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The Siwertell Coal Unloader at Kingsnorth

A Case History

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1. Introduction

The Siwertell ship unloader is a continuous bulk unloader, that has been used extensively to unload cement, grain and feedstocks, and minerals. More recently, it has been used for unloading coal, and two Siwertells have been purchased by the Central Electricity Generating Board (CEGB) in Great Britain. This article examines some of the reasons why the CEGB chose Siwertells and looks in detail at one of the Siwertells now in operation at the Kingsnorth power station.

2. Background

Kingsnorth, 25 miles east of London, is one of the largest dual-fired power stations in Europe. It has a capacity of 2,000 MW and uses 3 Mt/a coal. The Siwertell newly installed at Kingsnorth will unload about 1.0 to 1.5 Mt/a and has a capacity of 950 to 1,150 t/h.

Kingsnorth was designed to burn either oil or coal and switched in the 1970s from using oil to coal. That was when most of the existing coal unloading equipment was brought in. Today, 96% of what the power station burns is coal, the rest is oil.

Virtually all of the coal comes in by sea from the north-east of England in colliers of 5,500 to 11,500 DWT. The collier fleet is in the process of changing over to larger vessels of 18,000 to 22,000 DWT. This is part of a programme to cut down the costs of transporting and handling coal.

Two of the four grabbing cranes on the jetty at Kingsnorth are luffing cranes made by Stothert & Pitt. They were designed to unload vessels of 4,000 DWT and have difficulties reaching out to the far side of the holds in larger vessels. This sometimes resulted in queues of colliers waiting to be unloaded. The CEGB incurred demurrage charges and also had high maintenance costs on the old cranes.

In December 1982, after careful study, an order was placed for a Siwertell ship unloader for Kingsnorth and an identical machine for the neighbouring West Thurrock power station. These machines were ordered by the South Eastern Region of the Central Electricity Generating Board (CEGB), the public body responsible for electricity supply in England.

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3. Development

3.1 Replacement of Grabbing Cranes

The actual commissioning work was done by the Regional Projects Branch of the South Eastern Region. Contract Technical Officer Roger Harding, who was closely involved in the project, explained the background to the order: "The advent of the new generation of bulk unloaders coincided with the gradual falling-off in performance of our existing cranes. We could immediately see a dramatic saving in ship turn-round time by the use of fast bulk unloaders, and it was very much on this basis that we decided that we must investigate more carefully the bulk unloader."

3.2 Computer Model

Before purchasing new equipment, the CEGB looked into the whole fuel supply situation very carefully. The Corporate Planning Branch and Fuel Supplies Branch at the CEGB produced a computer model simulating the movement of the collier fleet and the discharging of coal at power stations.

The results confirmed that existing unloading equipment was too slow, particularly in view of the larger vessels being introduced.

With two Siwertells, the model showed that savings of around £ 2 million a year could be made. At the same time, by using larger colliers, 15 to 20% savings in coal transportation costs could be achieved.

3.3 Selection Process

The CEGB started looking into Siwertell ship unloaders some five years ago. In September 1979, CEGB representatives attended a test on coal with a Siwertell unloader at Landskrona, Sweden.

In this test, one of the holds was prepared with typical "foreign objects", and only two of these objects caused blockages in the inlet device. Time spent removing the objects was only about two minutes. This was done by simply reversing the vertical screw conveyor. Other large objects placed in the coal passed through the screw conveyors of the Siwertell without causing damage or delay.

More recently, CEGB officials visited Odense, Denmark, to see a Siwertell in operation unloading coal. This one has a capacity of 1,000 t/h and was ordered for the 630-MW Fynsvaerket power station.

3.4 Assembly

When the actual order was signed in December 1982, the CEGB wanted the two unloaders to start operation quickly (Table 1). Siwertell was able to deliver them within eleven months.

