Port of Bristol Bulk Handling Terminal

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1. Introduction

In early 1991 Balfour Beatty, one of Britain's major civil construction companies and Birtley Engineering, the country's largest bulk handling contractor formed a joint venture to tender for the major importation terminals which were planned by the two major power generators in the U.K., National Power and PowerGen. In that year three tenders were submitted; one project did not proceed, namely Immingham, and the consortium was successful with one of the other two projects which was at Bristol for National Power in association with The Bristol Port Company. The terminal will be operated by The Bristol Bulk Company Limited, a company jointly owned by The Bristol Port Company and National Power Plc which is being set up for the purpose. The client had appointed as its consulting engineers the combination of Halcrow Soros, whose brief was to prepare the performance specification, adjudicate the tenders and finally to assist the client's project staff to oversee construction as part of a Joint Project Team established for the purpose.

2. Objective

The terminal is a multi-user, multi-cargo bulk terminal, which apart from power station coal is required:

1. to receive a variety of other "hard" materials such as aggregates for despatch by road from the stockyard; and
2. to unload "soft" materials – fertilisers and animal feeds – from ships for transfer (via transfer station TS1) to a covered dry bulk store being developed by others adjacent to the Royal Portbury Dock.

The main parameters of the terminal were as follows:-

Annual throughput	7,000,000 t
Unloading rate	4,000 t/h
Stacking rate	4,000 t/h
Stockpile capacity	550,000 t
Reclaim rate	2,500 t/h
Train loading	1 x 45 HAA Wagon Train in 15 minutes

The client's proposals are illustrated in Fig. 1 (overleaf) and show the two continuous ship unloaders sited in the Royal Portbury Dock with the stockyards being located on the vacant land situated between the M5 motorway, the Lafarge plasterboard factory and the river Avon. The location of the nearest suitable position for the rail loading station was, however, on the other side of the river Avon some 3 km distant at the Saint Andrew's Road station, Avonmouth. Here British Rail had agreed to allow the construction of the rail terminal including additional railtracks and the two 2,600 t capacity rail loading silos.

The original proposals had indicated that the conveyor would be carried across the river Avon – some 500 m wide at this point – by a cable stayed bridge; provision being made on the bridge for the addition of a second conveyor at a future date should this prove a requirement. The BBB joint venture, however, took the view that a tunnelled crossing should be offered to the client as an alternative solution for 4 main reasons:-

1. Reduced risk of failing to obtain planning approval.
2. Reduced cost if a second conveyor was not realistically foreseen.
3. The proximity of a site of special scientific interest on the south side of the Avon.
4. Improved construction programme.

The client eventually decided on the tunnel alternative and the 1,400 mm conveyor now crosses the Avon through a 3.35 m diameter tunnel which commences at transfer house TS2A and emerges some metres to the south of transfer tower TS4.

An aerial view of the site is shown in Fig. 2.

3. Unloading and Stockyard Machines

This is not the forum for discussing the machines utilised on the site since descriptions can be found elsewhere within this publication. Suffice it to say that prior to the award of the main contract National Power placed the following orders:-

1. Kone Corporation for two continuous ship unloaders with a rated capacity of 1,750 t/h on coal with a specific gravity of 0.9 and capable of unloading vessels up to 120,000 DWT.
2. Strachan & Henshaw for one 4,000 t/h stacker with a 60 m boom, one 2,500 t/h reclaimer with a 50 m boom and a combined 4,000/2,500 t/h stacker reclaimer with a 50 m boom.

It was a condition that these orders be novated to the BBB joint venture upon the contract award and this duly took place.

4. Conveying System

There are dual conveyors on the quay which can be fed by either CSU, one conveyor C1 being rated at 4,000 t/h and the other, conveyor C2 at 2,000 t/h. The twin

