OIL SPILL RESPONSE AND EQUIPMENT FOR THE BTC PIPELINE SYSTEM IN TURKEY

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ABSTRACT

The BTC (Baku-Tbilisi-Ceyhan) Project includes a 42 in (107 cm) crude oil pipeline extending west from the Caspian Sea across Azerbaijan (433 km, 260 mi), through Georgia (250 km, 150 mi), and then southward through eastern Turkey (1076 km, 645 mi) to a new marine terminal at Ceyhan on the Mediterranean Sea. In Turkey, the pipeline crosses significant mountainous terrain (>2800 m, 8,500 ft), several major rivers as well as five fault zones. The marine terminal includes 7 storage tanks and a 2.7 km (1.6 mi) jetty able to handle two 300,000-dwt tankers simultaneously. The system is designed to transport 1 million barrels per day (~145,000 t/day).

The oil spill contingency plan is designed to protect sensitive areas, catchment basins, and to prevent the migration of spilled oil. Sensitive features were determined by pre-construction surveys and risk analyses, and updated by additional fieldwork focusing on the potential movement and impacts of spilled oil. Response guidelines based on risk and logistics determined the location of equipment depots and the level of equipment necessary to recover Tier 2 spill volumes. Pipeline equipment and depots are selected to rapidly recover spilled oil and to prevent its downslope and downstream movement. The marine response strategy focuses on protection of adjacent lagoons by on-water containment at the berthing area using an oil spill response vessel (OSRV), tugboats, and other workboats, and various lengths and types of booms, skimmers and storage capabilities.

INTRODUCTION

The combination of offshore Caspian Sea development, processing facilities in Azerbaijan and construction of a primarily 42 inch pipeline from Azerbaijan through Georgia and across eastern Turkey to a new marine terminal and storage facility on the Mediterranean Sea is one of the major oil and gas development projects of this decade. This paper focuses on the response strategy and requirements for purchase of related equipment to effectively respond to potential oil spills from both the pipeline and marine terminal in Turkey. Similar programs are underway in Azerbaijan and Georgia, and all elements are consistent across all three countries, in conformance with the Project's General Oil Spill Plan (Reid, 2004).

THE PIPELINE

Description of the Pipeline System (related to oil transport)

The pipeline in Turkey, buried for its entire 1076 km length, is 46-inch (177 cm) for the first 22 km (13 mi), 42-inch for the next 924 km (550 mi), whereupon it is reduced to 34-inch (86 cm) for its final 130 km (78 mi) as it descends from the Toros Mountains to sea level (Figure 1). The system includes four manned pump stations, two unmanned intermediate pressure reduction stations, 51 block valves, pigging facilities, a cathodic protection system, an optical fiber communications system, a leak detection system, and a computer-based Integrated Control and Safety System based on a fully automatic operation. Tankage at the pump stations includes tanks for crude oil surge relief, aviation fuel storage, diesel and lube oil storage, closed drain slop oil storage and fire water. Tankage at the pressure reduction stations are similar, but without aviation fuel. Valve-bodies are buried and valve operators are enclosed.

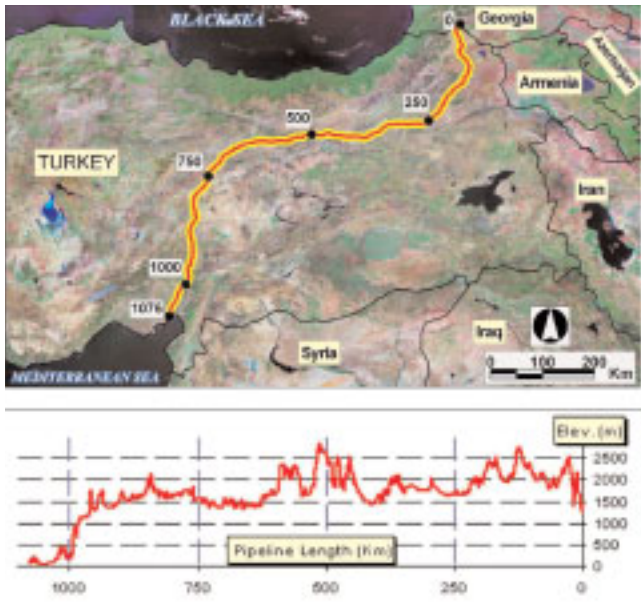

FIGURE 1. THE PIPELINE ROUTE IN TURKEY.

