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The Two Newest Transshipment Terminals in the U.S.

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Summary

The author gives details of the two newest, ORBA designed and constructed, ore and pellet transshipment terminals which are both located on Lake Erie in the State of Ohio.

1. Introduction

The two newest transshipment terminals in the U.S are both situated on Lake Erie in the State of Ohio. The Lorain Pellet Terminal was completed in 1980 and the Toledo Ore Railroad Co. Terminal was dedicated in 1981 and completed in 1982.

The completion of these two new terminals marks the culmination of a major modernization and cost reduction program undertaken by Armco and Republic Steel Corporation. The two companies jointly own the Reserve Mining Co. at Silver Bay, Minnesota which has been producing taconite pellets since 1955.

The recent half-billion dollar project encompasses two major tasks:

— Upgrading of the pellet plant at Babitt and Silver Bay, Minnesota which includes the construction of a new massive tailing system.

— Radical alteration of the pellet transportation system.

The producing plants of these two steel companies are located inland from the Lakes. Over decades, only small-sized ships could be used to negotiate the meandering river system to the plants. In the case of rail-based plants, ore or pellets were unloaded from the ships onto railcars by massive Huletts which are costly to operate and maintain.

To materially reduce pellet delivery cost, the antiquated ships had to be replaced by modern cost-effective 1,000 ft self-unloading vessels — the largest passable through the new lock at Sault Ste. Marie opened in 1970. New transshipment terminals had to be built to transship from the giant carriers to river vessels or onto railcars. These facilities must also serve as a "warehouse" for winter storage when the Lakes are frozen and the plant continues to consume raw materials for steelmaking.

2. The Lorain Pellet Terminal

The Lorain Pellet Terminal is located on a 19-acre site at the mouth of the Black River, approximately 30 miles west of Cleveland. The property was acquired by Republic Steel in December, 1978.

In March, 1979, ORBA Corporation was given the turnkey contract to design and build the facility following a feasibility study by ORBA*. The Terminal began receiving pellets in April, 1980 and commenced its full operation in August of the same year — in a record 17 months.

Fig. 1 shows the general arrangement of the Lorain Pellet Terminal. Taconite pellets are discharged ashore at 10,000 t/h by the 1,000-ft vessel's own self-unloading boom conveyor. By moving the vessel along the dock, different grades of pellets can be deposited in any one of the four stockpiles. As much as 532,000 long tons of pellets can be stored at the site. Segregation of the different pellets is accomplished by the use of Republic's semi-portable "Terrawall" system which is made up of heavy galvanized corrugated members normally used to retain highway embankments.

The stored pellets are reclaimed by gravity onto a 5,000 t/h tunnel conveyor system running longitudinally under the stockpiles. Through a junction at the upstream end of the tunnel, the pellets can thence be conveyed to a rail loading station or onto a shiploader (Fig. 2).

2.1 Simple Yet Functional Storage and Reclaim System

The Lorain pellet stockpile system was designed to satisfy the following criteria:

— A simple design to assure early project completion and ease of maintenance

— The entire stockpile was to be formed by vessel's discharge boom

— Highest pile capacity in the confined acreage
  — without exceeding allowable pressure on the bulkhead
  — leaving room for necessary railroad trackage

— Up to four kinds of pellets must be stockpiled

* For further details of this company, see also A.T. Yu: "ORBA Corporation: A Profile", bulk solids handling Vol. 2 (1982), pp. 573—575.