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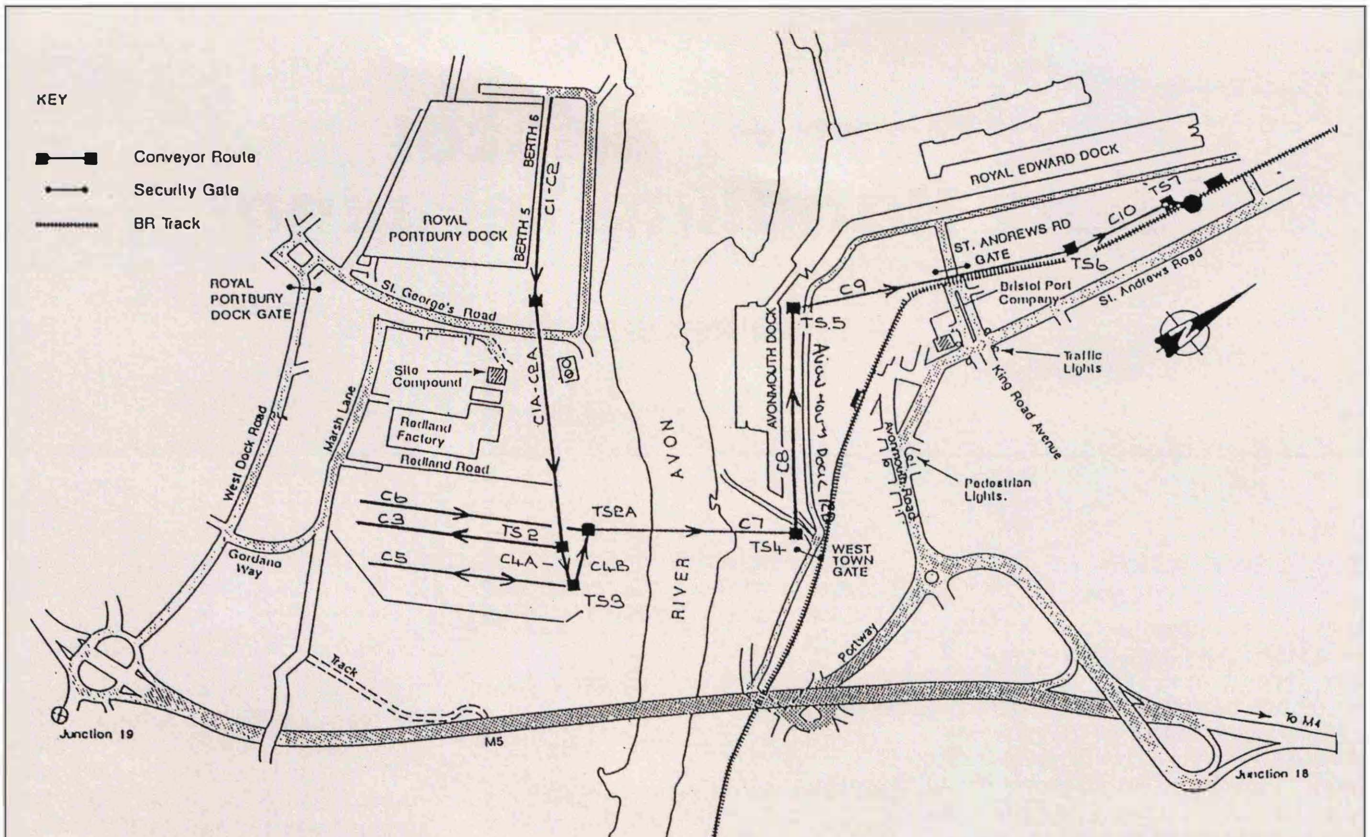

Fig. 1: Bristol bulk handling terminal – schematic site plan

Fig. 2: Aerial view in the construction phase of Bristol Terminal with unloaders middle left, stockyard bottom centre and train loading facility top left

conveying system (Fig. 3) continues to transfer house TS1, where the magnetic separators are sited at the head ends of conveyors C1 and C2, the conveyor system continues overland to the stockyard area where transfer station TS2 is located. This transfer house contains the sampling equipment and is where the feed can be directed into the stockyard along conveyor C3 and the stacker or via conveyors C4A and C5 to the bucket wheel stacker reclaimer.

Reclaiming can only take place from one stockpile at a time and material from any pile is fed onto conveyor C7 at transfer tower TS2A from where it descends under the river Avon to transfer house TS4. From here a series of 4 conveyors transports the material to the two 2,600 t capacity rail loading silos.

Table 1 gives details of the conveyors involved.

