Symposium on Taharoa ironsands project*

J. H. INGRAM
B.E., M.I.MECH.E., F.I.E.(AUST), (FELLOW)

A. M. McCONNELL
B.E., C.ENG., M.I.C.E., (MEMBER)

G. J. ADE
B.E., (MEMBER)

R. H. COOPER
B.E.(MECH), PH.D.

P. G. ARMSTRONG
B.E., (MEMBER)

T. B. GOODFELLOW
B.E.E., M.B.A., M.E.I.C.

D. R. BUIST
B.E.

1. INTRODUCTION

NEW ZEALAND Steel Limited is mining two major deposits of titaniferous ironsand on the west coast of the North Island of New Zealand. At the Waikato North Head deposit, the product is being mined for use in New Zealand Steel's direct reduction and electric-arc steelmaking operations, while at Taharoa the titaniferous concentrate is exported directly to Japan from the off-shore single point mooring buoy and slurry loading facilities.

The titanomagnetite is therefore used in two distinct ways. At Glenbrook the material is the basic raw material in the production of finished billet steel, by the direct reduction/arc furnace process, while in Japan the same material is used as an additive to the sinter feed in blast furnace operation.

2. HISTORY

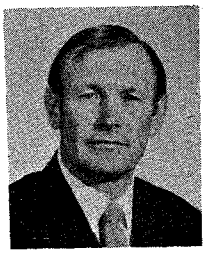
Since the early days of European settlement, attempts have been made to utilise these ironsands. In 1848 a small blast furnace was erected at New Plymouth, and a small amount of iron was made, but technically the venture failed because the sand blocked the draught system. In 1866, 100 tons of ironsand was sent to England where it was smelted and "puddled" into wrought iron bars, reported to be of good quality, but excessive costs precluded any follow up. From 1869 through to 1919 the work continued with varying degrees of success, mainly under the direction of E. M. Smith and later J. A. Heskett. It included a further plant at New Plymouth and one at Onehunga, where 10 furnaces, a rolling mill, a special canal, and a railway siding were constructed. This latter plant was a failure, mainly because of the loss of a suitable ironmaster and the plant was subsequently shipped as scrap to China. A 45 ft blast furnace was also erected, first at New Plymouth and later shifted to Onekaka for use on the limonite ores.

In 1949 successful trials were carried out by the New Zealand government at Onekaka with a blend of limonite and titanomagnetite. The further development of direct-reduction processes has resulted in the steelmaking operation becoming economically feasible.

The first steel was produced from the New Zealand Steel's Glenbrook plant in December 1969. At the same time, the preliminary shipments of titanomagnetite were made to Japan from the company's mining operations at Waikato North Head and these continued in small quantities over the next three years until the operations at Taharoa came on stream in October 1972.

J. H. INGRAM, general manager of New Zealand Steel Ltd. since 1969, served in the R.N.Z.A.F. from 1943 to 1945, and joined the Ministry of Works on the Roxburgh hydro scheme in 1951. After two years he became assistant manager for Australasia with Boving and Company Ltd., and in 1953 worked in the United Kingdom and Sweden with this company. In 1954 he was appointed managing director of Boving and Company (A.N.Z.) Pty. Ltd., an appointment he held until 1962 when he became managing director of the Cable Price Corporation Ltd. Seven years later he became general manager of New Zealand Steel Ltd.

Mr Ingram won the Ewan Parry Award in 1964 with a paper "The Australian hydro-electric industry" and was the author of "Engineering as training for management" in 1969. He was a member of the N.Z.I.E. Wellington branch committee from 1963 to 1968 and was chairman of the Wellington branch in 1967. Mr Ingram was chairman of the publications committee from 1968 to 1969 and was a member of the Council of the Institution from 1969 to 1971.

