervisors place FSSP equipment onsite according to the layout plan. Supervisors normally lay out equipment in this order and in accordance with appropriate TM:

- Collapsible tanks.
- Pumps and filter separators.
- Fitting assemblies and hoses.
- Fuel- and oil-servicing nozzles.
- Assembled FSSP equipment.

5-167. The operation of the FSSP consists of three areas:

- The receiving manifold is the point where bulk petroleum is transferred from 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.

5-168. Figure 5-5 displays an example of a fuel system supply point with associated equipment.

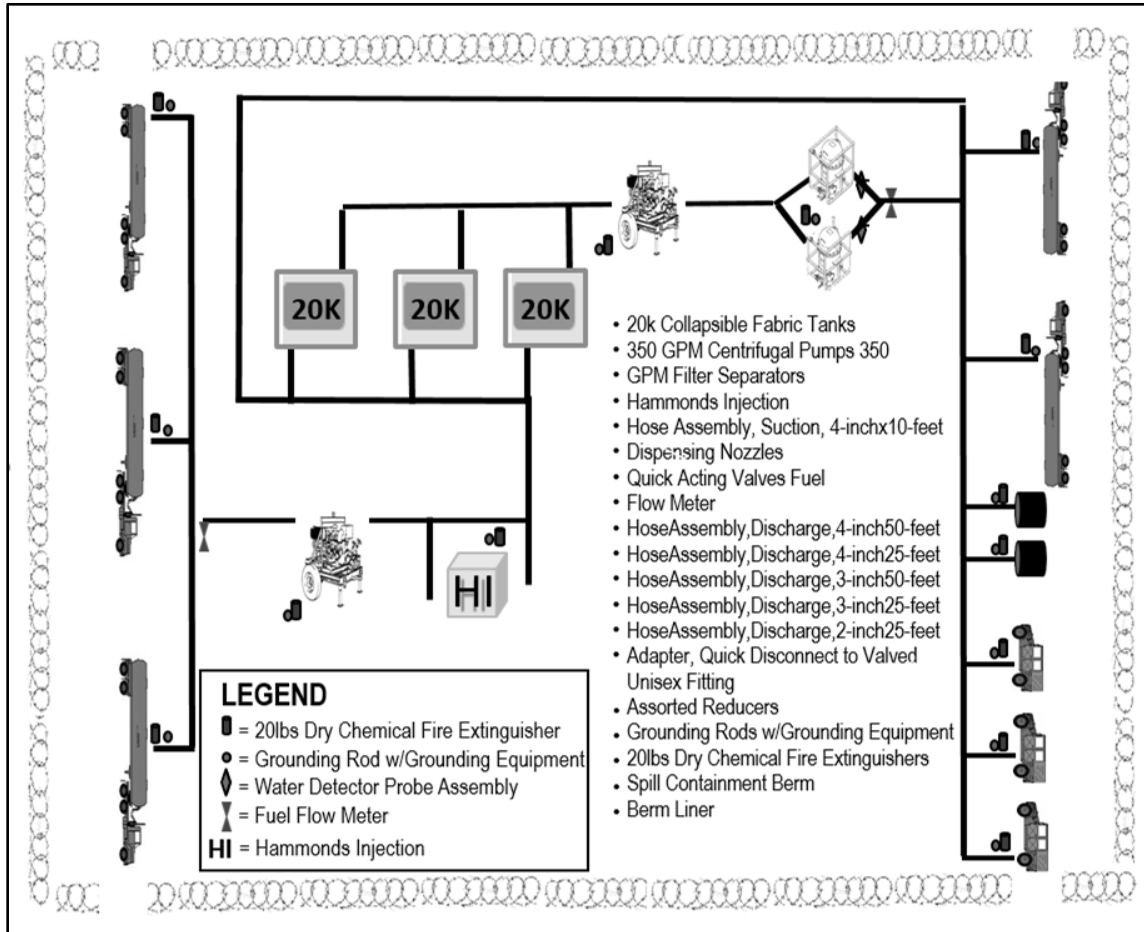


Figure 5-5. Fuel System Supply Point

MODULAR FUEL SYSTEM

5-169. The modular fuel system enables units to store and distribute fuel without collapsible fuel tanks or engineer support. The modular fuel system is comprised of two main modules, the tank rack module (TRM) and the pump rack module (PRM), which can interact with each other to form a fuel farm or execute a refuel-on-the-move. Figure 5-6 on page 5-30 shows a modular fuel system bulk layout. Figure 5-7 on page 5-30 shows a retail layout.

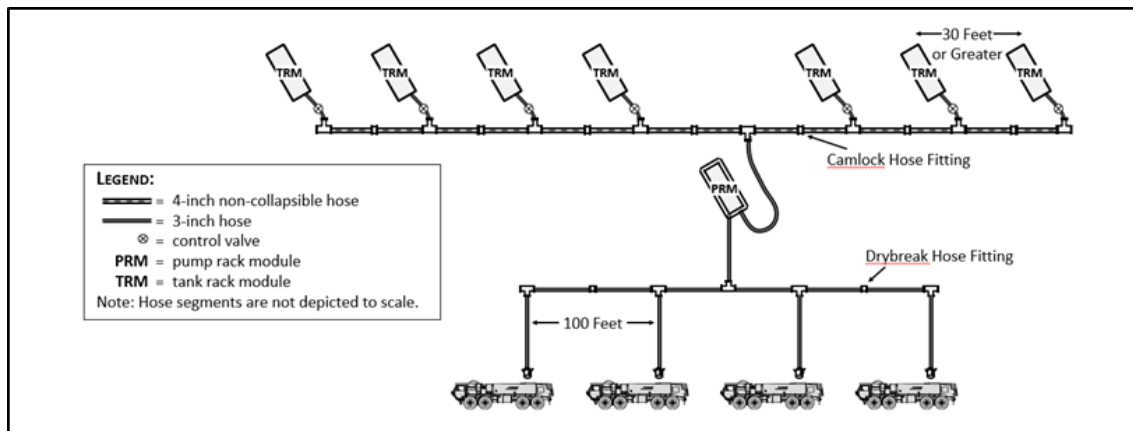


Figure 5-6. Modular fuel system bulk layout.

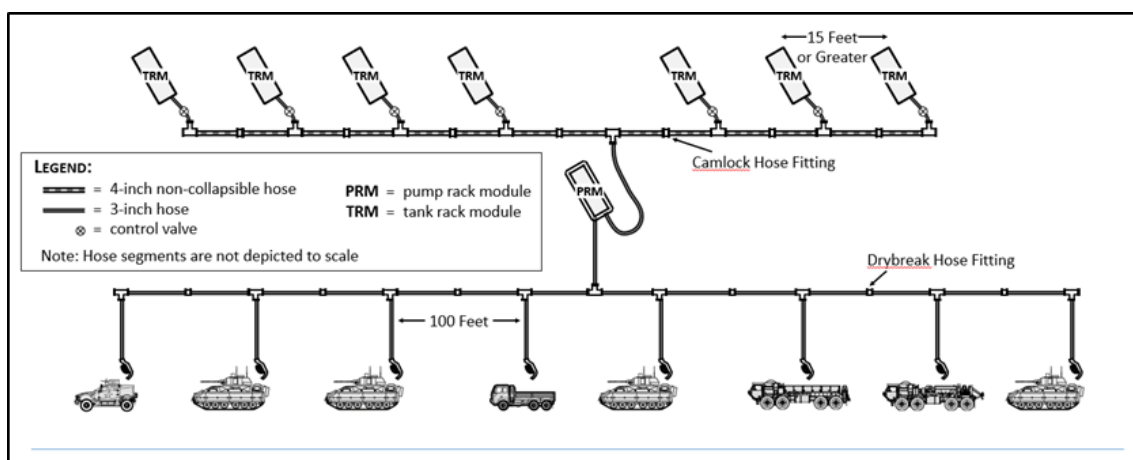


Figure 5-7. Modular fuel system retail layout.

5-170. The TRMs within the composite supply company can be used for bulk replenishment operations to BCTs. Full TRMs are sent forward where either the TRMs are swapped for an empty TRM or the fuel is transferred to empty HEMTT Tankers. With TRMs, the modular fuel system 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 pump rack module, to form a larger capacity bulk storage site.

5-171. The TRM is capable of performing retail operations while mounted on a HEMTT-LHS, PLS trailer or on the ground. While the TRM is equipped with an electric pump, hose, and retail nozzle, the TRM is not designed for conducting standalone retail operations. The TRM is designed to work with the PRM, HEMTT tanker, M969, the 350 GPM pumps of the FSSP, or the FARE system's 100 GPM pump.

5-172. For detailed information on the modular fuel system, see appendix A.

SECTION V – REFUEL ON THE MOVE

5-173. This section covers the concept, planning considerations, and employment of a refuel on the move, commonly known as a ROM. 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.

CONCEPT

5-174. 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.

5-175. Although ROM can be tailored to other tactical situations, the two primary purposes of a ROM are 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.

5-176. 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.

5-177. The manner in which this refueling is accomplished 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.

5-178. 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 CSSB 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.

5-179. ROM operations can be conducted by any level unit to meet mission requirements. Typically, a FSC 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.

5-180. A ROM can be as simple as utilizing HEMTTs or a modular fuel system, and as complex as needed utilizing any equipment available to support the largest of movements.

PLANNING CONSIDERATIONS

5-181. In planning a ROM operation, planners consider mission variables. Based on these considerations, planners identify, plan, and conduct the type of ROM operations that best support the commander's scheme of maneuver.

- Mission: The mission drives the need for ROM operations. Since the ROM site is a vulnerable, high value target, consider other refueling operations that 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: Planners consider known or expected enemy activity in the area of operations and area of interest. They make plans to clear and secure ROM site before the fuel trucks arrive. Risk increases significantly as the ROM gets closer to the enemy. Planners consider enemy artillery range when choosing the ROM sites and concealing the site's operations. Air defense assets should support the ROM site if there is any enemy air threat.
- Terrain: A thorough terrain analysis is an essential part of a successful ROM operation. ROM planners examine the routes of march, supporting road networks, cover and concealment, the locations of check points, and the ability of the terrain to support loaded fuel trucks and high traffic flow. For example, wet, swampy, or restrictive terrain will not support the weight of the trucks or high traffic flow of most ROM operations. A movement using multiple routes of march may require several ROM sites.
- Troops: Planners analyze the status of combat vehicle crew and supporting unit Soldiers. They consider whether they have enough crew members to operate the issue nozzle themselves, thus allowing the driver to remain in the vehicle during refueling; whether the Soldiers are trained on

ROM operations, and what forces were available to secure the ROM site and perform traffic control.

- Time: Planners consider the time it will take to cover the distances vehicles will be moving; the time available to coordinate, secure, establish, and camouflage the ROM site; the acceptance rate of unit vehicles and the amount of fuel (in either minutes or gallons) that they will receive. They 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 predetermined amount of fuel. If vehicles linger at the ROM site receiving excess fuel, it will create a backup of the following march units.
- Civil Considerations: ROM planners consider the surrounding civilian population and traffic patterns when selecting a ROM site location. As civilians can cause disruption in the execution of the ROM and require enhanced security, planners seek to locate the ROM in areas of limited civilian population and traffic.

ESTABLISHING THE ROM SITE

5-182. Prior to selecting the site layout for the ROM, ROM planners consider the information gathered from the METT-TC analysis. They make use of cover and concealment and consider all applicable environmental safety factors to mitigate risk.

5-183. The ROM planners ensure there is enough room in the site to allow minimum spacing between vehicles. They ensure the vehicles being refueled by the ROM have the most efficient and exit lane possible.

5-184. When setting up, the vehicle holding and marshalling areas before and after the ROM site, ROM site executors —

- 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 guide 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 into their convoy march elements or combat formations.

OPERATIONS

5-185. Successful conduct of ROM operations will require all supporting and supported units to work together. The operation must cover details of the organization, sustainment, and protection of ROM sites(s) and the timely, synchronized execution of the overall operation.

RESPONSIBILITIES

5-186. Planning staffs have several responsibilities to ensure a successful ROM mission. Planning staffs —

- Determine if they need more support requirements to conduct ROM operations, and coordinate their requirements with higher headquarters.
- Coordinate with higher headquarters for operational information and intelligence.
- Analyze all factors involved, including mission variables, to determine the form of refueling operation best suited to supporting the mission, and forward that recommendation to the commander.
- Select the location for the ROM site based on mission variables, ROM configuration, and the established march route.
- Coordinate ROM security support before setting up the ROM site.
- Coordinate with the military police for traffic control support at the site, if required.
- Receive and review estimated fuel requirements and coordinate with higher headquarters.

5-187. ROM site personnel —

- Retrieve the equipment necessary to the operation, perform preventative maintenance checks and services, and establish the ROM site.
- Ensure safety equipment is in place and personnel are familiar with the pertinent safety procedures.
- Ensure personnel are familiar and equipped with operational control signals (flags, lights, radios) to be used.
- Man fuel nozzles to refuel vehicles when convoy personnel are not available to refuel their own vehicles.
- Ensure vehicles safely enter and move through the ROM site and receive the prescribed amount or time allotment of fuel.

5-188. March unit commanders are subordinate to the ROM site commander 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 site personnel. ROM site personnel regulate the amount of fuel issue in accordance with the predetermined limits. These predetermined limits may be based on volume or, more often, time. The front seat vehicle passenger refuels the vehicle while the vehicle driver remains in the vehicle to ensure timely flow.

ROM EQUIPMENT CONFIGURATION

5-189. 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 conduct a ROM operation. ROM operations can be employed anywhere on the battlefield where there is a need to rapidly refuel combat vehicles.

5-190. Units can conduct a ROM in various configurations, using any reasonable combination of trucks, semitrailers or HEMTTs, along with any equipment available, such as FSSP, the HEMTT tanker aviation refueling system (HTARS), or AAFARS hoses. Figure 5-8 on page 5-34 shows a recommended layout and marshalling areas for a ROM operation. This setup is referred to as the long site configuration.

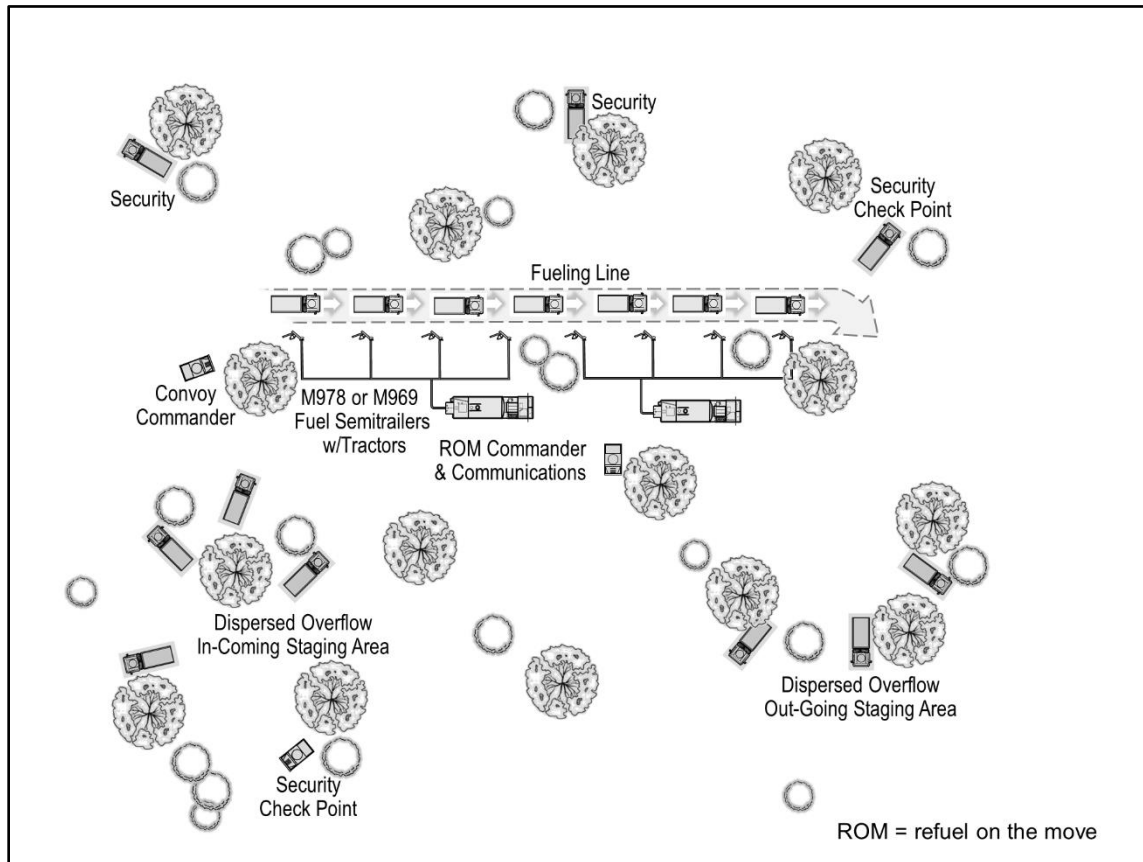


Figure 5-8. Example of a long site refuel on the move configuration

5-191. 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 or T. This will allow fuel issuing to continue to the combat vehicles. Fuel semitrailers can be shuttled to and from the ROM site to maintain a fueling tanker on-site.

5-192. 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 5-9.

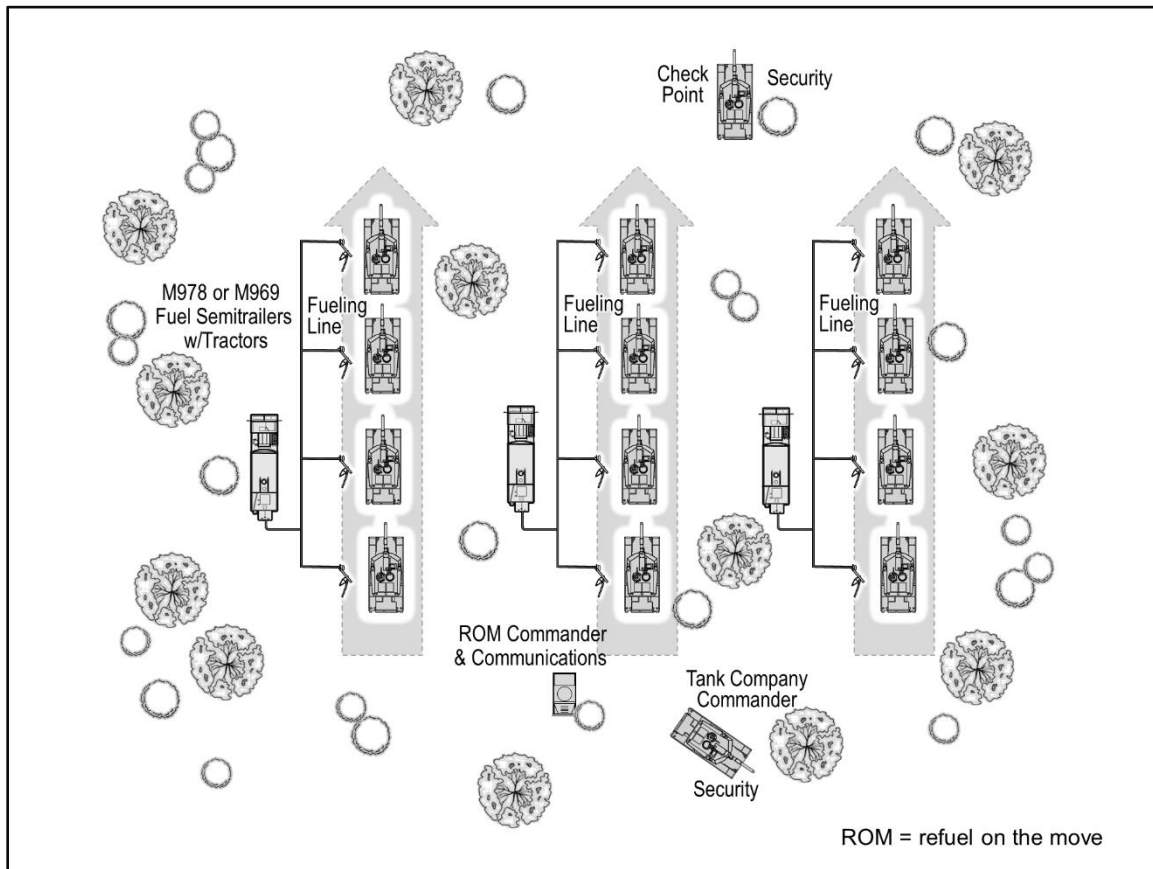


Figure 5-9. Example of a short site refuel on the move configuration

MINI-ROM

5-193. 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.

PLANNING CONSIDERATIONS EXAMPLE

5-194. 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. The flow rate 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

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.

5-195. 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.

ROM EXECUTION CHECKLIST

5-196. The checklist in table 5-2 represents considerations before, during, and after ROM execution.

Table 5-2. Refuel on the move execution checklist

<i>Pre-execution</i>
Refuel on the move (ROM) requirement identified
Site reconnaissance
Final plan established and briefed
Order given
Equipment and personnel assembled
Inspection of equipment and personnel
Rehearsal
Final inspection
<i>Execution</i>
Quartermaster party departs
ROM main body departs
Security element secures ROM site
Quartermaster party arrives at ROM site
Quartermaster party actions complete
Main body arrives at ROM site
Complete ROM is assembled
Lines packed, nozzles and valves checked
Camouflage complete
All support items (for example, warming tents, hazardous waste area, and spill kits) complete
First march unit arrives at ROM
Last march unit completes ROM
<i>Post-Execution</i>
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 preventive maintenance checks and services (PMCS) complete, fuel supply replenished
After Action Review
ROM party released
Sleep plan instituted

SECTION VI - AIRCRAFT REFUELING

5-197. 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.

5-198. Aircraft fuel distribution is accomplished through three means: rapid refuel points (also known as RRP) and FARPs and mobile refueler. Rapid refuel points are established to rapidly refuel large numbers of aircraft during surge periods, such as air assaults. Rapid refuel points are generally longer duration operations that are time consuming to establish and difficult to move. The bulk fuel storage and distribution capability of the rapid refuel point 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 rapid refuel points into heavy and light sections. The total number of points is METT-TC dependent. When operated by more than one unit, the rapid refuel point is known as a consolidated rapid refuel point.

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.

5-199. 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 (warm refuel), or with the aircraft engines turned off (cold refuel). Ensure that unit-specific SOPs are followed when refueling aircraft.

5-200. For site selection detail and planning considerations, additional refueling safety, personal protective equipment, and basic crash rescue plan and training, see ATP 3-04.17.

TYPES OF AIRCRAFT REFUELING

5-201. 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

5-202. Closed-circuit refueling (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 CCR nozzle that is part of the FARE system and the D-1 pressure nozzle (also called the single point nozzle).

5-203. 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

5-204. 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.

5-205. 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.

5-206. 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

5-207. 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

5-208. 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.

5-209. 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

5-210. The tactical setup of the refueling and 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.

Note: UH-72s will not be hot refueled (open port) without express permission by the aviation commander.

SPACING BETWEEN AIRCRAFT

5-211. 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 5-3 shows the minimum spacing to be used between aircraft during refueling and rearming points.

5-212. 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.

5-213. 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.

5-214. As CH-47 helicopters have a much larger footprint, than other Army helicopters, units establish a designated refueling point for CH-47s if multiple airframes are being serviced at a FARP. Enough space must be allowed between a CH-47 and any other helicopters so 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 discharge hoses can be added in between points to achieve the required safe fueling distance between helicopters. A second approach is to ensure 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 5-3. Minimum distance rotor hub-to-rotor hub

<i>Type of aircraft</i>	<i>Distance (in feet)</i>
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)

WIND DIRECTION

5-215. 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

5-216. 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

5-217. 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

5-218. 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

5-219. The layout of a marshalling area is not fixed, but is contingent on available space and needs of the unit.

OPERATION

5-220. 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.

COLD REFUEL FOR AIRCRAFT

5-221. Cold refuel refers to performing standard aircraft refueling operations, but without the aircraft or auxiliary power unit running and the rotor blades dormant. Listed below are the procedures for performing cold refuel for aircraft.

Position the Refueler

5-222. 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.

5-223. 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.

5-224. 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.

5-225. 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.

5-226. 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

5-227. 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 the Fire Extinguishers

5-228. 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

5-229. 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.

5-230. Attach the second ground cable and bond it to the aircraft. Ensure this connection is to a metal (non-painted) surface, not to include an antenna.

5-231. 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 the Fill Port

5-232. 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.

5-233. 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

5-234. 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.

5-235. 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

5-236. 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.).

5-237. 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.

5-238. 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

5-239. Warm refuel refers to performing standard cold aircraft refueling operations, but with the auxiliary power unit on the aircraft still running, and the rotor blades dormant.

5-240. 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.

5-241. The aircraft radio communication can still be received, but the aircraft cannot transmit during active refuel.

5-242. Required personal protective equipment (PPE) must still be worn when performing petroleum operations and the aircraft must be de-planed, with the exception of essential personnel, prior to fueling operations.

HOT REFUEL FOR AIRCRAFT

5-243. Hot refuel refers to refueling that can be accomplished with the aircraft engines turned on or running. Listed below are the procedures for performing hot refuel for aircraft.

Positioning the Aircraft

5-244. Start and operate the equipment in accordance with the appropriate TM to set the system in refueling mode.

5-245. Ensure the person manning the nozzle guides the aircraft into position using the signals described in ATP 3-04.17. Check with the pilot to ensure that all armaments are on SAFE.

5-246. Passengers must go to the designated passenger marshaling area. Marshaling 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.

5-247. 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.

5-248. 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.

5-249. Ground the aircraft to an authorized ground point using a grounding cable. Also, ensure the refueler is grounded in the same manner.

5-250. 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 the Fill Port

5-251. 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

5-252. 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

5-253. 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

5-254. 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

5-255. 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

5-256. 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.

EMERGENCY FIRE AND RESCUE PROCEDURES

5-257. The best preparation for coping with an emergency is the firefighting and rescue training that all refueling personnel should receive. The procedures and guidelines personnel perform in a fire or crash emergency are found in ATP 3-04.17.

5-258. For detailed employment of the AAFARS, HTARS, FARE and modular fuel system, Extended Range Fuel System II (ERFS II), and Fat Hawk in aviation support operations see ATP 3-04.17.

5-259. For details on the Forward Arming and Refueling Point Planning Checklist see ATP 3-04.17.

SECTION VII – ASSAULT HOSELINE SYSTEM OPERATIONS

5-260. The assault hoseline system is used to distribute bulk petroleum to establish and maintain linkage between high volume users in a variety of configurations. The assault hoseline system can be temporarily connected to a rigid pipeline for bulk delivery of petroleum to FSSPs. Where railroad transportation ends, the assault hoseline system 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

5-261. Personnel duties and requirements of the hoseline layout will be according to mission requirements (such as, the distance and configuration of the layout), the unit SOP, and the appropriate TM. Duties of the personnel performing the layout and operation of the assault hoseline system should include the following:

- Disassemble 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 or unload the employment and retrieval system.
- Operate and maintain the pump(s) and generator.
- Secure the hoseline if security is a risk.

5-262. During the deployment or recovery of the assault hoseline system, personnel will be required to do the following:

- Deploy, either powered or manually, the hoseline from the ERS.
- Ground guide the operator of the prime mover using appropriate hand and arm signals.
- If required, assemble the suspension supports kit, roadway crossing kit, and the assault hoseline system.
- Be properly trained to use the hoseline repair kit to repair the hoseline.
- Be properly trained and prepared to evacuate fuel and fumes from the hoseline using the displacement and evacuation kit.

LAYOUT

5-263. The assault hoseline deployment and layout should be according to the appropriate TM. The assault hoseline system layout is displayed in figure 5-10 on page 5-46

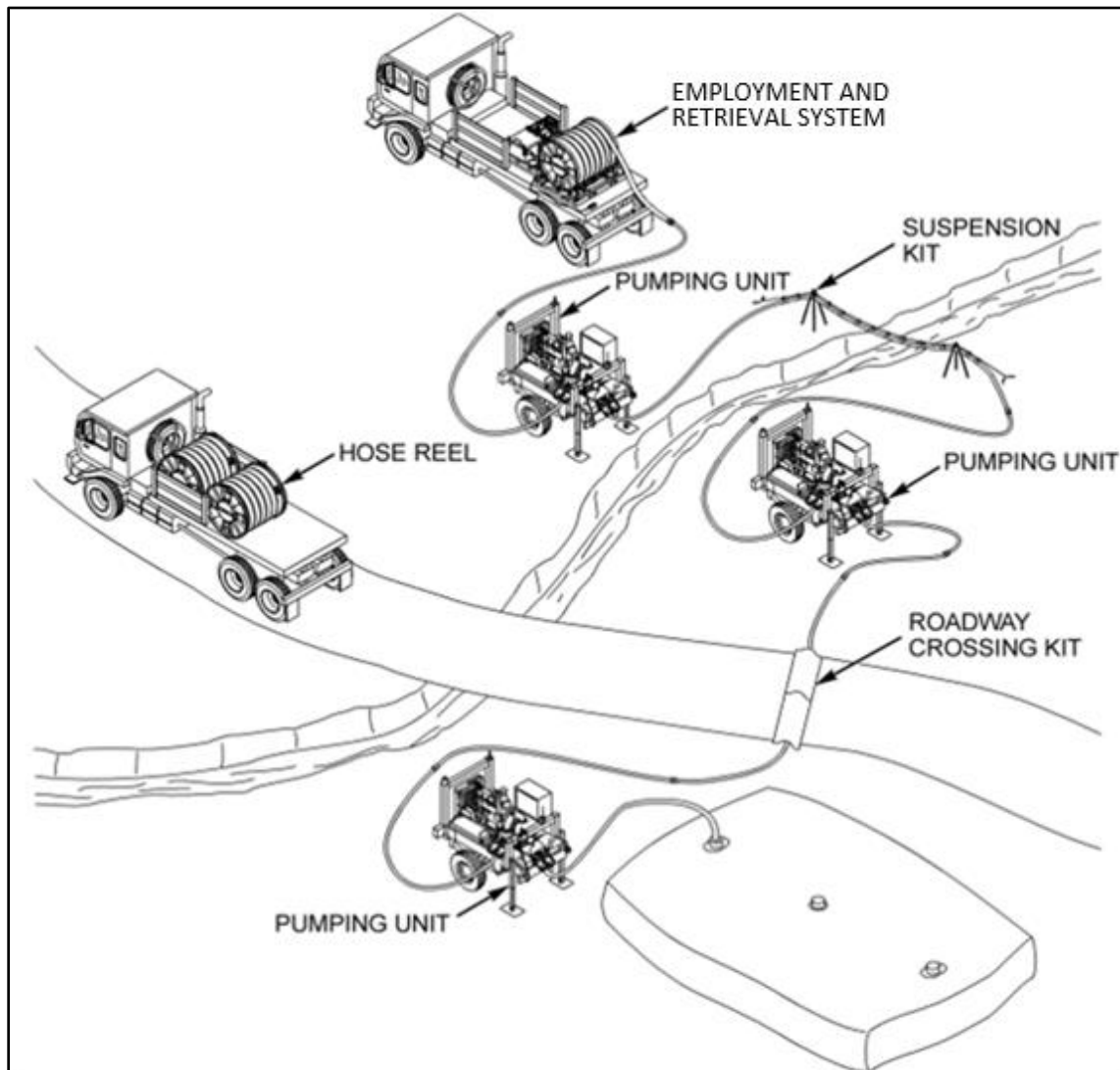


Figure 5-10. Layout of assault hoseline system

5-264. 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 conducting assault hoseline system 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.

The assault hoseline layout should be in accordance with the following criteria to properly layout the system.

ROUTE SELECTION

5-265. A route reconnaissance of the area between the stations in which the assault hoseline system 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 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.

5-266. 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 THE ASSAULT HOSELINE SYSTEM

5-267. Deployment of the assault hoseline system 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

5-268. 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

5-269. 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

5-270. When selecting pump station sites, the location of the lead or first pump station will be determined by the location of the fuel source.

5-271. 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.

5-272. 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.

5-273. 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.

5-274. For assault hoseline system hydraulics, see appendix H of this manual.

Pressure-Reducing Stations

5-275. 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.

5-276. 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

5-277. 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.

5-278. For additional information on the maintenance of the assault hoseline system, see the appropriate TM.

5-279. Assault hoseline system operations are 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 VIII – TANK VEHICLE OPERATIONS

5-280. 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

5-281. 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 (in this case, 4 x 5 feet) 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.

5-282. 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.

5-283. 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 E.

5-284. Ensure proper distance between tank vehicles is established prior to operation.

5-285. Tank cars should be inspected before each use according to MIL-STD-3004-1A. 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.

5-286. 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.

5-287. Tank vehicles must carry only one grade or type of fuel.

5-288. All grounding and bonding procedures must be followed in accordance with chapter 6 of this publication.

USE OF TANK VEHICLES

5-289. 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.

5-290. 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.

5-291. 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.

5-292. Ensure personnel conducting refueling are prepared for a fire emergency and the procedures in case of fire in accordance with unit SOP and chapter 6 of this publication.

5-293. 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.

5-294. 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 IX - DEFUELING OPERATIONS

5-295. 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

5-296. 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.

5-297. 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

5-298. 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.

5-299. A defueling tube is fitted onto the suction hose. The tube is inserted into the tank and most of the fuel is pumped out.

5-300. 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

5-301. 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

5-302. 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.

5-303. 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 the quality surveillance section of this chapter.

5-304. 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.

5-305. 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 may 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

5-306. 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

5-307. 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 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

5-308. 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.

5-309. 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

5-310. The same precautions apply to indoor defueling as outdoor defueling, except for the following exceptions:

- 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

5-311. 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.

5-312. 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

5-313. Drained fuel should be disposed of properly. Dispose of all drained fuel according to installation or local environmental policy.

SECTION X – WATERFRONT OPERATIONS

5-314. 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.

5-315. 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.

5-316. Piers and wharves at base terminals are equipped with ship-to-shore hoses; 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

5-317. 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.

5-318. 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.

5-319. 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

5-320. 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.

5-321. 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.

5-322. 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.

5-323. Prior to offloading refer to MIL-STD-3004-1A for testing requirements.

SECTION XI - TANK CAR OPERATIONS

5-324. 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 in chapter 2.

5-325. 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 for details of facility design requirements.

5-326. Procedures for loading and unloading tank cars are given in appendix G.

SECTION XII - PACKAGED PETROLEUM PRODUCTS

5-327. Packaged petroleum products are not the same as packaged petroleum fuels. Both are described below.

5-328. 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.

5-329. 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.

5-330. Soldiers storing or transferring class III products must accurately account for receipt, issue, and stocks on hand for both bulk and packaged products. Units must ensure protection, maintain control, and provide an audit trail. They must also inventory all packaged petroleum products at least once a year according to procedures in AR 735-5. Units adjust any inventory discrepancies. Aggressive management policies must be pursued to permit prompt and accurate identification of shortages or overages.

5-331. Using unit commanders responsible for receiving storing and issuing packaged petroleum products perform the following:

- Designate in writing a responsible individual to maintain control of all fuels and to provide an audit.
- Designate in writing a responsible individual to maintain control of all fuels and provide an audit trail.

5-332. All petroleum packaged products must be inspected at the frequencies established in MIL-STD-3004-1A, 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.

5-333. Products must be checked against the DOD Quality Status List 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 DODM 4140.27, Volumes 1 and 2.

5-334. Products with an expired shelf life that are not listed on the Quality Status List 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.

5-335. 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 Quality Status List, 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 Quality Status List, the activity will be able to benefit from any product extensions granted to other units or agencies that have submitted products for testing.

5-336. 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 Quality Status List.
- Marking of containers with new shelf-life test information.
- Segregation of off-specification items.
- Disposal procedures for off-specification product.

Chapter 6

Safety, Environmental Stewardship, and Protection

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

SECTION I - PETROLEUM PROPERTIES

6-1. This section describes the properties of various petroleum products to include flash point, specific gravity and explosive range.

DESCRIPTION OF FUELS

6-2. 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 DOD.

6-3. 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.

6-4. 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

6-5. 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

6-6. 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

6-7. 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.

6-8. The most common type of diesel fuel 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

6-9. 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

6-10. 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

6-11. Aviation gasoline (avgas) 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

6-12. 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 jet propulsion fuel, type 4 (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 fuel system icing inhibitor (FSII), static dissipating additive (SDA), or corrosion inhibitor/lubricity improver (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.

6-13. Additives are usually injected by the defense fuel supply point; however, there are exceptions when petroleum organizations must inject the additives.

6-14. FSII prevents the water in fuel from freezing at normal water-freezing temperatures and helps 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 or 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.

6-15. 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.

6-16. 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 or F-24 that provides lubricity to fuel wetted parts in reciprocating engines.

Note: Refer to MIL-STD-3004-1A for the receipt and use limits for jet fuel additives.

CHARACTERISTICS AND HAZARDS

6-17. 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

6-18. 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

6-19. 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

6-20. 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.

6-21. 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 0.7 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.

6-22. 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.

6-23. The key point is an empty or nearly empty petroleum tank or container is still very dangerous due to remaining fuel vapors.

Vapor Pressure

6-24. 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

6-25. 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

6-26. Electrostatic susceptibility 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

6-27. Autoignition temperature 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

6-28. 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

6-29. 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

6-30. Additional fuel properties and behavior after combustion are described below.

Heat of Combustion

6-31. 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 produced.

Flame Spread Rate

6-32. Aviation fuels containing avgas or kerosene mixtures have flame spread rates of from 700 feet to 800 feet per minute. Kerosene-based fuels (JP8 or F-24, Jet A-1/A, DF2) have flame spread rates of approximately 100 feet per minute.

Specific Gravity

6-33. 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

6-34. Fuels will not dissolve in water. This means water-based foams can be used for putting out petroleum fires.

FLAMMABLE AND COMBUSTIBLE PRODUCTS

6-35. 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.

6-36. 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.

6-37. Table 6-1 on page 6-6 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 6-1. Classification of flammable and combustible fuel

<i>Classification</i>	<i>Flash point (Fahrenheit)</i>	<i>Boiling point (Fahrenheit)</i>
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	
Combustibles		
Class II	At or above 100 and below 140	
Class IIA	At or above 140 and below 200	
Class IIB	At or above 200	

SECTION II - SAFETY AND HEALTH

6-38. Petroleum products can be handled and stored safely if users understand and respect the unique safety hazards they present. This section outlines hazard control measures and safety techniques to facilitate the safe receipt, storage, and issue of bulk petroleum. 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 lubricants presents safety hazards and precautions that bulk fuel managers and handlers must consider and alleviate during those processes. Thus, controlling bulk fuel vapor formation and ignition sources at all times is critical.

6-39. Safety training is the key to preventing accidents. Safety training starts during the Soldier's initial entry training and continues throughout their military service. Sustainment commanders are responsible for ensuring all fuel handlers are trained to know about petroleum and the safety principles for handling and using petroleum products. In addition, handlers learn self-care techniques, fire prevention, first aid, and emergency safety procedures.

6-40. The U.S. Army Quartermaster School Petroleum and Water Department website provides updates and messages regarding safety and health in petroleum operations for the petroleum handling personnel to review.

STORAGE AND TANK VEHICLES

6-41. 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, proper grounding, certain loading and unloading procedures and other procedures to ensure safe handling of petroleum products.

COLLAPSIBLE FABRIC FUEL TANKS

6-42. To avoid complete destruction of a tank farm by fire, units provide proper spacing between collapsible fabric fuel tanks by properly constructing earthen berms around the tanks. See TB 10-5430-253-13 for the proper dimensions for constructing fuel berms.

