TC 3-34.530

Inland Petroleum Distribution System Engineer Construction Support

JUNE 2022

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Preface

TC 3-34.530 provides a guide and basic reference for engineer units planning, building, and making major repair of the Inland Petroleum Distribution System (IPDS) in the theaters of operations (TOs).

The principal audience for TC 3-34.530 are the commanders and trainers of engineer construction units. This publication applies to all construction engineer units.

Commanders, staffs, and subordinates ensure that their decisions and actions comply with applicable United States, international, and in some cases host-nation laws and regulations. Commanders at all levels ensure that their Soldiers operate in accordance with the law of war and the rules of engagement. (See FM 6-27.)

TC 3-34.530 uses joint terms where applicable. Selected joint and Army terms and definitions appear in both the glossary and the text. Terms for which TC 3-34.530 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 TC 3-34.530 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.

TC 3-34.530 applies to the Active Army, Army National Guard/Army National Guard of the United States and United States Army Reserve unless otherwise stated.

The proponent of TC 3-34.530 is the United States Army Training and Doctrine Command (TRADOC). The preparing agency is the Collective Training Division, Directorate of Training and Leader Development, United States Army Engineer School. Send comments and recommendations on a DA Form 2028 (*Recommended Changes to Publications and Blank Forms*) to the Department of the Army, United States Army Engineer School, United States Army Maneuver Support Center of Excellence, Directorate of Training and Leader Development, ATTN: ATSE-D, 14010 MSCoE Loop, Building 3201, Suite LH2617, Fort Leonard Wood, MO 65473-8300; by e-mail to usarmy.leonardwood.mscoe.mbx.engdoc@army.mil; or submit an electronic DA Form 2028.

Introduction

This training circular provides an overview of engineer construction support provided to the Army IPDS petroleum supply, principles, and petroleum distribution in a TO. The information in this training circular can be used by all commanders, staffs, and engineer construction units to plan for engineer construction in support of the IPDS.

A complete listing of preferred metric units for general use is contained in Federal Standard 376B at website https://www.nist.gov/system/files/documents/2017/05/09/fs376-b.pdf.

Chapter 1

Introduction to the Inland Petroleum Distribution System

This chapter describes the Army bulk petroleum supply, principles, and petroleum distribution in a TO. It provides an understanding of modular fuel support, local sources such as refineries, commercial terminals, or Offshore Petroleum Distribution System (OPDS) to IPDS and finally to storage sites. It explains the containerization of IPDS pipeline sets, pump stations, and special equipment and safety considerations. The information in this chapter can be used by all Army organizations to plan for petroleum storage and distribution operations.

SECTION I – INTRODUCTION

1-1. This section provides an introduction to the IDPS and a brief description and principles of the IPDS.

BACKGROUND

1-2. Since World War II, petroleum distribution to military forces has been one of the most challenging missions for the military logistician. The military logistician provides petroleum fuels to operating forces whenever and wherever they are required. In industrialized TOs, fuel supplies are usually available locally. The storage and distribution systems (storage tanks, pipelines, roadways, and railroads) are already in place, although they may need to be repaired or supplemented. In an undeveloped TO, tankers or barges may be required for fuel supplies and the distribution system will have to be established.

1-3. In the mid-1970's, the Army recognized that supporting modern military forces with the vast amounts of fuel needed in war was a significant problem. The capability to support fuel requirements on the modern battlefield in a developed theater was marginal and in an undeveloped TO, it did not exist. In June 1977, the United States Army Quartermaster School published a study of bulk-petroleum fuels distribution in the TO which examined the requirements of a bulk-petroleum distribution system in war. Several significant conclusions resulted from the study, to include—

- Pipelines are the most efficient means of transporting the large quantities of bulk fuels required by modern warfare.
- Early logistics planning should include pipeline requirements and provisions for assigning pipeline construction and operating units as the theater develops.
- Pipelines, when used, should be extended as far forward into the combat zone as practical.
- A documented need existed for the development of an assault pipeline system with an over-the-beach capability to supply fuel to deployed forces from ocean tankers.

1-4. Because the Army is responsible for providing bulk petroleum (fuels) to the United States (U.S.) and its allied forces in a TO, the United States Quartermaster School conducted a study in the mid-1980s, focusing on bulk-petroleum distribution in the TO. The Army's main area of concern, at that time, was the under-developed Southwest Asia sector that had limited road and pipeline infrastructures. Development of two systems, an IPDS and an OPDS, began as an operational project under the name of Southwest Asia Petroleum Distribution Operational Project. The United States Navy eventually assumed responsibility for OPDS. These two systems have been refined and changed to enable the project stock to support the rapid tempo of the modern armed forces today.

MODULAR—FUEL SUPPORT

1-5. To meet current and future operational requirements, the United States Army is undertaking a total organizational redesign of its combat support and sustainment units. In terms of scope, the Army has not attempted such a massive transformation of its forces since the beginning of World War II.

1-6. This effort involves changing how the Army conducts operations and how it is organized to accomplish assigned missions. The organization and doctrine of the Army that appears as the result of transformation will not resemble that with which our nation fought the major conflicts of the last century. Today's operations require Army forces to respond rapidly with forces that move quickly and commence operations immediately upon arrival in distant TOs. To satisfy operational demands as different as those of Iraq, Afghanistan, and the Philippines, the Army has had to dismantle or reorganize its units to configure them for the tasks at hand. Modular forces are more relevant to the Regional Combatant Commander and generate versatile combat power with units that are more self-contained and that are truly joint independent.

1-7. The Theater Sustainment Command (TSC) is the senior Army logistics headquarters in a TO and is regionally focused and globally employable. The employment of OPDS and IPDS will continue at the theater sustainment base area, augmented with evolving petroleum systems as they are developed and fielded. Figure 1-1 is an illustration of theater fuel support. The sustainment brigade can be found at the theater, operational, or tactical level. Expeditionary sustainment brigades are primary subordinate commands of the TSC. They consolidate selected functions previously performed by division/corps and area support groups into a single operational echelon. The sustainment brigade level of assignment and mission determines the mix of functional and multifunctional subordinate battalions and companies under their control.

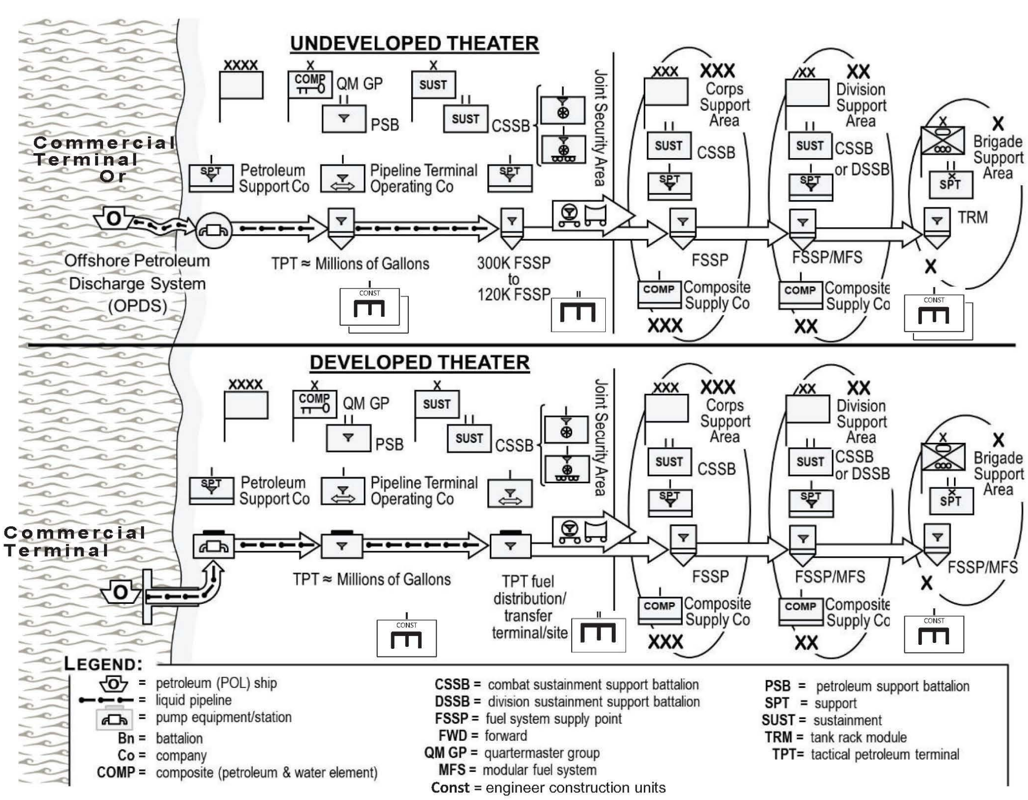


Figure 1-1. Petroleum distribution system

QUARTERMASTER PETROLEUM GROUP

1-8. 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.

1-9. The group may receive an operations order from the TSC or expeditionary sustainment command. However, its planning normally starts when it sees the theater Army's operation plan. The group plans the development, design, and construction of the tactical petroleum distribution and storage facilities based on the theater commander's operation plan. 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 joint petroleum office.

1-10. 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 expeditionary sustainment command distribution management center.
- Maintains petroleum requirements estimates and operation records.
- Works with the facilities section for operations of the pipeline and terminal system.

1-11. 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 expeditionary sustainment command'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.

1-12. 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

1-13. Brigade combat teams (BCTs) will be the primary organizations for fighting tactical engagements and battles. BCTs will have one of three standard designs—armored brigade combat team, infantry brigade combat team, and Stryker brigade combat team. These BCTs include battalion-sized combat service support units such as the brigade support battalion. The brigade support battalion is the BCT's organic logistics headquarters unit. The brigade support battalion combines unit distribution and area supply point distribution to ensure that services and supplies are delivered when and where they are needed.

1-14. The forward support company will be employed to support various combat battalions such as those combat battalions within the BCT. The forward support company is a multifunctional combat service support unit that is as mobile as the unit it supports.

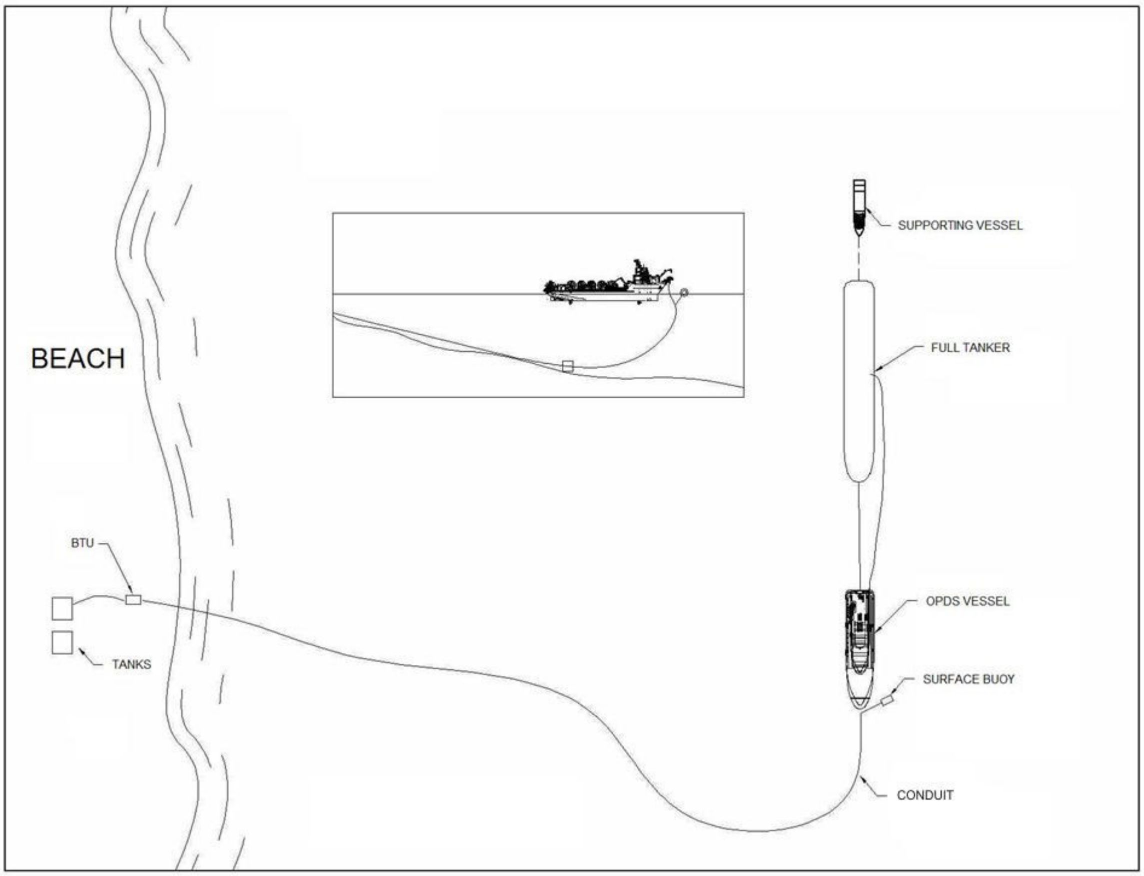
1-15. The modular force conversion was envisioned to relieve stress on the force, provide time to train, create more predictable deployment schedules, and enable the Army to maintain a continuous supply of ready land power to the Regional Combatant Commander and civil authorities.

1-16. In recent years, the changing world situation has altered the focus of OPDS/IPDS operations from Southwest Asia to worldwide. Modularity changes divisional units by creating independent BCTs containing the combined arms capabilities necessary to deploy. In Desert Shield/Desert Storm, significant amounts of IPDS equipment was deployed to support coalition forces in the liberation of Kuwait. Two OPDS systems were deployed to the theater but not used. A two-mile segment of pipeline was deployed to Somalia and installed from the Port of Mogadishu to the fuel storage area at the Somalia National Airport during operation "Restore Hope." During Operation Iraqi Freedom, the IPDS consisting of over 220 miles of pipeline and 20 fuel units of storage capability were deployed. This was a huge undertaking and the system worked as envisioned. Joint logistics over-the-shore exercises, which have included OPDS/IPDS, have been held on a reoccurring basis in such locations as Korea, Australia, California, and Virginia.

OFFSHORE PETROLEUM DISTRIBUTION SYSTEM

1-17. The OPDS is a United States Navy system and its purpose is to deliver fuel to the high-water mark on the beach. Located at the high-water mark is a beach termination unit. The beach termination unit serves as the interface between the OPDS and the IPDS and is considered the point when the Navy's mission (OPDS) terminates and the Army mission (IPDS) begins.

1-18. The United States Naval Ship Vice Admiral K. R. Wheeler, also known as the OPDS, is the only current prepositioned OPDS vessel. It carries no organic fuel. As noted, the capability serves as a terminal ship whose function it is to provide stand-off, pump-through service from any tanker of opportunity (see figure 1-2). The vessel is designed to operate in much more demanding sea states/weather conditions with a stand-off capability of up to 8 miles. The vessel provides the capability to pump up to 1.7 million gallons per day (6,435,200.03 liters per day), can stay on-station for extended lengths of time, and can rapidly redeploy to alternate locations quickly.



Legend:
BTU beach termination unit
OPDS Offshore Petroleum Distribution System

Figure 1-2. OPSD

INLAND PETROLEUM DISTRIBUTION SYSTEM

1-19. The IPDS system is a rapidly deployed, general support, bulk-fuel storage, and multifuel pipeline system consisting of commercially available and military standard petroleum equipment. The system has a design throughput of 720,000 gallons based on 600 gallons per minute (2,300 liters per minute) at 20 hours per day. The remaining four hours are allocated for maintenance.

1-20. This system provides the United States Army with the capability to support operational forces with bulk fuels in either a developed or undeveloped TO. Bulk fuel can be supplied from local sources such as refineries, or as shown in figure 1-3, over-the-shore with the OPDS/beach termination unit. This fuel is pumped inland by means of the pipeline and pump stations to fuel units and tactical petroleum terminals

(TPT). TPTs are made up of fuel units and are connected to the pipeline with pipeline connection assemblies (PLCA). Each fuel unit has a stand-alone bulk fuel receipt, storage, and distribution capabilities that allow them to be used as separate units when required.

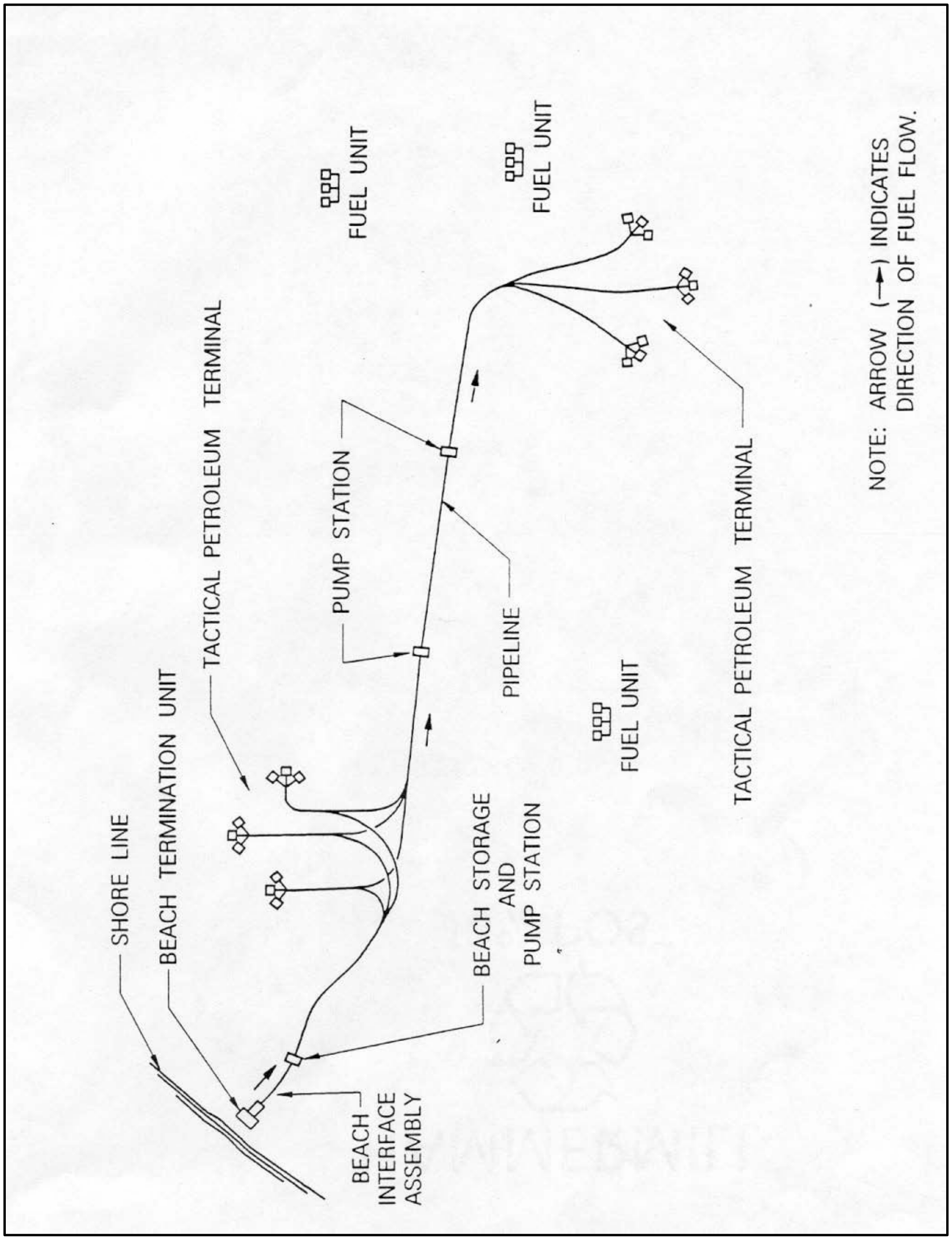


Figure 1-3. IPDS with beach termination unit

1-21. Engineer construction battalions, augmented by engineer construction companies, are responsible for surveying the pipeline trace, constructing the pipeline and pump stations, and forming the berms for the bulk fuel tank assemblies which are the storage tanks in the TPT. Quartermaster Petroleum Pipeline and Terminal Operating Companies are responsible for operating up to five pump stations (or up to 75 miles [120.7 kilometers] of pipeline) and either one TPT or two commercial terminals.

CONCEPT OF EMPLOYMENT

1-22. Theater operational plans specify fuel distribution requirements from which pipeline routes, the number and locations of pump stations, and the number and locations of bulk storage facilities are determined. If the OPDS is required, planning for the location and installation of it is accomplished concurrently.

1-23. In operation, the IPDS will be transported to the TO and installed by military units. Engineer units install the pipeline, construct the pump stations, and prepare storage sites. Quartermaster units install the storage system and operate the total system when it is completed.

SECTION II – CONTAINERIZATION

1-24. The IPDS, when not in use, is stored by subset configurations. The subsystems in the IPDS are—fuel units, PLCA, 5-mile pipeline sets, pump stations, pipeline support equipment (PSE), and special purpose equipment. All subsystems are stored in International Standard Organization (ISO) 20-foot (6.096 meter) containers. By storing the equipment in these containers, it greatly assists movement and accountability of the IPDS. The containers are marked to allow for the controlled movement, tracking, and staging according to the requirements of the operational plans of the TO. These set configurations and container markings are described in appendix B.

1-25. IPDS major components containers are identified in appendix B. When necessary, United States Army Forces Command contracted personnel can be deployed with the IPDS to provide technical support during the planning, construction, installation, operation and maintenance, and recovery phases of the operation as required.

1-26. The technical configuration of the IPDS incorporates the following three major groups of equipment:

- **Bulk-petroleum storage system.** The bulk-petroleum storage system consists primarily of fuel units and PLCA. Its primary function is to receive, store, and issue fuel. It provides 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.
- **Pipeline system.** The pipeline system consists of pipeline sets, pipeline pump stations, and PSE. Its primary function is to transport fuel from one area to another. The military planner can combine as many pipeline sets (5 miles [8.05 kilometers] each) and pump stations as is necessary to meet joint operational requirements.
- **Special-purpose equipment.** Special-purpose equipment provides specific-purpose components incorporated into the pipeline design to overcome specific joint operations are topographical problems or pipeline design problems. Their use is based upon the needs of the military planner when designing the IPDS.

SECTION III – SAFETY

1-27. Safety is something that should never be taken for granted. Safety is a frame of mind, not just a set of rules. Leadership, beginning at the top, must “lead” safety by example and emphasis. Throughout all phases of IPDS planning, staging, construction, operation, maintenance and recovery, and personal and equipment safety must be considered. In addition to performing risk assessments, leadership sets the tone for safety.

1-28. During planning, the pipeline route must be considered with an emphasis on ease of construction and obstacle avoidance. During construction, safe equipment operation is necessary to prevent personal injury and equipment damage. In addition, many heavy metal components must be moved and emplaced by hand, increasing the risk of injury. During operation and maintenance, the same risks present during construction applies with the added risk of fuel and fuel vapors. During recovery, the same risks apply as during operation and the same equipment used as during construction.

PRECAUTIONARY INDICATORS

1-29. In most of the manuals developed with the IPDS, precautionary indicators have been added for safety. Some are also found in this training circular.

WARNING

Instructions must be followed to avoid causing injury or death to personnel. These describe the procedure required and the injury that could result from failure to follow the procedure.

Warning example. Avoid making contact across battery terminals. This can result in severe arcing, which can cause explosions, resulting in death or serious injury.

CAUTION

Instructions must be followed to avoid causing damage to the product or other equipment incidental to the installation. A caution describes the procedure required and the damage, which could result from failure to follow the procedure.

Example caution. Impeller inlet cavitation occurs when engine speed is increased beyond the point of maximum suction vacuum. Cavitation is harmful to the pump unit and be avoided at all times. Cavitation can be detected by an excessively loud cracking noise in the pump housing.

Note. Notes are not really safety indicators, but are used as aids in installation, operation, and maintenance. They clarify procedures.

Example note: Make sure the priming port cap is securely in place on the pump casing.

PRECAUTIONS

1-30. The following safety procedures are not complete, but serve as a guide only:

- Avoid getting fuel on the skin. Wash fuel from the skin with soap and water as soon as possible. Seek medical aid if skin rashes or irritation develops and persists. If fuel gets on clothing, remove clothing promptly but carefully (see note). Wash skin with soapy water and replace clothes with clean items.

WARNING

If unable to soak individual with water, have victim hold on to a good ground source and slowly remove clothing to avoid causing sparks from static electricity.

- If fuel gets into the eyes or mouth, immediately flush thoroughly with water and seek medical aid if the eyes or mouth remain irritated.
- If fuel is swallowed, keep the victim calm. Have him drink a pint of milk or a canteen of water. Do not induce vomiting. Seek medical aid.

- Prohibit smoking except in designated areas. Prohibit matches and lighters in hazardous areas.
- Avoid conditions that may lead to static electrical discharge (arcing) or sparks. These include—
  - Wearing nonstatic producing clothing, leather gloves, and rubber-soled boots. Do not wear shoes with exposed nails, metal plates, or hobnails as these may cause sparks.
  - Not carrying or wearing exposed metal objects, such as knives, keys, or loose identification bracelets that could cause sparks if struck or dropped.
  - Keeping shirt pockets empty or buttoned.
- Keep shirtsleeves rolled down and shirts buttoned-up. This will help protect you in the case of a flash (vapor) fire.
- Never use liquid fuels as cleaning fluids for floors, equipment, clothing, hands, and so forth.
- Fuel vapors are heavier than air and will collect in low places such as pits or sumps; be especially careful in such areas.
- Beware of empty (or apparently empty) cans, drums, tanks, and hoses that formerly held fuel. Vapors can remain long after the container has been emptied.
- Keep all fuel containers, whether full or empty, tightly closed except when in use. Open fuel containers slowly, especially if they have been shaken or exposed to heat to prevent a fuel-air mixture from spewing out.
- Dispose of oily waste or rags immediately after using by placing in a self-closing metal container.
- Avoid spilling fuel. Clean up spills at once if they happen. Wipe up or dig up small spills and properly dispose of the contaminated waste. Follow local emergency procedures for large spills. Treat the area as dangerous until the vapors dissipate.
- Report leaks to the proper authorities. Do not operate leaking equipment.
- Do not conduct fuel-handling operations in a hanger, shop, or other confined area. This can cause fuel vapors to collect with no way to dissipate.
- Allow the proper distance between fuel storage and fuel transportation equipment for fire safety and maneuverability.
- Use only explosion-proof electrical equipment, lights, and fixtures in hazardous areas. Inspect often and correct any conditions that could cause sparking, arcing, or overheating.
- Disconnect the power source and pull the fuses before working on electrical equipment.
- Equipment requiring welding and cutting operations must be clean and vapor free. Heaters, welding torches, or blowtorches must not be used within 50 feet (15.24 meters) of fuel handling operations.
- At the discretion of the commander, stop all pumping operations during electrical storms or when other conditions such as high wind speeds are present and pose a danger to personnel or equipment.
- Bonding and grounding points and grounding cables should be tested frequently to ensure conductivity. Repair or replace parts that fail a continuity check. Bonding and grounding must occur before the fueling/defueling connection is made and must not be broken until fuel flow ends.
- Vehicles carrying fuel as cargo and those operating within 50 feet (15.24 meters) of fuel-handling operations must be equipped with a spark-arresting exhaust system.
- Protective earthworks (berms) around collapsible tanks should be built to give the least possible exposed fuel surface in case of tank rupture. Berms should be large enough to hold the contents of a full tank, plus one foot of free board. A small area generates the least vapor, and provides the smallest burning surface in case of fire.
- Do not top-load tank trucks or cars unless absolutely necessary. Start filling at a slow rate with the discharge hose near the tank bottom. When the hose end is submerged, loading can proceed at a full flow rate. This procedure will minimize vapor formation and the risk of ignition due to static electricity.
- Do not filter fuel through anything other than properly grounded filter separators.
- Do not throw or drag hoses and nozzles Avoid kinking and twisting hoses.
- Do not conduct fueling operations within 300 feet (91.44 meters) of active ground radars.
- Do not clip petroleum equipment ground wires to antennas.

- Firefighting equipment, including protective clothing, must be in good condition and readily available.
- Do not use water to extinguish or suppress a fuel fire. It is heavier than fuel and fuel will always come to the surface. Using water will result in the fire spreading over a larger area.

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Chapter 2

Inland Petroleum Distribution System Responsibilities

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

RESPONSIBILITIES

2-1. Building and operating IPDS is a large and vital undertaking with many divisions of responsibility between Army forces. Engineers at the theater headquarters and the TSC make basic decisions concerning IPDS including location, capacity, and storage facilities. General responsibilities of the theater commander, theater Army commander, and Theater Sustainment Command commander are stated in FM 4-0.

THEATER ARMY

2-2. Theater army headquarters provide broad planning guidance for Army petroleum support. The theater petroleum center serves as the operational Army link to strategic petroleum partners providing liaison between the Defense Logistical Agency Energy, host/partner nations, the Army Service Component Command, Army Petroleum Center, combatant command, and TSC as needed. It serves as the senior theater army petroleum advisor to the combatant command through operational planning support to the TSC petroleum and water branch or Army Service Component Command petroleum and water branch staffs. The Quartermaster Petroleum Liaison Team operates as a subunit of the theater petroleum center and provides the same capabilities of the theater petroleum center on a smaller scale. Both the theater petroleum center and the Quartermaster Petroleum Liaison Team are normally attached to an Army Service Component Command, TSC, or Expeditionary Sustainment Command as mission dictates. See ATP 4-43 for additional information. The theater army orders the required pipeline construction materials and coordinates the movement of the materials to the construction staging areas along the proposed pipeline route. The theater army coordinates with all host-nation petroleum suppliers.

2-3. The senior staff engineer in the theater army command is responsible for the coordination and synchronization of engineer operations across the area of responsibility (AOR). Responsibilities include coordination of efforts within the civil affairs brigades, nongovernmental, intergovernmental organizations, United States Army Corps of Engineers, other Services, the host nation, and other interested parties. The senior staff engineer plans for real estate actions, environmental actions, facilities construction, demining operations, mobility and countermobility operations, firefighting responsibilities, support to the construction of aboveground inland petroleum distribution pipeline, and general construction throughout the AOR in support of force requirements. He is also responsible for establishing overall engineer policy within the AOR. Engineer proponency at the joint, Army Service Component Command, and field Army may reside in the assistant chief of staff, logistics, and/or the logistics directorate of a joint staff. This supports the strategic and operational integrated planning required for operational activities that include setting the theater, terrain management, and base camp planning.

QUARTERMASTER BRANCH

2-4. Quartermaster units are responsible for the operation and routine maintenance of bulk-petroleum facilities. Quartermaster units have the capability of providing personnel and equipment assets to support logistics operations and services.

PETROLEUM GROUP

2-5. This quartermaster group (petroleum and water) provides command, control, planning, and supervision of multirole bulk petroleum and bulk potable water supply, storage, distribution networks, and quality surveillance and water purification, storage and distribution in support of unified land operations.

PETROLEUM SUPPORT BATTALION

2-6. The petroleum support battalion 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 battalion or brigade operations staff officer (S-3) is responsible for internal operations of the petroleum support battalion. The support operations section plans for external support, including theater storage and theater flow of bulk petroleum. The support operations 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 support operations section is responsible for coordinating bulk petroleum movement in the petroleum support battalion's area of operations according to the group's distribution plan. The plans officer is responsible for futures planning for the petroleum support battalion.

2-7. The petroleum support battalion support operations section plans and prepares a draft order for the S-3, who issues orders to the petroleum support battalion'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.

2-8. 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 support operation's next planning iteration.

PETROLEUM PIPELINE AND TERMINAL OPERATING COMPANY

2-9. This company's mission is to operate and maintain on a 24-hour basis, a section of pipeline not to exceed five pipeline pump stations and 75 miles (120.7 meters) and one TPT. The company's maintenance capabilities include repairing and replacing valves, blinds, pressure gauges, meters, pump units, coupled pipelines, hose lines, and related pipeline equipment.

ENGINEER BRANCH

2-10. Engineer units are responsible for the design, to include development of the hydraulic profile, construction rehabilitation, and major maintenance of bulk-petroleum facilities. Engineer support in the development of the bulk-fuel distribution system requires general and specialized construction skills. General engineer construction units require augmentation with specialized training and equipment to accomplish the mission.

- **Engineer battalion.** The engineer battalion is the primary military engineer unit to support the construction of the bulk-petroleum distribution system. The unit provides horizontal and general construction support for the pipeline construction mission. The engineer battalion is the higher headquarters of the engineer construction companies assigned to it for pipeline construction. Horizontal tasks include route clearing and leveling, pumping-station pad preparation, TPT berm construction, and construction-staging-area preparation. Vertical construction tasks include surveying, culvert construction, gap-crossing construction, and constructing the pipeline system.
- **Engineer construction companies.** These units provide the engineer battalion the technical expertise when augmented with specialized equipment for constructing the pipeline system. The unit has limited, independent capabilities to construct pipeline systems. Specialized equipment

includes forklifts, cranes, and backhoe loaders with drive head attachments. This unit does not have the movement assets to transport pipeline construction materials from the storage areas to the construction staging areas.

UNITED STATES NAVY

2-11. The United States Navy is responsible for the installation of the OPDS and ship-to-shore pipeline to the high watermark and the connections and operation of the beach-termination unit. They are also responsible for the installation and operation of the Single-Anchor Leg-Mooring System.

2-12. For the Army, fuel military construction project planning must include the Army Corps of Engineers and the United States Army Petroleum Center. Close coordination between the Combatant Commander Joint Petroleum Office, responsible host-nation agencies, military quartermaster, and engineer elements is critical to ensure the timely execution of theater bulk-petroleum sustainment and management. The stakeholders involved in the process may vary across different TO. Key responsibilities of the Combatant Commander's Joint Petroleum Office are discussed in JP 4-03.

2-13. The joint-operations area plans specify fuel distribution requirements from which pipeline routes are determined, the number and locations of pump stations are calculated, and the number and locations of bulk-storage facilities are determined. If OPDS is required, planning for location and installation is accomplished concurrently. During operations, the IPDS is designed to be transported to the joint operations area and installed by military units. Engineer units install the pipeline, construct the pump stations, prepare storage sites, and test the system. Quartermaster units install the storage system and operate the total system when it is tested and turned over by the Army engineers. When not in use, the IPDS is stored in predetermined configurations. These configurations and container markings allow for controlled movement tracking and subsequent planned arrival according to the requirements of the logistics program of the joint operations area scenario.

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Chapter 3
Planning

Successful pipeline construction requires careful planning based on detailed reconnaissance. Reconnaissance continues until actual construction. Planning may appear complete before construction, but last-minute enemy action may necessitate a major change in plans. Planning for petroleum supply support generally parallels the planning process in ADP 5-0. Time, space, distances, terrain, existing resources, requirements, and operating environment are planning factors. One of the most important planning elements for petroleum support is requirements computation. Supply publications, such as Operational Logistics (OPLOG) Planner contain planning data for Class III supplies. The petroleum planner should use them in coordination with the Theater Engineer Command theater development planning. The OPLOG is a tool that is simple to use, stand-alone program that gives estimated unit, mission, and/or overall level consumption for each class of supply including water, ice, and mail by unit, subunit, operation, or mission. All logistics supply estimate reports can be printed in MS Word or exported to MS Excel. The planner is updated annually with Department of the Army 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 United States Army Force Management Support Agency.

ELEMENTS

3-1. Petroleum supply planning involves the following major elements:

- Amount and type of product to be distributed (requirements).
- Receipt and distribution points (storage locations).
- Distribution system or method (transportation mode).
- Equipment to be used (pump, pipeline equipment, rail, truck, boat).
- Organizations and personnel required to operate the system and its equipment (units).