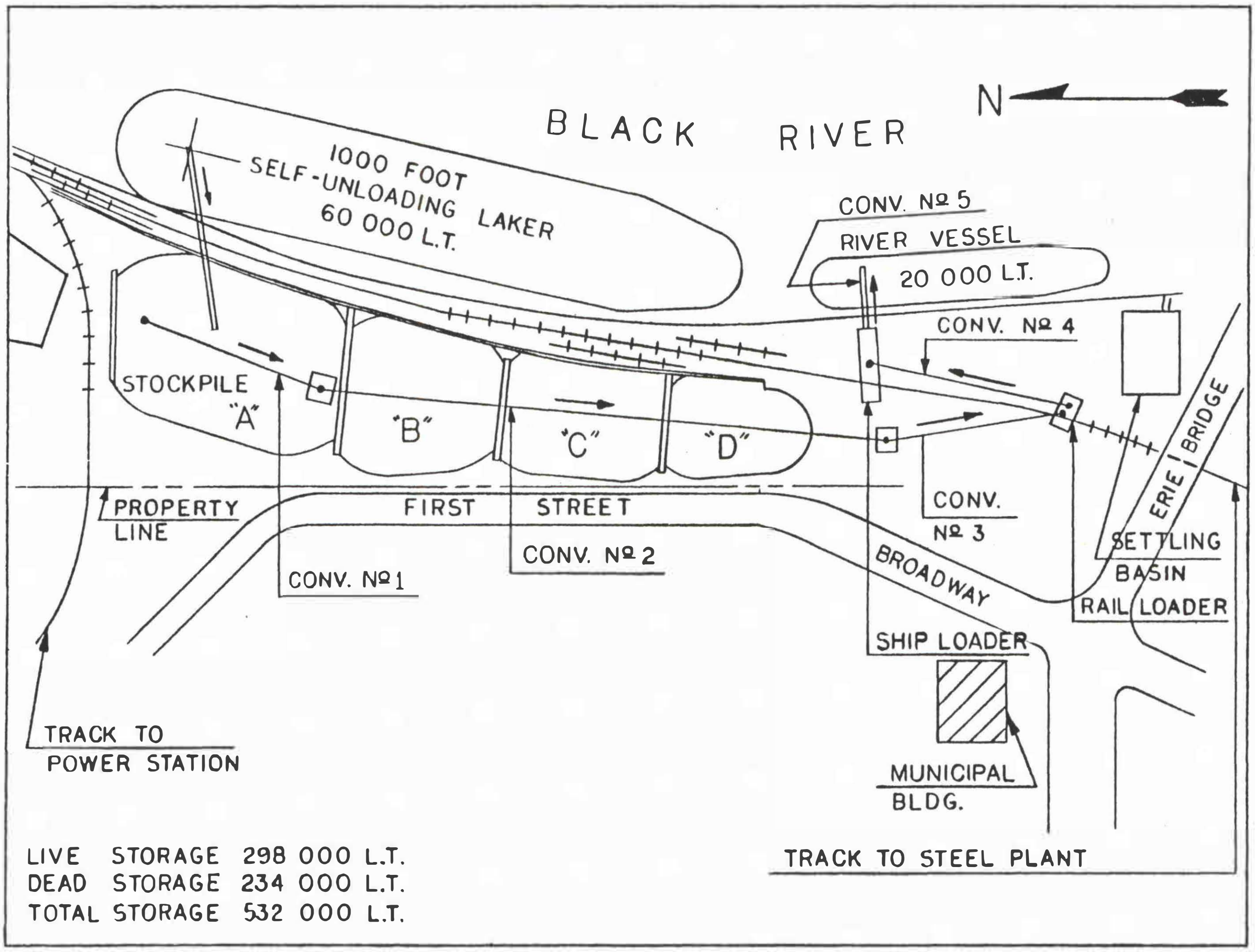

Fig. 1: General Arrangement — Lorain Pellet Terminal.

The unfavorable soil condition did not permit the use of one single in-line conveyor tunnel under the stockpiles. Value engineering indicated the most overall economical solution of breaking the tunnel conveyor into two consecutive flights intersecting at an angle of 15°. The tunnel would be placed on hard glacial clay or dense alluvial sand, resulting in significant savings in foundation costs. Ready-made "Terrawall" dividers were used to segregate different pellets (Fig. 3).

Since no terminal personnel are required to stockpile the pellets, it was determined that the reclaiming system should also function with minimum operating labor. Thirty-six gates and hopper inlets were provided in the roof of the concrete tunnel to load the pellets onto the reclaim conveyors. Each gate, when fully opened, permits 5,000 t/h of pellets to flow from the stockpiles to the conveyors. Each operation is monitored and controlled by an operator located either in the train loading or ship loading station. No other operating personnel are required resulting in only one operator for either system for loading trains or ships.

2.2 Highly Automated Precision Train Loading

Because rail cars of varying sizes and carrying capacities are used to serve the facility, it is necessary to weigh the pellets and load each car with predetermined amounts. This is accomplished by discharging the pellets from the 600-ton storage bin in the rail loading station into either of the two weigh hoppers located above the cars and beneath the bin. The hoppers are mounted on load cells which continuously weigh the incoming material and provide a signal which causes the bin gates to close when the proper weight of material has entered the hoppers (Fig. 4).

Strings of cars are moved beneath the hoppers by a radio-controlled locomotive by the loading station operator who positions each car for loading. When the car is in place, the operator positions the hydraulically actuated chute beneath each weigh hopper to properly place the pellets in each end of the car and opens the weigh hopper gates. As soon as the lower weigh hopper gates close, the upper bin gates open to begin filling the hoppers for the next carload. This system loads cars at the rate of about one per minute or 5,000 t/h.

In summary, the control of the entire system of conveyors, gates, chutes and train movement was designed to load railcars of random size and capacity at a highly efficient rate and is controlled and monitored by one operator.

