bulk solids handling Volume 1, Number 2, May 1981

Port Facilities at Narvik and Lulea

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Die Hafenanlagen von Narvik und Luleå
Les installations portuaires de Narvik et Luleå
Las instalaciones portuarias de Narvik y Luleå

ナルビクとルーレオの港湾設備

在纳维克和卢利亚的海港设备

تسهيلات الميناء في نارفيك ولوليا

Summary

The Ports of Narvik and Luleå are two of the most important shipping outlets in the West and their development which has been taking shape since 1945 is now almost complete. This paper traces the stages in their development and indicates problems and prospects for the future.

1. Introduction

LKAB (Luossavaara-Kiirunavaara AB) is a Swedish state-owned mining company and one of the principal suppliers of iron ore to the European steel industry since its foundation in 1890. In spite of the present competition from overseas iron ore producers, the main deliveries are still directed to many of the most important steel works in the EEC. In recent years, there has been a trend towards redistribution by a decrease of output to the EEC and simultaneously a growing share in Eastern Europe, Scandinavia and overseas customers in the USA, Mexico, Argentina, the Middle East and Indonesia, some of them using direct reduction methods for steel making.

2. Mine Locations and Rail Transport

The mines are located north of the Arctic Circle in Sweden at Kiruna, Svappavaara and Malmberget and shipments are made via Narvik at the Ofot Fiord on the Norwegian coast and via Luleå on the Gulf of Bothnia (Fig. 1). The ore is transported by rail 168 km from Kiruna to Narvik and 206 km from Malmberget to Luleå. Most of the Kiruna products and about 40 % of the

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Fig. 1: Locations of LKAB's mines and shipping ports and railway lines

Malmberget products are shipped via Narvik, the remaining part from Malmberget is exported through Luleå or sent to the steel works at Luleå. A 40 km branch line connects Svappavaara with the main line at Kiruna. The total 474 km length between the ports is a single-track electrified line. The section between Kiruna and Narvik is one of the busiest in the world. Up to 30 trains in each direction per day run this section with a round trip time of about 30 hours. This is made possible by means of radio communication, CTC-system and close located sidings. Each train containing 52 bottom-dump cars has a payload of 4,000 t. The daily maximum capacity is 100,000 t in winter. In the summer season maintenance work is carried out with capacity reduced to 60,000 — 70,000 t/day. The 435 km line on the Swedish side is owned and operated by the Swedish State Railways (SJ), the 39 km line on the Norwegian side belonging to the Norwegian State Railways (NSB) is operated and maintained by this company. The railway cars are owned by SJ and LKAB on a 50/50 basis, whereas the locomotives are owned, maintained and operated by the railway companies.

2.1 Mining Activities

The total annual capacity, at present 28 million t, can easily be increased to 32 — 33 million t. In 1974, the deliveries amounted to 31 million t which is the peak level attained so far. The total deliveries in 1980 are estimated to 21 million t with a sales value of 2,000 million Sw. Crs ($ 475 million). 18 million t will be shipped through Narvik (Fig. 2), Luleå will export 2 million t and distribute 1 million t locally to the steel mill. These shipments are far below the rated capacities, as seen from Fig. 3 which shows the development of the shipments from 1945 through 1980.

The number of employees, reduced substantially in the last years, is currently about 6,800 at the mines and ports and 7,500 totally, including subsidiaries, sales organization and group head office staffs in Stockholm.

The ore is extracted by underground mining at Kiruna and Malmberget and by open cast mining at Svappavaara. Kiruna is the world's largest underground iron ore mine with a capacity of 25 million t/year of crude ore, out of which 20 million t of products are obtained. The annual maximum outputs at Malmberget and Svappavaara are 9 million t and 3.5 million t respectively. At all the mines there are large concentration and agglomeration plants for processing of the crude ore into high grade products complying with the customers' requirements. There are four types of ore products, i.e. lump ore, sinter feed (upgraded fine ore), concentrates (processed high grade fines)

and pellets (agglomerates) delivered in more than twenty grades, classified by their physical and chemical composition, primarily contents of iron and phosphorous. During the recent five years LKAB has turned the interest to non-ferrous, and energy mineral (copper, uranium, coal) as well as ore-prospecting. Subsidiary companies have been formed for development of these business activities in the next 5—10 years.