6-43. In addition, units —

- Provide a minimum of 50 feet (15 meters) between collapsible fabric fuel tanks and the following:
 - Uninhabited building for new projects.
 - Pump house or filter separator building.
 - Taxiing aircraft.
 - Fence, if space is a limitation 9100 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 a minimum of 100 feet (30 meters) between collapsible fabric fuel tanks 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 collapsible fabric fuel tanks and the following:
 - Aircraft warning radar antennas.
 - Areas where airborne surveillance radar may be operated.
- Provide a minimum of 500 feet (150 m) between collapsible fabric fuel tanks and airport ground approach and control equipment.

SAFE DISTANCES FOR FUEL STORAGE IN HARDWALL TANKS

6-44. To avoid complete destruction of a tank farm by fire, units space the tanks a minimum clear distance of two diameters (or three diameters, center-to-center) for steel tanks, avoiding rigid geometric patterns. 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 6-2 shows the minimum distance between tanks for fuel storage.

Table 6-2. Safe distance for fuel storage in hardwall tanks

<i>Capacity of tank, in barrels</i>	<i>Distance between tanks, in feet</i>
Less than 2,500	50
2,500 but less than 5,000	75
5,000	100
10,000	130
15,000	160
20,000	180

6-45. 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.

6-46. Tankers are placed at a minimum of 25 feet apart (measurement taken from the center of the tank trucks) during transfer operations. Be aware that empty tankers are at least as dangerous, if not more dangerous, as full tankers due to residual vapors.

6-47. Refer to UFC 3-460-01, for minimum distance from adjacent buildings and property lines.

TANK VEHICLE OPERATIONS SAFETY

6-48. 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 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.

- Take precautions to prevent any fuel leak out of a tank vehicle from draining towards a nearby building or water.
- Parking of refueler vehicles and trailers provide a minimum of 25 feet between the centerlines of adjacent vehicles and trailers when in the parked position or 10 feet minimum of clear space between parked fuel vehicles and trailers, whichever is greater.
- Provide side protection, such as a common masonry wall of brick or tile, when needed.
- 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 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.

Note: For more vehicle-specific spacing guidance, reference the appropriate vehicle technical manual for required distance between respective vehicles.

6-49. 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. Ensure the chock block is positioned in the proper position for vehicles parked on a slope.

6-50. 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. Other considerations include—

- Ensure the receiving vehicle's driver has been trained on how to properly operate the dispensing nozzle and wear proper PPE. A driver familiar with his vehicle is more likely to fill it safely to the proper level without spillage. Then ensure the driver is actually properly operating the dispensing nozzle and wearing the appropriate PPE.
- Check the pressure/vacuum relief valves frequently in cold weather to be sure they are operating properly. Refer to the appropriate TM and coordinate with maintenance personnel to determine minimum and maximum pounds per square inch (psi) of pressure relief valves.
- Post NO SMOKING signs around the area of operations and enforce them. Prohibit smoking related materials around tank vehicles and in petroleum storage areas.

- Keep a fire extinguisher available 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.
- 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.
- 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.

6-51. 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 fire. Avoid driving near fires.

6-52. Clothes soaked with fuel become highly flammable. If clothes become soaked with fuel, wet the clothes with water and remove them. 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

6-53. 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.

6-54. 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.

6-55. 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.

6-56. 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.

6-57. 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.

6-58. Before opening aircraft or vehicle fuel ports or doing any other operation that would permit fuel vapors to escape into the air, fuel handlers should bond themselves to the equipment by taking hold of it with a bare hand. 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. Fuel handlers also should avoid inhalation of vapors. They should 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.

6-59. Proper clothing and footwear reduces the chance of static electricity buildup on fuel handlers and is discussed later in this chapter.

BONDING AND GROUNDING

6-60. The two primary static electricity control methods are bonding and grounding. 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. Bond the fuel nozzle to the vehicle or equipment by maintaining metal-to-metal contact between the nozzle and vehicle or equipment being refueled. The bond is maintained until the refuel operation is complete.

6-61. Earth grounding is the process by which an electrical connection is made to the earth. The earth, particularly soft damp earth, can accept electrical charges. The charges then dissipate harmlessly. To ground equipment, the handler 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.

6-62. 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.

6-63. 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.

6-64. 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 be absorbed. Install the ground rod and wire, and keep the soil around the rod moist. Ground rods are usually made of copper-weld steel. A portable sliding-hammer grounding rod 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.

6-65. 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 its top is level with the surrounding surface. At other facilities, drive the rod to a depth where its 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, when obvious damage is discovered and after any damage repair.

6-66. An effective grounding system has a resistance of 10,000 ohms or less. The unit or agency that maintains fixed grounding systems is required to 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.

6-67. No quick or easy way exists to test a ground's adequacy. The testing procedures can be 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.

- 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 the fuel handler 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.
- 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. See table 6-3 for required 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 refueling vehicle. The vehicle or aircraft being refueled is then grounded, and nozzle is bonded to the aircraft. Use this method only when it is absolutely impossible to use the first method.

Table 6-3. Required depths for ground rods

<i>Type of Soil</i>	<i>Depth of Grounding Rods</i>
Coarse ground, cohesion-less sands and gravels	6 feet
Inorganic clay, clayey gravels, gravel-sand-clay, clayey 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

- 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, that commander 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 bet the aircraft and the refueling system or refueler and between the nozzle and the aircraft. 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

6-68. Personal protection is key in preventing personal injury or death. It is the individual Soldier's responsibility to take the necessary measures and precautions, to include wearing personal protective equipment, using safe working practices and techniques and learning proper first responder procedures, 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.

6-69. When handling petroleum products, fuel handlers adhere to the safety considerations delineated in the appropriate safety data sheet, in order to protect their own health. Eye and skin contact should be avoided through the use of protective eyewear, fuel handler gloves, and protective outer garments.

6-70. Inhalation exposure can occur from the vapor or aerosol mist during fuel transfers. Site leaders position nearby personnel away from the vapor or aerosol plume. Handling and transfer of fuel should be performed in well-ventilated areas.

6-71. Clothing should be promptly removed if it becomes wet with fuel. Clothing should be laundered before wearing again.

6-72. To avoid personal injury, the command and fuel handlers will—

- 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, hard hat, splash and spray resistant eye protection, hearing protection, fuel resistant gloves, fire retardant clothing and boots.
- Wear eye protection (chemical-type goggles or face shield) whenever there is a likelihood of splashing or spraying liquid. Contact lenses should not be worn, and eyewash water should be provided.
- 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, avoiding fuel such as gasoline or kerosene, or other toxic agents for cleaning.
- Use walkways on tank vehicles, tank firewalls, and berms.
- Do not load, transfer, or move petroleum fuel if an electrical storm is within three miles.
- Ensure personnel bond themselves with equipment prior to performing any petroleum operations.

6-73. 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.
- 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 or igniting. 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

6-74. Personnel wear personal protective equipment or individual protective equipment 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 (chemical-type goggles or face shield), hearing protection, unit-issued fuel resistant gloves, and boots. Personnel required to wear personal protective equipment should be trained in its use, be issued the personal protective equipment or individual protective equipment, and ensure its serviceability. This organizational equipment must include fuel resistant gloves. In addition, personnel should —

- Wear shirt sleeves rolled down and buttoned.
- Avoid wearing or carrying loose items of clothing.
- Avoid wearing nylon or wool when conducting fuel operations as nylon or wool produces static electricity.
- Ensure footwear is serviceable.
- Avoid wearing contact lenses.

6-75. The joint service lightweight integrated suit technology chemical protective ensemble and protective mask, and other individual protective equipment, restrict movement and activities. In addition, they make it difficult to perform even the simplest tasks. Personnel may be required to wear mission-oriented protective posture (often referred to as MOPP) gear when directed. This normally occurs when threat forces have used CBRN weapons or are likely to do so. Petroleum organizations and units must familiarize their personnel to performing petroleum mission related tasks while wearing mission-oriented protective posture gear.

6-76. Supervisors conduct frequent risk assessments 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 wearing of field gear is at the commander's discretion. In addition, personnel should —

- Wear fuel-resistant or nitrile or neoprene gloves and protective clothing to keep fuel off the skin.
- Ensure proper eye wear (goggles, safety glasses or splash and spray resistant eye wear) and hearing protection is worn when handling fuels or operating equipment.
- Wear authorized fuel handler's coveralls, which offers 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.

6-77. A National Institute for Occupational Safety and Health approved air-purifying respirator with organic vapor cartridges or canisters may be permissible under certain circumstances. These circumstances include 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.

6-78. Personnel 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 FOR PETROLEUM-RELATED INJURIES

6-79. First aid (self-aid and buddy aid) is urgent and immediate lifesaving and other measures which can be performed for casualties (or performed by the victims themselves) by nonmedical personnel when medical personnel are not immediately available (FM 4-02).

6-80. If any type of petroleum product comes in contact with skin, wash it off immediately with soap and water.

6-81. 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.

6-82. 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 the Soldier's clothes as the Soldier removes them.

6-83. Safety data sheets give additional first aid procedures for exposure to hazardous materials.

6-84. Commanders must ensure —

- Personnel are trained on combat lifesaver procedures, to include artificial respiration.
- Refueling sites and equipment have adequate first aid kits and equipment to conduct first aid.

6-85. For additional information regarding first aid, refer to TC 4-02.1.

PETROLEUM FIREFIGHTING AND PREVENTION

6-86. The primary danger while handling petroleum is the chance of a fire or explosion. The following sections address the classes of fires, types of firefighting equipment and key planning considerations.

CLASSES OF FIRES

6-87. Fires are distinguished by five 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.
- Class K fires involve combustible liquids used in cooking such as grease, animal fats, and cooking oils. Wet chemical fire extinguishers best extinguish class K fires.

ELIMINATING THE ELEMENTS OF FIRE

6-88. Fires require three elements to keep burning—fuel, heat and oxygen. Eliminating or sufficiently controlling one or more of these elements will extinguish the fire.

- Eliminating the fuel element. 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.
- Eliminating the heat element. 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.
- Eliminating the oxygen element. It is impossible to remove all air in the area of a fire. However, firefighters can dilute the air and smother the fire. Diluting the air means reducing the percentage of oxygen in the air to the point it can no longer support combustion.

6-89. 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

6-90. 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. To avoid fire or explosions, the command and bulk fuel handlers:

- 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.
- Use only authorized tools, equipment, and clothing. Use explosion proof lights and flashlights. Friction and impact between tools and materials can create sparks.
- Do not use open flames, heating stoves, or other devices that give off heat, sparks, static electricity and other sources of ignition in petroleum storage and work areas.
- Prohibit the use of cell phones and unapproved electronic devices during refueling operations and in areas where petroleum vapors are present.
- Prohibit the use of smoking material, including cigarettes, matches and electronic smoking devices, in the vicinity of bulk fuel storage, as they are the single greatest cause of fires.
- Keep tools and equipment in safe and good working condition. Electrical equipment and wires create fire hazards when they produce exposed electrical currents (arcs and sparks) or when they create excessive amounts of heat.
- Pay particular attention to safety data sheet for cleaning and storing instructions. Spontaneous heating of a combustible material takes place when its characteristics and the right environmental conditions cause a heat-producing chemical reaction. 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.
- Always ground and bond petroleum equipment being used (such as the pump, filter separator, tank truck, storage tanks,) and the equipment receiving fuel during petroleum operations.
- 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 regarding welding and cutting using open flames that can ignite vapors. Any welding performed on or near petroleum product-use equipment must be closely controlled to prevent fires or explosions. Handlers thoroughly clean and reduce vapors to acceptable safety levels in storage tanks, tank cars, tank vehicles, drums, and vehicle fuel tanks before cutting or welding them, and check local policies for doing such work.

VAPOR AND COMBUSTIBLE MATERIALS

6-91. Vapors and combustible materials must be controlled and minimized 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 the fire presents less danger and risk. To minimize danger from vapors and combustible materials—

- Control spills with a proactive spill prevention program in accordance with DODM 4715.05 Vol. 1, AR 200-1, and local SOPs.
- Frequently inspect tank seams, joints, piping, valves, pumps, and other equipment for leaks. Repair leaks immediately. Replace defective hoses, gaskets, and faucets. Stencil collapsible tanks and hoses with wet dates.
- Ensure work and storage areas are 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.
- Fill containers 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.
- Remember 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.
- Ensure all nozzles and hand actuated valves are 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.
- Ensure areas are clean; proper storage and disposal 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 CFR, Part 172.
- Ensure fuel nozzles and hoses are capped when not in use.

FIRE EXTINGUISHERS

6-92. The primary method for fighting petroleum fires at smaller class III supply points is portable, carbon dioxide fire extinguishers. Procedures for placement include—

- 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.

6-93. Locate fire extinguishers (or signs indicating the closest one) throughout the supply point. The following are general guidelines for the use of fire extinguishers:

- According to National Fire Protection Association (NFPA) standards, disposable fire extinguishers must be replaced every 12 years. Refer to the date stenciled on the fire extinguisher.

All NFPA standards can be found at the NFPA website; the website address is listed in the references section of this publication.

- 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 assures that fire extinguishers are in their assigned place, are not blocked or hidden, and are mounted in accordance with NFPA 10.
- Pressure gauges show adequate pressure to determine whether leakage has occurred. A carbon dioxide 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 (annual, six-year, and 12-year maintenance checks).
- Recharge or exchange extinguishers immediately after use.
- Follow manufacturer's instructions for charging, maintaining, and using the extinguisher.

FIRE EXTINGUISHER TYPES

6-94. 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.

6-95. Fire extinguishers are also referred to by the amount (weight) of agent in the extinguisher, (for example, 20 pounds) and by the square footage the extinguisher can cover and the type of fire it can put out, which is expressed as a number and letter, (for example, [20 B:C]).

6-96. 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. Anytime fuel is moving, fire extinguishers will be readily available to the pump operator and all nozzle operators.

6-97. 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 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.
- The Fire Suppression Equipment System (FSES) is standard with large class III bulk supply systems. The FSES has the capability of extinguishing 1500 square feet petroleum fire with two agents, potassium bicarbonate powder and aqueous film forming foam. The FSES is part of the IPDS.

Firefighting Tactics

6-98. 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 the 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.

6-99. Supply point supervisors making firefighting plans —

- Assign two people to each fire point in the supply point and three personnel per FSES.
- Make sure all Soldiers in the supply point know and practice procedures for using the fire extinguishers.
- 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.
- 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.
- Require all personnel not involved in fighting the fire to 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.

6-100. In addition, supervisors 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 staffed. Fire drills are conducted as the tactical situation permits.

6-101. When using fire extinguishers, Soldiers should remember the acronym PASS:

- Pull the pin.
- Aim at the base of the fire.
- Squeeze the trigger.
- Sweep side to side.

6-102. 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

6-103. 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 be 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 open flames for possible sources of flammable vapor release. Ensure “NO SMOKING WITHIN 50 FEET” signs are posted in such locations to ensure 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

6-104. 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 enables leaders to take better care of Soldiers and their families. It also saves resources vital to operational readiness.

6-105. 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

6-106. The commander must instill an environmental ethic in their 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. 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 or 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.

6-107. The environmental compliance in a petroleum supply operations program should cover:

- Hazardous materials management in accordance with DA PAM 710-7.
- Hazardous waste management in accordance with the U.S. Army Environmental Command and the Resource Conservation and Recovery Act.
- Hazard Communications in accordance with DODI 6050.05, and AR 385-10.
- A spill prevention, control and countermeasure plan that identifies fuel storage locations therefore, potential spill sites and those measures taken to prevent a spill from occurring.
- A spill contingency plan is required in conjunction with the spill prevention, control and countermeasure plan. The spill contingency plan 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. The unit should have training on the plan and standard operating procedures.
- Environmental stewardship protection program measures.

6-108. Personnel at all levels must protect our environment. This includes Soldiers, NCOs, officers, commanders and appointed personnel.

6-109. 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.

6-110. NCO 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.
- Building a commitment to environmental protection.
- Identifying environmental risk associated with tasks.
- Planning and conducting 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.

6-111. Officer 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.

6-112. Appointed personnel are appointed by the commander and should receive formal training. Their responsibilities include:

- Acting as an advisor on environmental regulatory compliance during training, operations, and logistics functions.
- Serving as the commander's eyes and ears for environmental matters.
- Serving 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.
- Conducting environmental compliance assessments to meet all applicable federal, state, and local regulations concerning environmental regulations.

SPILL DEFINITIONS

6-113. 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 that covers less than 18 inches in all directions.
- A small spill that extends less than 10 feet in any direction, covers less than 50 square feet, and is not continuous.
- A large spill that extends farther than 10 feet in any direction, covers an area in excess of 50 square feet, or is continuous.

6-114. 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

6-115. 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.

- Stop the flow of fuel.
- Contain the spill.
- Absorb/accumulate/dig.
- Containerize the hazardous waste.
- Transmit a report.

6-116. 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 fuel.
- Preventing the discharge of contaminated water into storm drains or the sewer system.
- Recovering the oil or minimize its effects.

6-117. Recovered fuel and contaminated absorbents, such as rags, are placed in Department of Transportation approved containers for disposal as hazardous waste.

ENVIRONMENTAL COMPLIANCE EQUIPMENT

6-118. Emergency spill response, whether in garrison or 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.

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Appendix A

Petroleum Systems and Equipment

This appendix 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

A-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, hoses, class III supply points, tank vehicles, and rail tank cars.

A-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.

A-3. Storage requirements may be met by using existing airfield or airport fuel storage tanks, tactical fuel systems, railroad tank cars, or any container that meets operational, safety, and environmental needs. Fuel 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.

A-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 hoses. These systems can be special purpose equipment sets designed for aircraft refueling or for use with ground vehicles.

A-5. Any equipment problems are properly documented on a product quality deficiency report (PQDR) in order to ensure the specifications to which military equipment is designed and manufactured meets operational requirements. PQDRs also provide the Army the ability to hold contracted manufacturers accountable for defective equipment manufacturing.

A-6. Equipment maintenance, to include preventative maintenance checks and services and regularly scheduled services are among the most important tasks that units complete 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.

A-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, drain and clean the tank before use. The use of commercial contractors is required to clean fixed petroleum

storage tanks. 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.

A-8. When loading and unloading petroleum products, the product must be the same as the product as in the receiving container. A Type C test is required to be performed prior to receipt of product into inventory (color, appearance and American Petroleum Institute [API] Gravity). Consult MIL-STD-3004-1A and DA PAM 710-2-1 for further information on specific scenarios.

A-9. Never carry mixed loads of fuel in multi-compartment tank vehicles.

A-10. 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, a water detector test must be performed. Do not use the fuel if it is contaminated.

A-11. After loading and before discharging a tank vehicle, inspect the tank for water. If any water is found, drain and remove it.

A-12. Foreign objects should not be carried in pockets or clothing when working around petroleum tanks. Keep tools away from tank openings.

A-13. Keep hoses in storage compartments when not in use. Do not remove dust caps or plugs from nozzles until they are ready for use.

A-14. 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 AR 702-7.

STORAGE CONTAINERS

A-15. Storage tanks are 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. These pipelines 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.

A-16. 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.

A-17. 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.

A-18. 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.

A-19. It is extremely important 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

A-20. The 5-gallon fuel can is used to issue small quantities of fuel to using units. It is especially useful in conditions where the container must be carried by hand or attached to the end user vehicle. The 5-gallon fuel can is made of plastic.

A-21. 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. The 5-gallon can must be properly marked to prevent commingling or refueling of equipment with the wrong product.

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

A-22. The 55-gallon drum is used to issue petroleum products, in smaller quantities, to using units. The 55 -gallon drum is considered a class III (P) product.

Stacking of 55-gallon drums

A-23. Stack drums horizontally in double rows with the closures (bungs and vents) facing outward at the three and nine 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 drums on end because rain, snow, and ice will collect in the drumhead, fade the markings 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 to identify the contents, detect leaks, tighten bungs and change gaskets. Various methods for stacking 55-gallon drums are given below.

Nested Stacks

A-24. The type of product and the terrain determine the number of drums stacked. 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. To store drums in nested stacks, consider the following items:

- The layout should be 70 foot-square. Then divide 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 A-1 on page A-4. 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 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.
- 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

A-25. Consider dunnage stacks 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 or in vertical tiers. (See figure A-1.) Procedures for creating dunnage stacks include the following:

- Construct the foundation for the layout and the first tier of the unit as described in the section on nested stacks.
- Place two double rows of 1-inch planks on top of the first tier.
- Then, attach wooden cleats as in figure A-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 stacking the drums in a pyramid, position them as shown in figure A-2.
- If stacking 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.

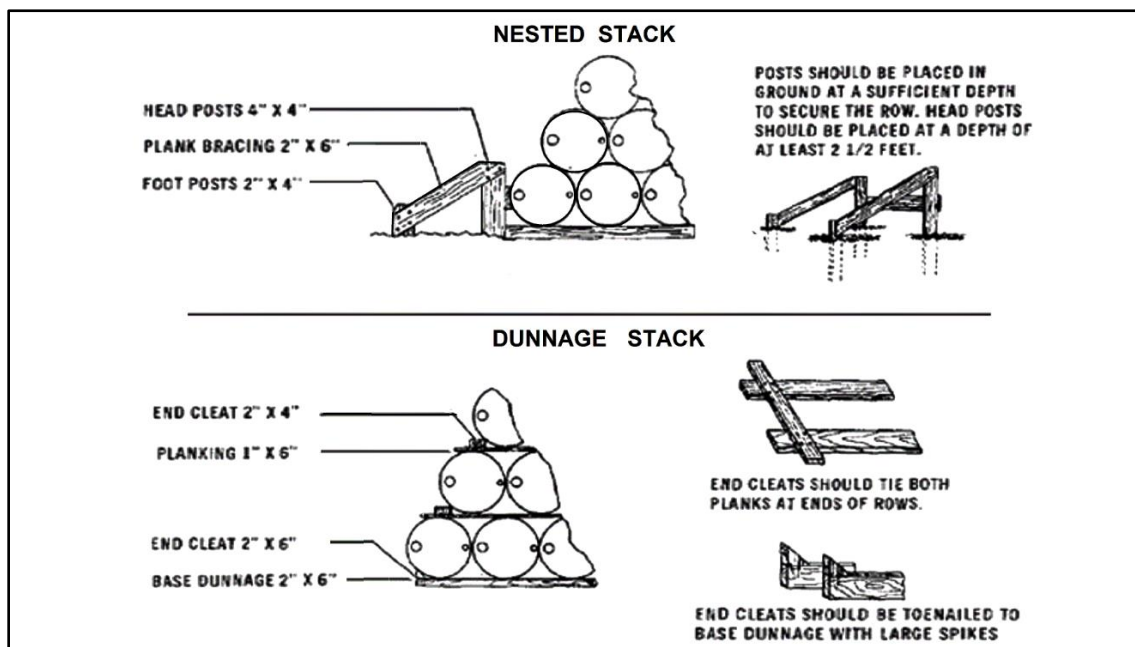


Figure A-1. Stacking of 55-gallon drums

Palletized Stacks

A-26. 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.

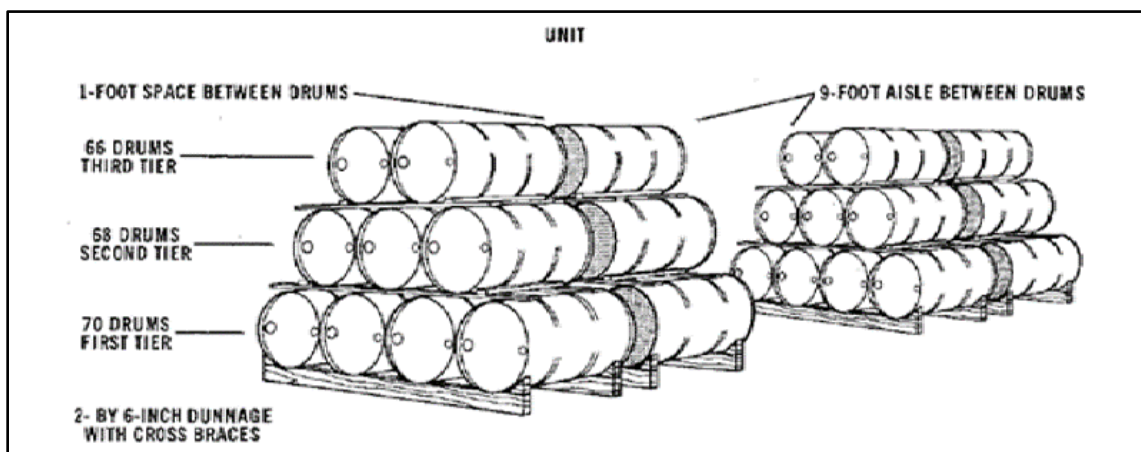


Figure A-2. Dunnage stack of filled 55-gallon drums

A-27. 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. Figure A-3 shows a typical site layout for storage of multiple palletized stacks.

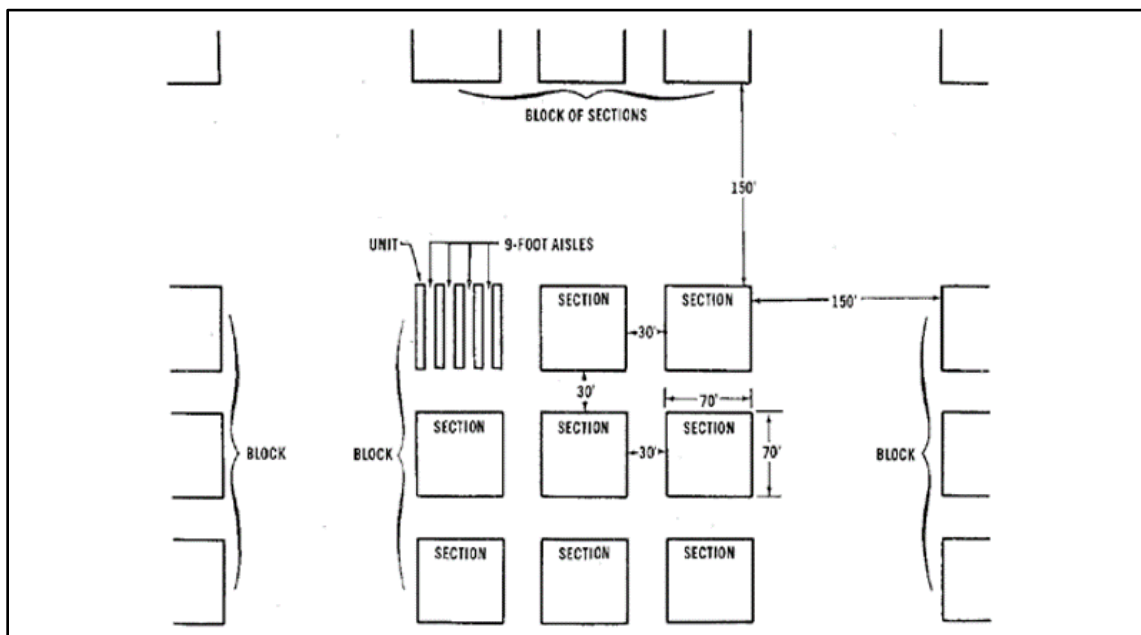


Figure A-3. Layout of area for stacking 55-gallon drums

Inspecting Containers and Storage Areas

A-28. Containers should be inspected biweekly for signs of leaks, abnormal swelling, or corrosion. In addition, 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. Remove unnecessary equipment in the area that hinders traffic movement or blocks 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

A-29. 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. The pressure control assembly is used to prevent overfilling and over-pressurization of the collapsible drum. The valve automatically shuts off the fuel flow when the collapsible fuel drums are full.

COLLAPSIBLE FABRIC FUEL TANKS

A-30. 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.

A-31. The typical collapsible fabric fuel tank, shown in figure A-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 and discharge assemblies with elbow fittings.
- Vent fitting assembly with a passive vent fitting assembly with a flame arrestor.
- Two filler and discharge hose assemblies with control valve.
- Two drain fitting assemblies with 2-inch x 10-foot hose assemblies.
- Berm liner equipped with four 2-inch x 10-foot hose assemblies.
- Two drain fitting assemblies and valve.
- Spare gaskets and O-rings.
- Type II or type III emergency repair kit.
- Lifting sling.

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.

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

A-32. 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 its expected service life, the responsible officer of that site or equivalent submits a

PQDR. Data required to fill out a PQDR is located on the data plate of the tank and on the shipping crate in which it was received.

A-33. 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.

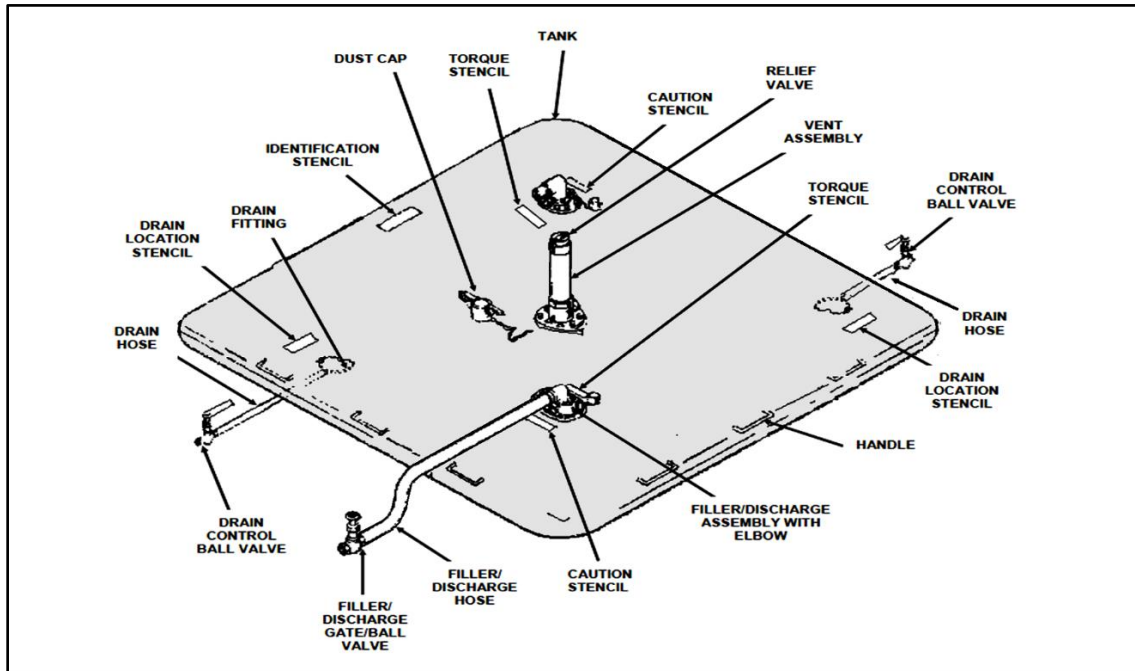


Figure A-4. Typical collapsible fabric fuel tank

A-34. There are currently four sizes of collapsible fabric fuel tanks in the Army inventory, all of which are made of an elastomeric woven fabric:

- The 3,000-gallon collapsible fabric tank is used to provide fuel to 800-GPM pumps at pump stations. It can also be used for temporary storage of liquid fuels where larger collapsible tanks are not practical.
- 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.
- 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.
- The 210,000-gallon collapsible fabric tank is also called the bulk fuel tank assembly. 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.

A-35. 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. Collapsible fabric fuel tanks over 10,000 gallon capacity should not be used for avgas storage to ensure timely stock rotation.

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

A-36. The 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.

A-37. 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 A-1 identifies allowable fuel quantities based on the size of the collapsible fabric tank.

- Black: Non-mission capable; 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, able to use to 100% of maximum storage capacity.

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

Shelf and Service Life of Collapsible Tanks

A-38. 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.

A-39. Shelf life is the period from which the tank is manufactured to the time when it is first filled. DODM 4140.27, Volume 1, 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). It is 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.

A-40. The Army shelf-life policy for collapsible fuel tanks as defined in TACOM LCMC MA 15-010, states: 12 years under depot like conditions. Depot storage conditions are defined as a dry, indoor environment. A dry-indoor environment for the purpose of this document is defined as one where the elastomeric component is not exposed to direct sunlight or the elements. This means any bag, blivet, or hose that is still in its wooden container or shipping container and is not directly exposed to sunlight or the elements is considered dry-indoor storage.

A-41. Elastomeric components stored in closed boxes, tricons or ISOs are considered a dry-indoor environment. Bags have a shelf life of 12 years and blivets and hose assemblies have a shelf life of 15 years.

A-42. Where there are instances or circumstances that units have the requirement to extend the shelf life of elastomeric components, the 923A or a 92F Senior NCO from the unit will be responsible for extending the shelf life in accordance with FTL 17-04. If a unit has a bag that is reaching 12 years, or blivets or hose assemblies reaching 15 years; a Senior 92F NCO or 923A will perform a visual inspection and file a memorandum for record with the results of the inspection. See FTL 17-04 for details on the process and criteria for extending shelf life of bags, blivets or hoses.

A-43. Elastomeric components stored outside on pallets or in boxes with the lid removed are not considered as being stored in a dry-indoor environment and have a shelf life of five years from the date of receipt.

A-44. 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. For example, 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 service-life of a minimum of three years.

A-45. DODM 4140.27, Volume 1 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.

A-46. 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 three 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 the tank is safe for use.

A-47. 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 is 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

A-48. The maximum storage capacity is set by the status of the fuel tank. Maximum storage capacity for a collapsible fabric fuel tank is used to determine the maximum storage capacity by cross linking the fuel tank capacity and status as shown in table A-1.

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

STATUS	210,000	50,000	20,000	3,000
BLACK (0%)	0	0	0	0
RED (50%)	105,000	25,000	10,000	1,500
AMBER (70%)	147,000	35,000	14,000	2,100
GREEN (100%)	210,000	50,000	20,000	3,000

A-49. 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

A-50. Classes of fluid leakage are—

- 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.

A-51. For additional information on collapsible fabric fuel tank inspections, refer to TB 10-5430-253-13.

FIXED TANKS

A-52. 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.

A-53. 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 such as motor gasoline (commonly referred to as 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.

A-54. 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.

A-55. 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.

A-56. Underground tanks may be of various types to include steel that will have a protective lining or coating.

OFFSHORE PETROLEUM DISTRIBUTION SYSTEM

A-57. The OPDS was designed by and for the United States Navy, for use with the Army IPDS or the Marine Corps' tactical fuel system. 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 and Marine Corps bulk petroleum distribution system. 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 operations. A civilian merchant crew staffs each tanker.

A-58. The new system does not incorporate afloat storage of fuel, but utilizes tankers of opportunity. The OPDS ship utilizes dynamic positioning, which requires no anchoring system. 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 pump fuel at a rate of 1.7 million gallons per 20-hour period from up-to-eight miles offshore in all bottom conditions. The OPDS ship provides the hose and pumping capability for a separate fuel tanker, which provides petroleum product for transfer to shore.

A-59. The system consists of an OPDS support vessel, an embarked tender vessel, and other watercraft including two lighter, amphibious, resupply cargos (known as LARCs), which will deploy the OPDS conduit and the BTU. The Navy is responsible for fuel delivery to the high water mark. The BTU serves as the interface between the oceangoing fuel delivery vessels and the ground-based distribution systems. Once the conduit is deployed, the support vessel will use dynamic positioning to hold the tanker supplying the fuel in place. Figure A-5 shows how the system connects from the supporting vessel through the BTU to prepare for connection to the Army IPDS. The Army receives fuel on the outlet side of the BTU and is responsible for moving the fuel inland.

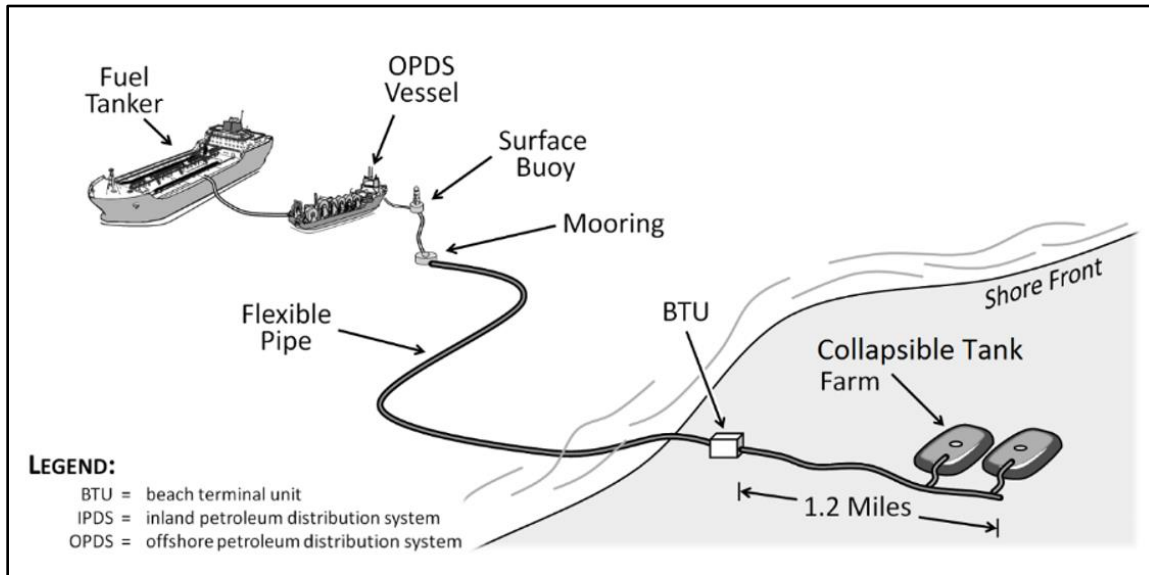


Figure A-5. Offshore petroleum distribution system

INLAND PETROLEUM DISTRIBUTION SYSTEM

A-60. The IPDS is a deployable ISO container configured, general support, bulk fuel storage and pipeline system. The IPDS is used to move bulk fuel as far forward in the theater as is practical. 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.

A-61. 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 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 multi-model network sources with a throughput capacity of 720,000 gallons of fuel per day (20 operational hours and four hours set aside for maintenance). This fuel is then pumped forward by means of a pipeline system and pump stations to tactical petroleum terminals. The pipeline can be constructed from multiple points. For quicker assembly, it is recommended to build from two or more start points simultaneously.

A-62. Each tactical petroleum terminal 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.

A-63. Some petroleum support companies have an assault hoseline section. These units utilize hoselines 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 identify leaks and to reduce and mitigate sabotage and theft. Generally, hoselines 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.

A-64. 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 the OPDS is required, planning for location and installation is accomplished concurrently. IPDS planning and execution is a collaborative process between quartermaster

petroleum and engineer personnel. Quartermaster units rely on engineer construction battalions for site preparation and construction of the IPDS. Engineers install the aluminum pipeline and pump stations.

A-65. Quartermaster pipeline and terminal operating units operate and maintain the pipeline and pump stations once they are installed. The IPDS can start at the BTU and run as far inland as practicable. It can also start at a TPT or commercial facility. The system is modular in design and can be tailored for any locality of operation. Basic components include pipeline sets, pump stations, and special purpose equipment.

A-66. Pump station intervals depend on system hydraulics. The normal interval on level ground is 15 miles. Pipeline hydraulics are briefly discussed in appendix H of this publication.

A-67. 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. PPTO companies 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.

A-68. The technical configuration of the IPDS 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. Figure A-6 displays the technical configuration of the IPDS.