CONSIDERATIONS

3-2. Design the petroleum supply system for the type of operations and climate of the specific theater. Plans must take into account the following:

- Supported mission and forces (size and composition).
- Requirements of the supported force.
- Climate requirements.
- Availability of transportation units (including the host nation) to move the petroleum distribution equipment from its theater entry port inland to the construction staging areas to provide required support.
- Speed with which pipelines and hose lines can be constructed and extended.
- Requirements for terminals, offshore unloading facilities, and distribution points.
- Requirements for both bulk and packaged products.

- Availability of petroleum operating units and other units needed to construct, install, and maintain petroleum distribution and storage facilities and communications equipment.
- Terrain features, which impacts on installing petroleum facilities and fuel-usage factors.

PLANNING CATEGORIES

3-3. Categories include—

- **Logistical.** Logistical planning requires translating factors such as troop strengths, numbers, and types of fuel-consuming equipment and vehicles, and tactical objectives into specific fuel requirements and distribution plans. Planning starts before the actual operations at the TO and theater-Army levels. The purpose of the planning is to ensure that products, distribution facilities, and operating units and personnel will be available when needed.
- **Operational.** Operational planning includes planning for both for reaching and maintaining the rated capacity of the distribution system and for maintaining that capacity to meet requirements placed on it. This planning is carried on along with operations. Revisions may be necessary because of tactical developments, losses in handling capacity due to enemy actions, and other factors that keep the system from operating as planned.
- **Supply levels.** The combatant command prescribes supply levels for the theater army in terms of days of supply. The theater army commander prescribes levels for the combat zone and the AOR. For planning purposes, a 30-day (minimum) theater supply level should be established for bulk fuel in the developed theater. In reality, the level may be greater than 30 days, depending on available tankage and other factors. The major portion of the theater level is maintained in the AOR. When planning, supply levels must take into account the needs of all users, including Air Force, Navy, and allies (when so designated).
- **Host-nation support.** In wartime, U.S. logistical support may not be readily available. U.S. combat forces may be supplied with common items and services, through agreements from the host nation. The type and amount of support should be specified in the agreements and included in the wartime logistical plans from all nations concerned. The amount of support, civil or military, that a host nation can provide depends on its national laws, industrial capability, economy, and willingness to give such support. Even if it is difficult to obtain host-nation support agreements, they should be pursued. Host-nation resources will most likely support the AOR, the corps, and the divisional areas, as appropriate. Host-nation support, if available, can significantly reduce support requirements. Procedures for mutual support among North Atlantic Treaty Organization nations are contained in directives agreed on for civil military cooperation. A host nation can be requested to provide civil resources, including facilities, food, services, or labor. National or allied commanders submit requests for civil military cooperation support to the territorial command of the host nation. Where possible, and preferable, national/allied civil military cooperation agreements are made with the host nation in peacetime.
- **Pipelines.** Pipelines are the most economical and rapid means of transporting large quantities of fuel between two points. Based on the planning considerations, a fuel-supply planner will consider using either a hose-line or coupled pipeline system. Petroleum units utilize hose lines, such as the assault hose system, and/or pipelines for use over short and long distances to replace or supplement vehicle delivery. This reduces the number of trucks on the main and secondary supply routes while ensuring that petroleum requirements are met efficiently and effectively. The lines must be patrolled sufficiently to reduce and mitigate sabotage and theft. Generally, hose lines can be installed rapidly and be in an operational condition in much less time than pipelines. Pipelines offer durability and the capability to operate at higher pressures, meaning pump stations can be further apart.
  - **Hose lines.** Military hose lines are available in sizes from 2 to 6 inches (5.08 to 15.24 centimeters) with strengths up to 740 pounds per square inch. Hose lines are used in TPTs, in ship-to-shore tanker unloading (or loading) lines, and for overland delivery of petroleum products within a 5-mile (8.05 kilometer) radius, based on mission analysis. Most hose lines can be installed quickly with minimal labor and equipment.

- **Coupled pipelines.** Coupled pipelines are always surface laid. Coupled pipelines can be used in an undeveloped TOs and can be economical for distances over 5 miles (8.05 kilometers). IPDS is the military standard for a coupled pipeline system. Aluminum pipes for the IPDS are 6 inches (15.24 centimeters) in diameter and are 19 feet (5.8 meters) long. The IPDS pipe is coupled with a hinged snap-joint coupling with either a one-piece or integral two-piece split-seal gasket.

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Chapter 4

Pipeline Construction

This chapter provides an overview of the Army IPDS petroleum construction.

SECTION I – PIPELINE TRACE SURVEY

4-1. This section provides an overview of the IPDS trace survey. The pipeline route is based on the petroleum supply and demand. The locations of the pipeline routes are assigned to the theater engineer command by the theater army support command. The route will determine construction time, effort, and material requirements in either a positive or negative manner. The engineer planners have the expertise to determine the best pipeline route from the source to the demand. Construction equipment access, terrain, obstacles, and pipeline trace camouflage are the key factors in determining the best construction route. Geospatial engineers have detailed topographic information that may help personnel evaluate an area and select the best route. A pipeline usually follows the most direct route possible from source to demand. After considering all the variables, the pipeline route is usually the route the campaign follows. However, the route should not run along the main supply route because it is an important military target. The pipeline route should roughly parallel secondary roads. This will enable the construction crew to execute the stringing operation of pipeline construction as quickly as possible.

4-2. The stringing operation is the most labor-intensive and time-consuming activity in military pipeline construction. A pipeline is normally laid between 20 feet (6.096 meters) and 50 feet (15.24 meters) from the shoulder of the road. (An alternate route may be selected if it will save in the construction, patrol, operating personnel, security, and maintenance areas.) Often, following the route that is cleared for power lines is best because power-line routes follow the most direct route (usually a straight line). However, access for vehicles during the stringing operations could be a problem, making the power line route unusable. Using cross-country cutoffs can be beneficial where primary roads wind excessively. and if the time and material savings are consistent with the extra construction and maintenance effort required. Based on the threat type and level, the route selected should use as much natural cover and concealment as possible, if there is no substantial increase in construction effort. Natural cover includes fence lines, hedgerows, and tree lines. The natural state of the pipeline route should be left as undisturbed as possible. Grading and leveling the pipeline route is undesirable from a concealment standpoint, but can greatly increase the rate of construction of an aluminum pipeline system. The tradeoff between camouflage and rate of construction must be weighed.

SITE AND ROUTE SELECTION

4-3. When conducting site and route reconnaissance, the following two points must be known:

- Where the fuel source is or will be located.
- Where the forces will be located requiring support.

TOPOGRAPHIC SURVEY

4-4. A survey, using a topographic map, is conducted first and may be supplemented by an aerial survey. Based on this survey, the best trace is selected and a hydraulic profile of the pipeline is constructed. Using the profile and the hydraulic limitations of the pumps, mark the pipeline trace and the required locations for pump stations, pressure reduction stations, check valves, suspension bridges, drain valves, vent valves, and all other pieces of equipment that are required to be placed according to the hydraulics of the pipeline.

ROUTE RECONNAISSANCE AND SITE LOCATION

4-5. Marking of the pipeline trace and the placement of components can be done when conducting the physical reconnaissance. Stakes or other marking devices must be used to indicate the actual path of the pipeline and the location of specific components (such as check valves, expansion devices, culverts) as determined by the map reconnaissance and the hydraulic profile. Those items identified as being required per the map survey/hydraulic profile have priority placement along the pipeline trace.

WARNING

The physical location of components may have to be adjusted during the physical trace survey, based upon site conditions at a specific location. However, to ensure that the change is compatible with the overall operation of the pipeline, the design engineer must approve changes. Injury to personnel and damage to equipment may result from unapproved changes.

TRACE CONSIDERATIONS

4-6. When laying out the pipeline path, consider the following:

- **Laying pipe.** The pipeline must be laid in as straight a line as possible. Because of the thermal expansion qualities of aluminum pipe, it will expand/contract with changes in temperature. If the deflection at a coupling exceeds 2-degrees during construction, the expansion of the pipeline during the fill and test could cause the coupling to fail.
- **Terrain.** The route should not run along the main supply route. Avoid difficult terrain when possible. Difficult terrain will require more time and equipment to construct the pipeline. Look for areas where other infrastructure has been installed such as roads, railways, power lines, commercial pipelines, barge canals, and other areas that have already had some type of terrain improvements and obstacle crossings constructed. Avoid stream banks, especially if the stream habitually floods lowlands and heavily populated areas because of the potential fire hazard that the pipeline presents.
- **Expansion devices.** Expansion and contraction devices, consisting of IPDS pipe and elbows, are required along the pipeline trace. There are two types of expansion devices. These are the U-loop and Z-shaped offsets and are equal in absorbing the expansion and contraction of the pipeline. The decision of which to use should be based on the following:
  - U-loops may be installed in situations where the trace is narrow and may be installed around obstacles such as trees or rocks. They may use 90-degree or 45-degree elbows.
  - Z-shaped offset can be installed on wide traces and conserve pipe sections and elbows. Remember if a Z-shaped offset is installed with 90-degree 3d elbows it must have two pipe sections in the middle.
  - A change-of-direction elbow may be used to absorb expansion and contraction of the pipeline, provided that it is located in an area that allows it to move freely without interference and it will not move into a hazardous area such as a road.

Note. Remember to count the number of elbows designated to be installed by type (degree) so not to run short. The number of elbows by type in each 5-mile pipeline set is included in table 4-1.

Table 4-1. Elbows in the 5-mile pipeline set

Elbow	*Quantity*
90 degree	62
45 degree	59
22 1/2 degree	10
11 1/4 degree	10
6 degree	12

- **Anchors.** Anchors must be installed at the following places:
  - At the first or second section of pipe before the receiver, and after the launcher at a pump station or pressure reduction station.
  - Between two expansion/contraction devices at the midpoint.
  - On the first pipeline section downstream from a gate valve or check valve.

Note. Ensure that the clamp of the anchor is tightened within the first 18 inches (45.72 centimeters) of the pipe section. This is the thickest portion of the pipe. See figure 4-1 for further clarification.

  - At change of direction elbows where pipe movement must be avoided to prevent pipeline damage or to prevent the pipeline from becoming a hazard (such as moving into a road).
  - Before and after obstacle crossings where pipeline stability is critical.

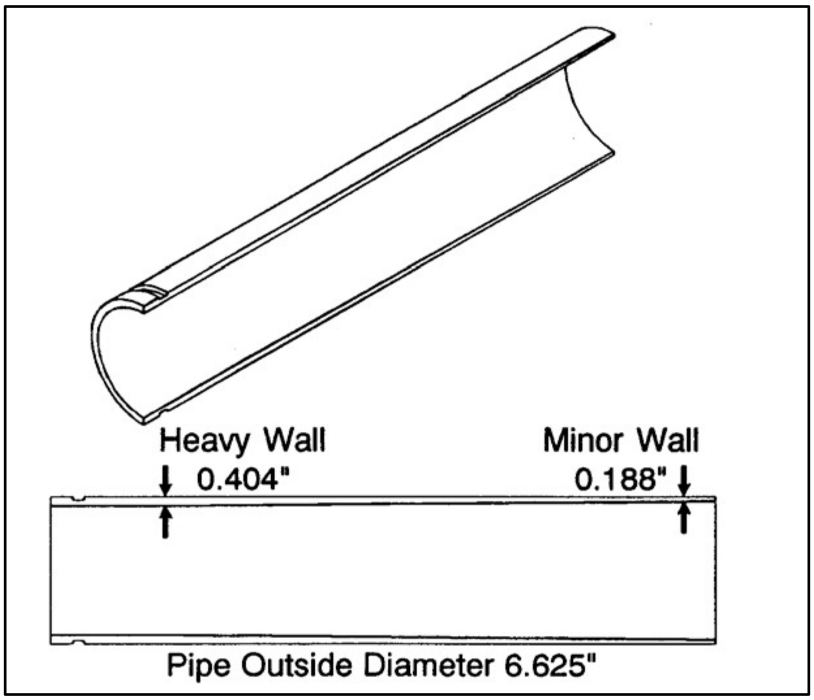


Figure 4-1. Variable wall thickness pipe

- **Road crossings.** When crossing a road, use the existing culvert, if possible. If a slight deviation is required to use existing culverts, use the deviation as an expansion device if possible. There are 80 linear feet (24.384 meters) of nestable culvert with each 5-mile pipeline set for constructing road crossings.

- **Obstacles.** Sometimes it may be necessary to cross rivers, streams, ravines, drainage ditches, and so forth. If possible, lay the pipeline on an existing bridge. If some type of crossing device, suspension bridge, or gap crossing must be constructed, try to pick the best possible location with consideration for the following:
  - As narrow as possible.
  - Banks relatively even.
  - Stable soil conditions to support the gap crossing or suspension bridge.
- **Pump stations.** Pump stations must be located according to the hydraulic profile. The pump station site must be on firm ground and should be as level as possible. Pump, creep, and other manifold misalignment caused by slopes in excess of 5 degrees, can cause severe problems. A typical pump station requires a minimum area of 60 feet (16.288 meters) wide by 140 feet (42.672 meters) long. This does not take into consideration tactical requirements that may require additional area. Adjust the size of the area accordingly, if needed.
- **Pressure reducing station.** These stations are located according to the hydraulic profile and are placed on the downward side of hills to reduce pressure that is increased due to gravity. Pressure reducing stations should be located on firm ground, but a level site is not as critical as with pump stations.
- **Rising-stem gate valve.** Gate valve assemblies are used as isolation block valves in the pipeline. The priority of placement is at critical areas such as water sources, bridges and tunnels, highways, cultural and historic areas, or any area that is a tactical or environmental concern. After these areas have been protected, any remaining gate valves can be spaced along the pipeline as desired, taking terrain features into consideration. Normally, gate valves are spaced at approximately equal distances. The gate valves are skid mounted, with 6-inch (15.24-centimeter) rising-stem, steel valves with IPDS single groove ends. Operate gate valves either fully open or fully closed. There are five gate valves with each 5-mile pipeline set.
- **Check valve.** Check valve assemblies are used on major grade changes in the pipeline to prevent backflow of fuel and over pressurization of the pipeline. Check valves are first located as required by the hydraulic profile to prevent over pressurization and then to prevent backflow. These same check valves are used in the pump stations and are included in the pump station equipment. They are skid mounted, 6-inch (15.24 centimeter) steel valves. A hinged disk allows fuel to flow in one direction only. Fuel flowing in the correct direction pushes the hinged disk up out of the way. Reverse fuel flow pushes the disk back against its seat and closes the opening. An arrow on the valve points to the direction in which the fuel must flow to open the valve. Check valves are self-operating and need little maintenance. There are three check valves per 5-mile pipeline set.
- **Pipeline vent assembly.** The pipeline vent assemblies are made up of a 1-foot (30.48-centimeters) long section of 6-inch (15.24-centimeter) steel pipe, grooved on both ends to receive the IPDS single-groove coupling clamp, with a 3/4-inch (19.05 millimeter) welded olet coupling and a 3/4-inch (19.05 millimeter) ball valve, fittings, and nipples. Vent assemblies are installed as dictated by the hydraulic profile at high points, to vent air from the pipeline during the fill and test operation or after repairs have been made to a section of pipeline. There are five vent assemblies in each 5-mile pipeline set.
- **Pipeline drain assemblies.** Drain valves are installed in low areas of the pipeline to aid in fuel recovery when draining the line for repairs or pipeline recovery. Install drain valves using the hydraulic profile and critical areas as a priority. Close the 2-inch (5.08-centimeter) ball valve during installation and at all other times unless it is in use. Three pipeline drain assemblies are in each set and are similar in appearance to vent assemblies.
- **Terminals.** Terminals must be located on reasonably flat terrain. There should be a usable road network to handle bulk-fuel tanker-truck traffic. A TPT consisting of three fuel units could occupy up to 150 acres. Consider the tactical requirements and any additional storage requirements when determining a location for bulk-fuel storage. The amount of concealment depends on the security requirements in the area.
  - There are eighteen 5,000 barrel (bbl) collapsible, fabric tanks in a TPT. Each tank will require a berm, graded to specifications, with inside dimensions of about 75 feet by 75 feet (22.86 meters by 22.86 meters).

- A contaminated fuel module, consisting of two 50,000-gallon collapsible tanks is also a part of each TPT. Each 50,000-gallon tank requires a berm with inside dimensions of 75 feet by 30 feet (22.86 meters by 9.144 meters).

SECTION II – PIPELINE CONSTRUCTION

4-7. This section provides an overview of the construction of IPDS.

FIVE-MILE PIPELINE SETS

4-8. The 5-mile pipeline set contains all of the components required to install 5 miles (8.05 kilometers) of operational pipeline under normal conditions. Specialized equipment such as anchor drive-heads and suspension bridges are contained in separate sets and are requisitioned separately. The 5-mile pipeline set and these specialized sets are discussed in this chapter.

ALUMINUM PIPE SECTIONS

4-9. There are 1,404 sections of 19-foot (5.8-meter) long pipe packaged in nine each 20-foot (6.096 meters) ISO containers. Each container holds 156 pipe sections. These pipe sections are used in the main run of the pipeline and have a maximum allowable operating pressure of 740 pounds per square inch. These pipe sections have a variable wall thickness to save weight and cannot be cut to different lengths due to the varying wall thickness (see figure 4-1, page 4-3). However, if the end groove is damaged, each end may be cut (not to exceed 6 inches [15.24 centimeters]) and regrooved once. If an end is cut, stencil the pipe section (for example, SIX INCHES CUT-OFF) with an arrow indicating the end that has been cut. For planning purposes, use a pipe diameter of 6.249 inches (158.7246 millimeters) for hydraulic calculations.

INLAND PETROLEUM DISTRIBUTION SYSTEM SINGLE GROOVE CONNECTION

4-10. The special groove design is wider than the standard commercial groove used with most pipelines around the world, and is not interchangeable with the standard groove. The IPDS single groove connections are found on the high-pressure pipeline and pump stations.

SNAP-JOINT COUPLING CLAMPS

4-11. The clamp has an integral gasket that makes pipe connections relatively easy. The coupling clamps are packed in sets of 25. There are one- and two-set boxes in the 5-mile pipeline set. Packed in the box with each set are a hammer, extra gasket, extra retaining pin, drift pin, and two assembly tools. The gaskets require lubrication for assembly.

RISING-STEM GATE VALVE

4-12. Gate valve assemblies are used as isolation block valves in the pipeline. The priority of placement is at critical areas such as water sources, bridges and tunnels, cultural and historic areas, or any area that is a tactical or an environmental concern. After these areas have been protected, any remaining gate valves can be spaced along the pipeline as desired, normally at about 1-mile (1.6 kilometers) intervals. The gate valves are skid mounted, 6-inch (15.24-centimeter) rising-stem, steel valves with IPDS single groove ends. Operate gate valves either fully open or fully closed. There are five gate valves with each 5-mile pipeline set.

CHECK VALVE

4-13. Use check valve assemblies on major grade changes in the pipeline to prevent backflow of fuel and over pressurization of the pipeline. Check valves are located as required by the hydraulic profile. These same check valves are used in the pump stations and are included in the pump station equipment. They are skid mounted, 6-inch (15.24-centimeter) steel valves. A hinged disk allows fuel to flow in one direction only. Fuel flowing in the correct direction pushes the hinged disk up and out of the way. Reverse fuel flow pushes the disk back against its seat and closes the opening. An arrow on the valve points to the direction in which the fuel must flow to open the valve. Check valves are self-operating and need little maintenance. There are three check valves per 5-mile pipeline set.

PIPELINE VENT ASSEMBLY

4-14. The pipeline vent assemblies are made up of a 1-foot (30.48-centimeters) long section of 6-inch (15.24-centimeter) steel pipe, grooved on both ends to receive the IPDS single-groove coupling clamp, with a 3/4-inch (19.05 millimeter) welded olet coupling, and a 3/4-inch (19.05 millimeter) ball valve, fittings, and nipples. Install vent assemblies as dictated by the hydraulic profile at high points to vent air from the pipeline during the fill and test operation, or after repairs have been made to a section of pipeline. There are five vent assemblies in each 5-mile pipeline set.

PIPELINE DRAIN ASSEMBLIES

4-15. Three pipeline drain assemblies are in each set and are similar in appearance to vent assemblies. Drain valves are installed in low areas of the pipeline to aid in fuel recovery when draining the line for repairs or pipeline recovery. Ensure that the 2-inch (5.08-centimeter) ball valve is closed during installation and at all other times unless it is in use.

ELBOWS

4-16. Elbows provide flexibility in laying the pipe, allowing turns, and controlling the expansion and contraction of the pipeline. There are two sizes of 90-degree elbows in the IPDS system. The long radius (3d) elbow is only in the 5-mile pipeline set and is used in the construction of the pipeline. The short radius (3r) elbow is only found in the pump station, and must be used to construct the pump station between the receiver and the launcher. The short radius (3r) elbows must not be used on the pipeline. They will not normally allow passage of scrapers or pigs. The elbows contained in the 5-mile pipeline set are shown in table 4-1, page 4-3.

PIPELINE SUPPORT EQUIPMENT

4-17. A PSE set is available to accompany deployed pipeline segments if required. The PSE is packed in five ISO containers and includes—

- **Container 1 of 5.** A hoseline pump and an additional allotment of spare parts (Interim Support Items List) to support the pipeline equipment are in the first container. Use the pump when the pipe is connected to a source that is not capable of providing the required pressure or flow to the 800 gallons per minute (3028.32 liters per minute) mainline pumps.
- **Container 2 of 5.** A hose line pump (600 gallons per minute [2,300 liters per minute]), two cutting, grooving, and beveling machines and an extra allotment of elbows are in the second container. Use the hose line pump for the same purpose as stated above.
- **Container 3 of 5.** The third container has additional pipe pup joints, gate valves, check valves, and other components to be used as required.
- **Container 4 of 5.** The fourth container has two anchor drive heads, two pioneer tool kits, the deadweight tester used to calibrate gauges, and other tools required for assembly and operation of the pipeline. In addition, it contains the rollers for the critical gap crossings and an extra coupling set.
- **Container 5 of 5.** The last container has the critical gap set, extra sandbags, and single-groove coupling gaskets.

PIPELINE INSTALLATION

4-18. The aluminum pipe used in the IPDS is highly reactive to changes in temperature. Changes in temperature will cause the pipe to expand (warmer) and to contract (cooler). In some geographical locations where the pipeline may be used, the seasonal temperature can vary by as much, or more than, 100 degrees Fahrenheit (37.7778 Celsius). This temperature change can cause expansion and contraction of up to 20 inches (50.8 centimeters) for every 50 sections of pipe.

4-19. It is important to consider the coldest temperature of winter and the hottest temperature of summer when constructing the pipeline to prevent expansion and contraction problems. Expansion can cause the pipeline to fail at a coupling if the side pressure deflects the joint greater than 4 degrees. Contraction can cause the pipeline to pull against obstacles and damage the pipe. Repeated expansion and contraction can cause the pipeline to move off the prepared trace. Control expansion and contraction by directing the movement into expansion/contraction control devices (see figure 4-2).

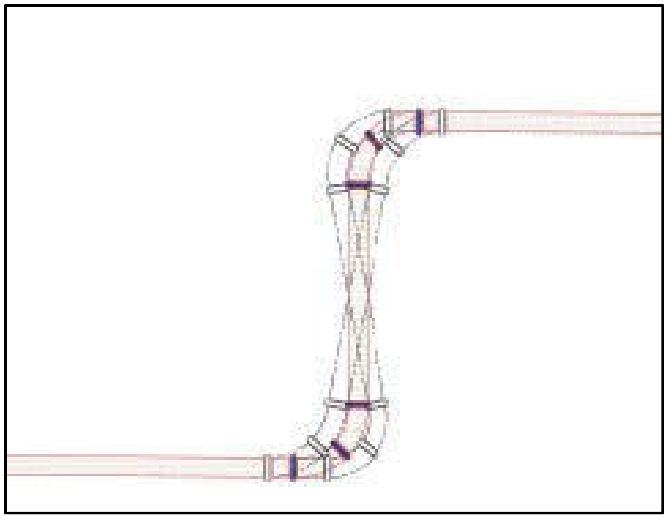


Figure 4-2. Expansion and contraction movement

4-20. To direct and control the expansion and contraction of the pipeline the following guidelines and principles should be considered:

- The pipeline should be installed as straight and level as possible. Use sandbags, or other support devices, as needed near couplings and anchors to keep the pipeline straight (see figure 4-3).

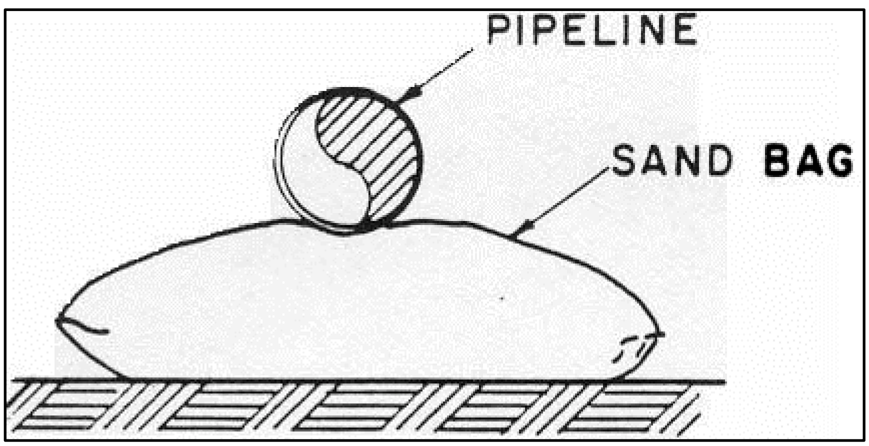


Figure 4-3. Sand bag support

- Coupling deflection should be limited to a maximum of 2 degrees during installation (see figure 4-4, page 4-8). The maximum during operation is 4 degrees deflection under any circumstances.

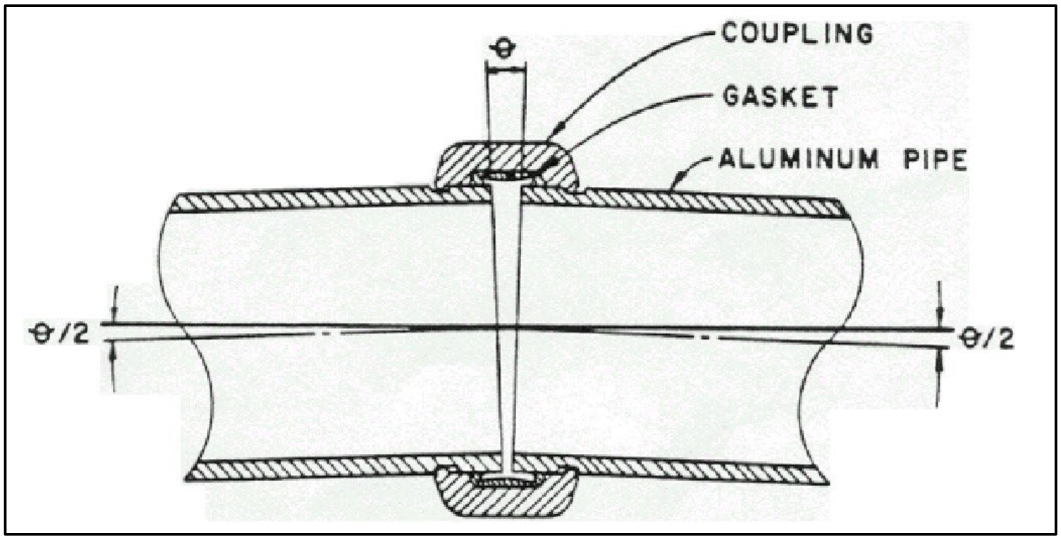


Figure 4-4. Pipe deflection

- A gap, approximately 0.2 inches (5.08 millimeters) to 0.7 inches (17.78 millimeters) (see figure 4-5 and figure 4-6), should be maintained between sections of pipe during construction to minimize expansion of the pipeline during pressurization.

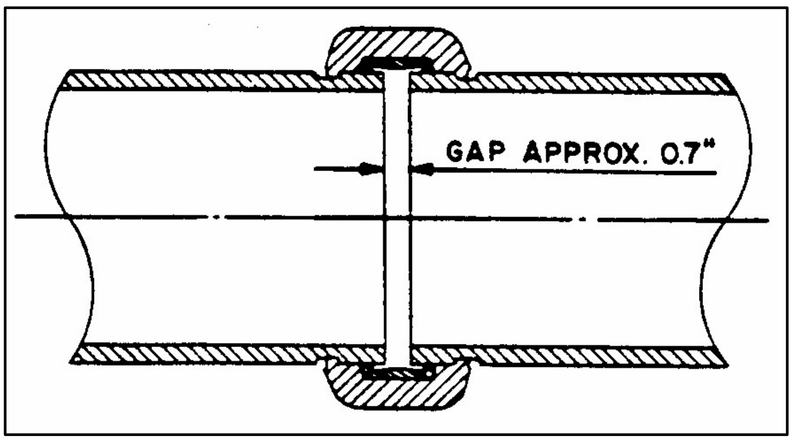


Figure 4-5. 0.7-inch pipe coupling gap

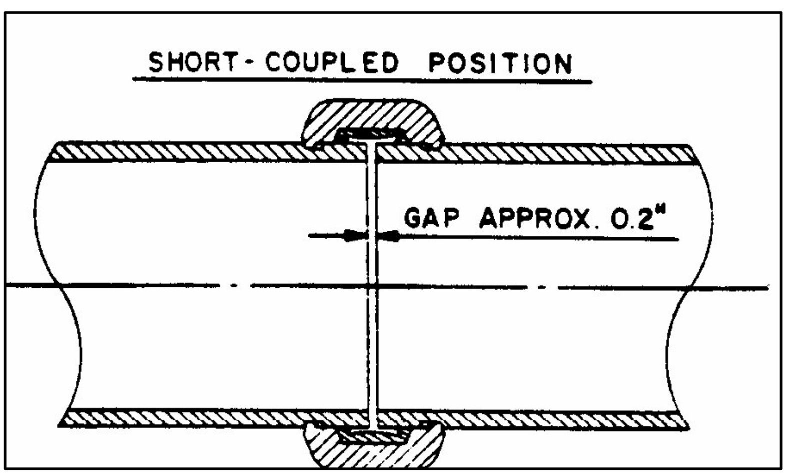
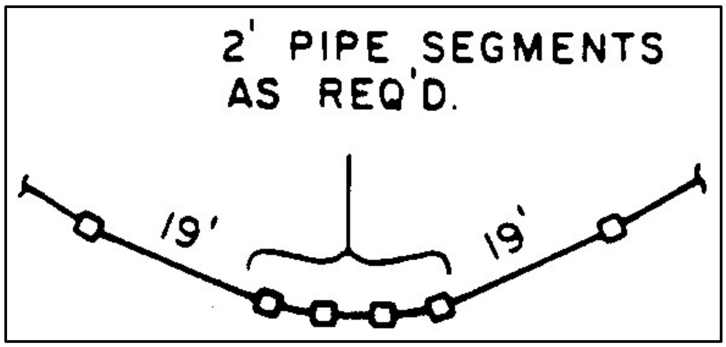


Figure 4-6. 0.2-inch short-coupled position pipe coupling gap

WARNING

Failure to install pipe sections with the proper gap (~0.7 inch [~17.78 millimeter]) can result in couplings exceeding 4 degrees of deflection during operation. This may result in leaks, injury to personnel, and damage to equipment.

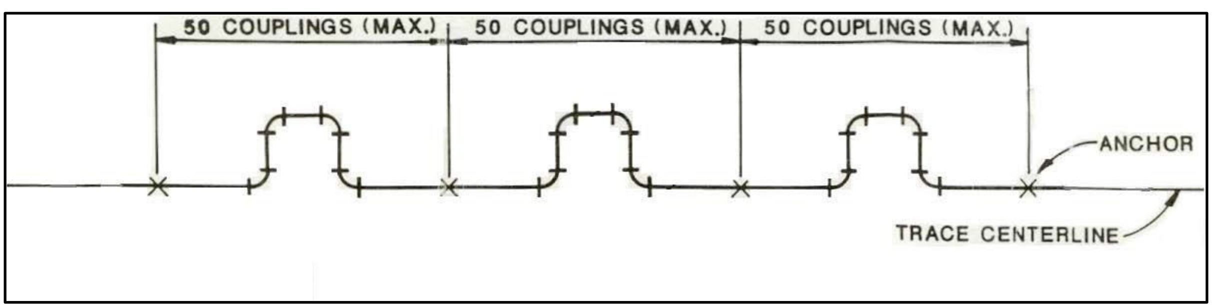
- Any desired turns or changes in direction, horizontal or vertical, should be made using elbows or short sections of pipe as required (see figure 4-7).



Legend:
Req'd required

Figure 4-7. Change of direction

- Use anchors to direct expansion and contraction of the pipeline into expansion/contraction devices. Install anchors between the expansion/contraction devices. The climate determines the distance between expansion devices. The greater the change in temperature, from the hottest summer temperature to the coldest winter temperature, the closer expansion devices will have to be placed. Normally, the distance between expansion devices will vary from 50 to 100 pipeline sections. In the example shown in figure 4-8, the climate dictated that expansion devices be no more than 50 pipeline sections apart.



Legend:
max maximum

Figure 4-8. Anchor placement for expansion control

WARNING

Exceeding the design distance between expansion devices may result in equipment damage and injury to personnel.

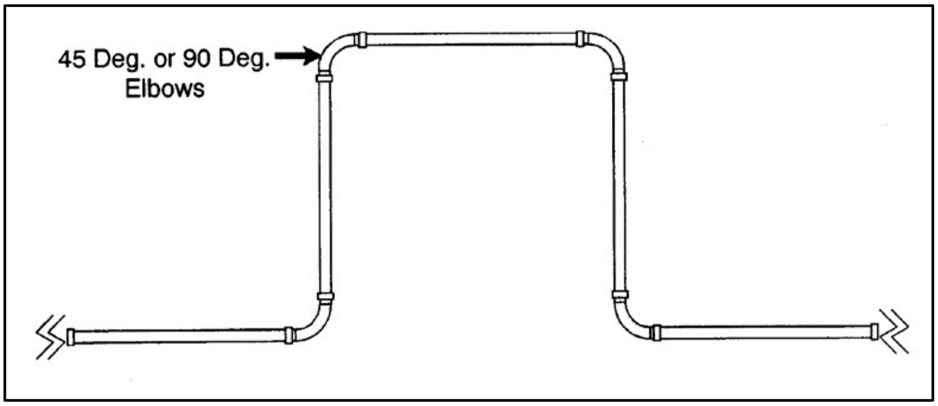
Depending on the situation, there may be short sections of pipe without an expansion device. An example might be if there is a road crossing (culvert) no more than 8 pipeline sections from a pump station. However, at no time will the distance between two anchors exceed 25 pipeline sections without an expansion device between them.

- Pressure reducing stations may have to be installed when the pipeline is laid on a long, down slope. The gravity pull on the product can cause pressure to build up during a down slope run that could over pressurize the pipeline. Remember, the pipeline cannot exceed over 740 pounds per square inch. A pressure reducing station consists of a receiver assembly, a pressure regulating valve, and a launcher assembly. Adjust the pressure-regulating valve to reduce pressure to a safe level for the down slope of the pipeline.
- Under static conditions (pipeline shut down under pressure) in hot climates, the product in the pipeline will expand as it is heated. This product expansion can build up pressure to unacceptable limits within and between pump stations. Thermal relief valves mounted on the launcher and receiver at pump stations and pressure reducing stations are set to open at approximately 900 pounds per square inch and can be adjusted downward. Excess pressure is allowed to escape from the pipeline into the launcher and receiver drains. The drain valves on the launcher and receiver must have a hose attached that allows the product to drain into a suitable container.