2.3 Shiploading Capability

When ships are to be loaded, rather than trains, the system operator is stationed in the cab on the shiploader and

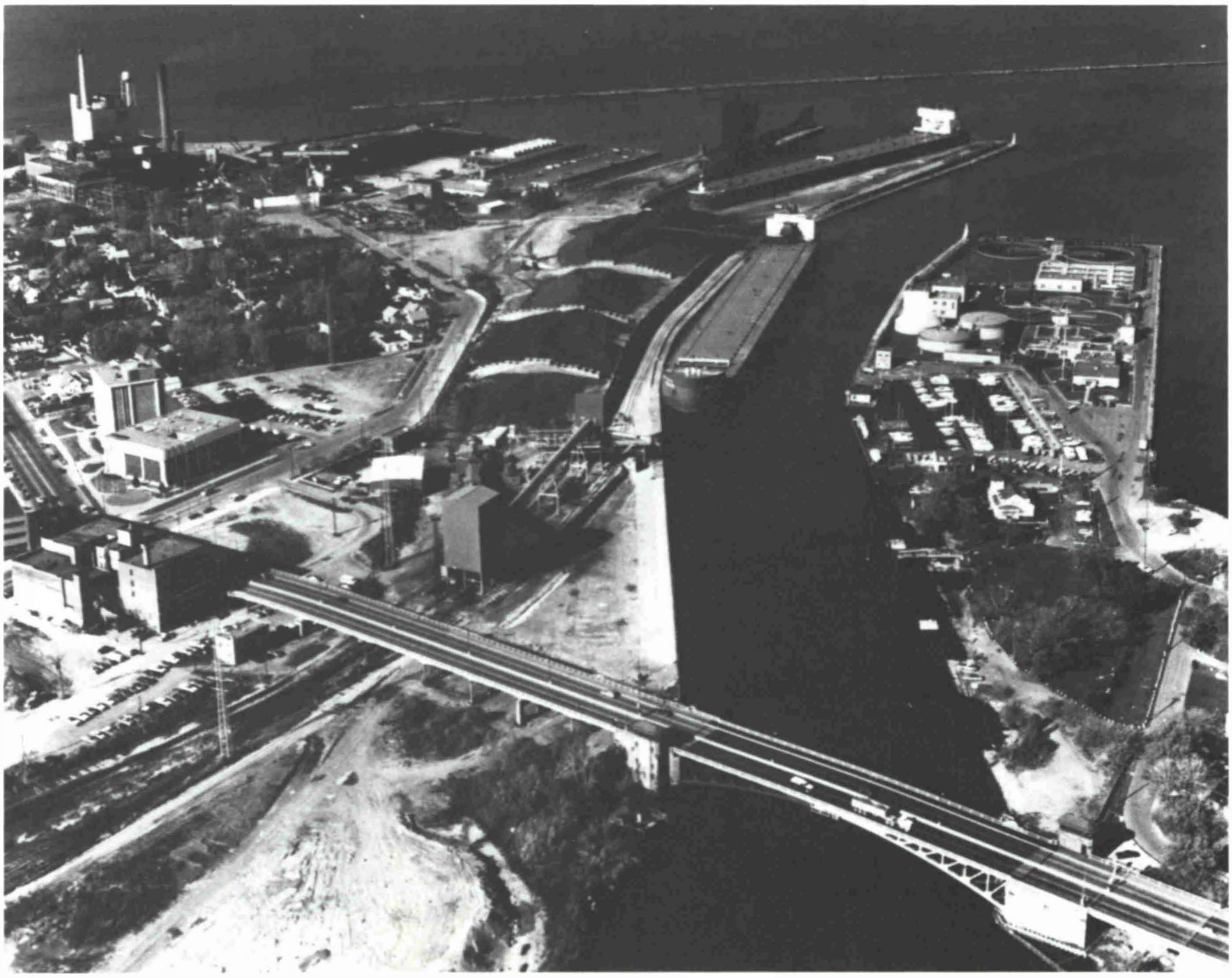

Fig. 2: Aerial view of the Lorain Pellet Terminal looking north towards Lake Erie. The 1,000-ft vessel with its 250-ft boom swung overboard is discharging taconite pellets at the rate of 10,000 tph. "Crib Wall" dividers form four separate piles of pellets. Tunnel conveyor under the piles reclaim pellets by gravity and feeds onto the surge bin (the tall building at the lower left of the property) which in turn loads the rail cars below. The small shiploader is near the bow of the ship.

Fig. 3: Close-up of the Lorain Pellet Terminal installation showing hood covers over the conveyor belts to prevent dusting. The shiploader junction house is on the upper right and the pellet stockpiles are on the upper left.

Fig. 4: Close-up of the surge bin over the rail tracks. Rail cars are being loaded by a weigh-hopper system. Weigh bills are automatically produced by a programmable controller in the operator's cab.

material is carried from the top of the train loading station by conveyor to a fifth conveyor located on the shiploader structure (Fig. 5).

This conveyor is mounted on tracks which enable it to be moved in and out over the deck of the vessel and the water side of it is pivoted so that it may be raised or lowered during the loading process. By providing these two ranges of motion, the shiploader is capable of loading either small river vessels or large 1,000-ft carriers at the rate of 5,000 t/h while positioning the discharge end of the loading boom to minimize the fall of pellets into the ship's hold.