3. Shipping Terminal Capabilities

The port facilities are estimated to handle up to 28—30 million t annually at Narvik and 8—9 million t at Luleå with an acceptable port time. Despite its northern latitude Narvik remains open throughout the entire year, owing to the favourable climatic conditions by the Gulf Stream. At Luleå the navigation season is limited to seven months, although a few ice-strengthened vessels operate short routes on the Baltic Sea during the winter season. Another disadvantage for Luleå is the draft restriction in the dredged entrance channel allowing call of maximum 45,000—50,000 dwt carriers fully laden. Narvik, apparently, has some basic advantages compared with Luleå, for example sufficient depth of water and loading capacity for super ore carriers, at present in the 250,000—300,000 t class and for even larger vessels in the future (Fig. 2). Other advantages are a sheltered harbour basin, moderate tide (2.5—3.5 m) and short distances to the European receiving terminals.

4. Development of the Shipping Terminals

The ore export from the mines in Lapland commenced in 1888 when the first ore consignment from Malmberget was shipped from Luleå. The first cargo in Narvik was loaded in 1903 from a provisional berth. The facilities were simple. The vessels were loaded by bottom-dumping of the railway wagons directly into the ship's holds from railway bridge structures above the berth. Stockyards were required for levelling-out the variations between rail transport and shipping. Stocking was made by means of small narrow gauge dump cars and reclaiming by steam or electric powered shovels into railway wagons. Although the manpower requirement was fairly large, this method was used in Narvik until 1956 and in Luleå until 1964, when conveyors and grab cranes took over.

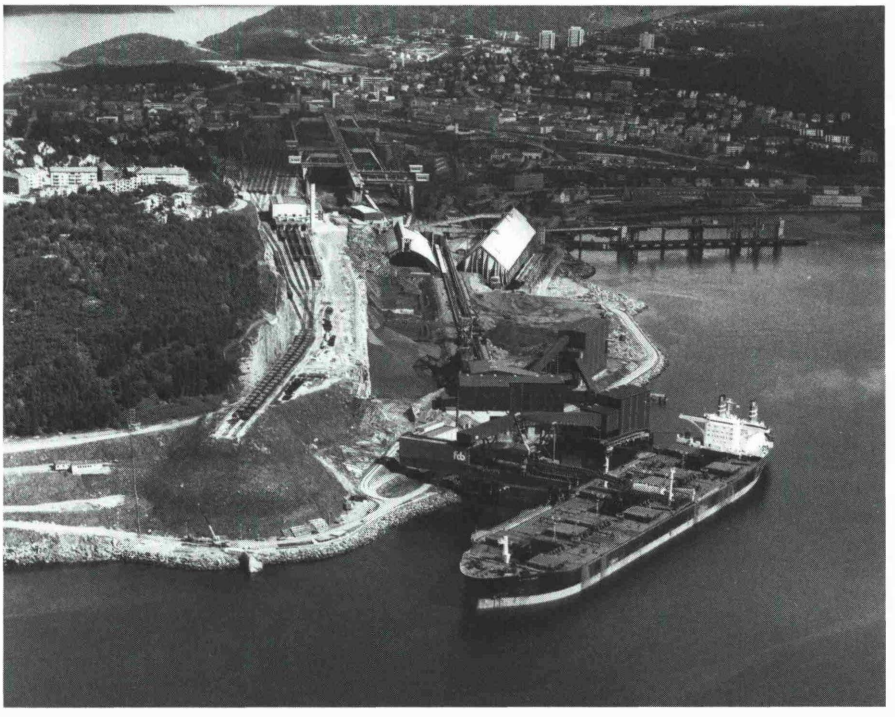

Fig. 2: Narvik: Last expansion stage — new berth stockyard and screening plant.
Railway yard, unloading station.
Old stockyards and pier in the background.
Loading of the largest vessel so far — 280,000 dwt.