EXPANSION DEVICES AND ANCHORS

4-21. Expansion devices are constructed of standard IPDS pipe and elbows and are designed to "absorb" the movement of the pipeline caused by expansion and contraction. There are two types of expansion devices used with the IPDS—the U-shaped loop and the Z-shaped offset. Both devices provide required pipeline flexibility and are considered equal from that standpoint. The Z-shaped offset is normally used when the terrain dictates a shift in the trace. A typical Z-shaped offset with one 19-foot (5.8-meter) pipeline section will require a 30-foot (9.144-meters) clearance in the trace. If the trace width is narrow, the U-loop should be installed.

- **U-shaped loop.** The U-loops (see figure 4-9) will normally be constructed with one pipeline length (19 feet [5.8 meters]) on a side and may use 45- or 90-degree elbows or a combination thereof. As elbows are limited, use 90-degree elbows with the U-loop whenever possible. The deflection at the loop can be as much as 20 inches (50.8 centimeters) from the cold to the hot position.



Legend:
deg degree

Figure 4-9. U-shaped loop

- **Z-shaped offset.** The Z-shaped offset shown in figure 4-10, will normally be offset one 19-foot (5.8-meter) pipe length using two 45-degree elbows at each corner. If it is necessary to construct the Z-shaped offset using 90-degree elbows, a minimum of two pipe sections is required in the offset.

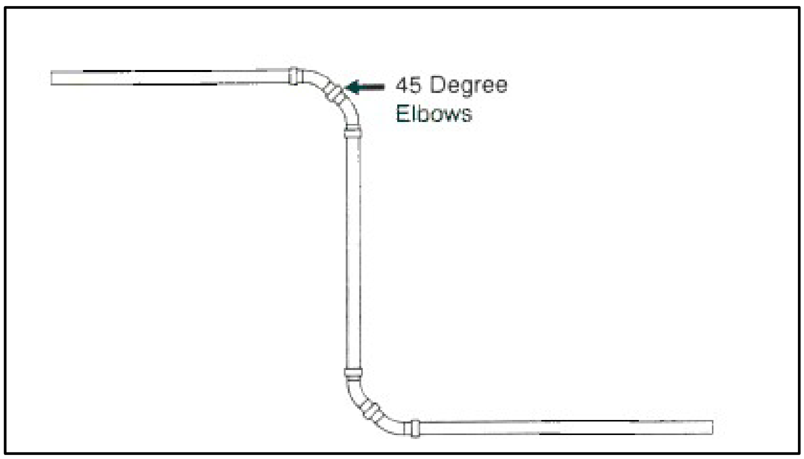


Figure 4-10. Z-shaped offset

- **Coupling positions.** Install expansion devices in the open position. During the fill and test operation, the pressure of the pipeline will force each coupled joint along the pipeline open to its maximum distance. This will force the pipeline to expand and should move the expansion device to the normal position. If the device is installed in a normal position, the movement will place the device in a closed position, greatly decreasing its ability to absorb pipeline expansion and may result in the pipeline breaking.

WARNING

At no time should the deflection of the pipe/elbow joints in an expansion device exceed 4-degrees. Note that when constructing Z-shaped offsets there are three joints at each turn when using 45-degree elbows. This will allow for a total of 12-degree deflection through a 90-degree turn. There are two joints when using 90-dgree elbows and the total deflection for a 90-degree turn would be 8-degrees. If the deflection through a turn exceeds the amount allowed, repairs must be made to prevent personal injury or damage to the pipeline.

Note. If the expansion/contracting device is operating correctly, the expansion device should be in the open position (see figure 4-11 and figure 4-12) when it is cool, and move towards the closed position as the temperature gets warmer.

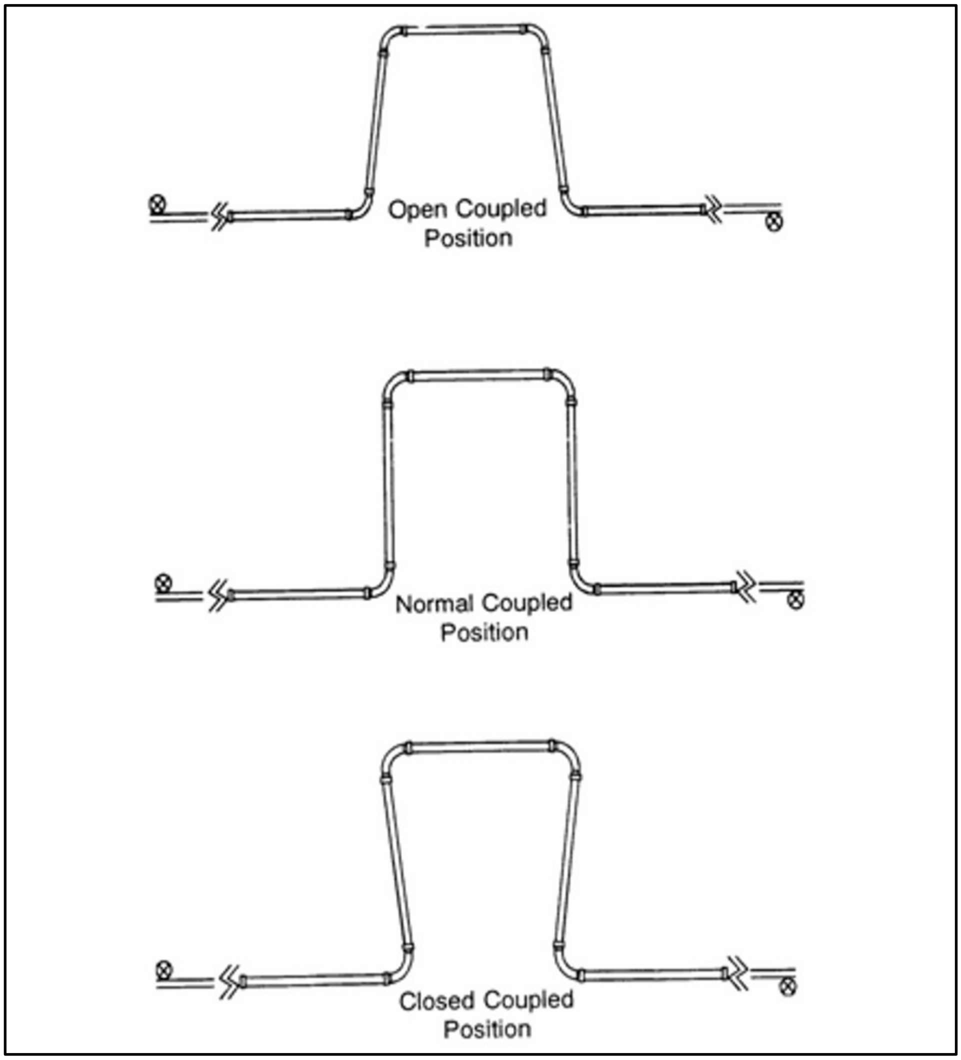


Figure 4-11. U-loop coupling positions

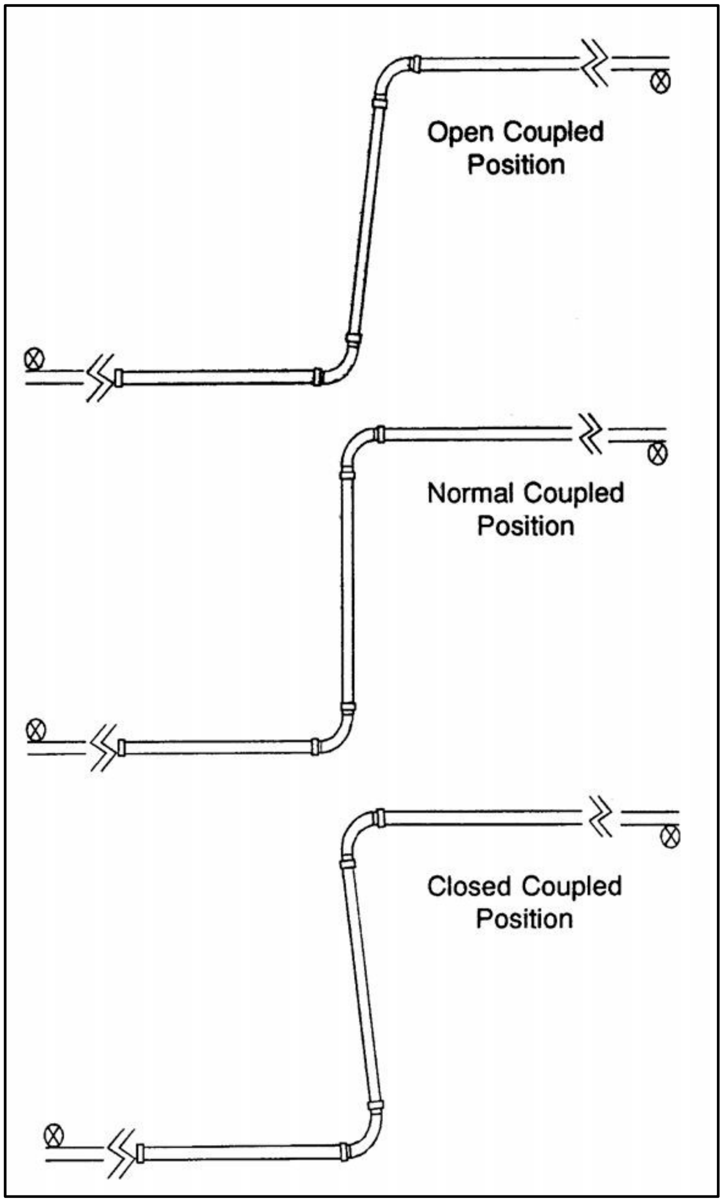
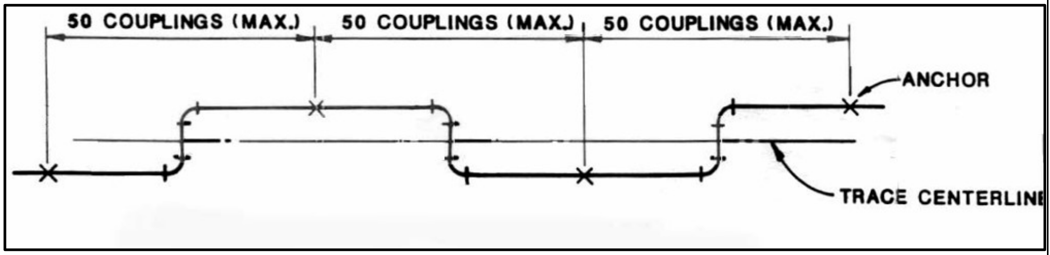


Figure 4-12. Z-device coupling positions

4-22. To control this expected expansion/contraction movement, the pipeline must be equipped with anchors and expansion devices (see figure 4-13, page 4-14). The anchor secures the pipeline to the ground and directs any expansion towards the expansion device. The flex in the couplings at the elbows allows these devices to move without breaking the integrity of the pipeline. In geographical areas where the seasonal temperature change can be anywhere from 50 to 100 degrees Fahrenheit (10 degrees to 37.78 degrees Celsius), there must be no more than 50 sections of pipe between expansion/contraction devices, with an anchor installed near the mid-point between them. In temperate climate areas with an expected temperature change of less than 50 degrees (10 degrees Celsius), the distance between expansion/contraction devices can be extended up to 100 sections of pipe. Remember, there must be an anchor between the devices.



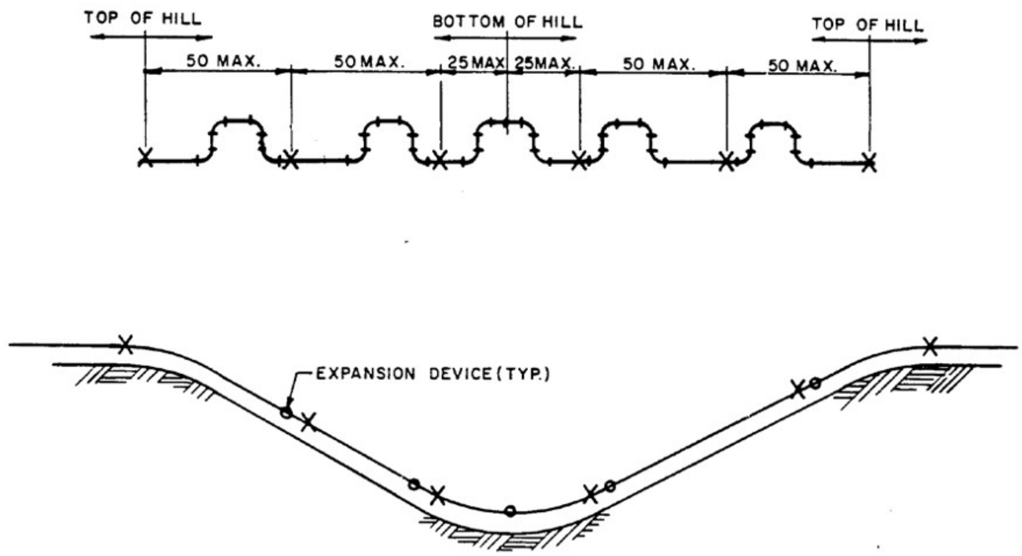
Legend:
max maximum

Figure 4-13. Expansion devices with anchors

4-23. The pipeline must be laid in an anchor–expansion device–anchor sequence with the anchor just outside each pump station starting the sequence. Place expansion loops in hilly terrain at the bottom of the hill with the anchors placed at the tops of the hills. On long, steep slopes there should be no more than 15 sections of pipe hanging downhill from an anchor.

4-24. Mandatory anchor points are located—

- Downstream and upstream of expansion loops (at the midpoint between loops) to direct expansion into the loops.
- On the first or second section of pipe outside pump stations and pressure reducing stations at the launcher and receiver assemblies.
- On the first section of pipe downstream of gate and/or check valves in the pipeline.
- On the first or second section of pipe on both sides of the elbows that change the direction of the pipeline, if the movement of the pipeline needs to be restricted. This includes both horizontal and vertical changes of direction. If installing an anchor, an expansion device must be installed.
- In hilly terrain there are specific steps taken to ensure that expansion devices operate correctly.
  - Use the top and bottom of hills as control points when selecting anchor locations.
  - Install anchors (see figure 4-14) at the top of hills with a maximum of 50 pipe sections to the next anchor. On steeply sloped hills, the distance may have to be decreased to as little as 17 pipeline sections between anchors. Place these intermediate anchors just below (downhill side) the expansion device. (For example: install anchor, then 40 pipeline sections expansion device, then one pipeline section, then install anchor, 40 pipeline sections, then expansion device.) In very steep terrain, reduce anchor spacing reduced.
  - Install an expansion device at the bottom of hills.



Legend:
max maximum
typ type

Figure 4-14. Expansion device on a hill

4-25. Change of direction elbows may be installed in conjunction with expansion devices without hampering the flexibility of the pipeline (see figure 4–15, page 4-16). The change of direction elbows will not be anchored.

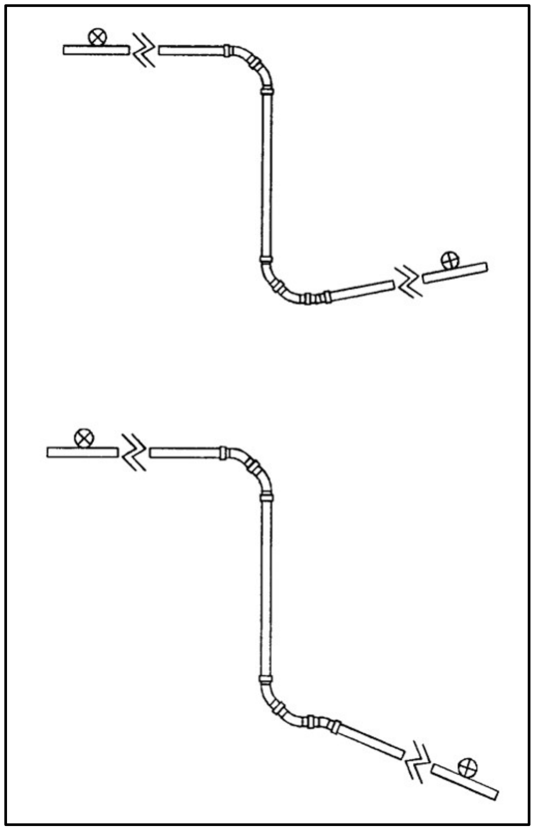


Figure 4-15. Expansion device with direction change elbows

HYDRAULIC DRIVE HEAD INSTALLATION

4-26. The hydraulic drive heads are in the PSE set. Requisition the PSE separately from the 5-mile pipeline set. Before installing anchors, prepare the hydraulic drive head. The drive head mounting is compatible with engineer assets like the tractor, wheeled industrial backhoe loader, skid steer, or high-mobility engineer excavator.

ANCHOR INSTALLATION

4-27. There are 48 IPDS anchors (see figure 4-16 and figure 4-17) and 2-piece clamps in each 5-mile pipeline set. The anchor is a screw-type anchor used in normal soil or soil with loose rocks. It is a 5-foot (1.524 meters) long, 1 1/2-inch square (38.2 millimeters) forged steel shaft, with a 6-inch (15.24-centimeter) diameter tapered helix welded on the bottom to provide self-driving insertion upon the application of right hand rotation. Fastened the clamp securely to control pipe movement. The clamp consists of an upper and a lower half with a neoprene strap to prevent damage to the pipe. Place anchors no closer than 12 inches (30.48 centimeters) from the coupling and no further than 18 inches (45.72 centimeters) from the coupling. This allows for pipe movement if the clamp slips and keeps the clamp on the thick-walled portion of the variable wall thickness pipe.

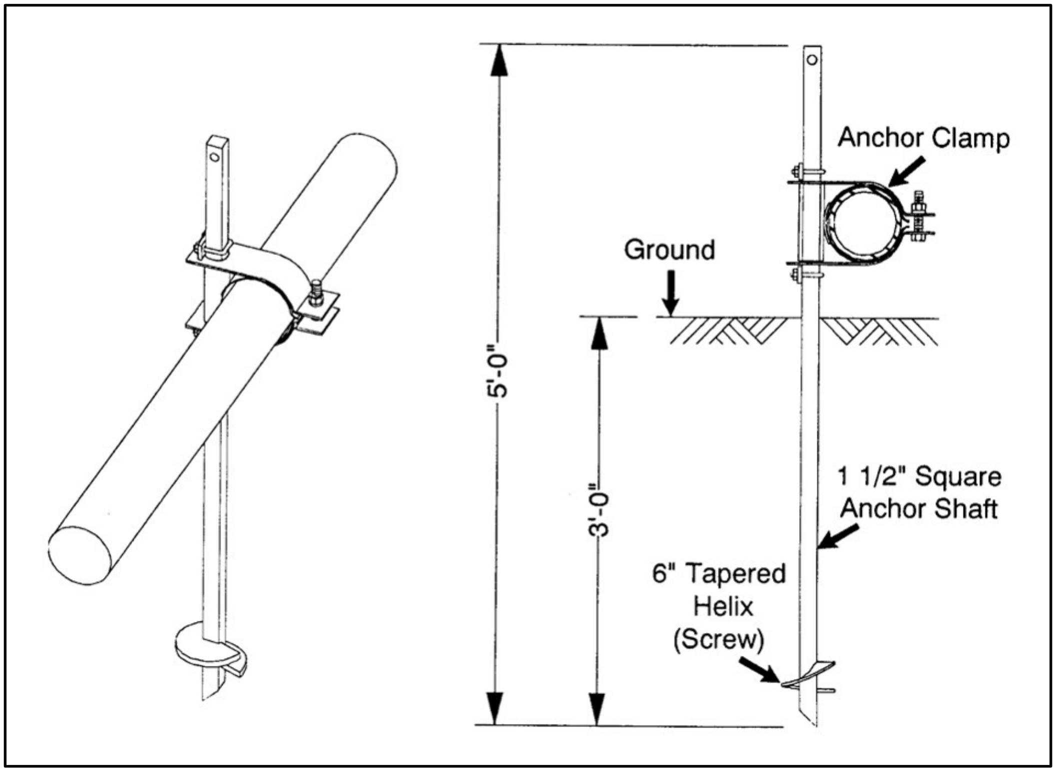
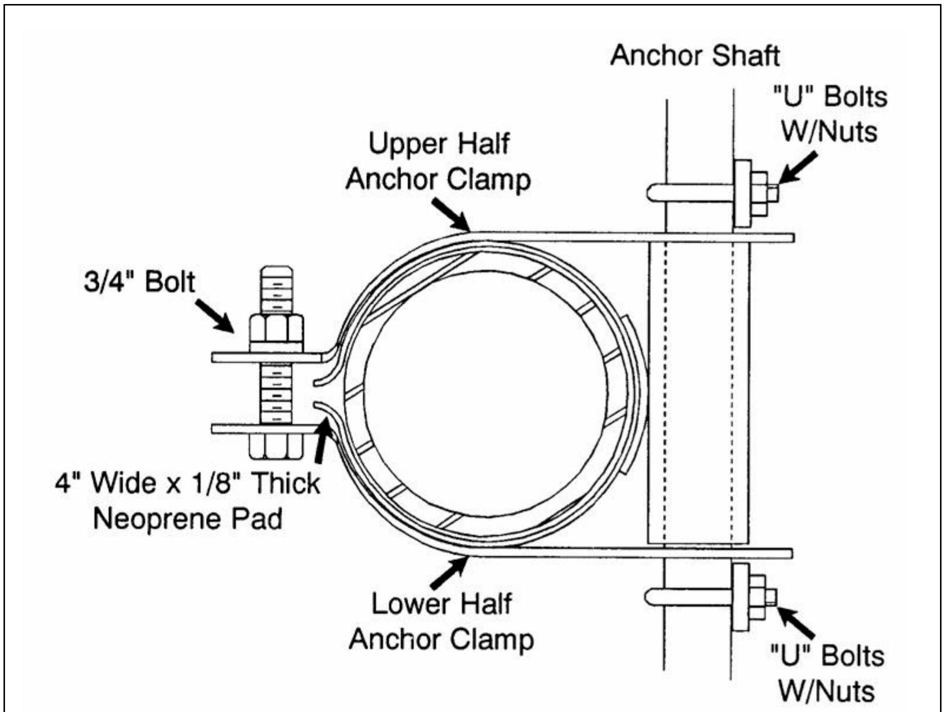


Figure 4-16. Anchors



Legend:
w/ with

Figure 4-17. Anchor clamp

4-28. Use the following steps for anchor installation:

- **Step 1.** Identify the anchor installation location. Install the anchor 12 inches (30.48 centimeters) to 18 inches (45.72 centimeters) from the coupling. Move the pipeline as required, allowing adequate space to install the anchor.
- **Step 2.** Lock the vehicle brakes and set up outriggers.
- **Step 3.** Attach an anchor to the drive head anchor adapter.
- **Step 4.** With the anchor in a vertical position, supply hydraulic power to the drive head so the anchor is rotating in a right-hand (clockwise) direction. Install the anchor by exerting steady downward pressure that ensures minimum disturbance of the soil and maximum holding power. Avoid excessive side loading on the drive head to prevent output shaft damage. After the helix advances a short distance into the soil, adjust the anchor entry angle so it is installed vertically. The minimum installed depth of the anchor is 3 feet (.91 meters). However, the top of the anchor shaft must be at least 18 inches (45.72 centimeters) aboveground level. In rocky soils, it may be necessary to modify the anchor helix diameter. Using an acetylene torch, reduce the diameter of the helix as required to allow the anchor to be augured into rocky soil.
- **Step 5.** Place the lower anchor clamp strap over the anchor shaft.
- **Step 6.** Lift the pipeline and wrap neoprene around it at the installation point of the anchor clamp.
- **Step 7.** Orient the lower half of the anchor clamp so that it is underneath the pipeline.
- **Step 8.** Place the pipeline onto the clamp.
- **Step 9.** Place the upper anchor clamp strap and tube over the anchor shaft. Match up the upper- and lower-strap bolt holes.
- **Step 10.** Place the U-bolts around the anchor shaft. Place the clip and nut over the ends of the U-Bolt. Tighten as needed.
- **Step 11.** Push the bolt up through the bolt holes of the upper and lower straps. Finally, place a lock washer and nut on the bolt. Tighten as much as possible to prevent pipeline movement.
- **Step 12.** After the pipeline anchor installation, check the tightness of the anchor by trying to move the pipeline and tighten as needed.

OBSTACLE CROSSINGS

4-29. IPDS is a tactical pipeline designed to be rapidly deployed and installed aboveground. There will not always be a nice flat, smooth surface for the pipeline, so expect to cross obstacles. It may be necessary to construct a pipeline across a road, railroad tracks, gaps, and small streams. Culverts and bridges may not always be available where needed, so be prepared to construct them.

PIPE SUPPORTS AND GUIDES

4-30. Install pipe supports and guides (see figure 4-18) to maintain joint alignment. Pipe supports and guides may be constructed of pickets, sandbags, or other available materials. If sandbags are used, allowance should be made for the pipe to settle, as the bags will compact when the line is filled with product. Sandbags should always be stacked pyramidal and never stacked one upon another. Pickets are used to keep the pipeline from slipping downhill when laid along a slope. There are 225 pickets and 2,000 sandbags in each 5-mile pipeline set.

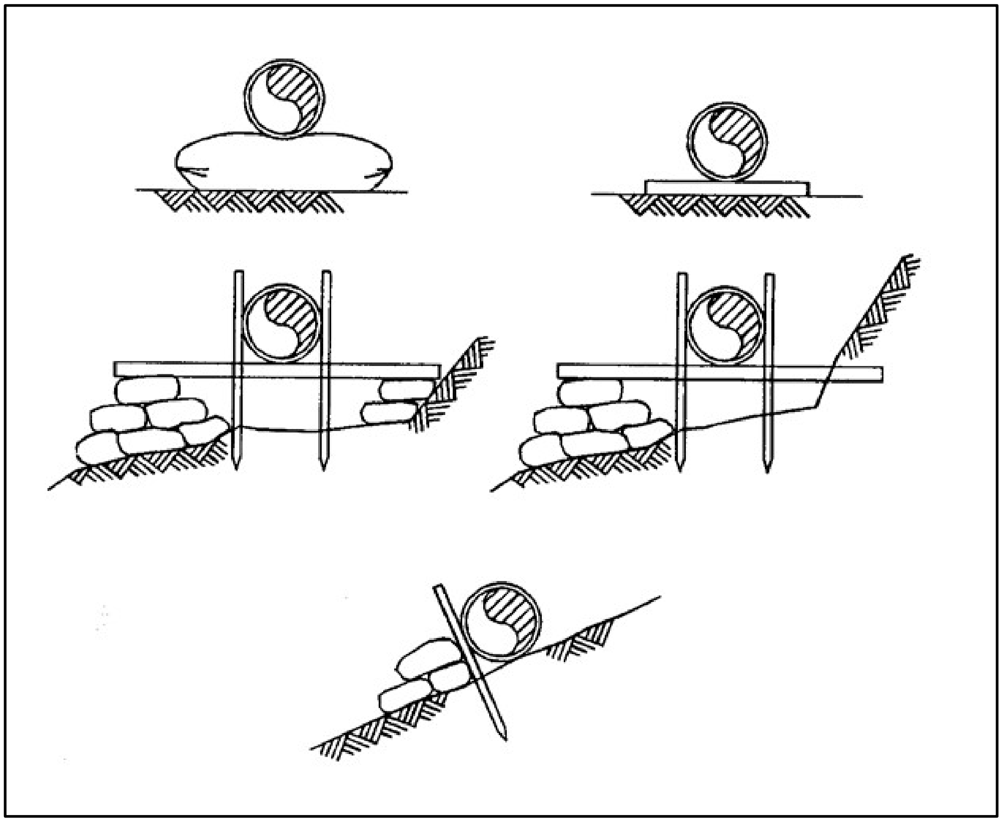


Figure 4-18. Pipe support guides

ROAD CROSSINGS

4-31. Use existing culverts whenever possible. Make sure the cross sectional area of the culvert is not significantly reduced, as this may prevent or restrict the runoff of water. Sandbags, wooden blocks, or other material should be used to support the pipe in the culvert to prevent damage due to expansion movement, if required.

4-32. Install culverts when existing culverts are not available. Eighty linear feet (24.384-meters) (82-foot halves [60.96 centimeter]) of 24-inch (60.96 centimeter) diameter, nestable, corrugated steel culvert (see figure 4-19, page 4-20) is included in each 5-mile pipeline set. To install the culvert, dig a trench 1 1/2 times the diameter of the culvert. Thoroughly pack down the backfill and support the pipeline running through the culvert. Anchor on both sides of the culvert on the first complete section of pipe. Twenty four-inch (60.96 centimeter) by 19-foot (by 5.8-meter) plastic culvert will replace the steel culverts on future buys of IPDS.

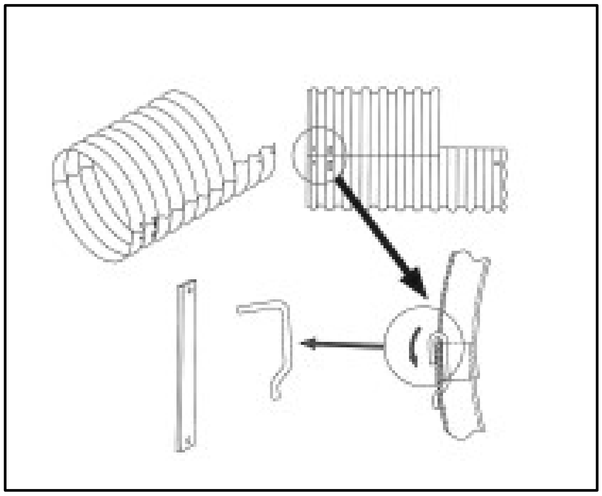


Figure 4-19. Nestable culvert

CRITICAL GAP CROSSING KIT

4-33. To aid in crossing gaps along the pipeline route in difficult terrain, a special critical gap crossing kit has been developed and added to the IPDS operational stocks. There are two types of critical gap crossings. The newer type (see figure 4-20) is precut and welded and is suitable for use when the pipe must be raised up to 12 feet (3.65 meters) aboveground level. The older type (see figure 4-21) consists of a 19-foot (5.8-meter) section of 4-inch (10.16-centimeter) steel pipe and must be cut and welded on site. Both types have a crossbar and roller assembly to support the pipe.

Figure 4-20. Critical gap kit (new)

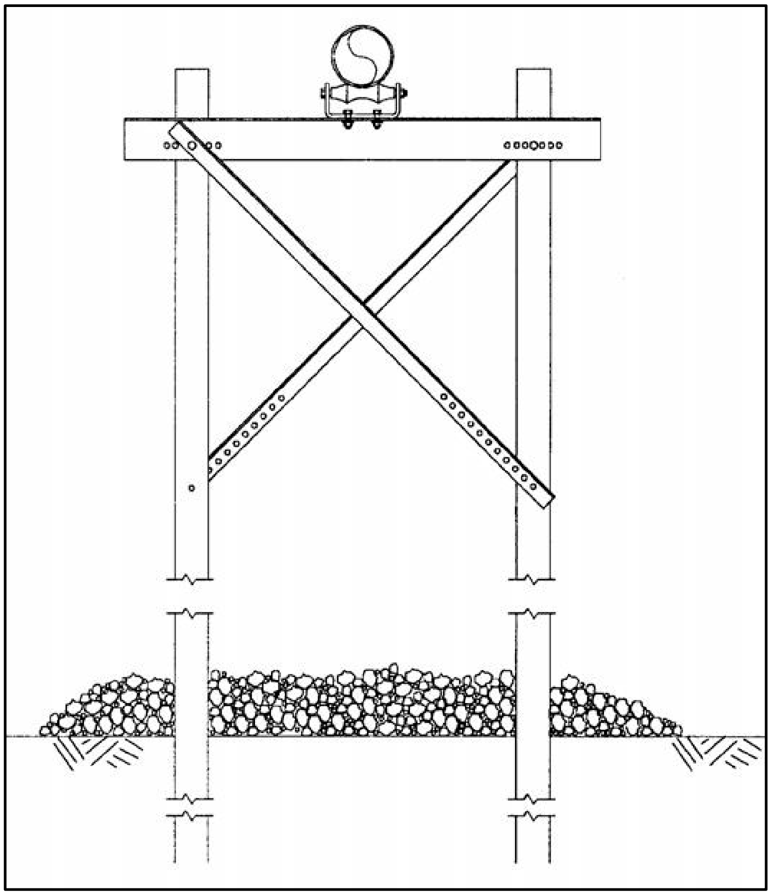


Figure 4-21. Critical gap kit (old)

4-34. The new type of critical gap crossings is easily assembled at the site. To raise the pipe up to 12 feet (3.65 meters), two 72-inch (1.83-meter) sections may be stacked and secured together. The following instructions are for assembling the old type of critical gap crossings.

- The kit consists of 4-inch (10.16-centimeter) steel pipe, cross beams, braces, and roller assemblies. The steel pipe can be cut and welded to any length required. A kit has enough material to cross up to 250 feet (76.2 meters) of gap.
- When installing gap-crossing material, ensure that the bottom of the pipeline is at least 2 feet (60.96-centimeters) above the high-water mark. This will allow debris to pass under the pipeline without catching and stressing the pipe.
- Layout procedures (see figure 4-22, page 4-22).
  - Locate and mark the gap requirement.
  - Mark and stake both sides of the gap on line with the actual pipe routing.
  - At one end of the gap, mark and stake a point 2 feet (60.96-centimeters) to the side of the actual pipe routing. Mark and stake a point 2 feet (60.96-centimeters) on the other side of the actual pipe routing.
  - Do the same on the other side of the gap. Connect the stakes on each side of the gap, on the same side of the pipe route, with a string line so that the string is parallel to the pipe routing.

Note. This string line marks the line that the critical gap posts will be installed on each side of the pipe routing.

  - Level the string line with the pipe routing.

- Locate the first set of posts offset from the center of the gap by about 8 feet (2.43 meters) and mark with a stake.
- Locate the second set of posts on the other side of the center point of the obstacle 16 feet (4.87 meters) to 17 feet (5.18 meters) from the first set of posts and mark with a stake.
- Going in each direction from the gap, mark each successive set of posts with a stake in 19-foot (5.8-meter) intervals.
- Locate the second post by offsetting a stake 48 inches (121.92 centimeters) on the opposite side of pipeline path.

