bulk solids handling Volume 1 Number 3, September 1981

# The Siwertell Bulk Discharger

**George Robinson, Scotland**

**Der Siwertell Schiffsentlader**
**Le matériel de déchargement de vrac Siwertell**
**El descargador a granel Siwertell**
シワテル粉体排出機
Siwertell散装卸货装置
جهاز سيورتل لتصريف المواد السائبة. بقلم جي. روبنسون.


## Summary

Siwertell of Bjuv, Sweden, have for several years been manufacturing ship dischargers using the principle of transmission of bulk materials by totally enclosed screw conveyors.

The paper centres on the assessment of the 350 t/h screw type discharger ordered from Siwertell by the Forth Ports Authority in December 1979 and commissioned in February 1981.

This particular discharger which is the first of its type in Britain, replaces two 7 ½ tonne E.L.L. grabbing cranes which fed to an underground conveyor band via surge hoppers standing at the rear of the quay. These cranes had a very limited remaining life, and the grabbing operations created a considerable amount of airborne dust which was unacceptable under the Health and Safety at Work Act.

The discharger has not been in operation for a sufficiently long period to prove its reliability but similar dischargers have proved the reliability of the design in practice elsewhere.

The external contra-rotating inlet screw at the cargo intake to the vertical conveyor has successfully overcome the poor filling factor normally associated with vertical screw conveyors.

The use of hydraulic actuators for manoeuvring the vertical conveyor in the ship's hold gives accurate control of the movements to the operator.


## 1. General Description

The new Siwertell Discharger recently installed at Leith Docks has a specified capacity of 350 t/h of rock phosphate to match an existing underground single belt conveyor by which various bulk cargoes are transported direct from the quay to the storage sheds of the Scottish Agricultural Industries Ltd. The Discharger is, however, designed for capacities up to and over 400 t/h with minor modification should the receiving shore conveyor be uprated or replaced by a higher capacity conveyor at some future date. The principle used in the Siwertell Discharger for transmission of the bulk material is based on the Archimedean screw and commences with a double start screw of 355 mm pitch and 425 mm diameter running at a constant speed of 315 rpm in the 12 mm thick cylindrical steel casing of the conveyor. The Discharger has three conveyors of this type, one vertical from the ship's hold, one on the luffing boom and one horizontally across the gantry to a drop chute feeding to the underground conveyor.

The vertical screw conveyor requires assistance to fill efficiently when its bottom end is immersed in the cargo and in this respect a specially designed variable speed contra-rotating inlet feeding screw-type device in fitted externally at the bottom of the conveyor. Material is pushed down to and into the vertical conveyor inlet by this device which is driven by a variable speed thyristor controlled motor through an external shaft from the top of the vertical conveyor. Material moving from one conveyor to another during discharge is transferred by gravity, and finally drops a height of 6.5 m to the underground conveyor's travelling hopper where its flow is regulated by a screw to the conveyor band along with the trapped controlled dust. Four long conveyor bands including an inclined band from underground to an elevated gantry take the bulk cargo into the warehouse of the adjacent fertiliser works of SAI Ltd. Belt weighers are available on the gantry band for check weighing of the ship's cargo if required.

The Discharger is designed to cover all movements required to unload the largest ship to use the berth viz. MV *Levantino* of 10,898 gross registered tonnes.

The required envelope of movement of the intake in the ship's hold is achieved by a hydraulic actuator on the boom providing movement control of the pendulum action of the vertical conveyor across the ship's hold in line with the boom and a slewing motion by machine cut rack and pinion of 120° to each side of a line across the hold. Movement of the boom in the vertical plane is again provided by actuators in conjunction with a counterweight of 66 tonnes on the boom. Difficulty in obtaining iron ore for the counterweight ballast led the Authority to purchase baryte material with a specific gravity of four for this purpose.

### 1.1 Travel

The drive to the travel gear is unusual by having six braked travel motors on the waterside bogies with no apparent crabbing action taking place. Three travel motors are fitted vertically on each of the two compensating bogies to drive three

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of the four wheels on each bogie. Compensating travel bogies on the landside rail, each with three wheels, are fitted to the pendulum leg of the gantry, and are therefore able to take up minor variations in the centres of the rails which are at 11.82 m centres.

The waterside track did not conform to the required accuracy and was therefore replaced. Double sections were retained to suit the location although single rail sections are preferable if time and costs permit.

