REPORT ON THE SURVEY

FOR

NICKEL SMELTER CONSTRUCTION IN POMALAA AREA

REPUBLIC OF INDONESIA

May 1972

OVERSEAS TECHNICAL COOPERATION AGENCY

PREPARED BY

THE JAPANESE SURVEY MISSION FOR

DEVELOPMENT OF NICKEL INDUSTRY IN POMALAA

PREFACE

In compliance with the request of the Government of the Republic of Indonesia, the Government of Japan decided to undertake a survey in relation to the Low Grade Nickel Ore Smelter Construction Project, planned by Indonesia's state-run enterprise ANTAM Company for the Pomalaa area in Sulawesi Island for the development of natural resources and for the promotion of industrialization of the country, to investigate the substance of the mining plan, smelting plan and other plans associated with this project and to study the economic feasibility of the said project and entrusted the implementation of the survey to the Overseas Technical Cooperation Agency, an executive organ of the Japanese Government.

In order to make doubly sure that the field survey and the preparation of a report are carried out to perfection, the Agency organized a survey mission for the Nickel Smelter Construction Project for the Pomalaa area, the Republic of Indonesia, comprising the following members with the cooperation of various government agencies and other private organizations.

Head:	Sakichi Goto	Overall responsibility
Member:	Ichitaro Wakamatsu	Productivity
" :	Shigeo Takeuchi	Geology and mining
" :	Kiyoaki Iwakuma	Smelting facilities
" :	Michihito Chiwata	Development plan
" :	Nobuyuki Ohtake	Coordination

The Mission conducted a field investigation for a period of one month from February 29 through March 26, 1972. Following the field survey in Indonesia, technical reviews and economic analyses of the project were made in Tokyo and the findings of these works have been summarized in this report. As described in the conclusions in the report, the project is considered feasible technically and economically. Besides, the report points out the necessity of coordinating the timing of construction so that the initial production may start before the exhaustion of the existing ore for exports. For this reason, the report recommends the start of construction of a smelter in January 1973 at the latest.

I shall be very happy if this report proves useful to the Government of the Republic of Indonesia in mapping out a concrete plan for construction of a nickel smelter under the project.

Finally, I should like to take this opportunity to express my profound gratitude to the officials concerned of the Government of the Republic of Indonesia; staffs of the Japanese Embassy in Djakarta; members of the survey mission; officials of the Japanese Government agencies and various business organizations for their cooperation and support which have brought the survey mission to a success.

May 1972

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency.

LIST OF MEMBERS OF SURVEY MISSION

Leader	Sakichi Goto	Professor, University of Tokyo
Member	Ichitaro Wakamatsu	Nittetsu Mining Consultants Co., Ltd.
"	Shigeo Takeuchi	Ditto
"	Kiyoaki Iwakuma	Nippon Steel Corporation
"	Michihito Chiwata	Economic Co-operation Department, Trade and Development Bureau, Ministry of International Trade and Industry
"	Nobuyuki Ohtake	Ditto

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I. LETTER OF TRANSMITTAL

Letter of Transmittal

May 1972

Mr. Keiichi Tatsuke,
Director General,
Overseas Technical Cooperation Agency,
Tokyo

Dear Sir,

I have the great pleasure of submitting herewith the Report on the Survey for Nickel Smelter Construction Project in Pomalaa Area, Republic of Indonesia.

The survey mission for the said project arrived in Indonesia on February 29, 1972 and stayed there for a period of about one month. During this period, the mission had interviews and discussions with the competent officials of Indonesian government and conducted a field investigation at the smelter construction site in Pomalaa area, South Sulawesi province, Sulawesi island.

The technical and economic feasibility of the project was studied on the basis of the findings of the field investigation as well as data and information collected before and after the survey. This report was prepared from the results of such study.

Under the project, the smelter construction is planned to be undertaken chiefly by P.N. ANEKA TAMBANG, a state-operated mining company of Indonesia, to attain an annual production of 4,000 tons ferro-nickel (in terms of Ni + Co content) from low-grade garnierite ores in Pomalaa area for export to Japan.

Consequently, the following conditions must be satisfied for the materialization of the project.

1) Garnierite ores have components suited for smelting and are available in sufficient quantities.

2) Construction site is favourably conditioned.

3) P.N. ANEKA TAMBANG possesses the technical and entrepreneurial ability required for the construction and operation of the smelter.

4) Smelter operation promises good profitability.

5) Marketing of the product is feasible under the existing demand-supply situation.

The mission exerted its utmost in studying all these conditions and bringint them to light.

The project feasibility can be justified both technically and economically as elucidated in Section 2-2 (Conclusions) of the report. I am convinced that upon its completion, the project will contribute largely to the regional development, technological improvement and increase of foreign currency earnings of Indonesia.

I wish to take this opportunity to express my deep gratitude to the competent Indonesian authorities, P.N. ANEKA TEMBANG and other Indonesian concerns and individuals for the valuable assistance extended during the survey.

Yours respectfully,

Sakichi Goto
Leader,
Japanese Survey Mission for
Development of
Nickel Industry in Pomalaa

II. SURVEY ITEMS AND CONCLUSIONS

2-1 Survey Items

The purpose of the survey was to study the smelter construction project formulated by P.N. ANEKA TABMANG (hereafter called "ANTAM"), a state-operated mining company of Indonesia, for production of 4,000 tons of ferro-nickel in terms of Ni and Co content, and evaluate its technical and economic feasibility in accordance with the request of BAPPENAS, the national development planning agency of Indonesia.

For this purpose, the following items were covered by the survey.

(1) Existing state of nickel industry in Indonesia.

(2) Technical level and financial status of ANTAM.

(3) Ores and their reserve.

(4) Smelting method and production plan.

(5) Economic feasibility.

2-2 Conclusions

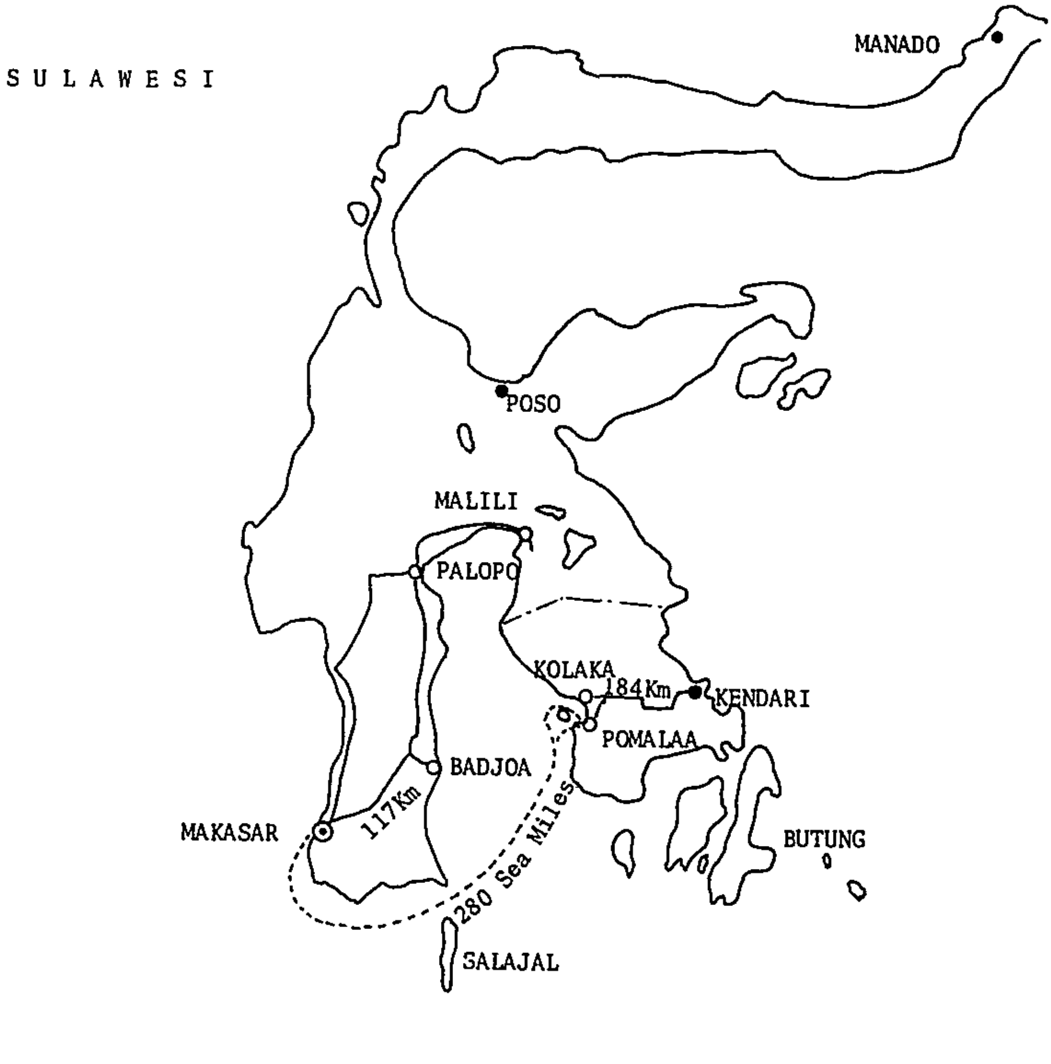
As a result of surveys and studies on the above-listed items, the mission reached the conclusion that the project is feasible both technically and economically.

The project is expected to produce various benefits for both Indonesia and Japan.

For Indonesia, the project is of value because it will keep the mines opened for the smelter operation even after Pomalaa area ceases to produce exportable ores, and it will give birth to many able metallurgical and assying experts by reason of the high technical level required for the smelter construction and thereby enhance the country's industrial development, and will also offer considerable economic benefits for the inhabitants of Sulawesi.

At present, oversupply of nickel is observed in Japan. However, if ferro-nickel is imported from ANTAM through Sulawesi Nickel Development Cooperation Co., Ltd. (hereafter called "SUNIDECO") which was established by five Japanese nickel smelting companies, the business relations between the two companies will open the way for future Indonesia-Japan cooperation. Since such cooperation is indispensable for the smelter construction which will be required, when the demand situation improves, for processing low-grade laterite ores occurring in the joint exploration area, the project is beneficial for Japan as well.

As detailed in the following pages, the smelter construction work should be so carried out that production can be started while exportable ores are available. Construction should therefore be initiated in January 1973.



III. BRIEF HISTORY AND PRESENT STATE OF NICKEL ORE DEVELOPMNET IN INDONESIA

3-1 Brief History

Development of nickel ores in Indonesia goes back to 1935 when Fried. Krupp Industriebau of Germany carried out a detailed survey of nickel mines in Pomalaa area at the request of N.V. Oost Borneo Maatschappij (O.B.M.), a Dutch mining company. After three years of exploration, O.B.M. established Bonitra Mining Company (B.M.C.) by joint investment with Krupp and mined nickel ores from Pomalaa deposit at the northern end of the area and from Batu Kira deposit found at Tandjung Pakar at the southern end of the area. Ores mined from these deposits were shipped to Krupp's steel mill in Germany. With the outbreak of World War II. Krupp withdrew from the company's management and O.B.M. exported about 130 thousand tons of ores to Japan from 1939 until it was closed in 1941 when the Pacific War broke out.

Two months after Japanese navy landed in 1942, the mine was reopened and run by Sumitomo Mining Co. under the military control, and about 120 thousand tons of ores were shipped to Japan up to the termination of the war. In parallel with its mining activity, Sumitomo embarked in the construction of a smelter in July 1942 and completed it in a period of about 13 months. This smelter had an annual processing capacity of 70 thousand tons and was capable of producing 8,920 tons of nickel matte (containing 25% of nickel) per year. Within three months after it was commissioned, however, the smelter was disabled for normal operation by war damage.

When the war ended, reopening of mining activity was planned by O.B.M. and other concerns but this was not realized as Indonesia declared independence and entered the war against Netherlands. Mining activity in Pomalaa area was suspended thereafter until security was restored in 1957 and local companies started export of nickel ores on a small scale.

In 1962, a production sharing agreement was concluded between SUNIDECO, B.P.U. Perusahaan 2 Tambang Umum Negara, a government organ for general supervision of ordinary state-operated mining enterprises, and P.T. Nickel Indonesia, and this animated the mining activity in Pomalaa area. Export of nickel ores from this area began to rise sharply from about 1968 when B.P.U. and P.T. Nickel Indonesia were amalgamated and reorganized into the present ANTAM, registering 600 thousand tons in 1970 as against 12 thousand recorded in 1962. Volume of ores exported from Sulawesi up to 1970 amounted to 1,200 thousand tons.

3-2 Existing State

Since the Foreign Capital Inducement Law was enacted in 1967, Indonesian government has been encouraging, besides the existing production sharing system, foreign investment in natural resources development.

However, Indonesia's Mining Law stipulates that the government holds the exclusive mining right, so that mining enterprises, whether state-operated or otherwise, are required to obtain the mining authorization granted by the Minister for Mining.

The Mining Law further stipulates that for the purpose of motivating those mining activities which have never been developed in the past or have not been and cannot be undertaken by government organs or state-operated enterprises holding the mining authorization, the Minister for Mining may, whenever he deems it necessary, designate other corporations or individuals (including private foreign enterprises) as contractors for such mining activities. This provision of the Mining Law enables foreign enterprises to acquire an exclusive right to explore and develop mineral resource in virtue of the so-called "contract agreement" concluded with the government.

So far, three foreign enterprises have concluded a contract for nickel ore development with the government. All of them, however, are still in the stage of survey of exploration and none is engaged in actual mining work. Nickel ores currently exported from Indonesia are therefore all produced under the P/S contract between ANTAM and SUNIDECO.

Table 3-1 – Production and Export of Nickel in Indonesia

(Unit: ton)

Year	Production	Export
1965	101,136	79,570
1966	117,402	133,650
1967	170,602	145,881
1968	261,973	240,542
969	256,213	257,761
1970	600,000	538,453

Source: Satistics of the Department of Mining, Indonesia.

Names and other particulars of the said three foreign enterprises which are currently engaged in nickel ore development are given below.

1) P.T. International Nickel Indonesia (subsidiary company of International Nickel Co. of Canada)

Survey expenses	:	$ 15,000 thousand
Business expenses	:	$200,000 thousand
Coverage	:	West and South Sulawesi

2) P.T. Pacific Nickel Indonesia (consortium of U.S. Steel Corp. of U.S.A., participated by the following companies)

- o Koniklijke Nederlandsche Hoogovens en Staalfabrieken, N.V., Netherlands.
- o Wm. H. Muller & Co., N.V., Netherlands.
- o New Mount Mining Corp., U.S.A.
- o Sherritt Gordon Mines, Ltd., Canada.

Survey expenses	:	$ 3,458 thousand
Business expenses	:	$75,000 thousand
Coverage	:	Waigeo Is. and its vicinities, and Mt. Saikrups, West Irian.

3) Indonesia Nickel Development Co., Ltd. (joint venture of the following Japanese companies)

Nippon Steel Corporation, Ltd., Mitsui & Co., Ltd., Mitsubishi Corporation, Ltd., Sumitomo Shoji Kaisha, Ltd., Nippon Mining Co., Ltd., Nippon Yakin Kogyo Co., Ltd., Pacific Metals Co., Ltd., Sumitomo Metal Min. Co., Ltd.

Survey expenses	:	$ 1,301 thousand
Business expenses	:	$75,000 thousand
Coverage	:	Halmahera Is. and its vicinities.

Outline of the contracts concluded by the said three enterprises is as given below.

1) Nickel Ore Development Project in Sulawesi by International Nickel

Name of Contractor: P.T. International Nickel Indonesia

This company is a subsidiary company of International Nickel Company of Canada (INCO) and was established under Indonesian Law and regulations.

Project Purpose and Area: Nickel development in East and South Sulawesi

Date of Contract Conclusion: July 27, 1968

Contract Area: An area of 6,600 thousand ha of East and South Sulawesi embracing coastal islands and islets but excluding Pomalaa area, and lying between Long. 120°45'E and 123°30'E and between Lat. 30'S and 5°30'S.

Special Terms of the Contract:

(a) P.T. International Indonesia (INI) undertakes to conduct surveys and exploration as well as assessment, development, mining, smelting, storage, transportation and marketing of nickel ores, and to carry out all activities related therewith.

(b) A period of five years or longer is to be spent for surveys, exploration and assessment, and this period may be extended for three years. Minimum cost to be appropriated for these activities is US$1,500 thousand.

(c) The project aims at producing 1,400 to 2,800 tons of low grade nickel ores (1.5% nickel content on the average) per year for smelting. The type and scale of the smelter is to be determined according to the kind and grade of ores. The production facilities planned under the project are anticipated to afford an additional supply of 11,500 to 23,000 tons of nickel annually to the world market.

(d) INI is to abondon the contract area consecutively so that it will be reduced to 75% of the original contract, area in the first year after the contract conclusion, 50% in the second year, and less than 25% in the fifth year.

(e) A minimum cost of US$75 million is estimated for the construction of production facilities.

(f) The term of the contract is 30 years from the date of commissioning the smelter but can be extended by the mutual agreement of the government and INI.

(g) INI is required to effect an advance payment of US$500 thousand to the government within 30 days after the contract conclusion and another US$500 thousand within 30 days after commencement of production. This advancement payment is to be effected as a credit loan gainst the rent, royalty and corporation tax which INI is to pay to the government.

(h) INI is required to pay to the government the corporation tax, rent and royalty according to the rates stipulated by the relevant laws and regulations.

(i) As an incentive measure for INI's additional investment, the government is required to grant an investment tax credit equivalent to 8% of additional investment amount.

2) Nickel Ore Development Project in West Irian by Pacific Nickel

Name of Contractor: P.T. Pacific Nickel Indonesia

This company is a limited liability company established at Djakarta, Indonesia, by the joint capital investment of the following companies which were registered as of the date of contract conclusion.

United State Steel Corporation; Koninklijke Nederlandsche Hoogovens en Staalfabrieken, N.V.; Wm. W. Muller & Co., N.V.; New Mount Mining Corporation; and Sherritt Gordon Mines Ltd.

Project Purpose and Area: Nickel ore development in Waigeo Is. and neighbouring islets and Mt. Saikrups, West Irian.

Date of Contract Conclusion: February 17, 1969.

Contract Area: Waigeo area – 283 thousand ha (part of Waigeo Is. and neighbouring islets including Grag, Balabalak, Kawe, Dju', Menjai Fum, Batang Pele, Batanta, Fam and Greater Fam, Boui, Lawak, Monuran, Schum, Gemien, Mansuar, and Kri).
Mt. Saikrups area – 100 thousand ha.

Special Terms of the Contract:

(a) P.T. Pacific Nickel Indonesia undertakes to conduct surveys, exploration as well as assessment, development, mining, smelting, storage, transportation and marketing of nickel, cobalt, iron and chrome ores and all those complex minerals, and to carry out all activities related therewith.

(b) General surveys, exploration and assessment are to be completed within a period of five years which may be extended for three years if necessary. Minimum cost to be appropriated for these activities is US$1,500 thousand.

(c) This project aims at mining 2,500 thousand tons of low grade nickel ores (averaging 1.5% in nickel content) per year for smelting. The type and scale of the smelter is to be determined by the kind and grade of ores. The production facilities planned under the project are ancitcpated to afford an additional supply of more than 20,000 tons of nickel annually to the world market.

(d) Pacific Nickel Indonesia is to abondon its contract area in a consecutive manner, reducing it to 75% of the original contract area in the first year after the contract conclusion, 50% in the second year, and less than 25% in the fifth year.

(e) A minimum cost of US$75 million is estimated for the construction of production facilities.

(f) The term of the contract is set at 30 years from the date of commissioning the smelter but can be extended by the mutual agreement of the government and Pacific Nickel Indonesia.

(g) Pacific Nickel Indonesia is required to pay to the government the corporation tax, rent and royalty pursuant to the provisions of relevant laws and regulations.

(h) As an incentive measure for additional investment, the government is required to grant an investment tax credit equivalent to 8% of additional investment amount.

3) Nickel Ore Development Project in Halmahera Is. Area by INDECO

Name of Contractor: The Indonesian Nickel Development Co., Ltd. (INDECO)

This company was established under the Japanese laws and regulations. As of the date of the contract conclusion, companies participating in the investment in this company were as follows.

Fuji Iron & Steel Co., Ltd., Mitsubishi Corporation, Ltd., Mitsui & Co., Ltd., Nippon Mining Co., Ltd., Nippon Yakin Kogyo Co., Ltd., Pacific Metals Co., Ltd., Sumitomo Metal Mining Co., Ltd., Sumitomo Shoji Kaisha, Ltd., and Yawata Iron & Steel Co., Ltd.