Diesel and jet fuel is supplied via road tanker to the pump intermediate pressure reduction stations for use in the emergency generator, firefighting pumps, helicopters (pump stations only), and hot water heaters. The diesel system comprises a horizontal underground fuel tank and distribution pump.

Pipeline Response Strategy

A significant amount of spill response planning was undertaken during the environmental impact analysis before construction, and continued throughout the construction phase of the Project. The response strategy was developed from:

1) A pre-construction km-by-km risk assessment of spill size and potential impacts taking into account ecological, cultural (archaeological), groundwater, and surface water resources along the pipeline;
2) Identification of Special Response Areas, each having a detailed response plan due to the presence of ecological and / or groundwater resources, and earthquake faults;
3) Identification of sensitivity along, and downstream of, the pipeline (Gundlach et al, 2005);
4) Identification of the probable downslope drainage (0.01 km basis from topographic maps) for oil spilled from the pipeline, with each drainage area minimally having two pre-designated Containment Sites for the spill control and recovery (Figure 2);
5) Development of a Containment Site Manual using a database format that identifies over 300 Containment Sites, road directions, environmental conditions, river / stream width seasonally, recommended response equipment, downstream receptors, site photographs and a location map;
6) Development of 1:30,000 scale topographic maps indicating drainage flow from the pipeline, Containment Sites, environmental areas, Special Response Areas, pipeline sensitivity, water bodies, Ecologically Important Areas (for plants), major river crossings, and roads to take to get to each Containment Site; and
7) Development of a Government Equipment Database, providing a computer-based listing of all spill response equipment available from government sources with established protocols for the use of that equipment.

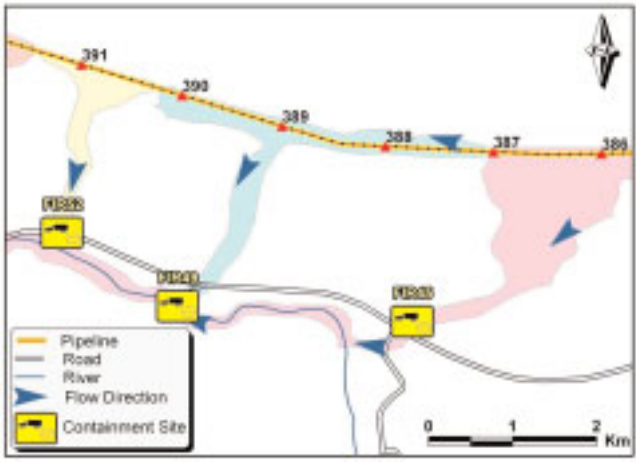

FIGURE 2. EXAMPLE DOWNSLOPE POTENTIAL SPILL FLOW ANALYSIS (SHADED BASINS), RELATED CONTAINMENT SITES AND PIPELINE KILOMETERS. EACH CONTAINMENT SITE HERE IS PLACED ALONG THE HIGHWAY TO PREVENT OIL FROM REACHING THE RIVER.

Pipeline Equipment Guidelines

The guidelines for acquiring equipment for the pipeline, bearing in mind the conditions indicated above and the previously referenced General Oil Spill Plan (Reid, 2004), are based on:

1) Establishment of a Tier 1 capability and appropriate spill response kits at each facility;
2) Placement of response kits on each fuel truck;
3) Employment of a 60-person Response Contractor to provide a Tier 2 response capability for the pipeline and terminal system;
4) Participation in an international Tier 3 response organization;
5) Establishment of four response depots (from north to south) at Kars, Erzincan, Kayseri and Ceyhan (Figure 3), designed to meet transit time guidelines below;
6) Development of the following time, spill volume recovery, and storage guidelines (1 m^3 = ~1 t):
   a. Less than 12 hours for the deployment of First Response resources sufficient to remove 520 m^3 in 36 hours at each primary Containment Site (equating to a skimmer name plate recovery capability of 34 m^3/hr considering 41% loss to between the pipeline and the site, and a derating of 25% of name plate values);
   b. Less than 24 hours for the deployment of a Full Tier 2 recovery capability of 2986 m^3 to be in place within 24 hours (equating to a skimmer name plate recovery capability of 141 m^3/hr considering the same factors as above).
   c. A First Response (<12 hours) in-place storage capacity of 356 m^3 of which 25% will be handled by portable storage tanks and 33% by lined pits, and considering 41% losses between the pipeline and Containment Site plus a 100% emulsification factor, and that the remaining material will be removed by tank truck or other means.
   d. A Tier 2 Full Response (<24 hours) in place storage capacity of 1450 m^3 using the same factors as above.
7) Off-road transport capability sufficient to reach potential work areas along the pipeline with no road access;
8) Transport under snow and winter weather conditions, to reach the appropriate Containment Site and the pipeline;

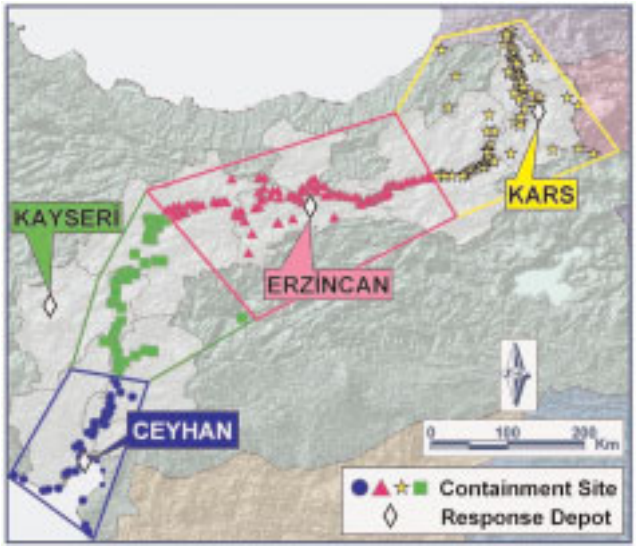

FIGURE 3. RESPONSE DEPOT LOCATIONS AND ASSOCIATED CONTAINMENT SITES.

9) Oil chemistry that shows a wide range of potential viscosities, ranging from a solid to near-solid mass to medium viscosities as temperatures range from far below freezing to 30°C, in addition to potential spills of lighter oils from fuel trucks;
10) Establishment of boom requirements such that a minimum of two maximum-flood river crossings can be handled by a single response depot;
11) Provision that equipment will be cascaded in from adjacent response depots as needed; and
12) Protocols established for the passage of Tier 3 equipment through Customs and at major airports.

MARINE TERMINAL

Description of the Terminal

The BTC Pipeline System's Ceyhan Marine Terminal is located in the upper Gulf of Iskenderun adjacent to the existing Botas oil export terminal (Figure 4). The upper Gulf has a relatively high degree of industrialization with several facilities having wharfs and terminals. A major coal-fired electric plant is located a few km to the south while a fertilizer plant and coal facility are located a short distance to the north. A major steel mill and LPG facility are across the Gulf to the east-northeast, and the region's main commercial port is located across the Gulf to the east at Iskenderun.

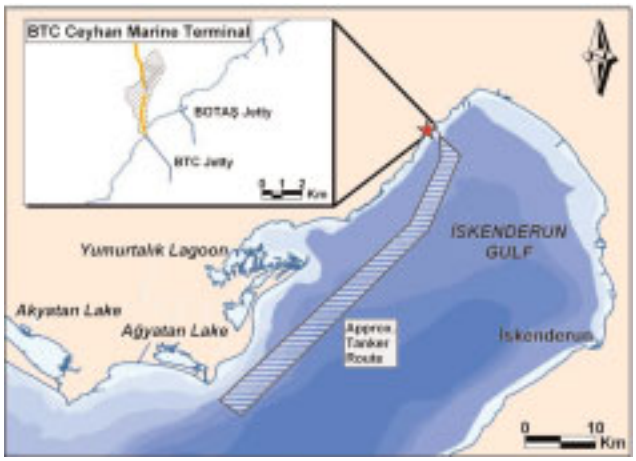

FIGURE 4. LOCATION OF CEYHAN MARINE TERMINAL AND ITS APPROXIMATE SHIPPING LANE IN ISKENDERUN GULF.