Conveyor Ref	Belt Width [mm]	Troughing Angle [°]	Belt Speed [m/s]	Capacity [t/h]	Drives [kW]	Length [m]
C1	1,800	35	5.0	4,000	2 x 250	767
C2	1,200	35	5.3	2,000	284	771
C1A	1,800	35	5.0	4,000	2 x 270	689
C2A	1,200	35	5.3	2,000	300	688
C3	1,800	35	5.0	4,000	2 x 290	603
C4A	1,800	35	5.0	4,000	250	107
C4B	1,400	45	5.0	2,500	100	130
C5	1,800	35	5.0/ 3.2	4,000/ 2,500	2 x 205/ 200	556
C6	1,400	35	4.8	2,500	270	642
C7	1,400	45	5.0	2,500	2 x 250	770
C8	1,400	45	5.0	2,500	2 x 185	668
C9	1,400	45	5.0	2,500	2 x 170	911
C10	1,400	45	5.0	2,500	2 x 300	405
C11	1,400	45	5.0	2,500	115	27
C12	1,400	45	5.0	2,500	75	14

Table 1: Details of conveyors

5. Sampling System

Twin Sampling Systems are provided at Transfer House TS2 which are designed to sample direct from the 2,000 and 4,000 t/h conveyors, and operate in accordance with the guidelines as specified in BS1017:1989 for the sampling of coals.

Each system incorporates a Birtley Cross Belt Primary Sampler with crushing and dividing equipment to give separate moisture and general analysis samples.

Cargoes of a variety of capacities to 120,000 t can be sampled to preselected programmes with adjustment in the PC control facility to allow primary samples to be processed at frequencies as low as 1 every 40 seconds.

Gross samples awaiting collection are stored in canisters located in Automatic Indexing Machines which are equipped with sealing features to preserve the samples from the ingress of air and foreign materials.

6. Dust Suppression

Dust suppression sprays are provided at each transfer point including those on the stockyard machines; the stockpile areas are also provided with a series of large area water sprinklers or cannons which are supplied by a piping network and connected to the dust suppression pumpset located in the pumphouse. Each of the cannons is positioned on a standpipe just above ground level and is controlled by a solenoid valve which is normally held in the closed position. When the sprinklers are shut down the standpipe is drained up to the top of the solenoid valve by an automatic drain valve.

The stockpile sprinklers are controlled automatically by a PLC from signals given by the main control system, which determines the frequency and duration of spraying cycles. The predetermined operational cycle is determined from information obtained and recorded from the weather station which monitors climatic conditions automatically using an anemometer, wind vane and rain gauge.

7. Power and Control

The terminal is effectively split into two parts regarding the electrical distribution system. The Portbury side of the terminal is supplied with power at 11,000 volts – 3 Phase – 50 Hertz, whilst the Avonmouth side of the terminal is supplied at 6,600 volts – 3 Phase – 50 Hertz.

Power is transformed down to 3,300 volts for conveyor drives, local electrical distribution around the terminal for auxiliary equipment, is provided at 415 volts – 3 Phase – 50 Hertz. The connected load at the Portbury side is approximately 6.6 MVA and at the Avonmouth side, approximately 4.0 MVA.

Control of the plant is achieved from a Central Control Room housing a duty standby computer terminal with serial communications to the various areas of the plant. The Control Room operator is able to monitor the status of auxiliary plant, stockyard machines and ship unloaders, communications are also provided from the road weighbridges and rail out loading terminal.

A comprehensive fire detection and fire alarm system has been installed to protect conveyors, control buildings and electrical sub-stations.

8. Effluent Treatment

The treatment of all run off water in most especially the Quay and Stockyard areas is one of the most significant requirements of the project. The run off from the quay area, being of concrete construction, is reasonably containable, however, the stockpile area required more consideration. During the construction of the stockpile an impermeable membrane was installed beneath the drainage blanket to collect all the leachate water which is then directed to the stockyard treatment plant.

8.1 Stockyard

The stockyard leachate is pumped together with surface water to twin concrete catchment areas where primary settlement of suspended solids takes place. The weir overflow from the settlement system is pumped to a 9 m diameter thickener via an oversize guard sieve bend which will remove any particles in excess of 1 mm. The sieve bend underflow is monitored for pH value and automatically dosed with acid/alkali solutions to maintain near neutrality. Flocculating polymers are added after pH adjustment to give a thickener overflow of less than 100 mg/litre, together with a thickener

Fig. 3: Erection of double conveyor gantry with transformer bay in background

Fig. 4: Train loading facility during construction

underflow which is then dewatered in a 2.6 m width multi roll filter. The filter cake from the MRF plant is conveyed to a ground stockpile area from where it can be transported for suitable disposal.