Table 1: Schedule of the Kingsnorth and West Thurrock order

December 1, 1982	order signed by CEGB
November 5, 1983	two Siwertell unloaders shipped from Malmö, Sweden
November 14, 1983	Siwertell unloader lifted onto jetty at Kingsnorth
November 22, 1983	Siwertell unloader in operation at Kingsnorth for the first time
February 9, 1984	passing of final operational tests after commissioning

A Siwertell is normally shipped in a few large sections and assembled on site. This can take anything from four to ten weeks. The Siwertells for Kingsnorth and West Thurrock were assembled in Sweden and transported to England by barge. This is the first time Siwertell has delivered their machines ready-built.

Siwertell investigated the costs of assembly in England, and in every case it was cheaper to do this work in Sweden. A further advantage was that Siwertell could carry out a number of tests before the unloaders were shipped out.

Each Siwertell is tailor-made to the customer's requirements. When designing the Siwertells for the CEGB, tides, the sizes of ships to be unloaded, and the types of jetties were all taken into account.

3.5 Lift-Off

On November 5th, 1983, the two fully assembled Siwertell ship unloaders left Malmö, Sweden (Fig. 1). They were shipped on board an 8,000-t barge through the Kiel Canal before being towed across the North Sea by oceangoing tugs.

Fig. 1: Two fully assembled Siwertell unloaders stowed on a barge at Malmö, Sweden, ready for shipment to England

The Contract Technical Officer watched when the Siwertell was lifted off: "The delivery started with the arrival of the jetty of the barge, the two Siwertells, and a large floating crane that had come across from Germany two days previously. The barge was laid directly alongside, and the sea lashings were cut whilst the fly jib of the floating crane was attached.

"The Siwertell was quietly lifted off, was brought round and landed on the jetty with no fuss, no problems with clearance, and the whole operation took less than 24 hours (Fig. 2). This meant that our jetty and the use of our jetty was only lost for this period.

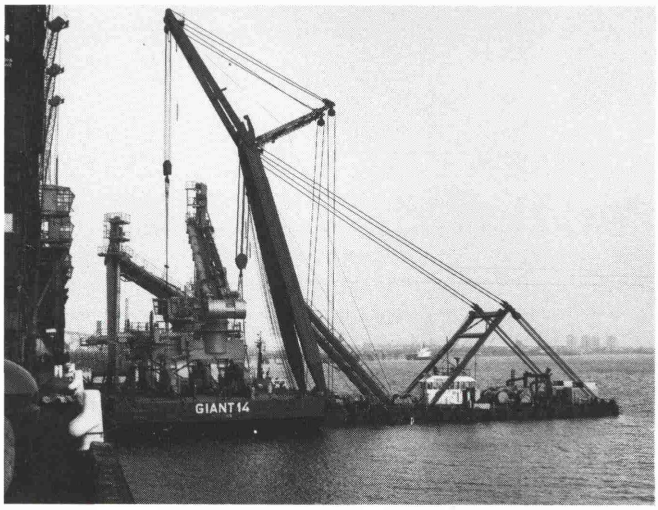


Fig. 2: Floating crane lifting the new coal unloader ashore at Kingsnorth

"Once the crane was landed, the barge was taken away with the second machine, we started commissioning, and eight days later we were digging coal," said Roger Harding.

3.6 Minimum of Disruptions

Assembly on site would have meant closing off one end of the jetty and severely restricting shipping movements. It could have resulted in three months of disruption and inconvenience.

"Our jetties are in constant use, and erection of any type of machine of the jetty itself would have caused significant probems both operational and also in the actual erection itself. The facilities that Siwertell were able to provide of putting the completed unloader directly onto the jetty had significant economic and operational savings for ourselves," said Roger Harding.

The Siwertell at Kingsnorth was lowered onto the existing rails on the jetty, and the only modification needed was the uprating of the conveyor belt on the jetty to take 2,250 t/h coal.

At Kingsnorth, the personnel had already experience of assembling an unloader on site. When the large horizontal boom unloader, made by Strachan & Henshaw, was assembled at Kingsnorth in 1978, it took the largest mobile crane in Britain at that time to lift up the horizontal section. Normal shipping operations were restricted for weeks during assembly.

3.7 Size

Fig. 3 shows the profiles of the Siwertell unloader and the horizontal boom unloader used at Kingsnorth. For all its size, the latter is capable of discharging 450 t/h, whilst the Siwertell has at least twice that capacity. At 320 t, the Siwertell is two thirds of the weight of the horizontal boom unloader, which makes it particuarly suitable for the jetty structures at Kingsnorth and West Thurrock.