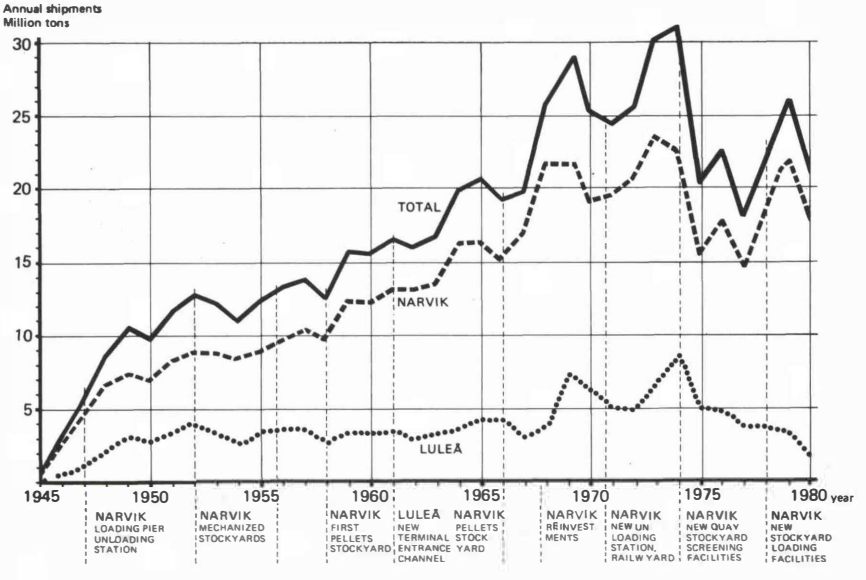

Fig. 3: Diagram showing LKAB's export shipments 1945—1980 and the development of the shipping terminals

The total shipments during the period 1908—1935 varied from 2 to 7.5 million t/year and increased in 1936—1939 to a maximum of 10.5 million t/year. The Narvik ore port was completely destroyed by military operations in 1940 and the shipments continued from Luleå with a maximum of 6.5 million t in 1943 decreasing to 0.7 million t in 1945. (Shipments from 1945 until now are shown in Fig. 3.)

After World War II a period of reconstruction and expansion started in 1947. The expansion at Narvik has been in progress in stages, each taking 3—4 years to construct (Fig. 3). The first stage in 1947—1950 consisted of a pier and train unloading facilities which increased the annual capacity and the shiploading rates. The period 1950—1957 was one of the most

Fig. 4: Narvik: Stockyard and pier built in 1948—1956, railway yard and unloading station in 1971—1974. The new berth in the background.

important in LKAB's history involving a vast investment scheme at the mines and in Narvik. An important step was taken between 1952 and 1956 by the construction of the first modern facilities for train unloading and a 2 million t capacity stockyard with conveyors and grab cranes — pioneer installations at that time (Fig. 4). The annual shipping capacity was 11—12 million t and the shiploading rate 4,000 t/h. In the next decade further improvements were made with covered stockyards and screening facilities for pellets. In 1968—1971 reinvestments of the conveyor system and shiploaders were carried out and a bucket wheel loader was installed at the main stockyard adapted to the existing installations. These improvements increased the total shiploading rate to 10,000 t/h, which in 1973 raised the annual shipment to 23 million t — the highest level attained so far. The costs of these investments were approximately Sw.Crs. 600 million in current prices ($ 140 million). In the following years, 1971—1978, the most comprehensive stage of expansion was carried out, increasing the shipping capacity to its present 30 million t/year. The total investment cost for this stage amounted to 750 million Norwegian crowns ($ 150 million).

The development of the shipping terminals has principally kept pace with the increasing output of the mines. This was especially noticeable in 1964—1967 after completion of the present terminal at Luleå and the improvement of the shiploading system and building of the pellets stockyards at Narvik.