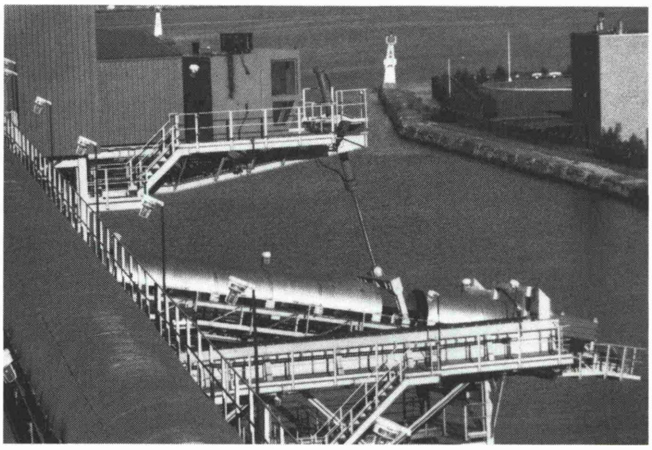

Fig. 5: Close-up of the Lorain shiploader. The boom is lowered, poised for ship loading. The control cab is on the fixed structure above.

2.4 Programmable Controller System

One of the most innovative features in the design of the Terminal was the extensive application of the latest developments in computer technology to control the material handling system while at the same time providing a comprehensive data management system.

The Programmable Controller (PC) is a solid state control device which has a user programmable memory to store instructions for specific functions such as control logic, timing, arithmetic, data logging and dynamic graphics. Used with Cathode Ray Tube (CRT) display devices, card readers and printers, the system provides complete communication with operating, maintenance and management personnel.

Because programs may either be entered and stored in the processor memory by using a keyboard or stored and transferred on cassette tapes, use of the PC permitted control scheme design and programming to continue at ORBA's offices while peripheral equipment was being installed in the field. Changes were accomplished by reprogramming and the entire control scheme was pretested before the controller was shipped to the site.

Elimination of the more traditional wire connected system of relays and control devices greatly reduced the time required to produce wiring drawings, field installation, and checkout.

In either rail loadout or shiploading mode of operation, the controller system selector switch, once set by the operator, will trigger all components of the system to start in proper sequence and time intervals as set in the control program. Additionally, the CRT display graphically depicts for the operator the mode of operation selected and conveyors which are operating (Fig. 6). If a component fails to start automatically or stops due to operation of a protective device, information is immediately presented on the screen and the operator can cause the proper control logic diagram to be displayed for use in directing maintenance personnel to the problem requiring correction.*

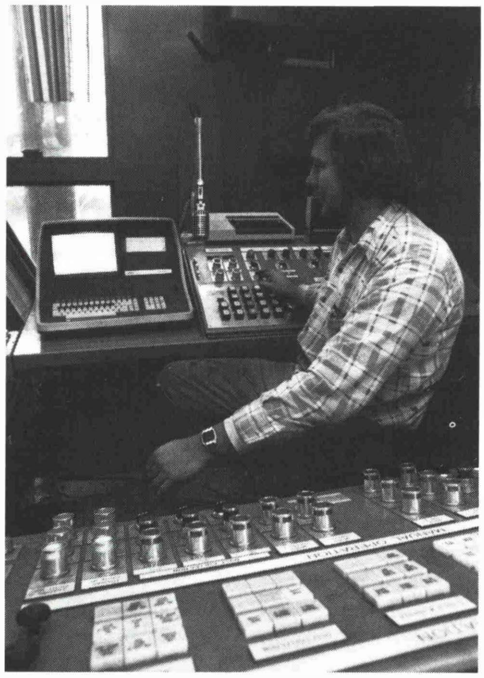

Fig. 6: The programmable controller in the control cab where reclaim/train loading operation is controlled by one operator with a console with CRT on his desk.

2.5 Rail Loadout by Programmable Controller

Railcars to be loaded are assembled in 30-car strings by the railroad. A clerk in their office provides sequence numbers, owner and identification number and car capacity by feeding punched cards into a reader which transmits this information to the PC system processor.

As each car is positioned beneath the loading chutes, the operator verifies that the actual car number agrees with that displayed on the screen and depresses a button on his console which opens the gates between the surge bin and weigh hoppers (Fig. 7). When the predetermined weight of the pellets has entered the hoppers, the controller closes the surge bin gates and opens the weigh hopper unloading gates to load the car. This automatic operation continues for each string of cars.

As the carloading proceeds, the printer in the railroad agency office prints a waybill for each car on a preprinted form showing, among other data, the type and exact weight of pellets in the car. Another report is automatically produced by the printer located in the office of the General Manager of the Terminal showing similar information at the conclusion of loading of each 30-car set.