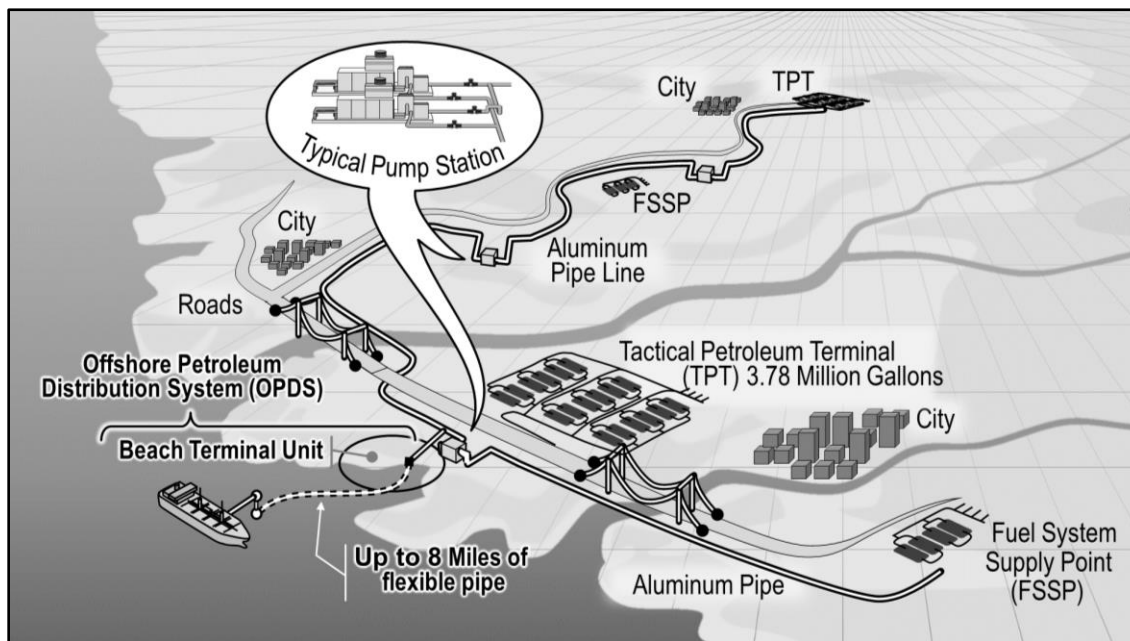


Figure A-6. Inland petroleum distribution system (IPDS).

TACTICAL PETROLEUM TERMINAL

A-69. The function of the TPT is to receive, store and issue bulk petroleum. In austere environments where bulk fuel facilities do not already exist, the TPT will store and provide the required quantities of fuel. They can also be used to augment existing facilities in a developed theater. The standard TPT, figure A-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 either from 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.

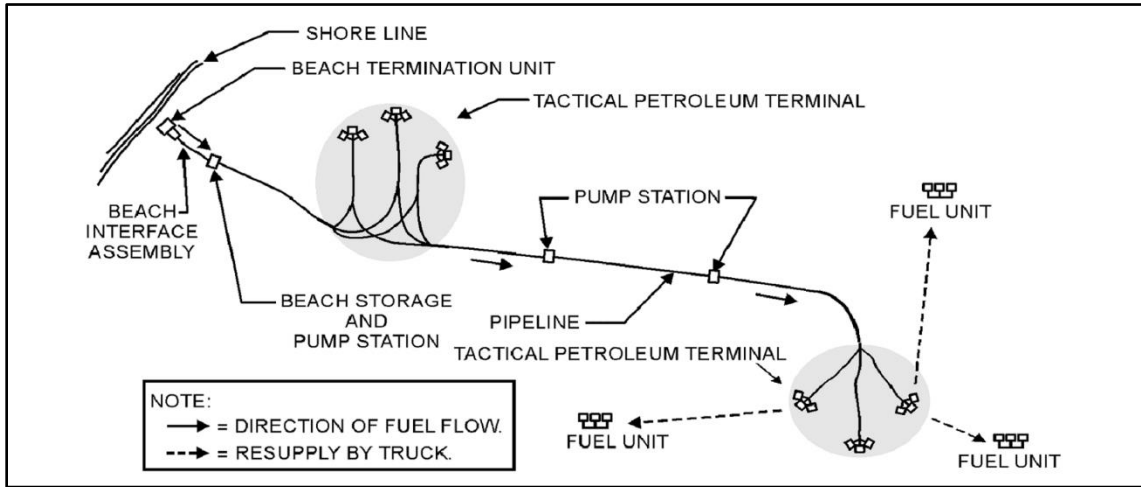


Figure A-7. A typical tactical petroleum terminal layout

FUEL UNIT

A-70. 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

A-71. 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, figure A-8 on page A-14, 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 camlocking 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.

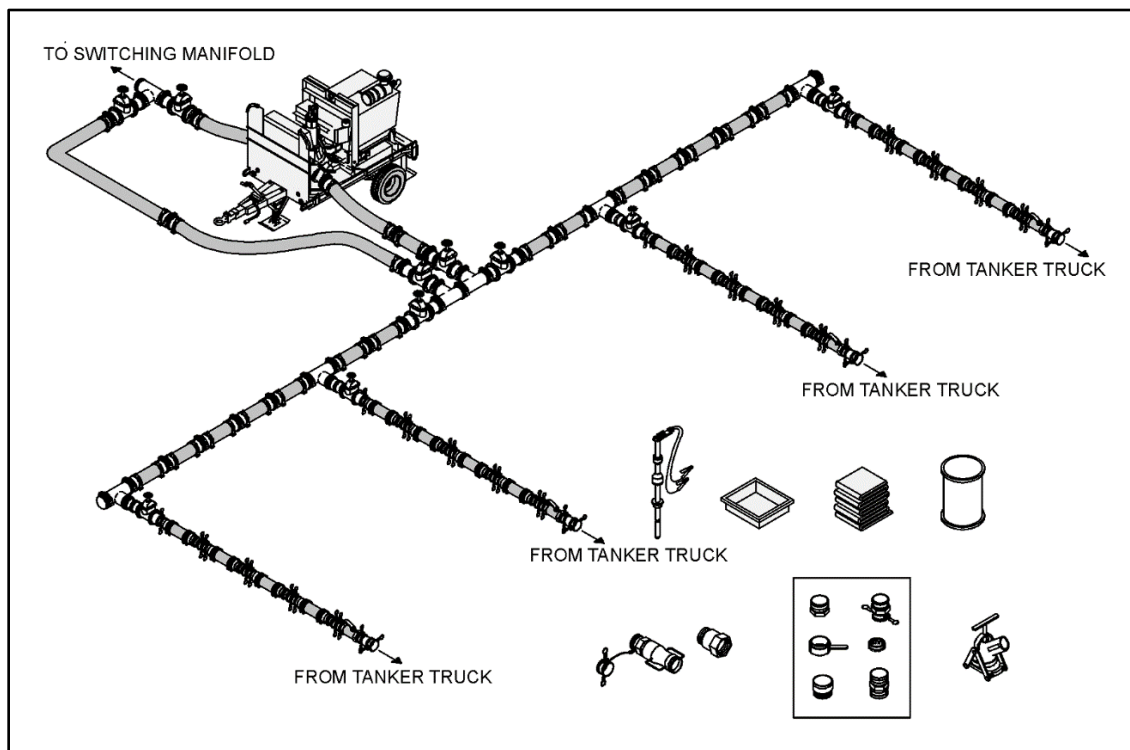


Figure A-8. Tanker truck receipt manifold

FUEL DISPENSING ASSEMBLY

A-72. The function of the fuel dispensing assembly is to issue bulk petroleum products from the fuel unit to tanker-trucks 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, figure A-9. The filter-separators are two-stage, vertical-type units designed to remove un-dissolved water and solid contaminants. Filter separators should be split to allow filtering of fuel back into the system. 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 six 4-inch fuel handling lines or the two 1½-inch fuel handling lines of the fuel dispensing assembly. The outlet fining for the six four-inch fuel-handling lines can be either a 3-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.

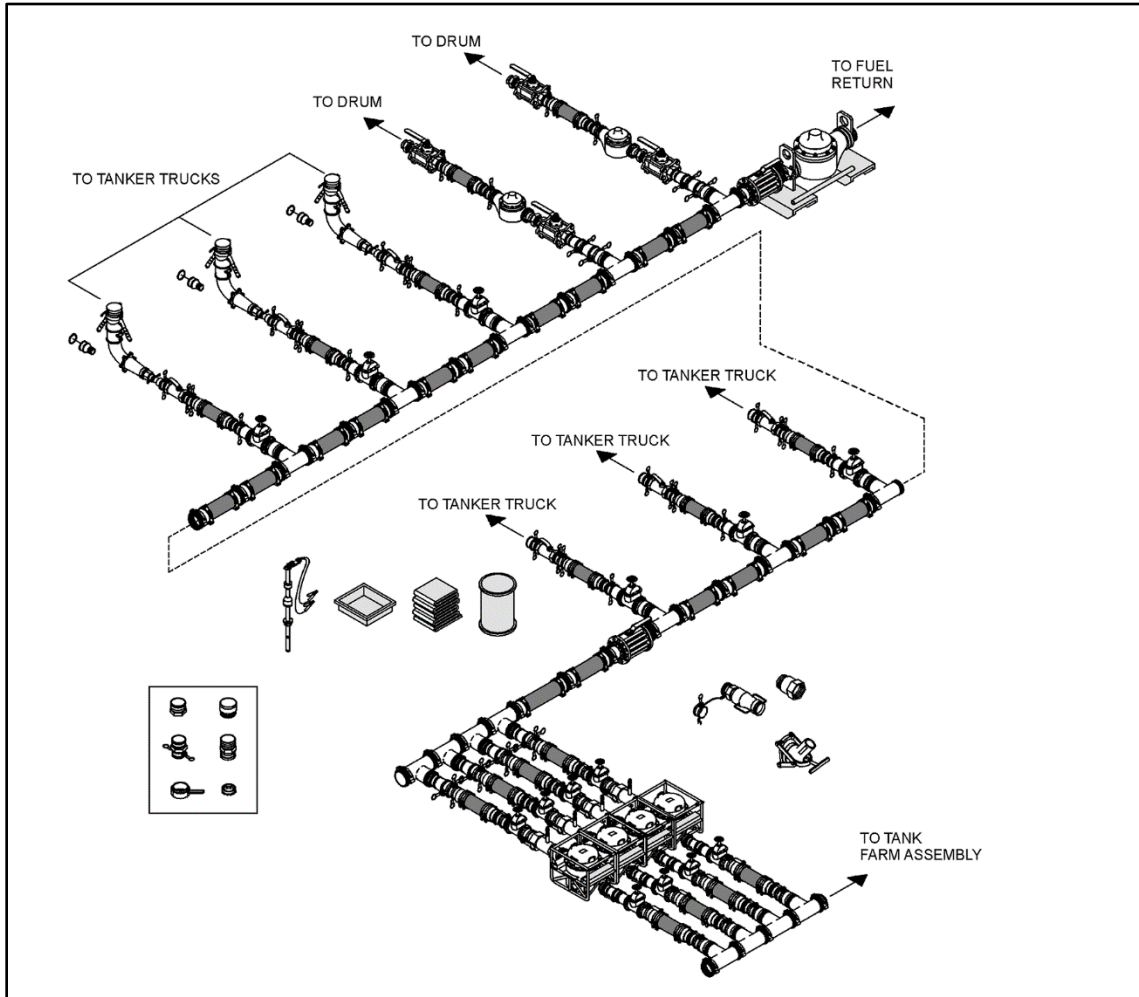


Figure A-9. Fuel dispensing assembly

TANK FARM ASSEMBLY

A-73. 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, 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 A-10 on page A-16 depicts the tank farm assembly.

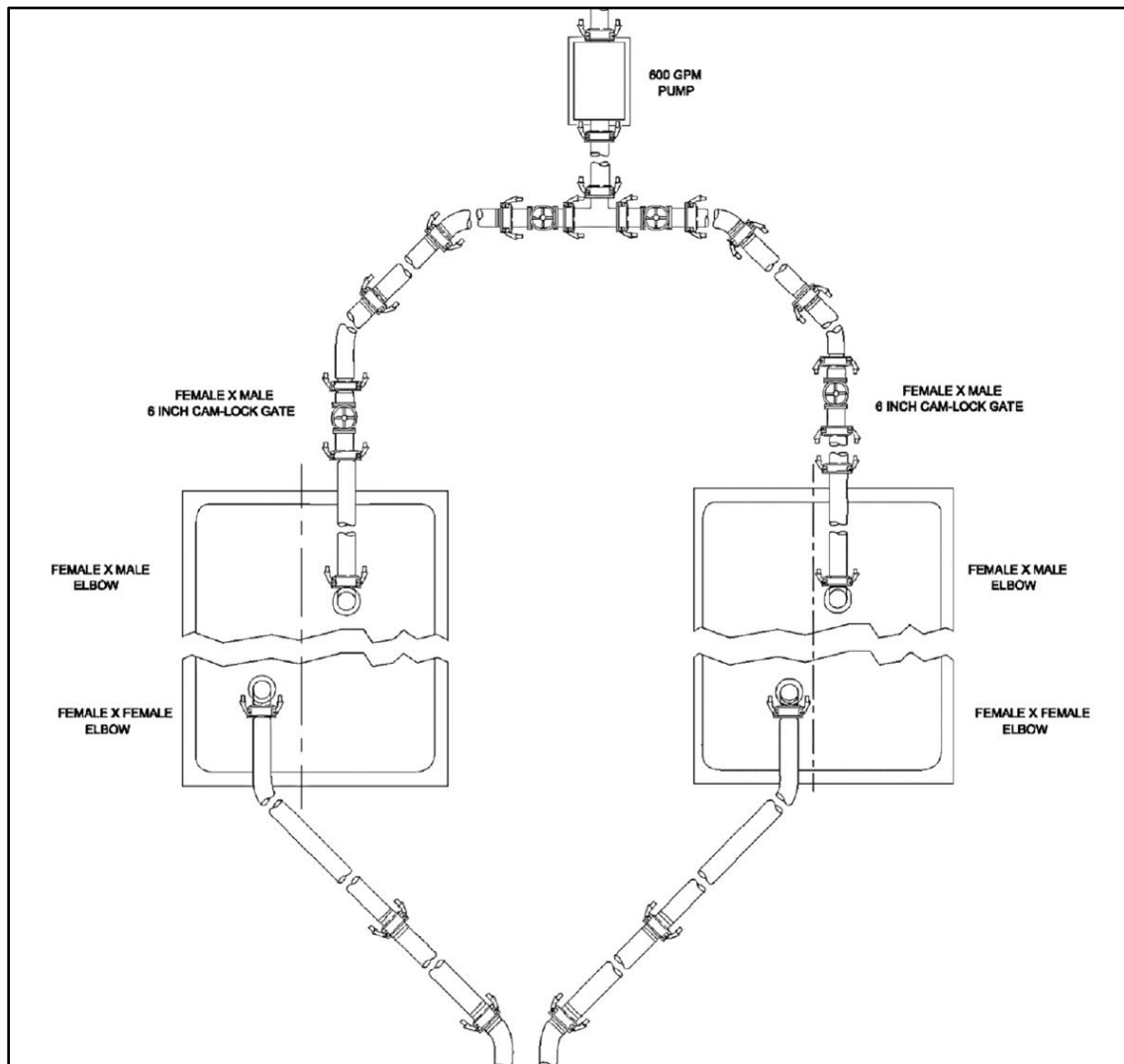


Figure A-10. Tank farm assembly

TRANSFER HOSELINE ASSEMBLY

A-74. 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. The transfer hoseline assembly provides this hose and its associated components. This hose is normally packed in triple containers, sometimes referred to as TRICONS. In operation, a triple container is placed on the back of a truck or forklift and the hose is dispersed where needed.

FIRE SUPPRESSION EQUIPMENT

A-75. Six sets of fire suppression equipment, figure A-11, are provided with each fuel unit. Each set consists of one trailer mounted fire extinguisher assembly, five 20 pound B:C fire extinguishers and three fire protection suits. The FSES contains two firefighting agents: Dry chemical compound (Purple K) and aqueous film forming foam. Purple K extinguishes fires by breaking up flame propagation. Water mixed with the aqueous film forming foam concentrate produces a foam that 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 compound.

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 FSES, is accomplished by use of a remote hose cart that contains an additional 150-feet of hose. The FSES has the capability of extinguishing a 1,500-square foot petroleum fire. Each FSES is supported with firefighting clothing. The clothing includes three aluminized proximity fire suits (with boots, gloves, and hood).

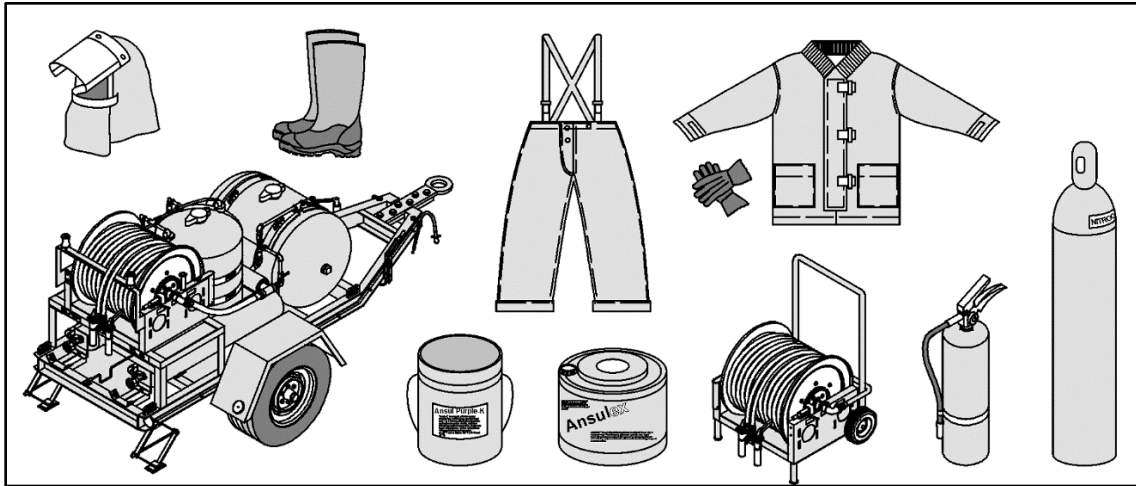


Figure A-11. Fire suppression equipment

50,000-GALLON TANK TPT, OPTIONAL CONFIGURATION

A-76. The function of the 50,000-gallon tank TPT is to increase or supplement the fuel unit's storage capacity. Figure A-12 on page A-18 shows the optional tank configuration. The 50,000-gallon tank TPT, 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.

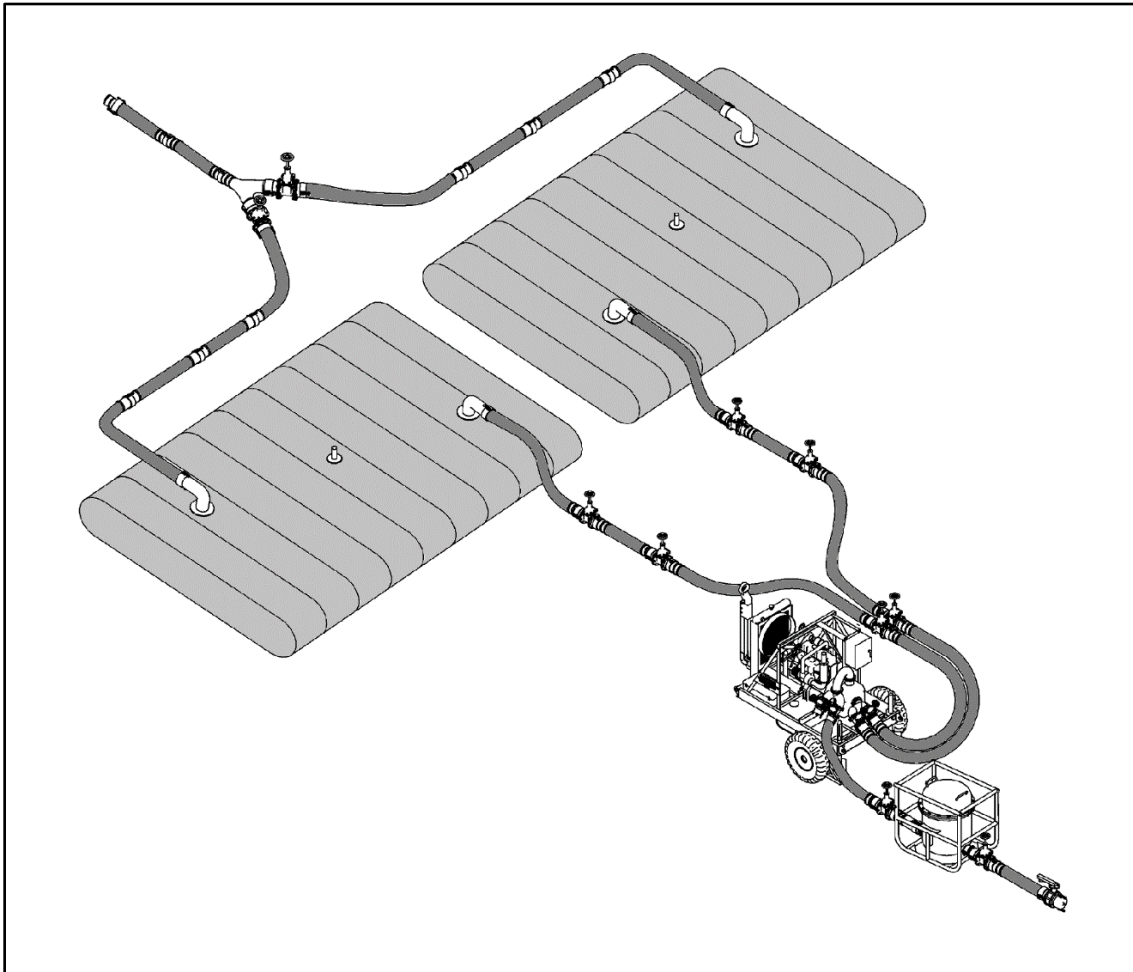


Figure A-12. 50,000-gallon tank TPT, optional configuration

PIPELINE CONNECTION ASSEMBLY

A-77. 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 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 five 20 foot-long ISO containers.

CONTAMINATED FUEL MODULE

A-78. The contaminated fuel module provides storage for fuel that 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

A-79. 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 A-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.

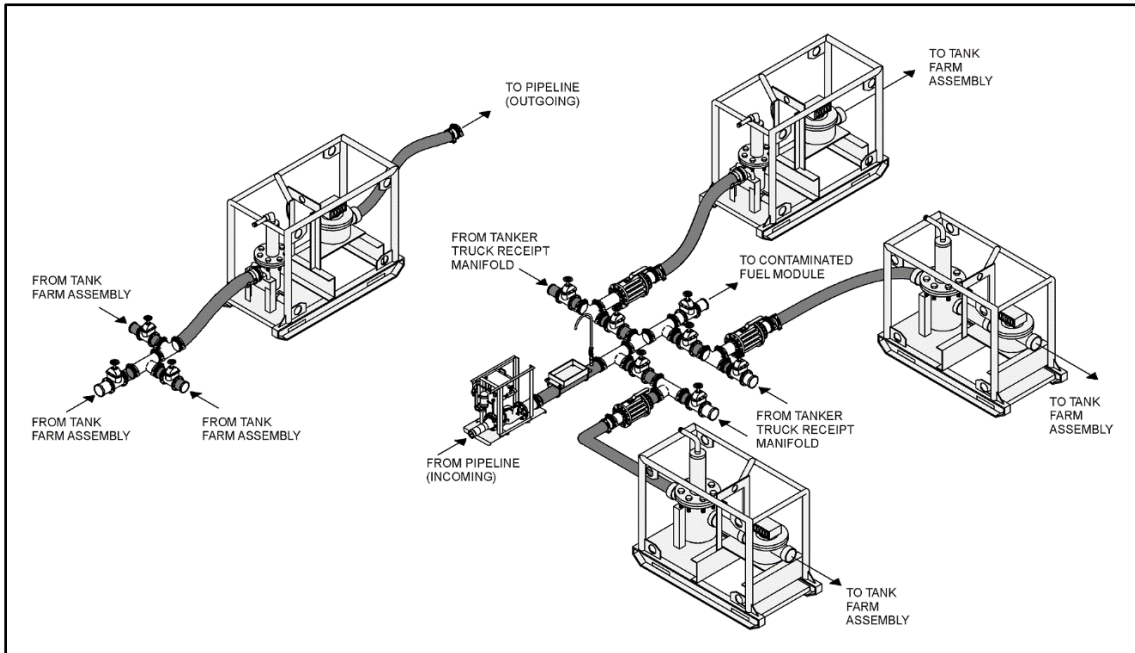


Figure A-13. Switching manifold

PIPELINE SYSTEM

A-80. 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 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. The components incorporated into the pipeline system are:

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

Pipeline Set, 5-Mile

A-81. 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 the planner 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 IPDS 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 over clamps and repair clamps for leak repair.
- Thirteen 20-foot-long ISO containers for pipeline storage.

Pipeline Pump Station

A-82. 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

A-83. 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

A-84. Special purpose equipment provides 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

A-85. 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 the 200-foot and 400-foot bridges are similar in design and function.

Critical Gap Crossing, Pipeline

A-86. The critical gap crossing, pipeline provides a means for pipeline crossing of ravines, swamps, or other critical gaps 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. 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 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

A-87. 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

A-88. 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

A-89. 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. The sizes are as follows:

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

120,000 AND 300,000 GALLON FSSP

A-90. The 120,000 gallon and 300,000 gallon systems each come with 350-GPM pumps and filter-separators, various receipt and issue points. Figure A-14 shows a typical layout for the 300,000-gallon systems. A typical layout for a 120,000 gallon FSSP is similar, but without the additive injector.

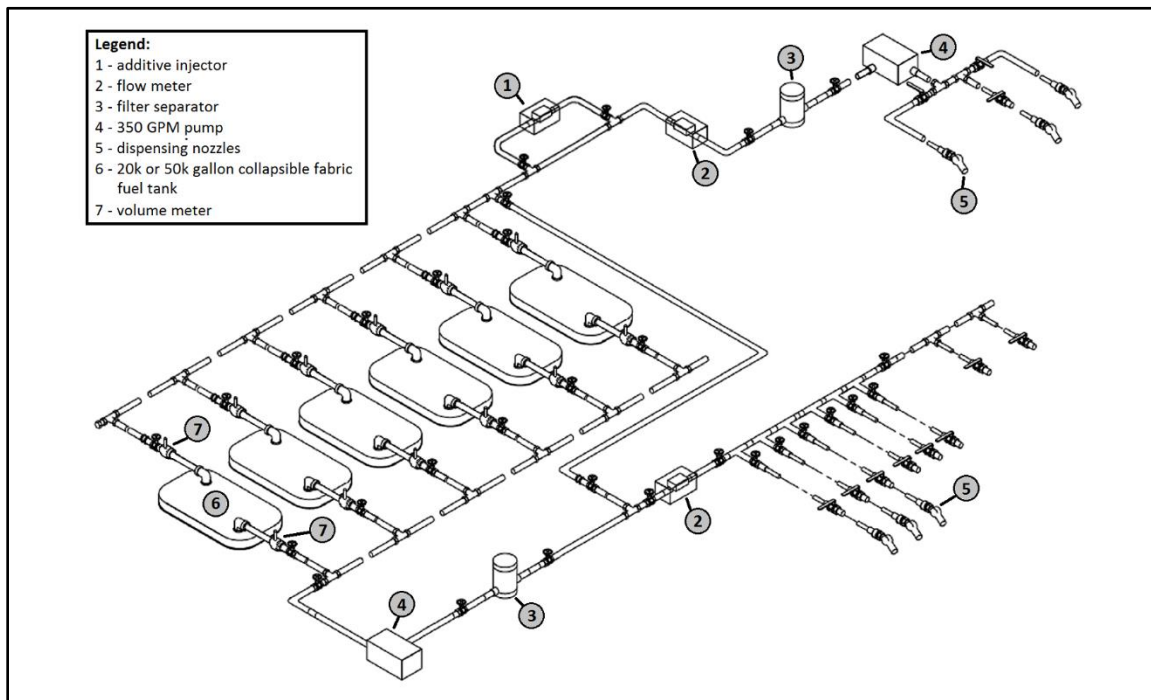


Figure A-14. 300,000 gallon fuel system supply point

800,000 GALLON FSSP

A-91. 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 pre-positioned stock. Figure A-15 shows a typical layout for the 800,000-gallon systems.

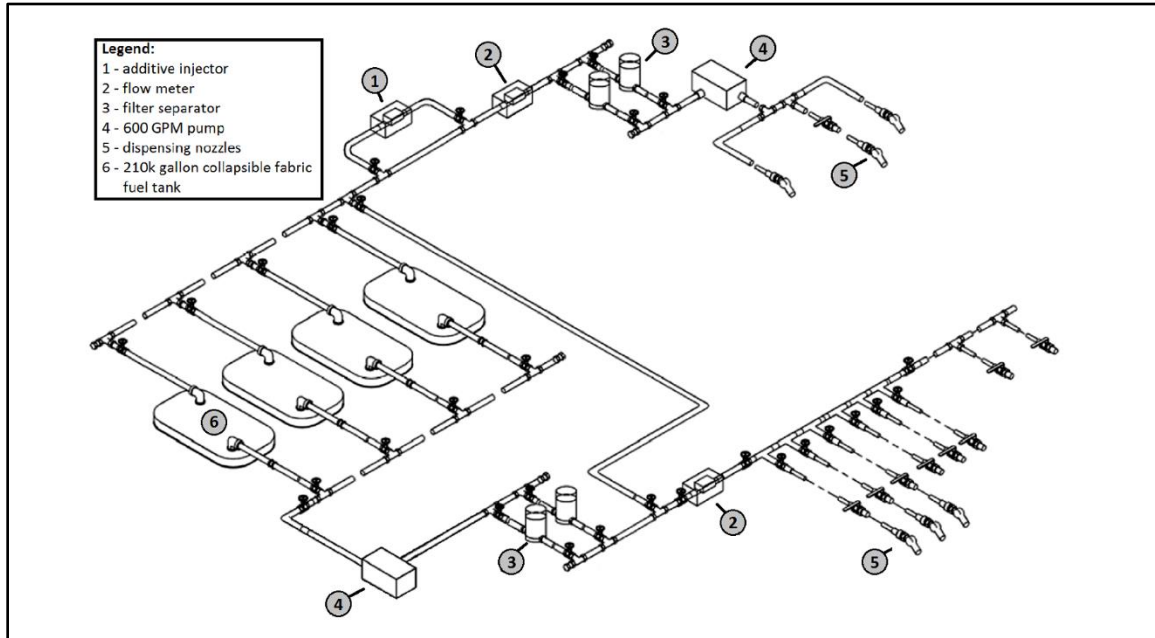


Figure A-15. 800,000-gallon fuel system supply point

FSSP SETUP

A-92. The system 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. Only the 300,000 and 800,000-gallon FSSP comes with additive injection capability.

A-93. The 120,000, 300,000, and 800,000-gallon FSSP set-up depends on METT-TC considerations. 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.) Four 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. 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 or improvement.

- The 120,000 and 300,000-gallon 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 800,000-gallon 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).

HOSE END STRAINER

A-94. 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.

A-95. Periodically, Soldiers have issues with fuel pumps shutting down at fuel points because debris in the fuel gets lodged in the pump strainer. 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. 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:

- The strainer is a 4 inch female x 4 inch male camlock 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.
- 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 or pump cavitation while product is still in the truck is an indication the strainer is clogged.

A-96. 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 help determine exactly which trucks are coming in with solid contamination in the fuel.

MODULAR FUEL SYSTEM

A-97. 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 and retail distribution system. It provides the 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 modular fuel system 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. The tank rack module is commonly employed by the composite supply companies, brigade combat teams and support brigades with the HEMTT tanker/PLS trailer configuration for bulk petroleum replenishment operations.

TANK RACK MODULE

A-98. The modular fuel system tank rack module (TRM) is used to receive, store, and issue fuel. The TRM is a 2,500-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 materiel handling equipment. The system includes the necessary hoses and fittings to connect and bulk transfer fuel to HEMTT tankers

A-99. The TRM enables retail operation by storing, transporting, and issuing fuel, and it provides bulk fuel and fuel accountability. The system can be used for line haul of bulk fuel throughout the theater. It enables organizations to carry and distribute the required days of supply while minimizing trucks and personnel. It is configured in a 20-foot ISO frame. A 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 PLS allows direct delivery of bulk fuel to the brigade area.

A-100. While the TRM is equipped with an electric pump, hose, and retail nozzle, the TRM is not designed to conduct standalone retail operations. The TRM pumps are rated at either 22 GPM (for the M107 model) or 40 GPM (for the M107A1 model) as compared to PRM's 600 GPM pump, and are prone to fail during long-term retail operations. The TRM is designed to work with the PRM, HEMTT tankers, M969s, the 350-GPM pumps of the FSSP, or the FARE system's 100-GPM pump. In the modular fuel system/HEMTT tanker configuration, the TRM functions as an additional bulk fuel source. The HEMTT's 300-GPM pump is used to conduct bulk fuel transfer from the TRM when the HEMTT is empty.

A-101. 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. BSB distribution companies use this configuration to perform sustainment replenishment operations with FSCs. Figure A-16 illustrates the modular fuel system/HEMTT tanker configuration. Figure A-17 shows a close-up view of the hoses in the modular fuel system/HEMTT tanker longitudinal transfer configuration. Figure A-18 displays the hoses in the modular fuel system/HEMTT tanker transverse transfer configuration.

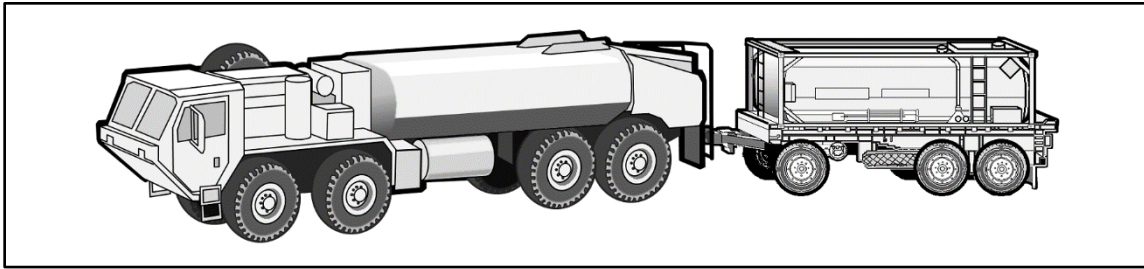


Figure A-16. Modular fuel system/heavy expanded mobility tactical truck configuration.

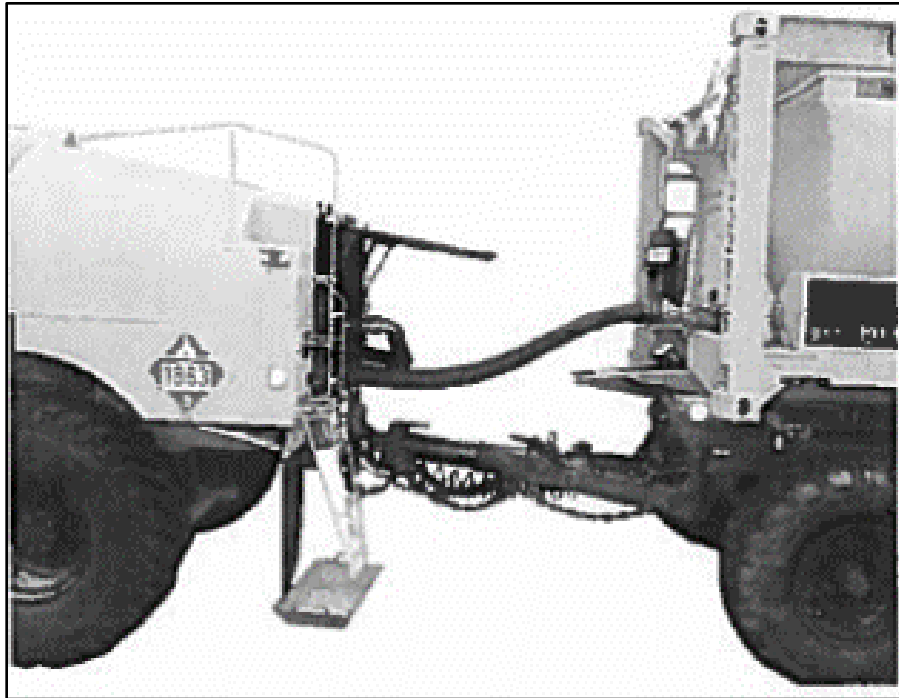


Figure A-17. Modular fuel system/heavy expanded mobility tactical truck longitudinal transfer configuration.

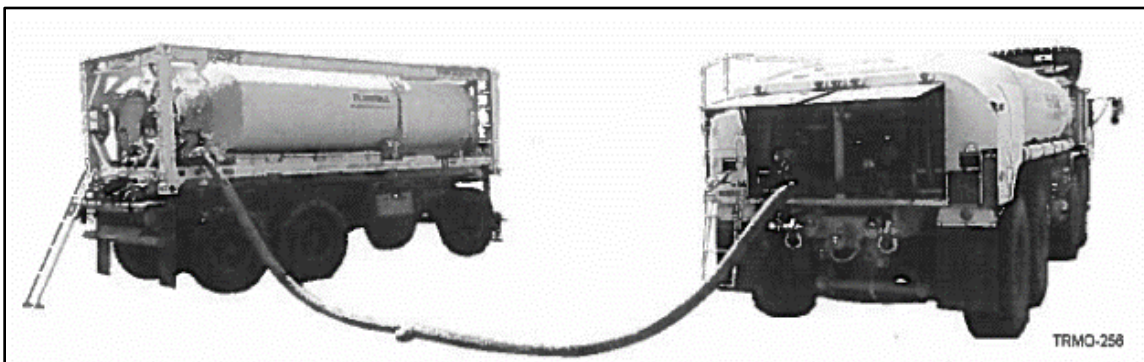


Figure A-18 Modular fuel system/heavy expanded mobility tactical truck transverse transfer configuration.

PUMP RACK MODULE

A-102. The modular fuel system pump rack module is a key component of composite supply company distribution capability. The modular fuel system pump rack module is used in conjunction with the seven tank rack modules to form 17,500-gallon fuel farms used by the composite supply company for sustainment replenishment operations. 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.

A-103. 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 fuel modular fuel system pump rack module and TRMs that are transported; deployed and recovered using HEMTT-LHS trucks, PLS trucks, and PLS trailers. The modular fuel system pump rack module consists of a pumping assembly with a filtration unit, fuel sampling capability, spill control equipment and accessories, and appropriate hoses, valves, and fittings.

A-104. The pump rack module has a 600 GPM pump/filtration and integrated storage with all the hoses, fittings and nozzles for eight retail or bulk refueling points. It can also be used for aircraft refueling. The modular fuel system pump rack module is deployed and recovered by organic unit assets using HEMTT-LHS, the PLS, and PLS trailers. Equipped with forklift slots, the modular fuel system pump rack modules can also be lifted by proper capacity forklifts, 20,000 pounds. The engine module could be pulled out and then the engine module and ISO frame can be picked up by 10,000 pounds.

A-105. The modular fuel system pump rack module conforms to NATO standards for demountable cargo beds (flat racks) allowing load handling system type trucks from other countries to load, unload, and transport the modular fuel system pump rack module.

ROM KIT

A-106. The ROM Kit (NSN 4730-01-684-1038) consists of enough hoses, valves, and fittings to refuel up to eight combat vehicles at the same time. Any cargo vehicle with a payload capacity greater than 5,000 pounds can be used. The ROM kit weighs about 4,880 pounds. It cannot be loaded on the fuel transporting vehicle due to the weight limit of the vehicle.

A-107. The main fuel source can be either the M969 semitrailer or the M978 HEMTT using onboard pump and filter-separator. The average flow rate will vary based upon the source of the fuel; a conservative estimate is approximately 30 GPM per point.

