

Army Builds Record Fuel Pipeline To Support Operation Iraqi Freedom

by **CPT Robert Kirkpatrick** and **LTC Robert Knowles, U.S. Army Reserves, Iraq**



The longest tactical fuel pipeline ever constructed by the U.S. Army was hastily built in Iraq to support combat operations and today serves the rebuilding operation in Operation Iraqi Freedom.

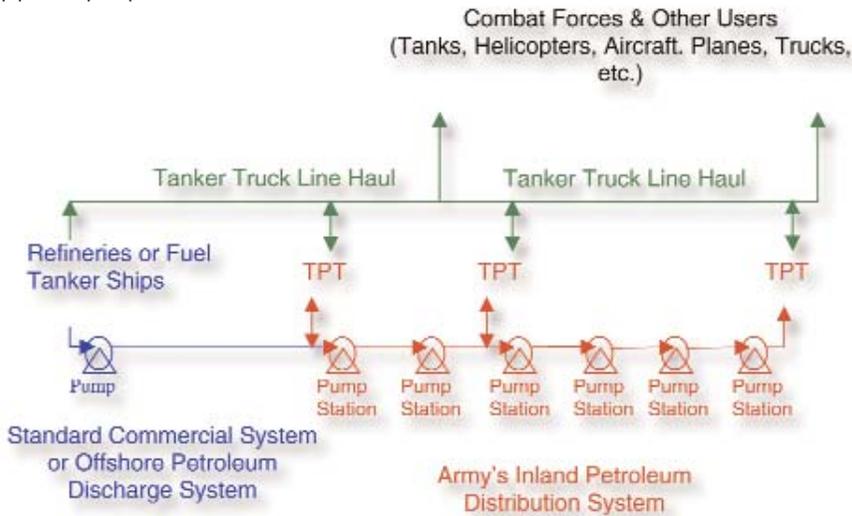
Adequate supplies are essential to modern combat forces in armed conflicts. In modern warfare, fuel makes up more than 70 percent of the tonnage of supplies that must be moved forward to support war fighters. The Army's Inland Petroleum Distribution System (IPDS) was essential in supplying fuel to air and ground forces in Operation Iraqi Freedom. The IPDS contained the longest tactical fuel pipeline the Army has ever constructed. It was rapidly built by hand to transport fuel. The



Army engineer soldiers hand-laid and coupled in excess of 66,000 pipe sections (220 miles) and constructed 20 pump stations.



Figure 1: Generic Military Fuel Distribution System with IPDS, pipeline, pump stations, and line haul.



struction was completed (Figure 2).

The IPDS pipeline consists of 6-inch diameter aluminum pipe sections, and pump stations. A five-mile pipeline set consists of all the components needed to construct five miles of pipeline and is transported in 13 containers. The individual pipeline sections are 19 feet long and weigh 107 pounds each. The pipeline sections are surface-laid by hand and connected via snap-joint coupling clamps (Figure 3). The clamps have an integral gasket and after closing are secured with a brass-retaining pin. Expansion joints are built along every 50 sections of pipe for thermal expansion and contraction. Screw-type anchors are clamped to the pipe between expansion joints to inhibit excessive movement of the pipe sections. Gate valves are installed along the pipeline to allow for the isolation of sections for maintenance and repair.

IPDS mainline pump stations are con-

- 416th Engineer Command** (Command, Control, & Management of Engineering & Construction in the Theater of Operations)
 - 62nd Engineer Battalion** (Combat Heavy, General Construction – Roads, Buildings, Airfields, etc.)
 - 808th Engineer Pipeline Company** (Provide IPDS Expertise to a Combat Heavy Battalion)
 - 226th Engineer Company** (Combat Heavy round out Company to the 62nd Engineer Battalion)

 - 49th Quartermaster Group** (Provide Fuel and Water to the Theater of Operations)
 - 240th Quartermaster Battalion** (Petroleum Pipeline Terminal Operation)
 - 267th Quartermaster Company** (Petroleum Pipeline Terminal Operation)
 - 109th Quartermaster Company** (Petroleum Pipeline Terminal Operation)
- Figure 2:** Units involved in Inland Petroleum Distribution System (IPDS) construction and operation.

pipeline construction began in Kuwait and continued into Iraq as Coalition forces moved forward during the war.