Project Purpose and Area: Nickel ore development in Halmahera Is. and neighbouring islands and islets.

Date of Contract Conclusion: July 24, 1972.

Contract Area: An area of 3,880 thousand ha embracing Is. of Halmahera, Morotai, Gebe, Obi, Seram, Batjan and neighbouring islets, and lying between Lat. 2°40'N and 3°50'S and between Long. 127°10'E and 129°50'E.

Special Terms of the Contract:

(a) INDECO undertakes to conduct surveys, exploration, assessment, development, mining, smelting, storage, transportation and marketing of nickel ores and to carry out all activities related therewith.

(b) General surveys, exploration and assessment are to be completed within a period of five years, but this period may be extended by three years if necessary. Minimum cost to be appropriated for these activities is US$750 thousand.

(c) This project aims at mining 1,500 to 2,500 thousand tons of low grade nickel ores (averaging 1.5% in nickel content) annualy for smelting. The type and scale of the smelter is to be determined according to the kind and grade of ores. Production facilities planned under the project are anticipated to afford an additional supply of 12,000 to 20,000 tons of nickel annually to the world market.

(d) INDECO is required to have an Indonesian juridical person established prior to the commencement of construction under Indonesian laws and regulations and having its registered office in Indonesia.

(e) INDECO is to abondon its contract area in a consecutive manner, reducing it to 75% of the original contract area in the first year after the contract conclusion, 50% in the second year, and less than 25% in the fifth year.

(f) A minimum cost of US$75 million is estimated for the construction of production facilities.

(g) The term of the contract is set at 30 years from the date of commissioning the smelter but can be extended by the mutual agreement of the government and INDECO.

(h) INDECO is to effect an advance payment of US$150 thousand to the government within 30 days after the date of contract conclusion as a credit loan against the rent, royalty and corporation tax to be paid by INDECO to the government.

(i) INDECO is to pay to the government the corporation tax, public dues and charges, rent and royalty according to the rates stipulated by the relevant laws and regulations.

(j) As an incentive measure for INDECO's additional investment, the government is required to grant an invest tax credit equivalent to 8% of additional investment amount.

IV. BRIEF HISTORY AND PRESENT STATE OF JAPAN'S NICKEL ORE DEVELOPMENT IN INDONESIA

4-1 Brief Hisjtory

What with its development experience in Sulawesi during World War II and what with its proximity to the archipelago, Japan has been repeately requested to cooperate in Indonesia's nickel ore development since the country won independence in 1956. These repeated requests prompted the establishment of cooperation system on the Japanese side. In March 1957, five Japanese smelting companies (Sumitomo Metal Mining, Nippon Mining, Nippon Yakin Kogyo, Shimura Kako, and Pacific Metals) made it clear that they would act jointly for nickel ore development in Indonesia and organized the Sulawesi Conference. The conference, established in conformity to the government's advice, was the only organization in Japan through which negotiations were carried out for developing nickel ores in Sulawesi.

Due to the security problem in Sulawesi and lack of definite nickel ore development policy on the Indonesian side, the negotiations were protracted considerably. With nationalization effected into the field of mining industry in 1960, however, Indonesian government requested, in October of the same year, Japan's cooperation in Sulawesi's nickel ore development through the Japanese Embassy in Djakarta.

Indonesian government established new statutory provisions governing mining industry in October 1960 to nationalize the development of strategic ores and incorporated the nickel ore development in Sulawesi in its First Eight Year Development Plan. This was one of the reasons why the said request was made on the government-to-government level.

Acceding to this request, the conference set up the establishment committee of SUNIDECO in May 1961 and dispatched a mission to Indonesia for negotiations with Indonesian government.

As a result of the negotiations, fundamental arrangements were made and a general agreement was concluded in July 1961, whereby the way was paved for promoting nickel ore development in Pomalaa area. As a consequence, SUNIDECO was established in October 1961 with an authorized capital of 300 million yen and a paid up capital of 75 million yen.

After its establishment, SUNIDECO continued negotiations with B.P.U. Perusahaan[2] Tambang Umum Negara and P.T. Nickel Indonesia on the basis of the general agreement in order to arrange for details of development cooperation. The formal contract was signed in November 1962 and came into effect in March 1963 with the approval of the two governments, and development activities were initiated in July 1963.

Development of nickel ores has been in smooth progress since the arrival of the first carrier in 1965. In the mean time, B.P.U. and P.T. Nickel Indonesia were reorganized into ANTAM under Government Ordinance No. 2 of July 5, 1968, whereby all the rights and obligations of the two organizations were transferred to ANTAM.

4-2 Present State

4-2-1 Development by SUNIDECO

SUNIDECO's primary activity is to extend cooperation in the development of nickel ores in Pomalaa area, Sulawesi island. In the nickel mining field of about 8,700 ha in Pomalaa area, ANTAM has been engaged in mining activity since July 1963. SUNIDECO offered a long-term credit of $1,350 thousand (principal) to ANTAM and also furnished necessary machines and equipment as well as the services of engineers. Through this cooperation activity, the first phase development plan (production of 10 thousand wet tons of nickel ores per month) drawn up for Pomalaa area was materialized in July 1965. SUNIDECO's development cooperation is based on the P/S system adopted by Indonesian government, so that Indonesia delivers the whole ore production to Japan, with 40% supplied in payment of the principal and interest of the credit and in remuneration for the cooperation services and 60% shipped on the ordinary L/C basis.

The credit established in favour of ANTAM was extended for the period ending at the end of March 1966 on condition that it would be refunded over a period of seven years starting from April 1966 and ending in March 1973. Over the past years, refundment has been made smoothly as scheduled.

With the ore production increasing remarkably under the development cooperation, it was confirmed in July 1968 that Pomalaa mines were capable of producing surplus export ores besides exporting 120 thousand tons annually under the P/S system. Motivated partly by the strong desire expressed by Indonesian government, SUNIDECO reached the conclusion that it would purchase the said surplus ores while maintaining an annual import of 120 thousand tons for seven years to recover the loan. As a consequence, SUNIDECO has been importing nickel ores both under the P/S system and on the commercial basis since July 1968.

Import of nickel ores from Pomalaa area recorded up to March 1970 is as tabulated below.

Table 4-1 – Import of Nickel Ores from Pomalaa Area

Shipment Period	Import Volume (W.M.T.)
Jan. 1965 to Mar. 1966	101,850 under P/S system
Apr. 1966 to Mar 1967	125,398 "
Apr. 1967 to Mar 1968	144,673 "
Apr. 1968 to Mar. 1969	127,943 "
"	119,833 on the commercial basis
Apr. 1969 to Mar 1970	124,980 under P/S system
"	163,743 on the commercial basis

Import of high grade nickel ores under the P/S system will come to an end in March 1973 when the P/S contract will be terminated, but the present reserves promise continued annual import of 600 thousand tons of high grade nickel ores up to 1974 or 1975.

With the view to accelerating effective utilization of low grade ores. SUNIDECO embarked in the exploration activity in Pomalaa area as a joint undertaking of Japan and Indonesia in November 1963 and completed it in March 1970. This was the first step towards the smelter construction in Pomalaa and is to be ensued by detailed prospecting and feasibility study for which arrangments are being made at present with Indonesian authorities.

4-2-2 Development by INDECO

The Indonesia Nickel Development Co., Ltd. (hereafter called "INDECO") concluded an agreement with the Indonesian government in July 1969 for nickel ore development in Halmahera area. As a result of exploration activity carried out for about a year and a half from January 1970 to September 1971, the company detected a total ore reserve of 130 million tons, i.e., 80 million tons in Obi island and 50 million tons in Gebe island.

V. BACKGROUND TO THE DISPATCH OF SURVEY MISSION

5-1 Smelter Construction Plan

5-1-1 Joint Exploration Activity of SUNIDECO and ANTAM

Even after termination of the P/S contract in March 1973, export of high grade ores to Japan can be continued to 1974 or 1975 at a rate of 600 thousand tons a year. A long-term contract has already been signed between SUNIDECO and ANTAM for the continued shipment of exportable ores to Japan.

During the period from November 1968 to June 1969, SUNIDECO carried out exploration activity in the entire Pomalaa area for the purpose of effective utilization of low grade ores. Outline of the exploration activity is as shown below.

Number of Pits	4,966
Total Extension of Pits	20,831 m
Average Pit Depth	4.15 m
Number of Specimens	20,211
Number of Specimens Assayed	20,211
Area Covered	5,458 ha

As a result of the exploration, the following ore reserves were confirmed.

120 million DMT	:	1.28% of Ni + Co and 31% of Fe
45 million DMT	:	1.5% of Ni + Co and 28% of Fe

Based on the above findings, SUNIDECO mapped out a smelter construction plan for annual ferro-nickel production of 12 thousand tons (in Ni content) (estimated construction cost: approx. 30 billion yen). ANTAM, on the other hand, set out on the formulation of its own smelter construction plan.

5-1-2 ANTAM's Smelter Construction Plan

Though exploration activity was carried out jointly by SUNIDECO and ANTAM, ANTAM worked out its own smelter construction plan for reasons given below.

1. ANTAM gained substantial experience through 10 years of joint nickel ore development activity carried out with SUNIDECO under the P/S system. During this period, ANTAM improved its technical level through active deputation of its engineers and staffs abroad and gained confidence in its ability to run a smelter on its own. Further, construction of a smelter by its own efforts and exertions was trongly desired and supported by the rising national sentiment of the country.

2. Reserves of exportable ores are expected to run out in 1974 or 1975. Therefore, development and production of low grade ores is a must for keeping the existing workers in employment because the suspension of mining activity in Pomalaa area will deprive about 850 workers (about 4,000 people including their families) of the means of living, and this could develop into a serious social and political problem.

3. SUNIDECO's construction plan demands a huge investment of about 30 billion yen and its execution calls for careful pre-investment surveys which must be preceded by considerable previous arrangements and preparations.

For these reasons, ANTAM determined to work out its own smelter construction plan. In August 1970, it requested Pacific Metals Co. to carry out the necessary feasibility study and conducted, as part of the study, an industrial test using 9,600 tons of ores. ANTAM states that the success of the test was the major reason for its recent decision on the smelting plan based on PAMCO-ELKEM system.

After perusal of the feasibility report, ANTAM requested Pacific Metals to provide the necessary technical cooperation. Pacific Metals, however, approached SUNIDECO for its prior approval for accepting the request by reason of the joint development plan agreed upon between five Japanese companies including Pacific Metals.

As a result of the discussion held between the four participating companies (Pacific Metals, Nippon Mining, Sumitomo Metal Mining and Nippon Yakin Kogyo), SUNIDECO agreed that Pacific Metals accept the request.

Consequently, ANTAM requested Pacific Metals to give a guarantee for forward transaction in order to cover part of funds with a loan from Bank of Indonesia.

Pacific Metals then requested SUNIDECO to give the said guarantee, and after a discussion between the aforementioned four companies, it was determined that the guarantee contract would be signed between SUNIDECO and ANTAM.

The contract provides, among others, for the following matters.

1) The contract is to run for about 10 years from about 1974 for an annual import of 4,000 tons of ferro-nickel (in nickel content).

2) The price is to be quoted F.O.B. and is to be lower than that quoted by INCO.

5-2 Introduction of Foreign Investment

ANTAM intended to implement its construction plan with the necessary fund covered mostly by its own capital and partially by loans. With both the master and associate agreements concluded with Pacific Metals, the company proceeded with the procurement of main machines and equipment. In September 1971, however, the government requested the company to introduce foreign loans for the project.

In explanation of this change in the government's investment policy, Mr. Sugeng, director in charge of mining and manufacturing industry of BAPPENAS, stated that the change was effected by the government's new decision to introduce foreign investment to the maximum extent for projects demanding a large foreign currency expenditure and thereby save the country's foreign exchange reserve and maintain the balance of international balance of payments.

5-3 Request for Dispatch of Survey Mission

Indonesian government considered that the smelter construction should be given high priority for increased foreign exchange earnings, promotion of regional development, and continued employment of workers, and requested Japan to send the survey mission.

VI. DEMAND-SUPPLY SITUATION OF NICKEL

6-1 Uses of Nickel

Nickel can be classified into metallic nickel having a high nickel content and ferro-nickel with a nickel content of 18 to 28% by the purpose of application. In addition to these two, nickel oxide is being used, though in small quantities, for newly developing application purposes.

Metallic nickel is used for a wide range of purposes such as catalyzer, plating, coins, production of electromagnetic equipment, production of equipment for chemical industry, etc. For these purposes, either pure nickel or nickel alloy is used.

Ferro-nickel is used for production of such alloy steel as corrosion resisting steel, heat resisting steel, magnet steel, etc. Stainless steel is one of the typical alloy steel and has a wide range of applications from kitchen utensils to equipment for chemical industry.

Ratios of nickel consumption in the free world stood at the following values in 1968.

37% for stainless steel, 15.0% for nickel plating, 14.0% for high nickel alloys, 11.0% for alloy steel for structures, 10.0% for steel castings, 3.0% for copper alloy, and 10.0% for others. Growth of stainless steel consumption is conspicuous in recent years.

Table 6-1 shows the classification of nickel and nickel alloys by application.

Table 6-1 Classification of Nickel and Nickel Alloys by Application Purpose

(a) Pure Nickel

Category		Application
Electro-magnetic Materials	Parts of electron tubes	Anode sleeve, getter material, grid material, anode plate, etc.
	Resistance wire	Resistance thermometer, etc.
	Magnetostriction oscillator	Ultrasonic oscillator, magnetostriction microphone, etc.
Materials for Chemical Industry		Material of bars, tubes, plates, wires, castings; and material of apparatuses resistant against dilute hydrochloric acid, organic acids, ammonia water, nitric acid, and alkalis.
Anode for Plating		Nickel plate, deporalized nickel, carbonized nickel, etc.
Welding		Cast iron assembling, flux application, etc.
Coins		Material of 50 and 100 yen coins.
Nickel Powder		Used in metallurgical production process of cemented carbide (TiC-WC-Ni alloy), permanent magnet (Al-Ni-Co alloy), sinter alloy from powder metallurgy (permalloy), bearing alloy, etc.
Nickel Oxide		Thermet (Al_2O_3-Ni group, boride of Cr and Zr-Ni group and TiC-Ni group), catalyzer for chemical synthetic proceses (for hydrogenation), alkaline battery, electrode material, glass industry (various nickel compounds for glaze, decolorizer).

(b) Ferro-nickel Alloy

Classification	Name	Major Chemical Components (%) Ni	Others	Remarks
Steel for structures	Ni steel	1.00-3.50	Cr 0.35-0.65	
"	Ni-Cr steel	1.00-3.50	Cr 0.35-10.0	High tensile steel and case hardening steel, JIS G4102.
"	Ni-Cr-Mo steel	0.40-4.50	Cr 0.40-35.0, Mo 0.15 -0.70	High tensile steel, JIS G4103.
"	Special cementation steel	2.00-4.50	Cr 0.20-10.0, Mo 0-0.30	Gear, cam, shafts and rings, JIS G4207.
Tool alloy steel		0.70-2.00	Cr<0.5	Saw, die block, press mold, JIS G4404.
Stainless steel	SUS 27-29	8.0-13.0	Cr 17.0-20.0	Distilling pipes used in high-pressure and high temperature chemical process, and other seamless pipes, JIS G4301;
"	SUS 32-33	10.0-16,0	Cr 16.00-18.00, Mo 2.00-3.00	
"	SUS 35-36	10.0-16.0	Cr 17.0-19.0, Mo 1.2 -2.75, Cu 1.0-2.5	
"	SUS 40-43	8.0-22.0	Cr 17-26	Ordinary equipment for chemical industry and acid resisting equipment.
"	SUS 62-65	10.0-15.0	Cr 17-20, Mo 3.00 -4.00	
Heat resisting steel	SUH 31-34	12.0-37.0	Cr 14.0-26.0, W 2.0 -3.0	JIS G4301
	Hastelloy	58	Cr 11-14, Mo 17-19	Heat and chloric acid resisting metals for heating furnace equipment, cementation chamber, annealing box, smoke tube damper, heat dissipator.
	Inconel			
	Incolloy			
"	BTG metal	65	Mn 1.5	Towers for synthetic ammonia process.
Stainless cast steel		5.0- 7.0	Cr 23.0-27.0, Mo 1.5 -2.5	JIS G5121
		8.0-12.0	Cr 17.0-21.0	
		10.0-14.0	Cr 17.0-20.0, Mo 1.75 -3.0, Cu 1.0-2.5	
		12.0-16.0	Cr 17.0-20.0, Mo 2.0 -3.0	
		19.0-22.0	Cr 23.0-27.0	
Heat resisting cast steel		4.0- 6.0	Cr 24.0-28.0	JIS G5122
		8.0-12.0	Cr 18.0-23.0	
		11.0-14.0	Cr 24.0-28.0	
		33.0-37.0	Cr 13.0-17.0	
Alloy cast iron		12.0-15.0	Mo 1.0-15.0,Cu 5.0 -7.0	Anti-corrosive cast iron (Austenite cast iron)
		18.0-22.0	Cr < 35.0	
		18.0	Si 5-6, Cr 2-5	Non-magnetic cast iron (Austenite cast iron)
		9-10	Si 2-25, Mn 5-6	
		5-15	Mn 4-10, Al 0.1-6.0	
Alloy chilled roll cast iron		2.0- 6.0	C 30-38, Cr 0.6-1.5	For high grade finishing of tin plates and Si steel plates.
Special alloy	Invar	36	Residual Fe contained.	Bimetal with little expansion coefficient
	Elinver	33-36	Cr 4-5 W 1-2	Standard measure, and diapason.
	Coval			

6-2 Demand-Supply Situation of Nickel in Japan and World

Demand for nickel in Japan has pursued a sharp upward trend over the past years by reason of a number of factors such as the rapid economic growth, improvement of industrial structure, and elevation of production level. Country-wise production and consumption of nickel are shown in Tables 6-2 ~ 6-4. Nickel consumption in Japan increased by 5.6 times during the ten year period from 1960 (17,600 tons) to 1970 (98,700 tons). Japan's share in the global nickel consumption also rose from 6% in 1960 to 17.2% in 1970. As a result, Japan became the world's second largest nickel consuming country in 1970, with the U.S.A. ranking top with 25.3%. (Communist block including USSR occupies 22.7% of the world's nickel consumption)

The demand-supply situation of nickel in Japan therefore gives a considerable influence on the world's nickel market at present.

The recent demand-supply situation of metallic nickel and ferro-nickel in Japan is shown in Figs. 6-1 and 6-2, and production and export of special steel in Tables 6-5 and 6-6.

From the latter half of 1971, however, this sharp growth of demand declined and the stock of ferro-nickel makers increased. At present, ferro-nickel production in Japan is cut down to nearly half the total production capacity. Special steel makers in Japan also suffered the decline of domestic demand and export, and are presently effecting 50% production curtailment by a depression cartel. Japanese nickel industry is therefore sustaining a severe business depression at present.

It is an unescapable fact that the production capacity of ferro-nickel far surpasses the demand at present. Viewed from the long-range prospect, however, the current depression is just a transitory condition and consideration must be given to the increase of global demand arising from the expansion of world population, advancement of developing countries, and other factors.

As is clear in Fig. 6-3 showing the consumption trend of nickel against crude steel in U.S.A. and Japan, Japan's nickel consumption is not so large as in the United States.

As shown in Table 10-3, however, installation of production facilities has been notably accelerated in Japan backed up by the increase of domestic demand and export of stainless steel. This demand increase is assignable to the shortage of global nickel supply which was caused by INCO's strike in 1966, decline of ore supply due to the storm and flood damage sustained in New Caledonia in 1967, and strike of INCO and Falconbridge in 1969. These factors acted combinedly to invite a sharp and temporary export increase of stainless steel and other nickel-containing alloy steels from Japan. As a result, the price of nickel, particularly that of pure nickel, rose sharply, reaching a ceiling price of 370 million yen per ton in December 1969. Fluctuation of nickel price from January 1969 is shown in Table 6-7.