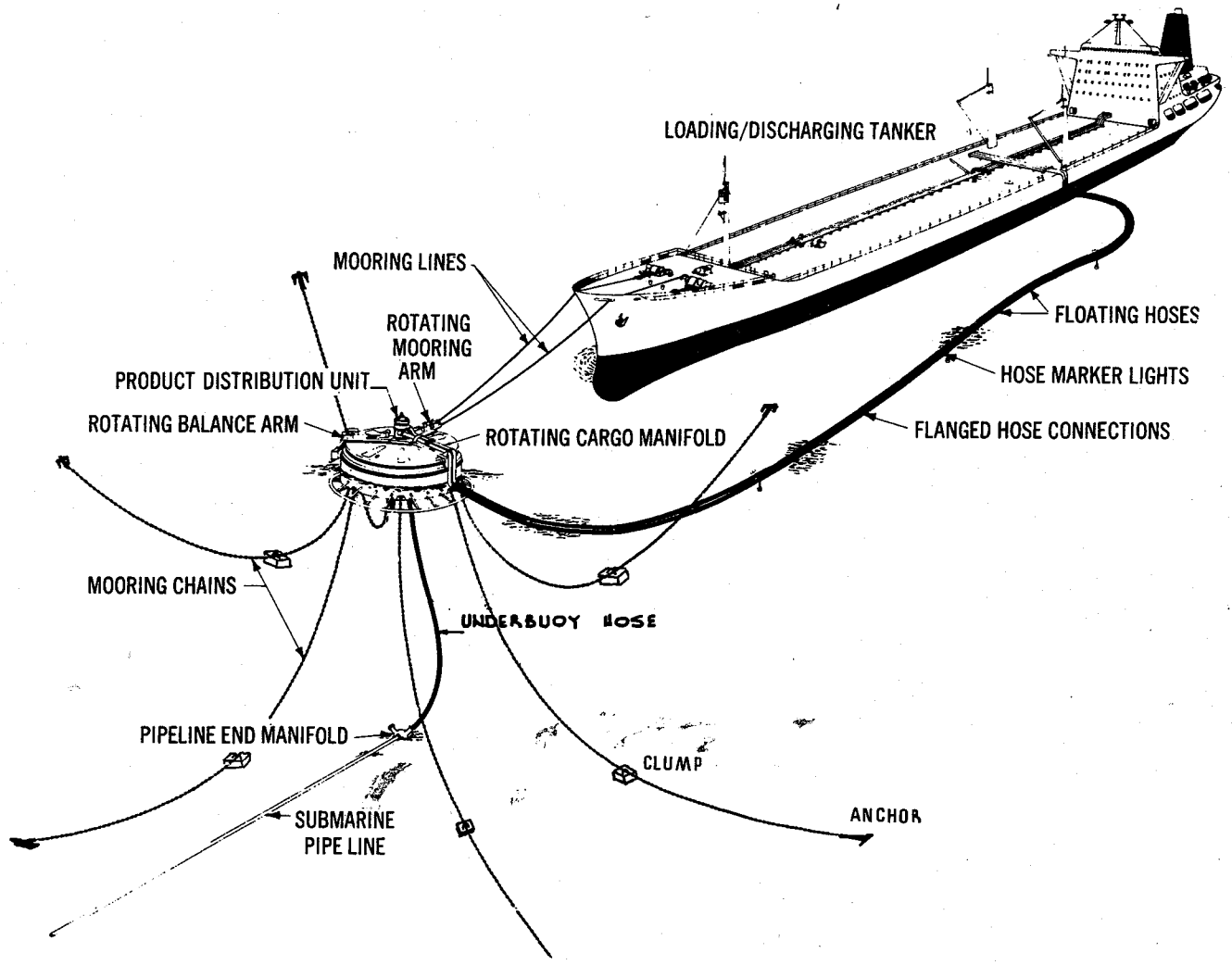


A. M. McCONNELL has been joint managing director of McConnell Dowell Constructors Ltd. since 1961. He has been associated with major projects such as the Marsden power station offshore circulating water system, the Auckland Harbour Bridge, the Auckland Harbour Bridge widening and approaches, the Kapuni natural gas pipeline, the Warkworth tracking station, the ironsands project at Waipipi, and with New Zealand Steel Mining. Mr McConnell was a foundation member of the Engineering Export Association of New Zealand and has been its director since its formation. He has been associated with overseas projects in Melbourne, Singapore, Sumatra, and Laos.