The Luleå terminal was built between 1961 and 1965 comprising completely new facilities for train unloading, stockyards and shiploading including a new 7 nautical mile long entrance channel (Fig. 5). The total cost was Sw.Crs. 220 million in current prices ($ 50 million). The Luleå terminal could be built separately from the existing installations without any inconvenience for the shipping, while in Narvik all new construction work, replacement and improvements had to be carried out under the constraint to avoid interference with the regular activities at the terminal.

The demand for even higher shipping capacity was apparent at that time, in view of the steadily growing tonnage of the ore carriers, increased output from

1. Marshalling yard
2. Unloading station
3. Distributor station
4. Ore stockyard
5. Stacking bridges
6. Bridge cranes
7. Transfer points
8. Boomstacker
9. Stockyard
10. Outgoing conveyor
11. Weighing and sampling stations
12. Quay
13. Shiploader
14. Workshop area
15. Change house buildings
16. Bentonite stockyard with grinding station
17. Office

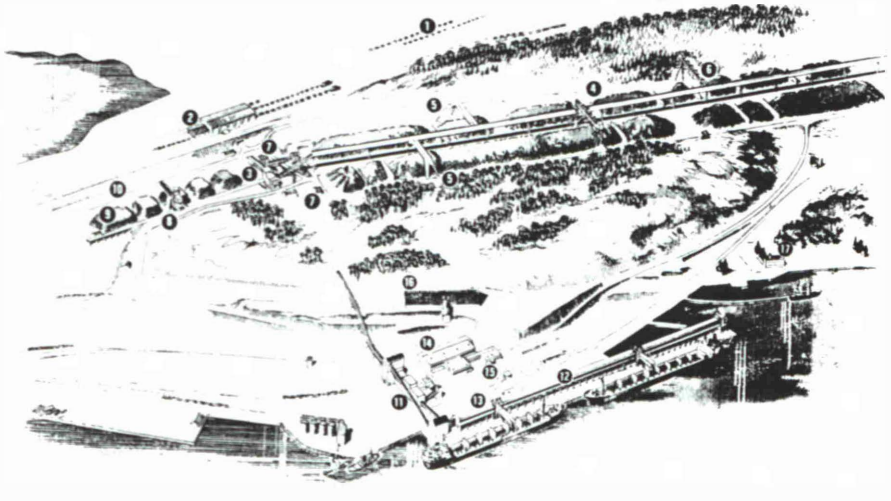

Fig. 5: Luleå: Perspective sketch of the ore shipping terminal

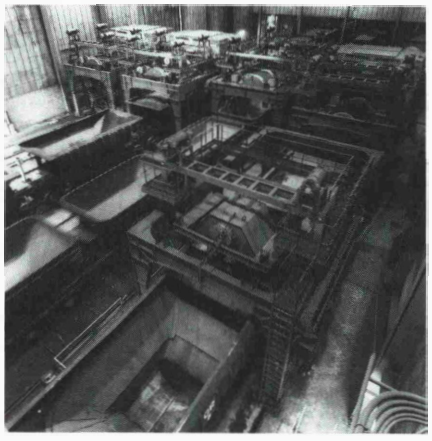

Fig. 6: Narvik: Train unloading facilities

the mines and more pellets and other high quality ore grades. Another impulse to further expansion was the request for reduced ship's port time to decrease the growing costs of demurrage. As a consequence of these factors, extensive operation research studies of the whole transport system from mine to ship were performed from 1968 to 1971. These studies called for further investigations for a long range expansion program which commenced in 1970 with planning and construction of a highly mechanized train unloading station and a connecting railway yard. These new facilities were essential to keep up the train discharge capacity when the present 100 t wagons (80 t payload) were put into operation. This part of the program which centralized the train unloading from three to one station and increased the capacity to 30 million t, was fulfilled in 1974. Another reason for construction of the unloading station were environmental problems. The stockyards with ore handling installations and the railway yard are surrounded by residential areas which were previously plagued with dust and noise trouble from the train unloading. These problems were solved by means of the new closed train unloading station (Fig. 6).