8.2 Quay

The quay water treatment plant is required to deal with water contaminated with fertilisers and organic matter as well as coal, and is therefore more comprehensive.

Washdown water and surface spillage from the ship unloaders and quayside is collected and pumped through an oil trap into a flash mixing tank, where it is dosed with polyelectrolyte to aid flocculation and correct the pH. Effluent then passes to a sedimentation pond where settlement of large solids takes place. Following settlement, liquor is pumped to a buffer tank which feeds, by means of gravitation, two Rotating Biological Contacting units for bio-reaction and removal of organic matter. Treated liquor is then passed to a final settlement tank for clarification prior to discharge.

9. Rail Loading Facility

The rail loading facility comprises two 2,600 t capacity steel silos lined to a position 5 m above its hip, with 6 mm thick 420T high flow stainless steel, polished to 0.4 μm finish. The tonnage of material held in each silo is monitored by 12 strain gauges located in the supporting columns of the structure and the material level is monitored by two ultrasound level controllers; a single ultimate high level probe is provided as a safety back stop to the above controls.

The silos, one over either rail track, each hold product type and grades appropriate to the needs of the users. With this arrangement it is possible to load two different grades of product simultaneously into trains destined for users with different needs (Fig. 4).

Each wagon is filled up to a set level, or tonnage depending on coal density and flow characteristics and the loading apparatus is continuously reset according to the actual load of previously loaded wagons as measured on the control weighbridge. The loading apparatus is locally controlled by the rail loading operator in the rail loading control room using the dedicated local system.

For trading purposes Department of Trade stamped gross and tare weighbridges are included in each of the arrival and departure tracks.

Due to the wide range of coal that may be handled through the facility it is essential to maximise the flexibility of the entire loading plant, in particular its control system as follows:

9.1 Flood Loading

This system is only suitable for flood loading up to 880 kg/m^3 bulk density. The flood loading or fill and trim loading system floods the wagon to a set height, then trims in flight coal held between the clam shell gates and the wagon top, into the void, automatically available at the back of each wagon. By accurately setting the opening times and positions of the gates and the trim chute height, each wagon is evenly and fully loaded to its maximum volume.

The geometry of each wagon hopper is detected by dedicated sensors, suitably positioned to open and close the clam shell gates at the required positions, one set of sensors are provided for each gate.

The first set of gates (gate 1) initially open fully then close down to provide the required discharge opening to ensure the wagon is filled to 50% of its optimum capacity. Gate number 2 is arranged to open at a position that will ensure coal is loaded (on top of the initial fill from gate 1) to a level controlled by the underside of the loading chute and by its natural angle of repose to the correct level just below the rim of the wagon hopper. In this case (gate 2) flow is controlled by the natural choking action of the loading chute.

9.2 Anticipatory Weigh Loading

This system is used when loading coal in excess of 880 kg/m^3 bulk density. In this case it is necessary to anticipate the volume of coal to be discharged through each silo discharge gate, and to trial load the leading wagons, once the true density and flow characteristics of the coal being loaded have been established, from the anticipatory loading system, accurate loading can quickly be achieved.

The expected coal density and type of coal together with train speed and wagon details are entered into the programmable logic controller. These are used to calculate the initial volume/tonnage to be discharged through each gate, which in all cases is to be 50% from each.

The type of coal provides the flow characteristics which sets the opening times and the initial gate apertures, which information is used to load wagon no.1. When this wagon has been fully draft weighed then actual recorded weight is used to reset the gate operating system and from then onwards continual adjustment is maintained throughout the train.

10. Conclusion

In summary, the project undertaken by the Balfour Beatty, Birtley joint venture for National Power and the Port of Bristol has produced as far as possible, an environmentally friendly installation in a remarkably short period. The instruction to proceed on the design and build project was received early in 1992 with the first ship being off-loaded in May 1993 with a target date of August 1993 for the completion of the rail loading station.

The terminal has been designed incorporating BATNEEC concepts (Best Available Technology Not Entailing Excessive Cost) to meet the requirements for authorisation under Part I of the Environmental Protection Act of 1990, and has combined the design, technical expertise and management, as well as resources of two of Britain's largest international multi-discipline construction groups.