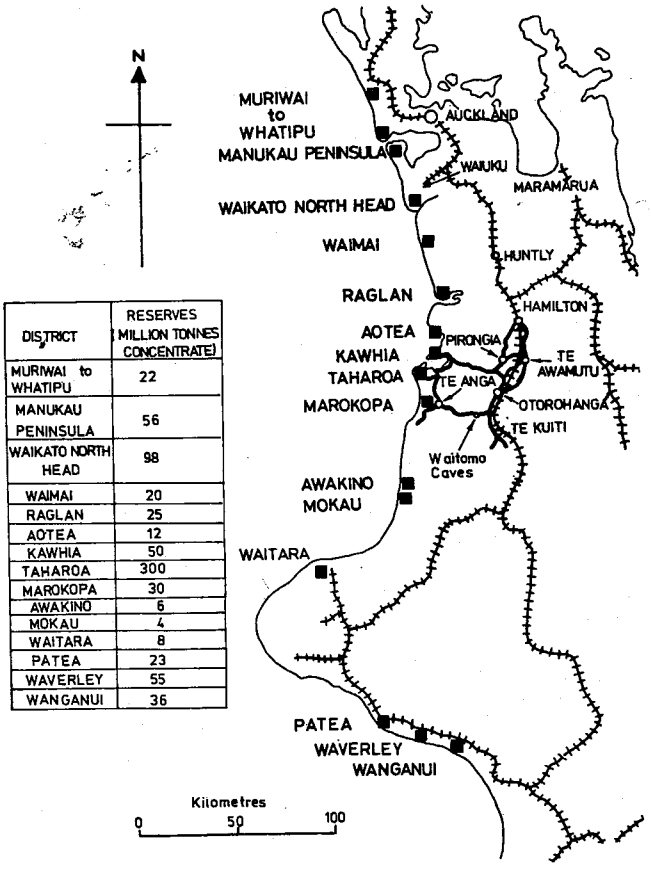
In 1953 he became project manager for Wilkins and Davies Construction Company, and was associated with the Rongotai airport project. In 1957 Mr McConnell became chief engineer and director of the Dryden Construction Company Group and was associated with the Tongariro power project investigation, the Hunua water main project, and the Manukau Harbour submarine pipeline.

He won the Fulton Gold Medal in 1968 and the Furkert Award in 1964 and 1968.

* A general interest article on five papers being published in *N.Z.I.E. Transactions.*



Schematic layout of single point mooring buoy. (Part of the paper "Offshore loading systems utilising slurrying techniques", by A. M. McConnell, P. G. Armstrong, and C. J. Ade.)



DISTRICT	RESERVES (MILLION TONNES CONCENTRATE)
MURIWAI to WHATIPU	22
MANUKAU PENINSULA	56
WAIKATO NORTH HEAD	98
WAIMAI	20
RAGLAN	25
AOTEA	12
KAWHIA	50
TAHAROA	300
MAROKOPA	30
AWAKINO	6
MOKAU	4
WAITARA	8
PATEA	23
WAVERLEY	55
WANGANUI	36

Fig. 1: North Island ironsand deposits.

3. LOCATION

The largest concentration of titaniferous ironsand in the world occurs at Taharoa. (See Fig. 1.) Here the reserves have been estimated in excess of 300 million tonnes of ore concentrate.

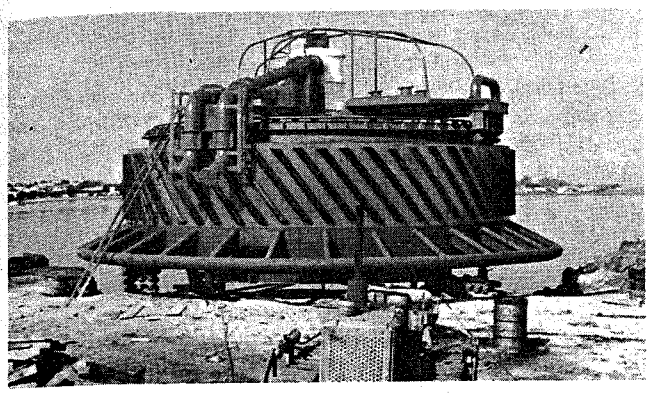
Taharoa is located 144 km due south of Auckland and 90 km by road from the city of Hamilton. The company has built 49 homes and is building a community centre to provide accommodation and a social centre for the employees. The Department of Education has provided two additional classrooms in the local school to cater for the increased number of children requiring primary level education (see Fig. 2).