The IPDS is a rapidly deployable system for bulk fuel storage and transportation. It includes Tactical Petroleum Terminals (TPTs) for bulk storage and a pipeline system to transport fuel. IPDS consists of pipe, pumps, valves, fuel storage bags, fittings and other associated equipment that can be quickly coupled together and put in service by military personnel (Figure 1). All components of the IPDS are stored in 20-foot ISO (International Standards Organization) containers for transportation and ease of handling.

By Army doctrine, Army engineers design and build the IPDS pipeline and the Army Quartermaster operates it. Army engineers serve on active duty and in the reserves. Both active duty and mobilized Reserve units constructed and operated the Operation Iraqi Freedom IPDS. The 416th Engineer Command (Reserve unit from Darien, IL) was given the mission of designing and constructing the IPDS in support of Operation Iraqi Freedom. The 416th Engineer Command assigned the mission of constructing the IPDS pipeline to the 62nd Engineer Battalion (Active unit from Ft. Hood, TX).



Figure 3: IPDS pipeline construction in southern Iraq.

Construction started in mid-January and continued as the 808th Engineer Pipeline Company (Reserve unit from Texas) arrived to provide technical expertise. The 226th Engineer Company (National Guard unit from Kansas) and C Company 46th Engineers (National Guard unit from Paris, TN) assisted in the construction. The 49th Quartermaster Group (Active duty unit from Ft. Lee, VA), and their 240th Quartermaster Battalion (Active duty unit from Ft. Lee, VA) operated the TPTs and IPDS pipeline pump stations when con-

structed along the pipeline to move fuel. Each pump station has two skid-mounted 800-gpm pumps with four containers of associated fittings and valves (Figure 4). The two pumps are manifolded so that the pumps can be switched from one to the other while running. One pump is normally used to pump fuel and one is on standby. The pump stations come with a receiver and launcher so the pipeline can be pigged (scraped). The Maximum Allowable Operating Pressure (MAOP) of the pump station and pipeline is 740 pounds per



Figure 4: Two adjacent Pump Stations (four 800 gpm pumps) at Udairi, Kuwait.

square inch gauge (psig). The desired suction pressure for the pumps is 100 psig.

The IPDS pipeline delivers fuel to Tactical Petroleum Terminals (TPTs) that store and distribute bulk fuel to tanker trucks and tactical refueling vehicles. Tactical refueling vehicles deliver the fuel forward to individual tanks and aircraft. Bulk fuel is stored in 5,000 barrel (bbl) rubberized fabric bags (bladders) that are installed in bermed areas at TPTs; however, due to the high ambient temperatures in the desert, the bags were limited to 70 percent capacity (Figure 5). The bags, pipeline and TPT fill stations are manifolded with hoses, valves, and 350 and 600 gpm pumps to move the fuel around within the TPT. The MAOP of the TPT is 150 psig. The fuel bladders were filled from tanker trucks and the IPDS pipeline.

Six TPTs for bulk fuel storage and distribution were connected to the pipeline to support Operation Iraqi Freedom. The locations of the TPTs were determined by the tactical situation. The first TPT was located at the end of a Kuwaiti commercial steel pipeline at Camp Virginia. The commercial pipeline connects the IPDS with Kuwaiti refineries on the Arabian Gulf (Figure 6). The assistance received from the Kuwaitis proved essential to our success in Operation Iraqi Freedom. Kuwait supplied the fuel used in the operation and accommodated our tactical needs by shutting down some of their producing wells and reconfiguring their commercial pipelines to supply us with fuel.



Figure 5: Tactical Petroleum Terminal (TPT) with fuel bags in protective berms in Iraq.

Fuel additives are injected at the TPTs to convert Jet A1 into JP8 fuel. The fuel additives suppress ice formation for aircraft, inhibit corrosion, improve lubricity for use in diesel engines, and disperse static electricity for safety. JP8 is used by the U.S. Air Force and Marine Corps and is the Army's standard fuel.