A-108. The area necessary to set up and operate the eight-point ROM kit is about 550 feet long by 150 feet wide. Multiple tankers can be connected to the ROM kit using “Y” and “T”-shaped couplers and valves. One tanker at a time will be dispensing fuel through the ROM to refuel vehicles.

FORCE PROVIDER FUEL SYSTEM

A-109. The force provider unit can store and distribute 1,200 gallons of petroleum using a tank and pump unit to refuel platoon equipment. The force provider module includes a 1,000 gallon collapsible tank for use with the 1070 generator micro grid system.

A-110. Additional fueling equipment includes—

- 28” x 32” aluminum frame cage with fork pockets and lifting handles, with self-priming pump (1hp 115V 1-phase pump and 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 camlocks.
- On/off 120V explosion proof switch with 25” power cord.

- Bonding reel.
- OPW 7B diesel automatic nozzle with swivel.

TANK VEHICLES AND TANK CARS

A-111. 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 ROM operations 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.

TANK TRUCK

A-112. 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)

A-113. 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 take-off from the vehicle's engine. The vehicle also has an alternate fuel delivery pump. This 25-GPM 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 separator canister assemblies, and a manual drain valve. There is a sampling probe on the discharge side of the filter separator for use with the 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 throughput. The hose ends have male camlock 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.
- To perform defueling or recirculation operations the HEMTT requires approximately 300 gallons of fuel to maintain suction.

A-114. 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. The M978 HEMTT takes a minimum of two people to operate the system.

Tank and Pump Unit

A-115. The tank and pump unit (commonly referred to as the 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. In addition, the tank and pump unit is equipped with a 50-GPM, electric pump, two 500-525 gallon tanks, 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).

A-116. The tank and pump unit can be used to fill 5-gallon cans, 55-gallon drums, and 500-gallon collapsible drums. It can be used to temporarily store product and refuel ground vehicles. The unit may also be used to fuel aircraft if no other aircraft refueling equipment is available.

A-117. 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. A general description of the components and installation considerations are listed in the paragraphs below.

Pump Unit

A-118. 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 psi. It has filter-coalescer elements and canister separator 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 camlocking 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, non-collapsible 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 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.

Fuel Tanks

A-119. Two welded aluminum, skid-mounted 500 gallon 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. Each fuel tank is equipped with four lifting shackles. Hoisting equipment, with a sling attachment, will be

required to load the tanks onto the truck using the lifting shackles. Tie-downs are provided for securing the tanks in the vehicle bed.

TANK SEMITRAILERS

A-120. The following paragraphs describe the various tank semitrailers used by the Army to perform its petroleum mission. Tank semitrailers are wheeled fuel tankers that travel over a variety of terrain that require additional prime mover support for transport.

M967

A-121. 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, 6 x 6 tractor truck or by a similar vehicle equipped with a fifth wheel.

A-122. 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.

A-123. The M967 semitrailer is used for bulk delivery of fuel. The semitrailer does not have the dispensing capability of the M969 and is not equipped for retail operations. 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

A-124. 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.

A-125. The semitrailer is designed to be towed by a truck tractor equipped with a fifth wheel. Authorized 5-ton truck tractor is the M1088. The 10-ton military adapted commercial 6 x 4 truck tractors (all models of the M915) are also authorized, only when driving on hard surface highways.

A-126. 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, M915A5, and the M1088 family of medium tactical vehicles. Tankers are not to be filled to exceed the load capacities of the tractors. The 10-ton military-adapted commercial 6 x 4 truck tractors with an anti-lock braking system are also authorized, but only when driving on hard surface highways.

A-127. The M969A2/A3 5,000-gallon tank semitrailer can be loaded through the bottom self-load/unload port. Top loading is permissible by exception with appropriate-level authority approval.

A-128. 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 and offloading 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.

A-129. 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-coalescer elements remove solid particles and coalesce any water in the fuel. In the second stage, five canister separators 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.
- Two 100-GPM meters are located in the roadside cabinet of the M969 tank semitrailer. 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-GPM and a self-load rate of 300-GPM. 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,

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

M1062

A-130. 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.

A-131. The semitrailer is designed to be towed by the M915 series tractor equipped with a fifth wheel. Maximum allowable speed is 55 miles per hour (88 kilometers per hour) on primary roads and 35 miles per hour (56 kilometers per hour) on secondary roads.

A-132. 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 feet long, 8 feet wide, and 8 feet 9 inches high. A piping assembly contains a roadside front port and a rear inlet. Fuel may be bottom loaded at either opening port or unloaded at front port only.

A-133. 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

A-134. The tank unit liquid dispensing, 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).

A-135. The tank unit liquid dispensing consists of one 525-gallon (low-profile) tank or one 600-gallon (high-profile) tank, tie down kit, storage boxes and ancillary equipment.

A-136. Only the low-profile tank has internal baffling. Internal baffling is used to prevent the surge of fuel during transport.

VAPOR RECOVERY KIT

A-137. The vapor recovery kit, as shown in figure A-19, 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 because 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.

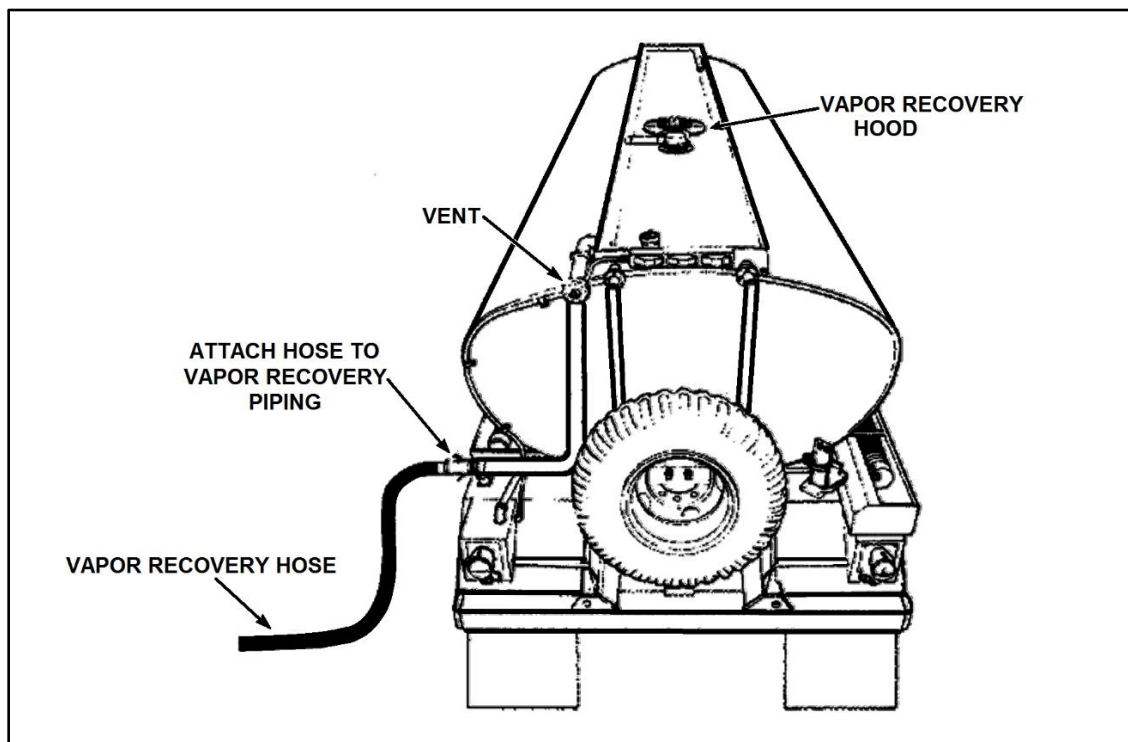


Figure A-19. Vapor recovery kit

CAMOUFLAGE

A-138. 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

A-139. 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

A-140. 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 between loads to avoid product contamination. Tank cars vary in capacity and design. Tank cars used for petroleum products usually have one compartment for one product.

Tank car capacity can range widely. Other tank cars have more than one tank compartment and carry more than one product at a time. Figure A-20 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

A-141. Each tank car compartment has a dome as shown in figure A-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

A-142. The safety valve used on most tank cars consists of a spring-loaded poppet valve that 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

A-143. Each tank car has a bottom outlet and is usually loaded and unloaded through it. The outlet valve as shown in figure A-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-inch to 4-inch Gossler coupling must be installed between the elbow assembly and the tank car 5-inch outlet.

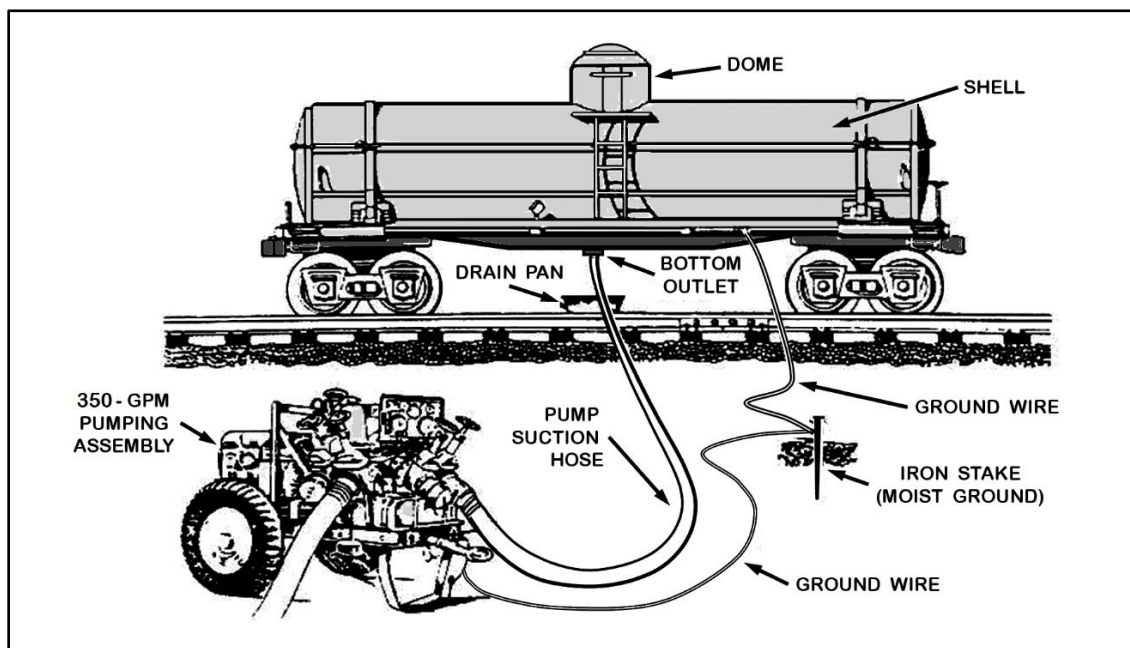


Figure A-20. Typical petroleum tank car

ASSAULT HOSELINE SYSTEM

A-144. The assault hoseline system 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.

A-145. The assault hoseline system consists of 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.

A-146. There are three each 350-GPM trailer mounted, diesel powered pumping units. The pumping rate for the assault hoseline system 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 assault hoseline system.

A-147. The assault hoseline system is stored in eight (8) triple containers and can be transported by aircraft, rail, ground vehicles and marine vessels.

A-148. This system takes six personnel (minimum) to set up and two personnel (minimum) to operate depending on the amount of pumping units used.

A-149. The area requirements for the assault hoseline system are 14,000-feet long by an approximate 20-foot wide track.

A-150. A 5-ton cargo vehicle serves as the prime mover required to deploy and recover the assault hoseline system. The system is deployed at 2.5 miles per hour and recovered at 0.75 miles per hour. A fuel source is required to make it fully operational.

AVIATION REFUELING SYSTEMS

A-151. The following describes equipment and systems specifically in Army aviation units. For more information related to aircraft refueling, see ATP 3-04.17.

Note: Ensure the fuel source is more than 100 feet away from aircraft during hot refueling.

ADVANCED AVIATION FORWARD AREA REFUELING SYSTEM

A-152. The Advanced Aviation Forward Area Refueling System (AAFARS), figure A-21 on page A-34, 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.

A-153. The system includes an adapter kit that allows the AAFARS to be connected to any source that can be accessed through 2-inch, 3-inch, or 4-inch camlock couplings. The adapters also allow connection of AAFARS components to any other fuel system components that use standard 2-inch, 3-inch, or 4-inch camlock couplings.

A-154. The AAFARS consists of a 225-GPM pump and a 240-GPM filter-separator (uses non-standard 6088 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 closed circuit refuel (CCR) nozzles with open port adapters, four open port nozzles, 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. It takes an open area approximately 500-feet by 300-feet to safely operate the system with aircraft entry and exit.

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

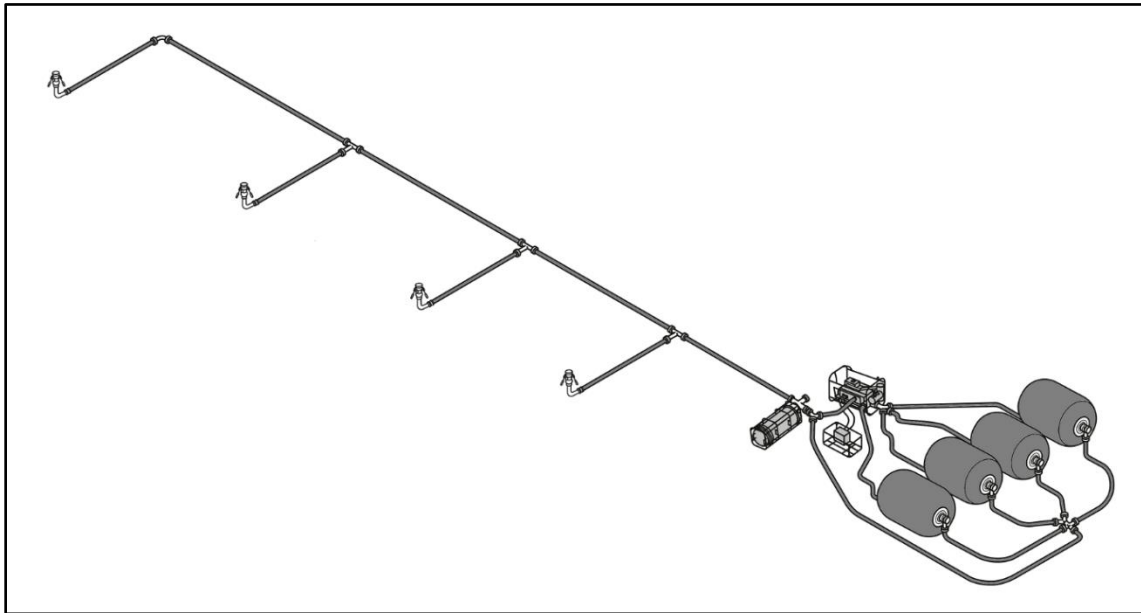


Figure A-21. Advanced Aviation Forward Area Refueling System (AAFARS)

HEAVY EXPANDED MOBILITY TACTICAL TRUCK TANKER AVIATION REFUELING SYSTEM

A-155. The HEMTT tanker aviation refueling system (HTARS), figure A-22, is used to refuel rotary wing aircraft in remote locations. The HTARS can be transported by trailer, a high mobility multipurpose 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.

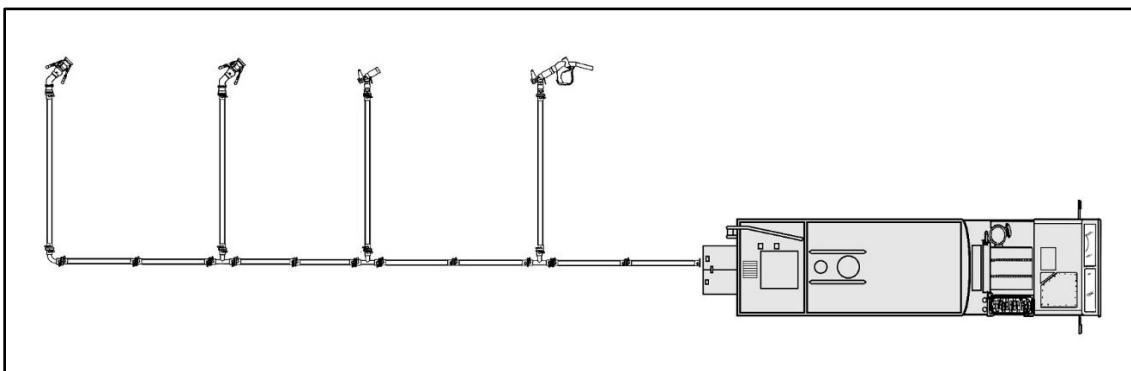


Figure A-22. HEMTT tanker aviation refueling system (HTARS)

A-156. 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.

A-157. It takes an open area approximately 500-feet by 300-feet to safely operate the system with aircraft entry and exit.

A-158. 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.

A-159. This system takes a minimum of two personnel to set up. The number of personnel to operate HTARS depends on the number of refueling points being used. Cold refueling requires one pump operator

and one person per refueling point. Hot refueling requires one pump operator and two people per refueling point.

FORWARD AREA REFUELING EQUIPMENT

A-160. Forward area refueling equipment (FARE-2), depicted in figure A-23, is used to rapidly establish a two-point refueling system for 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 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.

A-161. The FARE-2 is not configured to pump various types of fuels at the same time.

A-162. 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 CCR nozzles with open port adapters, and enough hose to connect all of the components for a safe operation.

A-163. Forward area refueling equipment uses dry-break quick-disconnect connections and is equipped with 2-inch female camlock adapters, 3-inch female camlock adapters, and 4-inch female camlock adapters.

A-164. It takes an open area approximately 50-yards by 50-yards to safely operate the system with aircraft entry and exit.

A-165. This system takes a minimum of two personnel to set up. The number of personnel to operate the FARE depends on the number of refueling points being used. Cold refueling requires one pump operator and one person per refueling point. Hot refueling requires one pump operator and two people per refueling point.

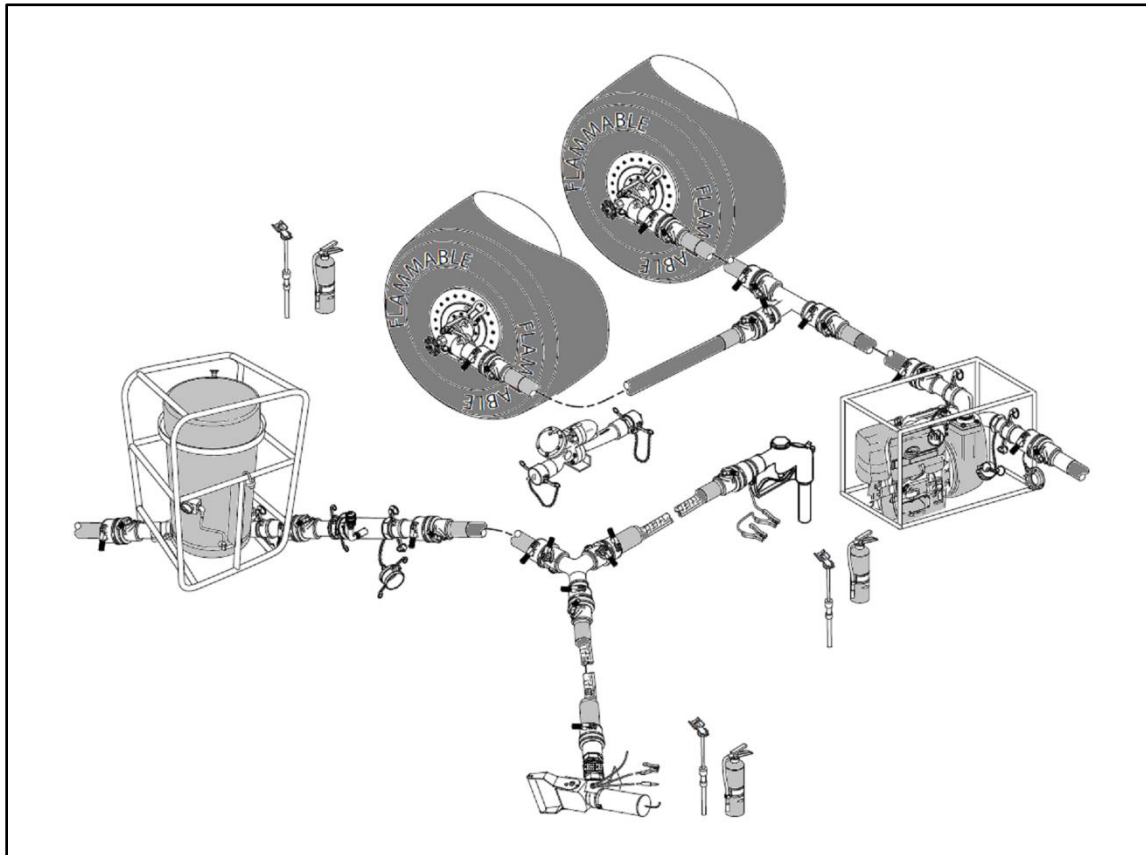


Figure A-23. Forward Area Refueling Equipment (FARE-2)

AIRCRAFT-TO-AIRCRAFT REFUELING SYSTEMS

A-166. The purpose of the aircraft to aircraft refueling system 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. Procedures for aircraft-to-aircraft refueling systems are discussed in ATP 3-04.17.

Fat Hawk and Wet Hawk

A-167. 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 consist of two fuel external stores support systems-equipped UH-60 aircraft with a crew including four petroleum personnel and refuel equipment to support the mission. The external stores support system tanks are 230-gallon tanks. One UH-60 can be configured with up to four external stores support system tanks for a total external capacity of 920-gallons.

A-168. 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 or 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.

A-169. 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 come in a platoon. A Fat Hawk can refuel and rearm these aircraft in less than 15 minutes without sling loading any fuel or ammunition.

A-170. A properly configured aircraft and a well-planned mission will result in the ability for two UH-60s with the Extended Range Fuel System II (ERFS II) to refuel and rearm a platoon of OH-58D aircraft in 15 minutes.

Wet Wing (C-17 FARP)

A-171. 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.

A-172. 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.

A-173. 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

A-174. The ERFS II – also known as Fat Cow - as configured and installed in the Army model CH-47D Chinook helicopter, is a crashworthy, ballistically self-sealing, internal auxiliary fuel tank system designed to provide a safe and convenient means of —

- Increasing the range and endurance of the CH-47D helicopter to include worldwide self-deployment capability.

- Transporting fuel for forward area refueling operations.

A-175. The system consists of one to three tank assemblies, each with a capacity of approximately 800 U.S. gallons, the connecting hardware and interface controls to rapidly onload and offload aviation fuel, and a FARE kit. System configuration is dependent upon the primary mission of the helicopter. The tanks are carried in the cargo compartment of the helicopter, and are secured to the cargo compartment floor with a specialized restraint system. The tank(s) are interconnected with the aircraft fuel system utilizing a fuel transfer hose assembly. Transfer of fuel to the aircraft main tanks is accomplished by operator interaction with a night vision goggle compatible fuel control panel mounted on the forward-most tank assembly. The fuel control panel also provides a display of the fuel quantity in each tank and total fuel quantity in all tanks.

A-176. The FARE kit supports missions requiring the rapid offloading of fuel to other aircraft or combat weapons systems. The FARE kit consists of a tank-mounted high-volume pump that interfaces with the fuel transfer hose assembly, to deliver fuel through a series of hoses and nozzles to two points outside the aircraft.

A-177. Normal operation of the ERFS II consists of: a) refueling, or the onloading of fuel into the ERFS II tanks, and, b) fuel transfer, or the offloading of fuel from the ERFS II tanks. Refueling may be performed by either: 1) single-point pressure refueling; or, 2) gravity refueling. Fuel transfer may occur by: 1) fuel transfer to the Chinook main tanks; or, 2) FARE transfer to other aircraft or combat weapons systems.

A-178. The ERFS II consists of five major functional components. They are the tank assembly, restraint system, fuel transfer hose assembly, fuel control panel assembly, and FARE Kit assembly.

A-179. The principles of operation and maintenance of the system is further described in the appropriate TM and ATP 3-04.17.

OTHER DISTRIBUTION EQUIPMENT

A-180. Other important distribution equipment includes pumps, meters, and dispensing nozzles.

PUMPS

A-181. The Army uses various pumps to move bulk petroleum throughout a theater of operations at all echelons. These pumps vary in size, and are measured in gallons per minute. 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 or hoseline.

50 Gallons Per Minute Pump

A-182. The 50-GPM diesel/JP8 engine driven pumping assembly is used to fill, remove, and transfer fuel to, from, and between containers.

A-183. 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

A-184. The 100-GPM diesel/JP8 engine driven pumping assembly is used to fill, remove, and transfer fuel to, from, and between containers.

A-185. There is also a different model used as a component of the FARE-2 system, later discussed in the appendix.

Advanced Aviation Forward Area Refueling System Pump

A-186. The pumping assembly is a modular, Soldier-portable pumping system, later discussed in this chapter.

A-187. The pump-engine module houses a self-priming pump that provides a flow of 225-GPM at 3400 revolutions per minute.

350-Gallons Per Minute Pump

A-188. The 350-GPM pumping assembly is a wheel mounted, 275 foot total head, diesel-engine driven, self-priming centrifugal pump. The assembly can be moved by a towing vehicle using the attached tow bar. However, it can only be towed for 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.

A-189. 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 assault hoseline system, later discussed in this chapter. There are various models of this pump.

600-Gallons Per Minute Pump

A-190. 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 at 2400 revolutions per minute.

A-191. 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 800,000-gallon FSSP.

800-Gallons Per Minute Mainline Pump

A-192. 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 revolutions per minute regardless of the discharge pressure. The pump has an approximate discharge head of 1,800 feet at 2,100 revolutions per minute. The 800-GPM pump is primarily used as part of the pump station with the IPDS.

METERS

A-193. The FSSP has a 4-inch inline flow meter assembly record to the total quantity of fuel passing through each side of the FSSP, one at the receipt side and one at the dispensing side.

A-194. The TPT has a 6-inch inline flow meter assembly. Four flow meters are a part of the TPT switching manifold.

DISPENSING NOZZLES

A-195. 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.

A-196. Most nozzles have dust caps 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

A-197. 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 nozzle is pressure-regulated at 45 psi.

Closed Circuit Refuel Nozzle

A-198. The closed circuit refueling 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 psi.

Open Port Nozzle or Gravity Fill Nozzle Adapter

A-199. 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 the handle seats the internal control valve and stops fuel flow. The open port nozzles used for either ground or aviation may have a camlock 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. See appropriate FSSP TM for different open port style nozzles.

A-200. 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.

SECTION II - QUALITY SURVEILLANCE SYSTEMS

A-201. Quality surveillance 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.

A-202. The purpose of quality surveillance 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. Quality surveillance 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.

A-203. Special equipment is designated to ensure quality surveillance is accurately and adequately being performed by petroleum operations personnel.

A-204. More information on quality surveillance is addressed in chapter 4 of this manual; TM 4-43.31 and MIL-STD-3004-1A.

PETROLEUM QUALITY ANALYSIS SYSTEM - ENHANCED

A-205. The PQAS-E is a fully integrated fuel laboratory in a 20 foot-long 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.

A-206. The PQAS-E is a petroleum quality surveillance lab capable of conducting B-2 modified level testing on aviation turbine fuel. B-2 level testing is considered modified because it lacks the existent gum and copper corrosion tests in accordance with MIL-STD-3004-1A.

A-207. This system takes MOS 92L petroleum lab specialists to set up and operate - two personnel to set up and two personnel to operate. The system and personnel must receive certification or the authority to operate through USAPC.

FUEL ADDITIVE INJECTOR

A-208. The fuel additive injector assembly, TPI-4T-4A-1, is a fluid powered, multi-additive injector system designed to inject fuel system icing inhibitor, static dissipater additive and corrosion inhibitor/lubricity improver additives into commercial aviation turbine fuels. It takes two personnel to setup and one person to operate.

A-209. The system is 40 inches wide, 48 inches long and 40 inches high. The TPI-4T-4A-1 is fielded with the 300,000 and 800,000-gallon FSSP.

A-210. This system operates at a flow rate ranging from 150-GPM to 700-GPM.

A-211. 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.

TEST KIT, AVIATION FUEL PETROLEUM

A-212. 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 TM 10-6630-223-13&P. This system takes one person to setup and one person to operate.

A-213. The test kit performs the following tests on petroleum products:

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

A-214. The test kit contains DMA35N with volumetric correction function, operating instructions, and carrying case. 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.

A-215. The meter displays the same results that would be obtained using the hydrometer and ASTM International® D1250.

A-216. The calibration of meters should be performed through Test, Measurement and Diagnosis Equipment 4180.

SAMPLING AND GAUGING KIT, PETROLEUM

A-217. 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, and 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. This system takes one person to setup and one person to operate.

A-218. The kit consists of an aluminum or plastic carrying case fitted with measuring and sampling equipment. The major parts of the kit are listed below.

- Carrying case.
- Cup-case thermometer, 0°F to 180°F range.
- Innage tape and bob.
- Hydrometers, ranging from 19 to 81 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.

FILTER SEPARATORS

A-219. 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. Handlers drain the water 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. In the event the filter separator cannot drain water from the fuel system, the equipment is to be considered non-mission capable since it cannot perform its intended mission.

A-220. Those covered in this manual range in capacity from 50-GPM to 600-GPM. All filter separators discussed in this manual use filter-coalescer and separator elements meeting the requirements of military specifications. Filter-coalescer and separator elements are used in varying numbers depending on the flow rate of the specific filter separator.

A-221. Filtration of all fuel into an end or consuming item is mandatory. Aviation fuel must pass through two filtrations (two separate filter separators) prior to issue to aircraft. If a filter separator is part of any fuel distribution system, filter-coalescer elements will be installed regardless of product being used.

A-222. 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.

A-223. 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-coalescer elements.

A-224. 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 SEPARATOR ASSEMBLY

A-225. The standard DOD filter element fits inside the DOD canister separator. 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.

A-226. 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-3004-1A. 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 and filtering elements are replaced, the filter separator vessel must be stenciled*DATE CHANGED* with the *MONTH AND YEAR*.
- Check the filter 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-coalescer elements, they should be checked for effectiveness by the supporting petroleum laboratory. Check new filter-coalescer 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.
- Remove unit from service if a sudden drop in differential pressure from previous readings is observed (it indicates a ruptured element) or if differential pressure exceeds the level indicating that the filters are clean and working in accordance with the appropriate technical manual.

CANISTER SEPARATOR

A-227. The standard DOD canister separator 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-stick coating.

FUEL FLOW

A-228. For DOD style filtration equipment, the canister separator 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 canister separators. The canister separator is installed directly over the filter element, concentric (same center axis).

A-229. For EI 1581 style filtration equipment, the separator and filter-coalescer elements may be configured for operation in a vertical or horizontal configuration. They still use gravity to separate the water from the fuel, but the separator is mounted apart from the filter element, on its own sealed mount to the effluent port. The separator 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.

A-230. For both the DOD and EI 1581 style filtration equipment, fuel enters the center tube of the filter element through a fitting at the bottom of the element. Solid contaminants 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 separator. The coated screen of the canister separator does not allow water droplets to pass through it, and they fall to the bottom chamber of the filter separator. Only clean and dry fuel passes through the screen of the canister tube into the effluent port.

100 GALLONS PER MINUTE FILTER SEPARATOR

A-231. 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.

A-232. The legacy and FARE-2 filter separators have a flow rate of 100 GPM. The working pressure of the legacy filter separator is 75 psi. The working pressure of the FARE-2 filter separator is 77 psi.

A-233. 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-coalescer and separator elements, 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

A-234. 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.

A-235. The liquid fuel filter separator is an aluminum vessel with an integral frame and is designed to house three filter-coalescer 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.

A-236. 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

A-237. 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 hoseline systems.

A-238. The filter separator is designed for a flow rate of 350-GPM and a top working pressure of 150 psi.

A-239. 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-coalescer element and canister separator assemblies. The filter separator also has an air vent valve so that air can be released from 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 - EMERGING TECHNOLOGIES

A-240. Emerging technologies that will soon be entering the force include the early entry fluid distribution system, bulk fuel distribution system, tactical fuel distribution system and mobile tactical retail refueling system (MTRRS) for fuel distribution and the Petroleum Expeditionary Analysis Kit (PEAK) for quality surveillance.

EARLY ENTRY FLUID DISTRIBUTION SYSTEM

A-241. The E2FDS is an emerging technology that can provide the capability to establish 850,000 gallon per day throughput capacity in 72 hours. It can be emplaced at the rate of 25 miles per day and retrieved at ten miles per day. The E2FDS inventory will consist of a limited amount of flexible conduit material with pump stations. The E2FDS can precede or extend the IPDS. It can only replace the IPDS within a very limited geographic area.

A-242. The E2FDS is comprised of a centralized control module, pump stations, a centralized control module, a retrieval system, 5-mile sets of flexible conduit, and conduit support equipment. It is emplaced and operated by petroleum supply specialists of the pipeline operating platoon and requires minimal engineer support to emplace the conduit or pump stations. Pump stations are centrally controlled to enable rapid and precise synchronization during pumping operations. The pump stations have embedded diagnostics and prognostics to ensure high materiel availability and maintainability.

A-243. Due to the E2FDS dispersion over several miles, and requirement to secure containers during the construction and operation phases, at a minimum two equipment staging locations are recommended (more possible if containers can be secured).

A-244. The base and intermediate terminals operated by the PSC are ideal to meet E2FDS container staging requirements since these locations will be occupied continuously.

BULK FUEL DISTRIBUTION SYSTEM

A-245. The BFDS mission is to throughput large quantities of fuel from Theater Security Area to the Corps rear. The BFDS will replace the M1062 7,500-gallon tankers and the M967 5,000-gallon bulk haul tankers currently in line haul medium truck companies.

A-246. The BFDS will carry a minimum of 7,500 gallons of fuel across improved and limited unimproved roads at normal convoy operating speeds.

A-247. The BFDS will maximize the tow capacity of the M915A3/A4/A5. It will also provide an accurate measurement and digital display of Class III(B) within the system. A commercially available petroleum semi-trailer will form the basis for the BFDS, which will be modified to incorporate capabilities required for military use. The BFDS is not capable of off-road or retail operations.

TACTICAL FUEL DISTRIBUTION SYSTEM

A-248. The tactical fuel distribution system (TFDS) 5000-gallon semitrailer is a fuel dispensing semitrailer used primarily for refueling ground vehicles. It will be a replacement for the M969 5,000-gallon retail tankers and the M967 5,000-gallon bulk haul tankers currently in tactical medium truck companies.

A-249. The TFDS bulk transport dispensing semitrailer is equipped with a pump assembly capable of bulk delivering fuel and self-loading at a rate of at least 350 GPM. The dispensing assemblies include a meter, a hose reel with electric rewind, 50 feet of dispensing hose, and nozzles. The TFDS is capable of off-road use with its M1088 prime mover. It is ROM-capable.

MOBILE TACTICAL RETAIL REFUELING SYSTEM

A-250. MTRRS, as displayed in figure A-24, replaces the legacy Tank and Pump Unit and the Tank Unit Liquid Dispensing which have exceeded their economic useful lives. The MTRRS is a 900 -1,200 gallon baffled bulk fuel tank which provides filtered and metered fuel, retailed at the rate of 17-40 gallons per minute. It is compatible with several transportation platforms such as 5-ton cargo trucks, palletized load systems, 5-ton trailers, and flat racks. The MTRRS functions as a fuel storage and retail point mounted on a wheeled platform or set on the ground. It allows tactical headquarter elements and specialized units at echelon above brigade to keep sufficient fuel stocks to support continuous use of critical ground equipment.

A-251. The MTRRS supports continuous operations of echelon above brigade command, control, information, and intelligence elements. It extends the operational reach and enables command and control from dispersed locations by providing organic fuel storage and retail capability to command posts and specialized tactical units.



Figure A-24. Mobile Tactical Retail Refueling System

PETROLEUM EXPEDITIONARY ANALYSIS KIT

A-252. The PEAK is a one-person portable stand-alone system which provides the ability to verify the suitability for use of petroleum products in a field environment. The PEAK tests key characteristics of kerosene-based and diesel fuels for use in ground and aviation equipment. It allows testing with results within minutes to determine the fuel grade, presence of required additives, and absence of contaminants, prior to issue for use in military platforms. The PEAK will replace the Aviation Fuel Contamination Test Kit.

A-253. The PEAK prolongs endurance and enables the freedom of action during decisive operations at decentralized locations. The PEAK provides fuel testing capability at the point of consumption.

A-254. The PEAK will be allocated to aviation units and to sustainment units with a fuel storage, distribution, and retail mission, including forward support companies, distribution companies, petroleum supply companies, and composite support companies.

SECTION IV – LIST OF POL EQUIPMENT AND LINE ITEM NUMBERS

A-255. Table A-2 shows a list of current common petroleum equipment along with their line item numbers.

Table A-2. List of bulk fuel equipment by name and line item number

<i>Equipment Name</i>	<i>Line Item Number (LIN)</i>
Advanced Aviation Forward Area Refueling System (AAFARS)	F42611
Forward Area Refueling Equipment (FARE-2)	H94824
HEMTT Tanker Aviation Refueling System (HTARS)	R66273
Extended Range Fuel System II (ERFS II)	C22759
Fuel System Supply Point (FSSP -120K)	F04898
Fuel System Supply Point (FSSP -300K)	F04966
Fuel System Supply Point (FSSP -800K)	F05034

Table A-2. List of bulk fuel equipment by name and line item number - *continued*

Equipment Name	Line Item Number (LIN)
Assault Hoseline System (AHS)	K54707
Petroleum Quality Analysis System - Enhanced (PQAS-E)	P25473
M978 Heavy Expanded Mobility Tactical Truck (HEMTT)	T58318
M978 Heavy Expanded Mobility Tactical Truck (HEMTT)	T58161
M978 Heavy Expanded Mobility Tactical Truck (HEMTT)	T87243
Modular Fuel System - Tank Rack Module (TRM)	T20131
Modular Fuel System - Pump Rack Module (PRM)	M05067
M967/A1 - 5K Tanker	S10059
M969 /A1 /A2 / A3 - 5K Tanker	S73372
M1062 - 7.5K Tanker	S73119
Tank and Pump Unit (TPU)	V12141
Tank Unit Liquid Dispensing - Lo/Hi- Profile (TULD)	V19950
Pump 800 GPM (IPDS)	P93102
Early Entry Fluid Distribution System (E2FDS)	Z-LIN
Extended Range Refueling System (ERFS)	E20380
Fuel Additive Injector	No LIN (NSN: 4930-01-547-6265)
Sampling and Gauging Kit, Petroleum	No LIN (NSN: 6680-00-151-5310)
Tactical Petroleum Terminal	No LIN (NSN: 3835-01-288-4604)
Test Kit, Petroleum	No LIN (NSN: 6630-01-558-5109)
Pump 50 gallons per minute (GPM)	No LIN (NSN: 4320-01-483-1058)
Pump 100 GPM (FARE)	No LIN (NSN: 4320-01-483-1067)
Pump 350 GPM (Unregulated)	No LIN (NSNs: 4320-01-483-1054; 4320-01-492-4091; 4930-01-524-4467; 4320-01-524-6953)
Pump 350 GPM (Regulated)	No LIN (NSNs: 4320-01-483-1055, 4320-01-492-4086)
Pump 600 GPM	No LIN (NSN: 4320-01-441-1086)

Appendix B

Marking, Labeling, and Placards

This appendix provides guidance for making and placards for bulk petroleum vehicles, equipment and storage containers, and provides NATO fuel codes and placard identification numbers. Each bulk packaging, freight container, unit load devise, 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 (for example, 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, for example, “Push”, “Pull”, or “Turn”. 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. 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.
- Include UN Number, the four-digit numbers that identify hazardous materials, and articles (such as explosives, flammable liquids, and toxic substances) 1863 for jet fuels, 1993 for diesel, 1201 gasoline, and 1203 for avgas 100.