* For further details please refer to G. S. Chopra and T. C. Gebhard: "Programmable controllers in New Pellet Terminal", bulk solids handling, Vol. 1 (1981), pp. 119—125.

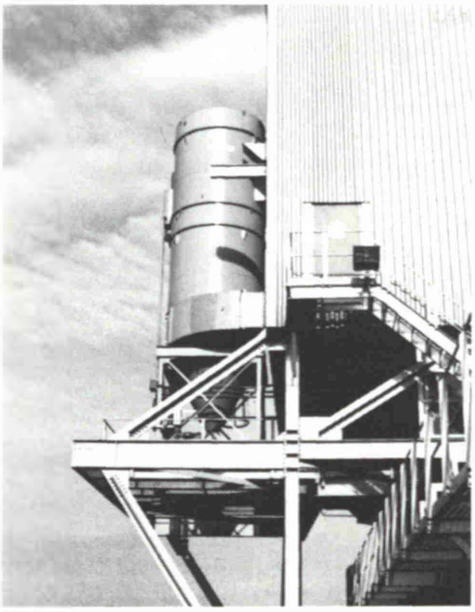

Fig. 7: Environmental control is a major concern at Lorain. A typical dust collector is shown at a junction house.

2.6 Vessel Loading by Programmable Controller

When shiploading, the operator is stationed in the operator's cab on the shiploader and, instead of car weights, the weight of pellets desired in each hatch of the vessel is entered into the processor.

The weight of material is determined by a conveyor belt scale and the computing function calculates the weight of material on the belt between the scale location and point of loading or discharge so that the correct total is placed in each hatch. Vessel loading reports are provided by the printer in a manner similar to train loading.

2.7 Additional Programmable Controller Capabilities

Other management reports printed at the end of each day include:

- Listing of all electrical faults and shutdowns showing the device that caused the stoppage.
- Time of occurrence and time of restart.
- Running time of major equipment.
- Inventory status including tons received, tons shipped by rail or vessel and tons in storage.
- Summary of carloading information.

Although the use of this advanced control system did expedite design and construction, the greatest benefits realized have been the availability of timely, accurate reports for shippers and terminal management and the immediate identification of the cause of interruption or malfunction for facility operating personnel.

In 1980, because of its contributions to the local economy and engineering technology, the Lorain Pellet Terminal was selected as one of the ten outstanding engineering achievements in the United States by the National Society of Professional Engineers. Among the achievements cited were its being the first lake, river, rail terminal and its ingenious use of programmable controllers for a bulk terminal.

3. Toledo Ore Railroad Company Pellet Terminal (TORCO)

Following years of development, particularly through the effort of the Toledo-Lucas County Port Authority, the transshipment facility at Toledo came to fruition. On May 1, 1980, the total responsibility contract for the engineering and construction of the terminal was assigned by Chessie System to ORBA Corporation. The $ 33 million facility began receiving pellets on June 3, 1981 and train loading commenced on July 2 the same year. Located adjacent to the City of Toledo, in Oregon, Ohio, the Terminal is served by both Chessie System and Conrail.

One-thousand foot self-unloaders discharge the taconite pellets via the ship-based boom conveyor onto a 100,000-ton storage pile which serves as surge at the waterfront to allow fast dispatch of the vessels. These pellets are then rerouted to the 800,000-ton primary stockpile for long-term storage. Site conditions dictated the layout and storage strategy. Pellets are reclaimed and loaded onto Chessie System's unit trains and dispatched to Armco's steel plants in Ohio and Kentucky.

3.1 The Storage/Reclaim Functions at TORCO

At the dock side, approximately 20% of the 100,000-ton surge pile is directly reclaimed through the tunnel gates by gravity with the remainder moved with the assistance of front-end loaders. Sixteen tunnel gates, spaced at 30 ft, are hydraulically operated and set to feed 2,000 short t/h of pellets each. Two (2) gates are open simultaneously to load the tunnel Conveyor C 1 at 4,000 short t/h. A belt scale on Conveyor C 1 monitors its output (Fig. 8).

Conveyor C 1 emerges from the tunnel and feeds Conveyor C 2 located on top of a 10 ft earth berm and runs the entire length of the 1,400 ft primary storage yard. A traveling stacker on Conveyor C 2 forms stockpiles on either side of the berm. As needed, pellets may be bypassed through the stacker to the loadout station (Fig. 9).

The 175-ft stacker boom, featuring a reversible belt, is capable of luffing 16 degrees and slewing an arc of 240 degrees. The rail-mounted stacker travels 1,287 ft to stockpile 800,000 short tons of pellets at 35 ft pile height (with space to expand to 1,200,000 short tons).

Reclaim from the storage yard is accomplished by two front-end loaders, each rated at 12 yd^3. A portable conveyor serves as a link to convey the pellets to the front end of the stacker boom in the reverse mode, thence onto Conveyor C 2, destined to the 80-ft surge bins in the load-out stations over the tracks. All of the belts are 48 inch wide (Fig. 10).