The second TPT was constructed at Camp Udairi to support airfield operations in central Kuwait. A third TPT was constructed on the Iraqi border and named Breach Point West (BPW). BPW was located about six miles from the Iraqi boarder — close enough to move fuel forward to support the ground attack but also in range of some Iraqi mortars

and artillery. Two additional TPTs were constructed in Iraq during the war, in the vicinity of captured air bases (Jalibah and Tallil). IPDS pipeline connected all the TPTs.

The 416th ENCOM designed the IPDS pipeline for the Coalition Forces Land Component Command (CFLCC) C4 logistics staff section. The CFLCC C4 was responsible for fuel and water supply during Operation Iraqi Freedom. The 416th ENCOM and the 49th Quartermaster Group worked with the

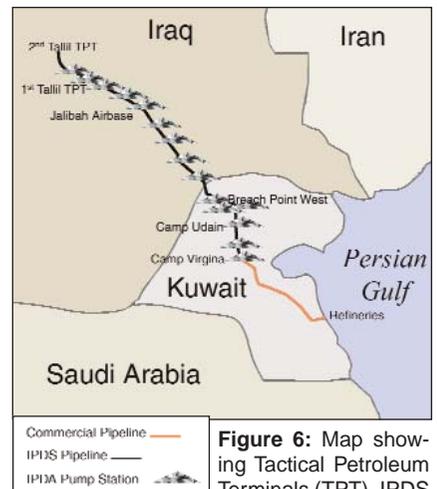


Figure 6: Map showing Tactical Petroleum Terminals (TPT), IPDS pipeline, and commercial pipeline routes to refineries.

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CFLCC C4 Petroleum and Water staff section to assess where TPTs and the IPDS pipeline should be constructed. The operations plan forecast how much fuel would be needed and where. Map and route reconnaissance were conducted to determine the best trace

for the pipeline to follow. Pump station locations were designated along the trace by design to maximize fuel throughput.

CPT Kirkpatrick designed the IPDS by plotting the trace on maps and determining elevation profiles and distances. The potential flow rates for various pump station locations were determined by matching pump curves to pressure drop vs. flow rate. Elevation changes along the planned route were not significant enough to cause loss of pressure at highpoints and would not result in over-pressurizing the pipeline at the lowest elevations.

The availability of pump stations was a logistical constraint. Installation of pump stations is also more rapid than pipeline construction, so in order to save available pumps for future pipeline construction in Iraq, a second parallel IPDS pipeline was built in Kuwait. CFLCC wanted to ensure there was fuel flowing to all the TPTs in Kuwait in order to build up a fuel reserve well before the ground war started, so a single pipeline was initially constructed connecting the TPTs at Camp Virginia, Udairi, and BPW.

Though most of the IPDS pipeline was laid on relatively flat ground, there were some challenges north of Udairi through a "moonscape" of old borrow pits and spoil piles that required a great deal of earthmoving. Because a single line was constructed initially, the pump stations were constructed closer together to obtain a higher flow rate for the system.

After the initial line to BPW was complete, construction on the second was initiated. The single pipeline had a flow rate of 700 gpm. Three options were investigated for the second line:

- Tie the second line into the first and remove 40 percent of the pump stations (for use up north), increasing the flow rate to 950 gpm,
- Tie the second line into the first and leave the pump stations in place, increasing the flow rate to 1,000 gpm and building in system redundancy, or
- Build a second identical line (including pump stations) in parallel, increasing the flow rate to 1,400 gpm.

CFLCC opted to build a second identical line in parallel without tying the lines together, assuming we would probably not build a pipeline into Iraq. This maximized the use of existing pump stations and maximized the flow rate. Both lines were used to help fuel the largest TPT the Army has ever built, at BPW, to ensure all units were topped off before the start of hostilities. A total of 4.4 million gallons of fuel were stored there at the start of the war.

Shortly before combat operations began, CFLCC made the decision to continue the IPDS pipeline into Iraq. Additional pump stations were required to be airlifted into Kuwait from the U.S. The first TPT established in Iraq was at Jalibah Airbase and was run by the U.S. Marine Corps (USMC). To transport fuel, the USMC uses an assault hose reel system that

operates at a lower pressure and has more pump stations, but is faster to install. Initially, Jalibah TPT, storing 1.2 million gallons, was supplied by the USMC hose reel system. The USMC hose reel transported fuel from BPW to Jalibah to support close attack aircraft.