Table 6-2 Mine Production of Nickel

Nickel content Thousand metric tons	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Finland	2,1	2,0	2,4	2,9	3,2	3,0	2,9	3,4	3,2	3,6	5,0
Greece	-	-	-	-	-	-	0,1	2,5	4,7	5,6	8,6
Europe1)............	2,1	2,0	2,4	2,9	3,2	3,0	3,0	5,9	7,9	9,2	13,6
Indonesia	0,5	0,3	0,3	1,0	1,1	2,3	2,6	3,8	5,5	4,9	10,8
Burma	0,1	0,1	0,2	0,1	0,1	0,1	-	0,1	0,2	0,1	*0,1
Asia1)..............	0,6	0,4	0,5	1,1	1,2	2,4	2,6	3,9	5,7	5,0	10,9
Rep.of South Africa.	*2,9	2,8	2,5	3,0	4,0	5,2	5,4	5,7	*7,5	*9,0	11,6
Other Africa	0,3	0,3	0,4	0,4	0,6	1,1	1,1	*1,2	*1,5	4,0	11,0
Africa	3,2	3,1	2,9	3,4	4,6	6,3	6,5	6,9	9,0	13,0	22,6
United States2).....	11,4	10,1	10,2	10,4	11,1	12,3	12,0	13,3	13,7	14,2	14,1
Canada	194,6	211,4	210,7	196,9	207,3	235,1	202,9	225,6	239,8	193,8	279,5
Cuba	14,5	18,1	24,9	21,6	24,1	29,1	27,9	34,9	37,3	*37,0	*40,0
Other America	0,1	0,1	0,2	1,0	1,1	1,1	1,1	1,1	1,1	1,5	*2,8
America	220,6	239,7	246,0	229,9	243,6	277,6	243,9	274,9	291,9	246,5	336,4
Australia	-	-	-	-	-	-	-	2,1	4,7	11,2	27,3
New Caledonia	53.5	53,3	33,8	44,5	58,2	61,2	67,8	82,2	116,1	117,0	138,5
Australia and Oceania.	53,5	53,3	33,8	44,5	58,2	61,2	67,8	84,3	120,8	128,2	165,8
Western countries...	280,0	298,5	285,6	281,8	310,8	350,5	323,8	375,9	435,3	401,9	549,3
USSR*	58,0	75,0	80,0	80,0	80,0	80,0	85,0	95,0	103,0	105,0	110,0
Poland	1,3	1,3	1,3	1,1	1,2	1,1	*1,5	*2,0	*2,0	*2,0	*2,0
Other Eastern .... countries*	2,5	3,5	4,0	3,0	3,5	3,5	4,0	4,0	5,0	5,0	5,0
Eastern countries...	61,8	79,8	85,3	84,1	84,7	84,6	90,5	101,0	110,0	112,0	117,0
Total World	341,8	378,3	370,9	365,9	395,5	435,1	414,3	476,9	545,3	513,9	666,3

1) Excluding Eastern countries.
2) Recovered nickel content. Nickel content of ores mined was as follows:

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1000 metric tons	12,8	11,9	11,9	12,2	14,0	14,7	13,6	13,9	15,7	15,5	16,3

Table 6-3 Smelter Production of Nickel[1)]

Thousand metric tons	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Germany, FR	2,5	3,0	3,2	1,9	0,8	0,3	0,3	0,3	0,6	0,8	0,6
France	10,0	10,9	10,4	9,6	8,1	8,2	12,8	12,7	10,3	9,6	11,0
Italy	0,5	0,5	0,3	-	-	-	-	-	-	-	-
E.E.C.	13,0	14,4	13,9	11,5	8,9	8,5	13,1	13,0	10,9	10,4	11,6
Finland	0,5	1,8	2,3	2,7	2,9	2,8	3,0	3,0	3,3	3,7	4,0
Greece	-	-	-	-	-	-	0,1	2,5	4,7	5,6	8,6
United Kingdom	34,3	38,0	38,3	38,1	38,0	40,5	37,5	38,6	41,7	29,7	36,7
Norway	30,4	32,2	29,2	26,4	30,1	31,8	32,2	28,2	32,2	35,6	38,5
Europe[2)]...........	78,2	86,4	83,7	78,7	79,9	83,6	85,9	85,3	92,8	85,0	99,4
Asia (Japan)........	18,7	23,0	15,1	19,1	27,5	26,1	29,8	42,8	54,7	65,0	89,9
Rep.of South Africa.	*1,2	*1,2	*2,5	*2,5	*2,5	*3,0	*5,4	5,7	7,5	*8,0	*9,0
Other Africa	-	-	-	-	-	-	-	-	-	*2,0	*5,0
Africa	1,2	1,2	2,5	2,5	2,5	3,0	5,4	5,7	7,5	10,0	14,0
United States	12,2	10,5	10,6	10,8	11,5	12,6	12,4	13,4	13,8	14,5	14,3
Canada	127,5	127,1	140,5	121,2	139,5	160,4	129,7	162,0	154,5	132,2	204,0
Cuba[3)]	14,5	18,1	24,9	21,6	24,1	25,8	25,4	30,9	35,0	35,0	*38,0
Other America			0,2	1,0	1,1	1,1	1,1	1,1	1,1	1,5	2,7
America	154,2	155,7	176,2	154,6	176,2	199,9	168,6	207,4	204,4	183,2	259,0
Oceania (New Caledonia)...	11,4	13,4	5,5	8,3	13,3	15,6	20,3	20,7	22,4	23,9	28,0
Western countries ..	263,7	279,7	283,0	263,2	299,4	328,2	310,0	361,9	381,8	367,1	490,3
USSR*..............	58,0	75,0	80,0	80,0	80,0	80,0	85,0	95,0	103,0	105,0	110,0
Poland	1,3	1,3	1,3	1,1	1,2	1,1	*1,5	2,0	2,0	2,0	2,0
Other Eastern countries*.	2,5	3,5	4,0	3,0	3,5	3,5	4,0	4,0	5,0	5,0	*5,0
Eastern countries ...	61,8	79,8	85,3	84,1	84,7	84,6	90,5	101,0	110,0	112,0	117,0
Total World	325,5	359,5	368,3	347,3	384,1	412,8	400,5	462,9	491,8	479,1	607,3

1) Primary nickel and nickel contained in ferronickel, nickel oxide sinter and monel metal smelted directly from ores.
2) Excluding Eastern countries.
3) Nickel content in oxide sinter and matte shipped to Eastern countries.

Table 6-4 Consumption of Nickel[1]

Thousand metric tons	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Germany, FR	23,0	22,0	19,2	20,3	25,6	30,7	33,6	31,0	35,4	36,8	40,9
Belgium	2,1	1,3	1,4	1,1	1,4	1,2	1,4	1,3	1,5	1,7	2,0
France	19,4	15,4	13,2	15,8	20,5	21,0	24,5	28,7	30,7	31,8	36,1
Italy	6,8	7,7	7,0	8,0	8,5	9,3	12,8	14,4	17,4	16,2	19,8
Netherlands	0,6	0,5	0,4	0,5	0,6	0,7	0,8	0,5	0,9	0,6	1,3
E.E.C.	51,9	46,9	41,2	45,7	56,6	62,9	73,1	75,9	85,9	87,1	100,1
Denmark	0,1	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Finland	0,9	0,6	0,5	0,5	0,3	0,4	0,5	0,5	0,5	0,3	0,3
United Kingdom	27,8	26,5	25,1	27,6	38,1	36,9	34,4	30,5	33,1	24,9	34,7
Yugoslavia	0,3	0,3	0,3	0,4	0,4	0,5	0,5	0,5	0,8	0,9	1,0
Norway	0,4	0,5	0,6	0,6	0,6	0,6	0,5	0,7	0,7	0,7	1,0
Austria	2,8	2,7	2,1	3,1	3,2	3,3	4,1	5,0	4,3	5,0	5,6
Sweden	8,7	8,9	8,1	8,4	11,6	13,1	13,5	15,5	16,5	16,1	23,1
Switzerland	1,4	1,7	1,5	1,0	1,3	1,4	1,4	1,1	1,6	2,1	2,3
Spain	0,4	0,6	0,6	0,6	1,0	1,3	1,2	1,6	2,0	2,9	3,1
Other Europe[2]......	0,1	0,1	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,2	0,2
Europe[2]...........	94,8	89,0	80,2	88,1	113,3	120,7	129,5	131,6	145,7	140,3	171,5
Japan	17,6	20,6	15,6	22,6	30,4	26,9	36,1	50,5	59,2	68,0	98,7
Other Asia[2]........	0,7	1,4	1,4	1,9	1,4	0,8	1,0	1,1	1,5	2,2	3,0
Asia[2].............	18,3	22,0	17,0	24,5	31,8	27,7	37,1	51,6	60,7	70,2	101,7
Africa	*0,3	*0,5	*0,5	*0,5	*1,0	*2,0	*3,0	*4,0	*4,0	*5,0	*5,5
United States[3].....	98,1	107,5	107,7	112,9	133,3	156,1	170,4	157,7	144,5	128,6	145,0
Canada	4,4	4,5	4,8	5,3	6,3	8,1	7,8	7,9	10,2	11,0	12,3
Other America	0,7	1,2	1,2	1,5	1,6	1,8	2,0	1,8	2,1	2,0	3,2
America	103,2	113,2	113,7	119,7	141,2	166,0	180,2	167,4	156,8	141,6	160,5
Australia and Oceania	2,2	1,2	1,6	2,0	2,6	2,5	2,9	3,5	3,0	2,8	*3,0
Western countries...	218,8	225,9	213,0	234,8	289,9	318,9	352,7	358,1	370,2	359,9	442,2
USSR*............... / Other Eastern countries*.	74,0	95,0	105,0	108,0	108,0	110,0	115,0	120,0	125,0	125,0	130,0
Eastern countries...	74,0	95,0	105,0	108,0	108,0	110,0	115,0	120,0	125,0	125,0	130,0
Total World	292,8	320,9	318,0	342,8	397,9	428,9	467,7	478,1	495,2	484,9	572,2

1) Including nickel content in ferro-nickel, and nickel oxide sinter.
2) Excluding Eastern countries.
3) Saurce US-Bureau of Mines. Consumption figures published by International Nickel Co. were as follows:

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1000 metr.ts.	102,1	106,6	115,7	136,1	167,8	186,9	159,7	154,2	140,6	149,7

Table 6-5 Special Steel Production in Japan

(Unit: t)

Calendar Year	Cr Steel	Ni-Cr Steel	Heat Resisting Steel
1965	127,000	269,000	8,000
1966	172,000	281,000	10,000
1967	212,000	437,000	13,000
1968	236,000	483,000	13,000
1969	294,000	634,000	16,000
1970	381,000	849,000	20,000
1971	1,053,000		-

Table 6-6 Export of Special Steel from Japan

Year	Export amount (t)
1965	119,000
1966	120,000
1967	139,000
1968	143,000
1969	176,000
1970	256,000
1971	267,000

Fig. 6-1 Trend of Demand-Supply Situation of Metallic Nickel in Japan

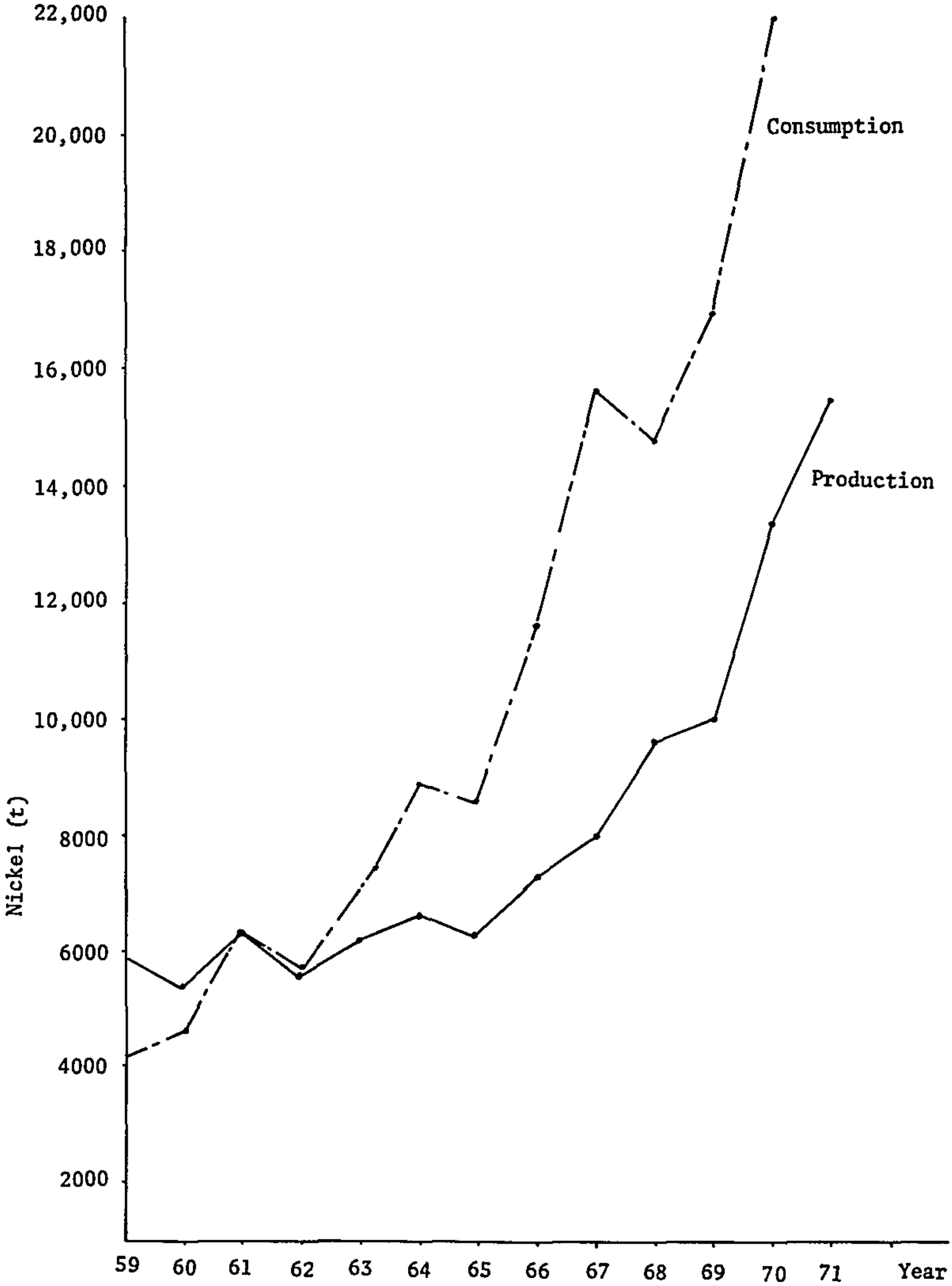


Fig. 6-2 Trend of Production and Shipment of Ferro-nickel in Japan

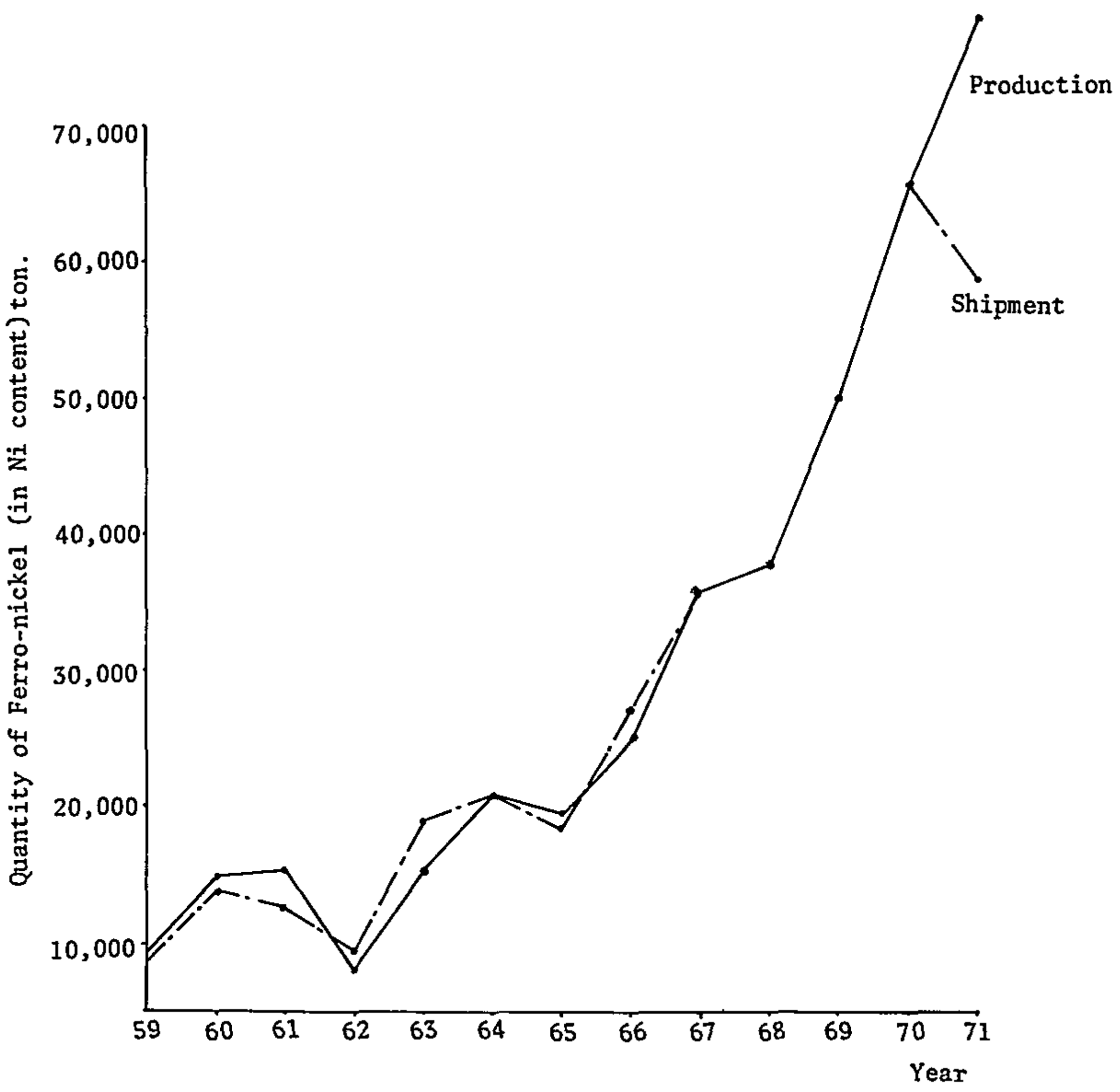


Fig. 6-3 Consumption trend of Nickel against Crude Steel

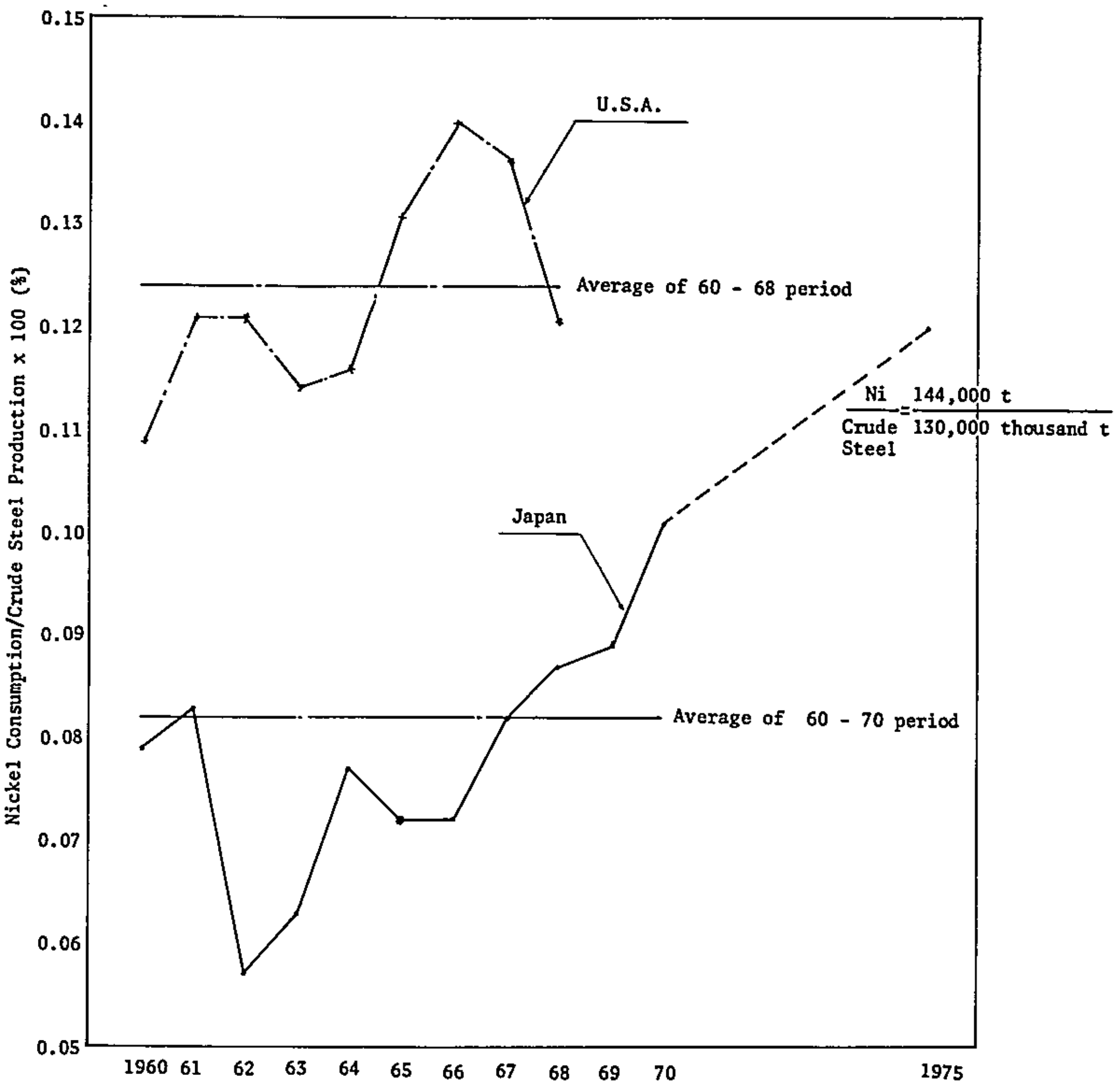


Table 6-7 Fluctuation of Nickel Price

		Ingot Nickel (Thousand yen/ton)	FeNi (25%) (Thousand yen/ton)	INCO's Quotation (Cents/lb)
1969	Jan.	1,450	880	103
	Feb.	1,580	"	"
	Mar.	1,700	"	"
	Apr.	1,750	980	"
	May	1,800	"	"
	Jun.	"	"	"
	Jul.	1,900	"	"
	Aug.	2,250	1,050	"
	Sept.	3,100	"	"
	Oct.	3,600	"	"
	Nov.	"	"	128 (Nov.24)
	Dec.	3,700	"	"
1970	Jan.	"	"	"
	Feb.	2,600	1,000	"
	Mar.	2,100	"	"
	Apr.	"	1,100	"
	May	"	"	"
	Jun.	1,900	"	"
	Jul.	"	"	"
	Aug.	"	"	"
	Sept.	"	"	"
	Oct.	1,700	1,200	133 (Oct.14)
	Nov.	1,600	"	"
	Dec.	"	"	"
1971	Jan.	1,425	"	"
	Feb.	1,345	"	"
	Mar.	1,340	"	"
	Apr.	1,350	"	"
	May	1,340	"	"
	Jun.	1,330	"	"
	Jul.	"	"	"
	Aug.	"	"	"
	Sept.	"	"	"
	Oct.	1,270	"	"
	Nov.	"	"	"
	Dec.	"	"	"
1972	Jan.	"	"	"
	Feb.	1,170	"	"
	Mar.	"	"	"

*133 cents/lb = $2,732.14/t

Development of such condition is ascribable to the fact that the world's nickel production is in the hand of a few large companies such as INCO, Falconbridge, Sherritt Gordon and Le Nickel. As is clear from their business condition shown in Table 6-8, these four companies produced 299,000 tons in 1968, covering about 78% of the world's total nickel production.