3.2 Railcar Loading by Programmable Controller

The surge bin can store up to 700 tons of pellets between the car positioning operation. The surge bin gates are designed to discharge a measured amount of pellets into two (2) 60-ton weigh hoppers. When a car is in position for loading, the hydraulic gates of the weigh hoppers are opened and the pellets are directed to the car below by two (2) hydraulically operated directional chutes. The cycle time per car is 85 seconds.

When a preset level in the surge bin is reached, the tunnel gates over Conveyor C 1 automatically close. This level

Fig. 8: Flow diagram of the Toledo Ore Company Terminal.

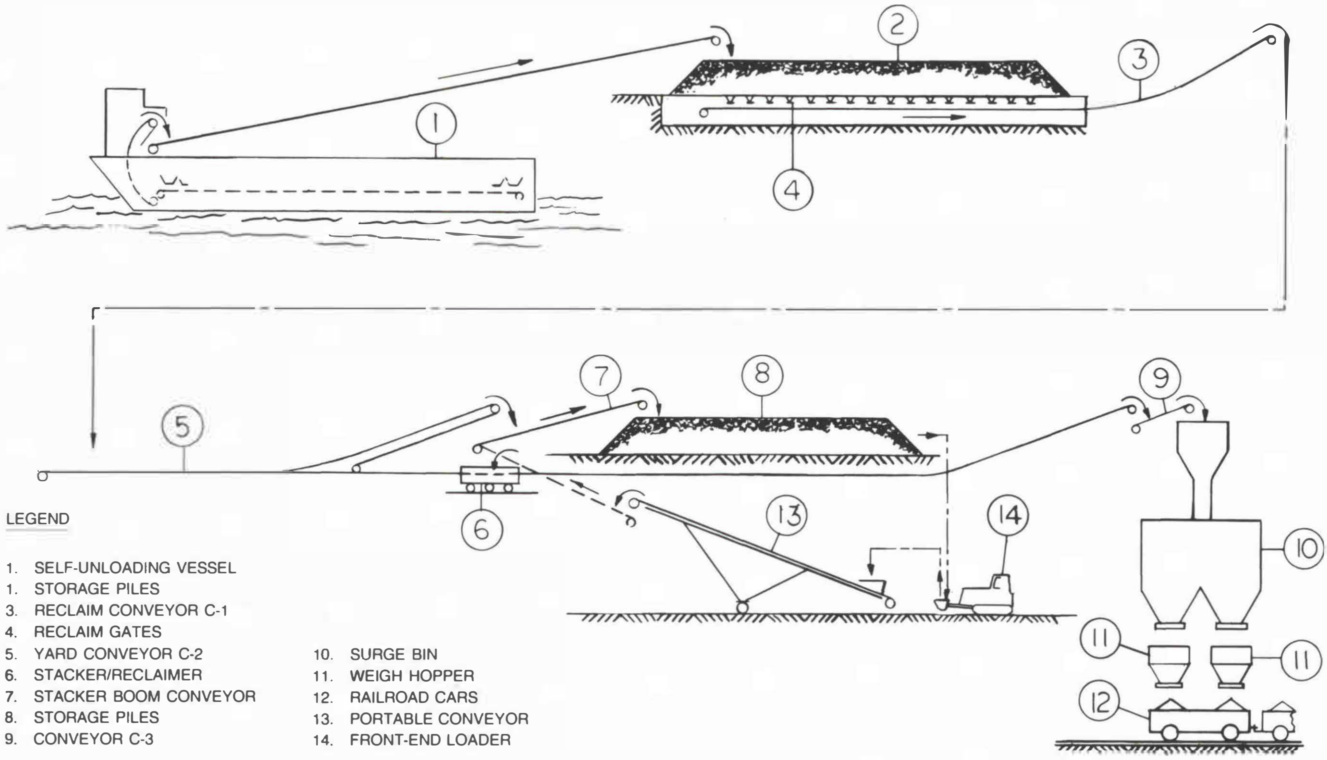

Fig. 9: Aerial view of the Toledo Terminal showing the 800,000 ton primary stockpile at the center and the dockside 100,000 ton surge pile near the top of the photo with a self-unloading ship discharging its cargo. The reclaim conveyor is at the center of the primary stockpile running towards the junction house to feed the transfer conveyor into the top of a surge bin for rail car loading.

