

BP ANGLE BAY OCEAN TERMINAL, MILFORD HAVENTechnical Description

The BP Angle Bay Ocean Terminal, which cost overall about £6½ million, comprises a jetty with two deep water tanker berths at Popton Point; administrative offices at Popton Fort; a tank farm for intermediate storage of the crude oil at Kilpaison Farm 1½ miles away on the south east corner of the bay; and a 60 mile pipeline to Llandarcy with one main pumping station beside the tanks at Kilpaison.

JETTYShore Arm

The 1,100-foot long shore arm of the jetty comprises a 16-foot roadway and 32-foot wide open pipe track. Open construction was used to prevent interference with tidal flow, and to allow small craft to pass through. Hexagonal steel piles driven into the rock bed of the Haven were capped with precast concrete muffs which in turn carry the precast concrete roadway and pipetrack. After erection the whole of the deck system was post-tensioned, using 1½-inch diameter Macalloy bolts.

Raker piles placed at every fifth bent take care of sway. The road slab itself spreads the wind load between the anchor bents. Road and pipe tracks run side by side over pile bents at 27-foot 6-inch centres.

On the pipe track as well as the twin 26-inch diameter crude pipelines which lead from the berthing heads to the tank farm, there are also:-

- Three 16-inch diameter bunker fuel pipes;
- 12-inch diameter diesel oil line;
- 12-inch diameter water line for fire-fighting;
- 10-inch diameter potable water line.

Sea Arm and Berthing Heads

There are two berthing heads provided, each capable of berthing 100,000 d.w.t. tankers in 54 feet of water.

The design presented difficulties since not many feet of softish silt overlies the rock. The consulting engineers (Messrs. Rendel, Palmer and Tritton) finally recommended that the best design to resist the considerable berthing force of a fully laden 100,000 ton tanker would be for each berth to consist of a pair of solid mass-concrete strong points, each 74 feet by 38 feet. This is known as a gravity structure. The trunkway or sea arm from which the berthing heads are extended is 1,220 feet long and lies at right-angles to the shore arm. The total length including the dolphins at either side is 2,300 feet.

The flow boom installation or hose handling gantry for each berth is carried by a piled platform between the two strong points. The section of the deck under the hoses is drained independently to a "slops tank" to prevent oil pollution. Rainwater falling on the area which may be contaminated by oil spillage is also collected in this way and the mixture of oil and water is pumped back into the crude oil line for eventual separation at the refinery.

Fendering System

The design of the jetty strong points is based upon the impact force which they will have to withstand. Gravity fenders are mounted in sets of four on each strong point; a set of four will absorb the energy of a 65,000 ton tanker moving at a speed of 1 ft/sec or a 100,000 ton tanker at $\frac{4}{5}$ ths ft/sec.

Each weight hangs on two pairs of links arranged so that when it makes contact with the side of the vessel it is pushed backwards and upwards into a recess in the face of the jetty. The maximum horizontal travel is 4 feet $10\frac{3}{4}$ inches, which gives a rise of 3 feet 6 inches; this will enable the fenders to offer a yielding and resilient face to the side of the tanker under all weather conditions.

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POPTON FORT

The administration and service area is located within the existing walls of Popton Fort.

The administration buildings and control centre are located in the upper works of the fort which have been rehabilitated to provide offices for the administration, marine staffs, crews, H. M. Customs, radio communication, marine stores, terminal stores, fire station, garage, canteens, rest rooms and ablutions.

Four tanks, with a total storage capacity of 30,000 tons, have been built in the lower portion of the fort to store heavy marine furnace oil, light fuel oil and diesel oil. They lie in an oil-tight rock excavation in the fort area: drainage passes through separators before entering the Haven. The base level of the tanks has been taken down to keep them below the sky-line.

The bunkering installation is capable of delivering up to 750 tons of fuel per hour to the berthing heads. Provision for heating bunker tanks is included by steam from an automatic boiler installation.

A potable water tank of 250,000 gallons capacity is provided for gravity distribution to berthing heads for ships' water. This tank is fed from a supply taken from the Pembroke Rural District Council water-works at Stemberidge.