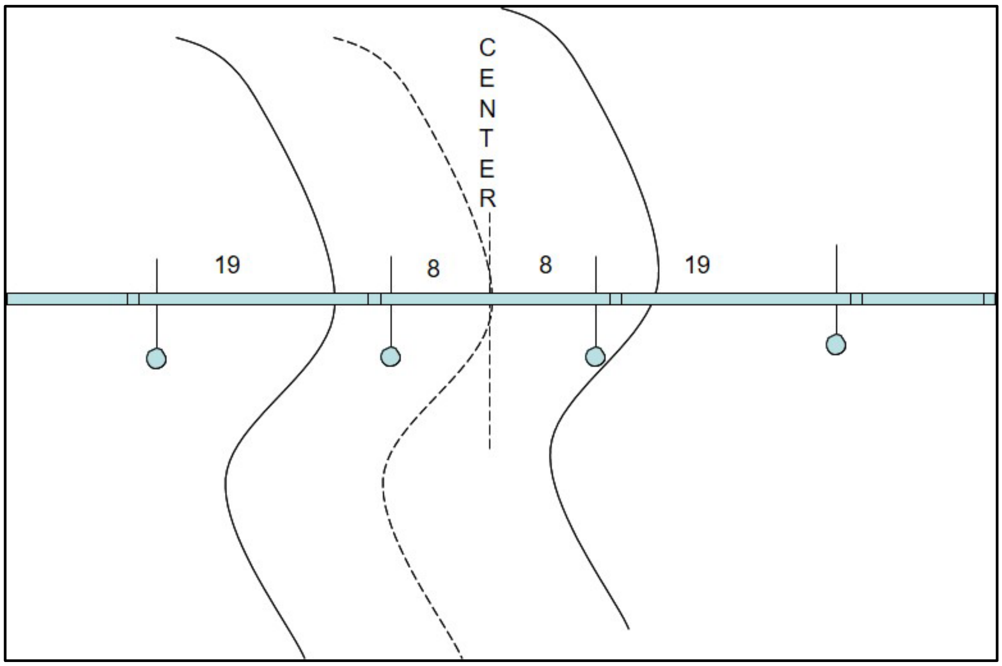


Figure 4-22. Critical gap layout

- Construction sequence and practices:
  - Cut 8 foot (2.43 meter) lengths, or shorter, of 4-inch (10.16-centimeter) pipe for posts.
  - Drive posts as far into the ground as possible.
  - Add sections if required to have posts extend 10 inches (25.4 centimeters) above the string line.
  - Weld upper crosspiece of 3.5 (8.89 centimeter) x 5-inch (12.7-centimeter) angle in place.

Note. Use the string line and a level to align these crosspieces.

- Add cross bracing, if required.
- Complete all post assemblies.
- Restring the string line, keeping the string line about 1 inch (25.4-millimeter) above the crosspieces and offset by 6 inches (15.24 centimeters) from the desired pipeline path.
- Weld the roller assemblies into place using the string line as a reference.
- String and couple the pipe starting in the center and working out to each side.

Note. This may require a pup joint on the upstream side.

Suspension Bridge

4-35. The pipeline suspension bridge (see figure 4-23) is prefabricated and packed in kits in 100-foot (30.48 meter), 200-foot (60.96-meter), and 400-foot (121.92-meter) sizes. These must be requisitioned separately as needed. The bridges are provided to cross rivers, chasms, or ravines that are identified in potential areas of operation. The bridges consist of the following major components: towers, guy wires, deadman anchors, main cable suspenders and cross bearers, staging boards, tension cables, wind guys, and hand ropes. To install the bridge, follow the detailed directions that are packed with the equipment.

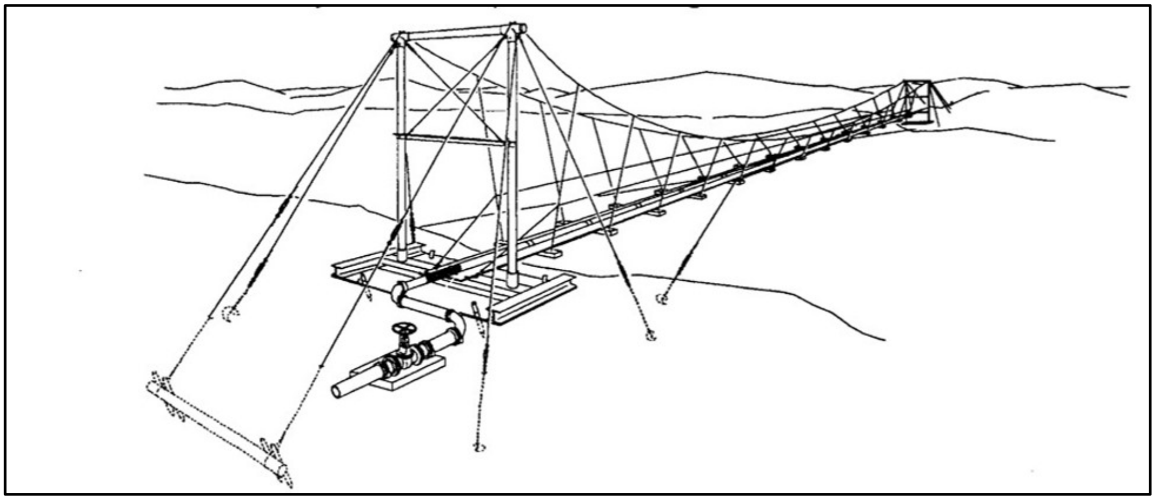


Figure 4-23. Suspension bridge

4-36. The following equipment may be required for site preparation and construction of the suspension bridge:

- Dozer, D-7.
- Fork lift rough terrain, 4k or larger.
- Crane, 20 ton, rough terrain.
- Welding machines, arc and acetylene.
- Truck, wrecker, with winch.
- Backhoe.
- Drive head.
- Sledge hammers.
- Rigging tool kits.
- Tag line projector.
- Snatch blocks.

Note. All work should be done in a manner consistent with safe work practices.

Suspension Bridge Installation

4-37. The maximum allowable height difference between the tower bases is 8 feet (2.43 meters). If the difference in height is more than 8 feet (2.43 meters), dig out the high-side tower location. Dig until the difference is not more than 8 feet (2.43 meters). Ensure that the area is graded level and totally on cut, not filled soil.

- **Step 1**. Tower base layout and site preparation.
  - Find the best location in the area for the bridge crossing on the banks of the river, chasm, or ravine to be crossed.

  - Use a hand sight level or other surveying equipment to determine the difference in height between the two tower base locations. A hand sight is supplied with the pipeline support supplemental tool kit.
- **Step 2.** Set tower bases.
  - Set the two tower bases into position.
  - Again, measure the difference in height between the two tower bases at the top of the I-beams and make a note of it.
  - Stake each tower base using four 1-inch (25.4-millimeter) by 3-foot (.91-meter) steel stakes, one in each of the four holes on the tower base.
- **Step 3.** Assemble and erect towers.
  - Assemble the high-side tower.
  - Assemble the low-side tower. It must include any difference in height between the two tower bases.
  - If there is a difference of height between the tower bases, install a leveling beam on the low-side tower a distance from the base I-beam equal to the difference in height.
  - Attach guy wires and lift the towers into place onto the bases.
- **Step 4.** Tower guy line installation. Four guy wires are required on each tower, for a total of eight.
- **Step 5.** Deadman anchor installation. Place the deadman anchors a distance of two times the tower height plus 4 feet (1.22 meters) away from the towers.
- **Step 6.** Main cable, suspender, and cross bearer installation.
  - Unroll the cable from two reels. Lay the cables out straight before marking them for suspender locations.
  - Attach suspenders and cross bearers while pulling the cable across.
  - Lift both cables and set in place on the tower caps.
- **Step 7.** Staging board installation.
  - Unroll the cable from two reels. Lay the cables out straight before marking them for suspender locations.
  - Attach suspenders and cross bearers while pulling the cable across.
  - Lift both cables and set in place on the tower caps.
  - Install a tag line across the bridge.
  - There must be a 9-foot (2.7432-meter) staging board on each side (on opposite ends).
  - Pull the connected staging boards across the bridge with the tag line.
- **Step 8.** Install two tension cables.
- **Step 9.** Install four wind guys.
- **Step 10.** Install the hand ropes.
- **Step 11.** Pipeline and pipeline strap installation.
  - Couple the pipe from the center toward both ends of the bridge.

Note. This may require a pup joint on the upstream side.

  - Thread 1/4-inch (6.35-millimeter) wire rope through the eyebolts on cross bearers and around the pipe securing it with a U-bolt clamp.
  - Lift both cables and set in place on the tower caps.
  - Double wrap the pipe with polyethylene tape where the pipe crosses over the I-beams.
- **Step 12.** Final adjustment.
- **Step 13.** Inspect entire bridge and check the tension.

SECTION III – TEMPORARY PIPELINE REPAIR

4-38. Small leaks in pipe sections and couplings can be temporarily repaired using repair clamps. There are two types of clamps that normally come with the IPDS—the repair clamp and the over-coupling clamp. The half-saddle clamp is in the Army supply system and may be issued as a replacement item for the repair clamp. If the leak is a small volume leak, it is not necessary to stop pumping operations while repair clamps are being installed. Replace repaired pipe sections and couplings with new pipe and couplings when the mission allows.

REPAIR CLAMP

4-39. The repair clamp (see figure 4-24) consists of two identical halves, 12 inches (30.48 centimeters) long with integral gaskets. It is designed to cover splits and holes in pipe sections up to 6 inches (15.24 centimeters) long. To mount a repair clamp—

- Place one coupling half under the pipeline.
- Put bolts in the upper half of the clamp, with the longer bolts in the center.
- Place the upper half of the clamp over the bottom half and align the bolts.
- Place nuts on the bolts and tighten the center bolts first.

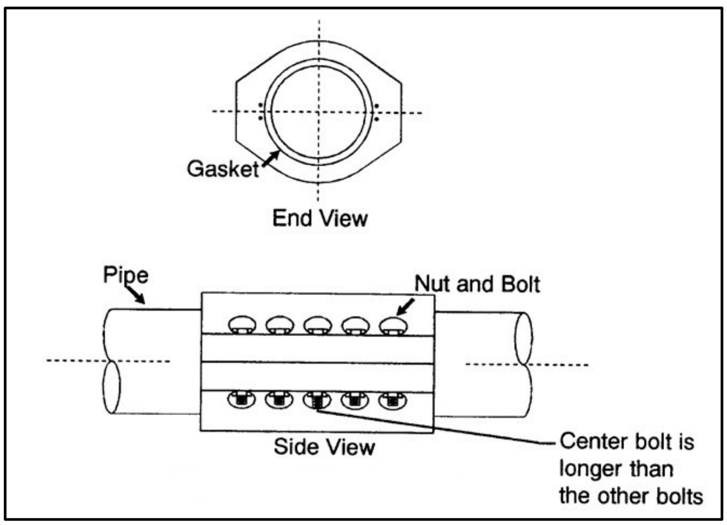


Figure 4-24. Repair clamp

OVER-COUPLING CLAMP

4-40. An over-coupling clamp (see figure 4-25, page 4-26) is used to control leaks at pipe joints. Before installing the over-coupling clamp, move the pipe and leaking coupling back and forth and up and down, attempting to seal the gasket and stop the leak. If this action does not stop the leak, install the over-coupling clamp over the leaking coupling. To install an over-coupling clamp—

- Dig a hole under the leaking coupling large enough to hold the over-coupling clamp.
- Swing five bolts away from the over-coupling clamp.
- The bolt in position number 6 is a hinge bolt.
- Open the over-coupling clamp, lubricate all exposed gasket surfaces and slide it over the leaking coupling.
- Swing the five bolts back into place.
- Tighten the bolts in order, as marked on top of the over-coupling clamp.

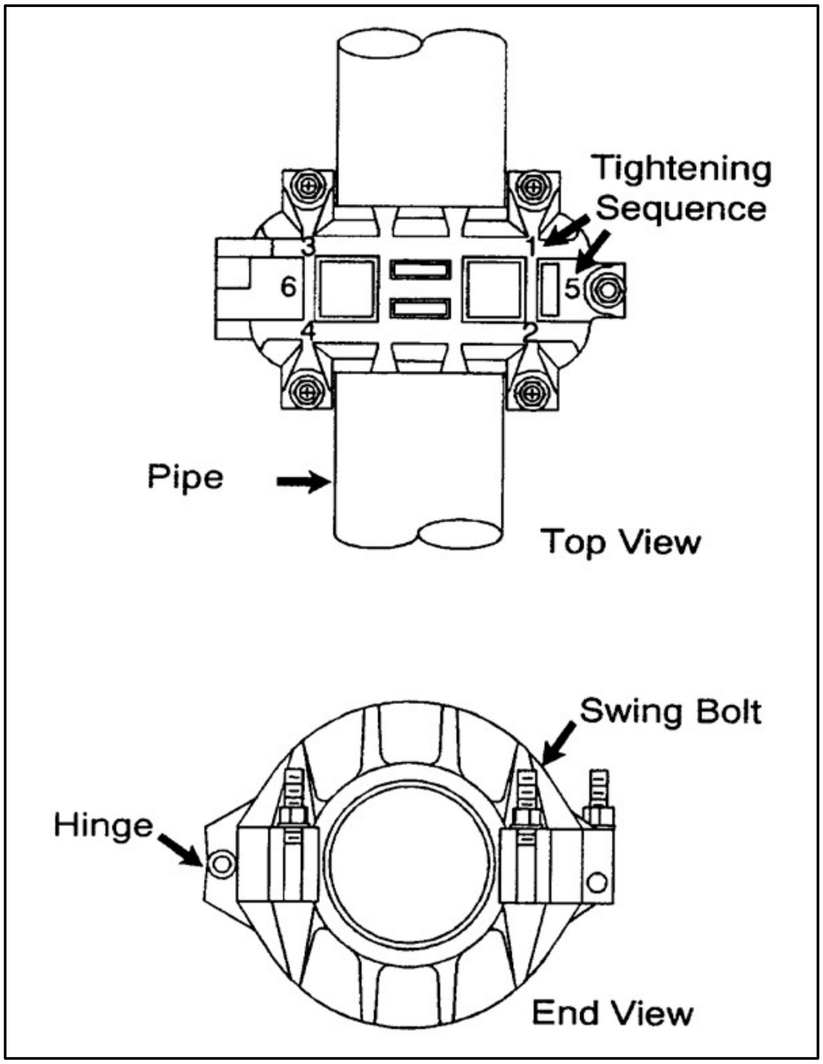


Figure 4-25. Over-coupling clamp

HALF-SADDLE CLAMP

4-41. The half-saddle clamp (see figure 4-26) is 12 inches (30.48 centimeters) long with an integral gasket. It is designed to cover splits and holes up to 6 inches (15.24 centimeters) long in the pipe. To mount a half saddle clamp—

- Place the saddle half of the clamp around the pipeline to cover the leak with the gasket and saddle.
- Place the clamp stirrups around the pipeline and align through the saddle half. Place the nuts on the ends of the stirrups and tighten them, starting in the center of the clamp and alternating side-to-side, and working towards the ends of the clamp.

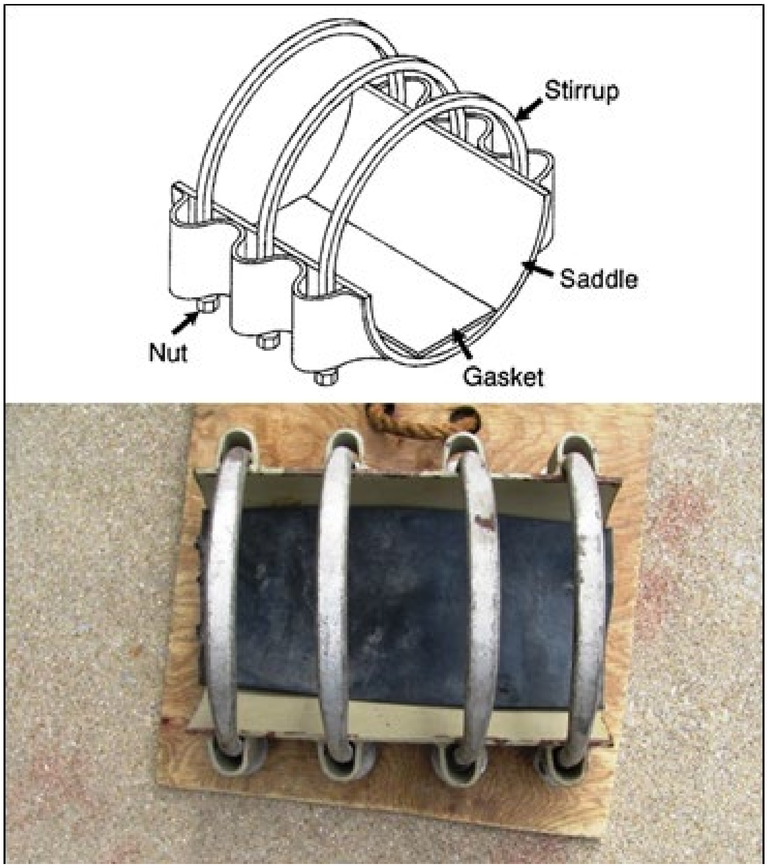


Figure 4-26. Half-saddle clamp

TAPPING MACHINE

4-42. Tapping machines (see figure 4-27, page 4-28) are included in the IPDS to tap and drain the pipeline when permanent repairs are made. The tapping machine is lightweight, easy to operate, and has an adjustable automatic feed rate for any cutting condition. The feed adjustment knob can be loosened or tightened until the operator feels the amount of force is suitable for the task. The machine comes furnished with a ratchet crank for manual operation.

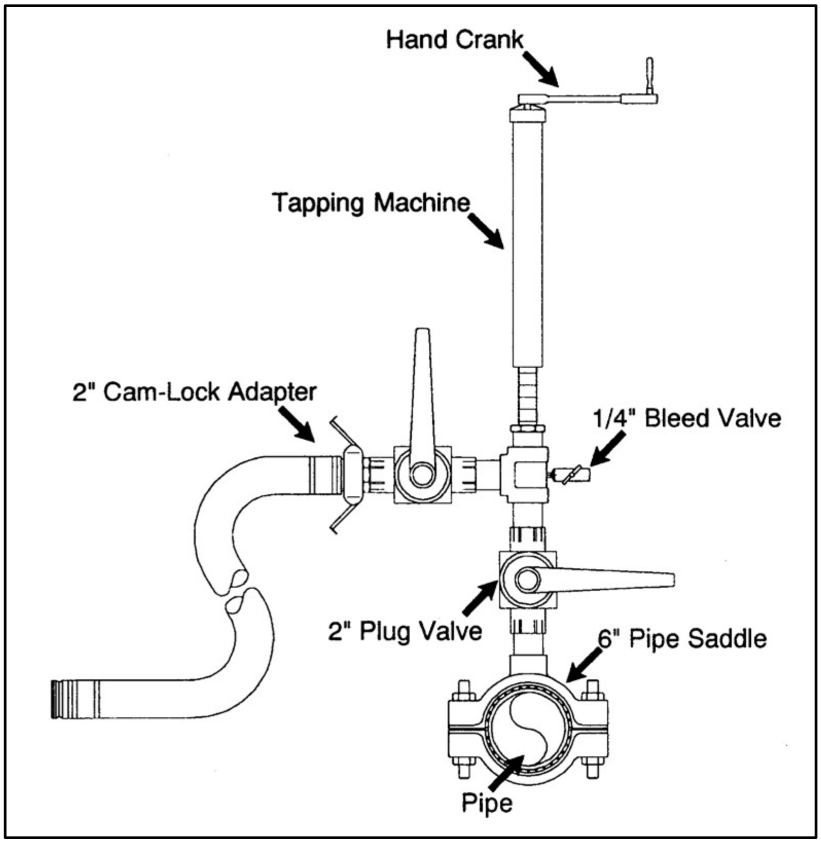


Figure 4-27. Tapping machine

Note. Tapping machines with a saddle and valve assembly may be in short supply; therefore, the section of pipe that is tapped should be replaced.

FAULTY COUPLING, GASKET, OR PIPE REPLACEMENT

4-43. Permanent repairs to coupled pipelines are made during shutdown (4 hours each day for planning purposes), by breaking the line and replacing the faulty coupling, gasket, or pipe section. To replace a faulty coupling, gasket, or pipe section—

- Follow all safety and environmental precautions.
- Close the gate valves on each side of the faulty coupling, gasket, or pipe section.
- If a drain valve is available, use it to drain the line. If not, use the tapping machine and tap the pipeline and drain the fuel from the section to be repaired into drums or a tank vehicle. (One mile (1.6 kilometer) of 6-inch (15.24-centimeter) pipe holds about 210 barrels or 8,820 gallons (33387.33 liters) of fuel.)
- Remove the coupling and gasket.
- Replace the pipe section.
- Grease the inside area on each half of the coupling and place it on the pipe.
- Lock the coupling clamp.
- Open the gate valves.

Chapter 5

Pump Station Construction and Operation

This chapter provides an overview of the Army IPDS pump station construction and operation.

SECTION I – MAJOR COMPONENTS

5-1. This section provides an overview of the Army IDPS pump station major components and capabilities.

MAINLINE PUMPS

5-2. The 800 gallons per minute (3028.32 liters per minute) mainline (see figure 5-1) pump is skid mounted. The skid is mounted on a flat rack configured to be compatible with a 20-foot (6.096 meter) ISO container. This pump can only be moved with a rough terrain cargo handler RT-240 or DV-43. A sling is also included in the pump accessory box to be used with a crane or similar piece of equipment. The major components of the pumping assembly consist of a flat rack, engine, pump, control panel, speed increaser with clutch, and flexible coupling.

WARNING

Lifting with cables, chains, or any other device requiring spreader bars cannot be used to move or reposition this pump. Damage to the lifting points or the pump can result from the use of unapproved lifting equipment.

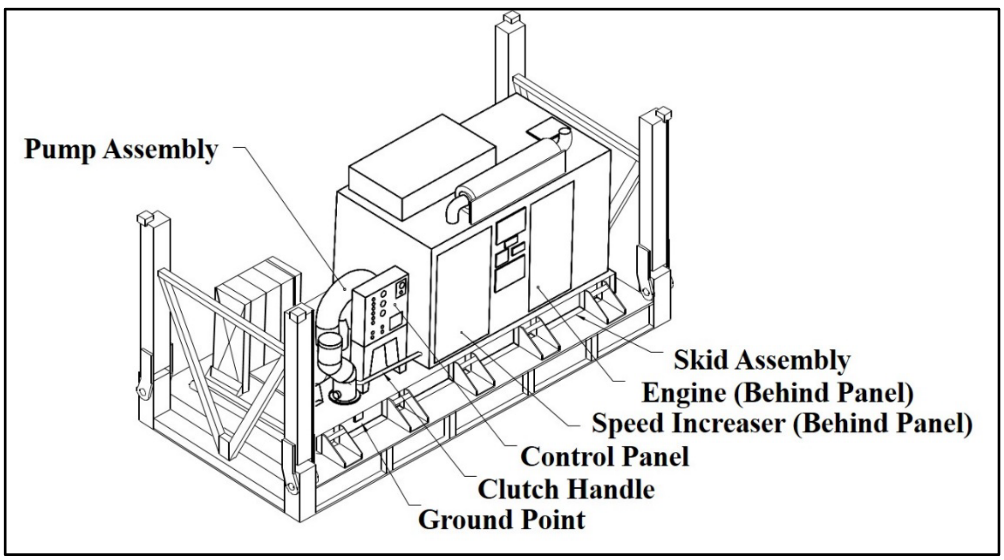


Figure 5-1. 800-gallons per minute (3028.32 liters per minute) pump

LAUNCHER

5-3. The launcher (see figure 5-2) is used to launch a "pig" or scraper through the line to clean it or to separate batches of product. The launcher assembly consists of the steel skid, the launching barrel, and the associated piping and valves. The launcher is installed on the outgoing side of the pump station and is the last component where product exits the pump station.

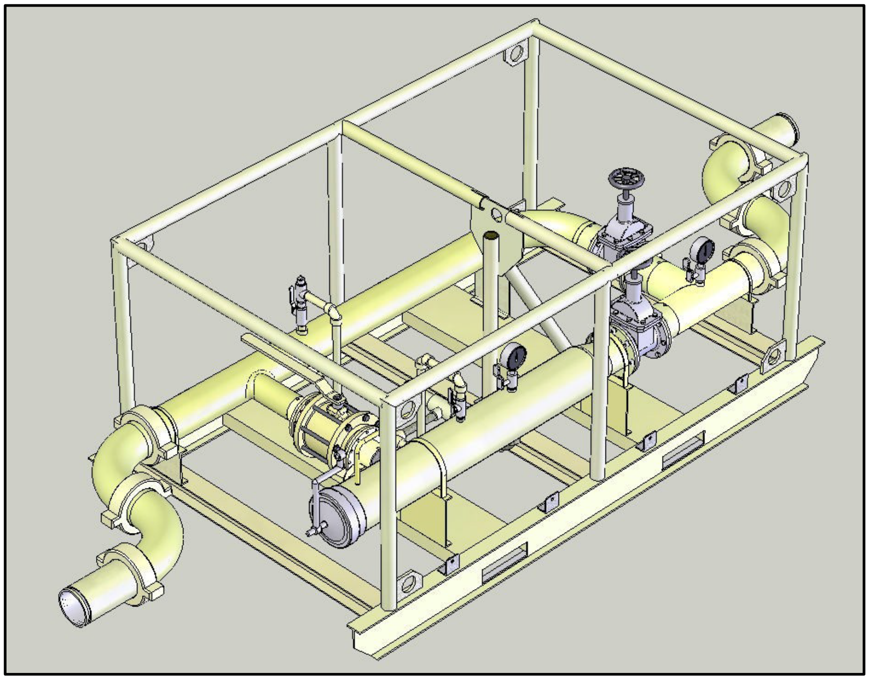


Figure 5-2. Launcher

RECEIVER

5-4. The receiver (see figure 5-3) is used to catch a pig or scraper at the pump station. The receiver assembly consists of the skid mount, the receiving barrel, and the associated piping and valves. The receiver is installed on the incoming side of the pump station and product enters the pump station via this component first.

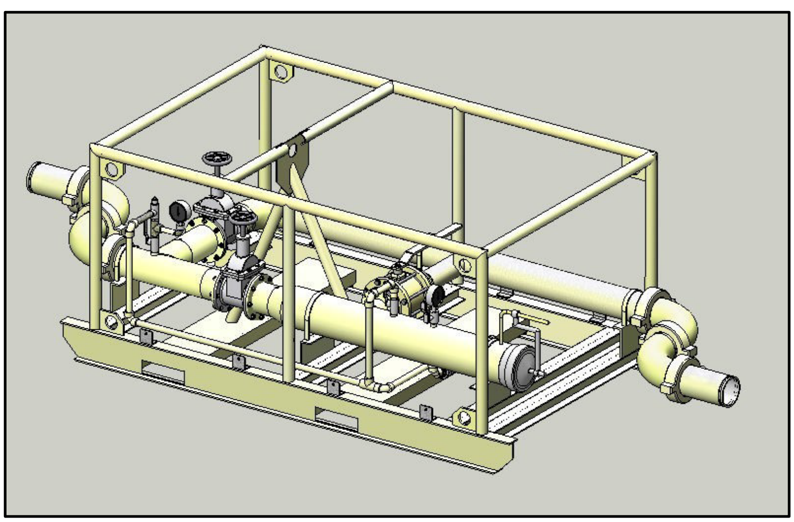


Figure 5-3. Receiver

STRAINER ASSEMBLY

5-5. A strainer assembly is installed to protect the pumps from damage due to dirt or debris in the pipeline. The design of the strainer basket ensures that all debris larger than .025 inches (0635-millimeters) in diameter is removed from the product flow. The strainer is installed between the receiver and the first pump. Refer to figure 5-4.

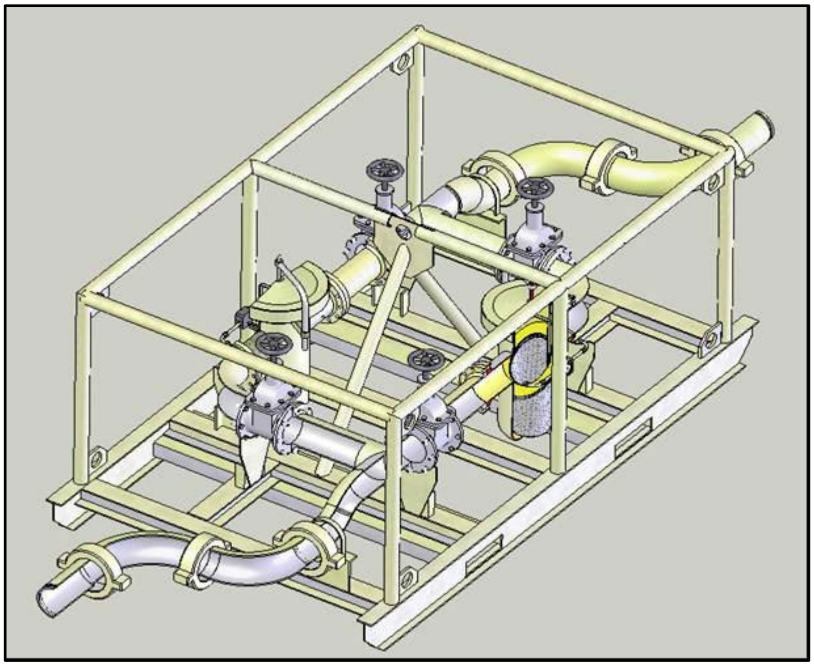


Figure 5-4. Strainer

FLOODLIGHT SET

5-6. There is a trailer-mounted floodlight/6-kilowatt (6,000 watts) generator set with the pump station. It provides light for nighttime operations. It has a telescoping tower with four 1,000-watt bulbs and two portable masts with two 500-watt bulbs on each mast. (See appendix A.)

VALVES, ELBOWS, PIPE NIPPLES, AND SPARE PARTS

5-7. The necessary valves, elbows, and pipe nipples to construct the pump station in either standard or reverse layout are located with the pump station. Repair parts for the 800-gallons per minute (3028.32-liters per minute) pump are located in container 3 of 6.

SECTION II – PUMP STATION CONSTRUCTION

5-8. This chapter provides an overview of the Army IPDS pump station construction.

PUMP STATION CONSTRUCTION

5-9. Constructing pump stations can be a very easy exercise if some simple rules are followed. Basically, there are two types of pump station layouts—standard and reverse (see figure 5–5, page 5-4). Which one you use will depend on where the road is in relation to the fuel flow of the pipeline. It is important to maintain access to the pumps in case they need to be replaced during operation. If the pump station is not properly constructed, pipeline operations may have to be shutdown to replace a nonoperational pump. The actual layout used will depend on terrain and available space, and may be different than illustrated in this training circular.

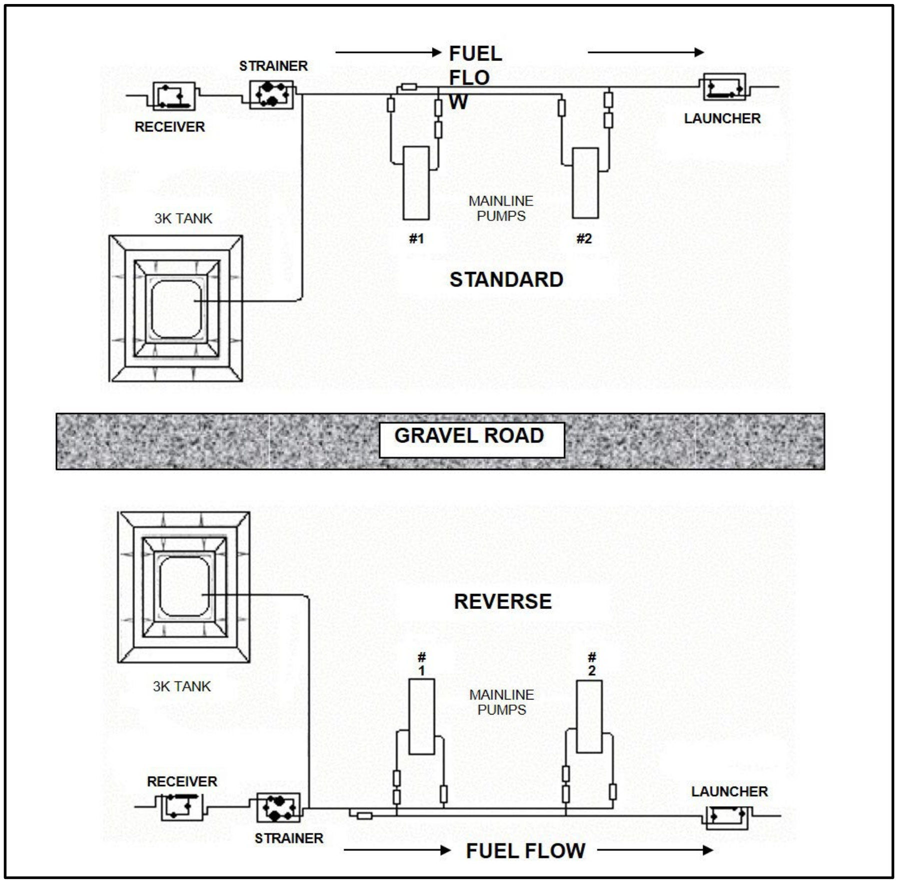


Figure 5-5. Standard and reverse pump station layouts

5-10. When constructing a pump station follow as closely as possible to this installation sequence regardless of the layout being followed.

- **Site selection.** The general location will be determined during the pipeline design phase. Select the exact location depending on the terrain features. A space of 140 feet by 95 feet (42.672 meters by 28.956) is ideal, especially if it is flat.
- **Pump positioning.** Pumps must be positioned for access to allow for replacement during operation if necessary. Use the correct layout (standard or reverse) to allow for access. Ensure that there is room at the rear of the pumps to move a tractor or flatbed trailer and a rough terrain cargo handler into position. This requires at least 50 feet (15.24 meters) and should be about 10 feet (3.048 meters) off the road (a total of 60 feet [16.288 meters]).
- **Layout staking.** Stake the anticipated location of the inlet and outlet piping about 95 feet (28.956 meters) from the edge of the road with 140 feet (42.672 meters) between the stakes (see figure 5-6). These two stakes will be targets for the pipeline construction crew to align the incoming and outgoing pipeline.

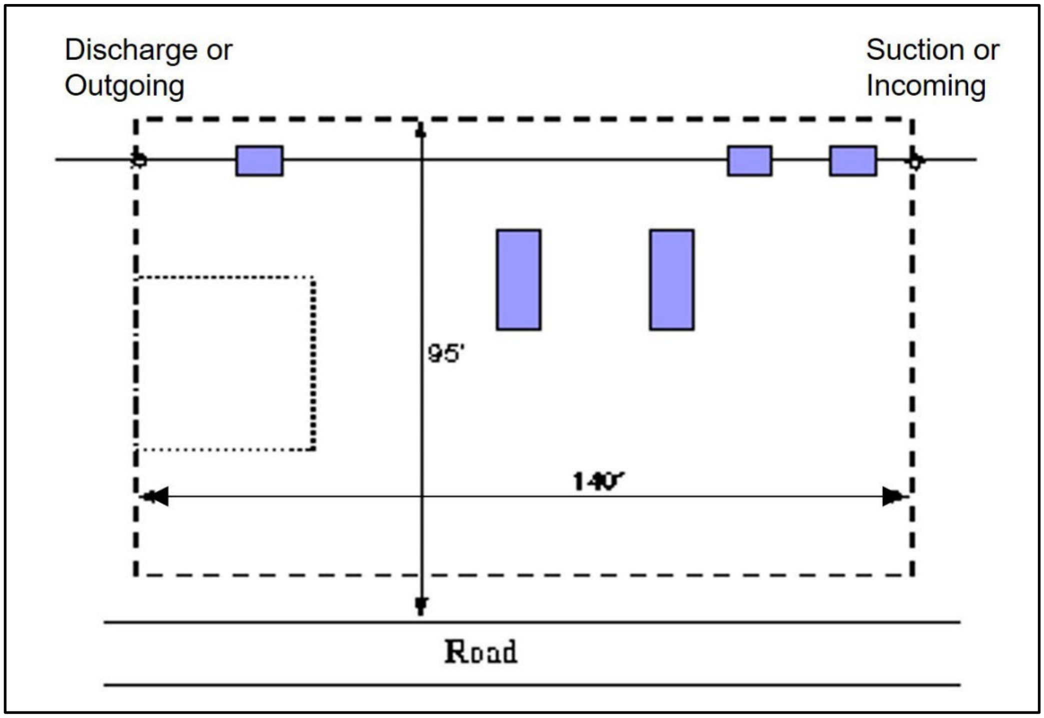


Figure 5-6. Select location

SITE GRADING

5-11. The site should be graded and leveled so that the slope does not exceed 5 degrees. The closer to the true level of the site, the easier construction and operation will be. Add gravel if necessary and available to provide a good base. All material used for the base must be compacted.