A master plan for the long range expansion, comprising a new berth for future large ore carriers and new stockyards, was worked out by Soros Associates of New York in cooperation with a project group of LKAB. This project called KALA was carried out in two stages. The first starting construction in 1974 with the berth and interconnecting conveyor systems to the existing plants, sampling and weighing facilities were commissioned in July 1977. The second stage of KALA included stacking and reclaiming equipment for the new stockyards and a screening plant. These facilities were commissioned in October 1978. The stockyard has a storage capacity of 1.5—2 million t and the screening plant has a rated maximum capacity of 6,000 t of pellets per hour. Preparatory work for a future doubling of the ship loading capacity were made in the first construction phase.

Extension of the total storage capacity by 1.3 million t in two reserve stockyards is now being prepared by means of excavation of an area at the old main stockyard and filling into the water. These stockyards will be used as emergency storages and will not have conveyor systems for material handling. Stacking and reclaiming will be carried out by means of front-end loading machines and dump trucks.

New facilities for train unloading and ship loading of apatite concentrate (raw material for fertilizer) have recently been commissioned and will be ready for regular operation from the beginning of 1981. The design capacity is 200,000 t/year and the total investment cost is estimated to about Sw. Crs. 30 million ($ 7 million). Special bulk carriers up to 10,000—12,000 dwt can be loaded at the inner side of the ore loading berth. The material handling system is totally closed for dustfree operation to avoid contamination of the ore at the stockyards and the ore loading berth (Fig. 7).

5. Facilities at Narvik

The layout of the Narvik terminal is fairly complicated as a consequence of a series of extensions during the past 30 years (Fig. 8). The detail planning has been difficult due to the demand for high flexibility because of the variety of ore grades handled (at present about 10 different grades). The limited space for enlarging of the storage areas is also a drawback. Thus, the stockyard at the new berth had to be blasted out of the hillside and the excavated rock used as fill in the sea (Fig. 2).

The actual storage capacity is now 5 million t. Negotiations with the Narvik

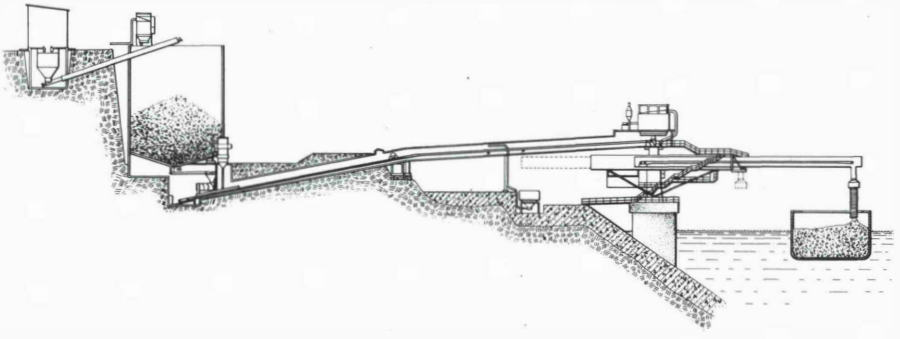

Fig. 7: Narvik: Apatite concentrate loading facilities

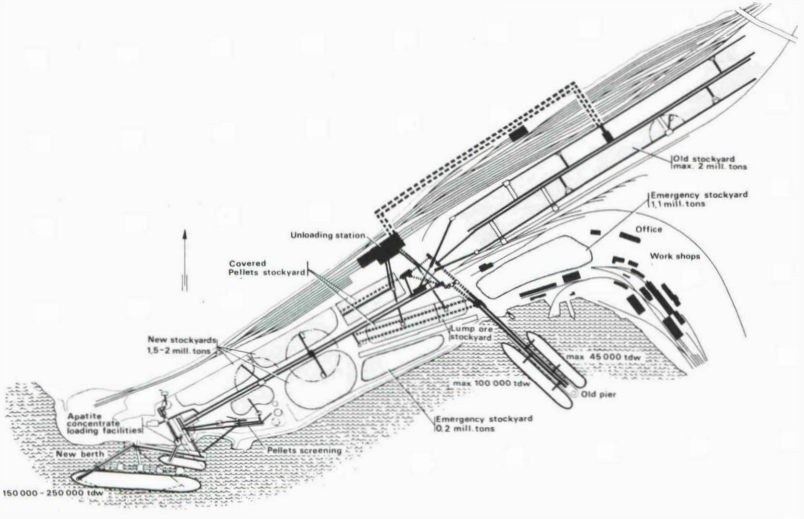

Fig. 8: Narvik: General plan of the ore shipping terminal

town council are going on to acquire new areas for future stockyards, located at the airport north of the ore port.