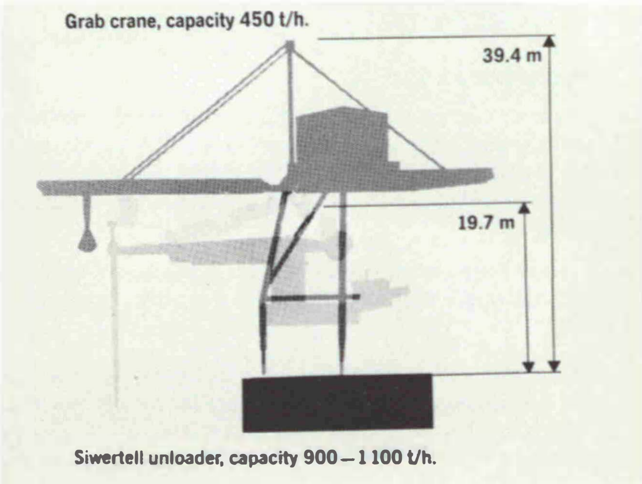


Fig. 3: Silhouettes to scale of the Siwertell and a horizontal boom unloader in use at Kingsnorth

A larger machine would have required more wheels and hence more space on the rails to support it. There is limited room on the 995-ft jetty, which currently has six unloaders on it, including the Siwertell (Fig. 4).