FUEL BERM

5-12. When preparing the 3,000-gallon (11356.2353-liter) tank berm, the inside dimensions must be 14 by 14 feet (4.2672 meters). Ensure that the tank is positioned within 200 feet (60.96 meters) of both pump's fuel tanks. See figure 5-7, page 5-6.

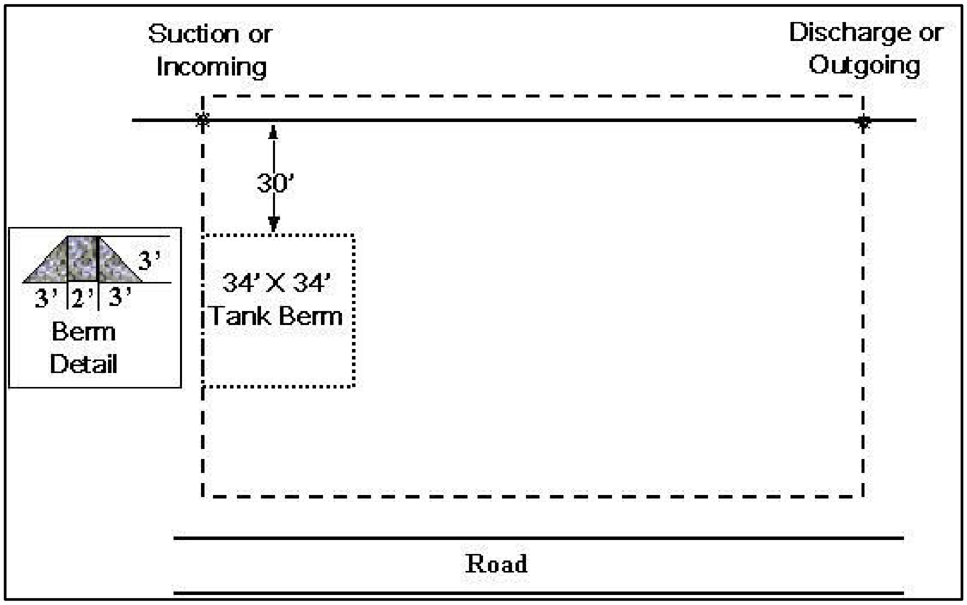


Figure 5-7. 3-K tank berm locations

STANDARD LAYOUT

5-13. Locate pump number 2 by measuring from the discharge stake towards the incoming stake 40 feet (12.92 meters) and placing a stake (number 1) at this point. From stake number 1, measure towards the road 10 feet (3.048 meters) on a perpendicular line and place stake number 2 at this point. Continue measuring along this second line for an additional 25 feet (7.62 meters) and place stake number 3 at this point. Mark the entire line (all three stakes) with string or other suitable marking material. Check for straightness to ensure that pump number 2's line is perpendicular to the incoming-outgoing line. Using a rough terrain cargo handler or sling with a crane, position pump number 2 with the discharge side of the pump against the line and the front discharge corner even with stake number 2. (See figure 5-8.)

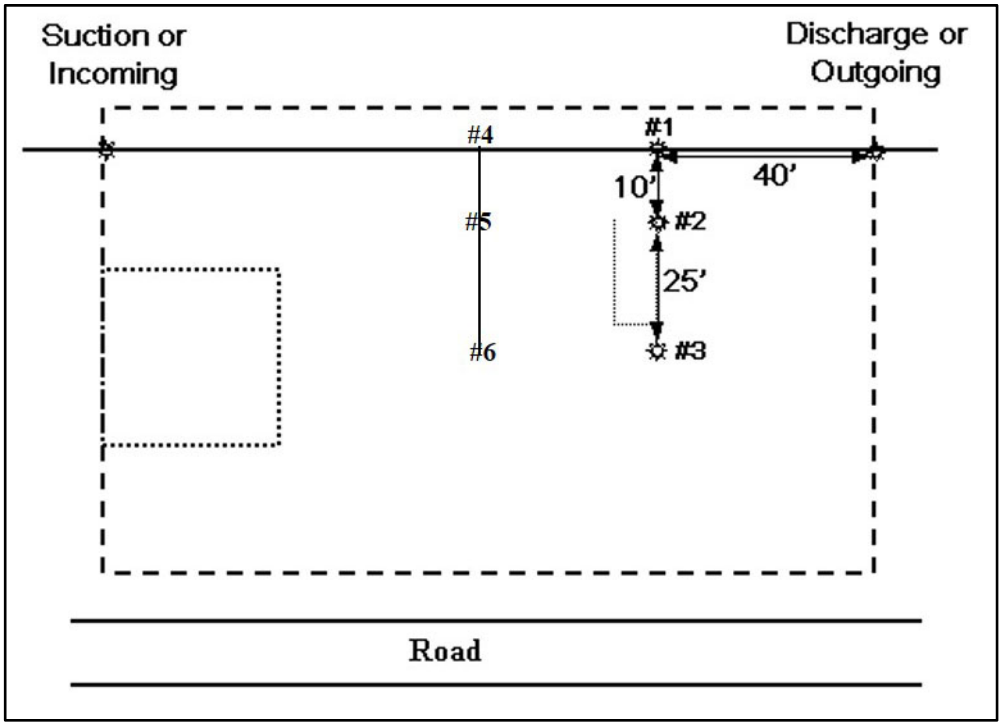


Figure 5-8. Pump number 2 layout marked (standard)

5-14. From stake number 1, measure towards the incoming side of the pump station 39 feet, 3 1/2 inches (11.9761 meters) and mark with stake number 4 (see figure 5-9). On a line perpendicular to the incoming-outgoing line and parallel to the line for pump number 2, measure towards the road 35 feet (10.668 meters). Mark this point with stake number 6 and mark the line with a string. From stake number 4, measure 10 feet (3.048 meters) towards stake number 6 and mark this point with stake number 5. Stake number 5 indicates the point where the front discharge corner of pump number 1 should be located. Emplace pump number 1 with the rough terrain cargo handler or crane with sling.

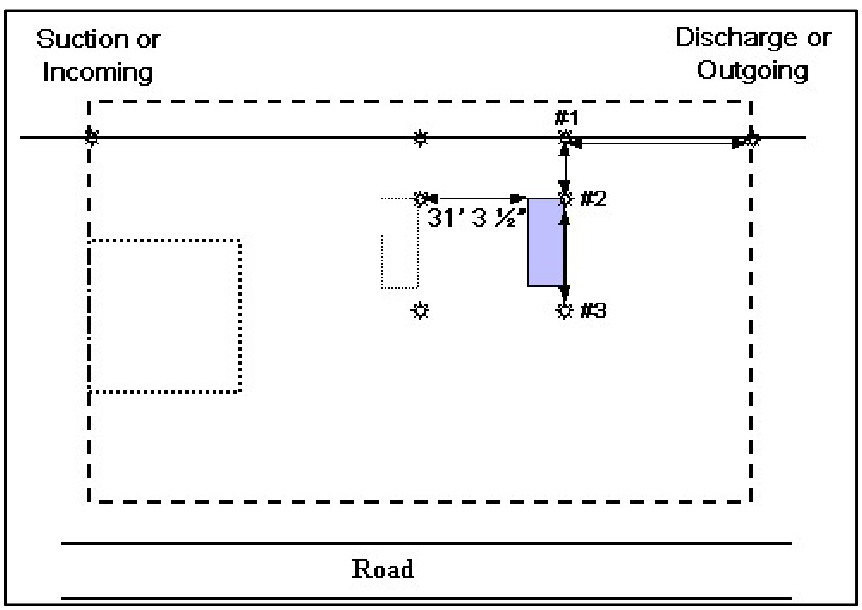


Figure 5-9. Pump number 1 layout marking (standard)

WARNING

Lifting with cables, chains, or any other device requiring spreader bars cannot be used to move or reposition this pump. Damage to the lifting points or the pump can result from the use of unapproved lifting equipment.

Note. The flat racks should be 31 feet, 3 1/2 inches (9.5377 meters) apart.

5-15. Ensure that the pumps are as close to level as possible. They can be no more than 5 degrees out of level. Double check the distance. Both the front and rear should be 31 feet 3 1/2 inches (9.5377 meters) apart. Deprocess the pumps according to the technical manual.

5-16. If the distance between the pumps is correct, the precut and grooved pup joints supplied with the pump station can be used. Nipples (pup joints), pipe sections, and elbows required for a standard and reverse layout are listed in table 5-1. The 19-foot (5.8-meter) pipe sections are supplied with the 5-mile pipeline set.

Table 5-1. Pump station pup joints and elbows

PUP JOINTS		
LENGTH	**STANDARD**	**REVERSE**
1’ (30.48 centimeters)	6	6
4’10” (1.4723 meters)	1	1
5’6” (1.6764 meters)	1	2
7’10” (2.3876 meters)	1	0
8’ (2.4384 meters)	1	0
12” (1) (30.48 centimeters)	4	4
9’6” (2.8956 meters)	3	2
19 foot (2) (5.8 meters)	3	6
ELBOWS		
90º (3r)	21	24

Notes. The actual number of 19-foot (5.8-meter) sections of pipe will depend on the site and setup. This is the minimum amount required. The 19-foot (5.8-meter) sections of pipe are contained in the 5-mile pipeline sets.

All pumps are mounted on flat racks.

SUCTION MANIFOLDING

5-17. Install the suction manifold by—

- Connecting a 12-inch (30.48-centimeter) pup joint to the suction and discharge sections of both pumps.
- Connecting 90-degree elbows (only 3r, short radius elbows are used in the pump stations) to all four sections pointing down towards the ground. Then connect 90 degree, 3r elbows to the 90-degree 3r elbows, and point them toward the manifold. See figure 5-10.

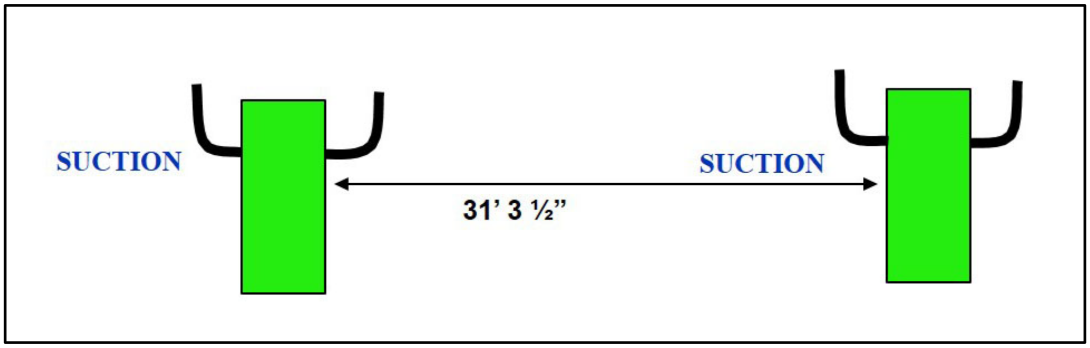


Figure 5-10. Pump layout (standard)

- Connecting a 9 foot, 6 inch (2.90 meters) long constant wall pipe section to the suction elbow of both pumps.
- Connecting a gate valve to both pipe sections. Then connect a tee to the gate valve of pump number 1. This is the unit on the inlet side of the station. (See figure 5-11.)

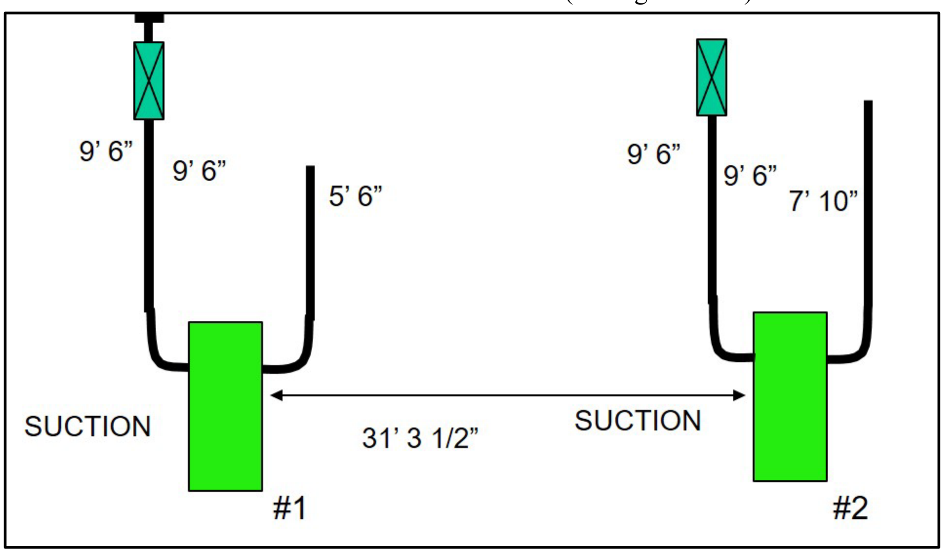


Figure 5-11. Pup joints, elbows, and gate valves (standard)

- Connecting a tee to the downstream side of the tee installed on pump number 1 with the branch of the tee pointing out from the pump. Then connect a 90-degree, 3r elbow to the tee with the elbow pointing towards the pump station outlet.
- Connecting a 90-degree, 3r elbow to the suction valve of pump number 2 with the elbow pointing towards pump number 1.
- Using a full pipe section, a full 9 foot, 6 inch (2.90 meters) pup joint, and an 8-foot (2.43-meter) pup joint to complete the suction header manifold for both pumps. (See figure 5-12, page 5-10.)

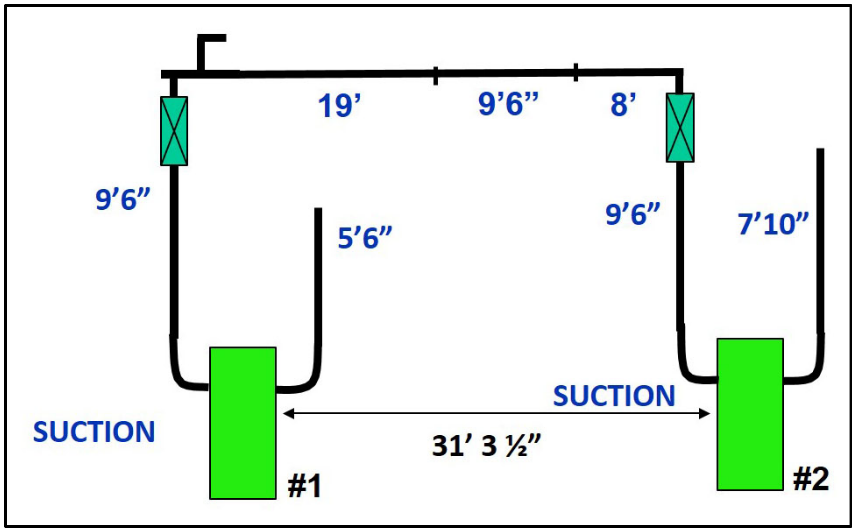


Figure 5-12. Suction completed (standard)

Discharge Manifolding

5-18. Install the discharge manifold by—

- Installing two pup joints to the discharge elbows. Use a 5-foot, 6-inch (1.6764 meter) pup joint on pump number 1 and a 7- foot, 10-inch (2.38-meter) pup joint on pump number 2.
- Installing a gate valve and check valve on the discharge side of each pump. The check valve will keep product from flowing back into the pump. You need a 1-foot (30.48-centimeters) pup joint between the two valves or the skids will overlap. (See figure 5-13.)

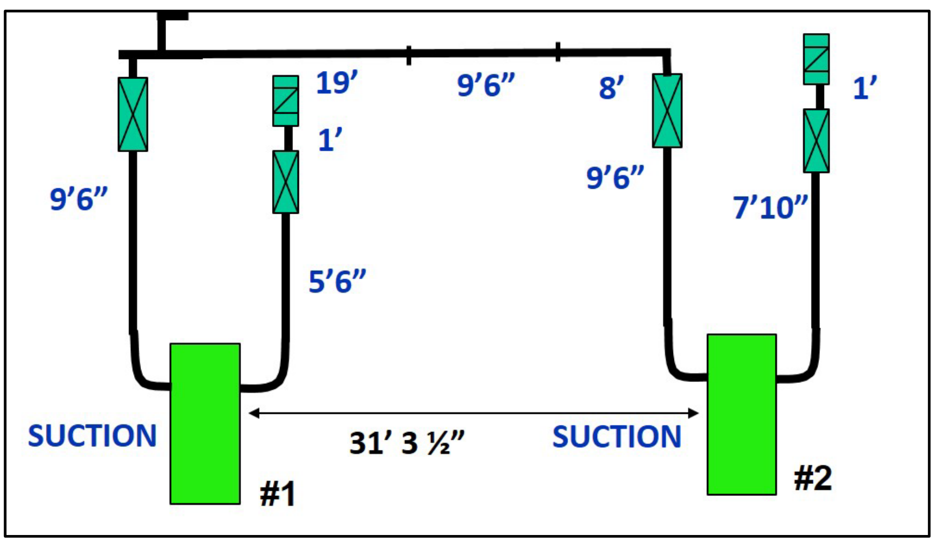


Figure 5-13. Discharge manifold (standard)

- Installing the bypass check valve. This will allow the pump station to be by-passed when necessary and the check valve prevents pumping in a loop (see figure 5-14).

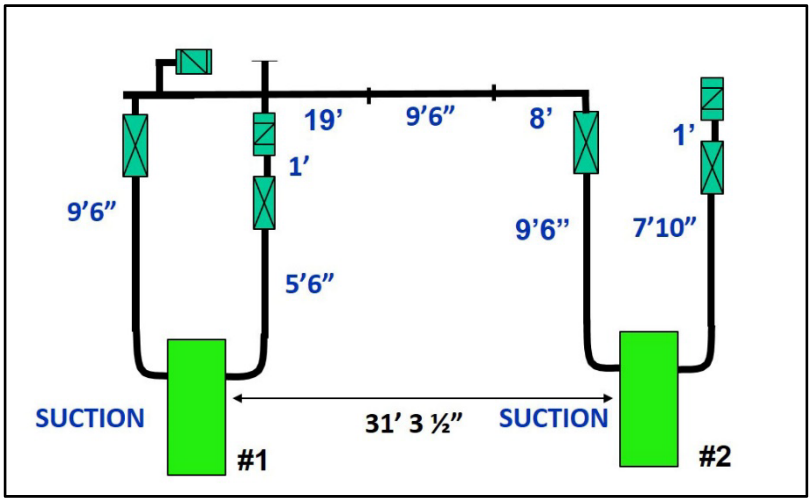


Figure 5-14. Discharge manifold check valve (standard)

- Using three 90 degree, 3r elbows to build a bridge over the inlet pipeline and attach a tee on the end pointing up. Always place the discharge over the suction, never the suction over the discharge. Air could be trapped in the bridge and when the air bubble gets large enough it may slip into the pump and put it off line. (See figure 5-15, page 5-12.)
- Installing a tee on the check valve of pump number 2. (See figure 5-15.)
- Completing the pump station manifold by installing the discharge piping. Use a 4-foot (1.22 meter), 10-inch (1.4732-meter) pup joint to connect the bypass check valve to pump number 1 discharge line. Use two full pipe sections to connect to pump number 2 discharge line. If all our measurements are correct, everything should fit. (See figure 5-15.)

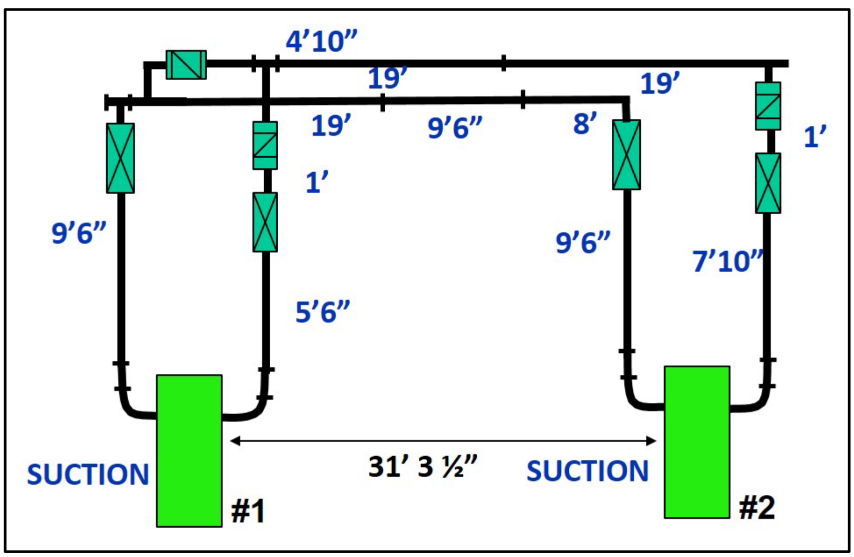


Figure 5-15. Manifolding complete (standard)

LAUNCHER ASSEMBLY

5-19. Install the launcher assembly by—

- Positioning the launcher assembly (see figure 5–16, page 5-12), if the site allows, so a full section of pipe or a pipe pup joint between the manifold and the launcher can be used. This will eliminate cutting a pup joint.

- Using two 90-degree, 3r elbows to connect the pipe to the launcher.
- Using two 90-degree, 3d (large radius) elbows from the 5-mile pipeline set on the outlet side of the launcher to connect to the downstream pipeline.
- Anchoring the first section of pipe outside the pump station at both the receiver and launcher.

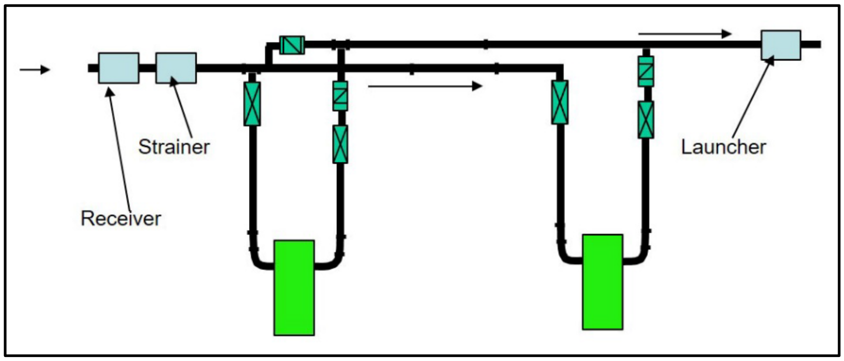


Figure 5-16. Standard pump station layout without 3K tank

STRAINER ASSEMBLY

5-20. Install the strainer assembly by—

- Positioning the strainer (see figure 5–16) on the inlet side of the pump station. If the site allows, use one section of pipe or a full pipe pup joint between the strainer and the manifold. Remember to check the direction of flow. Connect two 90-degree, 3r elbows to the inlet and outlet of the strainer assembly.
- Connecting a tee somewhere between the strainer's outlet elbow and the pump. To this tee connect the 6-inch (15.24 centimeter) grooved to 1-inch (25.4-millimeter) nipple with ball valve. This is the source of fuel for the 3,000-gallon (11356.2353 liter) tank.

RECEIVER ASSEMBLY

5-21. Install the receiver assembly by—

- Positioning the receiver (see figure 5–16) assembly and connecting to the strainer assembly. Depending on available space and desired working area, connect the two using standard lengths of pipe or pup joints. Pup joints may need to be cut if standard lengths cannot be used.
- Using 90-degree, 3r elbows, connect an elbow assembly to the outlet of the receiver assembly. Connect the receiver assembly to the pipeline by using two 90-degree, 3d (long radius) elbows.

3,000 GALLON, COLLAPSIBLE, FABRIC TANK

5-22. The 3,000-gallon (11356.2353 liter), collapsible, fabric fuel tank must be within the 200 foot (60.96 meter) hose range of the pump fuel tanks and the connecting point on the incoming pipeline. Position the 3,000-gallon (11356.2353 liter) collapsible fabric tank to allow drainage away from the pump area in the event of a tank failure.

5-23. Connect the hose to the 1-inch (25.4-millimeter) valve, on the 6-inch (15.24 centimeter) by 1-inch (2.54-millimeter) reducer, to fill the tank. Slowly open the 1-inch (25.4-millimeter) gate valve to prevent over pressuring the hose. Do not attempt to fill the tank if line pressure is greater than 150 pounds per square inch. Close the 1-inch (25.4-millimeter) gate valve when the tank is full.

REVERSE LAYOUT

5-24. The inside rear edge of pump number two, or the pump on the discharge side of the pump station, is located by measuring over 40 feet (12.92 meters) from the outgoing stake and measuring towards the road

35 feet (10.668 meters) (see figure 5–17). The inside edge of pump number 1, or the pump on the suction side, is located by measuring over towards the discharge side 31 feet, 3 1/2 inches (9.5377 meters).

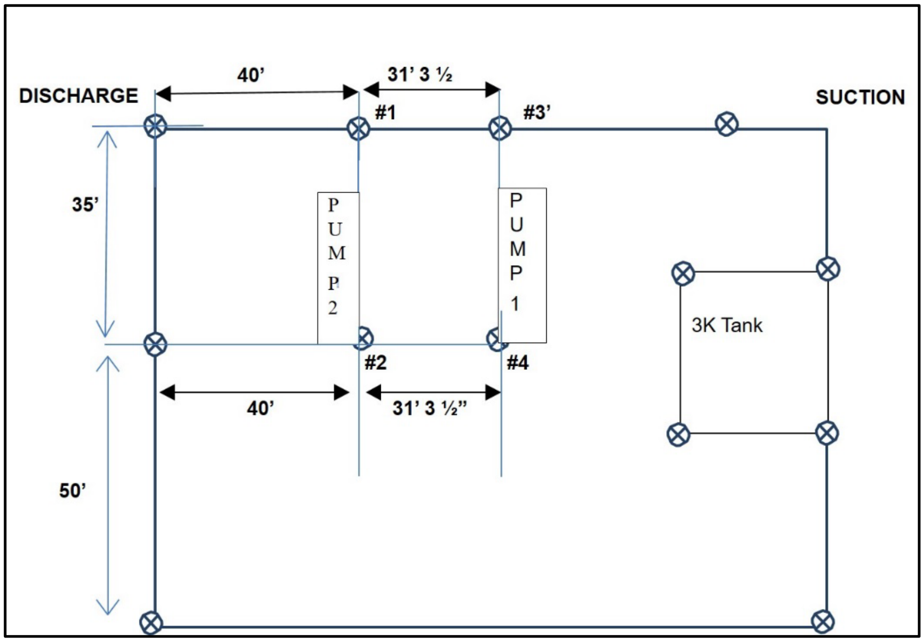


Figure 5-17. Pump locations marked (reverse)

5-25. Determine and mark with stakes (numbered 1 through 4) and engineer tape the exact location for the two mainline pumps. The front edge of the pumps will be about 10 feet (3.048 meters) from the manifold location and the pumps should be exactly 31 feet, 3 1/2 inches (9.5377 meters) apart to allow the precut pup joints packed with the system to be used.

5-26. Pumps can be transported by a palletized loading system or a flatbed trailer. The pump can be set into place using the rough terrain cargo handler or the provided sling and crane.

5-27. Check to ensure the pumps are as level as possible. They can be no more than 5 degrees out of level. Double check the distance between the pumps, both front and rear should be 31 feet 3 1/2 inches (9.5377 meters) apart. Deprocess pumps according to the technical manual.

5-28. If the distance between the pumps is correct, the precut and grooved pup joints with the pump station can be used. Pup joints, pipe sections, and elbows required for a standard and reverse layout are listed in table 5-2.

Table 5-2. Pump station pup joints and elbows

PUP JOINTS		
Length	***Standard***	***Reverse***
1' (30.48 centimeters)	6	6
4' 10" (1.4723 meters)	1	1
5' 6" (1.6764 meters)	1	2
7' 10" (2.3876 meters)	1	0
8' 2.4384 meters)	1	0
12" (1) (30.48 centimeters)	4	4
9' 6" (2.8956 meters)	3	2
19' (2) (5.8 meters)	3	6
ELBOWS		
90^0 (3r)	21	24

Note. The actual number of 19-foot (5.8-meter) sections of pipe will depend on the site and setup. This is the minimum amount required. The 19-foot (5.8-meter) sections of pipe are contained in the 5-mile pipeline sets.

Suction Manifolding

5-29. Install the suction manifold by—

- Connecting a 12-inch (30.48-centimeter) pup joint to all four suction and discharge sections. Connect 90-degree elbows (only 3r, short radius elbows are used in the pump stations) to all four sections pointing towards the ground. Then connect the 90-degree elbow to the 90-degree, 3r elbows facing towards the manifold. (See figure 5-18.)

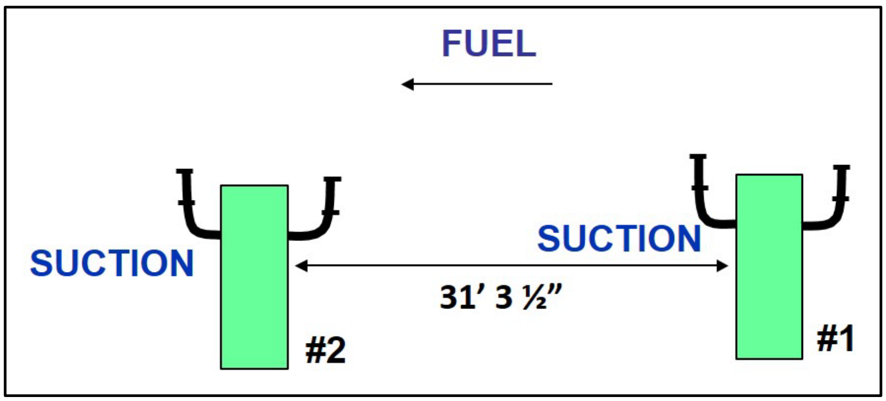


Figure 5-18. Pump layout (reverse)

- Connecting a 9 foot, 6 inch (2.74 meter, 15.24 centimeter) long constant wall pipe section to the suction elbow of both pumps.
- Connecting a gate valve to both pipe sections. Then connect a tee to the gate valve of pump number 1 and an elbow to the gate valve of pump number 2. Remember, pump number 1 is on the suction side of the pump station. (See figure 5-19.)

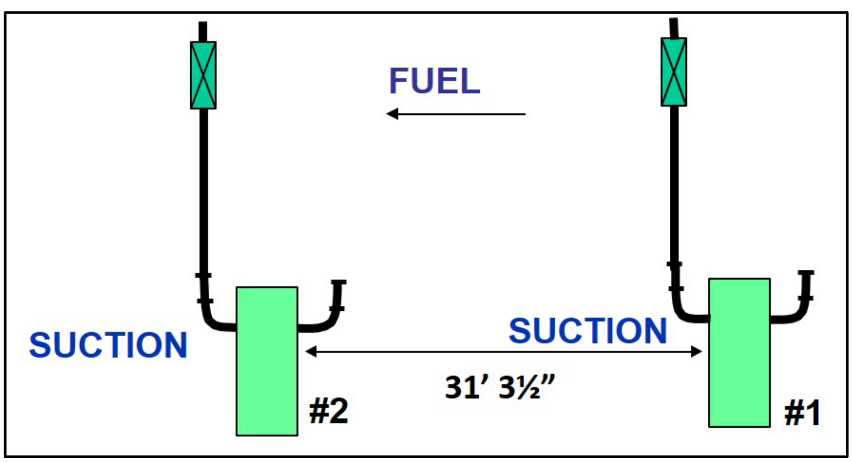


Figure 5-19. Pup joints, elbows, and gate valves (reverse)

- Using 19-foot (5.8-meter) pipe sections, connect the suction of pump number 2 to the suction of pump number 1 (see figure 5–20). If the measurements are correct, only two 19-foot (5.8-meter) sections of pipe will be needed.

- Connecting a 19-foot (5.8-meter) section to the other side of the suction "tee" on pump number 1. Connect a 90-degree, 3r elbow to the end of this 19-foot (5.8-meter) section. (See figure 5–20.) The suction manifold is now complete.

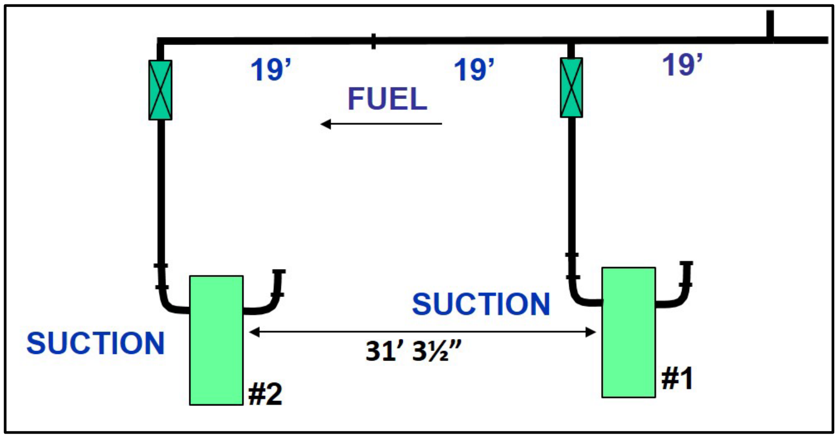


Figure 5-20. Suction completed (reverse)

Discharge Manifolding

5-30. Install the discharge manifold by—

- Installing a 5-foot, 6-inch (1.6764 meters) pup joint on the discharge side of each pump.
- Installing a gate valve and a check valve on the discharge side of each pump. The check valve will keep the product from flowing back into the pump. A 1-foot (30.48-centimeters) pup joint will be needed between the two valves or the skids will overlap. (See figure 5-21.)

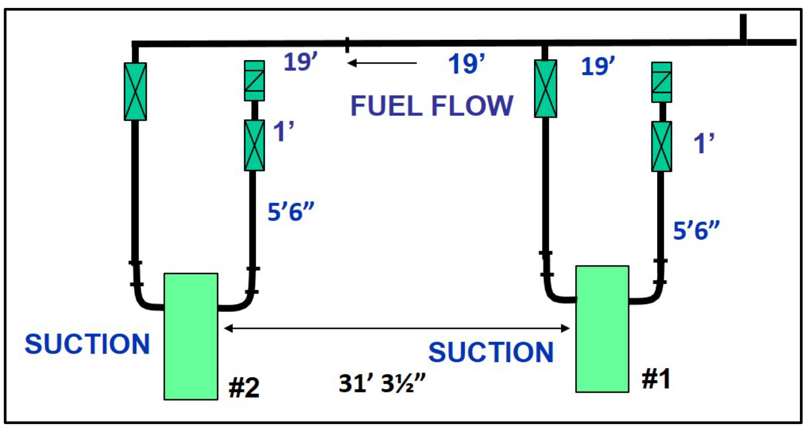


Figure 5-21. Discharge manifold (reverse)

- Installing the bypass check valve using a 4-foot, 10-inch (1.4732-meter) pup joint connected to the elbow at the beginning of the suction manifold. The bypass valve will allow the pump station to be bypassed when necessary and the check valve prevents pumping back into the suction manifold.
- Starting at the check valve on the discharge side of each pump build a crossover using three 90 degree, 3r elbows. The crossover will allow the discharge pipe of the pump to "crossover" the suction manifold and attach to the discharge manifold. Always place the discharge over the suction and never the suction over the discharge. Air could be trapped in the bridge and when the air pocket gets large enough would slip into the pump and cause it to go off line. (See figure 5-22, page 5-16.)