6-3 Sources of Nickel Supply to Japan

Due to the complete lack of domestic nickel resources, Japan resorts to import of ores, semi-finished and finished products to satisfy its nickel demand. As will be clear from Tables 6-9 and 6-10 showing Japan's import record, the greater part of nickel ores and nickel products has been supplied from New Caledonia, and the demand has been met chiefly by domestic smelting of ores with a small fraction of finished products imported to cover the supply deficiency. Fig. 6-4 shows the pattern of material supply. New Caledonian ores account for more than 80% of ores imported for production of ingot nickel and ferro-nickel. Nickel ore deposits are found in certain limited areas of the world. In the global ore production recorded in 1970, Canada occupied 41.9%, New Caledonia 20.7%, USSR 16.5%, and Cuba 6%. Thus, the majority of ore production in the free world centers in Canada and New Caledonia.

Because of this mal-distribution of ore deposits, the global ore supply is made unstabilized and the supply-demand situation on the world market is seriously influenced by the strike of one major company or storm and flood damages in a single producing area.

New Caledonian ores are purchased by single option from minor mines, with the price agreed to be automatically slided according to INCO's quotation under a long-term purchase contract.

In an effort to import ores from as many different sources as possible and thereby secure stable and expanded ore supply, Japanese companies are exerting themselves for concluding a long-term purchase contract with mining companies in Indonesia, Canada, Australia and the Philippines. At present, however, import conditions are not only controlled by sellers but also becoming stricter than ever due to the global deficiency of high grade ores and aggravating mining conditions.

As shown in Table 6-11, the import price of New Caledonian ores with a standard Ni content of 3.2% was 48 cents per kg of Ni + Co in 1962, but the price rose to 100 cents in 1969 per kg of Ni + Co at a Ni content. Further, the rejection point was lowered to 2.2% and it is likely that this percentage will become even lower soon or later.

As will be described later, SUNIDECO is engaged in the development of nickel ores in Pomalaa area, Indonesia, under the P/S system in order to secure the ore supply, and currently importing about 600 to 800 thousand tons of ores annually. Prices of ores imported from New Caledonia and Pomalaa area are shown in Table 6-11. SUNIDECO's development cooperation is instrumental in decentralizing supply sources since ores from Pomalaa area are cheaper than New Caledonian ores.

Decline of ore grade and price hike lead inevitably to lower payability of smelting operation in consuming area and are conductive to the progress of smelting in producing area. In the world's nickel ore producing countries, there is the trend for enhancing smelting operation in addition to mining activity for the purpose of promoting regional development and giving a higher added value before export. Under the so-called Yate law enacted in 1968, the French government is prompting social and economic development of New Caledonia and applying the policy for exporting nickel with as high an added value as possible.

Table 6-8 Business Status of World's Major Nickel Makers

Item \ Maker	International Nickel Co. (INCO)	Falconbridge	Sherrit Gordon	Societe Le Nickèl
Country	Canada	Canada	Canada	France
Total Sales	$767,330 th.	$105,206 th.	$56,754 th.	Frs.463,100 th.
Net Profit	$143,745 th.	$ 23,953 th.	$ 6,148 th.	Frs. 15,520 th.
Capital	$ 91,436 th.	$ 79,620 th.	$11,363 th.	Frs.181,610 th.
Dividend Ratio	$2.46/share	$3.50/share	$5.4/share	6%
Number of Employees	33,314	3,999	1,776	3,949
Production of Nickel Products (in Ni content)	480,840th.lb. (208 th. t)	70,712th.lb. (37 th. t)	25,133th.lb. (11 th. t.)	43,000t
Remarks				Production includes ore export.

Source: 1968 Business Report of respective companies.

Table 6-9 Nickel Ore Import on Customs Basis (In tons of wet ore)

	1963	1964	1965	1966	1967	1968	1969	1970
New Caledonia	610,478	1,085,529	862,829	1,114,333	1,500,677	2,418,138	3,077,097	4,009,271
Indonesia	30,913	39,500	79,450	133,653	128,455	234,969	268,099	524,543
Canada	19,679	17,817	20,481	18,069	23,740	23,500	17,582	20,181
France	10,591	-	-	-	-	-	-	-
Australia	-	-	-	-	5,903	22,564	32,642	107,006
South Korea	556	-	-	-	-	-	-	-
South Africa	313	-	-	-	-	-	-	-
Rhodesia. Niasaland	-	382	3,982	3,888	1,812	-	-	-
Philippines	36	-	-	-	-	24	-	-
Others	-	-	-	-	-	13,022	-	-
Total	679,496	1,143,228	966,742	1,169,943	1,660,587	2,712,207	3,395,420	4,670,316
(Nickel Matte)								
New Caledonia			4,344	4,794	3,250	5,843	7,095	7,460
Canada				233	6,369	6,710	5,240	10,832
West Germany				21	-	-	-	-
Others				-	-	-	4,414 (South Africa)	9 (USA)
Total			4,344	5,048	9,619	12,553	16,749	18,301

Table 6-10 Import of Nickel Products on Customs Basis (In tons)

	1963	1964	1965	1966	1967	1968	1969	1970
Pure Nickel:								
Canada	-	1,694	1,686	1,785	2,529	1,087	1,105	2,389
Norway	53	635	824	868	820	513	744	842
U.S.A.	94	33	2	190	191	0	150	312
U.K.	17	74	82	109	75	97	117	54
France	1	30	61	5	7	-	-	-
U.S.S.R.	-	-	-	12	5,096	1,522	4,063	4,612
Sweden	-	-	-	-	544	0	-	-
Others	-	-	-	84	781	179	353	1,927
Total	165	2,466	2,655	3,053	10,042	3,398	6,532	10,135
Ferro-nickel:								
New Caledonia	-	6,579	6,707	440	-	-	-	-
U.S.A.	-	20	-	217	1,146	297	-	164
France	-	-	-	24	145	-	-	-
U.K.	-	-	-	-	168	149	-	198
Brazil					1,065	596	313	4,216
Australia						105	-	-
Netherlands					123		-	-
Greece					180		-	-
								(147 from South America)
Total		6,599	6,707	681	2,827	1,147	313	4,725

Fig. 6-4 Pattern of Nickel Material Supply in 1970

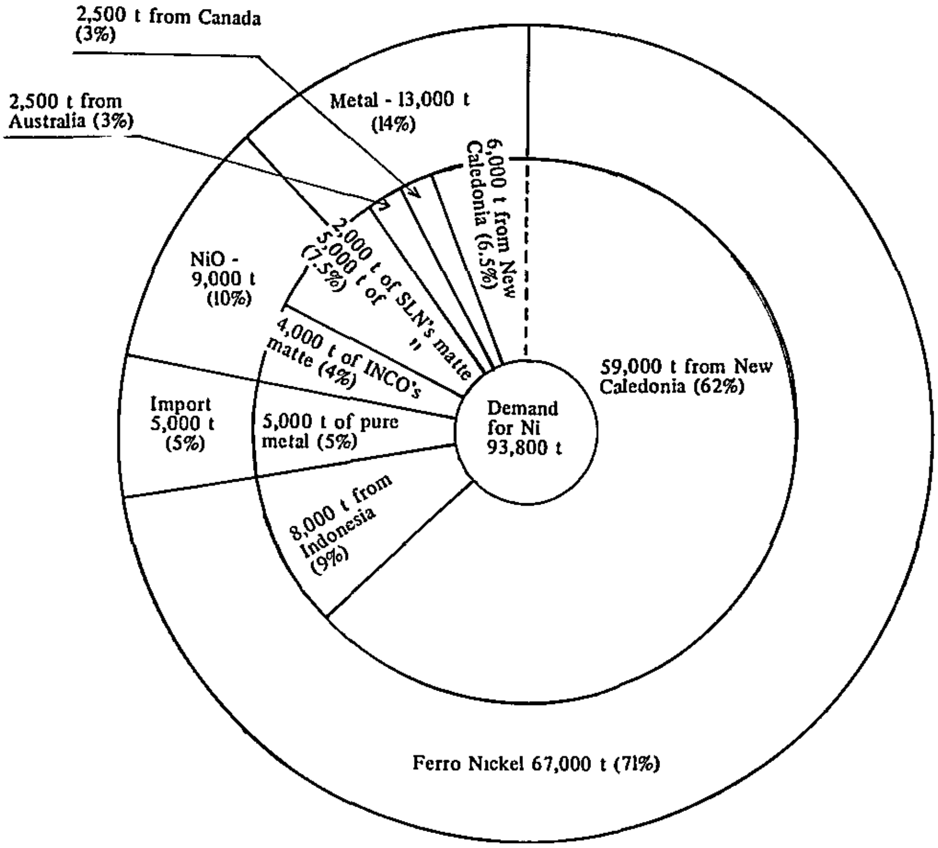


Table 6-11 Trend of Import Price of Nickel Ores

(Unit: ¢/kg of Ni + Co)

Area	New Caledonia					Pomalaa Mines
Year	Standard Grade %	Price	Year	Standard Grade %	Price	Price
1953	3.5	45	1962	3.2	48	45
54	3.2	29 - 35	63	3.2	47.76	45
55	3.2	29 - 44	64	3.2	47.76	45
56	3.2	44 - 67	65	3.2	47.76	45
57	3.2	67-75-63	66	3.2	47.76	39
58	3.2	63-55-48	(Nov.26)		52.37	42.52
59	3.2	48	67(Nov.9)	3.0	46.37-54.50-62.22	53.92
60	3.2	48	68	3.0	52.22-64.50	5 20
61	3.2	50	69	3.0	100	89,14
						(Jan/1970. 95.14)

Note: The standard grade of New Caledonian ores was altered to 3% in 1967, and that of Pomalaa ores to 3.1% in 1965 and then to 3% in 1966. Rejection point was 2.2% as of February 1970.

6-4 Distribution and Development of Nickel Ores

Nickel ore reserves in the world are shown in Table 6-12. As the table indicates, Canada accounts for about 50% (nickel sulfide ores), followed by Cuba (37%, laterite ores), the Philippines (6%, laterite ores), and Guatemala (3%, laterite ores). In potential ore reserve, the Philippines ranks top with 34%, then comes New Caledonia with 26% and Cuba with 23%. Indonesia's potential ore reserve is not considered very large.

The nickel ore reserve in West Australia is expected to increase with the progress of exploration activity. Exploration conducted in Indonesia is anticipated to result in the development of the country's smelting techniques and more economical utilization of low grade ores.

Table 6-13 shows the plans for accelerated production and development of nickel ores drawn up by major nickel companies of the world.

Of these plans, the production of INCO and Societe Le Nickel (SLN) have been already put into practice. Two units of SLN's square type 43,000 KVA electric furnaces, which were constructed in December 1970 at Doniambo, New Caledonia, are in operation now. Each of these furnaces has a production capacity of 12,000 tons per year (in Ni + Co content).

Though not many of development plans shown in Table 6-13 are considered to lead to actual ore production, it leaves no doubt that the global output of nickel ores will be substantially augmented through their implementation. Demand for nickel in Japan is on the steady upward trend, but the nickel industry is expected to face difficulties due to the low growth rate of export price and decrease of export items.

Southeast Asian countries including Indonesia are blessed with a vast reserve of low grade nickel ores. Development of smelting techniques and operation in these countries is to be materialized by the joint efforts of the government, academic and industrial circles because it will promote regional development in each country.

The present project is not specifically intended for development of low grade laterite ores. However, the grade of available ores is 1.8% (Ni + Co) and is lower than that of the ores currently processed by electric furnaces and therefore does not promise payability unless smelted in the producing area. This fact is to be taken into consideration as it points to the future course of development of Japanese nickel industry.

Table 6-12 Nickel Ore Reserves in the World

	Ore Reserve (1) (Confirmed)			Ore Reserve (2) (potential)			Remarks
	(Million ton)	Grade (Ni %)	Ni content (million ton)	(Million ton)	Grade (Ni %)	Ni content (million ton)	
1. Albania	-	1.0	-	-	-	-	Laterite ores containing Ni.
2. Australia	2.4	4.3	0.10	65.3	1.3	0.85	Laterite ores containing Ni, & nickel sulfide ores.
3 Brazil	-	-	-	16.0	4.5	0.72	Laterite ores containing Ni.
4. Canada	414.2	1.5	6.30	-	-	4.92	Nickel sulfide ores.
5. Cuba	356.0	1.3	4.63	10,530	0.8	13.22	Laterite ores containing Ni.
6. Dominica	-	-	-	72.4	1.6	1.12	"
7. Finland	7.0	0.8	0.06	-	-	-	Nickel sulfide ores.
8. Greece	-	-	-	10.0	0.7	0.07	Laterite ores containing Ni.
9. Guatemala	30.0	1.5	0.45	-	-	-	"
10. Indonesia	8.7	2.1	0.18	135.7	1.2	1.63	Garnierite ores and laterite ores containing Ni.
11. New Caledonia	-	2.6-3.1	-	1,400.0	1.1	15.40	"
12. Philippines	62.8	1.3	0.84	2,676.6	0.7	19.84	Laterite ores containing NI.
13. Rhodesia	7.0	1.0	0.07	16.6	0.8	0.13	Nickel sulfide ores.
14. South Africa	-	0.3	-	-	-	-	"
15. U.S.A.	16.2	1.5	0.24	-	0.25	-	Laterite ores containing Ni.
16. Venezuela	-	-	-	58.4	1.1	0.63	Laterite ores containing Ni.
17. Yugoslavia	7.5	1.4	0.11	-	-	-	"
18. Columbia	-	-	-	-	-	-	"
Total	911.8		12.98			58.58	
Average Grade in Ni Content		1.4					

Notes: 1. U.S.S.R. and China excluded.
2. 1) indicates confirmed reserve and 2) estimated or forecast reserve.
3. Reserve in New Caledonia, as reported in The Metal Bulletin, is 80 million tons (Ni content 2.0%).

Source: "Nickel, Canada and the World Mineral Report 16," by B.W. Mackenzie, M.R.D. Dept., E.M. & R., Ottawa.

Table 6-13 - Nickel Development Plans of Free World

Name of Company	Area	Kind of Ores	Development Plan: Annual production (In tons of Ni)	Development Plan: Year of Production Commencement	Development Plan: Wage Requirement (In $10 thousand)	Development Plan: Type of Enterprise	Development Plan: Other Particulars	Names of Mines and Estimated Ore Reserves	Remarks	Market
International Nickel Co. of Canada, Ltd	Canada Sudbury Manitoba West North Ontario	Nickel Sulfide Ores	70,000 (production increment)	1967-1971	20,000	INCO		Copper Cliff North Copper Cliff South Coleman Kirkwood Birchtree Soad Pipe Shebandowan Little Stobie	INCO's annual production capacity is planned to be increased to 270,000-290,000 tons in the latter half of 1971 by- 1) Ore production at nine new mines, 2) Expansion of existing mines, 3) Construction of new smelters, and 4) Modernization and expansion of existing smelters. Construction of a new smelter at Copper Cliff is planned to be completed for annual production of- (45,000 tons of pellet (11,000 tons of powder	U.S.A. and Europe
International Nickel Co. of Canada, Ltd.	Guatemala Lake Izabal	Laterite ores	Approx 23,000	1972-1973	18,000	Development to be undertaken by INCO's subsidiary company, Exploracionesy Exploracion Mineras de Izabal, established with Hanna's 20% capital participation.	Average Ni content of ores-1.5%.		Negotiations are in progress between INCO and Guatemalan government for final agreement. Production is scheduled to be started in three years after commencement of smelter construction.	Japan, U.S.A., and Europe.

Name of Company	Area	Kind of Ores	Development Plan					Names of Mines and Estimated Ore Reserves	Remarks	Market
			Annual production (In tons of Ni)	Year of Production Commencement	Wage Requirement (In $10 thousand)	Type of Enterprise	Other Particulars			
International Nickel Co. of Canada, Ltd.	France New Caledonia	Laterite ores	50,000	1974	20,000 (40 million dollars for exploration activity)	Development to be undertaken by COFIMPAC which was established by joint capital investment of Samipac (60%) and INCO (40%).	Ore grade Ni 0 3 - 1 5% Fe 30%	Plaine de Locs	SAMIPAC was established in 1967 and COFIMPAC in March 1969. SAMIPAC was established by the following joint investors. B R.G.M 30% Ugine-Kuhlman 30% French financial organizations and others 40% COFIMPAC was established with 60% of shares paid up by INCO, and marketing of its products is to be undertaken by INCO and French side at a 50:50 ratio.	U.S.A., Europe and Japan.
International Nickel Co of Canada, Ltd	Indonesia Malili	Laterite ores	11,000 (First production plan)	1974-1975	10,000-15,000	Development to be undertaken by INCO's Indonesian corporation, P T. International Nickel Indonesia.		Area of mining field-66 million ha	A 30 year mining contract was concluded with Indonesian government in July 1968. Tayler Woodrow International is to be engaged as mining contractor.	U.S.A., Europe and Japan.
Falconbridge Nickel Mines	Canada Sudbury	Nickel Sulfide ores	10,000	1970	6,500	Falconbridge		Storathcona Losiguock Lockery		U.S.A. and Europe
Falconbridge Nickel Mines	Dominica	Laterite ores (Ni 1.5%)	30,000	1971-1972	18,000	Falconbridge	Ore grade Ni 1.55%	62 million t	Production by large scale test plant operation has been in progress since March 1967 at a rate of 100 t/month on Fe basis (Ni content: 40-50%). Armco Steel Co. joined this project in March 1969 by acquisition of 16.4% of shares.	U.S.A., Europe and Japan.