The BTC Ceyhan Marine Terminal is composed of two primary facilities as well as an alternate Pipeline Control Center. An overview photograph of the area is presented in Figure 5.

The Ceyhan Export Terminal has seven 150,800 m^3 crude storage tanks, loading lines and administration and control buildings. Related facilities include a pig receiving unit, surge relief system, terminal pressure reduction station, and a wax handling system. There are two ship loading pipelines (42 in) transferring the oil from the storage tanks to the export tankers at the jetty by gravity feed.

The Ceyhan Marine Facilities include a fiscal metering station, a jetty capable of berthing two 300,000 dwt tankers simultaneously, and facilities for loading oil onto tankers. An offshore area is established for the temporary anchoring of awaiting tankers. Activity by other vessels, including local fishing, is not allowed in the Terminal area and is enforced by the Turkish Coast Guard that have a base at the Botas small boat harbor.

FIGURE 5. OVERVIEW OF CEYHAN MARINE TERMINAL AND THE EXPORT JETTY UNDER CONSTRUCTION (25 SEP 2004). THE JETTY CONTINUES FOR APPROXIMATELY 1 KM (>0.6 MI) TO THE BERTHING AREA (OUT OF THE PHOTOGRAPH). PHOTOGRAPH BY BARBAROS CELIKKOL.

Marine Conditions and Transport

Iskenderun Gulf is a relatively shallow (<90 m, 280 ft) and calm-water embayment ~40 km wide by 80 km long with good navigational conditions. A very weak counter-clockwise gyre predominates with currents <25 cm/s (<0.5 kn) to the southwest direction in the area of Ceyhan Terminal. Tides in the Gulf are ~30-40 cm (12–16 in), varying with wind setup.

Winds are mild (<5 m/s (<10 kn) for 55-60% annually) and predominate from the south-southwest. Winds are 15m/s (30 kn) for only ~5% of the time. Seasonally, winds are from the southwest during April to September (summer), and are roughly evenly distributed between northerly and southwesterly during the period from October to March (winter). Waves are most commonly less than 1 to 2 m (3–6 ft), but waves of several meters can be generated, particularly during strong winds from the SW.

The shipping lane to Ceyhan Marine Terminal is indicated in Figure 4. There are no shallows or other navigational hazards and the sea bottom mainly consists of clay, silt and sand. The Project's risk analysis indicates that approximately 2,200 ships berth in the Gulf every year, with ~35% being larger than 15,000 dwt. The planned oil transport activity from the marine terminal represents ~56.4 million dwt / year, while the existing oil transport in the Gulf is ~42.6 million dwt / year, of which the majority is related to the Botas marine terminal (36.4 million dwt), the export terminal of the northern Iraqi pipeline.

Marine Response Strategy

The marine response strategy is based on many of the same elements discussed for pipelines with the following changes:

1) Two risk assessments were conducted which included environmental criteria and potential spill volumes: one for the land-based tank farm / facility while the other considered marine transport;
2) An oil spill trajectory model was developed to indicate the probable distribution of spilled oil using four spill sizes and three spill locations;

3) Additional fishing, oceanographic and environmental studies were used to characterize the marine and coastal environments of the area, and served as a basis for coastal sensitivity mapping at 1:30,000 scale which defined shoreline sensitivity, ecological, human-use, and spill-response features, as well as pre-designated coastal Containment Sites; and
4) The strategy is focused on response to spills at the terminal and its surrounding waters in conformance with Turkish law and international conventions.