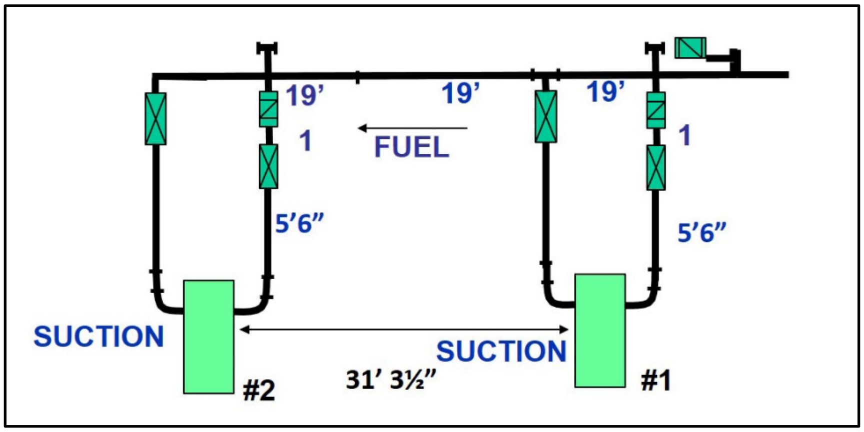


Figure 5-22. Discharge manifold check valve (reverse)

- Installing a tee on the check valve of pump number 2.
- Completing the pump station manifolding by installing the discharge piping. Use 19-foot (5.8-meter) sections to connect the discharge piping from the pumps together. Add an additional 19-foot (5.8-meter) section on the other side of the tee connected to the discharge piping of pump number 2 (see figure 5-23).

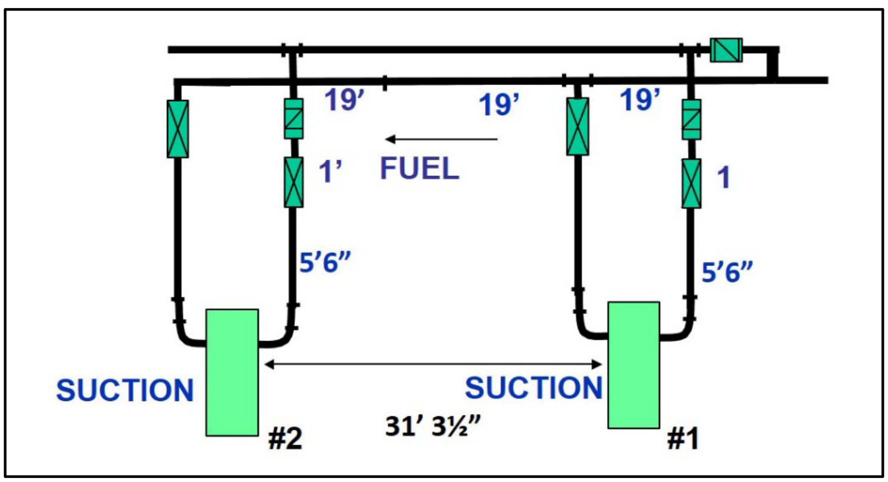


Figure 5-23. Completed manifold (reverse)

LAUNCHER ASSEMBLY

5-31. Installation of the launcher assembly.

- Position the launcher assembly (see figure 5-24), if the site allows, so a full section of pipe or pipe pup joint between the manifold and the launcher can be used. This will eliminate cutting a pup joint.
- Use two 90-degree, 3r elbows to connect the discharge pipe to the launcher. Use two 90-degree, 3d (large radius) elbows, from the 5-mile pipeline set, on the outlet side of the launcher to connect to the downstream pipeline.
- Be sure to anchor the first section of pipe outside the pump station, at both the receiver and launcher.

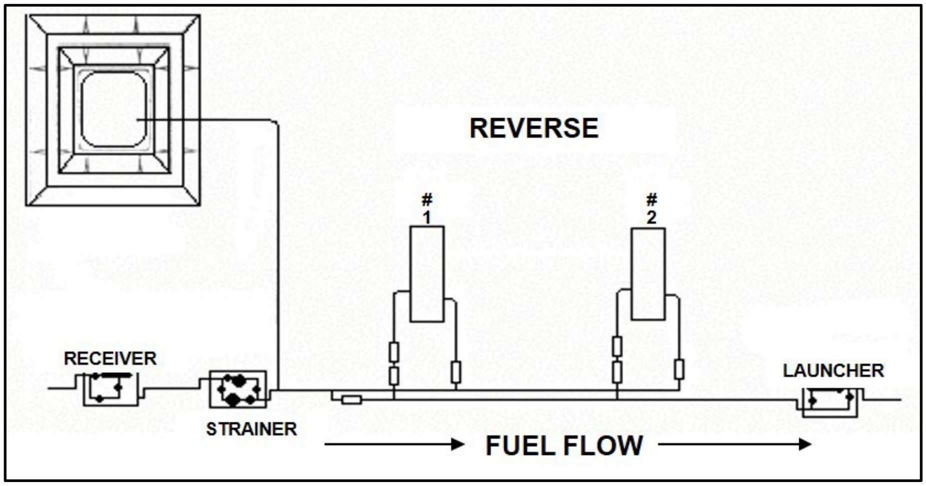


Figure 5-24. Reverse pump station layout

STRAINER ASSEMBLY

5-32. Install the strainer assembly by—

- Positioning the strainer (see figure 5-24) on the inlet side of the pump station. If the site allows, use one section of pipe or a full pipe pup joint between the strainer and the manifold. Remember to check the direction of flow. Connect two 90-degree, 3r elbows to both the inlet and outlet of the strainer assembly.
- Connecting a tee some place between the strainer's outlet elbow assembly and the pump. To this tee connect the 6-inch (15.24 centimeter) grooved to 1-inch (25.4-millimeter) nipple with ball valve. This is the source of fuel for the 3,000-gallon (11356.2353 liter) tank.

RECEIVER ASSEMBLY

5-33. Install the receiver assembly by—

- Positioning the receiver assembly (see figure 5-24) and connecting to the strainer assembly. Depending on available space and desired working area, connect the two using standard lengths of pipe, 19 foot (5.8 meters) or 9 foot, 6 inches (2.89 meters). Pup joints may need to be cut if standard pipe lengths cannot be used.
- Using 90 degree, 3r elbows to connect to the outlet (pump station end) of the receiver assembly. Connect the receiver assembly to the pipeline by using two 90-degree, 3d (long radius) elbows.

3,000-GALLON, COLLAPSIBLE, FABRIC TANK

5-34. The 3,000-gallon (11356.2353 liter), collapsible, fabric fuel tank must be within the 200-foot (60.96-meter) hose range of the pump fuel tanks and the connecting point on the incoming pipeline. Position the 3,000-gallon (11356.2353-liter) collapsible fabric tank to allow drainage away from the pump area in the event of a tank failure.

5-35. Connect the hose to the 1-inch (25.4-millimeter) valve, on the 6-inch by 1-inch (15.24-centimeter by 25.4-millimeter) reducer to fill the tank. Slowly open the 1-inch (25.4-meter) gate valve to prevent overpressuring the hose. Close the 1-inch (25.4-millimeter) gate valve when the tank is full. Do not attempt to fill the tank if the line pressure is greater than 150 pounds per square inch.

SECTION III – OPERATIONS

5-36. This section provides an overview of the Army IPDS pump station operation.

MAINLINE PUMP OPERATIONS

5-37. The pumping assembly (see figure 5-25) is a flat rack mounted, diesel engine driven, three-stage centrifugal pump, with an operational output of 6,800 gallons per minute (25740.8001 liters) at 1,800 feet (548.64 meters) of head. This rated capacity is delivered when any axis of the pumping assembly is positioned at any angle up to 5 degrees from the horizontal. The pumping assembly is suitable for operation at the design capacity and head from -25 degrees (-31.6667 Celsius) to 135 degrees Fahrenheit (57.2222 Celsius), and at any altitude from sea level to 9,000 feet (2743.2 meters) above sea level at an ambient condition of 100 degrees Fahrenheit (37.7778 Celsius). The operator's manual for the pumping assembly (national stock number [NSN] 432-01-193-34230) is TM 10-4320-307-10. Maintain mainline pump operations by—

- Ensuring the grounding cable is connected to a clean metal surface on the pump to establish a proper ground. Ensure tight electrical connections.
- Removing the two 5-foot (1.524 meters) ground rods from the storage bracket.
- Driving each ground rod into the ground to a minimum depth of 3 feet (.91 meters). Locate the ground rod as close as possible to the front or back edges of the skid.
- Connecting each skid-grounding pad to the corresponding grounding rod using the 6-foot uninsulated ground wire supplied. Ensure a tight electrical connection. (Wrap excess wire around the rod.)

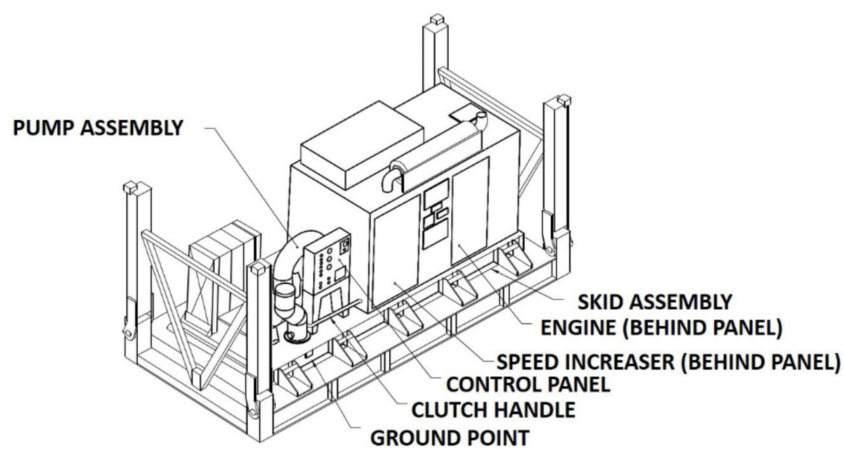


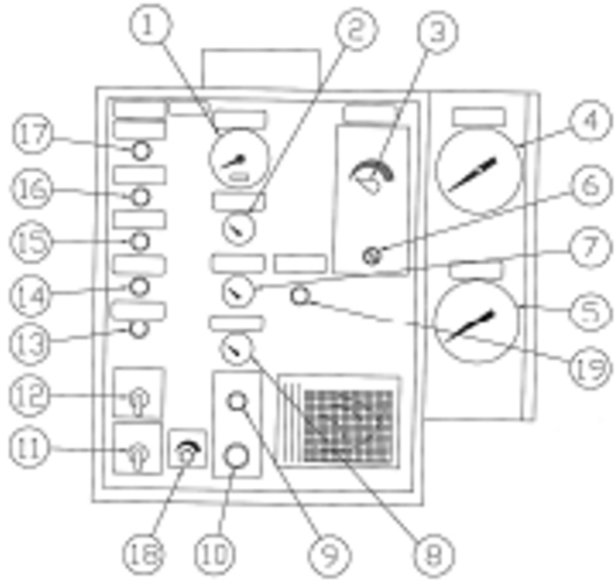
Figure 5-25. Mainline pump

CONTROL PANEL

5-38. All controls to start, operate, and shut down the pumping assembly are available to the operator on the control panel. Control panel layout is grouped by function and component application (see figure 5-26) to avoid buildup of explosive vapor mixtures in the panel enclosure. (If the pump is equipped with digital suction and discharge gauges, they are located on the control panel [see figure 5-27, page 5-20]. The analog suction and discharge gauges are relocated on the pump housing.)

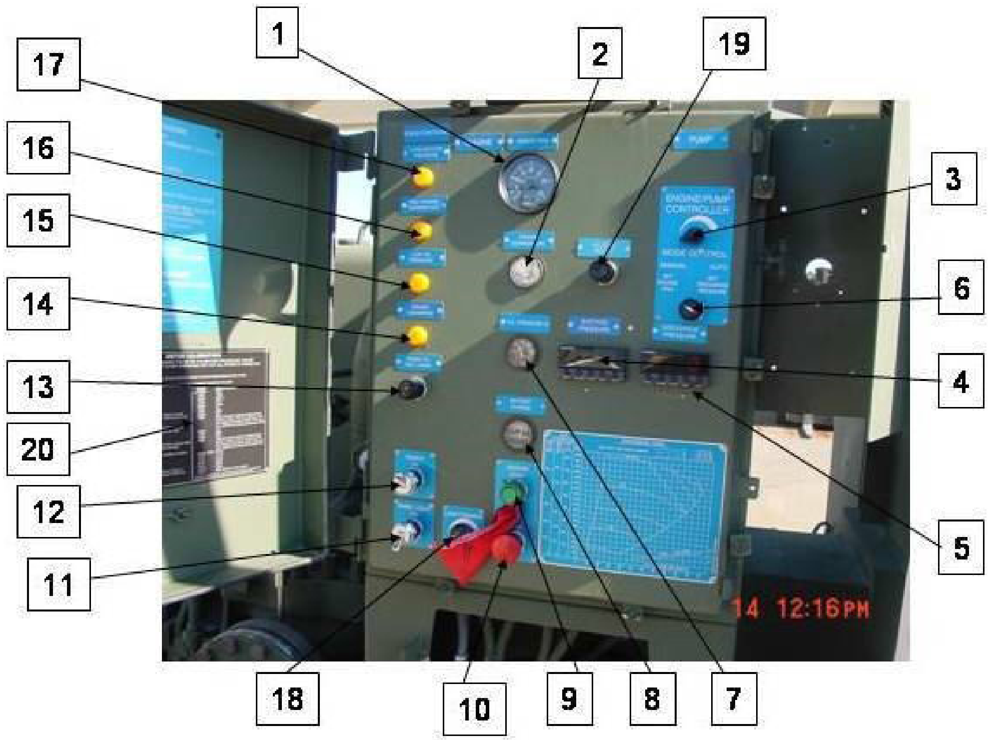
CLUTCH OPERATING LEVER

5-39. A manual clutch lever is located below the control panel. When engaged, the speed increasing gear transmits power from the engine flywheel to the pump shaft, matching optimum engine speed to optimum pump speed.



1. Engine Tachometer
2. Engine Coolant Temperature
3. Engine and Pump Control
4. Suction Pressure Gage
5. Discharge Pressure Gage
6. Engine Mode Control Switch
7. Engine Oil Pressure Gage
8. Battery Voltmeter Alarm
9. Start Switch Alarm
10. Pull To Stop Switch
11. Panel Lights Switch
12. Power Switch
13. Test Lamps Switch
14. Engine Over-speed Alarm
15. Low Oil Pressure Alarm
16. High Engine Temperature Alarm
17. Low Suction Pressure
18. Light Dimmer Switch
19. Reset Button

Figure 5-26. Analog control panel



1. Engine Tachometer
2. Engine Coolant Temperature
3. Engine and Pump Control
4. Suction Pressure Gage
5. Discharge Pressure Gage
6. Engine Mode Control Switch
7. Engine Oil Pressure Gage
8. Battery Voltmeter Alarm
9. Start Switch Alarm
10. Pull To Stop Switch
11. Panel Lights Switch
12. Power Switch
13. Test Lamps Switch
14. Engine Over-speed Alarm
15. Low Oil Pressure Alarm
16. High Engine Temperature Alarm
17. Low Suction Pressure
18. Light Dimmer Switch
19. Reset Button
20. Digital Gage Calibration Directions

Figure 5-27. Digital control panel

PUMP STATION START-UP

5-40. The following steps are required to put a pump station online:

- Check the pump units before the actual starting time. Perform before operation maintenance (preventive maintenance checks and services [PMCS]), and then start both pumps.
- To start the mainline pump—
  - Set the POWER ON/OFF switch to ON and then press and release the RESET button.
  - Set the PANEL LIGHT ON/OFF switch to ON if needed.
  - Set the MODE CONTROL MAN/AUTO switch to MAN.
  - Turn the ENGINE RPM/DISCHARGE PRESSURE control fully counterclockwise (low speed position).
  - Push the ENGINE STOP switch in.
  - Push the PRESS TO TEST LAMPS switch. Alarm lights should come on and then go off when the push button is released.

  - Verify that the clutch operating lever is in disengaged (down) position.
  - Push the ENGINE START switch. Keep the switch depressed (30 seconds) until the engine fires. If the engine fails to fire, refer to the technical manual troubleshooting chart.
  - After the engine starts, observe the ENGINE RPM gauge to verify that the engine is idling at its idle speed (approximately 800 to 1,000 revolutions per minute).
- Warm up the pumps, with the pump discharge valves closed, until the engines reach an operating temperature of 120 degrees Fahrenheit (248 Celsius) at an idle speed of approximately 800 to 1,000 revolutions per minute.
- Ensure that the mainline, bypass, and side valves on the receiver and launcher are in the proper position. (See paragraph 5-42 through 5-45 for correct position. The location of the different valves is shown on figure 5-30, page 5-23, and figure 5-32, page 5-24.)
- Ensure that the strainer is open and ready to operate.
- Open the suction valve on both pumps.
- If pressure is present, vent the air out of the pump case using the four vent valves in order, from lowest to highest vent. Open valve until fuel flows from the pump, then close the valve before proceeding to the next one. Use a drip pan to catch the discharged product.
- On the selected pump, when the pressure on the suction gauge reaches 100 pounds per square inch in pressure, or as otherwise directed by dispatch, engage the clutch and open the discharge valve very slowly to increase the engine speed to the discharge pressure required by the dispatcher. Ensure that the discharge pressure is increased while maintaining adequate suction pressure to prevent pump cavitation or low suction pressure shutdown. If adequate suction pressure cannot be maintained during start-up, notify the dispatcher. Once the set point is maintained, notify the dispatcher.
- Shut down the standby pump after the start-up discharge pressure has been attained.

SCRAPER OPERATIONS

5-41. Scrapers (see figure 5-28) are used to enhance and speed the initial purge and fill operations, separate products in the pipeline to reduce the amount of commingled fuel, and to clean the pipeline of contaminates and obstructions that cause pressure drop. Over a period of time debris, scale, and particles that settle out of fuel, may collect or build up in the pipeline. Scrapers are run through the pipeline to keep the debris from building up in the line. The pipeline dispatcher schedules the scraper operation on a pumping order. Scrapers are run from the launcher (see figure 5-28) at one pump station to the receiver at the next pump station. There is a scraper indicator on each barrel that shows when the scraper has been launched and received. By walking along the pipeline, you can hear the scraper as it passes each coupling.

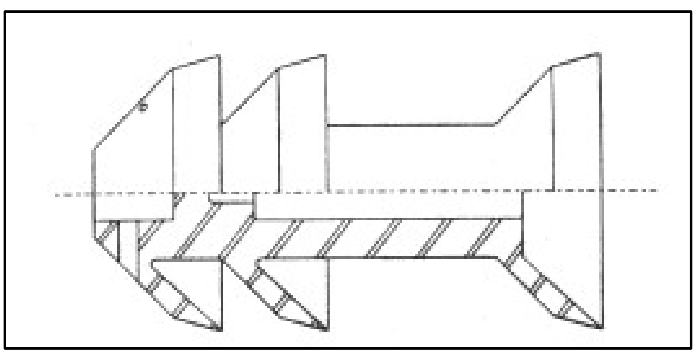


Figure 5-28. Scraper

- Launch the scraper into the pipeline by—

Note. The launcher is in "wet barrel" condition with barrel flooded and under pressure.

  - Ensuring that the launcher bypass valve is fully open.

- Closing the side and mainline valves to isolate the barrel of the launcher assembly.
- Opening the launcher assembly vent valve to relieve pressure from barrel.
- Opening the drain valve and drain the fuel from the launcher barrel into a container.
- Opening the safety vent (but do not remove) on the end closure, and then open the launcher barrel end closure (see figure 5-29) (use jacking screw if necessary).
- Inserting the scraper into the launcher barrel. Push the scraper as far as it will go into the launcher barrel.
- Closing and tightening the end closure, closing the safety vent valve, and closing the drain valve (see figure 5-30).

Note. Close the safety vent valve only hand tight. If it leaks after the barrel has been filled, use a crescent wrench to tighten.

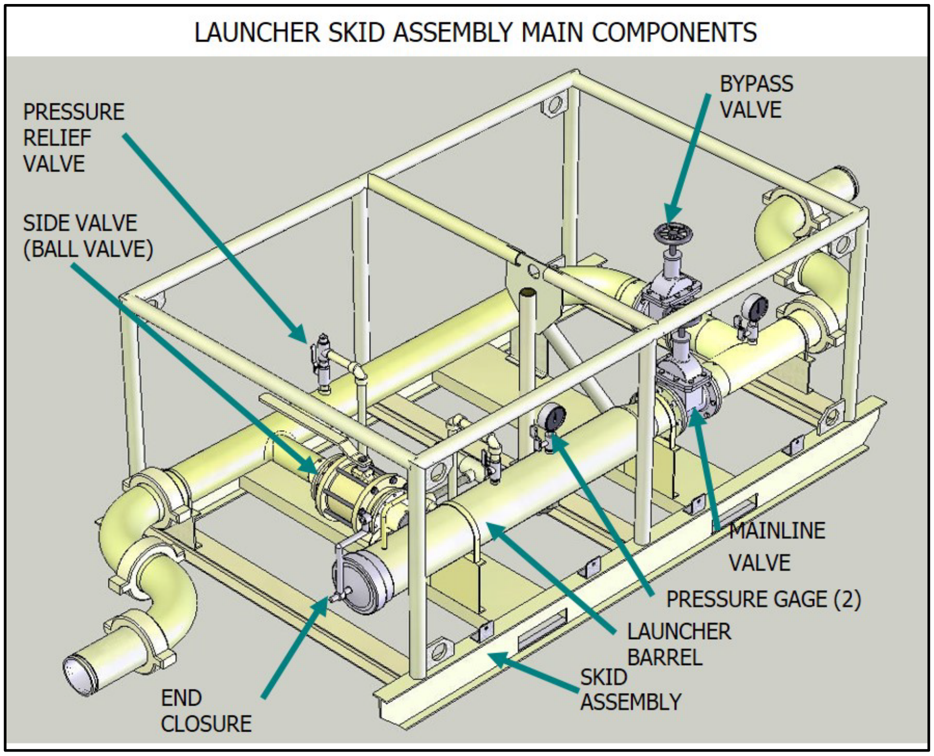


Figure 5-29. Launcher skid assembly

- Setting the scraper indicator by pushing the flag down (see figure 5-31.)

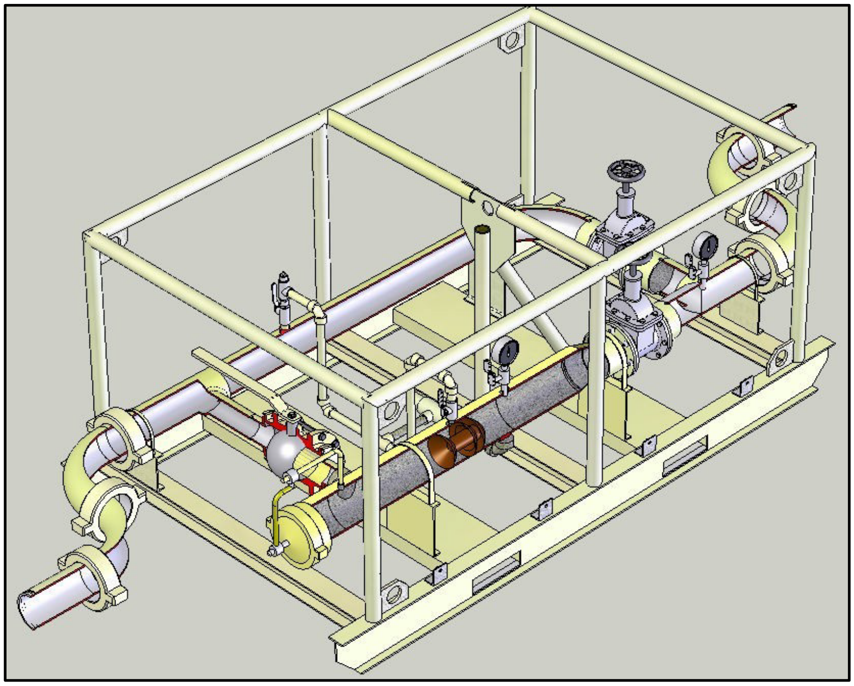


Figure 5-30. Launcher, end closure cap secured for operation

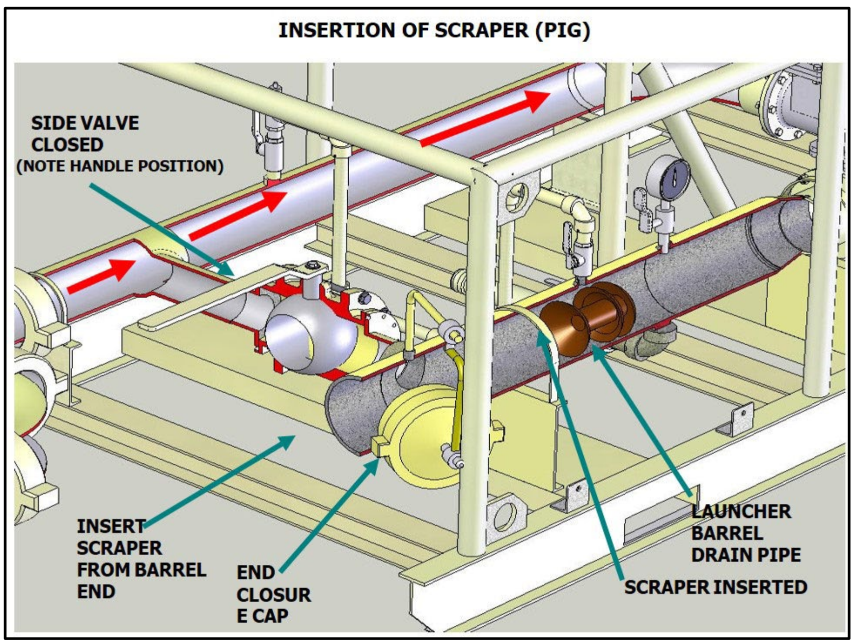


Figure 5-31. Launcher, pig insertion exploded view

- Slowly opening the side valve all the way.
- Closing the launcher assembly vent valve when the barrel is full.
- Slowly opening the mainline valve all the way when told by the dispatcher to launch the scraper.
- Slowly closing the bypass valve. As the bypass valve is closed, the flow is diverted through the barrel causing the scraper to be carried or forced into the pipeline.

- Watching the scraper indicator to verify that the scraper has been launched (notify the dispatcher the moment the scraper is launched).
- Opening the bypass valve after the scraper has cleared the scraper indicator. (See figure 5-32.)

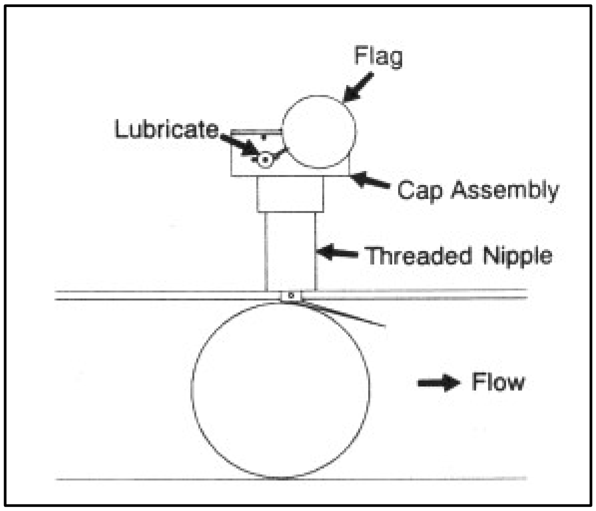


Figure 5-32. Scraper indicator

- Receive the scraper by—

Note. The receiver (see figure 5-33 and figure 5-34) is in "wet barrel" condition with barrel flooded and under pressure.

- Checking to ensure that the barrel closure is tight and not leaking.
- Checking to ensure that the safety relief bolts and chain are in place.
- Checking to ensure that the valves are properly positioned.
- Ensuring that the side and mainline valves on the receiver assembly are open.
- Ensuring that the bypass line is closed.
- Setting the scraper indicator in the down position.

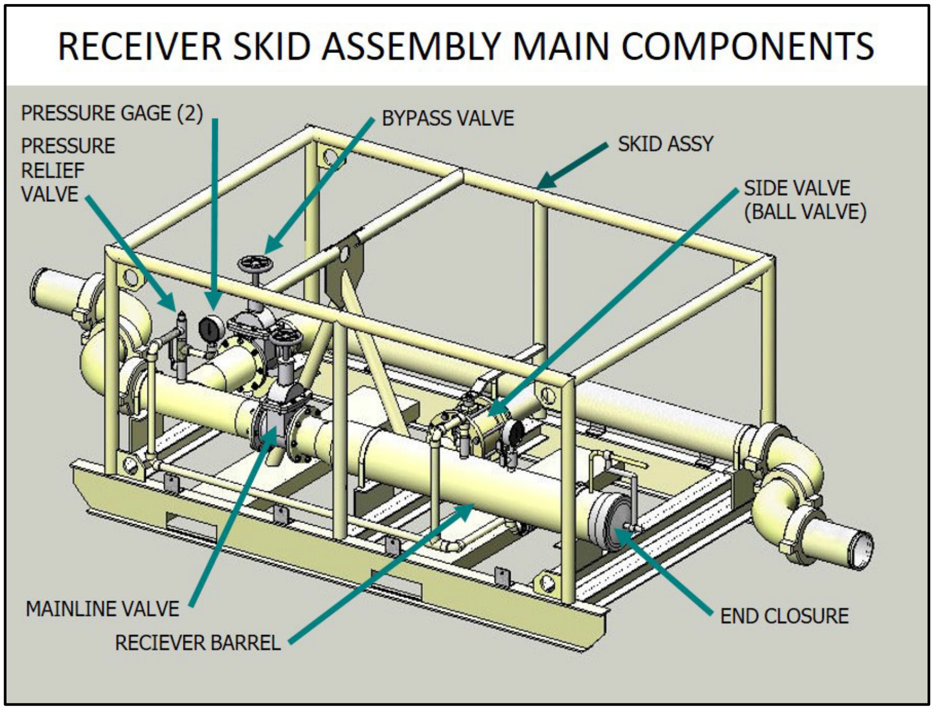


Figure 5-33. Receiver

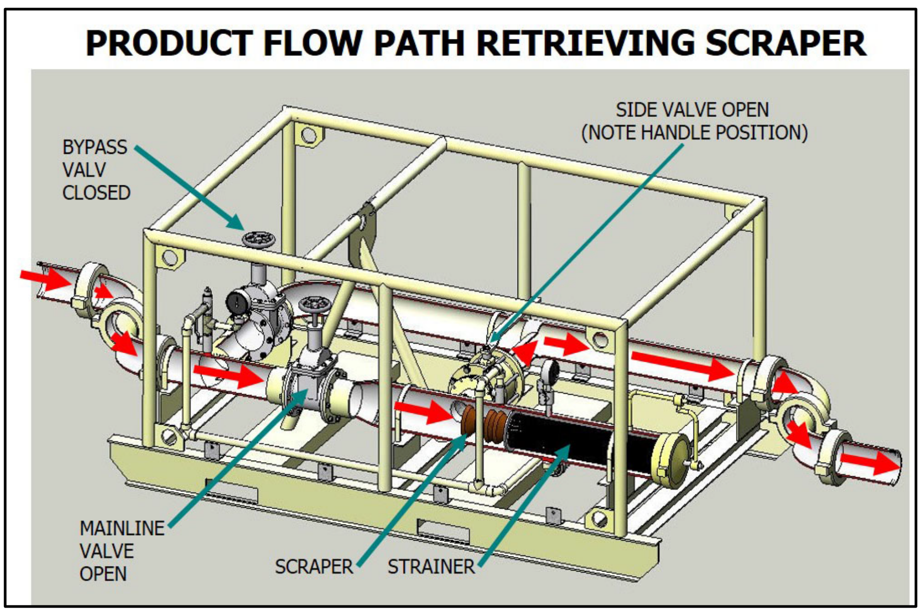


Figure 5-34. Receiver, flow receiving scraper

- Remove the scraper from the receiver by—

Note. The scraper indicator will pop up when the scraper has entered the receiver barrel.

  - Notifying dispatcher of scraper arrival.
  - Setting the product flow (see figure 5-35, page 5-26).
  - Opening the bypass valve.

- Closing the mainline and side valves.

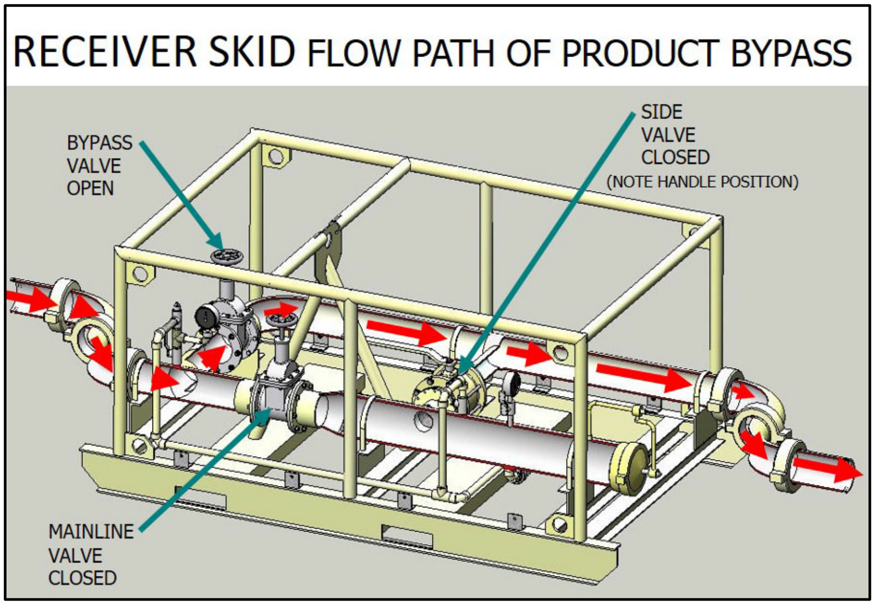


Figure 5-35. Receiver, flow before removing scraper

- Opening the receiver barrel vent, and draining the valve. Drain the product into a suitable container.
- Opening the safety vent and then opening the receiver barrel end closure.
- Removing the scraper, cleaning out the receiver barrel, and replacing the sleeve strainer into the barrel. (See figure 5-36.)