The mining and shiploading operations are centred at the ironsand deposit, close to the beach, about 3 km from the settlement (see Fig. 3).

4. DEVELOPMENT

Early geological exploration work was carried out by geologists of the New Zealand Geological Survey, namely H. E. Fyfe and D. S. Nicholsen. In 1957 a study of the possible development of the Taharoa deposit was made by Kaiser engineers for the purpose of supplying ore to a proposed New Zealand-based steel mill located in the South Island.

New Zealand Steel Ltd. commenced detailed exploration work of the deposit in September 1968,



IMODCO s.p.m. buoy. The buoy is ready for launching on a slipway at Onehunga, Auckland, prior to towing to the Taharoa site. (Part of the paper "Offshore loading systems utilising slurrying techniques", by A. M. McConnell, P. G. Armstrong and G. J. Ade.).

and, in the early work, completed 3 000 m of drilling over the 1 600 ha of the deposit. This was followed by more close-grid drilling of the most favourable area outlined for the commencement of the mining operations.

Detailed test work was carried out including:

1. Mineral processing work on samples by the company's technical services division in New Zealand, and overseas, both in Sweden and Australia.

2. Pumping test work, including a full-scale 300 m test loop, constructed and tested by McConnell Dowell, was carried out in New Zealand to check the feasibility and operating characteristics of a system to pump slurry 2 km to an ore carrier.

3. Extensive hydrographic test work was also carried out to establish the effect of weather, littoral drift, and surf action on a pipeline extending out from the Taharoa beach.

The results of these tests and associated work, established that both technically and economically it was possible to mine and concentrate the titanomagnetite and to pump it to an ore carrier 2 km off-

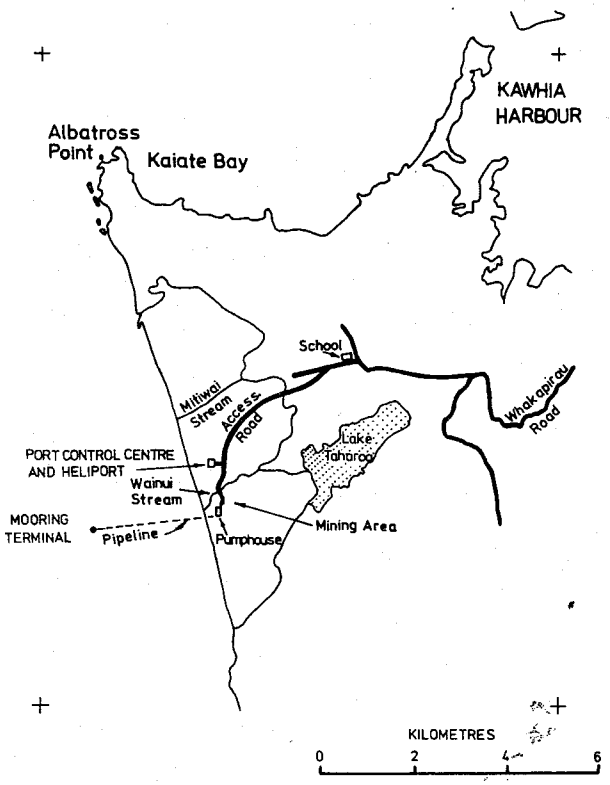


Fig. 2: Area map showing location of marine and shore-based facilities.

shore through the single point mooring buoy and floating hose system.

Parallel with the technical and economic feasibility work was the market development and the establishment of satisfactory long-term contracts to make the total project a reality. This work culminated in March 1971 in the signing of contracts amounting to 11.6 million t of concentrate with deliveries extending over 10 years.