Once the IPDS pipeline was advanced into Iraq, a spur line fed the TPT at Jalibah from the IPDS system; however, it did not have the ability to return fuel to the pipeline. The spur from our system allowed the Marines to pick up their hose reel for use elsewhere as they moved deeper into Iraq while maintaining aircraft refueling operations at Jalibah.

The second TPT constructed in Iraq was located southeast of Tallil Airbase, to support operations in Iraq. Reaching it consumed most of the remaining IPDS pipeline stock available in theater. After the Tallil TPT was put into operation, another TPT was constructed deeper in Iraq at new location northwest of Tallil. There were insufficient pipe and pump stations to complete an additional IPDS pipeline segment to reach the new TPT location. Fortunately, the Kuwaiti Oil Company had extended the commercial line from Camp Virginia to Udairi which allowed for the recovery of the IPDS pipeline and pump stations between Camp Virginia to Udairi, providing sufficient materiel for construction of the last segment of IPDS pipeline to the relocated TPT.

One of the challenges encountered during operation of the surface laid pipe was vehicle run-over. Small, wheeled-vehicle run-over may not cause visible pipe damage, but often the pipe failed later when under high pressure. Tanks and large trucks simply crushed the pipe. Vehicle crossing points were constructed by running the pipe through buried culverts, but run-overs continued, so a succession of protective measures was implemented. Initially, we installed a three-foot berm alongside the pipeline with pickets (metal fence posts) and engineer tape to mark it.

Most tactical military vehicles have no problem crossing a three-foot berm and continued to cross wherever convenient. In order to stop vehicle traffic, six-foot berms were constructed on both sides of the pipeline for much of the distance and additional crossing points were installed. To build the additional crossing sites, extra culvert material was purchased locally to supplement the culvert material that comes with the IPDS system. Eventually, tactical vehicles stopped crossing over the pipeline and used the constructed crossing sites but not until 130 miles of six-foot berm were constructed. Once protected, the pipeline was put into full operation.

The pipeline constructed to support Operation Iraqi Freedom is the longest operational IPDS tactical fuel pipeline the Army has ever constructed. It is longer and moved more fuel than any previous IPDS pipeline. To construct it, more than 1,300 twenty-foot ISO containers were transport-

ed and more than 1,500 soldiers were required to build and operate it. Army engineer soldiers hand-laid and coupled in excess of 66,000 pipe sections (220 miles) and constructed 20 pump stations. Engineer soldiers laying the pipe sections manhandled more than 4,500 tons of pipe material. The pipeline connected a series of six TPTs, each of which stored from 1.2 to 4.4 million gallons for a total theater storage capacity of 16.6 million gallons.

The IPDS provided fuel to sustain the 20-day armed conflict of Operation Iraqi Freedom. Approximately 35 million gallons of fuel were used in March 2003. More than 90 million gallons of fuel have been transported and stored in the Operation Iraqi Freedom. Sixty million gallons of that fuel was transported via the IPDS pipeline. The IPDS pipeline was instrumental to the success of the combat phase of Operation Iraqi Freedom and is still in service supporting the restoration of Iraq. It is a resounding success due to the outstanding efforts of all the soldiers who built and operate it. **P&GJ**

Authors: CPT Robert A. Kirkpatrick is



an Army Reservist with the 416th Engineer Command (ENCOM) of Darien, IL. In the civilian world, CPT Kirkpatrick is an engineer for Peoples Energy

Resources Corp. in the Chicago area. His experience at Peoples Energy includes working with petrochemicals and power production as well as natural gas and liquids pipelines. CPT Kirkpatrick was mobilized in November 2002 and deployed to Kuwait. Shortly after arriving in Kuwait he was assigned as the engineer design officer for the Inland Petroleum Distribution System (IPDS) pipeline.

LTC Robert B. Knowles is an Army



Reservist with the 416th Engineer Command (ENCOM) in Darien, IL. In the civilian world LTC Knowles is the Deputy Director of Combat Terrain Information

Systems, at the U.S. Army Topographic Engineering Center. LTC Knowles was mobilized in January 2003 and deployed to Kuwait. He was assigned as the engineer project officer for the Inland Petroleum Distribution System (IPDS).