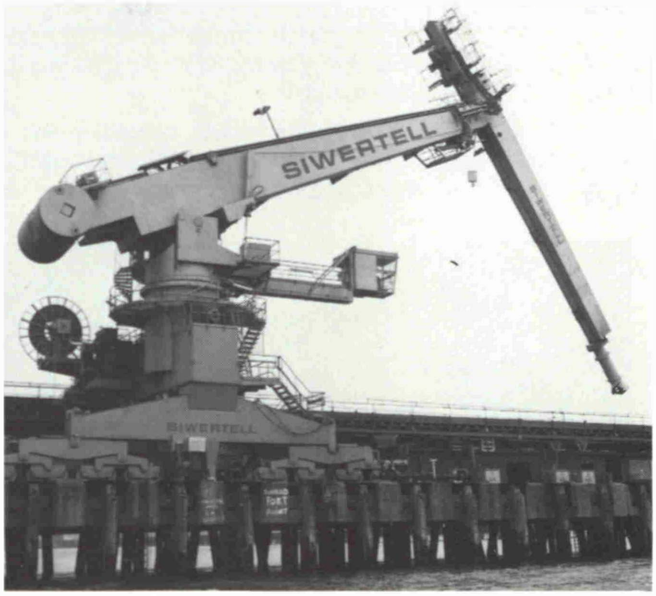


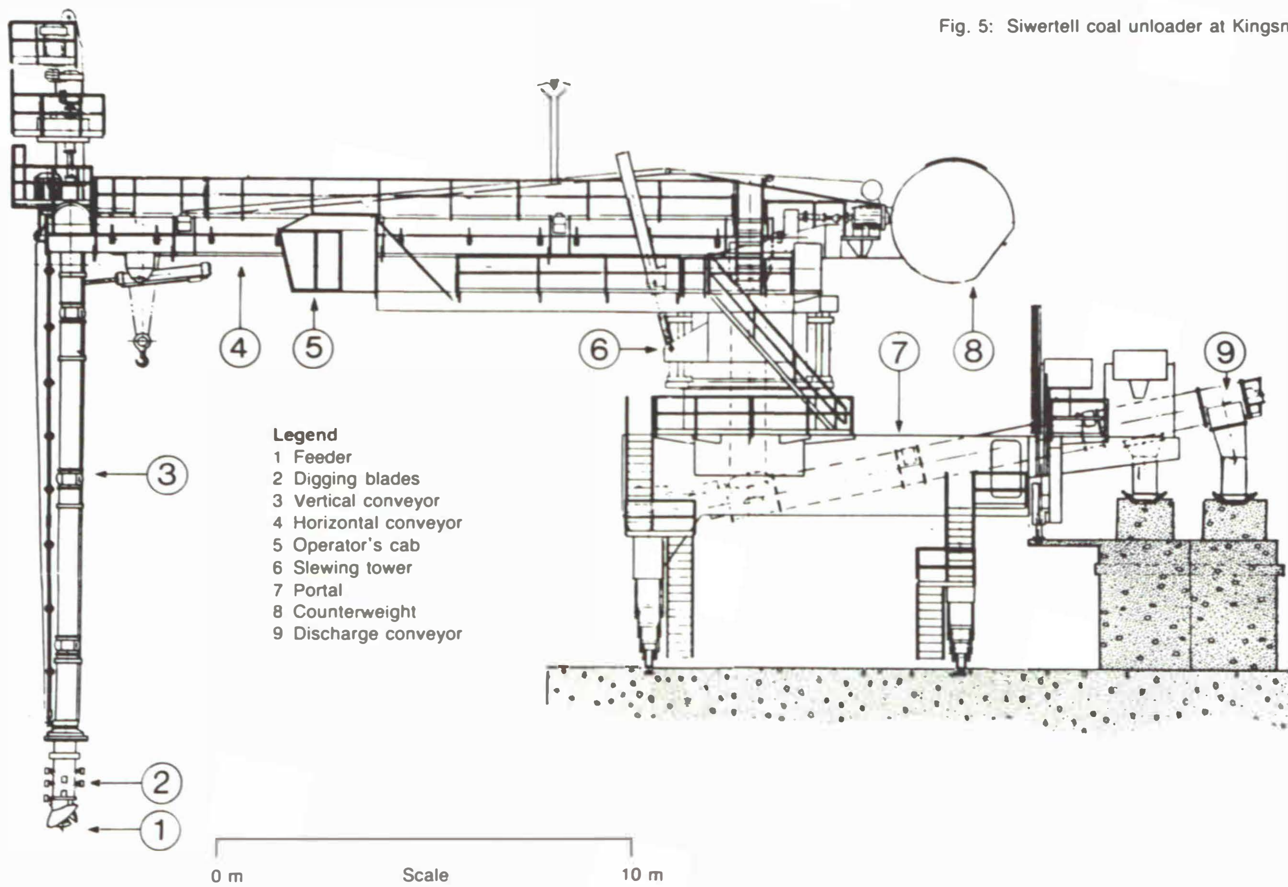
Fig. 4: Siwertell unloader after completed commissioning

4. Design, Operation, and Costs

4.1 How the Siwertell Coal Unloader Works

The Siwertell is a system designed for continuous transfer of material from ship to shore (Fig. 5). It does this by means of three screw conveyors which move material along in their flights. There is one screw in the vertical pendulum arm,

Fig. 5: Siwertell coal unloader at Kingsnorth



which transfers material to another in the horizontal arm. After passing down through the centre of the slewing tower, the material is moved by the third conveyor to a discharge opening above the conveyor belt.

The vertical screw has an outer casing around it with a counter-rotating inlet device at the bottom (Fig. 6), which is designed to throw material in as the inner screw draws it up.