Solid rail stops are fitted in addition to switches on the cable gantry to limit the travel of the Discharger. A parking drop bolt is also fitted to prevent the Discharger being moved by very strong winds.

### 1.2 Operator's Cabin

The cabin is situated on an arm which slews with the boom and remains overlooking the inlet on the vertical conveyor in the hold. It has an excellent range of vision, and has a comfortable revolving seat with controls mounted on each arm.

### 1.3 Power Supply

A high voltage supply to the discharger cable drum has been installed by the Authority to avoid the very large cable and the significant volt drop associated with any choice of low voltage supply for this type of machine. The cable, supplied by Siwertell under the Contract, consists of an outer protective flexible cover moulded round the three cores. This unusual cable presented initial jointing difficulties at the substation and at the Discharger. A 6.6 kV supply has been laid to a small substation built specially to supply the Discharger and a high level cable tray has been installed on a gantry to the landside of the plant along the operating length of the quay, with a cable turnover at its mid-point.

Alternative methods of power supply which were considered gave a choice between the overhead cable on a gantry, overhead conductor bars, a flat or round cable in a quay chase reeling out from a centre point or a cable with power supplied from one end of the quay requiring a cable drum of twice the capacity of the drum actually fitted. The alternative power supplies were discussed with the Health and Safety Executive before a final decision was made.

## 2. Siwerwell Discharger Design

The design of the Discharger was based on Siwertell's previously tried and proven machines in various parts of the world.

One particular difference from almost all of the previous designs was the substitution of hydraulics to operate the luffing motion in place of a winch using wire ropes and pulleys on a tower structure. This hydraulic operation had previously been confined to a fixed post type machine and although price did influence acceptance of this proposed design, the clean lines have given a neat functional appearance to the newly constructed Discharger. The main details of the various parts of the machine are as follows:

### Structure

The general arrangement of the structure of the machine is shown in Fig. 1, and the range of movements, excluding travel, are indicated. The legs of the structure consist of a front (waterside) fixed leg and a smaller back (landside) pendulum leg. The Authority limited wheel loads to 20 tonnes waterside and 15 tonnes landside to suit the rail foundations and the weight of structure, and the number of wheels to spread rail loading had to conform to requirements.

The gantry beam spanning between the rails was designed as a large box girder to support the luffing and slewing girder, two conveyors, and the counterbalance weight. The box girder has sufficient space within it to accommodate most of the electrics in a neat and tidy manner and has accommodation and space heating which is on permanently to avoid dampness. The luffing and slewing girder is a variable section box girder which supports a screw conveyor forward of the pivot point, the vertical conveyor and pendulum arm at its forward extremity, and a counterbalance tank filled with 66 tonnes of ballast at its rear end (Fig. 2).