There are three different berths, where ships can be loaded simultaneously. The old pier can serve 45,000 dwt ships at the inner side and up to 100,000 dwt at the outer side. The new berth has a water depth of 27.5 m at low water allowing accommodation of future super carriers in the 350,000—400,000 t class. The largest ship so far is "World Gala", 280,000 dwt (Fig. 2) which was shortloaded to 242,000 t, limited by the conditions at the receiving port. The shiploader is a Linear Slewing Loader, which means that the front end is travelling along the quay wall while the rear end rotates supported by a fixed turntable.

The design capacity at the new berth is 11,000 t/h of ore or 7,500 t/h of pellets. The loading facilities at the pier consist of two shiploaders on each side, designed for 10,000 t/h. In practice these capacities are reduced by 30—50 % owing to delays of hatch shifting, ballast pumping, etc. The daily output is now estimated to 100,000 t on average, occasionally reaching 150,000 t. The terminal is operating round the clock seven days a week, except on a few official holidays.

6. Facilities at Luleå

Luleå is one of the largest ports in Sweden in terms of the tonnage in spite of the declining ore exports since 1974. The import of oil and bentonite to LKAB and coal to the steel mill has partly compensated for the drop in the ore export. The drawbacks for the iron ore — i.e. on the whole closed shipping during the winter season and the draft restrictions — have limited the export to customers nearby in Finland, Poland, Germany and southern Sweden.

Another drawback is the expensive rail transport owing to the longer distance from the mine and the lower train load compared with the Kiruna-Narvik route. The trains on the line to Luleå are made up of 65—70 wagons of 54 t with 40—42 t car payload and 2,500—2,800 t train payloads. This railway section is also interferred by other traffic.

The ore is transferred from the train unloading station to the 4 million t stockyards and to the adjacent steel mill. The stockyards are principally used for storing during the winter season.

Although the ships' tonnage is limited to 45,000—50,000 dwt fully laden vessels, the record cargo so far is 66,400 t carried by a 76,000 dwt ore carrier. The annual shipments reached a peak level of 7.8 million t in 1974. The shipments in 1980 will be 2 million t export and 1.2 million t domestic deliveries.

7. The Future

The years since the oil crisis began have been troublesome for LKAB as for other iron ore exporting mines. The steel industry recession in Europe drastically reducing the demand for iron ore has affected the export from LKAB. Besides there have also been structural changes in the iron ore market owing to the increased competition from overseas mines and from particular quality characteristics, caused by the phosphorous content. Considerable efforts are now being made to convert the high phosphorous ore grades to low phosphorous grades which in the future will be even more demanded by the steel works. In that respect LKAB is in a more favourable situation than many competing mines because the magnetic ore is easier to concentrate and pelletize than the non-magnetic minerals prevalent at most iron ore exporting mines.

In a market with continuously increasing oil prices, another very important advantage is the low rate of oil consumption necessary for making pellets and for their transportation. The port of Narvik can now, after the recently completed extensions, accommodate the largest vessels existing today and provisions are being made to install additional ore handling, reclaiming and shiploading equipment in the future.

The proximity of the main customers in Europe will always be an advantage of growing importance in a shipping market with rising freight rates.

To sum up the prospects for the future, despite the problems today, the picture is positive as far as capacity and product development are concerned. The comprehensive investment program performed in the period 1970—1978 at the mines and the ports, provides for high capacities in production and shipping of established ore grades, as well as for new sophisticated ore grades to adjacent and distant markets.