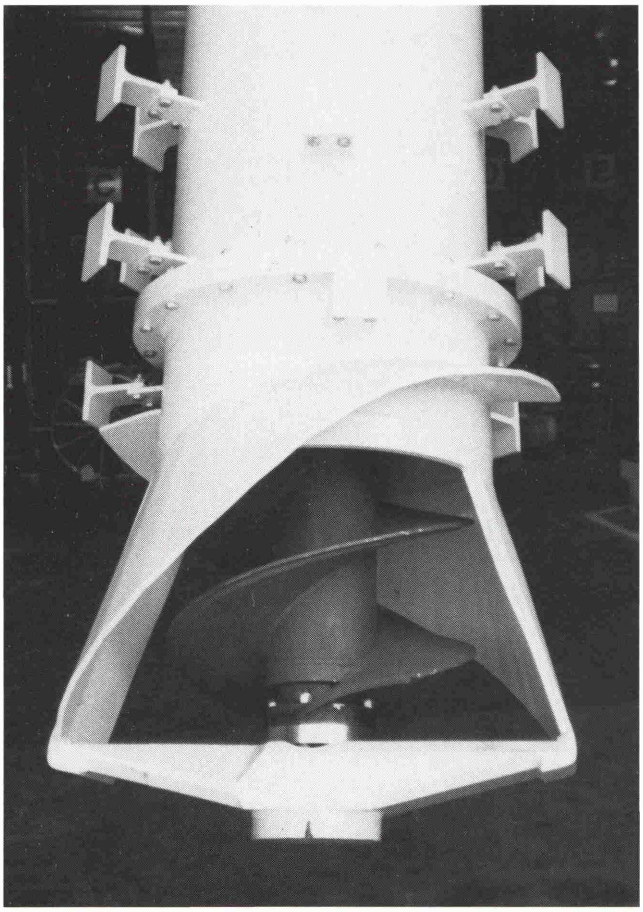


Fig. 6: Feeder for coal with collecting vanes and digging blades

The feeding of coal into the vertical conveyor is regulated at all times by the inlet device. The vertical conveyor itself is always moving at the same speed. With the inlet device, it is possible to regulate the fill factor in a range from 50 to 100 % for optimum load.

4.2 How It Is Operated

Eddie Russell, a driver at Kingsnorth, explained how the Siwertell is operated in a hold: "To trim the load, we travel along the jetty and make what we call a 'cut'. We keep on travelling until we reach the end of the hold, then we slew the machine whilst travelling. Then we go onto the next cut, and then we travel in the opposite direction.

"This way, it keeps the inlet device in the coal at all times, and therefore, we are able to keep a steady flow of coal coming up through the conveyors onto the belt."

4.3 Operational Costs

Power consumption is related to the size of the screw unloader, and for coal it will vary from 0.4 kWh/t for barge unloaders up to 0.9 kWh/t for 100,000-DWT ships. Energy costs for the Siwertell at Kingsnorth work out at 0.7 to 0.8 kWh/t material unloaded. The power consumption is comparable to that of a conventional grab crane of equivalent size.

To help drivers operate the Siwertell economically, there is a dial in the driver's cab which shows when the machine is working at full capacity. The feed control can be set automatically for the quality of the coal to be unloaded, ensuring that the inlet device works at the optimum speed without wasting energy.

4.4 Manoeuvrability

The Siwertell can be manoeuvred in a number of directions. The vertical arm has a pendulum arc of ±30 °. The horizontal arm can be luffed from 45 ° elevation to 20 ° depression. The tower can be slewed 200 to 240 °, and the whole unloader travels on rails.

"It is quite good for getting into the corners and can be manoeuvred just about anywhere on the ship", said Eddie Russell.

A problem with the grabbing cranes is that the grabs become difficult to manoeuvre in high winds. At Kingsnorth, the wind can reach up to 60 miles/h. With onshore winds of over 30 miles/h, the 5-t grabs swing dangerously close to the driver's cab on the luffing cranes, making them too dangerous to operate.

John Redman is Chief Officer of the 14,000-DWT collier "Garrison Point" which makes regular calls at Kingsnorth: "From the ship's point of view, the discharge from the Siwertell is much quicker than with the cranes. There is less damage in the holds. When discharging with grabs, we get frequent grab damage. With the Siwertell so far, there has been no damage to the holds."

4.5 Clean-Up

When there are about 2 ft of coal left in the hold, a front-end loader is lowered in by the Siwertell. This scoops material into workable piles for the Siwertell to discharge. At Kingsnorth, this last stage of unloading usually takes one or two hours for a 10,000-DWT ship.

Unlike grabs, the Siwertell can operate in close proximity to a front-end loader working in a hold.

4.6 Closed System

The Siwertell unloader is a closed system from inlet to oulet. Its operation therefore causes no spillage, which with open systems can be as high as 1 % of the cargo.

At Kingsnorth, the contrast is clear. The grabbing cranes dump their loads into a hopper, and there is usually some spillage onto the jetty. This has to be cleared up about once a week. Under the Siwertell, the jetty is coalfree.