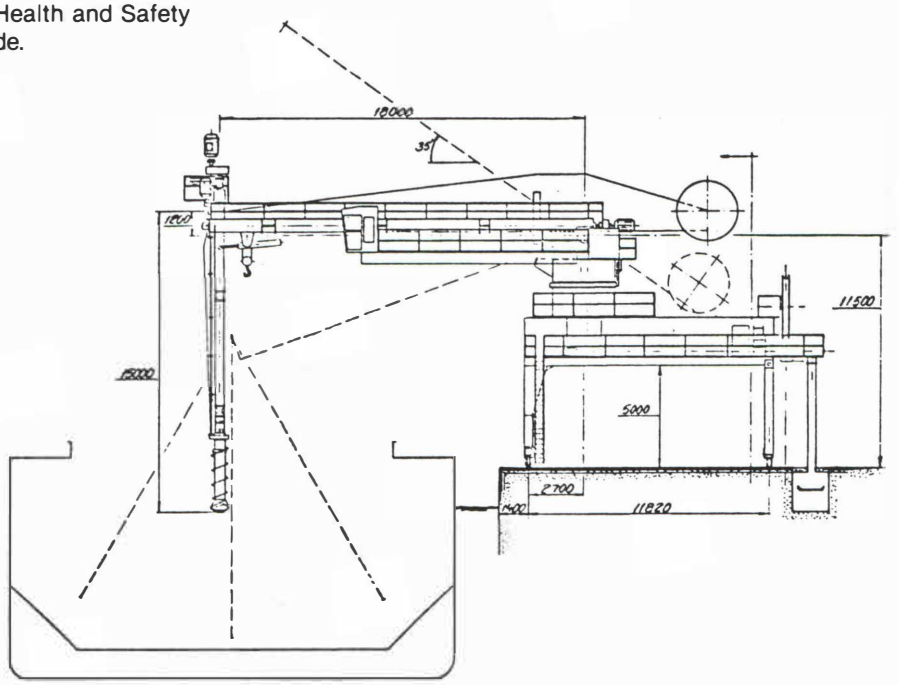


Fig. 1: General arrangement of the Siwertell Bulk Discharger

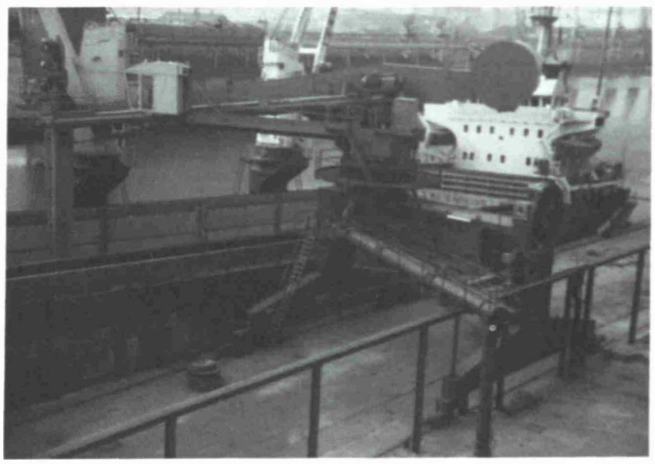

Fig. 2: Siwertell Bulk Discharger

The stabilising arm supporting the vertical conveyor and the drive shaft from the motor at the top of the arm to the inlet device at the bottom end of the conveyor is also of variable box section and pivots forward and backward on bearings.

Large sections of the structure were prefabricated in Sweden and transported to Leith on lorry trailers by Ro/Ro ferry from Helsingborg to Middlesbrough.

Considerable welding was, however, carried out on site by Siwertell and tested to the Authority's satisfaction.

The structural support for the tray to carry the high voltage and multicore control cable was designed by the Authority and erected under a contract placed by and supervised by the Authority. Contracts for replacement of the waterside rail, the HV substation, amenity accommodation, demolishing one 7.5 ton grabbing crane and relocating two 7.5 tonnes grabbing cranes by water skates were also placed and supervised by the Authority.

Erection craneage was supplied by the Authority and consisted mainly of hired lorry mounted telescopic mobile cranes up to 80 tonne capacity, and included some tandem lifts all under the supervision of Siwertell's Site Engineer.

The structure was assembled with comparative ease due in large part to fabrication and assembly of large parts of the unloader at Siwertell's workshops in Sweden (Appendix 1).

### 2.1 Design and Drawing Work

The Authority studied Siwertell's design of Discharger along with other designs of dischargers on the market at the time. Assessments and reports on the Siwertell design by other companies with interests in handling raw materials for the manufacture of fertilisers were checked and a visit was made to a terminal in Denmark equipped with a Siwertell Discharger in order to study maintenance and environmental factors before inviting Siwertell to attend the Authority's offices to show film and to attend question and answer assessment meetings.

The Siwertell screw conveyor system was chosen by the Authority mainly for its few moving parts and filling rate with absence of dust, low noise level and its ability to safely handle all of the SAI fertiliser raw materials.

The Contract was placed under *Model A* Conditions, but subject to the Authority's Special Conditions and a list of points of agreement, one of which was an undertaking by the Authority to speed approval of design and detail drawings by two visits of the Authority's Engineers to Siwertell offices in Sweden.

Design and detail work was carried out by individual engineers specialising in particular parts of Siwertell machines e.g., arm systems. Calculations were assisted by computer. Sets of design and detail drawings were kept to a size which could be contained in portable files.

The Authority's Engineers decided at an early stage to dispense with the bag filter dust collecting system included in the Siwertell design and positioned at the rear drop chute as the responsibility for dust control in the underground conveyor tunnel was accepted by the conveyor owners.

A further agreed modification with extra cost involved altering the line of the gantry conveyor from normal to the rail track to an angled position in order to increase the scope of the Discharger westwards with subsequent savings in civil work which would otherwise have been required to increase the length of the underground conveyor.

### 2.2 Additional Facilities

The Discharger has, incorporated in its design, an additional facility of being able to load bulk material from a ship to road vehicles on the quay by diversion of the material flow to a spout positioned under the gantry. A six tonne capacity hoist block is fitted at the end of the luffing boom to lift front loading vehicles from the quay and lower them into the holds for clean-up purposes.