Name of Company	Area	Kind of Ores	Development Plan: Annual production (In tons of Ni)	Development Plan: Year of Production Commencement	Development Plan: Wage Requirement (In $10 thousand)	Type of Enterprise	Other Particulars	Names of Mines and Estimated Ore Reserves	Remarks	Market
Sherritt Gordon Mines Ltd./Marinduque Mining and Industrial Co.	Philippines Surigao	Laterite ores	20,000-35,000	1972-1973	7,500	Joint development by Sherrit Gordon Mines and Marinduque Mining. Plant construction and operation to be undertaken by Sherritt Gordon and ore mining by Marinduque Mining	Production of 7,500 t of mixed sulfide (Ni 33, Co 22, S 35%) and 1,705 thousand t/a of leach residue (Ni 0 15, Fe 55%) is also planned.	A minimum of 62 million t of reserve is estimated. Ni - 1.35% Co - 0.10%	Hydro-metallurgical process developed by Sherritt Gordon is applied. A pilot plant was constructed at Fort Saskachewan in 1969. 10 thousand t of laterite ores shipped from the Philippines. Plant export made by Kobe Steel Ltd., Japan.	Japan.
Western Mining Co	Australia Kwinana	Nickel sulfide ores	15,000-18,000	1970-1971		Western Mining	Agreement reached with Sherritt Gordon on the application of the ammonia leaching-H_2 reduction method.	Ores to be mined in Kambalda area. Lunnon, Durken, Jan.	Annual production of 30 thousand t of nickel sulfide ores planned to be attained by the end of 1971. By-product-1,000 t/a of mixed sulfide with the following components. Ni 22, Co 23, Fe 0.2, Cu 0.01, S 30. % Ni 13, Co 0.4, Fe 30, Cu 0.6, S 25. %	Europe, U.S.A., and Japan.
Sherritt Gordon Mines Ltd./Western Mining Co.	Australia Ora Banda Kunanalling Broad Arrow	Laterite ores				A joint venture is planned to be established by Western Mining (51%) and Sherritt Gordon (49%)	Sherritt Gordon is to furnish the know-how of its hydrometallurgical process		$A250 thousand (approx. 1 hundred million yen) is to be borne by Sherritt Gordon at the outset for exploration activity. All the expenses incurred thereafter to be borne by the two companies according to the investment ratio.	

Name of Company	Area	Kind of Ores	Development Plan					Names of Mines and Estimated Ore Reserves	Remarks	Market
			Annual production (In tons of Ni)	Year of Production Commencement	Wage Requirement (In $10 thousand)	Type of Enterprise	Other particulars			
Société Le Nickel	France New Caledonia	Nickel oxide ores	30,000	1968-1972	12,000	15 thousand t to be produced by St Neo Caledonienne du Nickel, a joint venture with Kaiser Aluminum, and the remaining 15 thousand t to be exploited for Le Nickel's own production increase		Nepoui area and Thio area	SLN's production capacity (including that of the joint venture) is planned to be increased to about 65 thousand t/year in 1972.	Europe and U S.A.
Société Le Nickel	France New Caledonia	Laterite ores	50,000		20,000		Agreement reached with Sherritt Gordon on the application of the hydrometallurgical process	1,000 million t.		
Société Le Nickel	Venezuela	Nickel oxide ores	10,000			A development company to be established in Venezuela with SLN covering 20% of shares		Loma de Hierro.	Agreement was concluded with Venezuelan government in July 1967.	
SLN/Patino	France New Caledonia	Nickel oxide ores	40,000	1972	20,000			Poum area.	Investment ratios areas follows. SLN 51% Patino 30% Local capital 19%	Europe and Japan

Name of Company	Area	Kind of Ores	Development Plan			Type of Enterprise	Other Particulars	Names of Mines and Estimated Ore Reserves	Remarks	Market
			Annual production (In tons of Ni)	Year of Production Commencement	Wage Requirement (In $10 thousand)					
SLN/Penarroya Group	Yugoslavia Kavadarci	Laterite ores	12,000			Development planned to be jointly carried out by five companies including Compades, Power Gas Co, St. Le Nickel, Penarroya				
Ugine/Penarroya Group	Madagascar	Nickel oxide ores					SONIDAD (mining company) was established.		Investment ratios: Ugine-Kuhlman 33.5% Penarroya 21.5% Cofimer 12.5% Madagascar gov't 10.0% A.A.C. 7.5% Others 15.0%	
Penarroya Group	France New Caledonia	Laterite ores	50,000	1975		Joint venture.				
Morro Do Niquel S.A.	Brazil Pratapolis	Nickel oxide ores	2,000	1970-1971		Morro do Niquel		2.2% Ni+Co-800 thousand t 1.9% Ni+Co- 4,400 thousand t	11.67% of shares occupied by SLN.	
Columbia Government	Columbia Cerro Matoso	Nickel oxide ores							Nickel mines planned to be developed by a joint venture established by the participation of the following Columbian and foreign concerns. Columbian Industrial Development Agency Columbian Financing Corporation Hanna Mining Standard Oil	

Name of Company	Area	Kind of Ores	Development Plan: Annual production (In tons of Ni)	Development Plan: Year of Production Commencement	Development Plan: Wage Requirement (In $10 thousand)	Type of Enterprise	Other Particulars	Names of Mines and Estimated Ore Reserves	Remarks	Market
Japanese joint venture comprising Pacific Metals, Sumitomo Metal Mining, Nippon Mining, Nippon Yakin Kogyo, Yawata Steel, Fuji Steel, Mitsui & Co., Mitsubishi Corp, and Sumitomo Shoji	Halmahera Is. and surrounding islands	Nickel oxide ores	12,000 20,000	1973	7,500	Joint venture established with the participation of Japanese companies	A smelter is planned to be constructed according to the results of exploration commenced in 1969 for ferro-nickel production		Indonesian Nickel Development Co , Ltd (INDEFO) was established by Japanese participating companies.	Japan.
Anglo American Co	South Rhodesia Salisbury	Nickel sulfide ores	6,800	1969	2,800	Anglo American		Trojan Mine (1 million t) and Modziwa Mine.	Smelting plant constructed at Mlundura-Shamoa, Rhodesia	
Rio Tinto Ltd	Rhodesia	Nickel sulfide ores	5,000	1972		Rio Tinto				
Anaconda Group	Western Australia Widgemooltha	Nickel sulfide ores					Exploration now in progress		Investment ratios· Anaconda Australia 60% Conjinc Rio Tinto Australia 26-2/3% New Broken Hill 13-1/3%	
Great Boulder Golo Mines/North Kalgurli Ltd	Western Australia Scotia Mt. Martin	Nickel sulfide ores					Exploration now in progress.		Investment ratios: Great Boulder 51% North Kalgurli 49%	
Freeport Sulphur of Australia/Metal Exploration N.L	Western Australia Nepean	Nickel sulfide ores					Exploration now in progress			
Freeport sulphur of Australia/Metal Exploration N L.	Australia Queensland	Laterite ores					Exploration now in progress.	4 million t (Ni 1.55%)	Investment ratios: 50 50	

VII. P.N. ANEKA TAMBANG

P.N. ANEKA TAMBANG (hereafer called "ANTAM") is a state-operated mining company established in 1968 by reorganizing B.P.U. Perusahaan[2] Tambang Umum Negara in accordance with Government Ordinance No. 22. It engages in the exploration, mining, smelting and refining of metals, diamond and all other mineral resources excluding coal, petroleum, natural gas and tin.

The company has the following mines and smelter at present.

(1) Bauxite mines in Kidjang (Bintan Is.).

(2) Nickel mines in Pomalaa (Southeast Sulawesi).

(3) Gold mines in Tjikotok (West Djawa).

(4) Precious metal smelter in Djakarta.

(5) Diamond mines in Tjempaka (South Kalimantan).

(6) Iron sand mines in Tjilatjap (Central Djawa).

Under the provisions of the Mining Law (Law No. 11, 1967), mineral resources in Indonesia are classified into the following categories.

a) Strategic minerals (iron, tin, nickel, and other minerals for alloys and fuels).

b) Important minerals (copper, lead, zinc, gold and silver).

c) Minerals not falling under categories a) and b) above.

The Mining Law stipulates that the mining right for metals and ores falling under category a) should in principle be given to government agencies or state-operated enterprises alone. There actually are four public corporations engaged in mining activity, i.e., P.N. Pertamina (Petroleum Public Corporation), P.N. Tambang Batubara (Coal Public Corporation), P.N. Timah (Tin Public Corporation) and P.N. Aneka Tambang (Mining Public Corporation). Private mining activities are conducted on a small scale for production of minerals falling under category c).

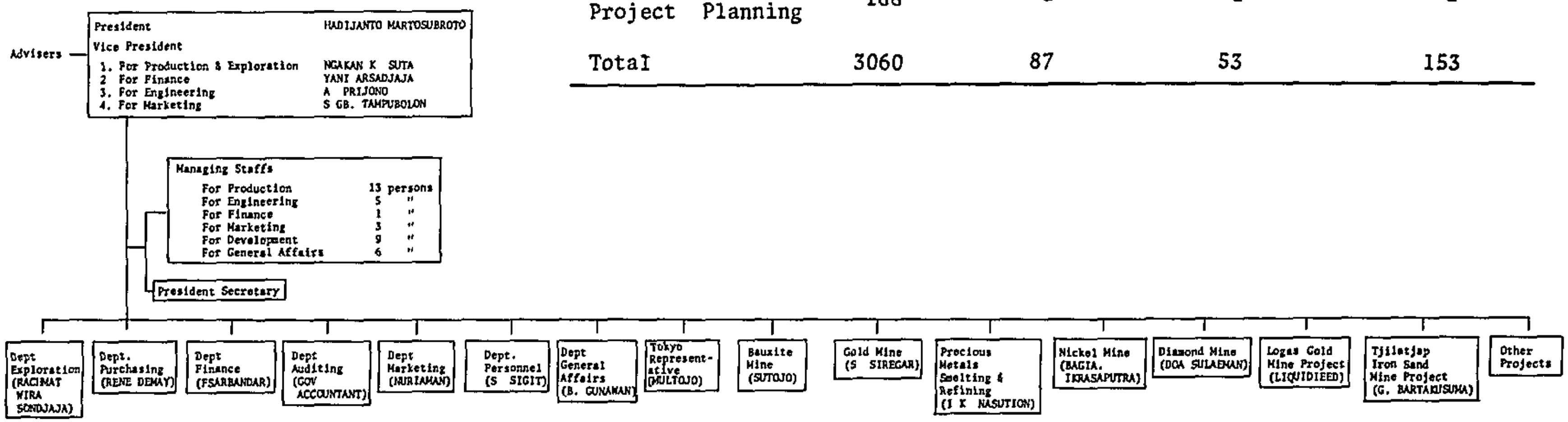
7-1 Staff Organization and Number of Employees

Fig. 7-1 shows the ANTAM's staff organization and Table 7-1 shows the number of workers employed at respective mines.

Table 7-1 Number of Employees by Mining Station

Mining Station	Number of Employees	School Graduates		
		College	Junior College	Industrial High School
Main Office	197	42	16	7
Bauxite Mines	762	8	8	53
Nickel Mines	796	16	11	29
Gold Mines	726	9	3	31
Precious Metals Smelter	108	4	1	6
Diamond Mines	196	3	12	27
Iron Sand Mines	87	5	2	-
Tokyo Branch and Project Planning	188	-	-	-
Total	3060	87	53	153

Figure 7-1 Staff Organization of P N ANEKA TAMBANG



7-2 Activities of ANTAM

Table 7-2 shows the production and sales proceeds recorded over the past few years.

Table 7-2 Production Trend of Major Minerals

	Bauxite		Nickel Ore		Gold	Silver
	(MT)	($thousand)	(MT)	($thousand)	(kg)	(kg)
1967	888,537	4,560	145,881	1,394	241	9,611
1968	847,751	3,881	240,542	2,367	185	9,613
1969	863,626	4,364	257,761	3,344	256	10,589
1970	1,182,239	5,895	538,453	8,315	236	8,802

As the above table indicates, nickel ores and bauxite account for the greater part of ANTAM's mineral production. Since the whole output of nickel ores and bauxite is exported to Japan, ANTAM shows keen concern about the market condition in Japan.

As for the nickel ore export to Japan, a long-term purchase contract effective for four years from 1971 was concluded between ANTAM and SUNIDECO. Under this contract, an annual export of 800 thousand tons was originally planned for 1971 and 1972, but this was altered to 600 thousand tons due to the depression in Japan.

Table 7-3 shows ANTAM's profit and loss recorded in the past three years.

Unit: US$

	1971 (Jan-Dec)	1970 (Jan-Dec)	1969 (Jan-Dec)
Revenue:			
(1) Export and domestic sales			
Bauxite ores	5,440,953	5,009,977	3,378,240
Nickel ores	9,302,465	6,002,970	2,011,342
Iron sand	1,086,673	-	-
Silver	588,168	251,766	468,611
Gold	373,988	335,599	561,323
Diamond	23,718	-	(Lead) 20,492
Revenues of Refinery	229,115	137,940	156,890
(2) Income from other sources			
Agency fee	46,775	33,500	22,504
Dispatch money	228,745	143,320	92,038
Cooperation funds	188,219	155,683	127,183
Interest	110,000	51,134	158,596
Others	65,817	176,125	585,696
(3) Inventory of products Ending of the year	774,798	782,379	661,440
Total Revenue	18,459,434	13,080,393	8,244,355
Expenditure:			
(1) Operating cost			
Materials and supplies	1,645,795	1,352,227	1,094,412
Labour	3,703,210	2,730,083	1,939,975
Maintenance	1,255,481	1,496,435	462,523
General expenses	3,648,000	1,331,000	540,789
Miscellaneous expenses	740,521	142,148	225,491
Depreciation	3,568,632	1,409,145	1,640,722
(2) Inventory of products Beginning of the year	839,100	661,439	1,036,987
Total Expenditure	15,400,739	9,122,477	6,940,899
Gross Profit (before corporation tax)	3,058,695	3,957,916	1,303,456
Corporation tax (45%)	1,376,413	1,781,062	586,555
Net Profit	1,682,282	2,176,854	716,901

As is clear from Table 7-3, the net profit after paying 45% of corporation tax amounts to a handsome sum, indicating that ANTAM's business is in very favourable condition at present.

Major activities currently undertaken by ANTAM are the exploration of nickel ores in Southeast Kalimantan and West Irian, iron sand exploitation in Jogjakarta, recovery of lead at the dressing plant at Tjikotok, rationalization of gold and silver smelting facilities, alumina production from low grade bauxite ores at Kidjang, and production of iron sinter or pig-iron from iron sand.

7-2-1 Bauxite Mines

In Indonesia, bauxite is produced only at the mines in Kidjang. These mines were opened by a Dutch company in 1935, and since they were transferred to Indonesian government in 1959, production pursued steady upward trend. The majority of bauxite output is exported to Japan. Production trend of bauxite is shown in Table 7-4.

In Kidjang, buaxite is produced by open-cut method with power shovels used to mine the 2 - 5 m thick bauxite layer after removing the 20 - 100 cm thick surface layer. Ores are carried to the washing mill by dump trucks and 0.5 to 0.7 tons of exportable bauxite can be obtained from 1 ton of ores. The stockyard has a capacity of 90 thousand t.

7-2-2 Gold Mines

The two gold mines located in Tjikotok and Tjirotan are exploited by underground mining work. Ores carried to the smelting plant at Pasir Gombong 4 km west of Tjikotok by the cable railway are processed by the cyanide method. These mines were opened in 1936 by a Dutch mining company, N.V. Mijnbouw Maatschappij Zuid Bantam (MMZB), closed for some time, and reopened in 1957. Trend of gold and silver production from these mines is shown in Table 7-5.

Table 7-4 Production of Bauxite

Year	(In MT) Production
1959	290,098
1960	348,018
1961	443,365
1962	449,205
1963	584,402
1964	656,644
1965	576,762
1966	688,185
1967	888,537
1968	847,751
1969	863,626
1970	1,182,239

Table 7-5 Production of Gold and Silver

Year	Gold (kg)	Silver (kg)
1957	44	1,470
1958	195	6,541
1959	222	9,790
1960	168	9,163
1961	179	10,558
1962	128	7,230
1963	137	8,672
1964	181	7,923
1965	209	9,294
1966	128	6,867
1967	241	9,611
1968	186	9,613
1969	257	10,590
1970	237	8,801
1971	330	8,876

7-2-3 Precious Metals Smelter (Unit P.P. Logam Mulia)

This smelting plant was established by R.T. Braakenziek in 1937 and sold to Bank Industri Negara in 1957. Materials processed at this plant are cyanide precipitate produced at Tjikotok gold mine and scraps of precious metals, and products are sold to the makers of goldwares and silverwares. Electrolytic refining method is applied for both gold and silver. By applying 300 A of electric current at 2.5 V for 24 hours, 5 to 6 kg of gold can be deposited. 6 to 8 kg of gold is produced per ton of ore. Silver is refined at a current density of 100 A/ft^2.

Major products turned out at this plant are as follows.

1) White gold plate.

2) Silver wires (0.04 mmØ - 0.18 mmØ).

3) Fuse metal of silver alloy.

4) Platinum plates.

5) Platinum crucibles.

6) Silver solder and blocks.

7) Gold ingot (100 g in weight, purity - 99.99% and over).

8) Silver nitrate (White crystalline powder having a purity of 99%, supplied in bottles each containing 500 gr).

9) Gold wires, gold and silver works for dental treatment, and gold and silver materials for ornamental purposes, and alloy production.

This plant also serves as the only official establishment for precious metals verification in Djakarta.

7-2-4 Diamond Mines

Indonesia's only diamond mines, located in Tjempaka area, South Kalimantan, had been owned by a private enterprise up to 1965 when a large diamond called Trisakti was found. By the discovery of this diamond, the government took over the mines and planned the construction of a new washing mill. When ANTAM was established, all the facilities and obligations of the mines were transferred to ANTAM, and the washing mill was constructed in 1971. At present, however, production still remains on a rather low level. Since diamonds are extremely mal-distributed in mined gravels, exploitation of diamond mines usually entails a considerable economic risk. However, results of exploration indicate that production of large quantities of diamonds can be expected in future.

7.2.5 Iron Sand Mines

The iron sand mines in Tjilatjap embarked in actual production in 1971. During this year, 300 thousand tons of iron sand was exported to Japan. With a new pier constructed and dredging conducted in the harbour area, loading facilities were improved and berthing of 30,000 t class vessels in now possible. Both design and execution of the port facilities improvement work were carried out by an Indonesian contractor and completed in a year. All the expenses incurred by the improvement work were borne by ANTAM.

Iron sand production resorts to the hydraulic mining method in which iron-laden pulp is separated from vein-stuff by magnetic concentration. By this method, 300 thousand tons of iron heading can be obtained from 1.5 million tons of crude ore. At present, mining is carried out in seven blocks.