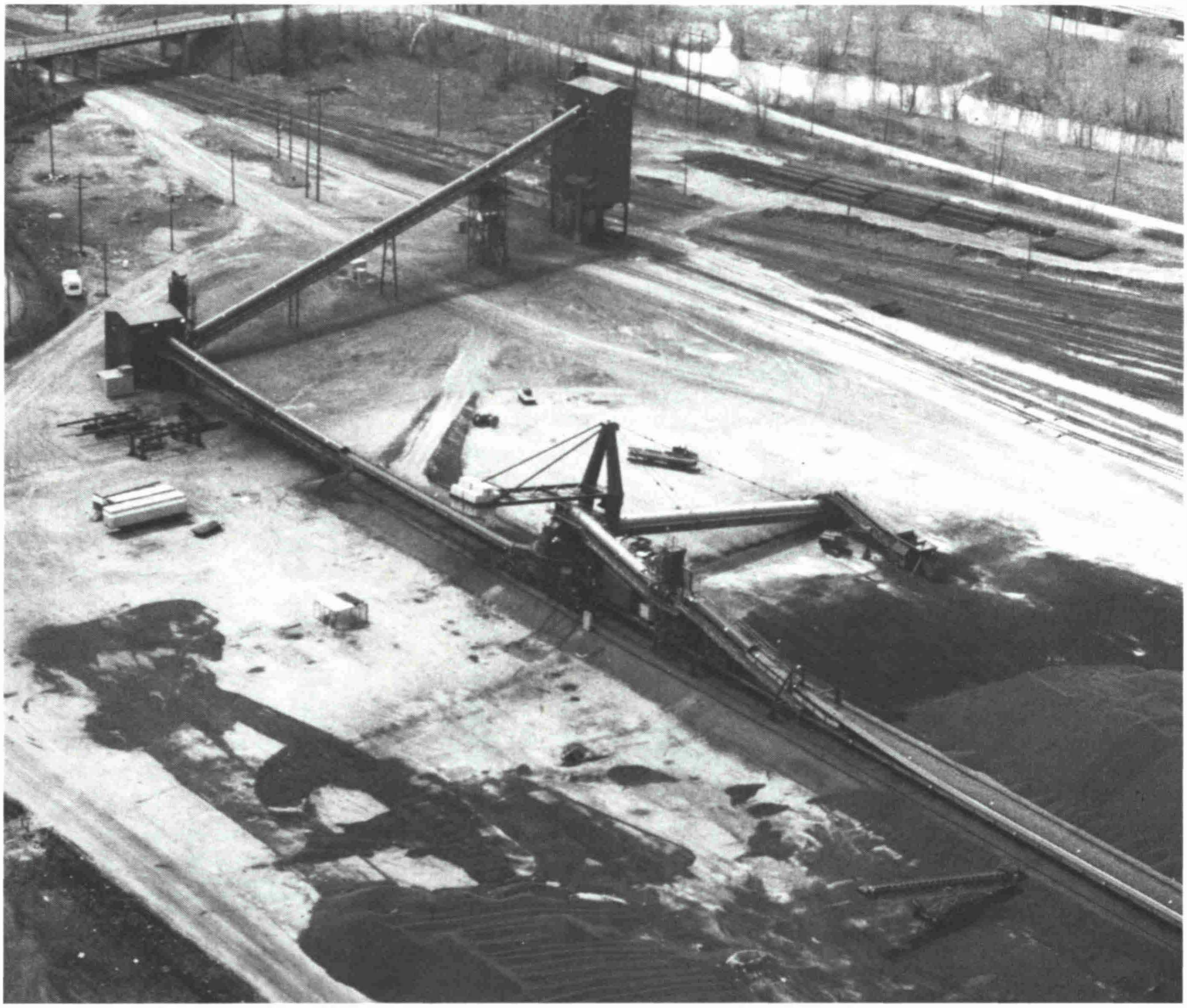

Fig. 10: Aerial view of the stacker serving the primary stockpiles in Toledo. The stockpile is reclaimed by front-end loaders via a portable conveyor, thence onto the head end of the reversible stacker boom. Pellets are discharged onto the main belt which ends in the junction house. The elevating conveyor feeds the surge bin for train loading.

allows the pellets remaining on the subsequent conveyors to continue to the surge bin without having to be shut down in a loaded condition.

The main control point of the terminal is in the operator's cab at the loadout station. There the operator controls the opening and closing of all gates and the starting and stopping of all conveyors as well as monitoring all safety devices.

Railroad cars at TORCO are sorted and assembled into "drags". The number of cars and capacity of each vary in each drag. Each car's initials, load limit, destination, ore type, etc., in the drag is recorded and entered into the program's mini-computer.

Each drag is then moved on the entering track of the loadout station; while inside the operator's cab, the operator views the drag information on the video screen. When the first car is in position and verified to agree with the information programmed, the railcar loading begins.

The pellets are released from the surge bin to the weigh hoppers by pressing the surge bin gate button on the console. As the pellets are filling the weigh hoppers, they are automatically being weighed and monitored by the program. When the car's weight capacity is reached in the weigh hoppers, the program closes the surge bin gates instantly. (The surge bin gates can only open when the weigh hopper gates are closed.)

The surge bin gates are controlled and opened by the operator for the first car in a drag; thereafter, the program initiates the weighing function for the remaining cars. The amount loaded into each car is automatically recorded into the program's memory for later retrieval to prepare a freight weigh bill.