Marine Equipment Guidelines

The guidelines for acquiring equipment operational in the marine environment are similarly based on many of the same factors as for the pipeline, with the following exceptions:

1) Some equipment will be stored onsite in the terminal area in addition to a nearby off-site facility;
2) The following time and spill volume recovery guidelines are used:
   a. Less than 12 hours for the deployment of First Response resources sufficient to remove 350 m^3 in 48 hours at a single Containment Site (equating to a skimmer name plate recovery capability of 23 m^3/hr considering 20% loss between the spill area to the Containment Site, and a derating of 25% of name plate values);
   b. Less than 24-hours for the deployment of a Full Tier 2 recovery capability of 2200 m^3 to be in place from two response depots within 24 hours (equating to a skimmer name plate recovery capability of 147 m^3/hr considering the same factors as above).
3) Sufficient boom to encircle a 300,000 dwt tanker and boom off designated sensitive areas / Containment Sites.

EQUIPMENT SELECTION

Based on the studies undertaken to date, specifications for the initial acquisition of major spill response equipment is detailed in Table 1. Although Table 1 lists equipment by response depot location, equipment will be cascaded into the emergency site as needed. A discussion of major items follows.

Boom—In response to the marine equipment guidelines presented above, (a) sufficient 12 inch (30 cm) and 18 inch (45 cm) boom is acquired to deploy at all Containment Sites in the probable spill area around the Terminal, and (b) sufficient 39 inch (1 m) ocean boom is available to encircle a stricken tanker and for use by tug-based recovery systems. In addition, the Oil Spill Response Vessel (OSRV) has its own 100 m (310 ft) supply of ocean boom onboard. Inland, sufficient boom is available at each response depot to cover two Containment Sites during river flood conditions. Boom vanes are acquired for each depot to assist boom stabilization in rapid current conditions.

Skimmers—The skimmers (brush, disc, weir, vacuum unit, rope mop, fast flow, and viscous) acquired for each response depot provide maximum flexibility to respond to various oil types (thick viscous oils to thin light products) in a variety of environments (fast moving streams, open water, pits, shallow marshes, rocky shores, etc). For rapid response at the marine terminal, the OSRV has an 80 m^3/hr mop-style brush skimmer fix-mounted to its bow, or it can deploy another skimmer as part of a side-arm recovery system. As needed, the large brush (60 m^3/hr) and weir (100 m^3/hr) skimmers listed in Table 1 are deployable from the specially designed tugboats that will be operating at the BTC Terminal.

Storage—Primary onwater marine storage is provided internally on the OSRV (20 m^3) and newly constructed aluminum storage barges (35 m^3, 249 bbl). As needed, additional storage is provided on each of the three tugs operating at the BTC Terminal (50 m^3). Offloading of collected oil will occur at the nearby small boat harbor at the Botas loading jetty, for transport to their oily water separator / ballast water treatment system. On land storage is provided by portable tank units and pits with reinforced plastic lining.

Boats and the OSRV—A 12.5 m (39 ft) OSRV with its bow-mounted brush skimmer system (80 m^3/hr) and 100 m (310 ft) of reel mounted ocean boom is the primary response method for an on-water marine spill. It is docked at the small boat harbor of the existing Botas jetty for rapid deployment with a permanently assigned response crew. During major spills, three tugboats, with special tankage, enable the deployment of additional response resources. The specially constructed aluminum barges, described above, are also designed as a work platform for recovery as well as for oily water storage.

Smaller vessels include a 6.5 m (20 ft) inflatable boat at each response depot that can be used to move material and personnel on reservoirs and large rivers as well as in Iskenderun Gulf. Small 4 m (12 ft) aluminum boats are deployable as needed for shallow streams and rivers, while larger flat bottom 6.1 m (19 ft) workboats are selected for work in shallow-water marine environments. Additional onwater support is provided by line and other boats used in marine terminal operations.

Vehicles—The first of the primary response vehicles for each depot is a high-axle, all-terrain flat bed 8x8 military style truck fitted with a crane and modular packages for waste storage, accommodation and vacuum tankage (for oil / oil+water transfers). A 6x6 truck with flat bed and crane at each depot provides additional support. Each depot also has a 4x4 pickup truck and 4x4 jeep-style automobile. For winter snow conditions, tracked BV206 vehicles are selected for use. Equipment is transported directly on the vehicle or on an open response trailer. All terrain vehicles (4x6 ATVs) are available for use at the work sites. Onsite fuel storage is provided from a towable military style 500-gal (~2 m^3) bowser.