VIII. EXISTING STATE OF POMALAA MINING STATION

8-1 Outline

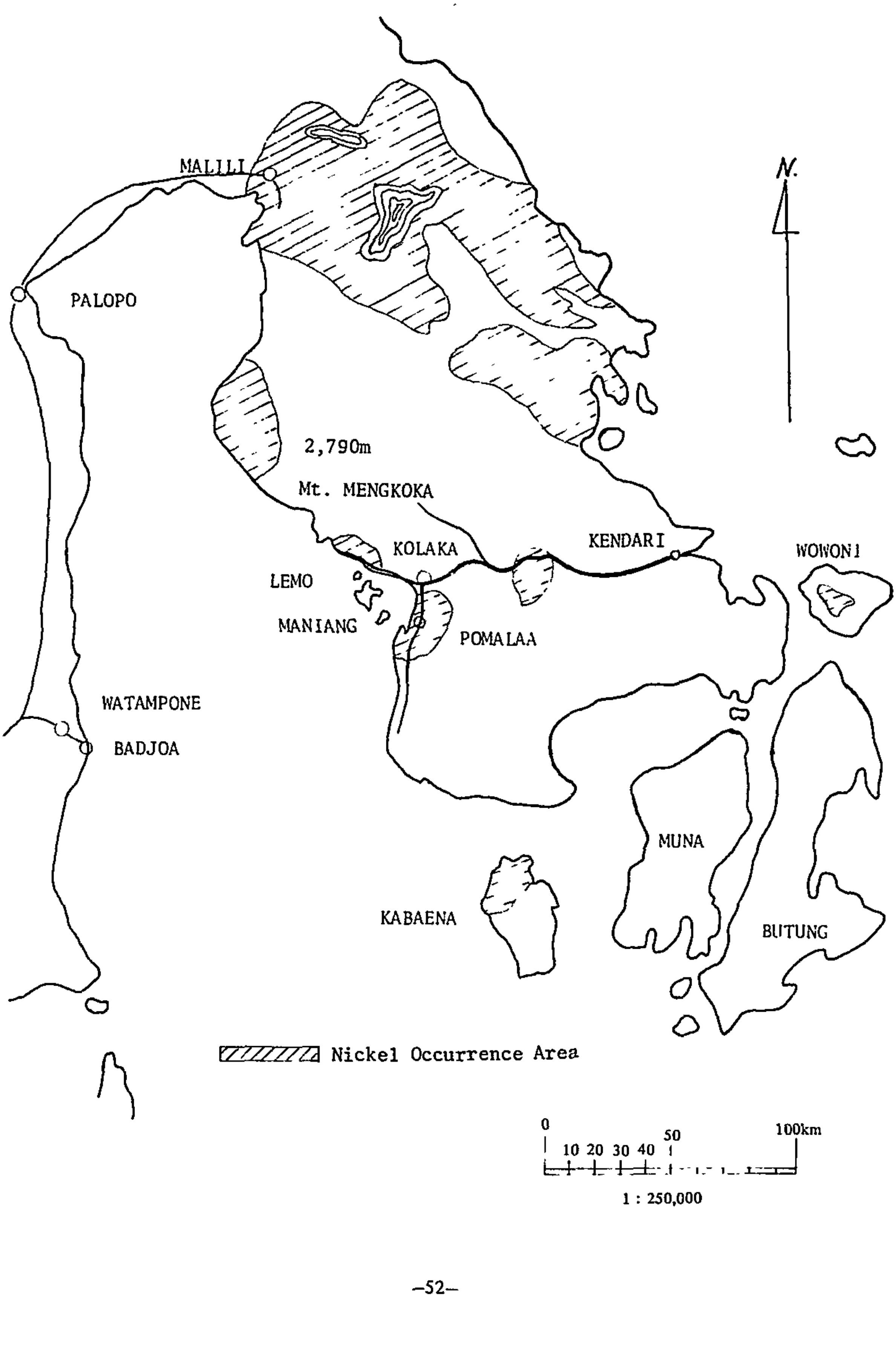
As shown in the location map in Section 2-2 and Fig. 8-1, Pomalaa area is situated in Kabupaten Kolaka, Southeast Sulawesi province. Communication between Kolaka and Kendari is maintained by the regular public service of mini-bus which runs between the two places two to three times a day. However, ANTAM's cars or private cars are the only transport means between Kolaka and Pomalaa area since there is no public communication service covering the approximately 35 km distance between the two places. The 185 km road connecting Kolaka and Kendari is in poor condition and it takes about eight hours to cover this distance. The quickest way from Djakarta to Pomalaa is to get to Makasar via Surabaja by air, and thence charter a light plane of Indonesian air forces.

The sea route from Makasar to Pomalaa is about 280 miles and it takes about 18 hours to cover this distance by a freighter making 13 to 15 knots. With no regular liner serving on this route, nickel ore carriers bound for Japan are the only sea transport means at present. ANTAM resorts to these carriers for the transport of sundry goods, vegetables, staff members and their families.

Pomalaa mines were opend in 1938 by a Dutch mining company, N.V. Oost Borneo Maatschappij (O.B.M.). During World War II, a nickel matte smelter was constructed by Sumitomo Mining Co. at the request of Japanese army but destroyed by air raids of Allied Forces. The mines were neglected up to 1956 due to Indonesia's independence war except that small enterprises kept on mining on a very small scale on Maniang island.

In 1960, Indonesian government took over the mines, established P.T. (Negara) Pertambangan Nickel Indonesia, and embarked on mining activity on Maniang island and Lemo island. This was ensued, as described in the preceding chapter, by the joint development activity with SUNIDECO which led to the present production in Pomalaa area and Tg. Pakar area.

Fig. 8-1 Location Map of Pomalaa Nickel Mines, Sulawesi.



8-2 Nickel Mines in Pomalaa Area

The nickel mining field owned by ANTAM covers an area of 8,700 ha extending for 14 km in north-south direction and 6 km in east-west direction. The mining lot is divided into the following four districts.

(1)	Northern district	:	Pomalaa deposit.
(2)	Central district	:	Latumbi·Tampla deposits.
(3)	Southern district	:	Tg. Pakar·Sapalaa deposits.
(4)	Island district	:	Lemo·Maniang deposits.

At present, nickel ores are mined at Pomalaa deposit and Tg. Pakar deposit. Deposits of Lemo island and Maniang island are now closed since mining of exportable grade ores from these deposits has already been completed. The deposits in the central district, however, still remain undeveloped.

8-3 Topography and Geology

8-3-1 Topography

Topography in Pomalaa area is generally flat and constitutes small hills. However, hill summits where high grade ores are abundantly distributed and the area where outcrops of bedrock serpentine are found are steeply inclined.

The entire mining field is covered with a tropical jungle in which more than 50 years old huge trees thrive. The jungle is cleared in the vicinity of mine facilities and working face. The area is topographically suited for open-cut mining.

8-3-2 Distribution of Ore Bodies

High grade ore bodies are distributed on the hill summit 50 to 200 m above sea level. Ore bodies are found beneath the 0.2 to 2 m thick lateritic surface layer having a low nickel content of 0.2 to 0.5%. Bedrock of ore body is serpentine which contains 0.1 to 0.3% of nickel.

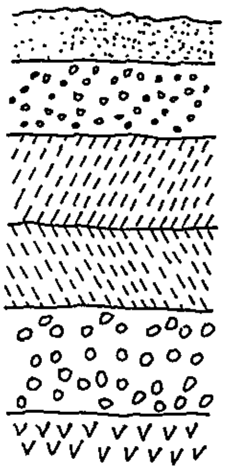
The ore deposit is the so-called residual deposit in which nickel content was retained by weathering. Since the tropical climate served for beneficiation, the deposit contains high grade nickel ores. Ores found in this area are garnierite ores.

On the hill summits, nickel bearing laterite ores are distributed with a thickness of 0.5 to 4 m, containing 1.0 to 3.0% of nickel and 20 to 40% of iron.

Laterit ores found in the periphery of ore body and in the entire mining field have a low nickel content and a high iron content, and were formed by a number of different processes.

8-3-3 Pomalaa Deposit

The general geologic profile of high grade nickel ore deposit in Northern Pomalaa district is shown below.

Depth (m)	Columnar Section	Ore	Ni + Co (%)	Fe (%)	Colour
0 ~ 1.0		Lateritic surface layer	0.2 ~ 0.5	10 ~ 20	Dark red
0.5 ~ 2.0		Nickel bearing laterite	1.0 ~ 2.0	20 ~ 40	Reddish yellow
1.0 ~ 3.0		Soft garnierite	1.5 ~ 3.0		Yellowish brown
2.0 ~ 4.0		Medium garnierite	1.5 ~ 4.0	6 ~ 17	↓
3.0 ~ 6.0		Hard garnierite	1.0 ~ 3.0		Yellowish green
		Serpentine	0.1 ~ 0.5	2 ~ 10	

It can be generally said that the nickel ore deposit in this district has the following features.

1) It is a residual deposit formed by serpentinization of peridotite.

2) It is distributed either circularly or elliptically on plateaus, hill summits and slopes near hill summits.

3) Garnierite ores found near the surface ground are composed of fine grains and have a large moisture content. Further, they usually have a high content of nickel and iron.

4) Grain size becomes larger and iron content drops sharply with the increase in depth, but the decline of nickel content is relatively small.

5) In portions where joints and fissures are well developed, high grade ores are formed by weathering.

6) Magnesia and silica grains tend to increase in ores of relatively high grade.

8-4 Mining

Pomalaa mines produce 600 to 800 thousand tons of nickel ores annually and the whole output is exported to Japan. Sales proceeds from ore export amount to US$9,300,000 and more than 50% of total sales proceed of ANTAM. They are not only the largest of ANTAM's mines but also its largest source. of income.

Nickel ore production in Pomalaa mines was conducted mostly in the northern Pomalaa deposit before and during the war. After the war, however, mining activity in this area was suspended due to security problems.

From about 1957, mines in Maniang island and Lemo island produced an annual output of about 10 thousand tons, but they are now closed since high grade ores are exhausted.

Full-scale mining.activity in Pomalaa and Tg. Pakar districts were commenced in 1965 after about two years of exploitation period following the completion of exploration activity. At present, the greater part of ores is produced from northern Pomalaa district.

Ore production during the past ten years is as shown below.

1961	15, 000	(D. M. T.)
1962	12, 000	
1963	30, 000	
1964	44, 500	
1965	101, 136	
1966	117, 402	
1967	170, 602	

Nickel ores began to be exported to Japan on a full scale in the latter half of 1965. Thereafter, the export volume increased year after year until the mining capacity reached 1 million tons in 1971. The nickel content of ores, however, followed a dwindling trend with the increase in production.

For export to Japan in 1971 and subsequent years, 3 million tons of garnierite ore reserve containing 2.2% or more of nickel were secured at the beginning of 1971. Table 8-1 below shows the export plan and the ore reserves to be exploited and shipped to Japan up to 1974.

Table 8-1 Plan of Nickel Ore Export to Japan

Unit: D.M.T.

Year	Production	Cumulative Production	Ore Reserve at Term Beginning	Remarks
1971	600,000	600,000	3,000,000	2.4-2.2% of Ni+Co
1972	800,000	1,400,000	2,400,000	"
1973	800,000	2,200,000	1,600,000	"
1974	600,000	2,800,000	800,000	Termination of p/s contract between SUNIDECO and ANTAM
1975	-		200,000	Residual ore reserve

With sufficient capital input being made for machines, equipment and personnel required for the attainment of the above production goal, ANTAM is amply capable of augmenting production to meet emergency needs.

8-4-1 Mining Method

Nickel ores are produced by open-cut mining. After the surface layer and laterite ores are removed by bulldozers, garnierite ores are carried out and loaded by means of dump trucks and power shovels. The nature of ores does not call for blasting work. The bench height ranges from 3 to 4 m, and working faces are maintained in good condition. High grade ores are mined from ore bodies 1, 3, 7 and 9. The distance from these ore bodies to the jetty is 2 to 3 km. It is expected that ores will be produced chiefly from ore bodies 4, 5, 6 and 10 in future. The distance between the southernmost fourth ore body and the jetty is a little more than 5.5 km.

8-4-2 Mining Machines and Materials

As shown in Tables 8-2 and 8-3, machines and materials currently owned by Pomalaa Mining Station for mining and construction purposes are rather small in size. However, since most of them are nearly new, it is believed that they promise an operation rate of 80 to 85%.

Construction machines are the earth moving machines procured under the smelter construction plan. At the site of smelting plant, excavation and levelling work is in progress in parallel with the jetty extension work.

Table 8-2 Mining Machines of Pomalaa Mining Station

Item	Specification		Quantity	Remarks	
				Year of Purchase	Maker
Power shovel	$0.8m^3$	110HP	2	1970	Sumitomo
Power shovel	$0.6m^3$	100HP	3	1972	Hitachi
Dozer shovel	$1.3m^3$	90HP	2	1971	Komatsu
"	$2.1m^3$	175HP	1	1972	"
Bull Dozer	D-80A-8	180HP	1	1968	"
"	D-80-A-12	180HP	5	1970-1972	"
"	D-30	55HP	1	1971	"
Road Roller	12 ton	50HP	1	1967	Sakai
Motor Greder		110HP	2	1970	Komatsu
Fork Lift		66HP	1	1969	"
Air compresser	120 cfm	50HP	2	1971	Hokuetsu
Crushing plant	20 t/hr	37HP	1	1964	Otsuka
Dump . Truck	8 t		18	1970-1972	Isuzu-Hino
"	7 t		13	"	"

Table 8-3 Construction Machines of Pomalaa Mining Station

Item	Specification		Quantity	Remarks	
				Year of Purchase	Maker
Dozer shovel	$2.2m^3$	175HP	1	1972	Komatsu
Wheel loader	$2.3m^3$	180HP	2	1972	"
Power shovel	$0.6m^3$	100HP	1	1971	Hitachi
Bull Dozer	D80-A	180HP	1	1972	Komatsu
Scraper	21 ton	200HP	3	1972	International
Dump . Truck	8 ton		5	1972	Isuzu

8-5 Stockpile and Loading

Nickel ores are carried out by dump trucks and stockpiled at Pomalaa jetty and Tg. Pakar jetty. The storage capacity of the two jetties is as shown below.

Pomalaa jetty	35,000 t
Tg. Pakar jetty	15,000 t

Stockpiled ores are charged into the hopper by bulldozers and loaded on barges by belt conveyor. Loading work is carried out in three shifts.

Barges carrying ores are towed by tug boats to the ore carrier (approx. 15,000 DWT vessel) anchored in the offing about 4 km from the coast, and ores are loaded by the carrier's derrick crane. For this ore loading work, ANTAM employs 200 labourers constantly on a commission basis in addition to its 104 workers. Loading capacity of belt conveyor and barges is shown in Tables 8-4 and 8-5.

Table 8-4 Loading Capacity of Belt Conveyor

Item	Pomalaa Jetty	Tg. Pakar Jetty
Storage Capacity	35,000 ton	15,000 ton
Length of Belt Conveyor	150m	70m
Width of Belt Conveyor	900m/m	900m/m
Electric Power for Belt Conveyor	50kw	30kw
Loading Capacity of Belt Conveyor	2,400 ton/day	1,000 ton/day

Table 8-5. Capacity of Barges and Tug Boats

Item	Capacity	Quantity
Tug Boat	180 HP	3
	170 HP	1
	120 HP	1
Barge	120 ton	8
	100 ton	4
	80 ton	8

To meet the present export demand, about four ore carriers of 15,000 DWT class enter the port each month. 10 to 12 days are required for one way voyage to Japan, and 7 to 10 days for unloading. Hence, a period of about one month is required for an ore carrier to make a return voyage between Pomalaa area and Japan.

8-6 Ancillary Facilities

8-6-1 Repair Shop

The repair shop is not very large in scale and is intended chiefly for replacement of parts of mining machines, welding work, and repair of barges, water pipes and mining facilities. About 290 workers including dockyard personnel are engaged in repair work, but their technical level is unknown. Major facilities installed at the repair shop are as follows.

Electric welding machine	6 units
Compressor	3 "
Drilling machine	3 "
Lathe (4 ft)	1 unit
Grinding machine	1 "

8-6-2 Electrical Facilities

Diesel power generators are installed for operation of all electrical facilities. Since no electric power is required for mining, most of power demand is for general purposes. The present power generating capacity (about 470 KVA) does not satisfy the demand and therefore, power for general domestic purposes is supplied only in the night-time and daytime power supply is limited to offices, repair shop and other facilities of the mining station. At present, generators which were used in ANTAM's closed gold mines are being installed. Generating facilities of Pomalaa Mining Station are shown in Table 8-6.

Table 8-6 - Generating Facilities of Pomalaa Mining Station

Purpose	Capacity	Quantity	Remarks
General purpose	100 KVA	2	220 V, 50 c/s
"	70 "	2	" "
"	27.5 "	1	" "
Repair shop	11 "	1	" "
Pomalaa jetty	30 "	2	" " , for belt conveyor
Tg. Pakar jetty	10 "	1	" " , "
Pump for domestic water supply	15 "	1	" "
Maniang island	5.5 "	1	100 V, 50 c/s, for lighting purpose
General purpose	1 "	2	" " , "

8-6-3 Assaying Facilities

ANTAM is conducting assaying and research work of ores in an assay room established near the mines. However, due to the shortage of research staffs, the ore assaying work to be conducted by the station's laboratory section is partly commissioned to the laboratory of Institute of Technology at Bandung. At present, ANTAM is carrying out the expansion of assaying facilities and training of research staffs.

8-6-4 Welfare Facilities

Employees are provided with satisfactory houses. Executive staffs live in Dutch style brick-made houses with a high ceiling and gardens are laid out in their wide building lot. Types and number of houses are shown in Table 8-7.

Table 8-7 - Residential Facilities of Pomalaa Mining Station

Type	Number	Power Consumption	Building Area
Class 1 (independent)	7	1000 w	170 m^2 (for dept. chiefs)
Class 2 (2 apartment house)	15	500	111 - 117 m^2 (for section/sub-section chiefs)
Class 3 (ditto)	38	300	64 - 70 m^2 (for staff members)
Class 4 (ditto)	74	200	63 - 70 m^2 (ditto)
Class 5 (5 - 12 apartment house)	730	100	36 - 48 m^2 (for labourers)

When the smelter construction is started, a maximum of about 100 Japanese staffs and about 500 local construction workers will be staying in Pomalaa area during the peak period. Construction plan should therefore be so worked out that they will be provided with sufficient supply of electric power, drinking water, sundry goods, etc.

At present, some of the houses for accommodating the smelter construction workers are already under construction.

In Pomalaa area, a primary school, junior high school, gymnasium, football ground, tennis courts, cinema house, etc. are established by ANTAM. An athletic coach is also in the service of ANTAM to improve the health of its employees. Further, a mosque and a church are annexed to the mining station. The hospital in the area is capable of accommodating 12 each of male and female adult in-patients as well as some children and infants. It is staffed by 61 personnel including two qualified doctors and a number of nurses who are engaged in medical treatment, care for child-birth, prevention of malaria, and other activities. Malaria is virtually exterminated in the area and can therefore be disregarded.

This hospital has a internal treatment-consultation rooms, surgical operation rooms, delivery rooms, dental treatment rooms, etc. When the smelter construction is started, dispatch of Japanese doctors, particularly surgeons, will be necessary. However, this may not be required if the plane service is improved because an hour's flight takes patients to Makasar where well-equipped hospitals are found.

8-7 Staff Organization and Labour Productivity

A total of 870 workers are currently employed by Pomalaa Mining Station. The total of employees and their family members who are subsisted by the station's mining activity is 4,009.

The school career of department heads and staffs on higher levels is shown in Table 8-8, the staff organization in Table 8-9, and the family composition of staff members in Table 8-10.

Table 8-8 School Career of Department Heads and Staffs on Higher Levels

Post	Name	Specialized Course	Year of Graduation
General Manager	Mr. Bagia	Mining Eng.	1961
Manager of Development Div.	Mr. Kosim	Metallurgical Eng.	1963
Secretary	Mr. Ruswir	International Trade Relation	1959
Makasar Representative Office	Mr. Nurain	Business Administration (Junior college)	1967
Production & Exploration Dep.	Mr. Darmoko	Mining Eng.	1963
Staff of Production & Exploration Dep.	Mr. Rizal	"	1965
Technical Engineering Dep.	Mr. Anton	"	1957
Shipping Dept.	Mr. Setja	"	1968
Finance Dep.	Mr. Tungka	Account (Junior college)	1964
General Affairs Dep.	Mr. Sukadi	English Literature (Junior college)	1958
Health Dep.	Dr. Anom	Medical Doctor	1970
"	Dr. Tata	"	1970

Staff members are composed of 7 college graduates, 13 junior college graduates, 46 industrial high school graduates, and 35 ordinary high school graduates. Thus, the level of their past education is considerably high. In particular, Development Division which is in charge of the smelter construction project is staffed by larger numbers of school graduates than in other divisions; the manager and 6 other staff members are college graduates, 1 is a junior college graduate and 2 are industrial high school graduates. Mr. Kosim, the manager, is known to have majored in the metallurgical course at University of British Columbia, Canada, and Mr. Siahaan and Mr. Hassan, staff members of the said division, are masters of science graduated from the Department of metallurgy of Kyoto University and Tokyo University, respectively. Appointment of these able staff members is indicative of ANTAM's forward looking attitude towards the smelter construction project.

As shown in the following sector-wise distribution of employees, however, Pomalaa Mining Station employees a small number of workers in direct sectors and an extremely large number of workers in indirect sectors.