Once the weigh hopper gates close, the program automatically begins the next car's loading cycle. Due to the difficulty of positioning a car directly under the weigh hopper openings, two (2) hydraulically operated directional chutes are used to center the pellets onto the car's sloping plates. This feature virtually eliminates the accidental opening of the car's unloading gates normally occurring from the pellet impact. The operator, however, having to initiate the actual dump button and controlling the directional chutes, confirms that the car is centered within the loadout station.

While the pellets are on their way to the car below, the surge bin gates are being refilled by the continuous running of the conveyor system.

3.3 Effective Measures of Environmental Control

The Terminal is located near a residential area. Many steps were taken to assure appropriate environmental controls and minimal dust generation.

A 15-ft high perimeter earth berm was constructed with onsite excavations. Shrubs and trees planted on the berm provide an aesthetic barrier to the residences and reduces sound transmission.

Transfer House 1, the closest structure to the nearby street, was carefully designed placing the drive of Conveyor C 1 away from the street and is completely insulated to reduce the noise that the drive and material movement might generate. An efficient dust collection system is provided at each transfer point, including the stacker (Fig. 11).

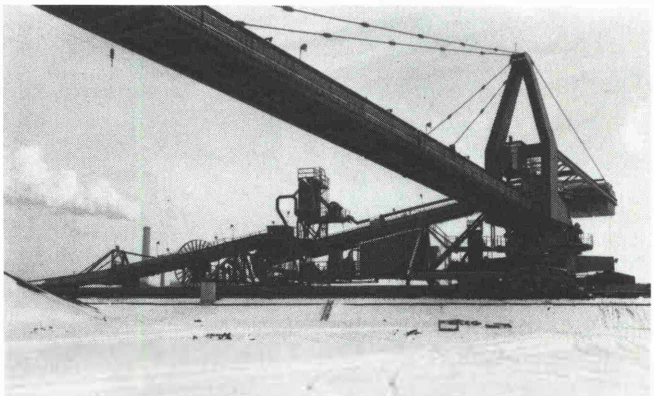

Fig. 11: Close-up of the stacker serving the primary stockpile at Toledo.

Where possible, each conveyor is fitted with hood covers. Conveyor C 2 is only partially covered to allow for the passage of the traveling stacker. In this case, windguards are supplied in lieu of covers.

A complete storm drain system surrounding the pellet storage yard prevents any possible contamination of Lake Erie. The drainage from the pellet storage runs off to a settling basin where only clear water is discharged while any undesirable settlement is held in retention for later cleanout.

3.4 Solutions to Geotechnical Problems

Soil conditions at the TORCO site limits the primary storage pile height to 35 ft. To replace all the undesirable soil would have been too costly and the limited property configuration did not allow relocating the storage yard. The solution was to introduce a downward force to counterbalance the pile weight to prevent any soil failure. This was achieved by building a 15-ft high ring of pellets around the storage yard perimeter.

To monitor the soil pressure, instruments are installed in the soil at strategic locations. This counter-balance pellet ring is placed at the outer perimeter by the use of a portable conveyor since it is beyond the reach of the stacker boom belt.

A combined mat foundation and relieving platform was constructed along the pier's bulkhead to support the central portion of the projected 100,000-ton surge pile as well as the tunnel. The relieving platform, constructed of concrete, is supported by over 400 drilled piers bearing on hard pan 80 ft to 90 ft below ground surface. This design enables the dockside pile to have a height of 60 ft at the apex over the tunnel.

3.5 Major Subcontractors and Suppliers

LORAIN

General Contractor	Johnson Brothers Corporation
Civil Contractor	National Engineering
Electrical Contractor	Lake Erie Electric, Inc.
Steel Erection	Vogt and Conant
Idlers	Continental Conveyor & Equipment Co.
Conveyor Belting	The Goodyear Tire and Rubber Co.
Programmable Controller	Square "D" Company
Reducers	Horsburgh and Scott Company
Motors	Harnischfeger Corporation
Structural Steel	Paterson-Leitch Company
H. V. Switchgear	General Electric
Dust Collection	CEA-Carter-Day Company
Motor Control Centers	Cutler-Hammer

TOLEDO

Site Preparation	Gill Asphalt and Cement Company
Electrical	Lake Erie Electric
Dredging	Luedtke Engineering Company
Dust Collection	Midwesco Energy Systems
Fabrication/ Erection Steel	Davidson Crane and Conveyor, Inc.
Conveyor Belting	Goodyear Tire and Rubber Company
Reducers	Horsburgh-Scott
Idlers	Continental Conveyor & Equipment Co.
Stacker	PHB Weserhütte, Inc.
Switchgear & Substations	General Electric Company
Motor Controls	Siemens-Allis, Inc.
Programmable Controller	Square "D", Inc.
Motors	Harnischfeger Corporation