The telecommunications system for this installation includes a single link teleprinter service to the BP refinery at Llandarcy and a V. H. F. radio telephone system to provide communication between the Marine Superintendent and tankers approaching the terminal up to a distance of 30 miles out to sea.

TANK FARM

The crude oil tank farm is at Kilpaison which lies one and a half miles away from the jetty at the south east corner of Angle Bay. The total area of the farm is approximately 220 acres and of this about 65 acres are being utilised to accommodate eight 21,000 ton capacity welded steel, floating roof tanks. These are grouped in four pairs, each pair

in an oil retaining bund. Crude oil is pumped by the tanker direct to the tank farm.

The linkup pipework is designed so that any selected pair of tanks may be emptied or filled and the contents of any pair of tanks can be transferred to either or both of any other pair of tanks. A manifold is located at the pumphouse comprising four 26-inch lines from each pair of tanks; this manifold will be connected to the two 26-inch diameter main transfer lines from the jetty.

There is one main pumping installation which is located at an elevation of 17.5 feet O.D. The plant comprises four electrically operated centrifugal pumps arranged for series pumping. These pumps have a capacity of over 700 tons per hour at the pipeline working pressure of 850 p.s.i., the drive being directed by 650 h.p. motors operating on 3.3 kV.

A minimum of two pumps is on load at any one time and the remaining pumps may be brought in according to the throughput required. With the present planned output it should not be necessary to use more than three of these pumps to pump the oil to Llandarcy.

No booster pumping stations are needed along the route but there is a control valve at Llandarcy to maintain pressure at the highest point on the pipeline (672 feet). There is also an automatic control valve at the pumping station to prevent surges when stopping the pumps.

The fire-fighting arrangements comprise a charged hydrant system supplied from a fire pumphouse taking its suction from an old Mill Pond which has been in existence since about 1600 A.D.

UTILITIES

Electricity

The estimated peak demand is about 3,750 K.V.A. The supply is taken from the South Wales Electricity Board by two $7\frac{1}{2}$ M.V.A., 33,000 volt overhead feeders terminating at the sub-station at Kilpaison Farm.

Water

By arrangement with Pembroke Rural District Council up to 250,000

gals/day are provided by gravity flow to a point on the south boundary of Kilpaison Farm. From this point the Company's own mains carries the supply to Popton Fort.

PIPELINE

The 18-inch diameter pipe was supplied by South Durham Iron and Steel Company. The pipeline itself, laid by George Wimpey and Company, has a total length of 60 miles and consists of 13,000 electrically welded lengths of pipe. After welding, each joint was examined by radiography, wrapped in glass fibre and treated with bituminous enamel. The external fibreglass bitumen protective coating was tested for homogeneous seal by a high voltage machine called a "Holiday Detector".

All joints were tested as the work proceeded under an air pressure of 100 lb./sq. in. and after completion the whole line was tested to a hydraulic pressure of 1,200 lb./sq. in.

Bends which were needed during the laying of the line were curved on the spot with a special pipe bending machine known as a Mobile Hydraulic Cold Bending Machine; or less formally, the "Big Cinch". There were 600 bends in all.

Passing through open country in Pembrokeshire, Carmarthenshire, Glamorgan and Swansea County Borough, the pipeline is laid throughout its length at a depth of not less than 2 feet 6 inches to the top of the pipe.

Many obstacles had to be overcome including 12 major roads; 8 B class roads; 53 minor roads; 33 private metalled roads; 1 canal; 4 major rivers; 28 stream crossings; 12 rail crossings; 3 underground aqueducts and several main gaslines.

The pipeline reaches its highest point 42 miles from Angle Bay at 672 feet.

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ANGLE BAY OCEAN TERMINAL - CONTRACTORS

Consulting Engineers	Rendel, Palmer & Tritton
Civil Engineering Contractor (Marine work)	Christiani & Nielsen Limited
Mechanical & Electrical Work	Constructors John Brown Limited
Subcontractor for Gravity Fenders	Weldall & Assembly Limited
Shore construction	Shellabear Price
Tank construction	Motherwell Bridge & Engineering Company
Rehabilitation of Popton Fort	George Argent. Hadsphaltic.
Main Pipeline Construction	George Wimpey & Company
Welding Equipment	Lincoln Electric Company Limited.

20th April, 1961