Built-in water mains on the Discharger cater for internal cleaning of the conveyors where there may be unacceptable contamination by residue from a previous cargo. Experiments using washed granite chips passing through the conveyors also cleared the system but could present handling and storage problems. Successful tests were carried out in Sweden with regard to removal of prilled sulphur left over in a test system. The sulphur was deliberately overheated to 90 °C but could not be made to explode or ignite in the test screw conveyor. Degradation was negligible.

Explosion panels are fitted to the casings of the conveyors on the Leith Discharger.

## 3. Assessment

The Discharger should achieve fills up to 80% in the enclosed conveyors when maximum intake is possible. A slow down in intake takes place during final clearance of the hold bottoms when assistance from front loading vehicles is required in the hold.

The Siwertell Discharger has proved to be efficient and has a low number of moving parts compared with bucket and other unloaders which may have a slightly higher efficiency. Pneumatic transmission on the other hand, although used extensively, has a lower efficiency in comparison with the Siwertell design of discharger.

Dust problems are seen to be eliminated completely as the material passes from the ship's hold to the underground conveyor.

The Leith Discharger has a minimum of controls. Indicators, warning devices, limit switches and ground-to-cabin communication equipment make the machine very safe to operate.

Phosphate, potash and sulphur prills are the materials handled at the Discharger berth.

## Appendix 1: General Technical Information

Transformer — 630 kVA, 6.6 kV/0.433 kV with gas bubble protection.

Inlet Drive Motor — 41 kW, 470 VDC, 95.6 A, 2200 rpm (Thyristor Control)

Inlet Device Cooling Fan — 0.55 kW, 415 V, 50 Hz, 1.4 A
1.1 kW, 415 V, 50 Hz, 2.4 A

**Conveyor Motors, Direct on Line Start**

| | |
|---|---|
| Vertical Conveyor Motor | 250 kW, 415 V, 50 Hz, 429 A, 1475 rpm |
| Horizontal Conveyor Motor | 90 kW, 415 V, 50 Hz, 151 A, 1465 rpm |
| Conveyor on Portal | 45 kW, 415 V, 50 Hz, 83 A, 1465 rpm |
| Travel Motor (6 No) | 23 kW, 415 V, 50 Hz, 70 A, slip-ring type |
| Inlet Device Lubricating Pump | 0.25 kW, 415 V, 50 Hz, 0.75 A |
| Cooling Fan Gear, Vertical Conveyor | 0.18 kW, 415 V, 50 Hz, 0.7 A<br>0.22 kW, 415 V, 50 Hz, 0.7 A |
| Vertical Conveyor Platform | Floodlight 1000 W, 110 V |
| Beam for Cabin | Floodlight 1000 W, 110 V |
| Horizontal Beam | Floodlight 500 W, 110 V |
| Telpher Hoist Motor | 12.5 kW, 415 V, 50 Hz |
| Horizontal Conveyor Lubricating Pump Motor | 0.25 kW, 415 V, 50 Hz, 0.75 A |
| Portal Conveyor Lubricating Pump Motor | 0.25 kW, 415 V, 50 Hz, 0.75 A |
| Transformers | 3 kVA, 415/220 V, single phase<br>600 VA, 220/ 24 V, single phase |
| Solenoid Valves for Hydraulics | 110 V, 50 Hz |
| Hydraulic Pump Motor — | 18.5 kW, 415 V, 50 Hz |
| Outlet for welding, seaside bogie | 3x415 Vx32 A |

**Protection Paintwork**

Surface treatment to SA 2.5 to SIS 055900 — 1967

1st coat — Hempadur Zinkprimer 1535
Hempadur HB 4520
Hempathane 5512

Polyurethane and chlorinated rubber were considered.

**Costs in Round Figures**

Expenditure of approx. £ 1 million for the whole project was authorised by the Authority's Board in December 1979.

Estimated Final Costs are as follows: (including spares)

| | |
|---|---|
| Discharger | £ 840,000 |
| Variations Orders | £ 15,000 |
| Cable Gantry and Craneage etc. | £ 44,000 |
| Reinstatement of Quay Rails | £ 30,000 |
| Provision of New HV Electrical Supply | £ 36,000 |
| Purchase of Hold Clean-up Skip | £ 400 |
| | £ 965,400 |

A final cost of about £ 1 million is expected for the whole project including the cost of contract supervision and work carried out by the Authority's own staff and its stevedoring subsidiary.