Table 8-9 Organization of Pomalaa Mines

- General Manager (Mr. Bagia)
  - Secretary (Mr. Ruswir)
    - Health Dept. (Dr. Anom) (Dr. Tata)
      - Health Sub Section
      - Security Sub Section
      - Nursing Sub Section
    - General Affairs Dept. (Mr. Sukadi)
      - Personal Affairs Sub Section
      - General Affairs Sub Section
      - Secretary
    - Finance Dept. (Mr. Tungka)
      - Warehouse Sub Section
      - Administration Sub Section
      - Finance Sub Section
      - Budgeting Sub Section
  - Manager of Production & Exploration (Mr. Bagia)
    - Shipping Dept. (Mr. Setja)
      - Loading Sub Section I
      - Loading Sub Section II
    - Technical Eng. Dept. (Mr. Anton)
      - Purchasing Sub Section
      - Civil work Sub Section
      - Electrical Power Sub Section
      - Docking Sub Section
      - Heavy Equipments Work Shop Sub Section
      - General Work Shop Sub Section
    - Production & Exploration Dept. (Mr. Darmoko)
      - Exploration Sub Section
      - Laboratory Sub Section
      - Surveying Sub Section
      - North Min. Sub Section
      - South Min. Sub Section
      - Maniang Min. Sub Section
  - Manager of Development Div (Mr. Kosim)
    - Assistant to Manager of Development
  - Makasar Representative Office (Mr. Nurain)
    - General Affairs Sub Section
    - Finance Sub Section
    - Export & Agency

Table 8-10 Family Composition of Staff Members

	Post/Section	Number of Workers	Number of Married Workers	Number of Children	Total
1	General Manager	1	1	3	5
2	Development Div.	11	7	11	29
3	Secretary	1	1	1	3
4	Management Staff	1	1	4	6
5	General Management Secretary	1	-	-	1
6	Production & Exploration Department	6	4	15	25
7	P. Maniang Mining Section	21	20	57	98
8	Southern Mining Section	38	37	91	166
9	Northern Mining Section	34	33	113	180
10	Surveying	22	22	57	101
11	Laboratory Section	16	12	37	65
12	Exploration	32	31	73	136
13	Engineering & Maintenance Department	7	7	14	28
14	Repair Shop	35	35	108	178
15	Heavy Equipment Repair Shop	155	135	361	651
16	Dockyard	44	36	115	195
17	Electrical Power Section	43	42	134	219
18	Civil Work Section	42	42	135	219
19	Purchasing	4	3	9	16
20	Shipping Department	104	53	283	480
21	Financial Department	5	5	21	31
22	Budget Section	4	4	9	17
23	Financial Section	14	10	35	59
24	Administration Section	9	9	21	39
25	Warehouse Section	25	25	85	135
26	General Affairs Department	17	9	36	62
27	Secretary Section	14	13	48	75
28	General Affairs Section	68	63	185	316
29	Personal Section	12	12	42	66
30	Health Department	9	9	25	43
31	Nursing	5	1	4	10
32	Health Section	18	16	55	89
33	Security Section	29	28	110	167
34	Makasar Representative Office	23	17	59	99
	Total	870	783	2356	4009

Management and administration	......	22	
Surveying	......	46	Geology, surveying and assaying.
Exploration	......	93	
Repair	......	247	Machines, electrical equipment, and civil engineering and earth moving work.
Loading	......	148	Vessels and dockyard.
Clerical work	......	126	Accounting, labour management, general affairs.
Welfare	......	146	Hospital, education and safety maintenance.
Makasar Office	......	23	
Others	......	19	
Total	......	870	

Productivity of the mining sector stands at about 25 t/person. Though this rate is equivalent to the average of mines in Southeast Asia, the productivity of the entire mining station (excluding loading sector and Makasar Office) is as low as 3 t/person.

Photo 1 - Pomalaa Area Viewed from Stockyard on Pomalaa Jetty

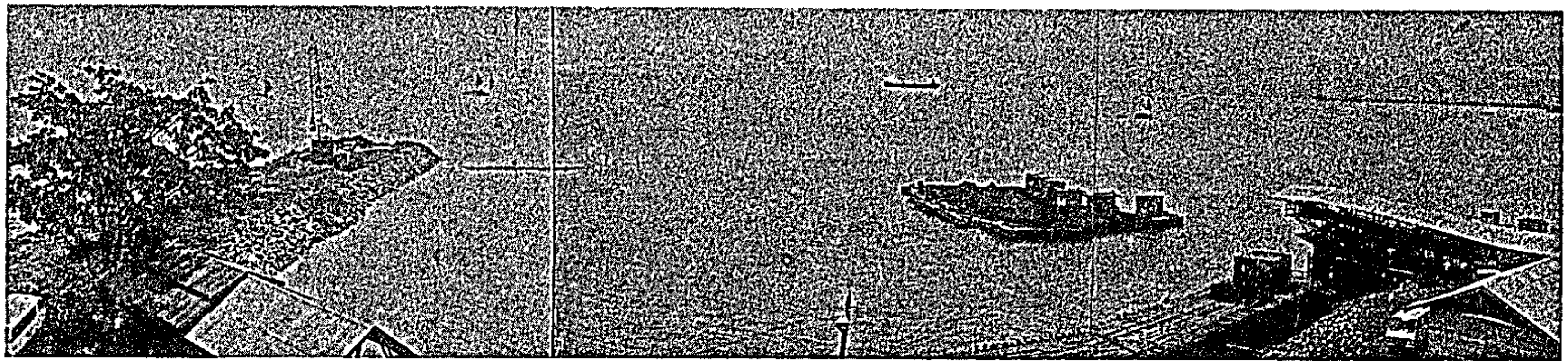


Photo 2 - View of Outer Sea from Pomalaa Stockyard

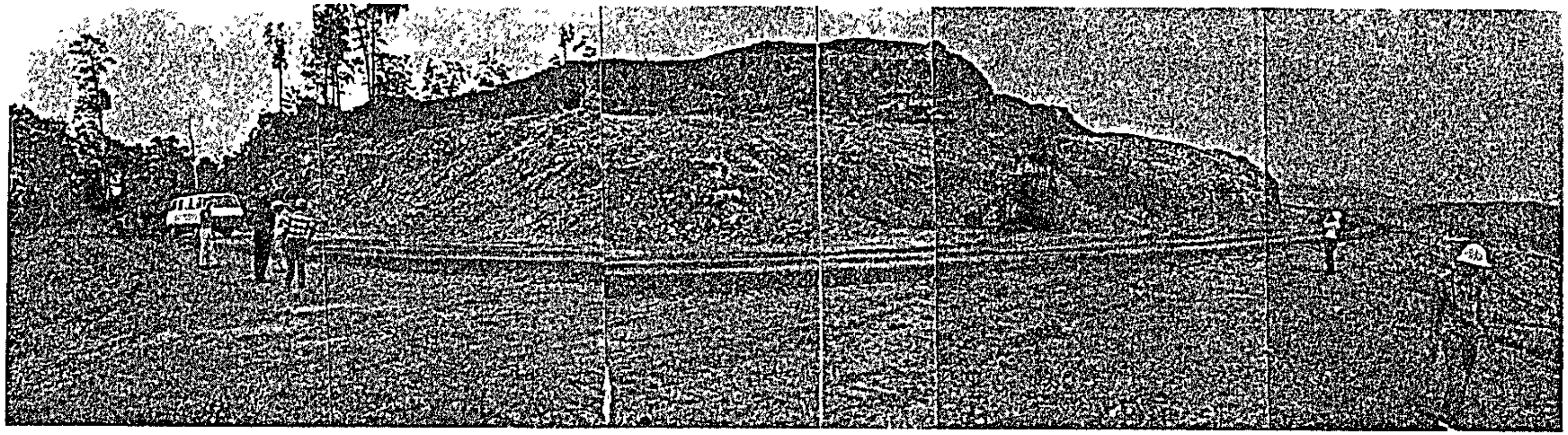
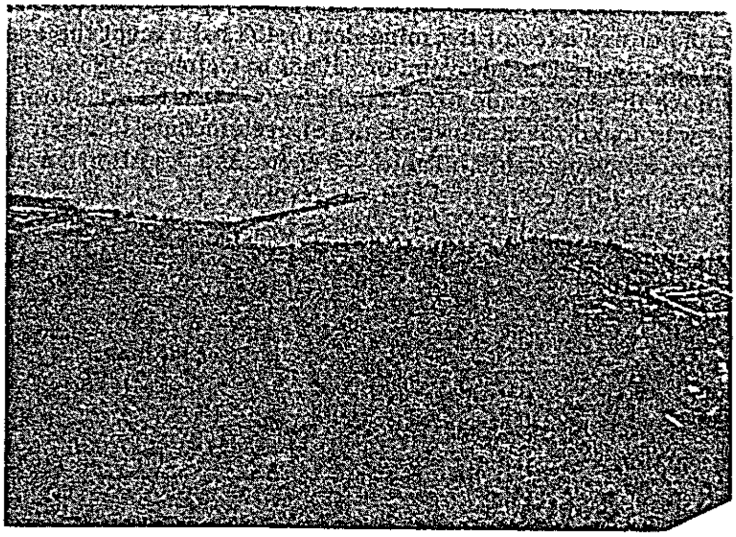


Photo 3 - Ore Body No. 9 of Pomalaa Ore Deposit.

Pomlaa jetty.

ANTAM's Pomalaa Mining Station.



Pomalaa village.

Photo 4 - Aerial View of Pomalaa Airstrip.

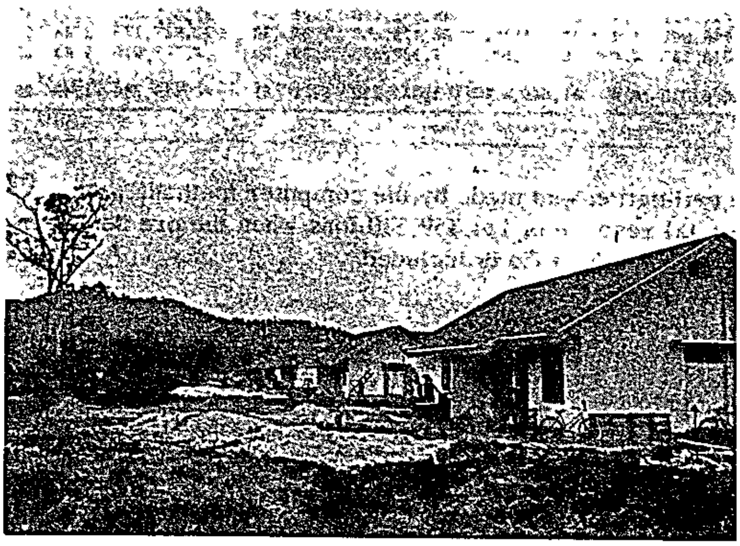


Photo 5 - Dormitories of Pomalaa Mining Station's Workers under Construction.

IX. ORE AND ORE RESERVE

9.1 Exploration

9.1.1 First Stage Exploration (Stage I)

The joint exploration by Indonesia (ANTAM) and Japan (SUNIDECO) was carried out over the entire area of the mine-lot (5,458 ha) except the area explored in 1962, for one year from November, 1968, to October, 1969. The main object was to explore the low-grade ore (containing 1.5% of Ni – Co) and as a result of which it was found the reserve of nickel ore amounts to about 45 million tons as shown in the following table. Table 9.1 shows the detail of the exploration and Table 9.2 shows the estimated ore reserve.

Table – 9.1 Detail of First Stage Exploration

Area explored	5,458 ha
Pits excavated	3,300 pits
Average depth of pit	6 m
Samples obtained	20,000 pcs.
Exploration cost	U.S.$217,800

Table 9-2 Ore Reserve Estimated by Exploration

Stage I

District	Area (m^2)	Depth (m)	Volume (m^3)	Ore reserve (D.M.T.)	Grade Ni+Co (%)	Grade Fe (%)	Reserve of ore containing more than 15% of Ni+Co: Ore reserve (D.M T.)	Grade Ni+Co (%)	Grade Fe (%)
Northern	6,422,181	5.4	34,680,043	48,552,060	1.28	33	19,604,500	1.50	29
Central	8,745,502	4.6	40,342,712	56,479,800	1.28	30	22,512,770	1.48	29
Southern	1,518,337	4.4	6,662,623	9,327,670	1 29	30	4,772,010	1.49	27
Total	16,686,020	4 9	81,685,378	114,359,530	1.28	31	46,889,280	1.49	28

Note—1. The estimation was made by the computer method.

2. The total reserve is 114,359,530 tons when the ore containing more than 1.28% of Ni + Co is included.

3. Specific gravity = 1.4

9.1.2 Second Stage Exploration (Stage II, Period 1)

The second stage exploration started in July, 1970, by the survey staff of ANTAM was completed in January, 1971, in which a minute investigation was carried out of twenty-one ore bodies and their environs in the area excluded from the joint exploration in 1969. The purpose of the exploration was to estimate the reserve of low grade ore (containing less than 2.2% of Ni + Co) which is not exportable. As a result of the exploration performed by the same method as that used for the first stage exploration it was confirmed that the reserve of nickel ore amounts to 11,090 thousand tons.

The detail of the exploration is shown in Table – 9.3 and the results are shown in Table – 9.4.

Table – 9.3 Detail of Second Stage Exploration

1)	Period of exploration	6 months
2)	Area explored ...... Ore body in Northern Pomalaa	250 ha
3)	Pits surveyed ...... 773 new pits were excavated and 314 old pits used.	
4)	Total number of pits	1,087 pits
5)	Total length of pits	7,911 m
6)	Average depth of pit	7.3 m
7)	Number of samples	6,065 pcs.
8)	Area explored	250 ha
9)	Reserve area of ores containing more than 2% of Ni + Co	140 ha

Table 9-4 Detail of Second Stage Exploration by Ore Body

Ore Body	Number of New Pit	Number of Old Pit	Total Number of Pit	Total Depth of New Pit (m)	Total Depth of Old Pit & New Pit	Number of Sample
No 1	18	49	67	448.2	521.0	508
" 2	29	21	50	313.5	388.8	367
" 3	35	12	47	243.6	532.0	471
" 4	79	58	137	606.4	976.2	590
" 5	61	37	98	289.0	508.6	366
" 6	80	16	96	391.0	399.0	370
" 7	66	-	66	405.0	406.5	380
" 8-N	45	-	45	500.8	512.0	467
" 8-S	58	-	58			
" 9-N	32	15	47	1,493.3	1,575.3	873
" 9-S	36	9	45			
" 9-W	20	12	32			
" 9-O	11	12	23			
" 10	78	40	118	521.9	693.8	652
" 11	33	5	38	235.9	352.4	187
" 12	29	15	44	341.0	373.6	314
" 15	26	-	26	176.4	196.1	157
" 18	37	13	50	314.8	475.5	363
TOTAL	773	314	1,087	6,280.8	7,911.3	6,065

Note – 1. Pit

The old exploration pits had been excavated at intervals of about 100 m x 100 m and the new pits were provided to from gridiron of 50 m x 50 m. All the pits were excavated by hand and each of them is 1 m x 1 m in size, and 14 m in the maximum and 7.3 m in average depth.

2. Sampling

Each samples was obtained in a shape of channel of 1 m long from the side wall of pits, of which weight was from 30 kg to 40 kg. The samples obtained were reduced to the pieces of 0.5 kg for the grade analysis which was performed at the laboratory of ANTAM and the Technical Institute of Bandung in Djawa.

9.1.3 Ore Reserve

The ore reserve of northern Pomalaa Area was estimated at 3,677 thousand tons by the first stage exploration (1969) as shown in Table – 9.6 and 11,099 thousand tons by the second stage exploration (1970) as shown in Table – 9.7. The former ore reserve (3,677 thousand tons) were obtained from the survey of a part of ore body to be digged by ANTAM which was carried out at the time of the joint exploration by SUNIDECO and ANTAM. Since this ore reserve was obtained by exploring the environs of ore bodies it includes much laterite ore of which Ni content is low and Fe content is high. However, this ore reserve to be digged by ANTAM is excluded from the ore reserve under the present smelting project; that is, the ore reserve for the present Project is 11,099 thousand tons obtained by the second stage exploration, consisting of garnierite of which Ni content is 1.8% or over and Fe content is from 12% to 15%.

Table 9-5 Ore Reserve of Northern Pomalaa Area

Location	Area m^2	Ore W.D m	Ore Volume m^3	Ore Tonnage D.M.T	Ore Assay % Ni+Co	Ore Assay % Fe	Over Burden Tonnage D.M.T	Over Burden Assay Ni+Co
Stage 1	803,463	3.3	2,594,844	3,677,177	1.78	17.97	1,121,627	1.00
Stage 2	1,550,451	5.2	8,176,469	11,099,357	1.91	14.55	1,359,100	1.20
Total	2,353,914	-	-	14,776,534	1.88	15.40	-	-

Table 9-6 Ore Reserve by Ore Body (Stage I)

Oer-Body		Area m^2	Ore W.D m	Ore Volume m^3	Ore Tonnage D.M.T	Ore Assay % Ni+Co	Ore Assay % Fe
Pomalaa	I	128,553	2.7	344,902	482,818	1.79	14.92
"	III	26,000	2.5	66,700	93,670	1.58	19.74
"	IV	121,913	3.9	473,326	669,700	1.71	19.64
"	VII	34,862	3.0	103,735	138,901	1.92	13.66
"	X	95,220	2.7	256,945	358,371	1.85	16.68
"	XII	132,695	4.2	559,523	783,333	1.76	18.18
"	XIII	46,320	2.7	124,768	174,675	1.79	17.56
"	XVII	96,650	3.2	311,775	481,271	1.86	20.26
"	XVII'	36,500	3.4	123,500	172,900	1.83	19.71
"	XX	84,750	2.7	229,670	321,538	1.68	16.93
Total		803,463	3.3	2,594,844	3,677,177	1.78	17.97

Table 9-7 Ore Reserve by Ore Body (Stage II)

Ore Body		Area m^2	Ore W.D m	Ore Volume m^3	Ore Tonnage D.M.T	Ore Assay % Ni+Co	Ore Assay % Fe
Pomalaa	I	126,966	5.9	761,860	1,118,659	1.84	11.68
"	II	69,761	5.3	379,464	531,247	1.86	12.49
"	III	92,924	4.3	422,542	591,395	1.83	14.65
"	IV	114,617	4.0	458,705	642,800	1.95	15.93
"	V	93,140	4.6	418,350	543,140	2.02	14.03
"	VI	79,173	4.8	380,106	452,083	1.88	13.32
"	VII	122,211	6.1	788,078	1,043,703	1.96	15.23
"	VIII-N	77,747	5.8	421,486	590,295	1.66	15.98
"	VIII-S	68,460	5.4	369,560	518,447	1.77	13.58
"	IX-N	90,690	4.5	415,147	584,457	1.72	13.68
"	IX-S	85,710	6.2	533,356	695,799	2.01	17.16
"	IX-W	46,706	5.8	266,485	351,229	1.97	13.97
"	IX-O	9,267	4.9	46,147	64,606	1.86	14.24
"	X	201,985	6.1	1,194,436	1,561,598	2.04	15.19
"	XI	40,762	4.2	166,488	233,074	1.83	13.98
"	XII	107,191	5.1	501,323	659,782	2.03	17.29
"	XVIII	123,141	5.4	652,936	917,043	1.96	13.80
Total		1,550,451	5.2	8,176,469	11,099,357	1.91	14.55

The bases on which ANTAM calculated the ore reserve were as follows.

1) The ratio of Ni + Co content to Fe content is assumed to be 1 : 7.

2) Calculation is made by dividing the ore reserve into two parts respectively containing Ni + Co of 1.8% or more and 2.0% or more.

3) The high grade ore suitable to export is excluded.

4) The specific gravity of 1.4 is used.

5) The ore reserve containing Ni + Co of 0.9% or less is excluded.

6) The depth of surface soil is assumed to be less than 3 m.

7) Pits are divided into triangular blocks, each forming one mine-lot to determine the ore reserve and grade by such lots.

8) The ore reserves are probable ore reserves.

9) The digging percentage and safety factor are not taken into account.

9.2 Assessment of Available Ore by the Survey Mission

This Survey Mission obtained the all data of the second stage exploration to assess the reasonableness of ore reserve calculated by ANTAM. The results of such assessment is shown in the following table as compared with the original data of ANTAM.

Table – 9.8 Comparison of Available Ore

Difference	Ore Reserve (D.M.T)	Safety Factor (%)	Minable Ore (D.M.T)	Grade Ni+Co	Grade Fe	Remarks
ANTAM	11,099,000	-	11,099,000	1.91	14.55	Probable ore reserves.
Survey Mission	9,427,000	90	8,484,500	1.96	15.47	Proved ore reserves and probable ore reserves.

9.2.1 Bases for Assessing Available Ore

As the data supplied to the Survey Mission by ANTAM were very massive and it was impossible to assess all of them in a short period, about 30% of them were selected by means of random sampling to make the assessment on the following bases.

1) The calculation is made by the same way as that used by ANTAM.

2) The cross-sectional and plane sectional calculations are made to check with the original data.

3) The specific gravity of 1.4 is used.

4) The ore containing Ni + Co of 0.9% or less is excluded.

5) The laterite ore containing Fe of 22% or more is excluded.

6) The high grade ore (containing Ni + Co of 2.2% or more) capable to export is excluded from the available ore calculated.

7) The safety factor of 90% is applied to the ore reserve to determine the quantity of minable ore.

9.2.2 Quantity of Available Ore Assessed by the Survey

The quantity of available ore assessed by the Survey Mission is shown in Tables – 9.9 and 9.10. No assessment was made of such quantity, 3,677 thousand tons, obtained by the first stage exploration due to lack-of data.