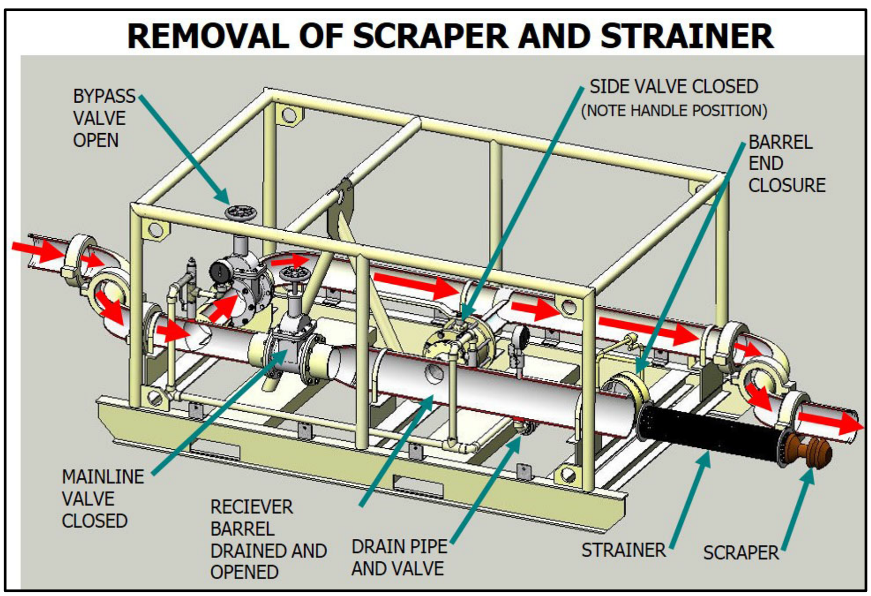


Figure 5-36. Receiver, removing scraper

- Closing and tightening the end closure and closing the safety vent.

Note. Tighten the safety vent only hand tight.

    - Closing the drain valve.
    - Opening the side valve slowly to fill the receiver with fuel and closing the receiver barrel vent.
    - Opening the mainline valve and closing the bypass valve after the receiver barrel is full.
    - Operating the receiver with the mainline valve open, the side valve open, and the bypass valve closed. The purpose for this configuration is to allow foreign matter and debris to be stained out of the product via the sleeve strainer.
- During normal pumping operations, leave the mainline and side valves open and close the bypass valve.

STRAINER ASSEMBLY OPERATIONS

5-42. Strainer assemblies protect the pumps from foreign objects in the pipeline.

STRAINER ASSEMBLY

5-43. A strainer assembly is installed in the pump stations, on the incoming side of the pumps to protect them from damage from dirt or other debris in the pipeline. The strainer assembly will remove debris .025-inch (635-microns) and larger in diameter. The skid-mounted steel strainer assembly has two separate, in-line vertical strainers. Quick opening closures allow access to the canister-shaped, wire-mesh baskets. Each strainer has a differential pressure gauge. The two gate valves for each strainer allow either strainer to be isolated for cleaning purposes.

5-44. The strainer assembly protects the mainline pump, trapping debris that could damage the pumping mechanism. During normal pumping operations, one strainer is in service at a time while the other strainer is on standby. The standby strainer will be in the wet barrel mode by first closing the inlet valve, opening the discharge valve, and finally purging the air from the strainer housing. The purpose of leaving the discharge valve open and the inlet valve closed on the strainer that is not in service is to avoid the possibility of excessively high (over) pressure occurring due to thermal expansion, and allow changing the strainers over quickly when the in-service differential pressure gauge indicates debris buildup.

5-45. During normal operations, one strainer (see figure 5-37, page 5-28) is in service at a time, with the other strainer on standby. Inspect line strainers often and clean on an as-needed basis. The frequency of cleaning depends on the quality of the petroleum product, the general cleanliness of the pipeline, and quantity of product pumped through the strainer assembly. The differential pressure gauge, mounted on each strainer, is color-coded and the pressure gauge is graduated to indicate the difference of pressure coming into and going out of the strainer. Although the pressure differential gauge (see figure 5-38, page 5-28) is color coded green up to 20 pounds per square inch, clean the line strainer when the pressure increases 5 pounds per square inch from the reading when the strainer was first placed in service. For example, the strainer is placed in service on 5 April and the pressure differential reads 7 pounds per square inch. On 23 April the pressure differential reads 12 pounds per square inch. There is a pressure differential difference of 5 pounds per square inch, making it necessary for the strainer to be taken out of service and cleaned.

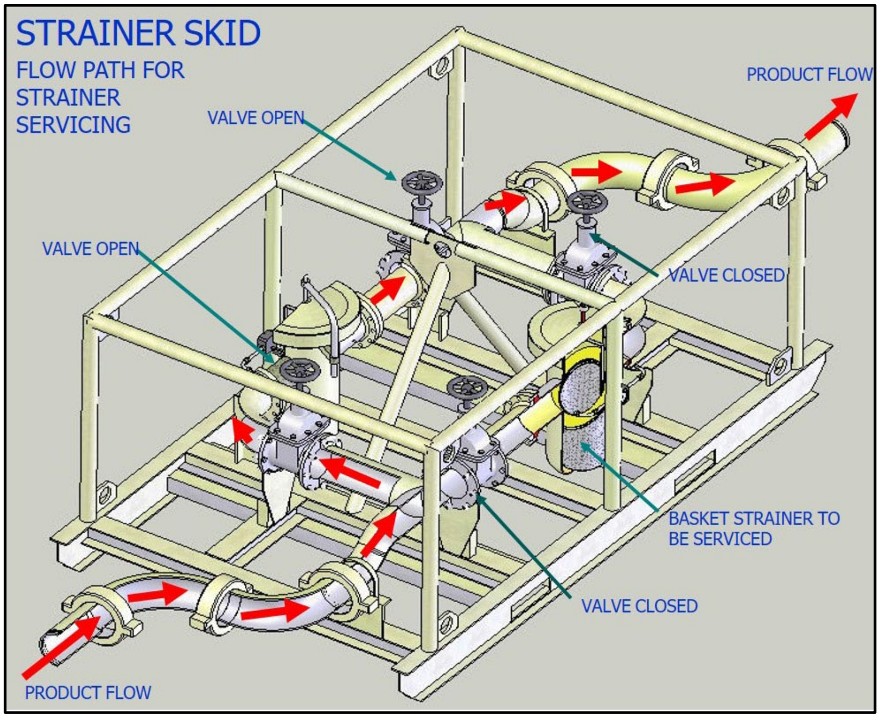


Figure 5-37. Strainer

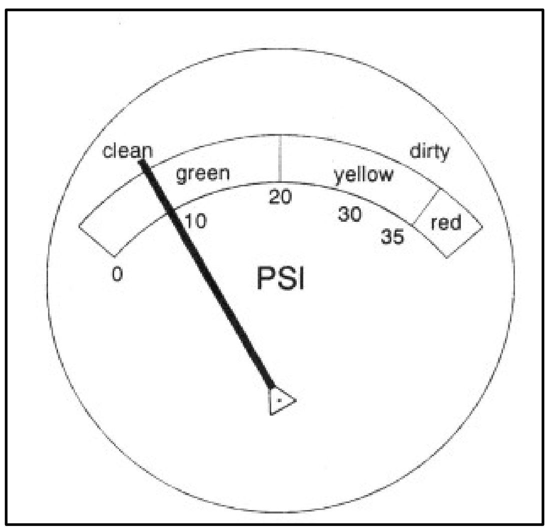


Figure 5-38. Differential pressure gauge

CLEANING

5-46. Strainer assembly (see figure 5-39) cleaning procedures include—

- Opening the gate valves on each side of the standby strainer. The outlet valve should already be open.
- Closing the gate valves on both sides of the strainer to be cleaned.
- Placing a container nearby to catch residual fuel and holding the wire-mesh strainer basket removed from the strainer.
- Opening the vent valve.

- Opening the drain valve slowly and draining enough fuel to give access to the strainer basket (about 5 gallons [18.93 liters]). Ensure that the container is large enough to hold the drained fuel.
- Removing the safety vent bolt from the top of the strainer closure.
- If the basket strainer cover cannot be turned by hand, loosen the cover with the jacking screw until the cover can be turned by hand. After the cover is open, swinging the cover out of the way.
- Carefully lifting out the wire-mesh basket. Do not allow the basket to hit against the housing. This could damage the basket and/or cause debris to drop down into the housing.

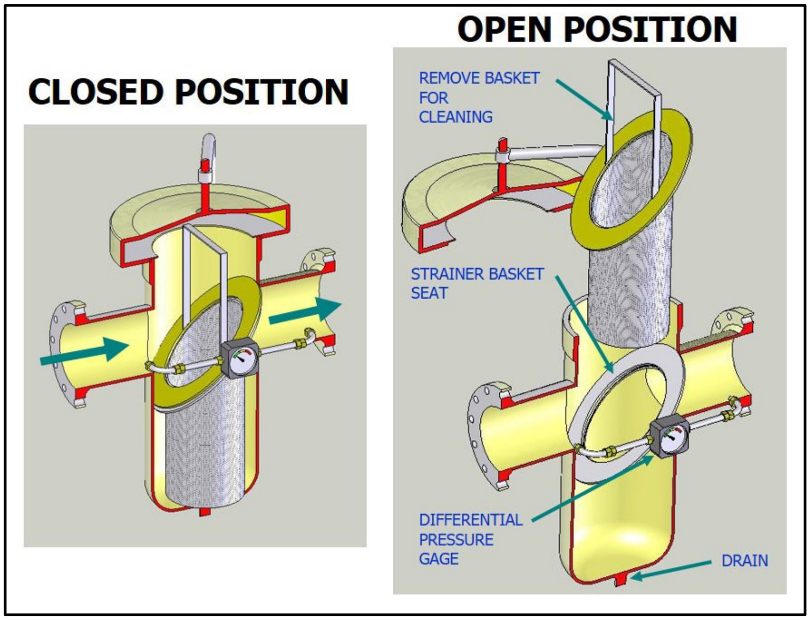


Figure 5-39. Strainer basket

- Cleaning the basket by—
  - Using a nonmetallic hand brush to clean the strainer mesh if necessary.
  - Removing any gum or tar from the outside of the basket with dry-cleaning solvent.
- Inspecting the basket for rust.
- Inspecting the O-ring gasket on the strainer cover and grease.
- Replacing the basket after it has been cleaned.
- Checking the height adjustment of the all-thread bolt on the top of the strainer basket. The end of the bolt must be even with the top of the O-ring in the top edge of the closure. This keeps the strainer basket in place during operation.
- Swinging the cover back into place and turn to the right until hand tight. If the cover leaks when placed back in operation, then use the jacking screw to tighten the cover ONLY enough to stop leaks or seeps.

Note. The cover is very heavy; ensure that fingers are not caught under it as it is replaced.

- Replacing and tightening the safety-vent bolt.
- Opening the gate valve on the outlet side of the cleaned strainer and bleed the air using the vent valve.
- Bleeding air from the strainers during operations using the vent valve on the side near the top of the strainer. The air should be bled every 15 minutes until no air is observed, then every hour.

ROTATION OF PUMP OPERATION

5-47. To rotate (change) which pump is being operated at the pump station, pump station personnel will—

- Perform before operation maintenance (PMCS) on the standby pump. Start and warm up the standby pump engine with the discharge valve closed.
- Open the standby pump suction valve.
- Vent the air out of the pump by using the four vent valves, in order, from lowest to highest. Open each valve until product flows from the pump, then close the valve before proceeding to the next one. Use a drip pan to catch discharged product.
- When the standby pump has reached operating temperature (120 degrees Fahrenheit [248 Celsius]), engage the clutch and open the standby pump discharge valve very slowly. Ensure that the pump control is in manual mode and increase the pump engine speed, thereby increasing discharge pressure to match that of the operating pump.
- On the pump to be taken off-line, decrease the discharge pressure to the minimum setting. Disengage the clutch, close the discharge valve, and allow the engine to idle for about 1 minute to cool.
- Stop the pump engine of the pump just taken off-line. Close the suction valve, open the top vent valve, and perform after operation maintenance (PMCS).

PIPELINE SHUTDOWN

5-48. When the system is shut down, the dispatcher will normally shut down the pipeline under “packed line” conditions. When sections of the pipeline or valves may require removal for maintenance, the dispatcher may direct sections of the pipeline to be shut down under “slack line” conditions. The dispatcher will set the shut-down pressures and sequence of shut down for each pump station.

Note. The dispatcher may direct some section of the pipeline to be shut down under pressure and other sections under slack conditions.

5-49. As directed, each station will—

- Under “packed line” conditions, shutdown pump stations one at a time from the last pump station to the first pump station by—
  - Decreasing the discharge pressure control slowly counterclockwise until the directed set pressure is obtained.

Note. Since the system recommends a minimum of 100 suction inlet pressure on each pump station, normally the system is not shutdown with less pressure; however, the dispatcher may direct it to be shutdown at a higher or lower pressure.

  - Disengaging the clutch.
  - Closing the discharge valve.
  - Closing the suction valve.
  - Venting the pump case pressure with the top vent valve.
  - Letting the engine idle for about 1 minute to cool.
  - Pulling the engine stop-switch, turn off power, and perform after operation checks (PMCS).
- Under “slack line” conditions, shut down pump stations one at a time from the first pump station to the last pump station by—
  - Decreasing the discharge pressure control slowly counterclockwise until zero discharge pressure is obtained.
  - Disengaging the clutch.
  - Closing the discharge valve.

- Closing the suction valve.
- Venting the pump case pressure with top vent valve.
- Letting the engine idle for about 1 minute to cool.
- Pulling the engine stop-switch, turn off power, and perform after operation checks (PMCS).

SYSTEM SHUTDOWN

5-50. When shutting down operations for any length of time, there are steps taken to protect the pump station and pipeline from pressure buildup caused by temperature changes. The pump station and the pipeline must be isolated from each other. The following steps must be accomplished to protect the pump station and pipeline while pumping operations are suspended for extended periods.

5-51. Within the pump station (see figure 5-40)—

- Leave all open valves in the strainer assembly in the open position.
- Open the top vent valve on each pump after closing both suction and discharge valves on each pump.
- Block in the pipeline by closing the bypass and side valves and opening the leave mainline valve on the receiver assembly. This allows excess pressure to bleed off the pipeline through the thermal relief valve on the receiver assembly of the upstream pump station.
- Block in the pump station by closing the side and bypass valves, and opening the mainline valve on the launcher assembly. This allows excess pressure to bleed off from within the pump station through the thermal relief valve on the launcher assembly.

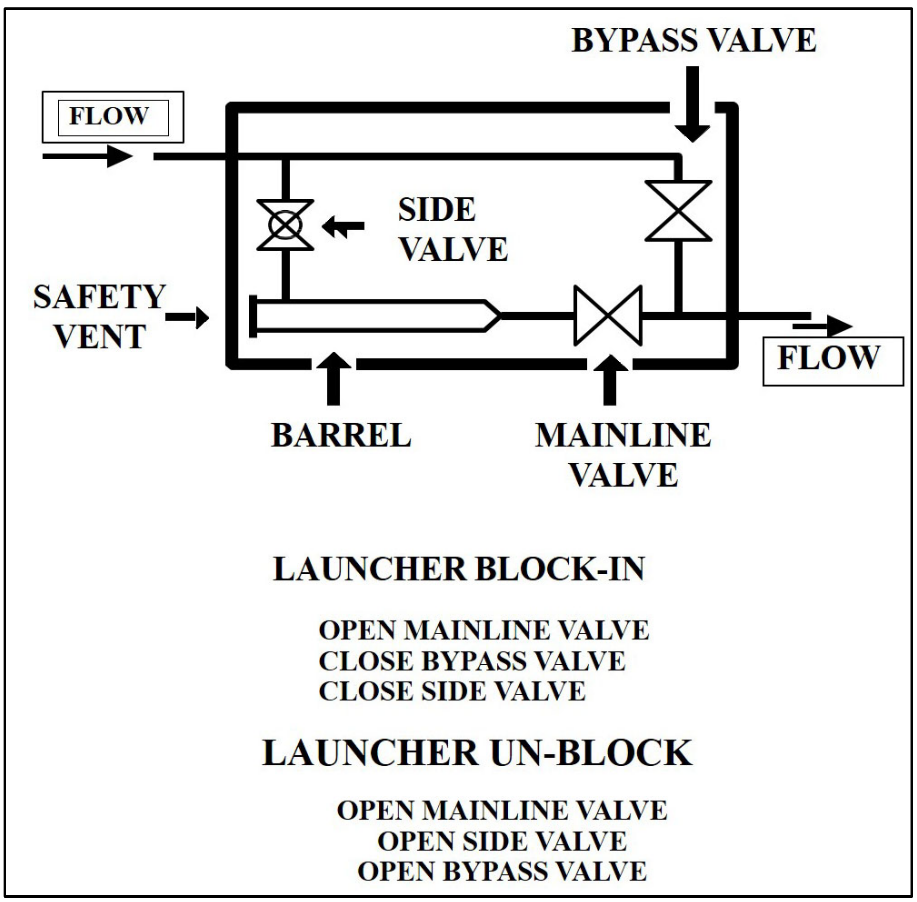


Figure 5-40. Launcher block-in and unblock procedure

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Chapter 6

Pipeline Fill and Test

This chapter is an overview of the fill and test procedures.

SECTION I – FILL AND TEST

6-1. The commander of the unit that constructed the pipeline segment, is responsible for coordinating the testing and inspection of that segment before turning it over to the operating unit. This is according to ATP 4-43. He conducts testing and inspection, normally conducted jointly by representatives of the constructing unit and the operating unit.

FILL OPERATION

6-2. The fill operation uses a product suitable for testing and must remove all the air from the pipeline. Water is the preferred test product because of its availability, cost, and low environmental impact in the event of leaks; however, fuel may be used at the discretion of the commander and as the situation dictates. The pressure test proves the integrity of the system and its ability to operate. Tests pressure is limited to the maximum allowable operating pressure of 740 pounds per square inch at any point in the system.

6-3. During the test, repair crews should stand ready to deploy to repair the pipeline if a leak is identified. More than one test may have to be performed to prove the pipeline suitable for use. If the inspection and test results are not within established standards, the commander of the operating unit may reject the pipeline as unsuitable for use. The pipeline is turned over to the operating company when the certificate of operability is signed.

PRETEST ACTION

6-4. Water is used throughout this chapter as the test medium. The strategic and tactical situations, as well as availability, may dictate another test medium. However, water should be used whenever it is possible to do so and there should be compelling reasons not to use water.

- Test all communications equipment. Dependable, continuous communications are required during operations all along the test segment and with all parties involved.
- Check the accuracy of all pressure gauges involved in the test. A deadweight tester is used for this purpose.
- Ensure that there are sufficient coupling clamps, gaskets, repair clamps, and tools available to perform repairs.
- Develop and follow a test plan to conduct the actual test. The test plan will include—
  - Determine the quantity of test medium and what segments are to be filled and tested.
  - Fill sequence, air evacuation, and monitoring plan.
  - Test pressures at pump stations or other locations.
  - Block-in sequence to isolate test segment(s).
  - Communication and reporting requirements.
- After all the pipeline equipment, pipes, valves, and fittings are physically connected, there should be a meeting of all personnel working with the testing program. Review and discuss each phase of the test plan, including a detailed communication plan.

- Ensure that mainline gate valves are completely open, check valves have been installed correctly (arrows on valve point in direction of flow), drain valves are closed, and vent valve assemblies are open and attended.

6-5. Compute test pressure—

- **Elevation.** Determine the elevation of the beginning and end of the test segment and of the low point in the test segment. For example—
  - Start point 200 feet (60.96 meters).
  - Low point 120 feet (36.57 meters).
  - End point 240 feet (73.15 meters).
- **Elevation distance.** Determine the distance between these points. For example—
  - Start point 200 feet (60.96 meters).
  - Low point 120 feet (36.57 meters) (plus) for 6.2 miles (10 kilometers).
  - End point 240 feet (73.15 meters) for 4.8 miles (7.724 kilometers).
  - Total test segment length 11 miles (17.7 kilometers).

6-6. The maximum working pressure of IPDS pipe is 740 pounds per square inch. As the highest pressure during the test will be at the low point, the beginning point pressure must be set not to exceed 740 pounds per square inch at the lowest point in the line.

6-7. The low point is 80 feet (24.384 meters) lower than the starting point. Divide 80 feet (24.384 meters) of head by 2.31 conversion factor and this equates to 34.6 or 35 pounds per square inch of water gained by pumping down hill. If the desired low point pressure is 740 pounds per square inch, the starting point pressure will be 705 pounds per square inch. This disregards the pressure loss due to friction in the pipe because the actual test is performed under static conditions.

6-8. The end point is 120 feet (36.57 meters) higher than the low point. Divide this by 2.31 and 51.9 or 52 pounds per square inch of water is lost, so the pressure at the end point should read 688 pounds per square inch.

6-9. Estimate the line fill and the amount of time required to fill the line using the total length of the test segment. Each mile of pipe holds about 8,820 gallons (33387.33 liters) of product. Multiply this by the number of miles of pipe in the test section (11) to get the total line fill (97,020 gallons [367260.65 liters]). If we fill at a 400 gallons per minute (1514.16 liters per minute) rate, it will take over 4 hours to fill the test section.

PIPELINE FILLING PROCEDURES

6-10. The pipeline scraper is loaded in the launcher and the launcher valves are positioned to avoid accidental scraper launching.

6-11. The receiver at the end of the test segment is set up to receive the scraper. The drain valve is open (air will be vented through the receiver drain), the bypass valve closed, and the side valve and mainline valve are open.

Note. If the pump station construction is complete, close the suction and discharge valves on the pumps, let some flush water go through the pump station manifolding, and past the launcher. If pump station construction is not complete, connect a length of 6-inch (15.24 centimeter) hose, using a double-groove to single-groove adapter from terminal supplies, to the outlet of the scraper receiver to direct air and flush water away from the station site.

6-12. Slowly pump approximately 3,000 gallons (11356.2353 liters) of flush water into the line, then launch the scraper.

6-13. Fill the line at approximately 300 gallons per minute (1135.62 liters per minute) to 400 gallons per minute (1514.16 liters per minute) flow rate. The scraper will travel at approximately 2 miles per hour (3.21

kilometers per hour) with a 300 gallons per minute (3.21 kilometers per hour) flow rate. Once filling begins, pumping should be steady and continuous until the segment is filled and the scraper is received.

6-14. During filling, the constructing unit patrols the pipeline following the scraper. Any leaks discovered are to be marked. The severity of the leak will dictate if pumping should be stopped for repairs. Sometimes a leak can be corrected simply by moving the coupling around to help seat the gasket. Close the vent valve assemblies after the scraper passes them and an unbroken stream of flush water is evident.

6-15. After the scraper has arrived in the receiver, close the downstream valve of the test segment, plus the receiver side valve and bypass valve on the receiver at the end of test segment. If downstream pump station manifolding is included in the test, close the launcher valves also.

6-16. The discharge pump station should allow the pressure to stabilize in the pipeline. If necessary, slowly increase pump engine revolutions per minute and increase the discharge pressure slowly in 50 pounds per square inch, or smaller, increments allowing the pressure to stabilize in the pipeline after each increase.

6-17. Close the discharge pump station launcher valves and bring the pump offline. If the discharge pump station's manifold is to be included in the test, close the pump discharge valve, and then bring the pump offline.

6-18. The line should be patrolled and be under constant surveillance during the test period. Leaks should be marked, repaired, and again the severity of the leak will dictate if isolation and repairs should be performed. Pipe movement will occur; therefore, locations for more sand bags, stakes, or anchors also need to be marked.

6-19. For a test to be successful and result in issuance of the certificate of operability, the test pressure must be maintained until the pipeline has been visually inspected by foot patrol (usually about 4 hours) with no drop in pressure.

CERTIFICATE OF OPERABILITY

6-20. The constructing unit prepares a certificate of operability, after the pipeline has been tested, inspected, and verified that it is constructed to standard. The commanders of both the operating unit and the constructing unit must sign the certificate. The signed certificate is forwarded to higher headquarters, with both the operating unit and the constructing unit maintaining a copy for their records. The certificate contains the following:

- A statement as to the operability of the tested segment and its acceptance by the operating unit.
- The section and actual mileage of the tested segment.
- The pipeline was constructed and tested to standard (hydraulic profile and design parameters).
- The testing pressure used.
- The test method (medium used) and the duration of the test.

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Appendix A

Cutting and Grooving Machine

This appendix provides an overview of the cutting and grooving machine

SECTION I – INTRODUCTION

A-1. The cutting and grooving machine can be used for pipe sizes 4 inch (10.16 centimeter), 6 inch (15.24 centimeter), and 8 inch (20.32 centimeter). This machine utilizes cutters made from cobalt alloy high-speed steel that can simultaneously cut and groove in one operation. A fixed tool slide is utilized for cutting the pipe, while a spring-loaded tool slide performs grooving, true to the outside dimension of the pipe. The cutting and grooving machine are engineered for fast, precise, reliable, pipe cutting and grooving. Ship the machine in a high impact, heavy-duty, molded plastic storage case. Inside the storage case is a molded foam insert that keeps the components of the machine from damage during handling. All operating tools, fixed tool slide, spring-loaded tool slide, and clamp feet for 4-inch (10.16-centimeter), 6-inch (15.24-centimeters), and 8-inch (20.32-centimeter) pipe diameters are included with the machine, and are necessary for its operation.

A-2. Machine specifications include—

- Machine capacity: 4-inch (10.16 centimeter), 6-inch (15.24 centimeter), 8-inch (20.32-centimeter) pipe.
- Machine functions: Cut-off and IPDS single groove pipe.
- Cutting tool surface speed: Approximately 60 surface feet per minute (18.29 meters per minute).
- Radial feed rate: From .0 to .006 inches (0 to 152.4 microns) per revolution. (Factory preset at .0022 [55.88 microns].)
- Drive requirements are shown in table A-1.

Table A-1. Drive requirements

Hydraulic	Pneumatic	Electric
• 6 gallons per minute (22.7125 liters per minute) at 1,800 pounds per square inch	• 65 cubic feet per minute (1,840.60 liters per minute) • 90 pounds per square inch • 3,000 revolutions per minute • Torque: 112 • Horse power: 1.5	• 24 volt, 40 amperes • Duty cylinder 15 minutes • Service factor: 1.0 • Horse power: .5

A-3. Grooving tool safety considerations.

- Never wear loose clothing or jewelry around rotating machinery.
- Always wear gloves, safety glasses, and hearing protectors when operating the cutting and grooving machine.
- Use a coolant (cutting oil) during operation.
- Always use a sharp cutting bit.
- Ensure that the adjustable clamp pad has been tightened properly.

- Always disconnect the machine from the power supply when mounting or removing the cutting and grooving machine.
- Before operating the motor drive, ensure that all personnel are clear.

SECTION II – SET UP AND OPERATION

A-4. This section discusses the set up and operation of the cutting and grooving machine.

INSPECTION AND SET-UP

A-5. Before the machine is removed from the carrying case, ensure that the inner ring locking pins are engaged. This will prevent inner and outer rings from spinning independently, making it difficult and dangerous to handle. If lock pins are not engaged, ensure that the splits are lined up. The splits will be lined up when the spring-loaded tool slide is at the top of the machine and the arrow tips are aligned. When this is accomplished, the locking pins can be engaged. The machine can now be safely removed from its case. The following checks must now be made:

- The tool slides are retracted.
- The required clamp pads and fixed feet are installed.
- The proper follower wheel adapter for the pipe being machined is on the spring-loaded slide.

A-6. To replace the fixed feet, the clamp pad, and/or the follower wheel adapter, the following procedures must be used:

- Remove the 2-foot (60.96-centimeter) mounts, (item 10, figure A-1) that secure the fixed feet to the inner ring. Install the required fixed feet for the required pipe size being used according to table A-2 (see figure A-2, page A-4).
- Located in the machine's outer ring, 90 degrees from the split, is an access hole. Insert a 3/8-inch Allen wrench into the hole, and turn the clamp pad screw in a clockwise fashion until the pad becomes disengaged from the inner ring (item 2, figure A-1). With the wrench still in the hole, locate and grasp the new clamp pad screw and guide the new clamp pad into the hole. Raise or lower the clamp pad in the pocket by turning the wrench accordingly.
- Using a 3/16-inch Allen wrench, remove the wheel follower axle, (item 87, figure A-2) and install with the wheel, (item 85, figure A-2) into either the wheel follower spacer, (item 95, figure A-2), or the female tool block (item 82, figure A-2).

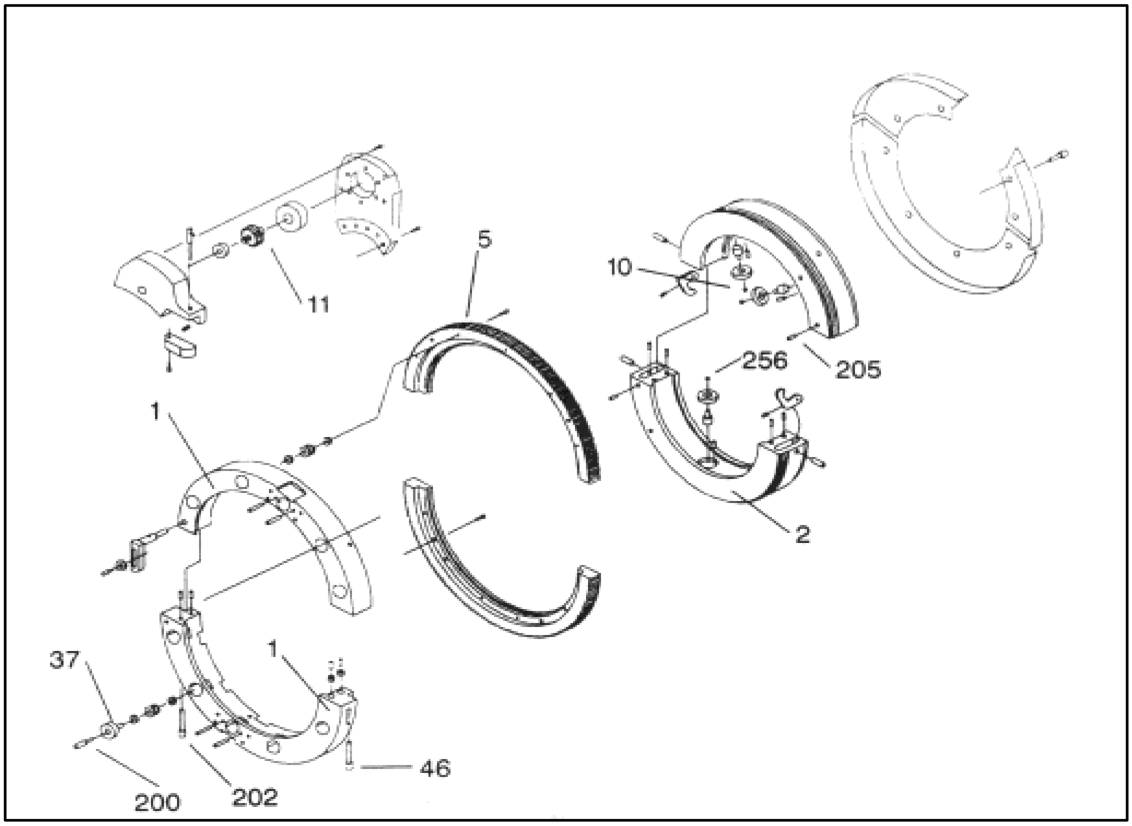


Figure A-1. Main frame assembly exploded parts view

Table A-2. Main frame equipment specifications

Split Frame (SF) 408	Fixed Foot	Clamp Pad	Wheel Follower Spacer Block
8-inch pipe (20.32 centimeter)	10-100-21	44-068-02	None
6-inch (15.24-centimeter) pipe	10-100-22	44-068-06	10-100-31
4-inch (10.16-centimeter) pipe	10-100-23	44-068-14	10-100-31 and 10-100-31.

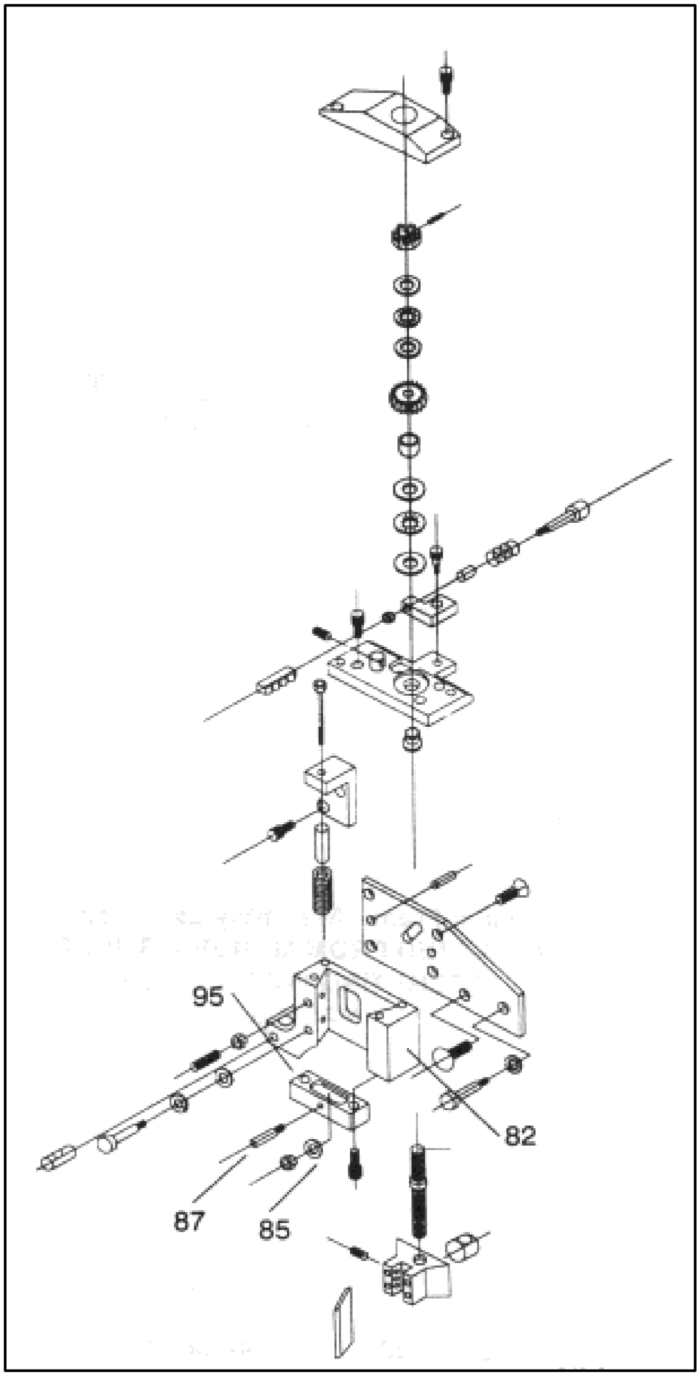


Figure A-2. Spring-loaded tool slide

MACHINE INSTALLATION PROCEDURES

A-7. Before trying to install the machine on the pipe, remove the arm located on the spring-loaded tool assembly to the upper position using the T-handled hex head tool. Once the machine is installed on the pipe to the proper cut line, the pivot arm must be moved to the lower position to lock the wheel follower to the pipe. If the machine is to be used on the open end of a pipe, check the latch-lock set screws (item 205, figure A-1, page A-3) and clamp screws (items 46 and 202, figure A-1) for tightness. When these screws are tight, the machine can be slipped over the open pipe end.

A-8. If the cut is to be made in the middle of a piece of pipe, the machine must be split open for installation. Begin the separation by loosening the two inner ring latch lockset screws (item 205, figure A-1), located on the face of the inner frame split. To avoid interference problems, back the head of the setscrews out of the housing approximately 1/4 inch (6.35 millimeter).

A-9. In the outer ring at the separation points, on the outside of the split, are two 5/16-18 screws, (items 46 and 202, figure A-1, page A-3). Begin by loosening the cap screw on the hinged side, which has the slotted hinge plate joining the two halves, 11 to 12 full turns. Next, loosen the cap screw securing the opposite split until it becomes disengaged from the opposing half. Now, with the machine firmly supported, pull the machine apart and swing it open.

Note. The machine will not pivot until the stripper bolt, located in hinge plate, reaches its maximum travel in the slot.