STORAGE TANK MARKING AND LABELING

B-3. Procedures for storage tank marking and labeling include the following.

- 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-161H.
- 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 U.S. designation (such as JP8 F-34; JP5, and F44). A list of NATO and U.S. fuel designations are in table C-1 in appendix C of this publication. Personnel provide identification banding or coding on tanks and piping according to MIL-STD-161H and maintain and inspect according to paragraph 4.4.

IDENTIFYING COLOR

B-5. The method prescribed in MIL-STD-101C 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

Interoperability

This appendix provides information on equipment to help U.S. and NATO fuel equipment to work together.

C-1. The Army's interoperability policy is to develop interoperability to enhance readiness in support of United States national defense and strategic goals, including operating effectively with unified action partners across the full range of military operations (AR 34-1).

C-2. NATO uses standardization agreements or STANAGs to improve interoperability of member nations, including the United States. NATO STANAGs that apply to fuel operations include —

- NATO STANAG 1135, *Interchangeability of Fuels, Lubricants, and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations*.
- NATO STANAG 2115, *Fuel Consumption Unit*.
- NATO STANAG 3149, *Minimum Quality Surveillance for Fuels*.

C-3. Table C-1 lists NATO fuel codes and placard identification numbers.

Table C-1. North American Treaty Organization (NATO) fuel codes and placard identification numbers

<i>Product</i>	<i>NATO Fuel Code</i>	<i>Placard Identification Number</i>
Avgas 100LL	F-18	UN1203
Gasoline Automotive	F-57/F-67	UN1203
Jet A-1	F-35	UN1863
Jet A with Additives	F-24	UN1863
Jet A with Additives +100	F-27	UN1863
JP4	F-40	UN1863
JP5	F-44	UN1863
JP8	F-34	UN1863
JP8 +100	F-37	UN1863
Diesel fuel grade 1	F-65	UN 1993
Diesel fuel grade 2	F-54	UN 1993
Diesel fuel marine	F-76/F-77	UN 1993

C-4. Table C-2 on page C-2 shows the parts of a NATO adapter set. Having these items will assist U.S. and NATO petroleum specialists to work with each other's equipment.

Table C-2. NATO adapter set components

<i>Name</i>	<i>Nomenclature</i>	<i>National stock number (NSN)/Part number</i>
Elaflex VK MK 80mm NPS	COUPLING SET, TANK TRUCK ADAPTER	3835-01-415-5873
American Petroleum Institute (API) Bottom Load Port to 4-inch camlock (female)	See Attached Parts Listing in Table C-3 .	See Attached Parts Listing in Table C-3 .
D1 Kit	See Attached Parts Listing in Table C-4 .	See Attached Parts Listing in Table C-4 .
Todo-Matic Dry Brake Adapter (male)	PARTS KIT, QUICK DISCONNECT COUPL	4730-01-632-2845
Todo-Matic Dry Brake Adapter (female)	PARTS KIT, QUICK DISCONNECT COUPL	4730-01-632-2839
4-inch camlock (female) to 3-inch camlock (male)	REDUCER, QUICK DISCONNECT	4730-01-548-0899
3-inch camlock (female) to 3-inch camlock (female)	COUPLING ASSEMBLY, QUICK DISCONNECT	4730-01-543-7882
4-inch camlock (female) to 4-inch camlock (female)	COUPLING ASSEMBLY, QUICK DISCONNECT	4730-01-543-3986
NATO Rail Tanker Coupling	COUPLING, RAIL TANKER, NATO	3835-01-414-0464
Tiedown Strap	RATCHET STRAP ASSEMBLY	3990-01-187-3615
5200 Series Lock	PADLOCK	5340-00-158-3805
Toughbox	Trunk, Locker	8460-01-471-1035

C-5. Table C-3 shows the parts of the API bottom load port to 4-inch camlock. This set is not required with M969A3 systems because an API bottom load port is integrated into the system by the manufacturer.

Table C-3. API bottom load to 4-inch camlock

<i>Name</i>	<i>Quantity</i>	<i>Nomenclature</i>	<i>National stock number (NSN)/Part number</i>
American Petroleum Institute (API) Bottom Load Port	1	COUPLING, PIPE	4730-0111-82285/891N
4-inch camlock (female) to flange	1	COUPLING, HALF, QUICK DISCONNECT	4730-00-840-5348 / MS27027-17
4-inch camlock (male) plug	1	PLUG, QUICK DISCONNECT	4370-00-640-6188 / MS27029-17
Gasket	1	GASKET, BONNET	5330-01-207-8302 / 10231-C
Bolt	8	SCREW, CAP, HEXAGON, H	MS90725-64
Washer	8	WASHER, FLAT	5310-00-087-7493 / MS27183-13
Washer	8	WASHER, LOCK	5310-00-637-9541 / MS35338-46
Nut	8	NUT, PLAIN, HEXAGON	5310-00-2682 / MS35691-17

C-6. Table C-4 shows the parts for Nozzle, Fuel and Oil (D1R1) Kit. This nozzle kit is compatible with all U.S. fuel equipment and several European commercial and military pieces of equipment. It is most commonly used for aviation transfer and refueling.

Table C-4. Nozzle Fuel and Oil (D1R1) Kit (01-318-6091)

Name	Quantity	Nomenclature	NSN/Part Number
D1 Nozzle	1	NOZZLE, FUEL AND OIL SERVICING	4930-01-440-1085
Dry-Brake to 2-inch camlock (female)	1	COUPLING ASSEMBLY, QUICK DISCONNECT	4730-01-298-0151
4-inch camlock (female) to 2-inch camlock (male)	1	REDUCER, QUICK DISCONNECT	4730-00-951-3293
Dry-Brake Hose, 25 feet	1	HOSE ASSEMBLY, NONMETALLIC	4720-01-515-3131

Note: As other nations may change equipment, units preparing to deploy to or work with NATO nations should contact units in theater for the most updated adapter information.

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Appendix D

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 and 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 and gauges should be familiar with proper calibration procedures.

D-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.

D-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 describes 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 D-1 on page D-2. Hoses should be the same size as the connection on meter (for example, 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 D-1 on page D-2. The meters should be installed close to each other (one hose length apart).
 - During the testing, ensure 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 in accordance with meter manufacturer's 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.

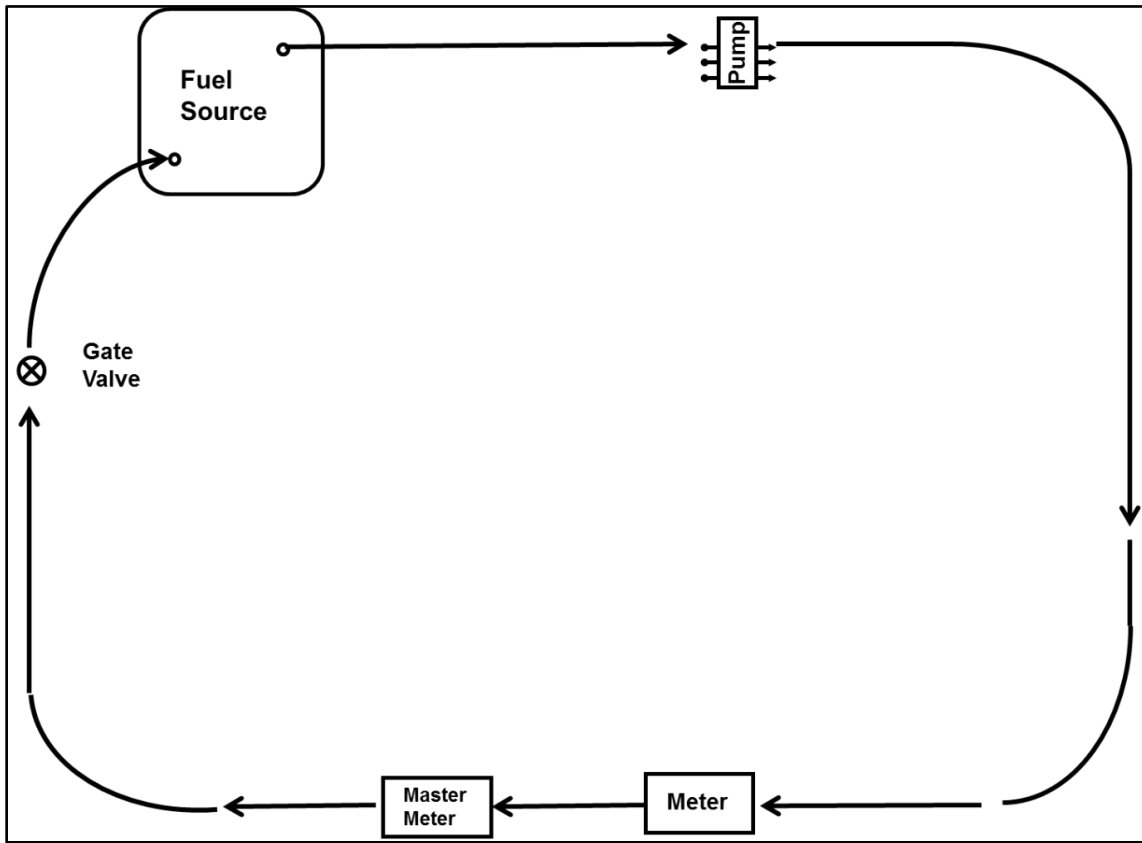


Figure D-1. Master meter layout

Appendix E

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.

OVERVIEW

E-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 or 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, or container that the fuel came from.
- Consolidating product by pumping fuel through system components to include filter separators, hoses and pipes back into a tank or container within the system other than the one the fuel came from.
- Displacing the amount of fuel contained in hoses or pipes downstream of the filter separator to the issue point nozzle with product that has been pumped through the filter separator. The fuel being displaced is pushed out the nozzle into a tank vehicle or container which is not part of the refueling system.

E-2. For tactical fuel systems, displacing, replacing, recirculating, or flushing twice the amount of fuel contained in the installed hoses or 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.

E-3. For refueling vehicles, displacing, replacing, recirculating, or flushing twice the amount of fuel contained in the installed hoses or pipes which are downstream of the filter separator to the nozzle is necessary and 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 or 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.

E-4. For fixed type systems, displacing, replacing, recirculating, or flushing twice the amount of fuel contained in the installed hoses or 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.

TABLES

E-5. Tables E-1 through E-3 show the amount of fuel in suction and discharge hoses.

Table E-1. Suction hose

<i>Diameter x Length (inches x feet)</i>	<i>Working Pressure (pounds per square inch)</i>	<i>Burst Pressure (pounds per square inch)</i>	<i>Fuel Content (gallons)</i>
2x10t	100	400	1.7
2x25	100	400	4.3
4x10	75	300	6.6
4x25	75	300	16.5
6x10	75	300	15.0

Table E-2. Discharge hose

<i>Diameter x Length (inches x feet)</i>	<i>Working Pressure (pounds per square inch)</i>	<i>Burst Pressure (pounds per square inch)</i>	<i>Fuel Content (gallons)</i>
2x25	150	600	4.3
2x50	150	600	8.5
4x50	150	600	33.0
6x50	150	600	75.0

Note: Working and burst pressures may vary by manufacturer.

Table E-3. Fuel content per foot

<i>Diameter (inches)</i>	<i>Fuel Content (gallons)</i>
2	0.17
4	0.66
6	1.5

Note: The 350 GPM pump holds approximately five gallons. The 350 GPM filter separator holds approximately 60 gallons.

E-6. It is mandatory recirculation be performed prior to the first refueling of the day. This should be accomplished in conjunction with daily PMCS for the refueling system or vehicle. Recirculation during preventive maintenance checks and services allows the differential pressure to be checked on the filter separator and if required, the water detection test performed. It is also mandatory to perform recirculation when a sample is required from filter separator or the nozzle, such as for the filter effectiveness test or type "C" testing.

E-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 F

Purging Petroleum Tank Vehicles and Rigid Walled Tactical Petroleum Tanks

This appendix provides guidance for draining and cleaning petroleum tank vehicles and rigid walled tactical petroleum tanks prior to deployments, field training exercises, and any other instance where draining and 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

F-1. There are times when tank vehicles or tanks must be drained, cleaned, and vapor freed. For the purpose of this appendix, the definition of 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 and 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 in accordance with 29 CFR 1910.146.

PREPARATION OF TANK VEHICLES AND TANKS

F-2. There are five basic options to prepare tank vehicles and tanks for storage, deployment, field training exercise, or maintenance. 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 in accordance with SPCC Plan for appropriate disposal.

Note: If the tank vehicle or tank has a filter separator, the elements and canisters must be removed. If the canisters are not damaged, they are reusable.

F-3. The drain empty option requires the following procedures:

- Ground and bond the tank vehicle or tank.
- Follow procedures in the appropriate 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.

F-4. The natural or forced ventilation option requires the following procedures:

- Step 1. Ground and bond the tank vehicle or tank.
- Step 2. Follow procedures in the appropriate TM to completely drain the tank shell and piping. Where applicable drain manifold, meter, pump housing, filter separator, and hoses.
- Step 3. If applicable, remove filter elements and canisters from the filter separator.

- Step 4. Ensure all low points within the system have been drained.
- Step 5. 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 or tank.

Note: If using natural ventilation go to step 9.

- Step 6. 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.
- Step 7. 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.
- Step 8. Turn on the air blower and force air into fuel compartments, piping, system components and hoses.
- Step 9. When vapors are released into the open air, precautions must be taken to eliminate ignition sources near the point of release.
- Step 10. Using an explosive meter, frequent testing of the atmosphere for vapors is required to determine the effectiveness of the ventilation.
- Step 11. When dry and vapor free, close all valves, hatches and nozzles. Install new filter elements in the filter separator if required.

F-5. The procedure for the steam dry option will be performed at the DOL maintenance or through a commercial contractor. The following procedures must be performed prior to having the tank vehicle or tank steam cleaned:

- Ground and bond the tank vehicle or tank.
- Follow procedures in the appropriate 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.

F-6. The flush with water option requires the following procedures:

- Requires a facility with an oil and water separator.
- Ground and bond the tank vehicle or tank.
- Follow procedures in the appropriate 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 or tank over an oil water separator at an authorized hazardous waste disposal site for the unit or installation.
- Completely fill tank vehicle or tank with water and allow it to overflow until all traces of product are removed.
- If tank vehicle or 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 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 or forced ventilation to finish the drying process. If required use an explosive meter to perform atmospheric testing to ensure the tank vehicle or 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.

F-7. The purge with CitriKleen option requires the following procedures:

- Step 1. 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.in accordance with Ground Precautionary Message 94-02, 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 or 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
 - 500 gallon capacity use - 1.5 gallons of CitriKleen
- Step 2. Requires a facility with an oil and water separator.
- Step 3. Ground and bond the tank vehicle or tank.
- Step 4. Follow procedures in the appropriate TM to completely drain the tank shell and piping. Where applicable drain manifold, meter, pump housing, filter separator, and hoses.
- Step 5. If applicable, remove filter elements and canisters from the filter.
- Step 6. Ensure all low points within the system have been drained.
- Step 7. Once all fuel has been drained, close all valves, hatches and nozzles. Replace all caps and plugs.
- Step 8. 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.
- Step 9. Close and secure all hatches and valves.
- Step 10. Disconnect ground cable from tank vehicle or tank.
- Step 11. Drive a minimum of six miles breaking frequently to agitate the purging solution mixture around the tank shell.
- Step 12. Ground and bond the tank vehicle or 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 and repeat steps 1-12. If you are not reusing the purging solution, continue with steps 13-20.

- Step 13. If you are not going to transfer the purging solution mixture to another tank vehicle or tank, position the tank vehicle or tank over an oil water separator at an authorized hazard waste disposal site for the unit or installation and ground and bond.
- Step 14. Follow procedures in the appropriate tank 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.
- Step 15. For tank vehicles or 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.
- Step 16. For tank vehicles or 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.
- Step 17. Ensure all low points are drained.
- Step 18. Using an explosive meter, perform atmosphere testing to determine the effectiveness of the purging.
- Step 19. 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.
- Step 20. When dry and vapor free, close all valves, hatches and nozzles. Install new filter elements in the filter separator if required.

F-8. A tank vehicle or tank is considered a confined space. You must comply with all applicable sections of OSHA's confined space standard, 29 CFR 1910.146 and any local or installation regulations before entering. Prior to entering a tank vehicle or tank, consult your local/installation environmental, safety and medical personnel for additional guidance.

Appendix G

Loading and Unloading Tank Cars

This appendix describes the procedures for loading and unloading tank cars.

PROCEDURES FOR LOADING TANK CARS

G-1. The procedures for loading tank cars are described below.

SAMPLING AND GAUGING

G-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

G-3. Inspect pumps, hose, pipelines, and manifolds to see that they are in good working condition and clean.

SPOTTING THE TANK CAR

G-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 THE DOME COVER

G-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 THE TANK CAR

G-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-3004-1A.
- 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

G-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.

G-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.

G-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

G-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.
- 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

G-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

G-12. Certain procedures must be followed before tank cars are unloaded. The procedures to follow are given below:

INSPECTING RECEIVING CONTAINERS

G-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

G-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 THE TANK CAR

G-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

G-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

G-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

G-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.

DOMES UNLOADING

G-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

G-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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Appendix H

Hydraulics

This appendix covers the petroleum product properties that are pertinent to pipeline and hoseline hydraulics, and considerations for the installation of pipelines and hoselines. In addition this appendix discusses the mechanics and mathematical formulas required to determine pipeline and hoseline hydraulics.

TRACE SELECTION

H-1. Prior to installing the IPDS or assault hoseline system equipment, a thorough study of the terrain is required using maps, aerial surveys, photographs, and terrain walks (where possible). Based on this survey, the optimum trace is selected and a hydraulic profile is constructed. Things to consider when planning the route for the trace include:

- The route should be as direct as possible from the fuel source to the forces requiring support and present a minimum number of obstacles and obstructions.
- Will the trace follow MSRs or secondary roads? There are advantages/disadvantages to both to consider.
- If roadways do not exist or cannot be utilized, select a route that is accessible to vehicles required for emplacing and constructing the systems.
- Keep security precautions in mind. Utilize natural camouflage wherever possible and avoid routing the systems through populated areas.
- Avoid difficult terrain when possible, as this will increase the emplacement/construction time significantly.
- Significant change in elevation can lead to overpressure problems.
- Consider the number of crossings along the trace. Culverts can be used to cross smaller roads. Gap crossing kits can be used to cross larger gaps (such as, rivers, streams, ravines, drainage ditches). If possible, consider altering the trace to utilize existing bridges or engineer constructed line of communication bridges to minimize construction time.
- Joint deflection for IPDS pipeline is limited to 2° . If the deflection at a coupling exceeds 2° during construction, the expansion of the pipeline could cause the coupling to fail.
- Expansion devices are required for IPDS pipelines. There are two types of expansion devices used. These are the “U” loop and “Z” shaped offsets and are equal in absorbing the expansion and contraction of the pipeline. “U” loops may be installed in situations where the trace is narrow and may be installed around obstacles such as trees or rocks. “Z” shaped offset can be installed on wide traces and conserve pipe sections and elbows. Terrain at the expansion location will generally dictate which one you select. For planning purposes, always plan to use a “U” loop for every expansion joint because it requires more equipment (worst case).

H-2. Branch lines connect with the existing or planned main lines of IPDS. Planning for branch lines is the same as planning for the main line. Generally, branch lines will come out of an intermediate terminal vice directly out of the pipeline.

TERRAIN PROFILE CONSTRUCTION

H-3. Plotting the terrain profile (drawn on graph paper) is needed to determine the location of pump stations. To construct the terrain profile, first obtain a topographical map or other source of material that provides accurate information about terrain along the projected trace route. Using this information, plot the trace route on graph paper as follows:

- Divide the horizontal base of the graph paper, figure H-1, into spaces that represent uniform distances, any suitable scale can be used. The smaller the increment, the more accurate the trace planning will be; however over significant distances the scale will likely still be large, to include potentially having to put multiple graph papers together. The terrain profile base represents the entire horizontal distance the system will operate.
- Divide the vertical left-hand edge of the ground profile graph, figure H-1, 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 trace's route.

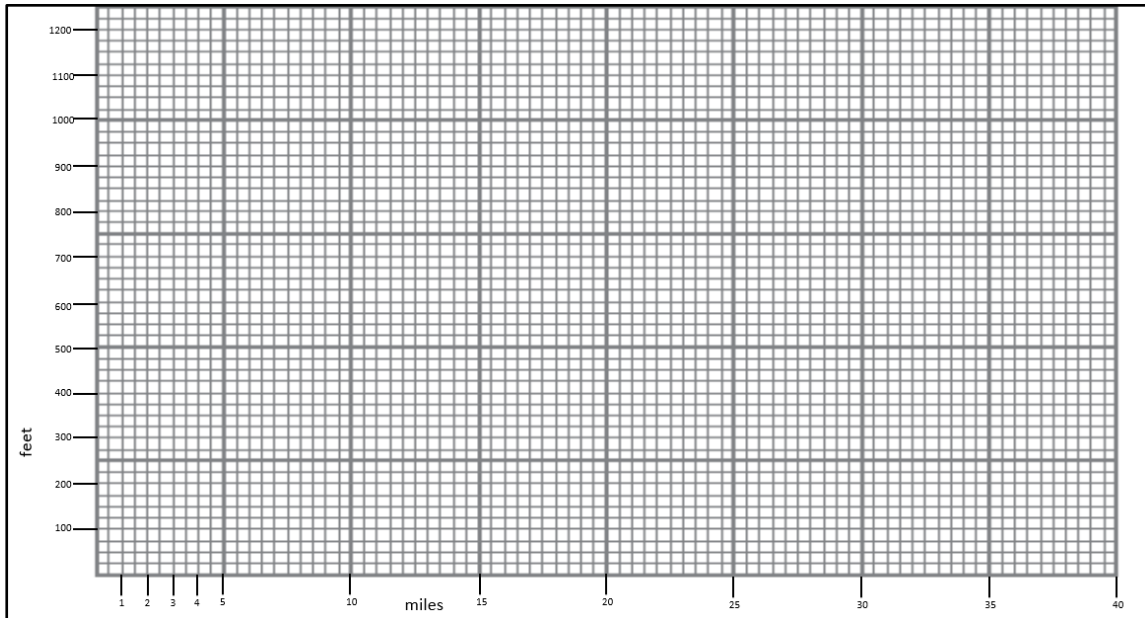


Figure H-1. Graph paper setup

- At left-hand edge of the terrain profile graph, figure H-2, mark a point that represents the first pump station elevation.
- Continuing across the terrain profile graph, figure H-3, at a minimum, mark points where significant changes in elevation occur. The more points that are plotted, the more accurate the planning will be.

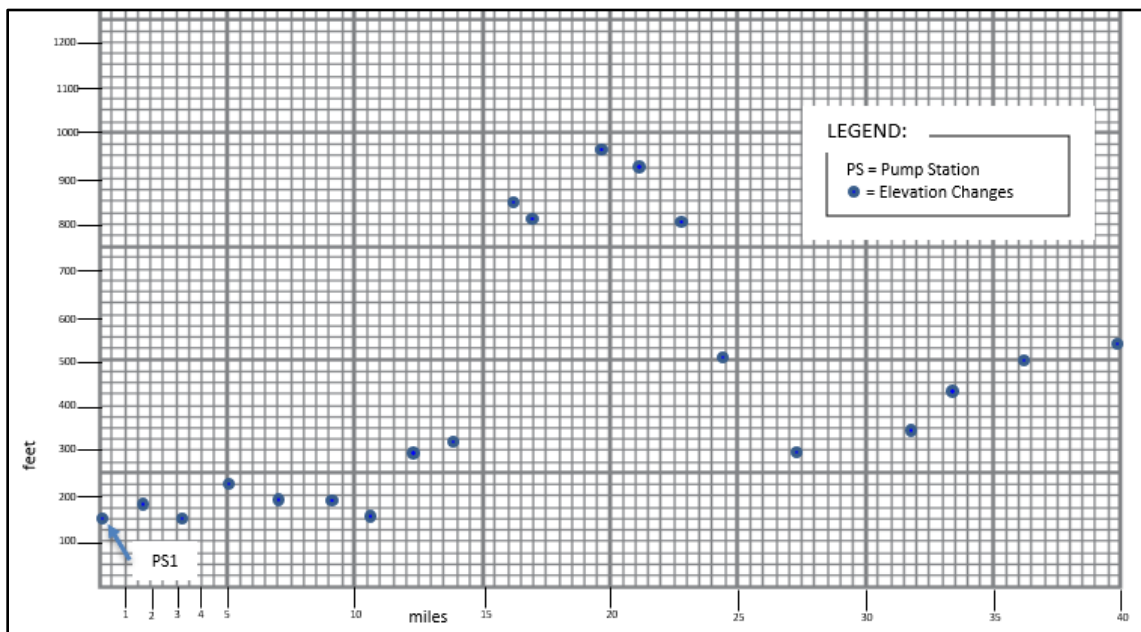


Figure H-2. Plotting elevation changes

- To complete the trace, figure H-3, join the points marked on the graph with a straight line.

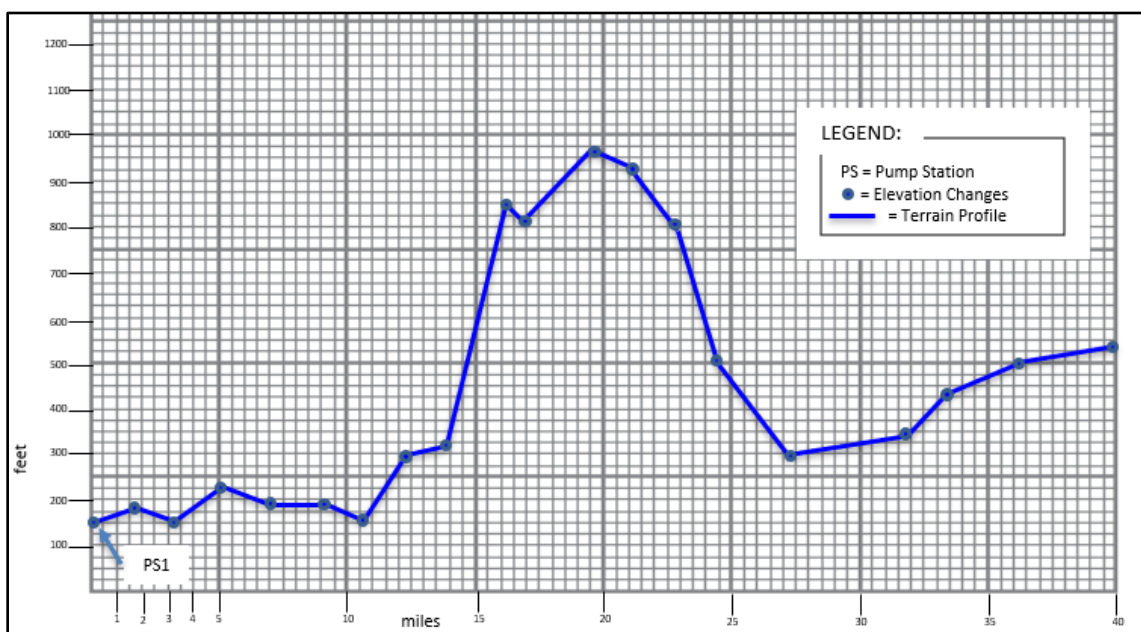


Figure H-3. Terrain profile

HYDRAULIC GRADIENT

H-4. The hydraulic gradient (Hg) is utilized to determine the location of each pump station after the first pump station. The Hg is calculated based upon the several factors that will be discussed in the following paragraphs. Once the Hg is determined, it is added to the terrain profile in a location that allows the user to use a parallel ruler to plot parallel lines to determine the placement of downstream pump stations.

DESIGN FUEL

H-5. The first step in determining the Hg is to determine the design fuel. The design fuel should be the heaviest fuel that you intend to push through the pipeline or hoseline. The design fuel for the U.S. Army should almost always be JP8 to meet the primary fuel on the battlefield throughput requirements. The fuel temperature utilized for planning purposes is generally 60°F unless you know that the temperature of the fuel would be significantly higher or lower in your scenario.

AVAILABLE HEAD

H-6. The next step is to determine how far the pump can push the fuel, without friction.

- Determine the Total Available Head (TAH) by reading the pump curve of the pump and converting from psi to feet.
- Determine the Net Available Head (NAH) by subtracting the required head that needs to be available at the next pump station. For the IPDS, 20 psi is required to be available on the inlet side of the pump station.

TOTAL AVAILABLE HEAD

H-7. TAH is determined by reading the pump curve using the desired flow rate and RPM, then converting pressure from psi to feet of head (H_f).

- See figure H-4 for an example using the IPDS 800 GPM mainline pump; 1800 RPM is the ideal setting for that pump, and 600 GPM being the desired flow rate based upon the desired output of 720,000 gallons per day ($720,000/20$ operating hours/ 60 minutes = 600 GPM). You will notice that there not a bar for JP8, we will need to convert the water number to JP8 to get the best estimate. Reading up from the 600 GPM line until it hits the 1800 RPM line it hits the water bar at approximately 575 psi.

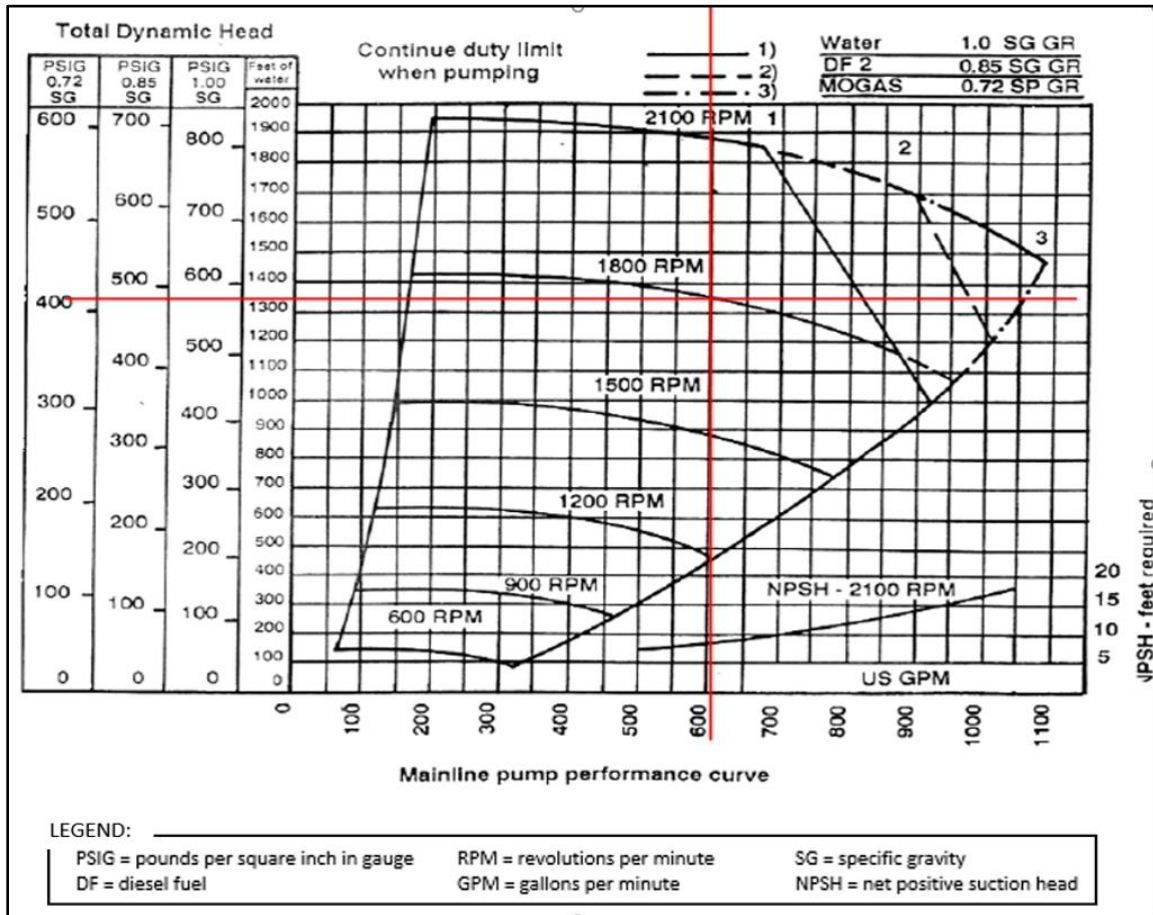


Figure H-4. IPDS 800 gallon per minute (GPM) pump performance curve

- For planning purposes, generally utilize a generic specific gravity for each fuel type as noted below:
 - Mogas (gasoline): 0.7250
 - Diesel Fuel #2: 0.8448
 - JP4: 0.7753
 - JP5: 0.8203
 - JP8/F-24: 0.8063

Note: All examples will use JP8 specific gravity.

- Continuing with the IPDS example:
 - To convert from water, use proportions.

$$\begin{array}{rclcl}
 \text{PSI of diesel} & \longrightarrow & 575 & \longleftarrow & X & \longleftarrow \text{PSI of JP8} \\
 \text{SG of diesel} & \longrightarrow & 1 & \longleftarrow & .8063 & \longleftarrow \text{SG of JP8 (generic)} \\
 & & & \text{Cross Multiply} & & \\
 & & & (575 * .8063) = 1 * X & & \\
 & & & 463.6 = X & &
 \end{array}$$

- The output pressure of JP8 is 463 psi.
- Convert psi to H_f by using the formula:

$$\begin{array}{rcl}
 \text{Feet of Head} & \longrightarrow & H_f = \frac{\text{Constant} \cdot 2.31 \cdot \text{PSI}}{\text{SG}} \\
 & & \text{Specific gravity} \\
 & & H_f = \frac{2.31 \cdot 463.6}{.8063} \\
 & & H_f = 1328
 \end{array}$$

- IPDS TAH for JP8 (60° F/0.8063 specific gravity) at 600 GPM/1800 RPM is 1328 feet.
- See figure H-5 for an example using the assault hoseline system 350 GPM pump; 1800 to 2000 RPM is the ideal setting for that pump, and 350 GPM being the desired flow rate. You will notice that there not a bar for JP8, we will need to convert the mogas number to JP8 to get the best estimate. Reading up from the 350 GPM line until it hits the 1900 RPM line it hits the mogas bar at approximately 55 psi.

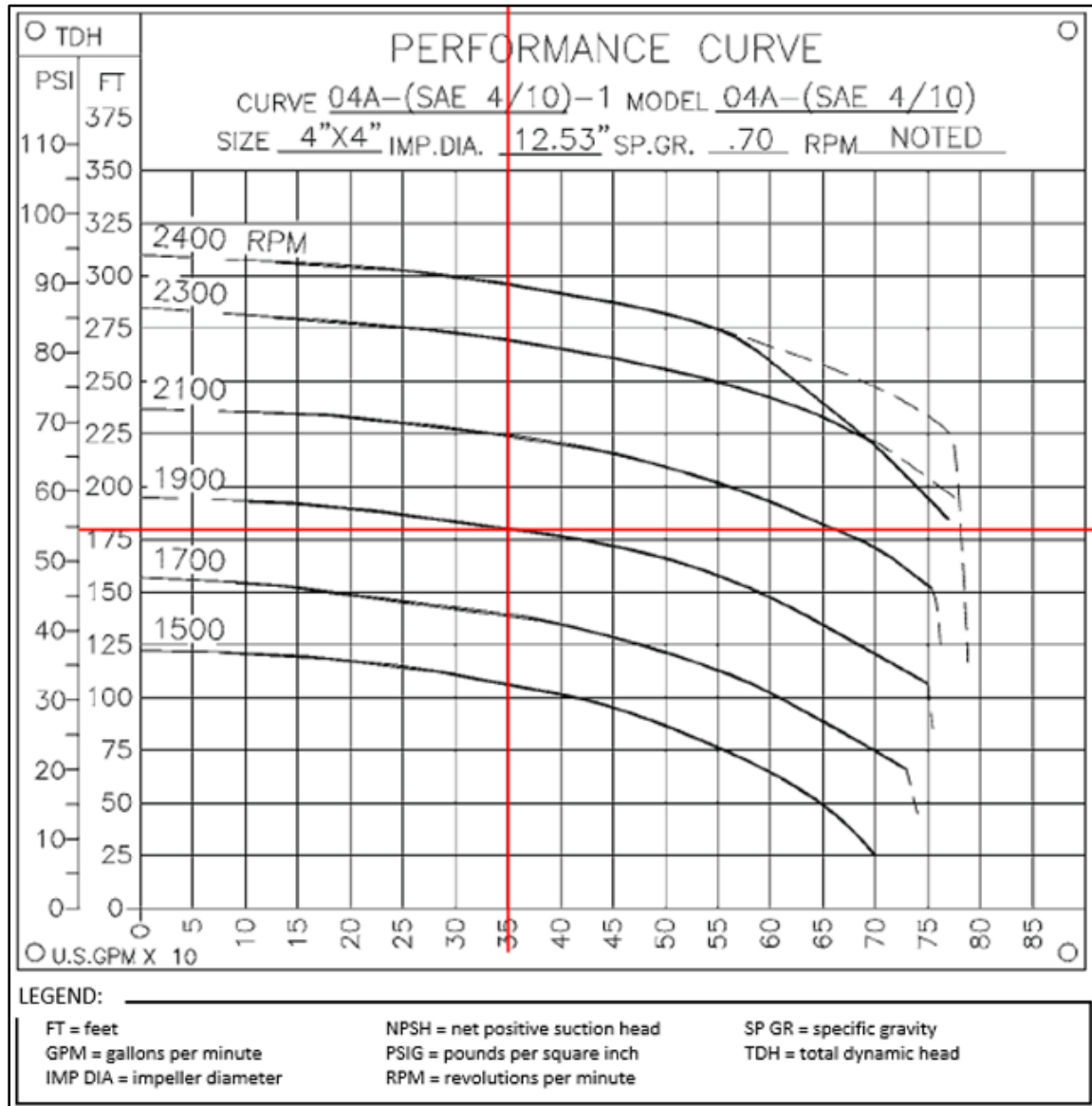


Figure H-5. 350 GPM pump performance curve

- To convert from mogas, use proportions.

$$\begin{array}{ccccc}
 \text{PSI of mogas} & \longrightarrow & 55 & \longleftarrow & X & \longleftarrow & \text{PSI of JP8} \\
 \text{SG of mogas (from} & \longrightarrow & 0.70 & \longleftarrow & .8063 & \longleftarrow & \text{SG of JP8} \\
 \text{pump curve)} & & & & & & \text{(generic)} \\
 & & \text{Cross Multiply} & & & & \\
 & & (55 * .8063) = 0.70 * X & & & & \\
 & & 63.35 = X & & & &
 \end{array}$$

- The output pressure of JP8 (60° F/0.8063 specific gravity) at 350 GPM/1900 RPM is 63 psi for the assault hoseline system.
- Convert psi to H_i:

$$H_f = \frac{2.31 * 63.35}{.8063}$$

$$H_f = 181.49$$

- Assault hoseline system TAH for JP8 (60° F/0.8063 specific gravity) at 350 GPM/1900 RPM is 181 feet.

NET AVAILABLE HEAD

H-8. NAH takes into account the head required to be available at the next pump station to continue pumping without potential cavitation of the pumps. For the IPDS and assault hoseline system, 20 psi I required to be available on the inlet side of the pump station.