Other Equipment—A full range of additional equipment has been procured as part of the startup process for pipeline and terminal operations. This includes everything from sorbents, to video equipment, computers to shovels, satellite phone to bird cleaning units, and a host of other supplies and materials. An independent Response Contractor has been selected to manage and maintain all equipment.

FUTURE EQUIPMENT SELECTION

Equipment selected to date is based on the planning documents and guidance requirements discussed at the beginning of this paper. Additional equipment will be procured upon additional reviews by the selected Response Contractor, as well as from lessons learned at pre-linefill spill drills and during pipeline commissioning and operations.

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BIOGRAPHY

Dr. Gundlach has over 30 years' international experience in oil spill response and planning. He has participated in numerous oil spills, drills, and planning exercise, and has published extensively on oil spill impacts and emergency response management.

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Table 1. Major spill response equipment initially acquired.

Item Response Depot	CMT	Kars	Erzincan	Kayseri	Total
HARD BOOM					
Inshore / River 18-inch, 45-cm (m)	1400	100	200	100	1800
Inshore / River Boom 12-inch, 30-cm (m)	1600	400	400	400	2800
Ocean 36-inch, 90-cm trailer Reel Packs (m)	1500	0	0	0	1500
Tidal Seal Boom (m) 5-m sections	110	30	30	30	200
Shallow Water Boom Paravane	2	2	2	2	8
SKIMMERS					
Small Brush Skimmer (12 m^3/hr)	2	1	1	1	5
Disc Skimmer (20 m^3/hr)	2	1	1	1	5
Light Vac Unit 30 m^3/hr with drums / fittings	1	1	1	1	4
Small weir (9.5 m^3/hr)	1	1	1	1	4
Rope mop (5 m^3/hr) 2 pulley system	1	1	1	1	4
Hi Capacity Brush Skimmer (60 m^3/hr)	1	0	0	0	1
Mini Fast Flow Skimmer (30 m^3/hr)	1	1	1	1	4
Compact Viscous Skimmer (17 m^3/hr)	1	1	1	1	4
Hi Capacity Weir Skimmer (100 m^3/hr)	1	0	0	0	1
STORAGE					
Portable Tanks (10 m^3)	16	16	16	16	64
Plastic Pit Liners (>40m^3)	20	20	20	20	80
12.2 m, 249 bbl marine storage barges	4	0	0	0	4
BOATS / OSRV					
6.5 m Inflatable+ 70 hp motor+trailer	2	1	1	1	5
6.1 m alum workboat +90 hp+ trailer	4	0	0	0	4
4 m alum workboat + light weight motor	0	2	2	2	6
12.5 m Oil Spill Response Vessel (OSRV); 20 m^3 tanks, 60 m^3/hr skimmer, 100 m boom	1	0	0	0	1
Tugboats for marine operations, 50 m^3 storage capacity + crane.	3	0	0	0	3
VEHICLES					
8x8 Military style Hooklift Hi Axle Truck	1	1	1	1	4
Flat Bed Module for 8x8 Truck	1	1	1	1	4
Vacuum Unit for 8x8 Truck	1	1	1	1	4
Accommodation Module (20 ft) for 8x8 Truck	1	0	1	0	2
Waste Module (water tight) for 8x8 Truck	1	1	1	1	4
6x6 Truck with Hiab Crane + Cargo Bed	1	1	1	1	4
Tracked Vehicle BV 206 with hook crane	0	1	0	1	2
Tracked Vehicle BV 206 with hiab crane	0	1	0	1	2
4x4 diesel, dual cab Pickup Truck + chains	1	1	1	1	4
4x4 (Jeep) 3 L Off Road Vehicle w/ chains	1	0	0	0	1
Open Response Trailer, Double Axle	1	1	1	1	4
6 x 4 ATV Utility Wagon	2	2	2	2	8
500 gal single axle Fuel Bowser	1	1	1	1	4