4.7 Capacity

The Siwertell at Kingsnorth is rated for 950 to 1,150 t/h. In one test, it recorded an output of 1,400 t/h on so-called "easy coal". The capacity depends on the quality of coal and the configuration of the holds.

The Siwertell can keep up a high discharge rate over the ship. In an over-the-ship test on an 11,000-DWT ship with "bad coal", it recorded 760 t/h. The guaranteed capacity stated in the contract for this type of coal was 665 t/h (Table 2).

Table 2: Test results at Kingsnorth

Two-hour test on "bad" coal	1,027 t/h (guaranteed 959 t/h)
Over-the-ship test on 11,000 t "bad" coal	760 t/h (guaranteed 665 t/h)

The discharge with grabbing cranes is at a peak at the beginning of unloading, but rapidly falls off to 50% of the initial rate as the grabs have to move further down into the hold to reach the load (Fig. 7).

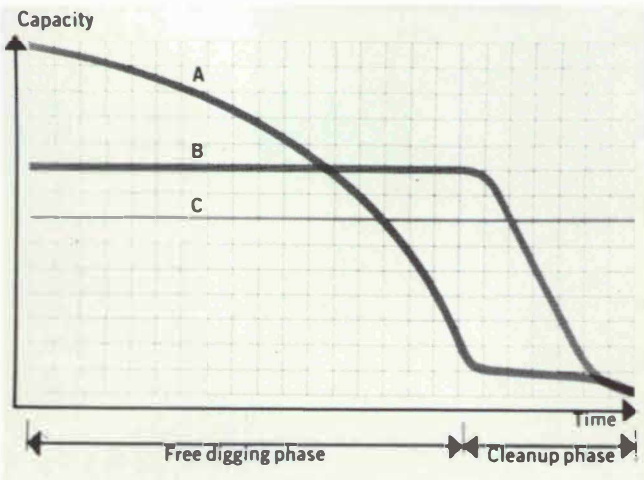


Fig. 7: Typical flow profiles of grabbing crane (A) and Siwertell (B) operating at the same through-ship capacity (C)

This falling-off is further accentuated by a falling tide. Ships come in on the high tide at Kingsnorth, and at low tide, they can be 19 ft lower in relation to the jetty; this means an extra 38 ft for the grabs to move.

4.8 Time-Saving

It is now feasible for ships to dock at high tide and to have left port on the next high tide. According to Percy Wright, Supply Foreman at Kingsnorth, "Where the grab cranes would take somewhere around 24 hours to discharge a 10,000-t collier, we could do it with the Siwertell in approximately fourteen hours."

With the time saved, the ships can make more journeys per year. At Kingsnorth, it also allows time for vital maintenance on the conveyor belt taking coal from the jetty into the power station. This is a single belt and now, with ships being unloaded faster, there is more time to plan maintenance on the belt.

4.9 Maintenance

As for maintenance on the Siwertell, the Technical Officer said that "We are hoping that we can keep the routine maintenance down to no more than ten days a year. If all that Siwertell hopes for happens, which is related to screw wear and bearing life, this is all it will be."

The reasons for any stoppages during operation are easy to find with the help of a fault-finding panel in the switchgear room in the main beam. By looking at the control lights, the driver can tell where the fault is and either reset the unloader or call for an electrician if it is a major fault.

4.10 Reliability

Kingsnorth and West Thurrock are almost totally dependent on the coal supplies coming in by sea. At peak rates, Kingsnorth can burn up to 19,000 t/d coal. Ships come in on the tide and have to be unloaded quickly.

"At these riverside stations, we are very concerned about reliability. Unless we have reliable unloaders, our costs in burning oil or switching to other coal-fired stations will be prohibitive.

4.11 Costs per Tonne

The Technical Officer summed up some of the reasons why the CEGB chose Siwertells: "After investigating the various options of either purchasing new grabbing machines or, as an alternative, one of the new bulk unloading machines now available, we had no hesitation in picking the Siwertell. This is providing us with a dramatic reduction in operational costs and, in particular, in capital costs in terms of pounds per tonne per hour capacity.

"Using fast unloading machines, we have been able to reduce the time ships spend alongside the jetty to a third of what it has been when discharging with cranes."