- Continuing with the IPDS example:
 - Convert 20 psi to H_f

$$H_f = \frac{2.31 * 20}{.8063}$$

$$H_f = 58 \text{ (really 57.3 but you want to round up here, never down (to make sure enough is coming into pump))}$$

- NAH = TAH – Suction Head (continuing the IPDS example from above).

$$\begin{aligned} \text{NAH} &= 1328 - 58 \\ \text{NAH} &= 1270 \end{aligned}$$

- IPDS NAH for JP8 (60° F/0.8063 specific gravity) at 600 GPM/1800 RPM is 1270 feet.
- Assault hoseline system:
 - Convert 20 psi to H_f (58 H_f , same as with IPDS example above).
 - NAH = TAH – Suction Head

$$\begin{aligned} \text{NAH} &= 181 - 58 \\ \text{NAH} &= 123 \end{aligned}$$

- Assault hoseline system NAH for JP8 (60° F/0.8063 specific gravity) at 350 GPM/1900 RPM is 123 feet.

REYNOLDS NUMBER

H-9. The next step is to determine how much H_f is lost per mile due to friction to help determine where to place the follow on pump stations. The first part of this step is to determine the Reynolds Number. The Reynolds Number is a dimensionless number that describes the ratio of inertial forces to viscous forces. Use the Reynolds Number Field Data Formula to determine the Reynolds Number.

$$\text{Re} = \frac{\text{Constant} \rightarrow 3160 * \text{Flow rate in GPM} \leftarrow Q}{\text{Diameter of the pipe in inches.} \rightarrow d * \text{Kinematic Viscosity in cSt} \leftarrow K}$$

- Continuing with the IPDS example, the flow rate required was 600 GPM and the diameter of the pipeline is 6.249 inches (nominal diameter). Kinematic Viscosity must be determined using the chart in figure H-6, contained in the *Handbook of Aviation Fuel Properties*, which was provided courtesy of the Coordinating Research Council. A complete copy of the handbook can be purchased at the Coordinating Research Council website.

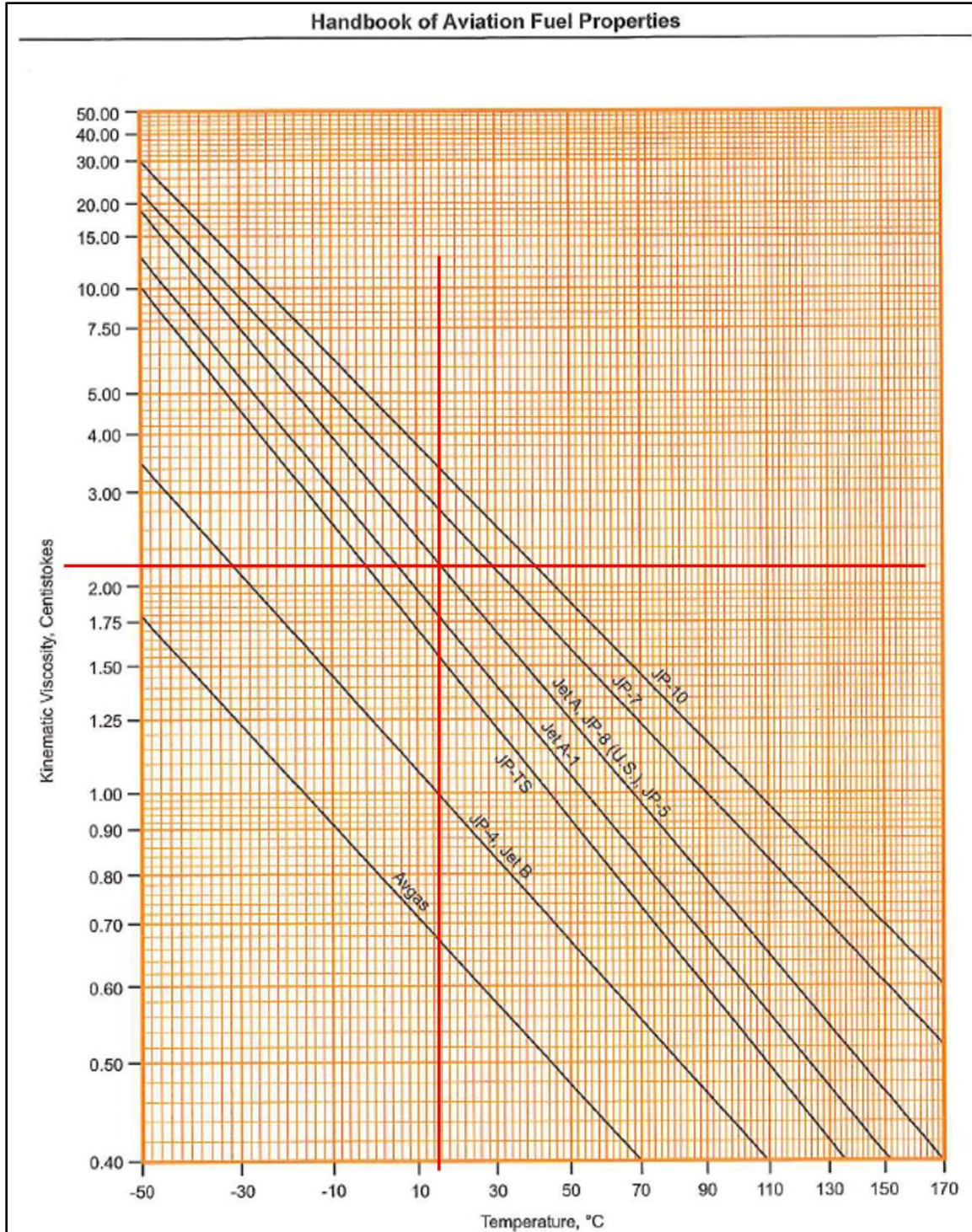


Figure H-6. Kinematic viscosities of aviation fuel versus temperature

- Reading the chart in figure H-6, using our design fuel (JP8 @60°F), the kinematic viscosity is 2.2 cSt.
- Complete the Reynolds Number formula:

$$Re = \frac{3160 * 600}{6.249 * 2.2}$$

$$Re = 137,912.98$$

- There are three types of flow that can be determined using the Reynolds Number.
 - Laminar – Reynolds Number from 0 to 2,300.
 - Transitional – Reynolds Number from 2,301 to 4,000.
 - Turbulent – Reynolds Numbers greater than 4,000.
 - Army pipeline and hoseline operations are always turbulent.

FRICION FACTOR

H-10. The second step to determine how much H_f is lost per mile due to friction is to determine the Friction Factor using the Reynolds Number calculated by following paragraph H-9. To determine the friction factor for turbulent flow, the Colebrook-White Equation is widely accepted for describing the Darcy-Weisbach friction factor. The only drawback to using the equation is that it is implicit and will require iteration to solve. Where iteration is possible and there are no constraints on computation speed, calculation with the Colebrook-White equation is appropriate.

$$\frac{1}{\sqrt{f}} = -2 \log_{10} \left[\left(\frac{\frac{\text{Roughness in inches}}{\epsilon}}{3.7d} \right) + \left(\frac{2.51}{Re \sqrt{f}} \right) \right]$$

Friction Factor
Diameter of the pipe in inches.
Friction Factor

Reynolds Number

H-11. To solve the Colebrook-White Equation with iteration it requires selecting a value for the friction factor, comparing the results from both sides of the equation to assign a new value for the friction factor repeatedly until both sides of the equation are as equal as possible. This is time consuming by hand, and it is recommended to contact the Army Petroleum Center for assistance with automating the iteration function using computer software.

H-12. If calculating by hand calculator or by computer where iteration is difficult, the Churchill equation is most appropriate for Army applications as it is explicit and is accurate to within the error of data used to construct the Moody diagram. The equation is presented using two intermediate values (A and B) for simplicity.

$$f = 8 \left[\left(\frac{8}{R_e} \right)^{12} + \frac{1}{(A+B)^{1.5}} \right]^{0.8333}$$

Reynolds Number

Where:

$$A = \left[2.457 \ln \left(\frac{1}{\left(\frac{7}{R_e} \right)^{0.9} + 0.27 \frac{\epsilon}{d}} \right) \right]^{16}$$

Reynolds Number

Roughness in inches

Diameter of the pipe in inches.

$$B = \left(\frac{37,530}{R_e} \right)^{16}$$

Reynolds Number

- Continuing with the IPDS example:
 - Solve for A (answer in scientific notation for simplicity). IPDS internal absolute roughness in inches is 0.00006.

$$A = \left[2.457 \ln \left(\frac{1}{\left(\frac{7}{137,912.98} \right)^{0.9} + 0.27 \left(\frac{0.00006}{6.249} \right)} \right) \right]^{16}$$

$$A = 2.64068 \times 10^{21}$$

- Solve for B (answer in scientific notation for simplicity).

$$B = \left(\frac{37,530}{137,912.98} \right)^{16}$$

$$B = 9.0443 \times 10^{-10}$$

- Complete the Churchill equation.

$$f = 8 \left[\left(\frac{8}{137,912.98} \right)^{12} + \frac{1}{(2.64068 \times 10^{21} + 9.0443 \times 10^{-10})^{1.5}} \right]^{0.8333}$$

$$f = 0.0168$$

- The friction factor for IPDS operations pumping JP8 (60° F/0.8063 specific gravity) at 600 GPM/1800 RPM is 0.0168.
- For planning, assault hoseline system hose friction loss is 2 psi per 100 feet of assault hoseline per the technical manual.

HEAD LOSS

H-13. The third step to determine how much H_f is lost per mile due to friction is to determine the head loss (H_L) per mile using the Darcy-Weisbach Modified Model Equation.

$$H_L = \frac{0.031 * f * L * Q^2}{d^5}$$

Friction Factor → f
 Constant → 0.031
 Diameter of the pipe in inches. → d
 1 mile of pipeline → L
 Flow rate in GPM → Q

- One mile of IPDS pipeline does not equal 5,280 feet. One mile includes (at worst case):
 - 1 gate valve. A gate valve has the equivalent length of 4.5 feet for pressure loss calculations.
 - 1 check valve. A check valve has the equivalent length of 50 feet for pressure loss calculations.
 - 289 sticks of pipe. 278 sticks for the straight-line mile (each stick is 19 feet); 11 extra sticks for expansion (Expansion “U” every 50 sticks amount to 5.5 joints per mile).
 - 22 90° elbows (4 per expansion joint (5.5 joints per mile)). A 90° elbow has the equivalent length of 6.7 feet for pressure loss calculations.
 - All totaled, there are 5,692.9 feet of pipe in a mile of IPDS.

$$H_L = \frac{0.031 * 0.0168 * 5,692.9 * 600^2}{6.249^5}$$

$$H_L = 112.01$$

- Continuing the IPDS example, calculate the H_L per mile. The answer is in feet/mile.
- The H_L per mile pumping JP8 (60° F/0.8063 specific gravity) at 600 GPM/1800 RPM is 112.01 feet/mile.
- Assault hoseline system H_L per mile: Since the friction was given as 2 psi loss per 100 feet, we can convert that to psi loss per mile by multiplying by 52.8 (52.8 100 foot intervals in a mile). The total H_L per mile is 105.6 psi. Then you can convert to feet:

$$H_f = \frac{2.31 * 105.6}{.8063}$$

$$H_f = 302.54$$

- The H_L per mile pumping JP8 (60° F/0.8063 specific gravity) at 350 GPM/1900 RPM is 303 feet/mile.

HYDRAULIC GRADIENT CALCULATION

H-14. To determine the distance between pump stations for the H_g ; take the TAH and NAH and divide by the H_L per mile. The answer will be in miles.

- Continuing the IPDS example; the H_g for TAH is:

$$H_{g\text{TAH}} = 1328 / 112.01$$

$$H_{g\text{TAH}} = 11.86$$

- Continuing the IPDS example; the Hg for NAH is:

$$H_{g\text{ NAH}} = 1270/112.01$$

$$H_{g\text{ NAH}} = 11.34$$

- Continuing the assault hoseline system example; the Hg for TAH is:

$$H_{g\text{ TAH}} = 181.49/302.54$$

$$H_{g\text{ TAH}} = 0.60$$

- Continuing the assault hoseline system example; the Hg for NAH is:

$$H_{g\text{ NAH}} = 123/302.54$$

$$H_{g\text{ NAH}} = 0.41$$

Note: The assault hoseline system pumps that come with the system are not sufficient to pump the fluid the full length of hoseline provided with the system. Planners have to figure out how many additional pumps are needed for the trace and procure them for the mission.

PLOTTING HYDRAULIC GRADIENT

H-15. The next step is to plot what is known as the hydraulic gradient triangle using the TAH, NAH, and the Hg for each. First, plot the NAH vertically, then the corresponding Hg horizontally. Then plot the TAH vertically and follow with the corresponding Hg. Figure H-7 on page H-14 shows an example of plotting the hydraulic gradient triangle.

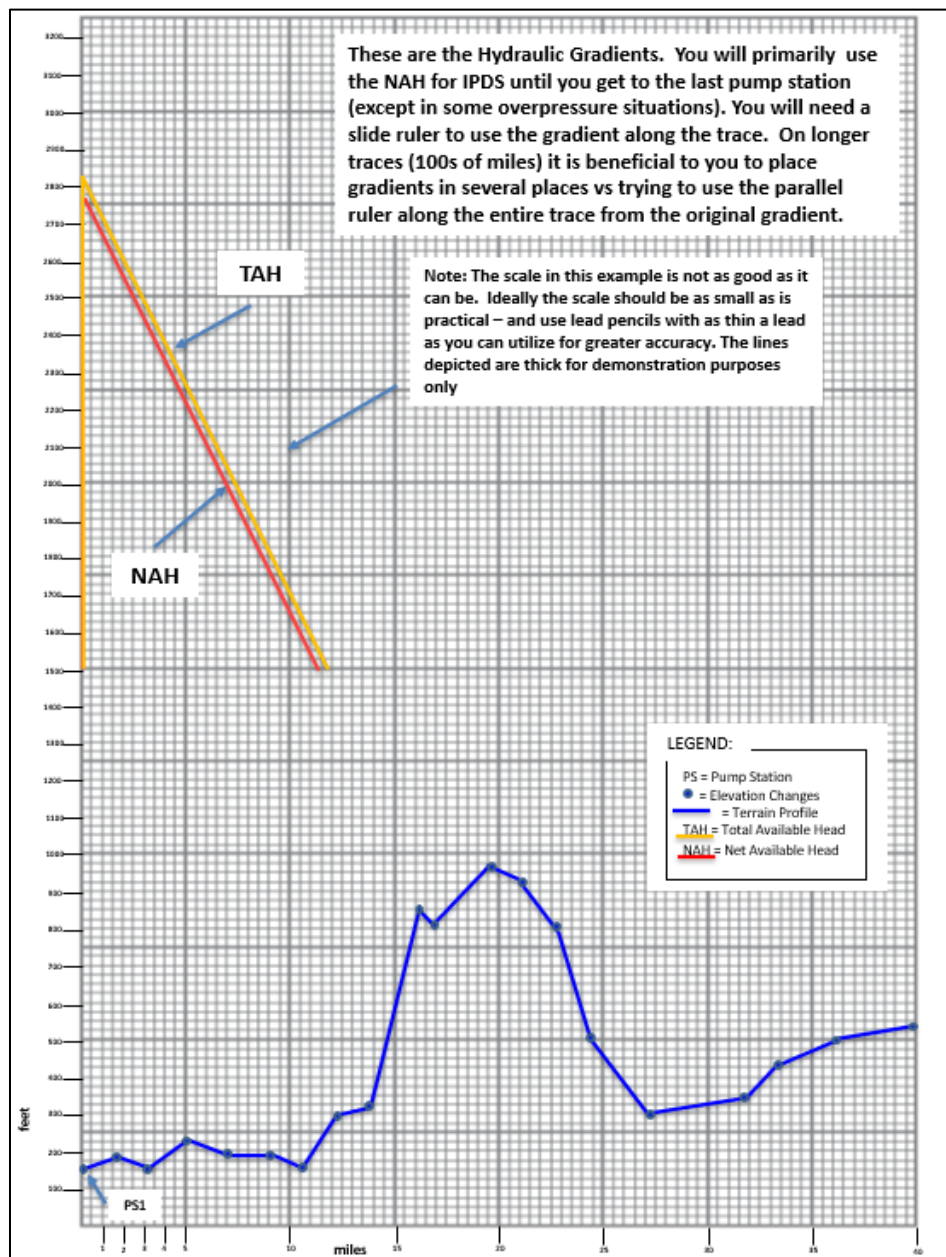


Figure H-7. Plotting Hydraulic gradient (Hg) on trace

PLOTTING PUMP STATIONS

H-16. Using the NAH Hg, begin at pump station 1. Plot up the NAH distance, then use a parallel ruler to plot a parallel line using the Hg from the top of the NAH above pump station 1 to the trace profile. Where the Hg crosses the trace is where pump station 2 is placed. Repeat the process until the trace is finished or a suspected overpressure situation is encountered. Overpressure will be discussed later in this appendix. Figure H-8 shows an example of plotting pump stations.

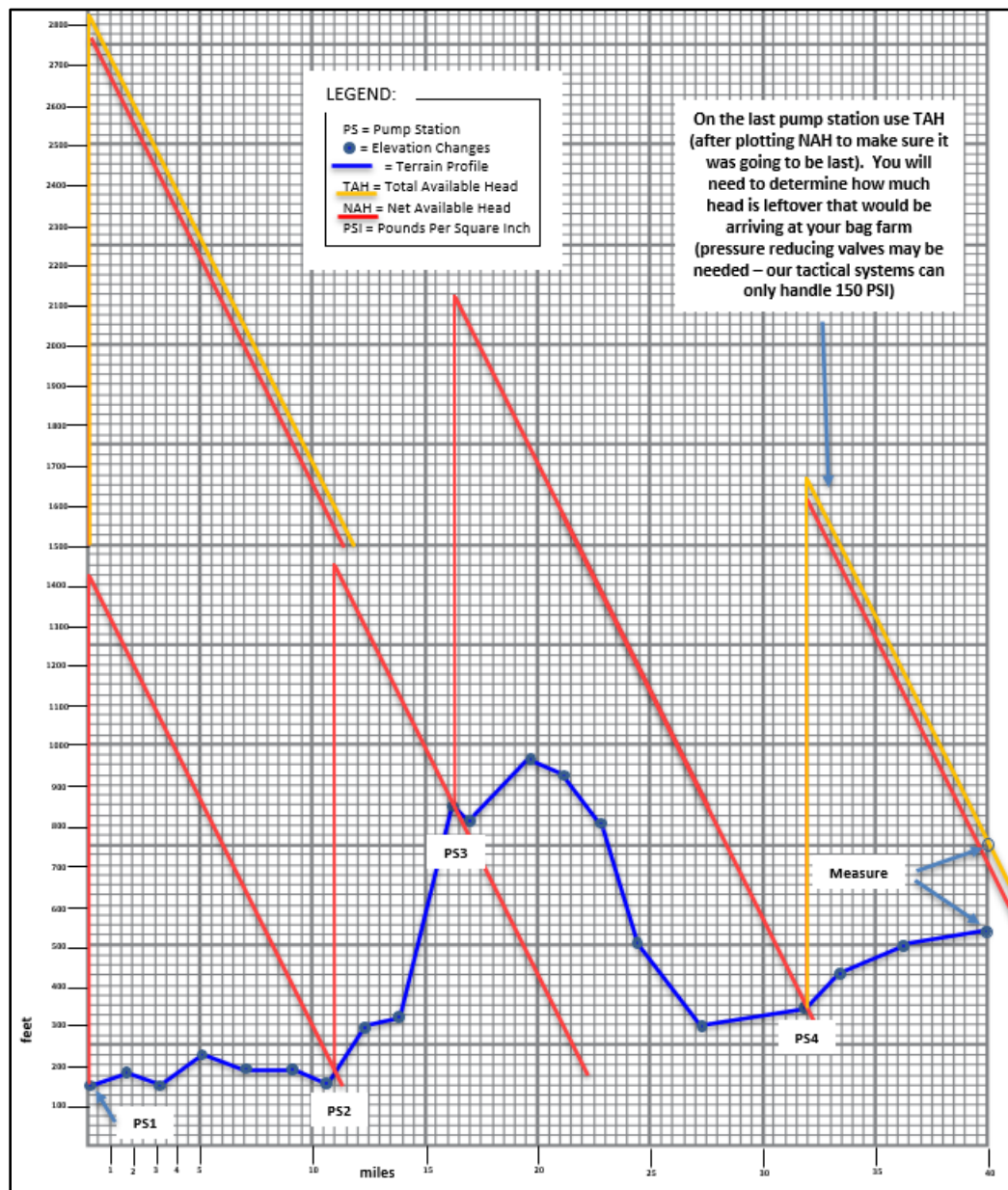


Figure H-8. Plotting pump stations along trace

H-17. On the last pump station use the TAH (after plotting NAH to make sure it was going to be last). You will need to determine how much head is leftover that would be arriving at your bag farm. Pressure reducing valves may be needed; our tactical systems can only handle 150 psi.

- Measure up from the elevation at the end of the trace to the TAH Hg and determine leftover feet of head (see figure H-9 on page H-16).

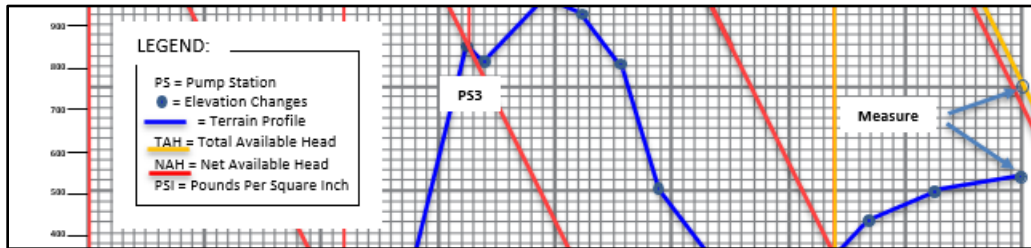


Figure H-9. Measure pressure at the end of the trace

- Convert that to psi to determine if you need to reduce pressure prior to the tank farm.
 - Continuing the IPDS example, the remaining H_f at the end of the trace is approximately 220 H_f ($760 - 540 = 220$).

$$\text{PSI} = \frac{220 * 0.8603}{2.31}$$

$$\text{PSI} = 76.8$$

- The remaining pressure is 76.8 psi. In this example, pressure reduction is not needed prior to entry into the bag farm (150 psi max for Army systems).

OVERPRESSURE

H-18. Where there are large changes in elevation, the pressure caused by the fuel at rest (Static) or in motion (Dynamic) may exceed the maximum safe working pressure (MSWP) of the pipeline or hoseline. The following section discusses steps that are used to determine areas of overpressure and mitigate or relocate the next pump station (if required).

STATIC OVERPRESSURE

H-19. Static overpressure is the force exerted on a fluid at rest. The following steps will determine if you have a static overpressure situation:

- From the last pump station before the major drop in elevation, measure up the distance that represents the TAH for the pump station. Name that point "O1".
- Next, using a parallel ruler, align one side with the TAH H_g , extend the opposite side of the ruler until it is aligned with "O1". Draw a line using the H_g until it intersects with the trace. This line represents the true gradient. The true gradient indicates the point along the trace at which all pressure has been expended and, if fluid was being pushed, it would be at 0 psi.
- Convert the MSWP for the pipeline or hoseline from psi to feet of head.
 - MSWP for IPDS is 740 psi.
 - MSWP for the assault hoseline system is 150 psi.
- Locate the highest elevation point on the trace (prior to the large change in elevation) and name that point "O2". From "O2", measure straight down the distance that represents the MSWP. Name that point "O3".
- From "O3", draw a horizontal line to the right though the trace. Name the first point of the intersection "A" and the second point of the intersection "B". "A" is where static overpressure begins. "B" is where static overpressure ends. If the horizontal line does not intersect with the trace, there is no static overpressure.
- The way to solve static overpressure with Army equipment is to place bags at the start of the static overpressure to drain the fuel off into when the pipeline or hoseline is being shut down. This necessitates placing a pump station there to push fuel back into the line when starting back up.

This basically becomes your next pump station and you adjust all remaining pump stations from the new one.

- Example #1 (see figure H-10) demonstrates an example of a situation where static overpressure occurs.
- Example #2 (see figure H-11 on page H-18) demonstrates an example of a situation where static overpressure does not occur using the same trace and data, with the only exception being the MSWP is slightly higher.

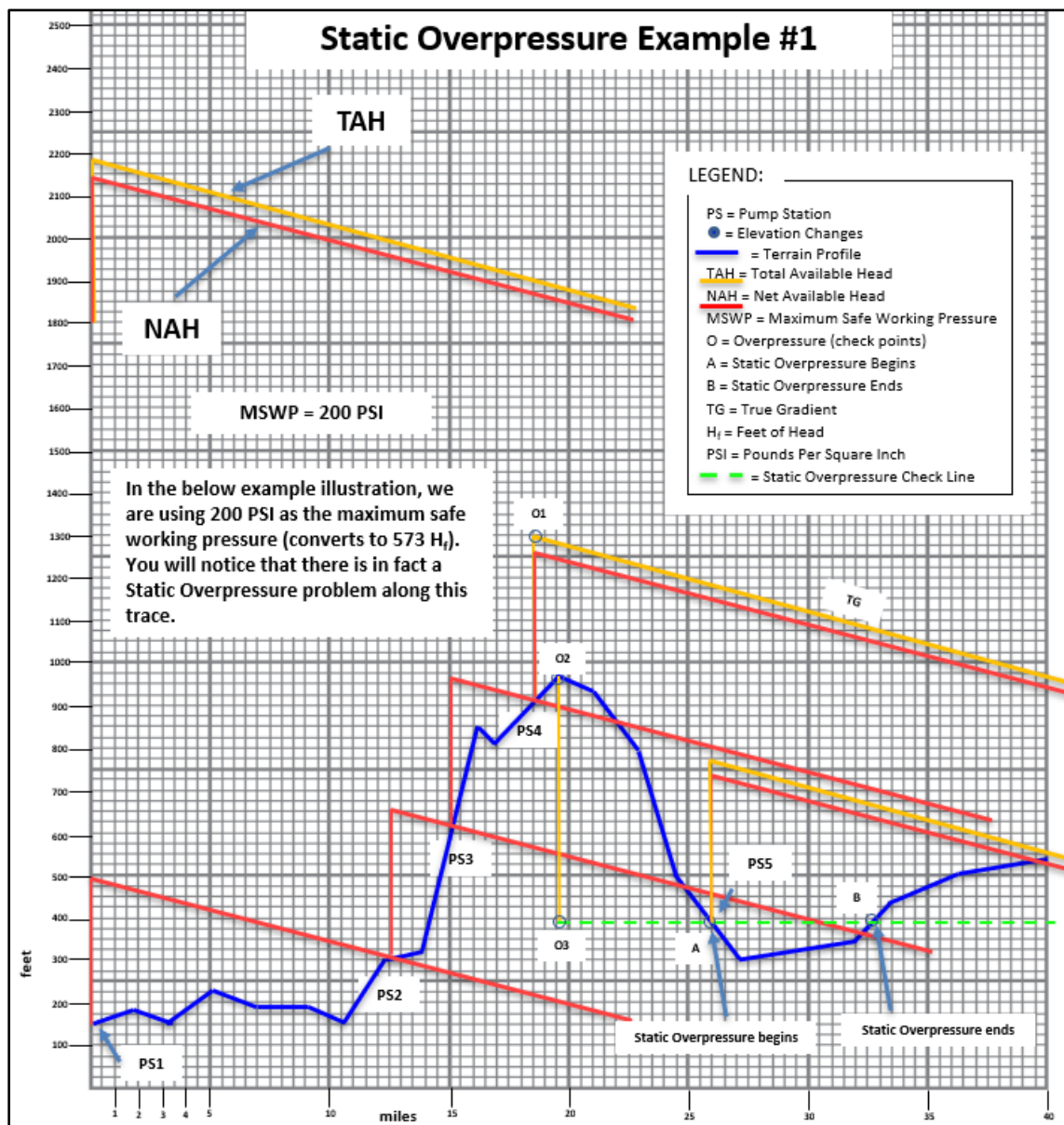


Figure H-10. Example #1 of static overpressure

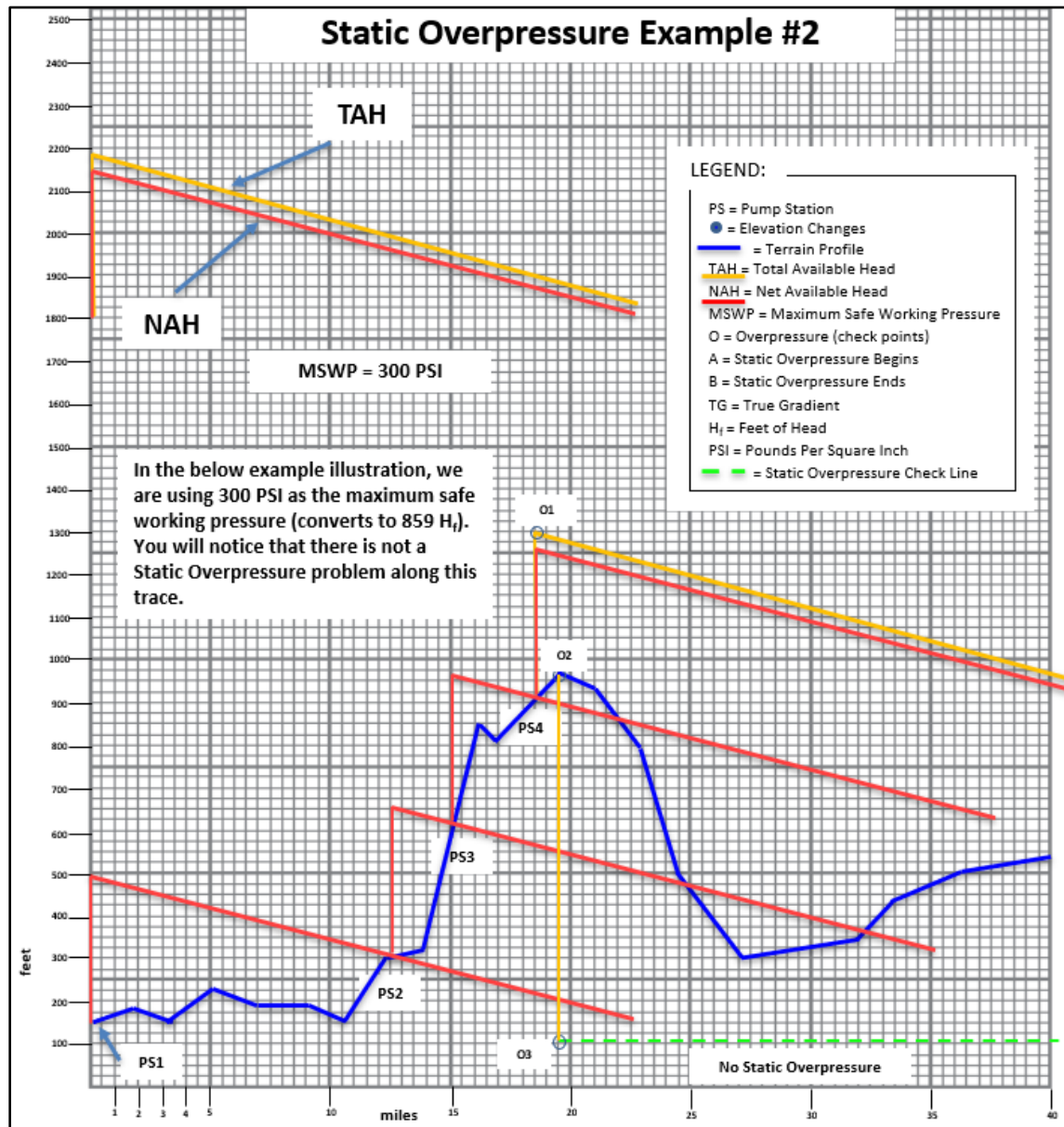


Figure H-11. Example #2 of static overpressure

DYNAMIC OVERPRESSURE

H-20. Static overpressure is the force exerted on a fluid in motion. The following steps will determine if you have a static overpressure situation:

- From “O1” (done earlier during static overpressure check), measure down the MSWP. Name that point “O4”.
- Using the parallel ruler, align one side with the Hg, extend the opposite side of the ruler until it is aligned with “O4”. Draw a line down from “O4” until it intersects the pipeline or hoseline trace once. Name the point of intersection “C”. “C” is where dynamic overpressure begins. If the line from “O4” does not intersect the pipeline or hoseline trace, there is no dynamic overpressure. A solution for dynamic overpressure is to place pressure regulating valve.

- Example #1 (see figure H-12) demonstrates an example of a situation where dynamic overpressure occurs.
- Example #2 (see figure H-13 on page H-20) demonstrates an example of a situation where dynamic overpressure does not occur using the same trace and data, with the only exception being the MSWP is slightly higher.

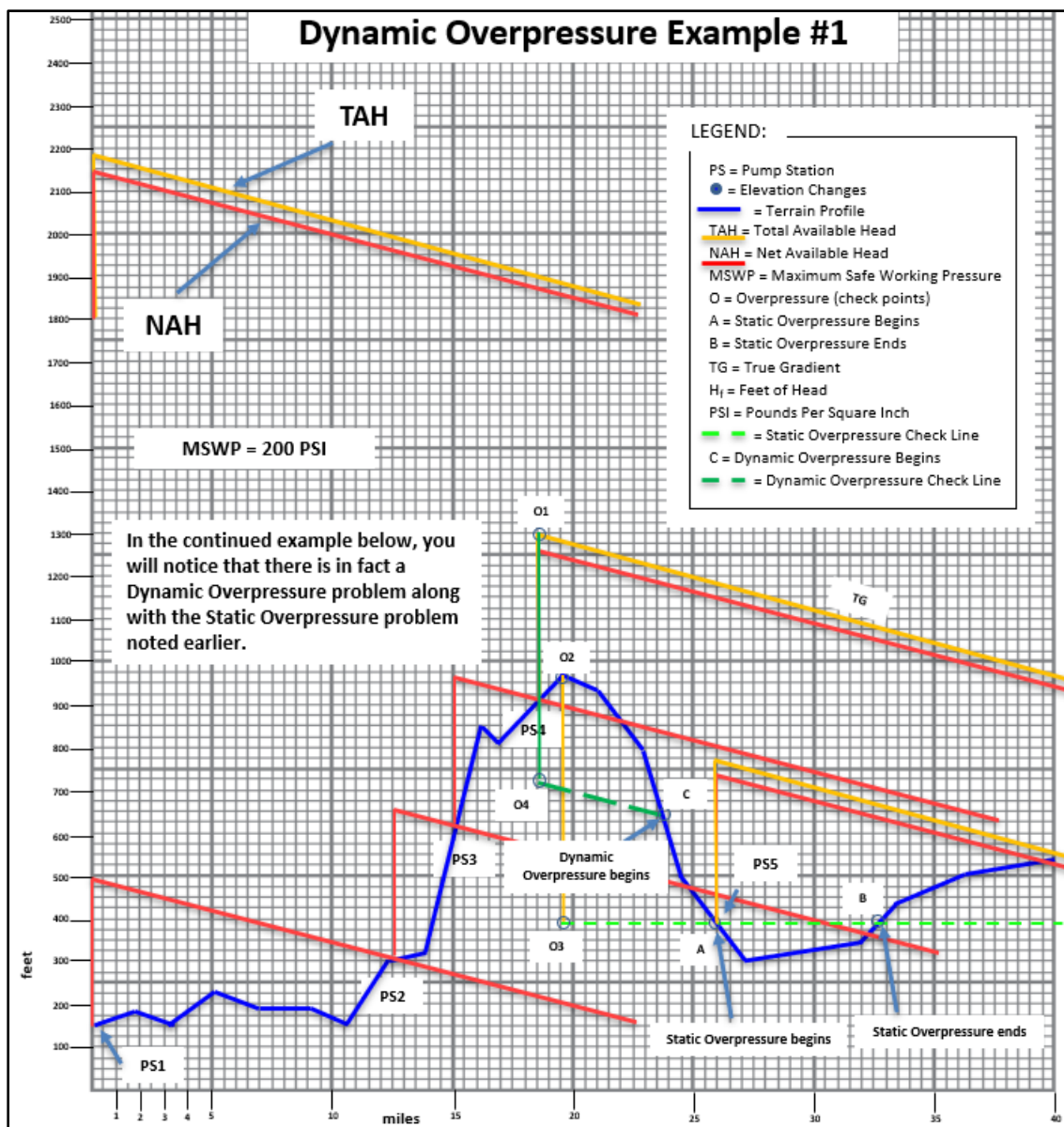


Figure H-12. Example #1 of dynamic overpressure

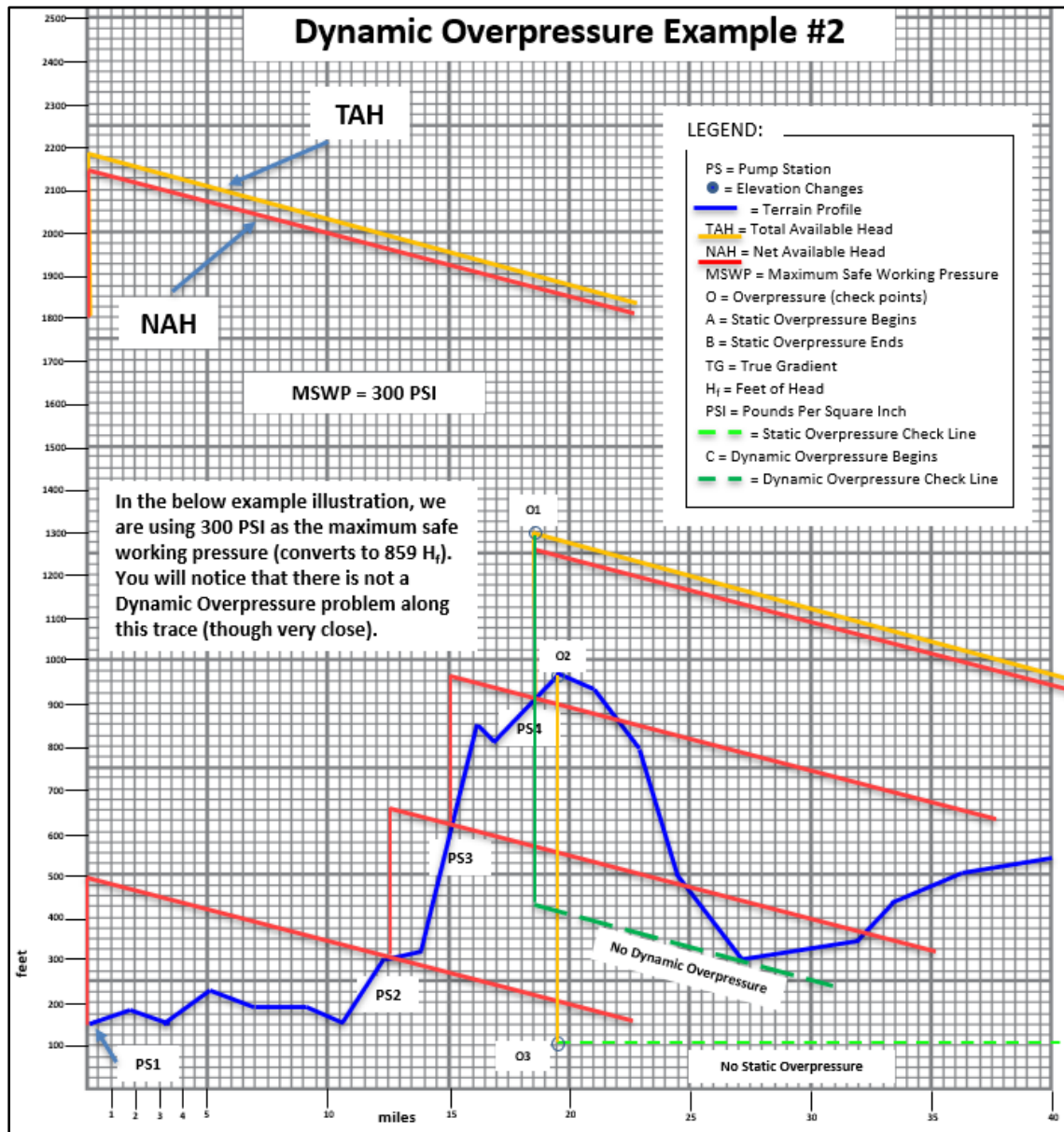


Figure H-13. Example #2 of dynamic overpressure

Appendix I

Petroleum Product Factors

This appendix displays petroleum factors that enable the petroleum handler and planners to plan and execute petroleum operations.