These contracts were signed with five Japanese steel mills, namely Nippon Kokan Kabushiki Kaisha, Kawasaki Steel Corporation, Sumitomo Metal Industries Ltd., Nippon Steel Corporation and Kobe Steel

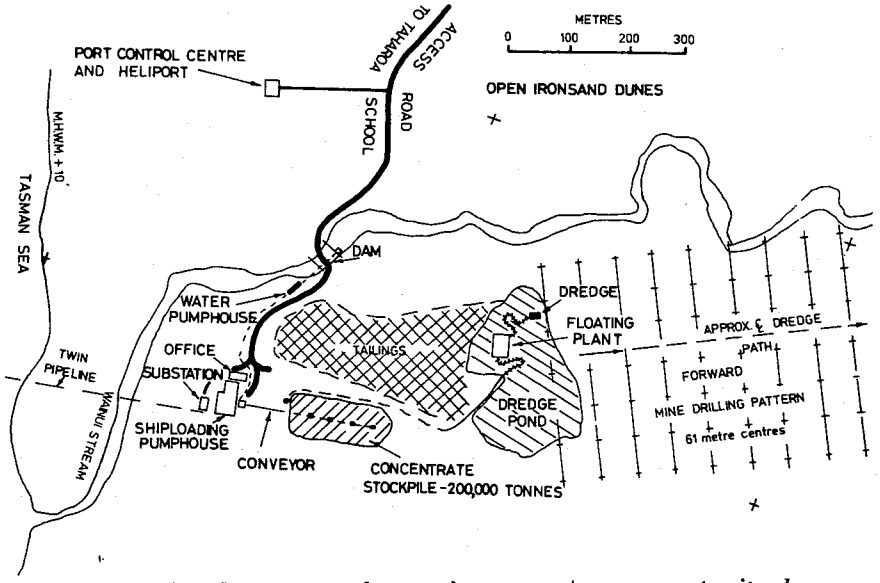
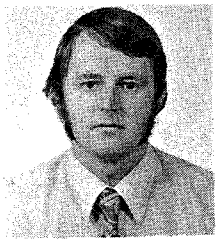


Fig. 3: Taharoa ironsands operation—general arrangement—site plan.

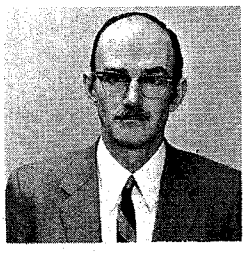
P. G. ARMSTRONG is technical director of the McConnell Dowell group of companies. After graduating in 1953, he spent two years with the New South Wales University of Technology, first as technical officer and then as teaching fellow, taking a post-graduate course in hydrology. In 1956 he joined the Ministry of Works, and between then and 1967 was associated with projects at Mangakino (the Atiamuri earth dam) and steel penstock fabrication for Ohakuri and Atiamuri. In 1960 on the Aratiatia power project he was the engineer responsible for the intake tunnel and all headworks, becoming engineer in charge at Aratiatia in 1963 until the project was completed. This was followed by a period with the Ministry of Works at Tongariro, where he was resident engineer on the Tokaanu power project.

Joining McConnell Dowell Ltd. in 1968, he became project manager and was associated with the Taranaki Harbours Board No. 3 wharf wall and the Kapuni pipe-wrapping contract. From 1969 and until taking his present appointment in 1972 he was operations manager responsible for all the company's contracts.



G. J. ADE joined McConnell Dowell Constructors Ltd. in 1970 as project engineer responsible for design-and-build contracts associated with building extensions and offshore loading facilities for ironsand concentrate. In 1973 he was appointed operations manager for McConnell Dowell (South-east Asia), responsible for contracts in that area and is currently involved with submarine pipeline installations in Singapore and Indonesia.

In 1960 he completed his degree at Canterbury and joined Wilkins and Davies Construction as site engineer on multi-storey buildings, bridges, the Picton ferry terminal and the Newmarket motorway structure. In 1964 he joined the Marlborough Catchment Board as an assistant engineer and was responsible for the construction of the Taylor flood detention dam. One year later he joined the practice of C. C. Davidson, consulting engineer, Blenheim, and then in 1967 became project engineer with the Nelson City Council and was closely associated with the new sewage disposal scheme for the city of Nelson. This project was completed under Mr Ade's supervision when he had transferred to Beca Carter Hollings and Ferner, consulting engineers, in Wellington. A year later, after making a feasibility study for all the services for the proposed town of Pauatahanui, he joined McConnell Dowell Constructors Ltd.



T. B. GOODFELLOW has been development manager of New Zealand Steel Limited since 1967.

In 1954 he made two voyages with the Port Line as a marine engineer, and then settled in Canada where he undertook design and construction engineering with Ontario Hydro, Racey McCallum and Associates/Bell Canada on the mid-Canada line project and with Bell Canada on the Quebec-Labrador and other projects. He also undertook feasibility studies both in Canada and New Zealand prior to returning to New Zealand permanently in 1967 to take up his present appointment.