A-10. Mount the machine over the pipe so the two fixed clamp pads are situated at the top of the pipe at 10 and 2 o'clock and the adjustable clamp foot is situated at 6 o'clock to support the machine's weight. This will also aid in the machine's alignment. Swing the machine up and push the halves together, tightening the two outer ring 5/16-18 cap screws (items 46 and 202, figure A-1), ensuring that the alignment pins fall into corresponding holes. Tighten the two 5/16-18 set screws (item 205, figure A-1) that will drive the inner ring latches to the locked position. Go back and retighten the outer rings to ensure a tight seat.

A-11. Next install the tool bits. The cutting tool will be mounted on the fixed tool slides and the grooving tool will be mounted on the spring-loaded tool slide. Once the cutting tool has been selected, raise the male tool slide to its highest position. Next, loosen the four tool holder bolts (item 256, figure A-1) and insert the tool into the slot. Point the blade tip to the right and approximately 1/8 inch (3.17 millimeter) above the outside diameter of the pipe when facing the tool slides. Next, select the correct grooving tool. Raise the tool holder in the spring-loaded tool slide to its highest position. Next, loosen the four tool holder bolts and insert the grooving tool into the slot. Point the grooving tool so the cutting edge is to the right when facing the tool slide.

OPERATION

A-12. Set the machine along the desired cut line by setting the inside edge of the cutting bit on the measured cut mark, and tighten the adjustable clamp screw by inserting the wrench through the hole in the frame.

Note. Any further tightening could result in damage to the inner frame. If the machine is mounted on a vertical pipe or a pipe other than horizontal, be sure to check that the machine is square to the pipe. Check at two positions, one located at 3 o'clock and one at 9 o'clock.

- Before continuing, disengage the inner and outer ring locking pins located on the outer ring behind the parting and spring-loaded tool slides.
- At this time, the tool bit stagger must be set. The cutting bit should be approximately 1/8 inch (3.17 millimeter) from the pipe. To adjust the cutting bit, turn the slotted hex nut on top of the slide either right or left as required. Lower the spring slide to the pipe by moving the pivot down on the spring-loaded slide. Next, adjust the groove tool bit so that it is approximately 1/8 inch (3.17 millimeter) from the pipe using the slotted hex nut on top of the spring-loaded tool slide. When adjusting tools, the cutting bit will always be closest to the pipe. Spin the machine by hand in a clockwise direction to check the machine and tool clearances around the pipe.

A-13. All drive motors lock into the mainframe assembly with a bayonet-type lock. The motor drives are held in place by the quarter turn handles (item 3, figure A-3, page A-6). Adjust the handles by pulling them out and then turning them in or out.

- To install the motor drive, rotate the bayonet ears away from the handles and insert the drive square into the pinion (item 11, figure A-1, page A-3). Rotate the motor drive until the slots slip into the handle screws.

- Adjust the handle as needed and tighten. Connect the motor drive to the proper power supply.
- Before any motor is activated, double check to ensure that the inner/outer ring lock pins are out, and inserted in storage holes. With the cam lock disengaged, slowly run the machine around and check that there are no obstructions as the machine rotates. As this is rotating machinery, be careful that the operator or any standby personnel are clear from the machine. Once this has been checked, the cam lock may be engaged and the cut may begin.
- The machine is now ready to make the cut. After the cut has been started, ensure that both tools are cutting properly. If the machine appears to be under heavy load, release the cam plunger and let the tool pressure release itself. Retract the slides and check for dull or chipped tools. After the problem is found, return the tools to the proper stagger and resume cut. When the groove tool shoulder contacts the pipe, pull the cam plunger and the grooving tool rotated through the groove several times to cleanout metal chips.

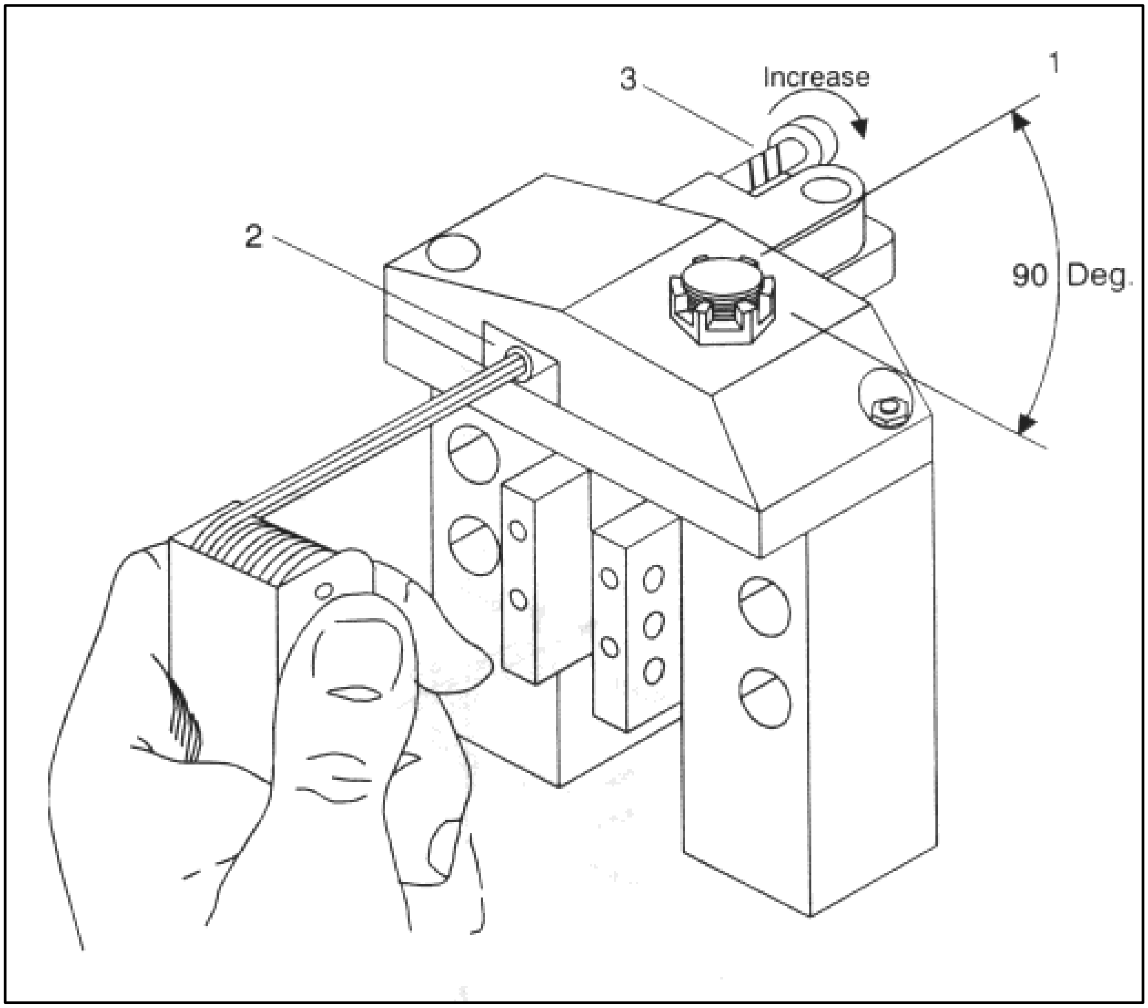


Figure A-3. Feed rate adjustment

MACHINE REMOVAL

A-14. Removal of the machine from the pipe should not occur until several things are done first. Retract the tool slides to their uppermost position. Then remove the tooling so it will not damage or cause injury to the operator. Next line up the splits of the rings so that the spring slide is on the side with the fixed feet. Remove the power supply and motor after the splits are aligned. Retract the spring slide until the spring travel limit spacer bottoms out. At this time, lock the inner ring locking pins so the two rings will be locked as one. Loosen the adjustable clamp pad and slip the machine off the end of the pipe.

SECTION III – MAINTENANCE

A-15. This section discusses the maintenance of the cutting and grooving machine.

MAINTENANCE

A-16. The following maintenance schedule must be followed to ensure safe and efficient operation of the machine:

- **Daily.** Check and replenish the air motor oilier lubrication, if necessary.
- **Weekly.** Check for proper adjustment of the tool-slide gib plate (item 19, figure A-4, page A-8) by trying to wiggle the male tool slide. Adjust the tool slide glib plate if there is excessive play or the fit is too tight.
- **Monthly.**
  - Remove clamp adjustment screw and apply a liberal coat of grease to the threads of the screw.
  - Clean debris from all tool slides and apply a liberal coat of grease to the mating parts, as well, as the feed screw and push rod bushing.
- **Quarterly.**
  - Disassemble all tool slides completely, clearing any debris and apply a coat of grease to all gib plates and the feed screw.
  - Remove the main bearings from the outer housing. Clean all the parts and reassemble with a light coat of heavy-duty grease.

MACHINE ADJUSTMENT PROCEDURES

A-17. This section describes procedures of how to make adjustment to the grooving machine.

- **Tool slide gib adjustment.** Check for proper adjustment of the tool slide gib plates by trying to wiggle the male tool slide. If there is excessive play or if the fit has become too tight, the following procedure should be performed.
  - **Tool slide assembly.** While turning the feed screw (item 23, figure A-4) use a ratchet and a 9/16-inch (14.2875-centimeter) socket to adjust the gib tensioning screws (item 210, figure A-4), using a 1/8-inch (3.17-millimeter) hex key.
  - **Spring-loaded tool slide assembly.** While turning the feed screw (item 23, figure A-4) using the ratchet and 9/16-inch (14.2875-centimeter) socket, adjust the gib tension screws, (item 210, figure A-4) with hex key.

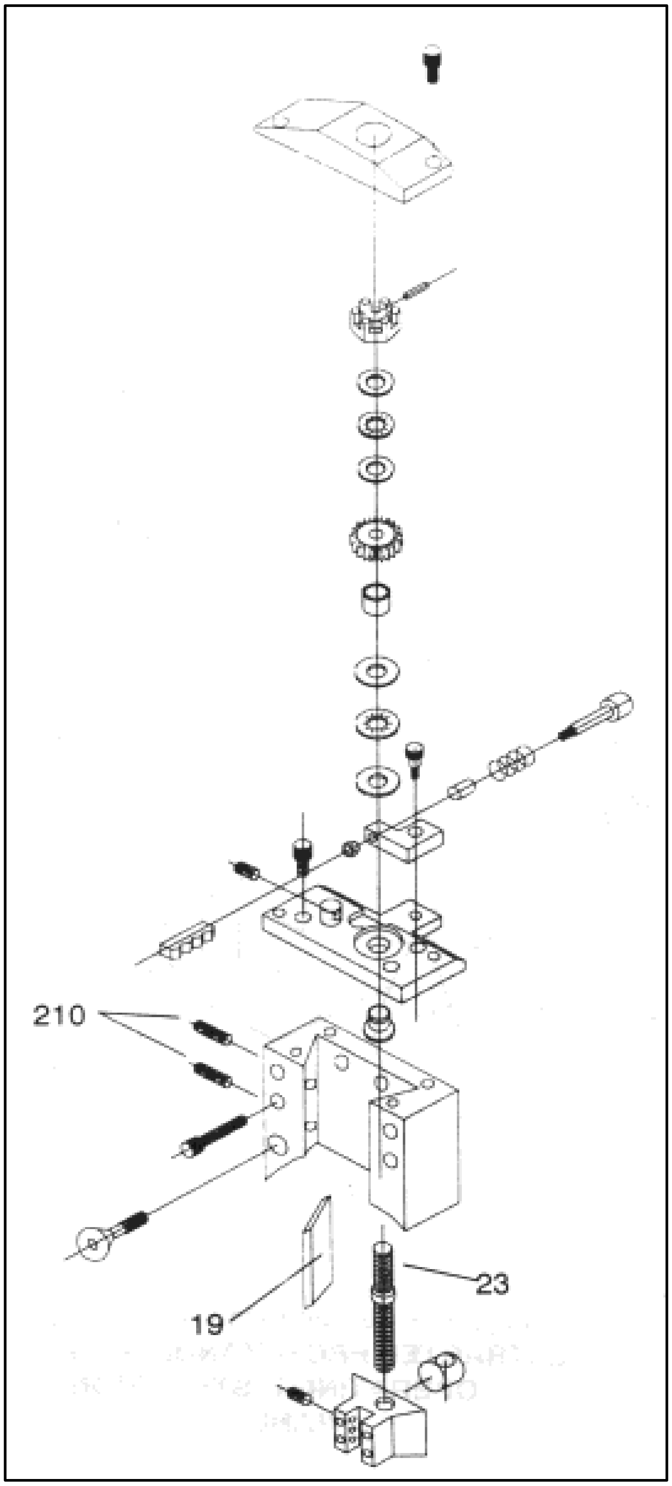


Figure A-4. Tool slide assembly

- **Feed plunger adjustment.** The feed rate is preset at the factory to 0.002 inches. This rate has been determined optimal for most cutting applications.
  - The parting slide is set to feed at approximately .002 inch per machine revolution.
  - When cutting pipe of varying wall thickness or material, it may become necessary to adjust the feed rates up or down to optimize cutting times or finish a specific application.

- **Feed rate.** To check the feed rate use the following steps:
  - Place a mark on the tool slide cover 90 degrees away from castle nut.
  - Rotate the machine under power with the feed cam engaged and count the revolutions it takes the castle nut pin to move 90 degrees to the mark on the cover.
  - To calculate the feed rate, multiply the number of revolutions required to turn the castle nut 90 degrees by 4.
  - Divide that number into .062 inch (1.5 millimeter), which will give the feed rate per one machine revolution.

Example: Factory preset parting slide.

Factory Preset Parting Slide

7 Revolutions x 4 = 28

.062/28 = .0022-inch (5.8 microns) feed per one machine rotation.

Example: Factory Preset Beveling Slide

9 revolutions x 4 = 36

.062/36 = .0017 inch (43.18 microns) feed per one machine rotation.

- The feed rates are adjustable from zero to six thousands of an inch per machine revolution. Check the feed rates and if an adjustment is required. Follow the following steps:
  - Loosen the feed plunger locking screw, (item 2, figure A-5, page A-10) with the Allen wrench. Rotate the plunger by hand (item 3, figure A-5) clockwise to increase the feed rate. Turn the plunger counterclockwise to decrease the feed rate. One full revolution of the plunger will increase or decrease the feed rate by approximately .001 inch.
  - Tighten the feed plunger-locking screw, (item 2, figure A-5) which will lock the feed plunger at the desired feed rate.
- **Feed screw bearing load adjustment.** When the tool slide is feeding inconsistently or erratically, it may be necessary to check and adjust the feed screw-bearing load. Use the following steps to adjust the feed-screw bearing:
  - Remove the feed system cover.
  - Check for thrust washer play. If the thrust washer directly under the castle nut can be turned by hand, the bearing load must be increased.
  - Remove the castle nut pin with a 3/32 pin punch.
  - Using a 9/16 wrench, tighten the castle nut until the next slot lines up with the pinhole.
  - Reinstall the castle nut pin.
  - Check the thrust washer stack up for play.
  - Check the push rod assembly operation. The push rod assembly must move in, advancing the feed system, and then retract to its original position as it passes the engaging cam on every machine rotation.
  - If the push rod assembly does not retract after striking the cam, feeding the tool slide down or operates inconsistently, the load on the thrust bearing stack-up is too tight. Remove the castle nut pin and back off the castle nut to the next hole.

Note. If the feed screw and castle nut rotate when backing off the castle nut, tighten the gib set screws to lock the feed system, allowing the castle nut to back off. See the gib adjustment procedure.

- **Main bearing removal and adjustment.**
  - To remove bearings, disassemble the inner and outer rings (items 1 and 2, figure A-1, page A-3) by sliding the inner ring out of the outer ring. Next, remove the stripper bolts (item 200, figure A-1) and pop out caps (item 37, figure A-1). This will expose the bearing and spacers. Check for cracks and bearing fatigue. If okay, reassemble.
  - The rear bearings must be removed as a complete unit. Remove ALL stripper bolts from the ring gear (item 5, figure A-1). Carefully remove the gear from its locating pins. Be careful not to lose the bearings or washers. Inspect and reassemble if the bearings are okay. Check the inner ring grooves for excessive wear and grease. Reassemble the inner and outer rings.

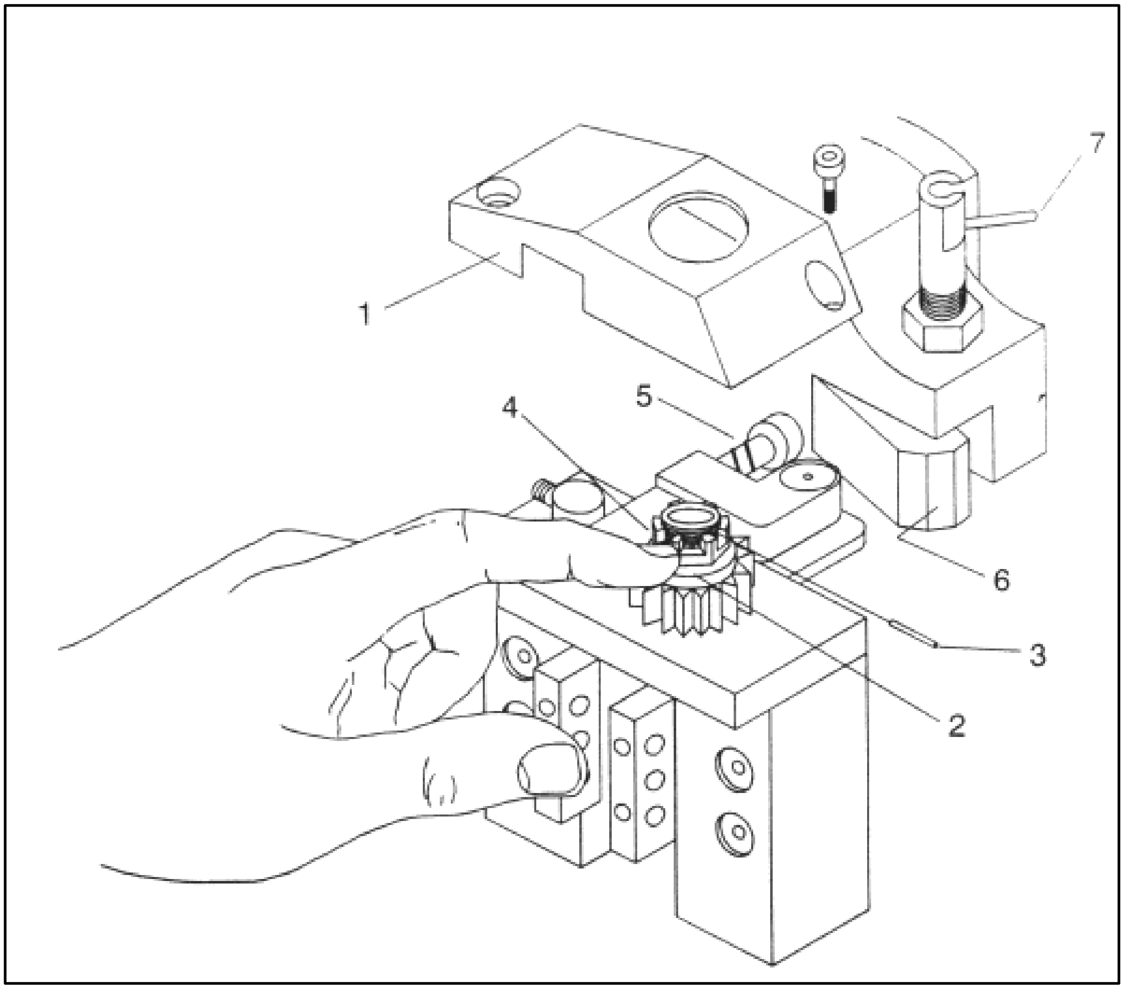


Figure A-5. Feed screw bearing load adjustment

Appendix B
Container Identification

This appendix provides an overview of the component and associated equipment.

INLAND PETROLEUM DISTRIBUTION SYSTEM CONTAINER IDENTIFICATION

B-1. This section describes the container identification marking for IPDS equipment sets.

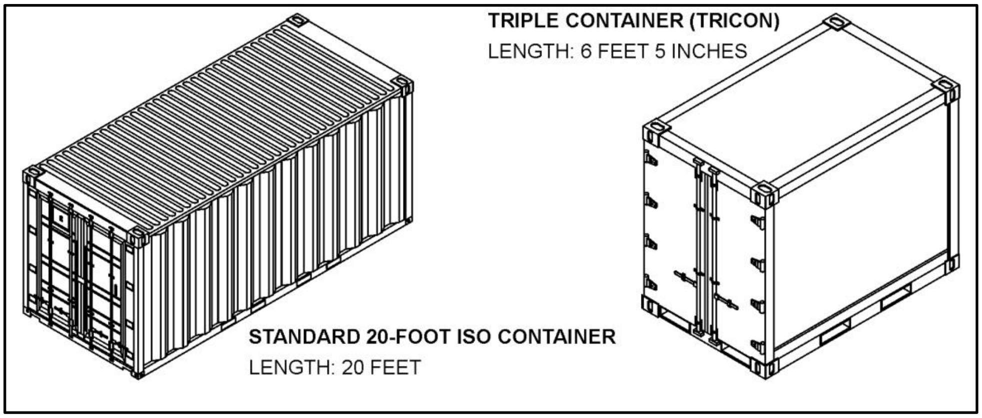
ALUMINUM PIPELINE FACILITIES

B-2. Figure B-1 shows the packaging symbols for the IPDS.

Figure B-1. Set symbol and set number

- **Five-mile** pipeline set. This set consists of pipes, couplings, and gaskets needed to build 5 miles (8.05 kilometers) of pipeline. The set also includes gate valves, check valves, vent assemblies, elbows, pipeline anchors, culvert materials, over couplings, and repair clamps needed for a 5-mile (8.05-kilometer) section of pipe.
- **Mainline pumping-station set.** This set consists of pumps, gate valves, check-valve launchers, receivers, strainers, light sets, and pump shelters needed to construct a standard, mainline pumping station. Most mainline pumping-station kits include two pumping units to facilitate 24-hour operation. Each pumping-station set differs slightly in its capabilities and component listings.
- **Pipeline suspension-bridge set.** Pipeline suspension-bridge assemblies are available in 100-foot (30.48-meter), 200-foot (60.96-meter), and 400-foot (121.92-meter) kits. A set consists of towers; guy wires; deadman anchors; main cables, suspenders, and cross bearers; staging board; tension cables; wind guys; and hand rope needed to construct the bridge. No special tools are required.

B-3. All IPDS equipment sets are packed in 20-foot (6.096 meters) ISO containers (see figure B-2 and figure B-3, page B-2) with the exception of the hoseline sets which may be packed in triple containers, and the 800-gallons per minute (3028.32-liters per minute) mainline pumps which are mounted on flat racks. All of the equipment, except that packed in triple containers, can be moved by palletized loading system trucks and can be loaded/unloaded from other carriers (for example, rail, stake, or platform) by a rough terrain cargo handler.



Legend:
ISO International Standard Organization

Figure B-2. IPDS containers

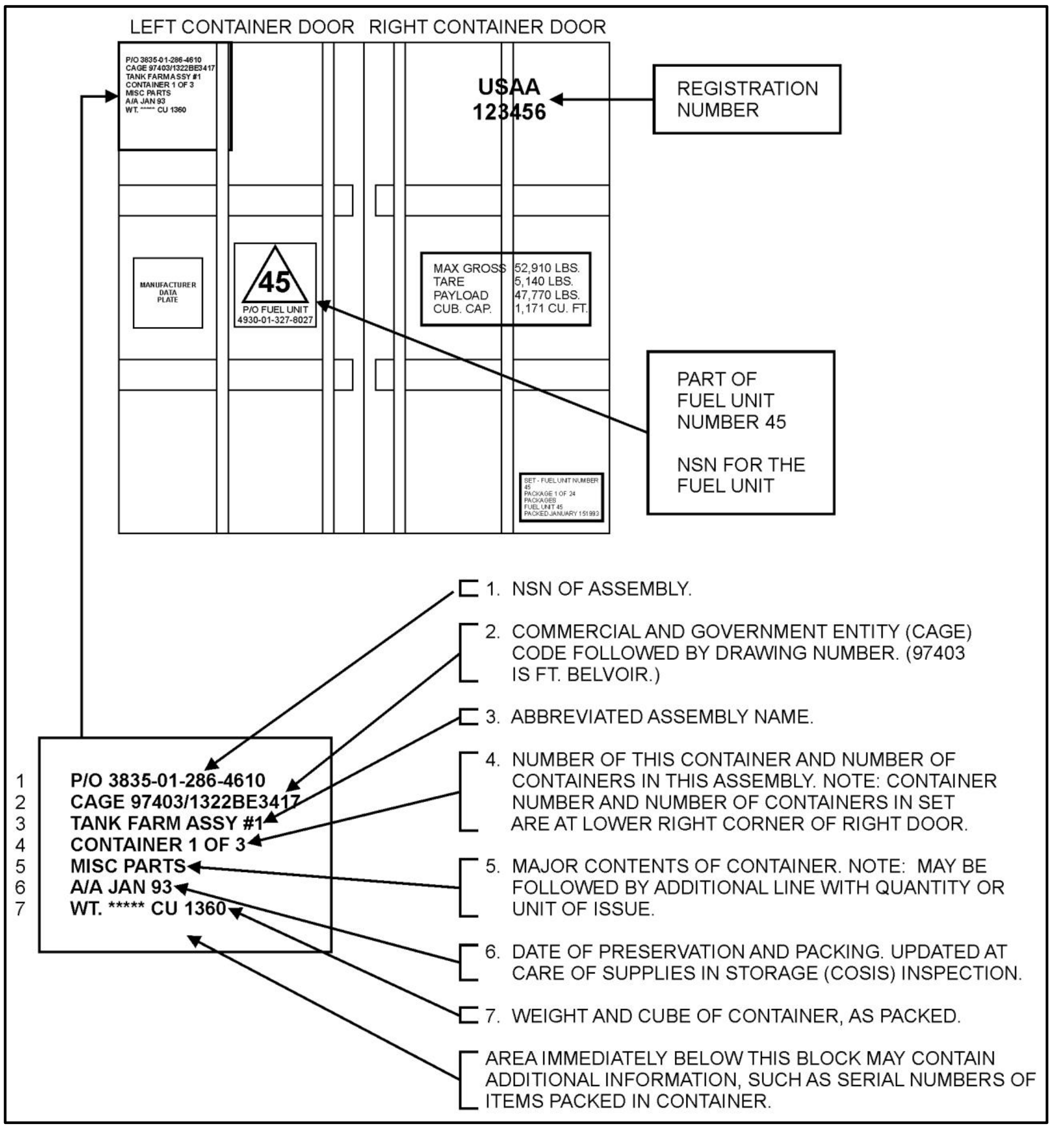
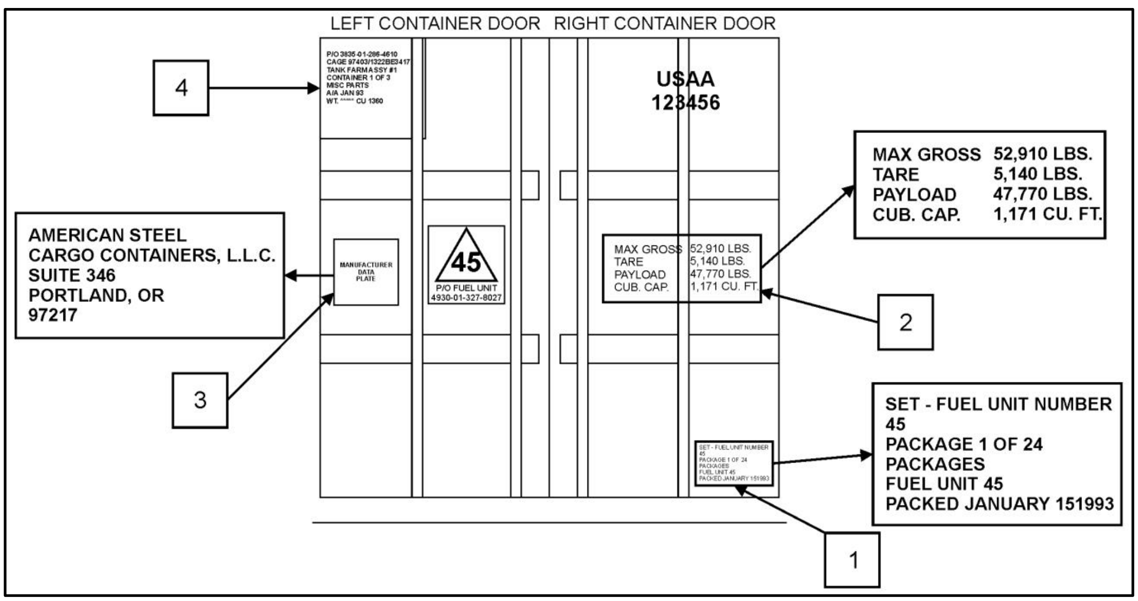


Figure B-3. Front of container markings (a)

Legend:			
A/A			
assy	assembly	max	maximum
cap	capacity	misc	miscellaneous
cu	cubic	NSN	national stock number
cub	cubic	P/O	purchase order
ft	foot	USAA	United States of America
Jan	January	wt	weight
lbs	pounds		

Figure B-3. Front of container markings (a) (continued)

B-4. The label in the lower right corner of the container's front door lists the container number of the set and the number of containers in the set (see figure B-4, item 1). It contains the package identification, which is listed on this container as 1 of 24. There are three containers in a tank farm assembly of which this container is a part. In the upper left corner of the left door (see figure B-4, item 4), the third line of information lists this container as 1 of 3. The area labeled in the center of the front right door lists empty and loaded weight information (see figure B-4, item 2). The area labeled in the center of the front left door is reserved for the manufacturer of the container (see figure B-4, item 3). The manufacturer's information may be found at other locations, also. Some of the same data is listed on the side of the container (see figure B-5, page B-4) and the rear of the container (see figure B-6, page B-4).



Legend:	
cap	capacity
cu	cubic
cub	cubic
ft	foot
lbs	pounds
LLC	limited liability company
OR	Oregon
P/O	purchase order

Figure B-4. Front of container markings (b)

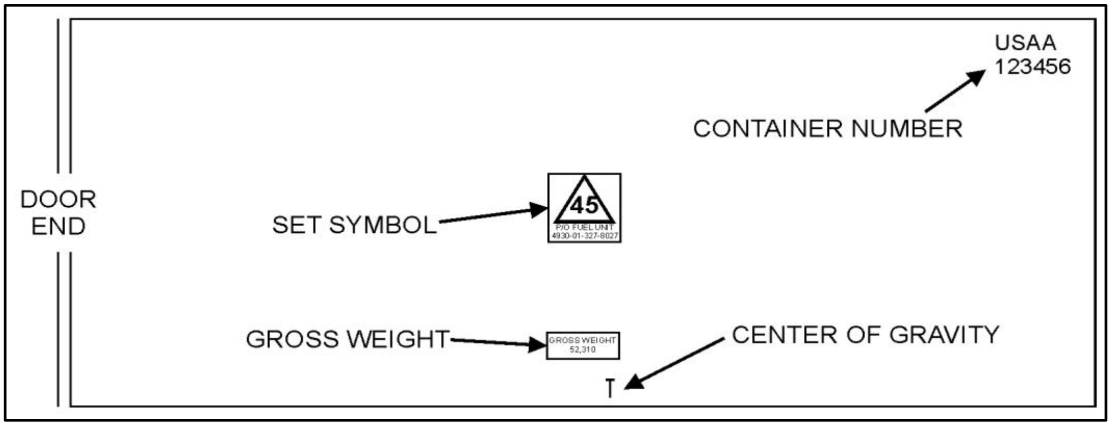


Figure B-5. Side of container

Legend:
P/O purchase order
USAA United States of America

Figure B-6. Rear of container

Appendix C

Engineer Inland Petroleum Distribution Tasks

ENGINEER CONSTRUCTION COMPANIES

C-1. Table C-1 identifies the collective tasks that are associated with the construction of IPDS.

Table C-1. Engineer construction companies IPDS collective training tasks

Task Number	*Task Title*
05-CO-5001	Perform Project Management
05-CO-5250	Perform Construction Operations
05-PLT-5215	Install a Coupled Pipeline
05-PLT-5300	Construct Expedient Coupled Pipeline Supports
05-PLT-5301	Construct Pipeline Suspension Supports
05-PLT-5302	Excavate a Pipeline Trench
05-PLT-5305	Install Underground Pipeline Crossing Site
05-PLT-5306	Install Pipeline Pumping Stations
05-PLT-5307	Install Underground Pipeline Crossing Site
05-PLT-5308	Test Pipeline System
05-PLT-5309	Repair a Pipeline
05-PLT-5310	Prepare Pipeline Route Profile
05-PLT-0313	Construct Revetments
05-PLT-1018	Perform an Engineer Reconnaissance
05-PLT-1020	Perform a Technical Reconnaissance
05-PLT-1021	Conduct a River Reconnaissance
05-PLT-5101	Construct Combat Roads/Trails
05-PLT-5102	Construct Roads
05-PLT-5106	Install a Culvert
05-PLT-5108	Perform Clearing, Grubbing, and Stripping Operations
05-PLT-5110	Perform Lifting and Loading Operations
05-PLT-5111	Provide Construction Site Compaction Support
05-PLT-5112	Perform Soil Stabilization
05-PLT-5113	Provide Construction Site Cut/Fill Support
05-PLT-5114	Provide Construction Site Drainage
05-PLT-5115	Provide Dust Control Measures
05-PLT-5118	Maintain Existing Roads
05-PLT-5116	Provide Excavation Support
05-PLT-5117	Provide Grading Support
05-PLT-5137	Provide Borrow Pit Support
05-PLT-5144	Perform Dump Truck-Hauling Operations
Legend: CO company	PLT platoon

C-2. Table C-2 identifies the individual tasks that are associated with the construction of IPDS.

Table C-2. Individual IPDS tasks

Task Number	*Task Title*
052-12K-1080	Install Inland Petroleum System (IPDS) Pipe Sections Using Snap-Joint Coupling Clamps
052-12K-1081	Install Inland Petroleum System (IPDS) Repair Clamp
052-239-3036	Supervise the Installation of Pipelines
052-248-1013	Install a Coupled Pipeline
052-248-1014	Repair a Coupled Pipeline
052-248-1016	Install Components With a Pumping Station
052-248-2003	Emplace a Flexible Hose Line
052-248-1017	Repair a Flexible Hose line
052-12T-3011	Conduct an Engineer Construction Reconnaissance

Glossary

The glossary lists acronyms and terms with Army or joint definitions. Where Army and joint definitions differ, (Army) precedes the definitions.

SECTION I – ACRONYMS AND ABBREVIATIONS

AOR	area of responsibility
ATP	Army techniques publication
attn	attention
bbl	barrel (an oil barrel that is a measure of volume of crude oil and other petroleum products)
BCT	brigade combat team
DA	Department of the Army
FM	field manual
IPDS	Inland Petroleum Distribution System
ISO	International Standard Organization
JP	joint publication
MO	Missouri
No.	number
OPDS	Off-Shore Petroleum Distribution System
OPLOG	operational logistics
PLCA	pipeline connection assemblies
PMCS	preventive maintenance checks and services
PSE	pipeline support equipment
RPM	revolutions per minute
S-3	battalion or brigade operations staff officer
TC	training circular
TM	technical manual
TO	theater of operation
TPT	tactical petroleum terminals
TRADOC	United States Army Training and Doctrine Command
TSC	Theater Sustainment Command
U.S.	United States

SECTION II – TERMS

This section contains no entries.

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