I-1. Table I-1 shows the petroleum product factors of various types of petroleum products.

Table I-1. Petroleum product factors

Fuel	API gravity @ 60 degrees Fahrenheit		Density @ 15 degrees Celsius (kg/m ³)	Specific Gravity	Pounds per			Barrels per			Barrels/day to equal	
	Range	Average			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	5-74	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	0.8150	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
LEGEND:	API = American Petroleum Institute Kg/m ³ = kilograms per cubic meter											

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Appendix J

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 INTERNATIONAL/AMERICAN PETROLEUM INSTITUTE/ENERGY INSTITUTE OF PETROLEUM TABLES 5A AND 5B

J-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.

J-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-person 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 ASTM International® D1250 Tables 5B & 6B.

J-3. Tables 5A and 5B give 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

J-4. The first step in volume conversion is fuel classification and temperature. Described below are the procedures that must be followed during fuel classification.

- Step 1. 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 promptly.
- Step 2. Agitate the contents of the sample container by shaking it thoroughly.
- Step 3. Slowly and carefully pour the sample down the inside of a clean, dry hydrometer cylinder, filling the cylinder approximately 3/4 full.

- Step 4. 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.
- Step 5. Set the cylinder on a level surface where it is protected from air currents.
- Step 6. 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 J-1.
- Step 7. 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.
- Step 8. 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.

- Step 9. Stir the sample gently by raising and lowering the hydrometer, and watch the movement of the mercury in the thermometer. When the mercury stops moving, take a temperature reading and record it.
- Step 10. 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.
- Step 11. When the hydrometer is floating freely at rest, read it at the bottom of the liquid level (also known as the meniscus) 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 J-2.
- Step 12. 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).

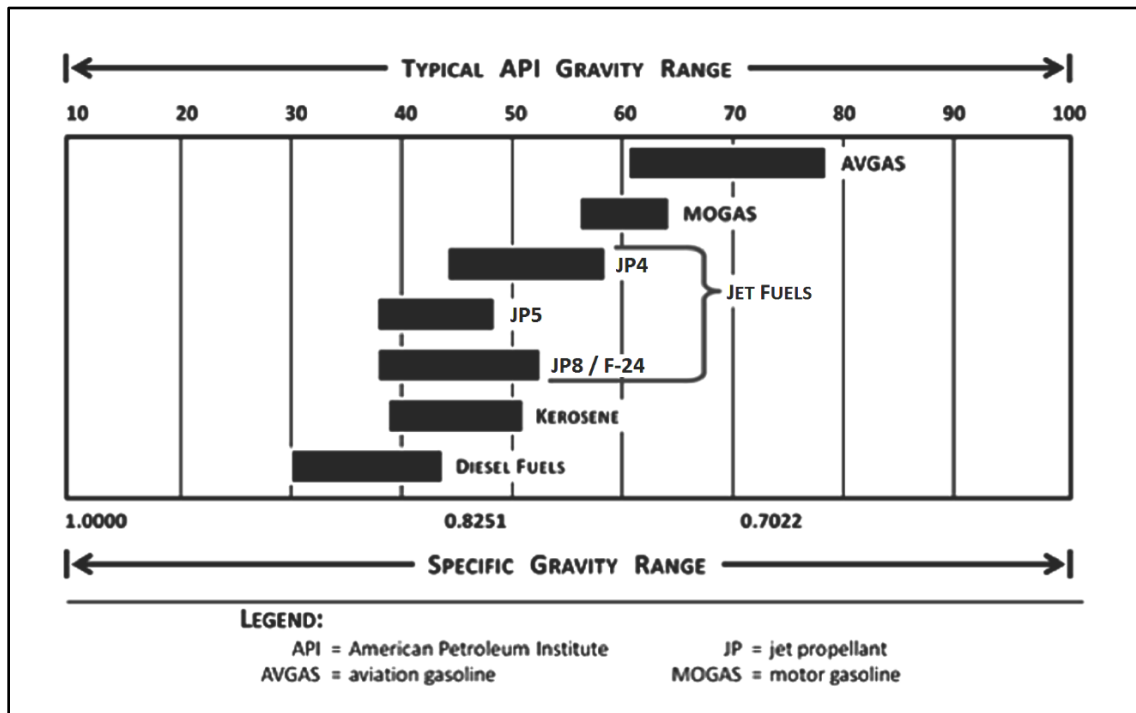


Figure J-1. Typical API gravity ranges (corrected to 60 degrees Fahrenheit)

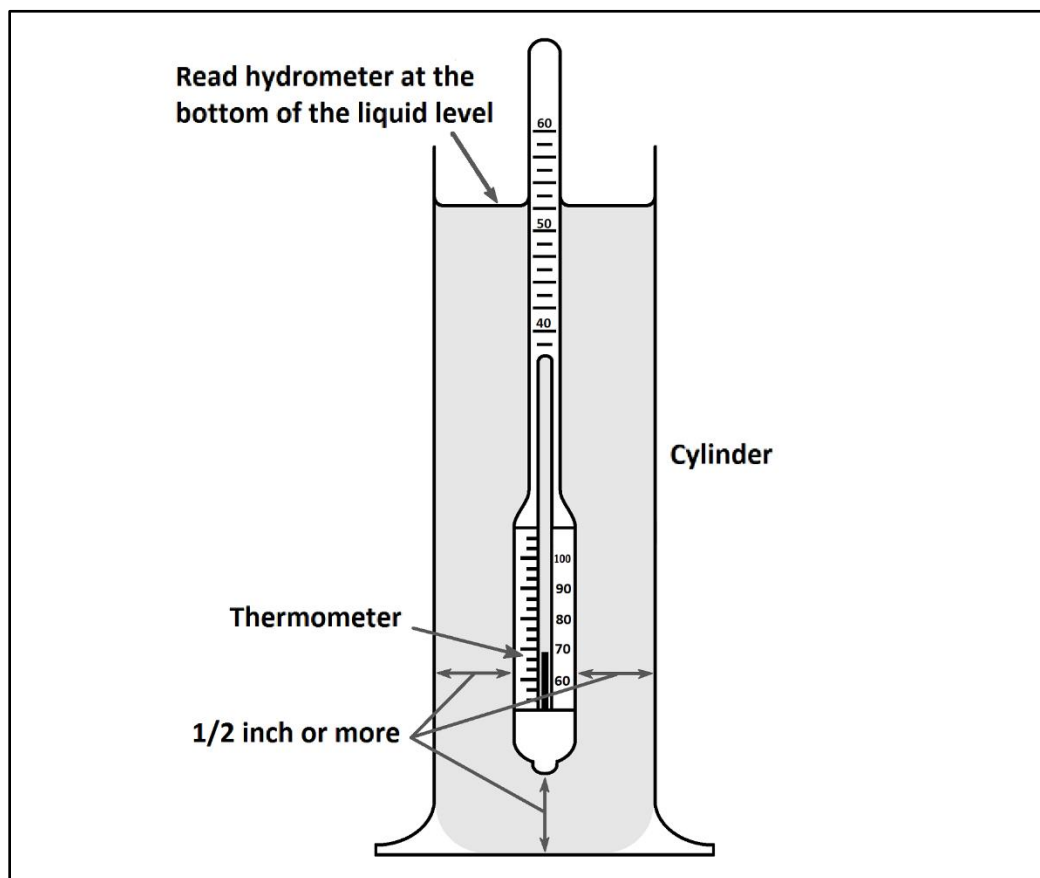


Figure J-2. Hydrometer ready to be read

CORRECTING OBSERVED READING TO 60°F

J-5. Using Table 5A or 5B, 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 provide 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 1250. However, when API gravity is corrected to 60°F for the purpose of volume correction using Table 6A or 6B, 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

J-6. The fuel is now classified. The steps are described below:

- Compare the corrected API gravity with the API gravity ranges shown in figure J-1 on page J-3. 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 TABLES 6A AND 6B

J-7. Tables 6A and 6B provides 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.

J-8. Table 6A is used for JP4 and table 6B is used for all petroleum products other than JP4 See DA PAM 710-2-1. 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, one U.S. 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 U.S. gallons measured at 83° occupy a volume of $63,162 \times .9890$ (or 62,467) U.S. gallons at 60°F.

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Appendix K

Volume Correction of Collapsible 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 60°F.

K-1. The method for obtaining a sample from a collapsible fuel tank to perform volume correction is as follows:

- Gauge the fuel bag from the reference point in accordance with 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 and 6B of ASTM International® D1250 by:
- Displace twice the amount of product contained upstream of the filter separator.

K-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 filter separator.
- 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.

K-3. Take the sample downstream of filter separator from sampling probe to obtain observed API and Temperature.

K-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.

K-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.

K-6. Take the observed temperature and the corrected API gravity and use ASTM International table 6b to determine the volume correction factor.

K-7. Multiply the volume correction factor by the strapping chart volume to determine the volume corrected physical inventory.

K-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 there is an observed API gravity reading of the JP8 issue fuel bag of 47.1 and an observed temperature of 80°F, correct the API gravity using Table 5B to 45.2 and determine the volume correction factor (Table 6b) to be 0.9897, use this volume correction factor to correct the physical inventories of all other JP8 fuel bags.

K-9. See tables E-1 through E-3 in appendix E for the 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 L

Quality Surveillance

This appendix discusses general instructions and minimum procedures to be used in performing quality surveillance functions of petroleum products.

DEFINITIONS

L-1. Quality assurance 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.

L-2. Quality surveillance is the aggregate of measures (such as blending, stock rotation, and sampling) 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 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. Units conduct quality surveillance as part of receipt, issue, transfer, storage and maintenance operations.

QUALITY SURVEILLANCE CONSIDERATIONS

L-3. 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

L-4. Commanders will implement quality surveillance programs for bulk petroleum in accordance with AR 710-2, DA PAM 710-2-1, and MIL-STD-3004-1A. Commanders ensure an effective petroleum operational surveillance program is maintained to ensure safe delivery of acceptable fuel into vehicles, aircraft and other military equipment.

L-5. The Quality Surveillance Program is 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. 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.

L-6. 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-3004-1A, or more frequently if desired for closer surveillance or when directed by USAPC.

L-7. Commanders in theater establish a sampling schedule at the frequencies established in MIL-STD-3004-1A 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

L-8. 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, regrading, or disposing of products.

L-9. 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 the fuel meets specification requirements before it is pumped into its point of use.

L-10. An effective quality surveillance program requires properly trained personnel. Commanders are responsible for establishing an effective training program to ensure that unit personnel who handle fuel and lubricants are proficient in proper sampling and testing procedures.

L-11. 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 Army petroleum lab operations can be found in TM 4-43.31 and TM 10-6640-264-10.

SAMPLE TYPES AND SAMPLING PROCEDURES

L-12. 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.

L-13. 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

L-14. 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

L-15. An all-level sample is one obtained by submerging a stoppered beaker or bottle to a point as near as possible to the draw off level, but above the free water level, then opening the sampler and raising it at such a rate that it is about 70-85% full (in no case shall it be completely full) as it emerges from the liquid.

All Level Composite

L-16. An all level composite sample is prepared by combining a number of samples and treated as a single sample.

Line Sample

L-17. A line sample is obtained from a designated location within the fuel system while the fuel is flowing. Flush the sample until at least the volume of the line has been drawn into a separate container before drawing the line sample.

Nozzle Sample

L-18. A nozzle sample is taken from a dispensing nozzle.

Top Sample

L-19. A top sample is taken six inches below the top surface of the tank contents.

Upper Sample

L-20. An upper level sample is taken from the middle point of the upper third of the tank contents.

Middle Sample

L-21. A middle sample is a spot sample taken from the middle of the tank's contents (a distance of one-half of depth of liquid below the liquid's surface).

Lower Sample

L-22. A lower sample is one taken at the middle point of the lower third of the tank contents.

Bottom Sample

L-23. A bottom sample is 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.

Spot Sample

L-24. A spot sample is a sample taken at a specific location in a tank or from a flowing stream in a pipe at a specific time.

Composite Sample

L-25. A composite sample is a blend of spot samples mixed in proportion to the volumes of material from which the spot samples were obtained.

Drain Sample

L-26. A drain sample is one taken from the draw-off or discharge valve.

Conveyance Volumetric Composite Sample

L-27. A conveyance volumetric composite sample is 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.

Tube or Thief Sample

L-28. A tube or thief sample is 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

L-29. There are several different types of samplers used to take liquid petroleum samples. These are given below.

- The weighted beaker sampler is a stainless steel beaker 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-level 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

L-30. 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

L-31. Specific information on standard sampling procedures are located in TM 4-43.31; FTL 18-01, Change 1, API Manual of Petroleum Measurement Standards, ASTM International D4057, and ASTM International D4177.

L-32. 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.

L-33. 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

L-34. 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.

L-35. 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.

L-36. 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.

L-37. Fuel samples may be collected in glass bottles if they are to be submitted for water and sediment tests to a local laboratory. Submit one gallon U.S. Department of Transportation-approved metal sample containers for gasoline or aviation fuels which will be shipped by a military or commercial activity.

SAMPLE IDENTIFICATION

L-38. 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 M-1 on page M-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.

L-39. Units are required to maintain a sample log to track quality surveillance for storage tanks, facilities, refueling systems and vehicles, and bulk deliveries. The sample log at a minimum contains the date sampled, name of person taking the sample, sample source, type of sample, date sample results are received, results, and a remarks block.

L-40. 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.

L-41. 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

L-42. Quality surveillance testing represents the balance between good quality surveillance 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. Units maintain quality surveillance by adhering to the sampling and testing requirements in accordance with MIL-STD-3004-1A, DA PAM 710-2-1, and AR 710-2.

L-43. A petroleum quality analysis team is part of petroleum groups, theater lab detachments, aviation support battalions, PSBs, and composite supply companies. These teams conduct analysis of petroleum products received and stored in operating units and provides area petroleum lab support as directed under field conditions. The team operates out of its PQAS-E. It ensures bulk fuel meets specified physical and chemical properties and conducts modified B-2 level testing.

L-44. MIL-STD-3004-1A 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.

L-45. MIL-STD-3004-1A 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-3004-1A shall be followed. This is especially important for a property such as color that presents no operational problem, but may indicate possible deterioration.

L-46. MIL-STD-3004-1A provides a detailed breakdown of the type of tests required for each product class. These tests are those most likely to reveal contamination or deterioration which may have occurred during product handling or storage. MIL-STD-3004-1A 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-3004-1A for identification of a non-conforming product and for its disposition are to be initiated.

L-47. All terminals (commercial and military) receiving and storing bulk products must be equipped and capable of performing tests required by MIL-STD-3004-1A. When the capability does not exist at the terminal or facility, other laboratories, either commercial or military, may be used.

FUEL CONSIDERATIONS

L-48. The quality and cleanliness of fuel is vital to the safe operation of aircraft and equipment. Fuel that does not meet the specification limits or intra-governmental receipt limit can have an adverse effect on military equipment, including a catastrophic effect on aircraft. Fine sediment in the fuel may block the engine fuel supply system and erode critical parts in the engine and fuel control systems.

L-49. 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.

L-50. 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. 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, water detection, 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

L-51. Quality surveillance testing and sampling are used to find common contamination or deterioration hazards. The hazards that affect equipment are sediment, water, microbiological growth, commingled fuel, loss of additive, and formation of gum.

Sediment

L-52. 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. See MIL-STD-3004-1A.

- 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

L-53. 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

L-54. 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

L-55. Frequency of sampling and testing 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

L-56. 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

L-57. 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 water detection test kit. The water detection test must be taken on a moving stream of fuel. Test system and 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

L-58. Laboratory testing ensures 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-3004-1A.

Fuel classification (API gravity test)

L-59. 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 J includes the API gravity ranges of common military fuels, an equipment list, and the procedures required to conduct the API gravity test.

Water detection test

L-60. The presence of water in a fuel is tested with the automotive and aviation fuel water detector kit, commonly referred to as the aqua-glo kit. Aviation fuels may not be used if they contain more than 10 parts per million (ppm) of water. The 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 water detection test is required daily from each fuel source prior to issuing fuel to aircraft.

L-61. Procedures to perform the water detection test can be referenced in the Gammon technical products operating procedure manual or appropriate TM.

Fibrous material

L-62. 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

L-63. 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 D2276.

SAMPLING AFTER AIRCRAFT ACCIDENTS OR INCIDENTS

L-64. Fuel samples are taken after aircraft mishaps by an accident investigating team appointed by the proper authority. See DA PAM 385-40 for investigation of Class A through E accidents or 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

L-65. 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.

L-66. 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 M and MIL-STD-3004-1A. Forward these samples to the appropriate petroleum laboratory in accordance with AR 710-2.

Sampling from Fuel Sources

L-67. 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 water detection 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.

L-68. 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

L-69. All sampling and testing of avgas is to be performed by trained personnel in accordance with MIL-STD-3004-1A.

L-70. Avgas must pass through one filtration between the storage system and the consuming equipment.

Sampling and Testing of AVGAS

L-71. 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 self-contained aboveground tank (SCAT), a one quart sample must be drawn from the dispensing nozzle and a visual inspection for color and appearance must be conducted.

L-72. 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.

L-73. Upon receipt of drummed (55-gallon metal drums) avgas, a 1-quart, all-level sample, 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.

FIELD TESTS FOR CONTAMINATION

L-74. There are several ways to check for product contamination in the field. Product temperature and gravity, visual checks, particulate contamination by color and the water detection test all provide clues to product contamination.

L-75. 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 afield 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 water detection test 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

L-76. 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.

L-77. Products shall be tested in accordance with the appropriate MIL-STD-3004-1A 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.

L-78. 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 the 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 PAM 710-2-1.

L-79. Additional requirements for bulk petroleum products are detailed in MIL-STD-3004-1A. Requirements for packaged petroleum products are detailed in MIL-STD-3004-2.

PRODUCT RECLAMATION AND DISPOSITION

L-80. 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

L-81. 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.

L-82. 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.

L-83. 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.

L-84. 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

L-85. 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.

L-86. When an Army-owned product does not meet the specification requirement or intra-governmental receipt limit 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

L-87. 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 water detection test to be performed. It is also mandatory to perform recirculation when a sample is required from filter separator or the nozzle, such as for the filter effectiveness test or type "c" testing.

L-88. Filter effectiveness testing must be performed to ensure that filter separators are performing to standard in accordance with AR 710-2 and DA PAM 710-2-1. The filter effectiveness test is a snapshot in time that assesses filter separator performance on the date the sample was taken. Appendix F discusses how to conduct the filter effectiveness test.

L-89. 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.

L-90. 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.

L-91. 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.

L-92. 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.

L-93. 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-3004-1A. 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.

Appendix M

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 testing. 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.

M-1. DA PAM 710-2-1 provides filter effectiveness 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 filter effectiveness testing which involves passing one gallon of fuel through a matched weight monitor downstream of the filter separator under flow conditions.

M-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 filter effectiveness monthly requirements.

M-3. All units with MTOE authorized millipore sampling equipment shall comply with monthly filter effectiveness 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 or the millipore sampling device is inoperable and in the process of being repaired or replaced. All installations and 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 USAPC.

M-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.

M-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.

M-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.

M-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.

M-8. Figure M-1 on page M-2 shows a DD Form 2927.

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	NON	9130-01-031-5816
Product Contract Number	Batch/Lot/Inspection Number	
Manufacturer/Supplier DLA Energy		
Quantity Represented 2300	Sample Source A-103	PII/Delivery/ODI Date
Local Sample Number 13-210	Sampled by John Doe	
Date Sampled 10/31/2013	Time Sampled 1300	
Organization, Address, Telephone, Fax Number, Email Address, URL PWD MIF Fort Lee, Virginia 804-734-1234 804-734-4321 john.doe.mif@va.mil		
Test Series <input type="checkbox"/> A-Test <input type="checkbox"/> B-2 Test <input type="checkbox"/> C-1 Test <input type="checkbox"/> C-Test <input type="checkbox"/> Special (see back)		
Sample Priority <input checked="" type="checkbox"/> Routine <input type="checkbox"/> Urgent <input type="checkbox"/> Special		
Sample Information <input type="checkbox"/> Filter Effectiveness <input type="checkbox"/> Procurement <input type="checkbox"/> Packaged <input type="checkbox"/> In-Plane <input type="checkbox"/> Correlation Sample (see back) <input type="checkbox"/> Storage Ineffectiveness <input type="checkbox"/> Special/Additional Information on back		
Sample Type <input type="checkbox"/> Paper <input type="checkbox"/> Metal <input type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> Composite <input type="checkbox"/> All-Steel <input type="checkbox"/> In-Line <input type="checkbox"/> Other (Specify)		
DD FORM 2927 (JUL 2007) S/N 010213128/400		
Special/Additional Information		
Correlation Information Submitting Activity Results and Methods		
Particulates _____ by _____		
PSII _____ by _____		
Flash Point _____ by _____		
Time Filtration _____ by _____		
For Area or Regional Laboratory Use Only		
DD FORM 2927 (JUL 2007) (BACK)		

Figure M-1. DD Form 2927, petroleum and lubricants sample identification tag

Appendix N

Field Blending of Additives in Commercial Jet Fuel

This appendix provides commanders and petroleum personnel guidance on techniques for additizing, blending, and testing commercial jet fuel by hand to meet the requirements of the JP8 specification. These procedures are to be used only with tank vehicles when unadditized fuel is supplied and an additive injector is unavailable.

GENERAL

N-1. Normally, fuel is procured and supplied in its final form; however, there are areas of operation where the supply chain is not mature or JP8 is not available. During these times it may be required for the Army to manually introduce additives to commercial jet fuel to meet the JP8 specification. When additive injectors are not available, or when DLA Energy is unable to procure fuel to the desired JP8 specification, users will be required to introduce the additives into commercial jet fuel by hand. When blending additives, each type of additive must be mixed separately.

Note: Only neat (unadditized) fuel will be blended utilizing these procedures. Blending additives with fuel containing any additives from the source is to be coordinated with your command's petroleum systems technician, petroleum laboratory technician, and USAPC for instructions.

CALCULATING ADDITIVE RATIOS:

N-2. Due to the concentration of the additives involved, FSII will be blended in neat form and CI/LI and SDA will be diluted with jet fuel in accordance with table N-5 on page N-3. Follow the steps in paragraph N-9 for proper blending procedures.

N-3. Fuel must be tested prior to acceptance to determine additive concentration levels in the fuel.

- If there are no additives present, follow appropriate blending quantities in accordance with table N-5 on page N-3.
- If additives are present but do not meet the specification requirements, contact your command's petroleum systems technician, Petroleum Laboratory Technician, and USAPC for instructions.

ADDITIVES

N-4. This section explains the purpose for adding SDA, CI/LI, and FSII to neat fuel and outlines the procedures for determining the correct additive-to-fuel ratio for SDA, CI/LI, and FSII.

STATIC DISSIPATER ADDITIVE

N-5. SDA is introduced at prescribed levels to Jet A and Jet A-1 to improve the conductivity of the fuel and is only needed if fuel conductivity is below 150 pS/m. It increases the rate of static charge dissipation. Refer to table N-1 on page N-2 for the specification limit.

N-6. Stadis® 450 marketed by Innospec Fuel Specialties LLC (formerly Octel Starreon LLC), and AvGuard SDA manufactured by Afton Chemical Corporation, are the only Army approved SDAs. Refer to table N-2 on page N-2 for the NSNs to procure SDA.

N-7. Prepare the premix by combining the SDA in a ratio of 1:19 with a volume of unadditized fuel, as indicated in table N-5 on page N-3, in a suitable container such as a clean and dry can or one-liter bottle.

Shake the container for one to two minutes in order to mix thoroughly, premix should be clear and free of any phase separation.

Table N-1. Chemical and physical requirements and test methods

<i>Property</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Test method</i>
Fuel electrical conductivity, pS/m ¹	See note 1	See note 1	D2624
Note 1: The conductivity must be between 150 and 600 pS/m for F-34 (JP-8) and between 50 and 600 pS/m for F-35 (Jet A-1), at ambient temperature or 29.4 °C (85°F), whichever is lower, unless otherwise directed by the procuring activity. In the case of JP-8+100, JP-8 with the thermal stability improver additive, the conductivity limit must be between 150 to 700 pS/m at ambient temperature or 29.4 °C (85°F), whichever is lower, unless otherwise directed by the procuring activity.			
LEGEND: C= Celsius F= Fahrenheit pS/m = picosiemens per meter			

Table N-2. Static Dissipater Item List

<i>Nomenclature</i>	<i>Container size</i>	<i>National stock number</i>
Static Dissipater Additive	One gallon can	6850-01-097-2060
	Five gallon can	6850-01-099-4015
	Fifty-five gallon drum	6850-01-447-4075

CORROSION INHIBITOR/LUBRICITY IMPROVER

N-8. CI/LI is added at prescribed levels to Jet A or Jet A-1 to improve the corrosion resistance and improve lubricity of the fuel. A field recommended concentration of 15 ppm minimum is typically used for field blending regardless of the CI/LI additive to achieve desired corrosion and lubricity protection and ease of blending. Refer to table N-3 for the NSN to procure CI/LI or directly from a vendor listed in a current edition of the Air Force Qualified Products Database, QPD-25017.

N-9. Corrosion inhibitor/lubricity improver (CI/LI) additive shall be premixed and blended into neat fuel. Prepare the premix by combining the CI/LI using the appropriate syringe with a volume of fuel as indicated in table N-5 (to achieve 15 ppm) in a suitable container such as a clean and dry can or one-liter bottle. Shake container for one to two minutes in order to mix thoroughly, premix should be clear and free of any phase separation.

Table N-3. Corrosion inhibitor/lubricity improver (CI/LI) item list

<i>Nomenclature</i>	<i>Container size</i>	<i>National stock number</i>
Corrosion Inhibitor/Lubricity Improver, MIL-PRF-25017	One gallon can	6850-01-180-1074
	Fifty-five gallon drum	6850-01-292-9780
DCA-4A- 50/50	Fifty-five gallon drum	6850-01-627-4812
DCA-6A-80/20	Fifty-five gallon drum	None assigned

FUEL SYSTEM ICING INHIBITOR

N-10. FSII is added to fuel to prevent freezing of free water. This additive is soluble in both fuel and water and, in the presence of water, will migrate from the fuel to the water. It has the added benefit of dramatically slowing the growth of any microbial contaminants in the fuel. Recommended concentration of FSII in fuel is 0.07 to 0.10 volume percent for JP-8.

N-11. The use of FSII (di-ethylene glycol monomethyl ether) is mandatory and shall be in accordance with MIL-DTL-85470. Refer to table N-4 for the NSN to procure FSII.

N-12. Use table N-5 to determine the required amount of FSII based on the total of volume of fuel to be treated. Use a 1,000 ml bottle to measure, then consolidate in the clean and dry 5-gallon fuel can that is included in the equipment list. Add directly to the tank in neat form; no premix is required.

Table N-4. Fuel system icing inhibitor (FSII) item listing

<i>Nomenclature</i>	<i>Container size</i>	<i>National stock number</i>
Fuel system icing inhibitor, MIL-DTL-85470	Five gallon can (5 gal)	6850-01-377-5074
	Fifty-five gallon drum (55 gal)	6850-01-089-5514

Note: Commercial fuels are commonly made to conform to ASTM D1655. The ASTM International fuel specification does not contain FSII unless specified. Fuel System Icing Inhibitor conforming to MIL-DTL-85470 shall be added to commercial and NATO fuels not containing an icing inhibitor prior to refueling operations, regardless of ambient temperatures.

Table N-5. Additive blending quantities (calculations based on neat fuel)

<i>Fuel quantity requiring additives, (in gallons)</i> (a)	<i>FSII @ 1000 ppm (0.10%)</i> (b)	<i>CI/LI @ 15 ppm</i> (c)	<i>Minimum neat fuel required for mixing CI/LI</i> (d)	<i>SDA @ 1.5 ppm</i> (e)	<i>Minimum neat fuel required for mixing SDA</i> (f)
1,000	1.0 gals / 3,785 ml	57 ml	57 ml	6 ml	114 ml
1,250	1.25 gals / 4,732 ml	71 ml	71 ml	8 ml	152 ml
1,500	1.5 gals / 5,678 ml	86 ml	86 ml	9 ml	171 ml
1,750	1.75 gals / 6,624 ml	100 ml	100 ml	10 ml	190 ml
2,000	2.0 gals / 7,571 ml	114 ml	114 ml	11 ml	209 ml
2,250	2.25 gals / 8,517 ml	129 ml	129 ml	13 ml	247 ml
2,500	2.5 gals / 9,464 ml	143 ml	143 ml	14 ml	266 ml
2,750	2.75 gals / 10,410 ml	157 ml	157 ml	16 ml	304 ml
3,000	3.0 gals / 11,356 ml	170 ml	170 ml	17 ml	323 ml
3,250	3.25 gals / 12,303 ml	185 ml	185 ml	18 ml	342 ml
3,500	3.5 gals / 13,249 ml	199 ml	199 ml	19 ml	361 ml
3,750	3.75 gals / 14,195 ml	213 ml	213 ml	21 ml	399 ml
4,000	4.0 gals / 15,142 ml	227 ml	227 ml	23 ml	437 ml
4,250	4.25 gals / 16,088 ml	242 ml	242 ml	24 ml	456 ml
4,500	4.5 gals / 17,034 ml	256 ml	256 ml	25 ml	475 ml
4,750	4.75 gals / 17,981 ml	270 ml	270 ml	27 ml	513 ml
5,000	5.0 gals / 18,927 ml	284 ml	284 ml	28 ml	532 ml
5,500	5.5 gals / 20,820 ml	313 ml	313 ml	31 ml	589 ml
6,000	6.0 gals / 22,713 ml	341 ml	341 ml	34 ml	646 ml
6,500	6.5 gals / 24,605 ml	370 ml	370 ml	36 ml	684 ml
7,000	7.0 gals / 26,498 ml	298 ml	298 ml	39 ml	741 ml
10,000	10 gals / 37,854 ml	568 ml	568 ml	57 ml	1083 ml
LEGEND: CI/LI = corrosion inhibitor/lubricity improver ml = milliliter FSII = fuel system icing inhibitor ppm = parts per million gals = gallons SDA = static dissipater additive					

Note: DCA-4A 50/50 and DCI-6A 80/20 come premixed from the manufacturer and do not require further dilution prior to fuel blending. If DCA-4A 50/50 is used multiply the volume of CI/LI provided in table N-5 column (c) by two (2). If DCI-6A 80/20 is used multiply the volume of CI/LI provided in table N-5 column (c) by five (5). Do not add column (d) as it is already premixed.

BLENDING PROCEDURES

N-13. Prior to conducting any blending operations, inspect all equipment and ensure that all supplies, additives, personal protective equipment, and spill kits are on hand and serviceable. Ensure that the vehicle pumps are operational. This may require the tanker to be partially filled with fuel and operated prior to blending fuel. See operator's TM for PMCS procedures. Ensure that the filters are serviceable. DO NOT use any equipment that is unserviceable. Only operators trained on the equipment being utilized and familiar with POL operations should be performing these procedures. Drain any water from system, if necessary.

N-14. Blending additives into the fuel in mobile tank vehicles and trailers with internal pumps is the only acceptable method. This allows the fuel to be mixed in a single source and then distributed to the aircraft or vehicle at a location. No additional equipment is necessary, other than the equipment identified in these procedures, and this task can be performed wherever the fuel is needed. Additionally, once this task is completed the mobile tank is free to move to the location of the equipment needing servicing.

N-15. Follow the following steps to achieve appropriate blending levels of SDA, CI/LI and FSII:

1. If there are no additives present, follow appropriate blending quantities in accordance with table N-5 on page N-3.
2. Fill the tank with six inches of fuel, approximately 400 gallons for an M978 and 800 gallons for an M969.
3. Continue to fill tank, pour the agitated premix(s) into the tank as it is being filled. Ensure all premix(s) are added to the tank by the time the tank is half full, approximately 1,250 gallons for an M978 and 2,500 gallons for an M969.
4. Complete filling of the tank.
5. Once the tank is full, thorough mixing of the additives can be achieved by recirculation through the hose system to the recirculation port/D-1 receptacle.
6. In accordance with the operator's manual, recirculate at least one time the rated capacity of the tank.
7. Once recirculation is completed, drain water from the filter separator.
8. Transfer the entire quantity of fuel into another tank vehicle and recirculate at least one time the rated capacity of the tank.
9. Once recirculation is completed, drain water from the filter separator and pull an all-level sample for testing of FSII and SDA in accordance with steps 10 and 11 below.
10. If test results for the SDA and FSII additives are within JP8 specification requirements, which are .07-.10 Vol% for FSII and 150-600 pS/m for SDA, the fuel may be issued. If the test results are not within specification, repeat steps 7 and 8 above.
11. If test results are still not within specification, contact your command's petroleum systems technician, petroleum laboratory technician, and USAPC for instructions.

Note: If transfer of fuel to another tank vehicle, as identified in step 9 above, is not operationally possible the fuel must be recirculated a total of at least 2 times the rated capacity of the tank. Draining water from the filter separator after the first full recirculation and again after the second is required.

SAMPLING

N-16. A sample is a small amount of fuel which is representative of the whole product. Samples are important because they are used to determine the quality of petroleum products. At a minimum, samples shall be one U.S. gallon to perform additive testing. Improperly taken samples can completely invalidate a test, only trained and experienced personnel shall be assigned to sample the products. This cannot be overstressed: No amount of laboratory work gives reliable data on a product if the sample is not a true representation of that product.

N-17. Fuel that has been field blended is required to be sampled and checked using the B-2 anti-icing additive test kit and the conductivity meter to determine if fuel had been sufficiently additized.

N-18. Once the additives and neat fuel have been blended utilizing the procedures provided in the *Blending Procedures* section above, take a one gallon all-level sample using a weighted beaker or a weighted glass bottle.

TESTING

N-19. The following methods will be used to test for FSII and SDA levels:

- FSII: Use the Anti-icing additive test kit (B-2), NSN: 6630-01-165-7133, and record the results.
- SDA: Use conductivity meter found in the Conductivity Test Kit, NSN: 6630-01-115-2398, and record the results. Instructions for both methods can be found in TM-6640-264-10.

N-20. Verify the results of the tests for FSII and SDA meet the use limit for JP8. At this time the CI/LI test can only be performed at the Army Petroleum Lab and at select DOD labs.

N-21. Conduct a visual color, appearance, API gravity and sediment test (Millipore) using the particulate comparison chart and, if refueling aircraft, the water detection test kit. Ensure all results are recorded on the fuel sample log.

CHECKLISTS

N-22. To help keep track of Adding and blending jet fuel and additives, fuel handlers document their completion of adding, blending, sampling and testing procedures.

N-23. Table N-6 on page N-6 shows a sample jet fuel additization checklist. Table N-7 on page N-7 provides a sample fuel blending worksheet.

Table N-6. Jet Fuel Additization Checklist

Step Number	Item of interest	✓
1	Inspect vehicles and ensure that all supplies, additives, personal protective equipment, and spill kits are on hand and serviceable.	✓
	a. Begin with a pre-inspection and inventory of the vehicle and equipment. Drain any water from the system.	✓
	b. Ensure that all equipment needed for additization operation is present and serviceable.	✓
	c. Ensure vehicle pumps are operational.	✓
	d. Ensure that filter separators are serviceable.	✓
2	Test receiving fuel for fuel system icing inhibitor (FSII).	✓
3	Test receiving fuel for fuel conductivity.	✓
4	Test receiving fuel temperature	✓
5	Calculate, measure and premix additives.	✓
	a. Static dissipater additive (SDA)	✓
	b. Corrosion inhibitor/lubricity improver (CI/LI)	✓
6	Fill the tank with six inches of fuel.	✓
7	Continue to fill tank, pour the agitated premix(es) and FSII into the tank as it is being filled. Ensure all premix(es) and FSII are added to the tank by the time the tank is half full.	✓
8	Complete filling of the tank.	✓
9	In accordance with the operator's manual, recirculate at least 1 time the rated capacity of the tank. If available, utilize particle counter from the sample port during recirculation.	✓
10	Once recirculation is completed, drain water from the filter separator.	✓
11	Transfer entire quantity of fuel into another tank vehicle and recirculate at least one times the rated capacity of the tank. (If transfer of fuel to another tank vehicle is not operationally possible, the fuel must be recirculated a total of at least two times the rated capacity of the tank. Draining water from the filter separator after the first full recirculation and again after the second is required.)	✓
12	Once recirculation is completed, drain water from the filter separator.	✓
13	Pull an All-Level sample for testing of FSII and Conductivity.	✓
14	Test FSII level.	✓
15	Test conductivity	✓
Remarks:		
<div> <div>Name:</div> <div>Date</div> <div>Signature</div> </div> <div> <div>SGT Riley Doe</div> <div>3 November 2021</div> <div>Riley Doe</div> </div>		

Table N-7. Sample Jet Fuel Additive Hand Blending Worksheet

JET FUEL ADDITIVE HAND BLENDING WORKSHEET					
Unit Name:	HHC 1-2 AVN, Camp Page			Date:	3 November 2021
Method (circle one):		Truck to Truck		Recirculation	
Before Additization					
Sample Source:	HQ 443			Source Volume:	2,500 gallons
Sample Serial Number	Time	Visual	Water PPM	FSI %V	ECON pS/m
21-165	0800	C & B	1.0	0.00	0
Calculations					
Additive			Neat Fuel		
FSII:	9464 mL FSII				
CI/LI:	143 mL CI/LI			143 mL neat fuel	
SDA:	14 mL SDA			266 mL neat fuel	
After Additization					
Sample Source:	HQ 444			Source Volume:	2,500 gallons
Sample Serial Number	Time	Visual	Water PPM	FSI %V	ECON pS/m
21-166	0830	C & B	1.1	0.09	530
Operator/Tester Information					
Rank, First and Last Name		Phone Number	Email	Signature	
SGT Jim Bob		555-1212	jim.f.bob@army.mil	Jim Bob	
SPC Jane Doe		555-1212	jane.c.doe.mil@army.mil	Jane Doe	

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Appendix O

Aviation Gasoline Considerations

This appendix discusses the considerations when storing, handling and procuring avgas.

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

O-1. 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 will be executed between the various fuels organizations. A lead fuels function or agency will be designated to coordinate avgas requisition, receipt, storage and quality control to eliminate redundancy. The memorandum of understanding will be coordinated with the JPO.

O-2. When determining requirements units must plan for product rotation to occur at a minimum every 90 days to maintain product quality.

O-3. For new avgas requirements, the requesting unit will submit a DLA Energy Requirements Worksheet 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

O-4. 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.