While in Canada he carried out post-graduate studies in business administration at the University of Toronto and during this period developed an econometric model of the New Zealand economy.

Ltd. Simultaneously, an agreement to transport the ore from the proposed off-shore terminal to Japan was made with three Japanese shipping lines, namely, Kawasaki Kisen Kaisha Ltd. for the *Yasukawa Maru,* Showa Shipping Co. Ltd. for the *Nichiho Maru,* and Japan Line Ltd. for the *Long Beach Maru.* All vessels are capable of carrying around 45 000 dry tonnes, and are equipped for slurry loading and conventional grab discharge.

The two main contracts for the project were placed in April and September 1971, and work on the site commenced late in 1971. Commissioning of the dredge and concentration plant was carried out in August-September 1972, and the first shipment was completed on programme at the end of October 1972.

Since that date production has continued, and to October 1973 800 000 t has been shipped. In the first year of the operations, only two ore carriers will have been operating, but the third vessel started on the run in October 1973, and from this date the production level will be raised to 1.2 million dry tonnes a year.

5. OPERATIONS

The main features of the operation are shown diagrammatically in Figs. 4 and 5.

5.1. Mining and concentration

The mining and concentration operations are carried out on a dredge pond, the ironsand being mined from the advancing face with a cutter-suction dredge of 750 t/hour rated capacity. The ironsand is fed to the floating surge bin through a pontoon-supported, flexible 450 mm pipeline. The surge bin mounted on a separate pontoon structure, includes a trommel screen for removing down to 3 mm material from the feed.

Primary concentration is carried out by eight Reichart cones, the concentrate from which is pumped to the final magnetic section, made up of four banks of separators, each consisting of two 900 mm × 96 Sala wet magnetic separators in series with one top-fed Mortsell magnetic separator. The tailings from the final Mortsell are re-circulated back to the middlings from the cones. In the middlings circuit, a further gravity cone concentrator is followed by a single drum wet magnetic separator and a Mortsell in series. The concentrate from the middlings circuit is pumped out with the final concentrate if it is up to specification. Alternatively, it can be returned to the main magnetic separating banks. Throughout the various stages tailings are rejected, and the circuit has been more than correctly described as a rejection circuit rather than a concentrate circuit.

No difficulty has been experienced in maintaining the design specification of the plant, and production levels have at times exceeded the designed output of 300 t/hour maximum. Tailings are stacked via a land-line system, behind the plant, while the concentrate is pumped off the floating installation to the shore-based feed regulating tank. From this point, the concentrate is picked up on two pumps in series and elevated to the four cyclones mounted on 24 m high towers along the stacking-out structure, where final dewatering prior to stacking is carried out.

5.2. Shiploading

The concentrate is reclaimed from the 200 000 t capacity stockpile through variable speed controlled

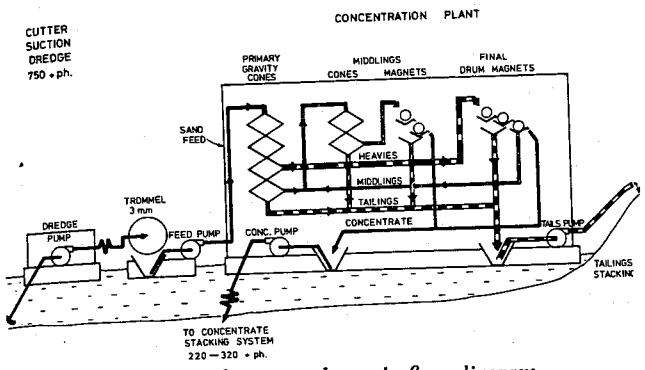


Fig. 4: Taharoa—schematic flow diagram.

belt feeders on to under-stockpile conveyor. Two DH8 dozers are used to assist in feeding the concentrate on to the feeders and in tidying up the stockpile. Loading is carried out at an average rate of 1 000 t of solids an hour. The concentrate is mixed with water to the desired density in the constant density tank, and then picked up by the main shiploading pump system.