O-5. SCATs or portable fuel storage tanks 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-6. Procured or installed SCAT systems must meet minimum design and construction requirements of UFC 3-460-01, NFPA 30, and UL-142, UL-2080, UL-2085 or international equivalent. Spacing, tank capacity restrictions and spill containment restrictions shall conform to UFC 3-460-01 and NFPA 30.

O-7. Procured or installed SCAT systems must meet minimum emergency venting and pressure relief requirements of API STD 2000, UL-142, STI SP001, NFPA 30, or international equivalent. These requirements must be met to prevent loss of vapor pressure and to include provisions for emergency venting.

O-8. All containers storing avgas must be covered or shaded to protect minimize the environmental impacts and maintain product quality due to sunlight.

O-9. 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-32233D 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.

O-10. 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.

O-11. 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

O-12. See appendix L for product quality concerning avgas.

EQUIPMENT

O-13. Infrastructure and equipment markings shall be in accordance with MIL-STD-161H.

O-14. 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. The following list of refueling equipment is authorized and recommended for avgas use.

- Forward area refueling equipment.
- AAFARS.
- Collapsible coated fabric tanks.
- Seal drums (blivets).
- Elbow coupler valve.
- M978, HEMTT tank truck.
- Tank rack module.

Appendix P

Arctic and Extreme Cold Weather Considerations

This appendix provides information and guidance on operating in extreme cold weather conditions.

P-1. Extreme cold can significantly slow material handling and maintenance activities by numbing exposed skin, such as the face and hands. Activities that normally require only minutes in temperate weather may require hours in extreme cold. Movement by foot or vehicle over snowy and icy surfaces is slower and poses a high risk of injury to personnel and damage to equipment.

P-2. Subfreezing temperatures result in freezing water in water tanks, waterlines, and equipment exposed to snow and water penetration. Because water expands when frozen and metals and plastics become brittle in subzero temperatures, standing water in equipment may freeze and damage components in areas with close tolerances and no room to expand. Additionally, metals contract at lower temperatures and expand at higher temperatures. Consideration must be given to guard components and equipment against improper clearances that can lead to binding or excessive looseness when exposed to subfreezing temperatures. In regards to fuel, there is always a presence of water to consider.

P-3. Commanders and logisticians must make every effort to winterize vehicles and equipment with cold weather lubricants and antifreeze liquids. Equipment should be kept free of snow and water to prevent the effects of freezing water by keeping equipment running or placing impermeable covers on it when in storage or not in use. Material handling and storage personnel should be provided with suitable head gear and gloves to minimize the effects of severe cold weather.

Note: Although fuels do not completely freeze, they will be the same temperature as the air. To prevent frostbite. Fuel handlers must always wear gloves designed for handling petroleum products when working with fuels.

PERSONNEL

P-4. One major problem facing units unfamiliar with cold weather operations is the Soldier's lack of adequate training in cold weather operations and maintenance. If troops presently stationed in temperate climates are to be expected to move to cold climates and perform their mission, cold weather training is of the utmost importance.

P-5. A large portion of a Soldier's time and energy in cold weather areas is expended in self-preservation. This naturally reduces the efficiency of personnel in the operation and maintenance of materiel. In addition to operating their equipment, soldiers must learn the expedients and improvisations incident to living and distribution in cold regions.

PERSONAL PROTECTIVE EQUIPMENT

P-6. At a minimum fuel handlers should be properly equipped with the following items for extreme cold weather:

- Base layer:
 - Lightweight or midweight polypropylene top and bottom.
 - Contact gloves
 - Eye protection
 - POL gloves.

- Insulating layer:
 - Shirt, cold weather.
 - Black fleece or liner, cold weather (or both).
 - Coat.
- Outer shell:
 - Generation II GORETEX® jacket or Generation II GORETEX® trousers
 - Cold weather jacket (wind shirt),
 - Extreme cold/wet weather jacket (hard shell),
 - Extreme cold/wet weather trousers (hard shell).
- Additional items:
 - Issued GORE-TEX® gloves with liners
 - Issued wool socks with synthetic liner sock
 - Temperate boots; cold weather boots recommended.
 - Balaclava and neck gaiter.
 - Suspenders.
 - Arctic necklace (lighter and lip balm worn around neck).
 - Flame resistant fuel handler's coverall.

Note: Contact gloves must be worn when working outdoors. POL gloves and eye pro must be worn when working with fuel.

PREVENTION OF COLD WEATHER INJURIES:

P-7. Supervisors are responsible for enforcing proper preventive measures in order to reduce the detrimental effects of cold weather on fuel handling military personnel and mission accomplishment. Preventive measures include but are not limited to the following.

- Clothes are to be appropriate and worn properly.
- Clothing must be kept dry; wet and damp clothes changed as soon as possible.
- Clothing is to be worn loose and in layers; hands, fingers, and the head are to be covered and protected.
- All clothing must be clean and in good repair (no broken zippers or holes).
- Proper boots must be worn, ones that are not too tight and are dry.
- Socks must be clean and dry, an extra pair of socks must be carried, wet or damp socks must be changed as soon as possible, and foot powder must be used on feet and in boots. Wipe dry the inside of vapor barrier boots at least once per day, or more often as feet sweat. Dry leather boots by stuffing with paper towels.
- Feet are to be washed daily if possible.
- Gaiters are to be worn to keep boots dry when necessary.
- Gloves or mittens are to be worn.
- Hands must be warmed under clothes before hands become numb. Skin contact with snow, fuel, or bare metal is to be avoided, and proper gloves are to be worn when handling fuel or bare metal.
- Gloves are to be waterproofed by treating them with waterproofing compounds.
- Face and ears are to be covered with a scarf, and an insulated cap with flaps over the ears or a balaclava is to be worn.
- Face and ears are to be warmed by covering them with warm hands. The face and ears must not be rubbed.
- Face camouflage is not to be used when the air temperature is below 32 °F.
- Sunscreen is to be worn when appropriate.
- Sunglasses are to be worn to prevent snow blindness.

Note: Frostbite is freezing of skin, and is most prevalent in the fingers, toes, ears and face. It occurs with exposure to below-freezing temperatures (< 32 °F) and during direct contact with cold metal and super-cold petroleum (fuel), oil, and lubricants (POL). As the wind chill temperature goes below minus 15, the risk of frostbite substantially increases. Both natural and man-made wind increase the risk of frostbite.

MATERIEL

P-8. Operating materiel in temperatures down to 10°F presents few problems. Conditions are similar to those experienced in the northern portion of the continental United States during the winter.

P-9. From -10° to -25°F, operations become more difficult. At the warmer end of this range, lack of winterization will result in only a slight loss of operating efficiency. Proper training will prevent many failures of materiel as well as injuries to operators.

P-10. When temperatures drop below 25°F, operations become increasingly difficult. At temperatures in the vicinity of -50°F, the maximum efforts of well-trained personnel are required to perform even a simple task with completely winterized material. Non-acclimated troops will encounter difficulties at even the warmer temperatures above -10°F.

CLEANING AND PREPARING MATERIEL

P-11. Before operating vehicles, crews should review appropriate operator's manuals for cold weather operations. All operator's manuals include a section subtitled "Operations Under Unusual Conditions (Cold)". Additionally, operators must know other basic skills, such as working with tire chains and slave starting.

P-12. Soldiers must maintain materiel in the best mechanical condition at all times to withstand the added difficulties and prevent failures in subzero operation. Commanders must place special emphasis on maintenance inspections.

P-13. Soldiers must carefully service various components of materiel before, during, and after each operating period in accordance with the pertinent TM. They must promptly report all failures and repair them. Failure to give this extra service and maintenance will result in actual damage, lost time, unwarranted expense, and improper functioning.

P-14. Placing materiel in proper mechanical condition requires time for necessary and careful disassembly, repair, cleaning, and reassembly. Low temperatures must be anticipated far enough in advance to permit completion of the conditioning before the onset of cold weather.

P-15. Operators must be very cautious when using materiel that has been inactive for a long time. For example, if lubricants congealed in the various components, parts could fail.

P-16. Refer to pertinent operator and unit maintenance TMs for operation, lubrication, PMCS, and maintenance under unusual conditions.

RUBBER

P-17. In addition to natural and synthetic rubber, there are hundreds of rubber substitutes. These synthetic rubbers look and usually react like natural rubber, although most of them do not attain a greater flexibility at high temperatures. However, as it is cooled, natural rubber will gradually stiffen, although it retains a large part of its elasticity until temperatures below -20°F are reached. Special care should be observed with collapsible bags and hoses due the behavior of rubber in arctic conditions.

Tires

P-18. Tires become rigid in cold, causing flat spots on portions that come in contact with the ground during shutdown periods. At severe cold temperatures, sidewalls become brittle and crack.

P-19. Tires must be inflated to the appropriate pressure at cold temperatures. A tire inflated to 40 psi indoors will change to 25 psi when moved outside at -50°F. This can result in tire slipping on the rim and ripping the valve stem off the tube. In general, tires should be inflated in the motor pool 10 psi over the normal pressure for winter operation. Aircraft tires become rigid in cold weather, causing flat spots on parts that come in contact with the ground. In severe cold temperatures, sidewalls become brittle and crack. Every effort should be made to minimize the length of time that material constructed primarily from rubber and plastic is exposed to extreme cold temperatures.

Rubber covered cables

P-20. Extreme care must be taken in handling cables at low temperatures. If the rubber jackets become hard, the cables must be protected from shock loads and bending to prevent short circuits caused by breaks in the covering. If cables are to be bent, they must first be warmed. Neoprene jackets on cables become very brittle and break readily at low temperatures. For example, fuel hoses may crack when allowed to crystallize from cold weather exposure or may break if bent when frozen.

P-21. Below -20°F, certain peculiarities are observed. When cooled gradually but continuously over a short time, the rubber will remain flexible until a temperature of approximately -60°F is reached; then it suddenly loses its elasticity and becomes very brittle. Furthermore, if the rubber is consistently kept at a temperature below -20°F for a long time, even though it does not approach lower temperatures, an effect similar to crystallization occurs, causing it to become brittle.

METALS

P-22. Metals become brittle in severe cold temperatures; thus parts cannot withstand the shock loads that they sustain at higher temperatures.

P-23. For example, at -20° F certain steels can stand only 50 percent of the shock load they can stand at room temperatures. For a given change in temperature, various metals will expand or contract different amounts. These characteristics will especially affect bearings in which the bearing and shaft are of different metals, parts of different type metals bolted together, and meshing gears of different metals. Special care should be taken in adjusting parts of this type for cold weather operations, especially when adjusting bearing clearances. Nozzles consist of metal and rubber so considerations must be taken when connecting to aircraft. Materials expand and contract at different freezing temperatures therefore attaining a seal when fueling can compromise the secure connection which could lead to a fuel leak and consequently risk a spark from the rotary splash.

PLASTICS

P-24. In general, plastics expand and contract much more than metal or glass. Any parts or materials made of plastic must be handled carefully. Many of the vehicular canvas covers have plastic windows which become very brittle and, in many cases, break due to a combination of cold and vibration.

GLASS

P-25. Glass, porcelain, and other ceramics can be expected to perform normally at low temperatures if handled carefully. Cracking may result if heat is applied directly to cold windshields or vehicle glass.

FABRICS

P-26. Fabrics, in general, retain their flexibility even at extremely low temperatures provided they are kept dry. However, tarpaulins present difficulties in conforming to their intended dimensions due to shrinkage. This is usually the result of wrinkles that are extremely difficult to smooth out at subzero temperatures. Whenever possible, tarpaulins should be unfolded in heated enclosures.

BATTERIES

P-27. In cold weather, all batteries provide less power, so a greater quantity of batteries or more frequent charging of batteries is required. Cold weather batteries are recommended, if available. Dry batteries must be stored at temperatures above 10° F and must be warmed gradually, either with body or vehicle heat, before use. In subzero weather, additional battery chargers must be on hand to meet heavy requirements for battery maintenance. Battery stocks should be replenished often, paying particular attention to items with unique proprietary batteries. Also, personnel must avoid relying on Service-specific items that require batteries not carried by the theater-level sustainment organization.

PETROLEUM, OILS, AND LUBRICANTS

P-28. In the extreme cold weather environment, fuel is the single point of failure in the whole operation. If there is no fuel, simple work does not happen. Ground operation increases fuel consumption rates of individual vehicles by 30 to 40 percent, requiring more fuel filtering and distribution.

P-29. Cold weather operations require increased testing, recirculation, equipment maintenance, and fuel usage due to extended equipment operation requirements. Draining of water from systems must be done when not operating equipment to prevent freezing of lines. Hoses and bags will become brittle when in extreme cold temperatures and can break and crack. Depending on the temperature, adding icing inhibitors to fuel may be necessary. Diesel fuel will reach its freezing point and begin to gel at around 15° F, whereas, jet fuel has a much lower freezing point of around -51° F. Fuel additives are available to decrease the possibility of fuel gelling (for example, fuel system icing inhibitor in accordance with MIL-DTL-85470). Although fuels do not completely freeze, they will be the same temperature as the air.

P-30. Although fuels do not completely freeze, they will be the same temperature as the air. To prevent frostbite, fuel handlers must always wear gloves designed for handling petroleum products when working with fuels.

P-31. In steep-sloped mountains, vehicle fuel consumption increases by 30 to 40 percent. As vehicles ascend, the amount of oxygen available is reduced and the engine efficiency drops. On average, vehicles lose 20 to 25 percent of their rated carrying capacity, however, overall fuel consumption for the unit decreases because of lower vehicle movement. Heavy reliance on aviation assets for resupply and movement increases aviation fuel requirements. Units that operate in cold weather need to plan for fuel use and storage. Fuel points supply units with refined or white gasoline produced for pressurized stoves. Special fuels may be needed for host nation equipment.

P-32. Individuals carry special fuel for personal or squad stoves. NSN 7310-01-578-6413 uses diesel or jet propulsion fuel, type 8, cutting the need for multiple fuels. Some fuels may need additives to prevent freezing and gelling. In arctic conditions, fuel spilled on flesh can cause instant frostbite if the proper gloves are not worn. Multi-viscosity oil (15W-40) is recommended for most vehicles in cold weather. Use of 15W-40 prevents frequent oil changes in an environment with a great variance in temperature. Vehicles should be changed to multi-viscosity oil before embarkation. In sustained extreme cold conditions, 10W oil will be required. Cold weather mountain operations require arctic engine oil, a synthetic SW-20 lubricant used for temperatures down to -65° F.

P-33. Cold weather mountain operations require arctic engine oil, a synthetic SW-20 lubricant used for temperatures down to -65° F. Arctic engine oil is approved for engines, power steering systems, hydraulic systems, and both manual and automatic transmissions. For weapon systems, lubricant specifically designed for arctic weather should be used.

P-34. When units are widely-dispersed they may be able to store only a limited quantity of fuel, which limits operations when circumstances prevent timely resupply. Increased quantities of lightweight, portable fuel storage containers may be needed. Up to twice the normal number of fuel cans may be required if transporting fuel to vehicles, rather than bringing vehicles to the refueling point. Adequate quantities of 5- gallon cans, nozzles, and 1-quart fuel bottles must be available. When vehicles, generators, and petroleum, oils, and lubricants containers are brought into warm storage from the cold, fuel tanks and containers should be filled at least three-quarters full to prevent condensation.

FUEL SYSTEMS

P-35. For a satisfactory start, engine fuel must produce a combustible mixture with air. Atomization, which increases the rate of vaporization of the fuel to produce combustible mixtures, is adversely affected by low temperatures. Engines using commercial diesel fuels are particularly difficult to start in cold weather. Many fuels, such as DF-2, contain waxes that congeal at temperatures below 0°F (-18°C). If this occurs, the filter will clog, and the fuel will not flow. Diesel fuel grade D-1 is designed for use in cold regions. Military specified JP-8 is the preferred fuel for all systems. See table P-1 for additional arctic fuel measures.

P-36. As part of proper fuel system maintenance, drain fuel filters frequently and at the end of each day of operation. Do not assume that filters are dry if nothing flows from the drain cock. If water is present, it could have frozen solid overnight. Drain filters into an approved and appropriately marked and labeled container and turn in according to unit operating procedures for disposal.

CONDENSATION

P-37. Always keep fuel tanks filled to the proper markings. Refuel only to the expansion marking immediately after halting to reduce condensation in the fuel tank. The more fuel there is in the tank, the smaller the volume of air from which moisture can be condensed. Arctic fuels for gasoline or diesel engines are developed and selected to obtain the proper atomization necessary for a combustible fuel-air mixture. It is essential that pump unit's tankers be provided with JP-8 or appropriate cold-weather-grade fuel if other than JP-8 use has been approved. Standard JP-8 fuel has a minimum specification requirement of -52°F (-47°C), which ensures gelling will usually not occur at extreme-cold or even hazardous-cold temperatures.

ANTIFREEZE COOLING SYSTEMS

P-38. Ethylene-glycol-distilled water mixed solution is the most common antifreeze agent used for both military and commercial engines. It is used for temperatures of 32°F (0°C) down to -50°F (-45.5°C). To use, mix with distilled water. Verify antifreeze capability to -50°F (-45.5°C) with a refractometer.

P-39. Arctic antifreeze solution is an ethylene-glycol based antifreeze with several additives that are mostly used by the military. It is used for temperatures of -40°F (-40°C) down to -90°F (-68°C).

P-40. To use, do not dilute; use full strength as packaged. Do not add an antifreeze extender additive with arctic antifreeze. Propylene-glycol-distilled water mixed solution is only used by the military in commercial products under warranty, as prescribed by manufacturer's instructions. It is used for temperatures of 32°F (0°C) down to -76°F (-60°C). Commercial items that are under warranty are to follow the manufacturer's recommendations until the warranty has expired. Do not use it in Army vehicles past the warranty period. When switching over to military standard automotive antifreeze, flush the cooling system to remove all the commercial antifreeze.

OTHER EQUIPMENT CONSIDERATIONS IN EXTREME COLD

P-41. Operation under conditions of extreme cold may cause equipment problems due to loss of flexibility. Nozzle seals and coupling face seals are especially subject to damage. In -20 ° F, fuel hoses may crack when allowed to crystallize from cold weather exposure or may break if bent when frozen. If pump is stopped for long periods of time in below freezing conditions, remove four drain plugs and drain volume. Cover and shelter pump if possible. For filter separator operations below 32°F, if a heated shelter cannot be provided, locate unit so that natural barriers can be utilized to the fullest extent possible to prevent water in the filter separator from freezing. Prior to stopping unit, drain all water from vessel and valve until clear fuel is discharged from the drain valve. This will prevent water from freezing in vessel. Do this at each shutdown of operation.

P-42. CI and SDA increase in viscosity at extreme cold temperatures resulting in decreased additive injection. It may be necessary to recalibrate the CI and SDA injectors for cold weather operation. If the fuel additive injector is to be shutdown longer than 72 hours at temperatures below 32°F, fuel additives must be purged from the system. Warm additive if possible when it thickens.

Table P-1. Arctic fuel operations equipment considerations

<i>Equipment</i>	<i>Temp Range</i>		<i>Notes</i>
	<i>Min</i>	<i>Max</i>	
AAFARS	-25°F	120°F	Fuel tanks and containers should be filled at least three quarters full to prevent condensation.
FARE-2	-50°F	125°F	Never leave liquid in the pump casing. Drain the casing immediately through the drain plug. During winter months and cold weather, the liquid could freeze and damage the pump casing. Operation under conditions of extreme cold may cause equipment problems due to loss of flexibility. Nozzle seals and coupling face seals are especially subject to damage.
350 Gallons Per Minute (GPM) Pump	-50°F	125°F	Never leave liquid in the pump casing. Drain the casing immediately through the drain plug. During winter months and cold weather, the liquid could freeze and damage the pump casing. Nozzle seals and coupling face seals are especially subject to damage.
Fuel Additive Injector	-25°F	120°F	If the fuel additive injector is to be shut down longer than 72 hours at temperatures below 32°F, fuel additives must be purged from the system. Warm additive if possible when it thickens. Corrosion inhibitor (CI) and static dissipater additive (SDA) increase in viscosity at extreme cold temperatures, resulting in decreased additive injection. It may be necessary to recalibrate the CI and SDA injectors for cold weather operation.
Tactical Petroleum Terminal (TPT)	-25°F	140°F	Block heaters may be used in engine crankcases. These can be operated off the floodlight set generators. Run engines routinely if block heaters. Block heaters do not come with TPT supply. Avoid touching metal surfaces with bare hands. Personal injury can result from freezing.
Test Kit, Petroleum	-25°F	140°F	Replace preformed gaskets in dust caps. In arctic conditions, fuel spilled on flesh can cause instant frostbite if the proper gloves are not worn.
Pump Rack Module (PRM)	-25°F	100°F	Engine coolant and lubricants can freeze. Batteries can freeze and crack, creating explosive and dangerous conditions. Rubber seals on nozzle and couplings are especially subject to damage. Water can form in the primary and final fuel filters, filter-separators, and fuel tank as the PRM cools down. Keep fuel tank as full as possible while operating the PRM in cold conditions.
Tank Rack Module (TRM)	-25°F	100°F	

Table P-1. Arctic fuel operations equipment considerations - *continued*

<i>Equipment</i>	<i>Temp Range</i>		<i>Notes</i>
	<i>Min</i>	<i>Max</i>	
Tank and Pump Unit (TPU)	-65°F	120°F	
M978	-25°F	120°F	In -20°F, fuel hoses may crack when allowed to crystallize from cold weather exposure or may break if bent when frozen. Has an arctic engine heater kit (NSN 2990-01-369-1295) which can keep the M978 operation to -50°F.
M969	-55°F	120°F	Use OEA-30 (MIL-PRF-46167) Lubricating Oil, internal combustion engine, Arctic; or OE/HDO-SMPL-I (MIL-PRF-32626) Lubricating Oil, internal combustion engine, synthetic base, combat/tactical service. Lubricate oil can points every six months.
M967	-55°F	120°F	
M1062	-25°F	125°F	Use OE/HDO-30 Lubricating, engine oil.
HEMTT Tanker Aviation Refueling System (HTARS)	-50°F	120°F	Do not operate fuel system in area of tents or shelters. Do not operate heating equipment within 100 feet of fuel system.
600 GPM Pump	-65°F	155°F	Cold weather mountain operations require arctic engine oil, a synthetic SW-20 lubricant used for temperatures down to -65°F. An ether start kit can be used when the engine will not start normally in cold weather. It injects a mist of liquid ether into the engine air intake system to aid ignition. The kit components are the ether cylinder, control nozzle, and the hose between the nozzle and the air intake.
800 GPM Pump	-50°F	135°F	Cold weather mountain operations require arctic engine oil, a synthetic SW-20 lubricant used for temperatures down to -65°F. If pump is stopped for long periods of time in below freezing conditions, remove four drain plugs and drain. Drain the volute. Cover and shelter the pump if possible.
Collapsible Bags 3K thru 800	-25°F	140°F	Keep snow and ice from building up on top of the tank or on vent and pipe assembly. Keep snow and ice from couplings to ensure proper assembly and disassembly. In severe cold temperatures (-20°F), sidewalls become brittle and crack. Avoid unnecessary folding, unfolding, or rolling of tank that might cause flaking, cracking, or delamination of coating material.
<p>Note:</p> <p>Cold weather operations require increased testing, recirculation, equipment maintenance, and fuel usage due to extended equipment operation requirements. Draining of water from systems must be done when not operating equipment to prevent freezing of lines. Depending on the temperature, adding icing inhibitors to fuel may be necessary. Diesel fuel will reach its freezing point and begin to gel at around 15°F, whereas jet fuel has a much lower freezing point of around -51°F. Fuel additives are available to decrease the possibility of fuel gelling (MIL-DTL Specification 85470, Inhibitor, Icing, Fuel System, High Flash, North Atlantic Treaty Organization Code Number S-1745). Although fuels do not completely freeze, they will be the same temperature as the air. For more information, refer to ATP 3-90.97, the relevant equipment TMs, TM 5-4330-263-13&P, and WP0007.</p>			

Appendix Q

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.

Q-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?

Q-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?

Q-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 fuel 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 units whose capacity equals or exceeds 5,000 gallons?

Q-4. Filter Separator:

- Is equipment properly grounded?
- Is date (month and year) of last change of filter-coalescer elements stenciled on equipment?
- Have filter-coalescer elements been changed within the past 36 months?
- Is a record of pressure differential gauge readings available?
- Are filter effectiveness samples submitted every 30 days for testing?
- Are sample reports (Petroleum Laboratory Report) on file?

Q-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 (to include absorbent materials), grounding rods, and fire extinguishers in place?
- Is traffic flow one way and signs posted?

Q-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 water detector test performed and log maintained?

Q-7. Environmental Protection:

- Does the unit have reporting procedures in their SOP?
- Are procedures for various operational 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?

Q-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 units whose capacity equals or exceeds 5,000 gallons?
- Are inventories conducted and documented?
- Is the monthly fuel report and adjustment action completed in accordance with the regulation?
- Is the fuel report submitted within three working days to the approving authority for action?

Appendix R

Future Quartermaster Force Structure

This appendix provides a snapshot of the AimPoint 2035 Army force structure, the near-term quartermaster force being developed, and the Theater Petroleum and Water Group force structure scheduled for implementation by 2025.

R-1. The joint force is refocusing from fighting counterinsurgencies and violent extremist organizations to countering and possibly confronting near-peer adversaries. Competition and conflict will occur in multiple domains (land, air, sea, space and cyberspace), and there will be multiple threats across the competition continuum in the future operational environment. The Army AimPoint 2035 initiative seeks to modernize and build a force structure better prepared to undertake multi-domain operations against near-peer adversaries.

R-2. Headquarters at echelons above brigade are being augmented with additional staff and capabilities to better operate in the space and cyberspace domains. Multi-Domain task forces are being created to focus on penetrating an enemy environment, employing assets that can counter enemy anti-access/area-denial weapons and network-focused targeting of U.S. units. The Army plans to develop new theater fires commands intended to coordinate long-range fires of Army missile and extended-range artillery systems. Sustainment units are changing in response to the new environment as well. For example, there will be three different versions of the composite supply company. Figure R-1 on page R-2 shows the currently projected quartermaster force structure for fiscal year 2027 approved during Total Army Analysis 23-27.

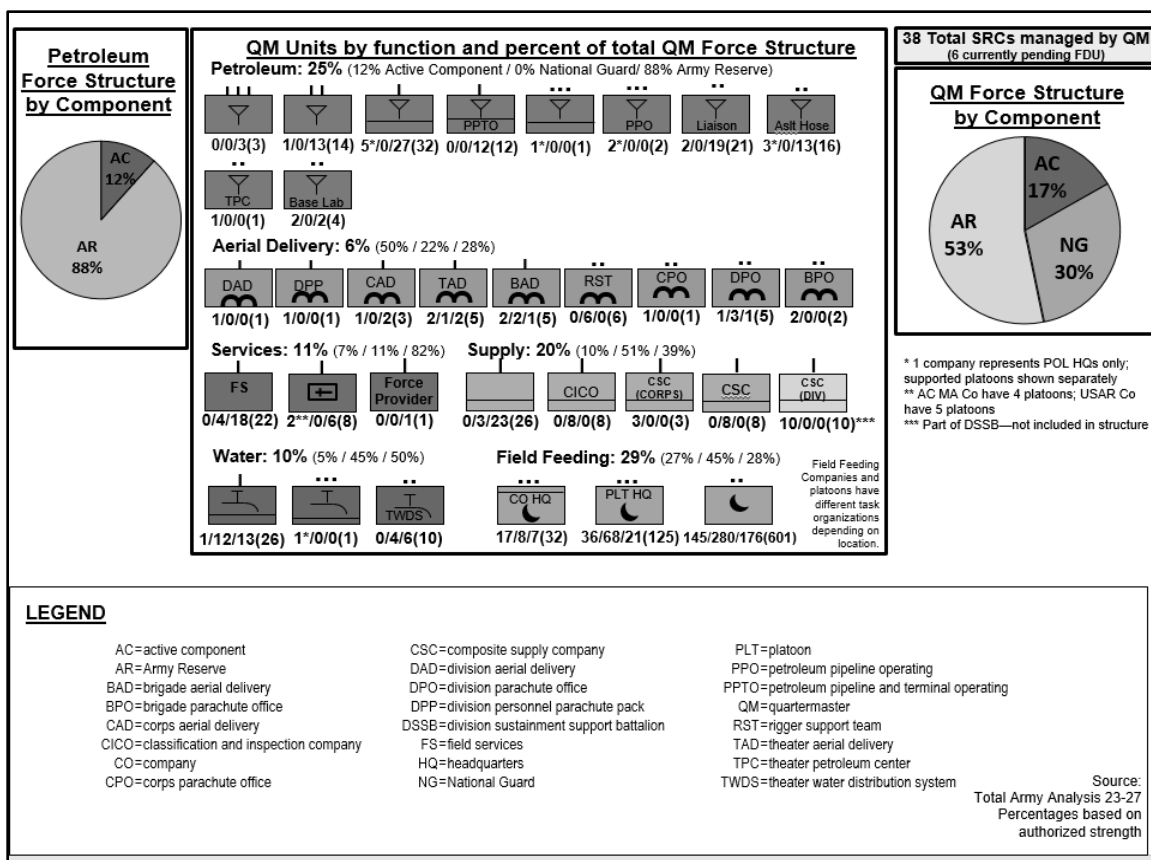


Figure R-1. Currently projected fiscal year 2027 quartermaster force structure

R-3. As part of this change, the quartermaster group (petroleum and water) listed will become the theater petroleum and water group (TPWG) by 2025. Figure R-2 shows the projected TPWG force structure.

R-4. The TPWG will be approximately twice the size of the current quartermaster group, allowing for an organic future plans cell and a more robust execution and tracking system for bulk fuel distribution, storage and quality surveillance.

R-5. The TPWG will increase capability for multi-service theater integration, synchronization, planning and organization, and contain the required personnel, expertise, responsibility and authority to execute theater bulk petroleum and bulk potable water operations for large-scale combat operations and multi-domain operations.

R-6. There will be four main branches within the TPWG:

- The requirements branch builds and validates requirements for Service, Joint and Multinational forces, determine supportability in coordination with DLA Energy, provides gaps and shortfalls to the TSC for decision and JPO approved requirements to the DIB.
- The DIB develops and plans the theater's class III (B) and bulk potable water concept of execution for sustainment support, SOPs, and multimodal distribution plan for validated customer support requirements.
- The petroleum and water operations tracking center manages execution of theater bulk fuel and bulk potable water storage and distribution from theater to corps level via ground transport, inland waterways, rail, conduit, pipelines and facilities to customers.
- The quality surveillance and safety branch develops and executes the theater quality surveillance plan, which will include theater-level laboratory operations.

R-7. In addition, there will be specialty teams, including —

- Theater forward plans team to provide a forward presence in selected theaters supporting integration, synchronization and coordination between the TSC and its supporting TPWG. It will work directly with SPO plans and operations developing theater plans and enhance coordination with Army Service component command, TSC, partner nations, Allies, joint services, JPO, SAPO, DLA Energy and other partners as needed.
- Distribution teams to coordinate and manage end-to-end product movement and transfer across the multimodal distribution network.
- An engineering planning and management team to perform site surveys and identify requirements for existing and proposed petroleum and water infrastructure feasibility, pipeline or conduit traces and detection of subsurface water, well drilling.

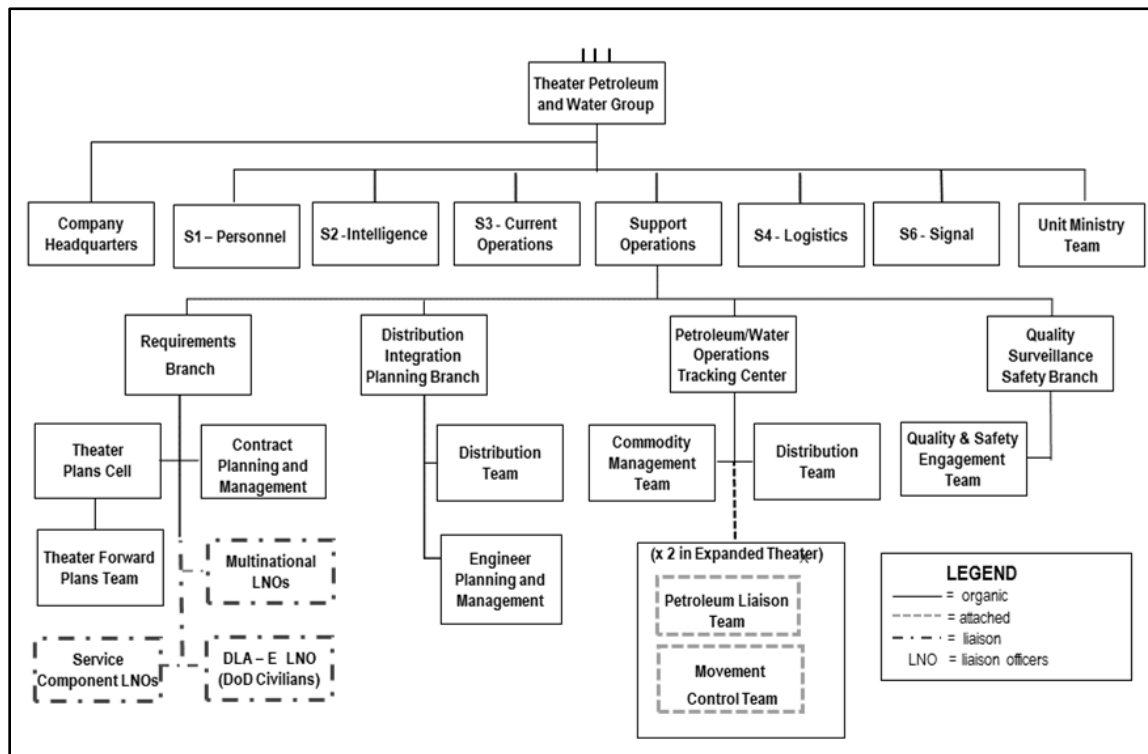


Figure R-2. Projected theater petroleum and water group force structure

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Glossary

The glossary lists acronyms and abbreviations for Army and joint terms.

SECTION I – ACRONYMS AND ABBREVIATIONS

ACSA	acquisition and cross-servicing agreement
AO	area of operations
AOR	area of responsibility
API	American Petroleum Institute
APS	Army pre-positioned stock
ASB	aviation support battalion
avgas	aviation gasoline
BCT	brigade combat team
BFDS	bulk fuel distribution system
BRAG	black, red, amber, green
BTU	beach termination unit
BSB	brigade support battalion
C	Celsius
CASCOM	Combined Arms Support Command
CAB	combat aviation brigade
CBRN	chemical, biological, radiological, and nuclear
CCDR	combatant commander
CCR	closed circuit refueling
CI/LI	corrosion inhibitor/lubricity improver
CONPLAN	contingency plan
COP	common operational picture
CSSB	combat sustainment support battalion
DA	Department of the Army
DIB	distribution integration branch
DLA	Defense Logistics Agency
DMC	distribution management center
DOD	Department of Defense
DSB	division sustainment brigade
DSSB	division sustainment support battalion
E2FDS	Early Entry Fluid Distribution System
ECAB	expeditionary combat aviation brigade
ERFS	Extended Range Fuel System
ESC	expeditionary sustainment command

F	Fahrenheit
FARE	forward area refueling equipment
FARP	forward arming and refueling point
FM	field manual
FMSWeb	force management system website
FSC	forward support company
FSES	fire suppression equipment system
FSII	fuel system icing inhibitor
FSSP	fuel system supply point
G-3	assistant chief of staff, operations
G-4	assistant chief of staff, logistics
GCC	geographic combatant command
GPM	gallons per minute
HEMTT	Heavy Expanded Mobility Tactical Truck
H_r	feet of head
H_g	hydraulic gradient
H_L	head loss
HTARS	HEMTT tanker aviation refueling system
ICIS	integrated consumable item support
IPDS	inland petroleum distribution system
ISO	International Organization for Standardization
J-3	operations directorate of a joint staff
J-4	logistics directorate of a joint staff
JOA	joint operational area
JP4	jet propulsion fuel, type 4
JP5	jet propulsion fuel, type 5
JP8	jet propulsion fuel, type 8
JPO	joint petroleum office
JTF	joint task force
LHS	load handling system
LOC	line of communications
LOGPAC	logistics package
LOGSTAT	logistics status
LOTS	logistics over-the-shore
MSWP	maximum safe working pressure
MTOE	modified table of organization and equipment
NAH	net available head
NATO	North Atlantic Treaty Organization
NCO	non-commissioned officer
NFPA	National Fire Protection Association
NSN	national stock number

OE	operational environment
OPDS	offshore petroleum distribution system
OPLAN	operation plan
OPLOG	operational logistics
OPORD	operation order
OPTEMPO	operating tempo
PEAK	Petroleum Expeditionary Analysis Kit
PLS	palletized load system
PMCS	preventive maintenance checks and services
ppm	parts per million
POL	petroleum, oil, and lubricants
PPTO	petroleum pipeline and terminal operating
PQAS-E	Petroleum Quality Analysis System - Enhanced
PQDR	product quality deficiency report
PRM	pump rack module
PSB	petroleum support battalion
PSC	petroleum support company
psi	pounds per square inch
pS/m	pico Siemens per meter
QLET	Quick Logistics Estimation Tool
REPOL	reporting emergency petroleum, oil, and lubricants
ROM	refuel-on-the-move
S-1	battalion or brigade personnel staff officer
S-3	battalion or brigade operations staff officer
S-4	battalion or brigade logistics staff officer
SAPO	subarea petroleum office
SCAT	self-contained aboveground tank
SDA	static dissipating additive
SOP	standard operating procedure
SPO	support operations
SRC	standard requirements code
TACOM	United States Army Tank-automotive and Armaments Command
TAH	total available head
TBX	transportation brigade (expeditionary)
TFDS	tactical fuel distribution system
TM	technical manual
TPC	theater petroleum center
TPWG	theater petroleum and water group
TPT	tactical petroleum terminal
TRM	tank rack module
TSC	theater sustainment command

U.S.	United States
USAMC	United States Army Materiel Command
USAPC	United States Army Petroleum Center
USTRANSCOM	United States Transportation 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. (JP 3-0)

area of responsibility

An operational area defined by a commander for land and maritime forces that should be large enough to accomplish their missions and protect their forces. Also called AO. (JP 3-0)

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. (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. (JP 3-09.3)

distribution management

Synchronizes and optimizes transportation, its networks, and materiel management with the warfighting functions to move personnel and materiel from origins to the point of need in accordance with the supported commander's priorities. (ADP 4-0)

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. 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. (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. (JP 4-01.6)

logistics over-the-shore operations

The loading and unloading of ships without the benefit of deep draft-capable, fixed port facilities; or as a means of moving forces closer to tactical assembly areas dependent on threat force capabilities. Also called LOTS operations. (JP 4-01.6)

***offshore petroleum distribution system**

A bulk petroleum transfer system used by offshore tankers to provide petroleum for storage in the beach support area, or for onward movement inland. Also called OPDS.

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. (JP 3-0)

throughput distribution

A method of distribution which bypasses one or more intermediate supply echelons in the supply system to avoid multiple handling. (ATP 4-11)

unit distribution

A method of distributing petroleum by which the receiving unit is issued supplies in its own area, with transportation furnished by the issuing agency. (ATP 4-11)

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ATP 4-43
18 April 2022

By Order of the Secretary of the Army:

JAMES C. MCCONVILLE
General, United States Army
Chief of Staff

Official:

A handwritten signature in black ink, appearing to read 'Mark F. Averill', written in a cursive style.

MARK F. AVERILL
Administrative Assistant
to the Secretary of the Army
2208904

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