These pumps consist of six Warman slurry pumps, connected in series. A twin 300 m pipeline system, one as a standby, extends from the shore-based pump station across the beach and along the seabed 2 km from the shore, to the 20 m mark. At this point the pipelines are coupled from the seabed to the underside of the IMODCO s.p.m. buoy by flexible hoses, and then by flexible floating hoses from the buoy to the ore carrier.

R. H. COOPER has been engaged on research at New Zealand Steel Ltd. since 1969. His principal work has been directed towards the Taharoa project and New Zealand Steel's reduction plant. From 1962 to 1964 he researched the properties of both single and polycrystalline Armco iron. For two years from 1965 he undertook post-doctoral research at the University of Oxford, continuing work on the properties of rapidly deformed metals. Mr Cooper joined New Zealand Steel Ltd. in 1967 and started a training programme which took him to the British Iron and Steel Research Association, to Sandvik Steel, to Lurgie Chemie, and to the Steel Company of Canada (Stelco), where he and other members of New Zealand Steel carried out work on pelletising and reduction testing for New Zealand Steel's direct reduction plant.

Dr Cooper has published three papers as a result of the work at Oxford on subjects associated with the yield and flow of low-carbon steels tested at high rates of strain.

D. R. BUIST has been mining manager for New Zealand Steel Ltd. at Glenbrook since 1966. He was born at Ngakawau and graduated at the Otago Mining School in 1953. Gaining a post-graduate scholarship in coal mining, he spent two years (1954-56) in the United Kingdom with the National Coal Board. Returning to New Zealand in 1957, Mr Buist was mine manager of State Coal Mines at Greymouth and Linton until he became production manager with Fletcher Industries, Dunedin, in 1963. Three years later he took up his present appointment.

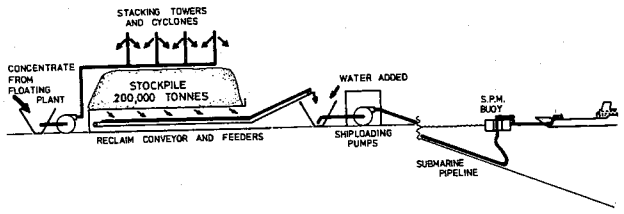


Fig. 5: Stockpiling, reclaiming, and shiploading—schematic.

5.3. Port operations

The port at Taharoa consists essentially of the s.p.m. buoy, the associated navigational aids, the shore-based control centre, and an area covered by a 5 km radius from the buoy. The port is under the control of the Marine Department, and the company employs two fully qualified pilots who pilot the vessels on to the terminal and supervise the loading operation.

When a carrier is in the Taharoa Harbour limits, one of the pilots is always on board and the service vessel is in constant attendance.

A service vessel is used in the mooring operation to pass the mooring ropes to the carrier, and to tow the floating hoses into position to enable these to be lifted by the ship's gear and coupled onto the ship's manifold system. This service vessel is also used to assist in all the marine maintenance work, including the regular work of greasing and lubrication, and as the support vessel for divers who inspect the under-buoy system of hoses, pipeline, chains and anchors.

The servicing of the carrier from shore is carried out by helicopter, which, when not operating, is stationed on the helipad near the control centre at all times a carrier is in the harbour.

An efficient radio system for local control, combining fixed and portable units with duplicated back-up facilities, is provided to maintain communication between the operational centre, the ore carrier, service vessel, helicopter and shore-based loading control centre.

Regular weather reports are received at the control centre by a separate radio, fixed on the appropriate channel.

6. QUALITY CONTROL

Throughout the mining and shiploading operations, regular sampling is carried out, and the samples are analysed by the staff in the laboratory at Taharoa. Additional information is obtained ahead of the mining operation by advanced drilling and sampling, so that the total operation is planned well in advance.

7. FUTURE MARKETS

The present plant has capacity in excess of the existing sales contracts commitments, and the company is looking at other potential markets for this product. It considers that there will be a growing demand on the international scene for the titanium-rich magnetite concentrate.

At the moment the major potential market would appear to be in Japan and in areas where large steel mills are located close to deep-water harbours. Here the considerable advantages in the ease of handling large bulk carriers, that can be readily loaded by slurry methods at Taharoa, can be fully utilised and handling costs minimised. ▽