Table – 9.9 Quantity of Ore Assessed by the Survey Mission

Exploration	Area m^2	Ore					
		Depth m	Volume m^3	Reserve D.M.T	Minable Ore D.M.T	Grade (%) Ni+Co	Fe
Stage I	803,463	3.3	2,594,844	3,677,177	2,941,740 *1	1.78	17.97
Stage II	1,550,452	5.9	9,134,780	12,760,250	11,484,500 *2	2.02	14.85
Total	2,353,915		11,729,624	16,437,427	14,426,240	1.97	15.49

*1 Safety factor = 80%
*2 Exportable ore (containing Ni+Co of 2.2 % or more) of 3 million tons is included.

Table – 9.10 Assessed Quantity of Ore by Ore Body

Name of ore body		Area m^2	Depth m	Volume m^3	Ore Reserve D.M.T	Minable Ore D.M.T	Grade (%) Ni+Co	Fe
Pomalaa	I	126,996	6.8	869,360	1,217,100	1,095,490	1.95	12.55
"	II	69,716	6.7	472,050	660,870	594,980	1.93	13.09
"	III	92,924	5.2	480,890	643,240	578,920	2.07	14.75
"	IV	114,617	4.3	492,000	689,080	620,170	1.96	15.68
"	V	93,140	5.7	531,500	744,100	669,690	2.24	15.82
"	VI	79,173	5.3	416,560	583,190	524,870	1.96	13.88
"	VII	122,211	7.0	855,060	1,197,090	1,077,360	2.09	16.01
"	VIII-N	77,747	5.8	421,500	590,300	531,270	1.78	15.98
"	VIII-S	68,460	5.4	369,560	518,450	466,600	1.72	13.58
"	IX-N	90,690	5.4	434,860	608,810	547,930	1.92	14.11
"	IX-S	85,710	7.9	682,640	955,700	860,130	2.23	17.00
"	IX-W	46,706	6.2	288,160	403,430	363,090	1.92	14.02
"	IX-O	9,267	4.9	46,150	64,600	68,140	1.86	14.27
"	X	201,985	6.4	1,302,130	1,822,980	1,640,680	2.07	15.02
"	XI	40,762	4.8	197,610	276,660	248,990	1.91	13.66
"	XII	107,191	4.9	527,360	738,300	664,470	2.12	17.39
"	XVIII	123,141	6.0	747,390	1,046,360	941,720	2.01	13.72
Total		1,550,451	5.9	9,134,780	12,760,250	11,484,500	2.02	14.85

Note – Quantity of ore assessed by the Survey Mission
11,484,500 t – 3,000,000 t (exportable ore) = 8,484,500 t
Ni content (Ni + Co) = 1.96 %
Fe content = 15.47%

9.3 Exploration Plan in Future

ANTAM is establishing or implementing its exploration plan with the emphasis of future policy laid on the following facts.

In northern Pomalaa about 3.67 million tons of ore reserves were secured by the first stage exploration in 1969 and about 11.09 million tons of ore reserves were secured by the second stage exploration in 1970. However, a great importance has been attached to the fact that both the ore reserve and grade were not confirmed due to the pits provided at intervals of 50 m x 50 m or more, and the exploration has been continued since 1971 to confirm them with the number of pits increased by reducing the intervals at present to 25 m x 25 m. As the excavation of pits is now made entirely by hand it becomes difficult to dig deaper than 10 m or 12 m, and a boring machine is on order to overcome the difficulty.

At present the third stage exploration is being planned in which a minute investigation will be made on the exploration of Tg. Pakar area. It is also planned to purchase a boring machine to carry out this exploration.

9.4 Mining Plan

The quantity of nickel ore necessary for the present Project is 250,000 tons per annum in dry weight, or 343,000 tons per annum in wet weight (actual weight to be mined) as the ore usually contains moisture of 27%. In order to mine this quantity of ore it is necessary to remove the surface soil of 54,000 tons per annum. The mining plan is shown in Table – 9.11.

Table 9-11 Mining Plan

(Unit : ton)

Division		Dry weight	Wet weight
Mining	Quantity mined per annum	250,000	343,000
	" " " month	20,800	28,600
	" " " day	860	1,180
	" " " hour	148	203
Stripping	Soil removed per annum	-	54,000
	" " " month	-	4,500
	" " " day	-	180
Stripping ratio		0.22	0.16

Note - 1. Working days

It is planned on the 290 working days per annum

General holidays......................... 52days

National holidays......................... 8days

No working days during the rainy season.... 16days

2. Working hours of a day

The calculation is made on the 5.8 working hours per day.

$$8\text{hrs.} - 1\text{hrs.} \times \frac{50}{60} = 5.8\text{hrs.}$$ (actual working hours)

9.4.1 Equipment Investment

The amount of investment necessary to attain the above production is estimated at $1.5 million by ANTAM as follows:

Machines, equipment	U.S.$	460,130
Residences, warehouses	"	909,580
Road	"	15,920
Miscellaneous	"	114,360

The above shows the amount of investment which has been put in the existing facilities and is not needed at the time when the operation is started under the Project. The mining machines must be renewed systematically year by year and ANTAM contemplates to form a plan of annual investments for such renewals. The investment amounts for residences, warehouses and road are the estimated values of existing investments.

ANTAM has a plan to equip the mining machines shown in Table – 9.12 in order to produce the ore of 343,000 tons and to remove the surface soil of 54,000 tons per annum.

Table – 9.12 Mining Machines and Equipment (in US. $)

(Unit US$)

Name of machine	Specifications	Nr	Unit price	Amount	Durable years
Power shovel	0 6-0 8 m^3	2	41,240	82,480	4 years
Loader	1 5 m^3	1	21,444	21,444	"
Bull-Dozer	D-80	3	42,059	126,177	"
Dump Truck	7 ton	9	10,634	95,706	2
Motor Grader	CD-31	2	24,030	48,060	4
Road Roller		1	9,957	9,957	4
Jeep		4	5,658	22,632	3
Pick-up		3	4,765	14,295	3
Motor cycle		10	827	8,270	3
Truck		1	6,507	6,507	3
Air compressor		3	8,201	24,603	4
Total				460,131	

9.4.2 Employee Plan

The planned number of employees for the mining department is 270 persons in total consisting of direct force of 108 and indirect force of 160 persons. At present the total employees of Pomalaa Mine are 870 persons; while the number of employees planned for the Project by ANTAM is 675 persons together with those of the smelting department, thus producing a redundancy of about 200 persons. As the handling volume by the shipping and mining department in particular will decrease, it is quite possible to secure the working force by the transposition of existing employees.

9.4.3 Mining Cost

The planned cost of mining is US$2.85 per ton on the basis of ore production of 250,000 tons and surface soil removal of 54,000 tons per annum, and it provides a sufficient allowance for the rise in price for the future ten years. The following facts may be noted in regard to the contents of mining cost shown in Table – 9.13.

1) Mining machines and equipment

Thought the mining machines and equipment amounting to about U.S.$400,000 seems sufficient in view of the scale of Pomalaa Mine and the conditions of mining, the investment of U.S.$460,000 increased by 15% is reasonable when the state of affairs in Indonesia is taken into account.

2) Repair expenses of mining machines and equipment

The repair expenses which account for 15% of the total investment seems to be reasonable.

3) Labour cost

The labour cost which account for 53% of the mining cost is rather expensive, for which the following reasons may be mentioned.

(a) Mining force

The workers much in excess of necessary number are allotted to the mining force.

(b) Mining efficiency

The mining efficiency for the Project is as low as 13 tons per worker against the present 25 tons per worker (of direct staff).

(c) Wage of workers

The wage of workers is rather expensive compared with the wages of workers at present prevailing in Indonesia.

The reason why an excessive number of workers are allotted to the mining force is that any dismissal of redundancies is difficult due to the state of affairs in Indonesia and the activities of communists in the outlying islands and, therefore, ANTAM has no way but to look to the natural wastage of the existing employees in order to increase its operating efficiency. It may be an inevitable measure in forming the plan.

The allotment of excessive employees causes the increase in worker's residences and incidental facilities which in turn makes the mining cost rather expensive.

Table 9-13 Mining Cost

(Unit : US$)

Cost elements \ Cost		Amount	Cost per ton: per dry weight ton	Cost per ton: per wet weight ton	Remarks
Materials	Fuels, Oils and fats	31,030	0.125	0.091	
	Analysis, Test	6,600	0.026	0.009	
	Total	37,630	0.151	0.110	
Labour cost	Rank 1	28,422	0.114	0.083	12 persons
	Rank 2	65,368	0.262	0.191	46 "
	Rank 3	272,842	1.091	0.795	216 "
	Total	366,632	1.467	1.070	274 persons
Maintenance cost	Machines, Equipment	71,160	0.285	0.207	
	Houses, Warehouses	18,192	0.073	0.053	
	Road	1,600	0.006	0.005	
	Miscellaneous	2,108	0.008	0.006	
	Total	93,060	0.372	0.271	
Prime cost		497,322	1.990	1.451	
Administrative expenses		19,117	0.076	0.056	
Depreciation	Machines, Equipment	143,272	0.573	0.418	
	Houses, Warehouses	45,479	0.182	0.133	
	Road	1,592	0.006	0.005	
	Miscellaneous	5,718	0.023	0.017	
	Total	196,061	0.784	0.573	
Total		712,500	2.85	2.08	

Quantity of ore mined = 250,000 tons

Grade - Ni+Co = 1.8%
Fe = 18 %

Surface soil removed = 54,000 tons

9.5 Problem in Mining

There is no problem in the mining method and machines, and the securing of employees for the mining of low-grade ore, judging from the ability of ANTAM. The most important problem is to coordinate the grades of ores.

With the grade of raw ore becomes lower it becomes more difficult to distinguish the grade with the naked eye. The necessity to supply the smelting plant with the ores of uniform quality makes it important to carry out the quality control at the mining site. The measures to be taken for such quality control include the following.

1) To provide many working faces in many ore bodies.

2) To provide the working face of long length with the height limited less than 3 m.

3) To prepare the assay maps of each working face to make a systematic mining.

4) To confirm the grade of ore with increased number of supplementary pits or boreholes for respective ore bodies.

5) To provide the stockyards divided by grades of ore at the smelting plant so that the ores of various qualities can be blended.

9.5.2 Mining of Hard Ore

Due to the original of garnierite ore, the reserve of hard ore occurs in the lower part of its ore body. A preferable method to mine the hard ore is to dig it by means of a power or dozer shovel or, if the digging by such shovel is difficult, to dig it using a bulldozer and to use a loader for loading.

9.5.3 Mining Plan under the Smelter construction

ANTAM has a plan to complete the smelting facilities in Pomalaa by the end of 1974 and to start the production of ferronickel in 1975. The quantity of ore necessary for the plan is 250 thousand tons (in dry weight) per annum, with planned content of Ni + Co of 1.8% and Fe of from 12% to 15%. As the moisture content of the ore from Pomalaa area is usually 27% in average, the quantity to be digged will be 343 thousand tons per annum.

1) Mine Life

The smelting plan covers 11.1 million tons of ore from the ore deposit in northern Pomalaa which have been secured by ANTAM by its second stage exploration, and which will supply the raw ore for 44 years. If the available ore of 8.45 million tons assessed by the Survey Mission is adopted it will supply the raw ore for 34 years. In either case the ore reserve is sufficient for the present Project. In addition, some increase in the estimated ore reserve is expected from the third stage exploration being planned by ANTAM for the survey of ore deposit in Tg. Pakar and the minute investigation of the environs of ore deposit which have been excluded from the second stage exploration; thus, there will be no problem in the supply of nickel ore.

2) Exportable ore and the construction plan of the smelter

The export of ore to Japan under contract between ANTAM and SUNIDECO is to terminate by the end of 1975 fiscal year (May, 1975). Continueing to it the production of ore will be commenced in the same fiscal year (June, 1975) to supply it for the smelter planned by ANTAM as shown in Table – 9.14.

Table – 9.14 Mining Plan (in D.M.T.)

(Unit : D.M.T.)

Fiscal year		1971	1972	1973	1974	1975	1976
Ore for export	Ore reserve at the beginning of year	3,000,000	2,400,000	1,600,000	800,000	200,000	-
	Production	600,000	800,000	800,000	600,000	-	
	Remaining ore reserve					(200,000)	
Ore for smelting	Production	-	-	-	60,000	250,000	250,000

As seen from the above table, the export contract of high grade ore will terminate in May, 1975, leaving the ore reserve of about 200 thousand tons and the actual digging will come to end in September, 1975. This is the reason why ANTAM should hasten to complete its project for construction of the smelter. In order to put the plant facilities in service several months in advance of running out of ore for export, the construction of such facilities should be started early in 1973 as it is expected to take twenty six months to complete the construction. Any delay of the construction works will constitute a serious crisis for ANTAM to lose its most important source of earnings as well as cause a social problem for the local workers. Therefore it is desirable to start the construction works in January or February of 1973.

X. SMELTING PROCESS

The products from nickel ore are metallic nickel, ferronickel and nickel oxide and at present various methods as shown in Table – 10.1 are used to manufacture them.

10.1 Smelting of Nickel Sulfide Ore

Nickel sulfide ore is easily dressed and provides the concentrate of high nickel content. The concentrate of nickel sulfide is used principally as a material to manufacture metallic nickel. In Japan, the nickel matte for metallic nickel is produced from both the concentrate of nickel sulfide and the siliceous ore (garnierite ore) by the Shisakajima Smelter of Sumitomo Metal Mining Co., Ltd.

In Canada, the metallic nickel is manufactured from the concentrate of nickel sulfide by various methods shown in Table – 10.1 by such smelters as International Nickel Co. (INCO), Falconbridge and Sherritt Gordon.

As no nickel sulfide ore is produced in Indonesia, any further mention is not made of it here.

10.2 Smelting of Siliceous and Laterite Ores

Siliceous ore which is produced in Indonesia and New Caledonia is imported into Japan principally to manufacture ferronickel and partly to use it as the material for metallic nickel. So far there is no satisfactory method to concentrate commercially either of siliceous and laterite ores. In 1970, the siliceous ore containing about 2% or 3% of Ni + Co was imported into Japan, including 73,000 tons (in net weight of nickel) chiefly from New Caledonia and partly from Indonesia (about 8,000 tons in net weight of nickel)

Though the smelting of laterite ore is not made in Japan because of its generally low content of Ni (about 1.5%) and high content of Fe, it has been operated at the producing districts of the ore. For example, Nicaro and Moa Bay of Cuba and Sered of Czechoslovakia recover metallic nickel or nickel oxide and nickel sulfide as the materials to produce metallic nickel by the wet process; Larymna of Greece manufactures ferronickel by the preferential reducing method.

Recently it is reported that a plant of the wet process from laterite is being constructed in Philippines with the technical assistance of Sherritt Gordon Co.

The ore to be covered by the Project is garnierite ore containing about 1.8% of nickel with Ni to Fe ratio (in weight) of 1 : 7. Its grade is far lower than that of ore being smelted presently by various smelters in Japan which contains 2.2% or more of nickel (including cobalt) with Ni to Fe ratio of 1 : 5 or more and it is not the so-called exportable ore. The nickel content which is profitable for smelting of course varies with the market price of nickel; any way it will be more advantageous to smelt such low-grade ore at the mining district because of very low cost of ore than to transport it to Japan for smelting.

Table 10-1 Smelting Process of Nickel in the World

1. Nickel Sulfide Ore			
Metallic nickel	I. Electrolytic process	Ni concentrate→roasting, smelting$_1$ →converter removing iron$_2$→slow cooling and floatation for removal of Cu ^{1}(Ni, Cu, Fe matte) ^{2}(Ni matte) oxidizing roasting$_3$→reducing smelting$_4$→electrolytic refining$_5$ ^{3}(Ni oxide) ^{4}(Ni anode) ^{5}(Ni metal)	INCO USSR Sumitomo metal Mining Co., Ltd.
	II. Matte-electrolytic process	Ni concentrate→roasting, smelting$_1$ →converter removing Fe→electrolytic refining$_2$ ^{1}(Ni, Cu, Fe matte) ^{2}(Ni matte anode)	Falconbridge
	III. Ammonia leaching process	Ni concentrate→leaching with ammonia$_1$→Hydrogen sulfide for removal of Cu$_2$→hydrogen reduction$_3$ ^{1}(Ni solution) ^{2}(Ni purified solution) ^{3}(Ni powder)	Sherritt Gordon
	IV. Carbonyl process	Ni concentrate→Ni oxide→ gas reducing$_1$→carbonylization$_2$ →decomposing$_3$ ^{1}(Crude Ni powder) ^{2}(Ni carbonyl) ^{3}(Ni powder)	INCO
Nickel oxide	V.	Intermediate product from electrolytic process for metallic nickel	INCO Tokyo Nickel
2. Nickel Oxide Ore			
Metallic nickel	I. Electrolytic process	oxide ore→matte smelting$_1$→ converter removing Fe$_2$→oxidizing roasting$_3$→the process hereafter is the same as the method I for Ni sulfide ore. ^{1}(Ni, Fe matte) ^{2}(Ni matte) ^{3}(Nickel oxide)	USSR Sumitomo
	II. Matte electrolytic process	oxide ore→matte smelting→ converter removing Fe→the process hereafter is the same as the method II for nickel sulfide ore	Shimura Kako Co., Ltd.

Nickel oxide	III.	Intermediate product from the electrolytic process	Le Nickel
	IV. Ammonia leaching process	oxide ore → selective reduction → leaching with ammonia$_1$ → removing of Fe and ammonia$_2$ → roasting → sintering → Ni oxide$_3$ [1](Ni solution) [2](Ni carbonate) [3](Ni oxide) sinter	Nicaro
(Metallic nickel)	V. Sulfuric acid leaching process	oxide ore → leaching with sulfuric acid$_1$ → pouring of $H_2S$$_2$ → leaching with sulfuric acid$_3$ → removing of Fe, Cr, Al, Cu, Ib, Zn$_4$ → hydrogen reduction sintering$_5$ → Ni briquette [1](Ni solution) [2](Ni sulfide) [3](Ni solution) [4](purified nickel solution) [5](Ni powder)	Free Port Sulphur
Ferro-nickel	VI. Blast furnace process	oxide ore → briquette → blast furnace$_1$ → converter → ferronickel ingot [1](crude ferronickel)	Nippon Mining Co.,
	VII. Elkem process	oxide ore → rotary kiln → electric furnace → converter → ferronickel ingot	Pacific Metals Co., Hiuga Smelting Co., Le Nickel Morro de Niqull
	VIII. Krupp-Renn process	oxide ore → rotary kiln$_1$ → crushing → gravity separation, magnetic separation → ferronickel ingot [1](half melted reduced ore)	Nippon Yakin Kogyo Co., Zobcovice
(Metallic nickel)	IX. Moussoulos process	oxide ore → rotary kiln$_1$ → electric furnace selective reduction$_2$ → converter → ferronickel [1](selective reduction) [2](crude ferronickel)	Larco
	X. Hanna process	oxide ore → rotary kiln$_1$ → electric furnace$_2$ → skip mixer$_3$ → electric furnace, or multiple furnace$_4$ → ferronickel [1](pre-heating) [2](melting only) [3](ferrosilicon reduction) [4](refining)	Hanna

As stated previously, in addition to the garnierite ore mentioned above the Pomalaa mine-lot owned by ANTAM has the huge reserve of laterite ore developed by the joint exploration of ANTAM and SUNIDECO of Japan. Depending on the demand and supply of nickel in future a smelting plant to process this laterite ore should be constructed by the cooperation of ANTAM and SUNIDECO. A plan for constructing a smelting plant was submitted to the Government of Indonesia in October, 1970, under the name of SUNIDECO. This plan should be reviewed in view of the change in the supply-demand relations and the progress of technology.

10.3 Ferronickel Smelting Process from garnierite Ore from Pomalaa Area

An average constitution of garnierite ore containing low percent of nickel from pomalaa area is shown in Table - 10.2.

Table – 10.2 Average Constitution of garnierite Ore from Pamalaa Area

(In percent of weight)

Ni	Co	Fe	Cr	Mn	Cu	SiO_2	MgO	CaO	Al_2O_3	P	S	L.O.I.
1.78	0.02	12.0	0.5	0.16	0.005	44.0	22.0	2.0	1.3	0.001	0.02	9.0

This ore is about the same as that being smelted presently in Japan but its nickel content is low. Theoretically it can be smelted by any of smelting processes now used in Japan. The typical processes among them are shown in Fig. – 10.1 and the characteristics of these processes are described briefly in the following subparagraphs.

10.3.1 Kiln-Electric Furnace Process (Elkem Method)

This process is used by Hachinohe and Shibata Works of Pacific Metals Co., Ltd.; Hiuga Smelting Works Co.; Date Works of Shimura Kako Co., Ltd.; Saganoseki Smelter of Nippon Mining Co., Ltd.; and Hinode Kagaku Co.. In general, the ores which have been crushed are heated by a rotary kiln to remove adhering and crystallized water and then the hot ores are charged in a electric furnace of closed type for reducing smelting. The electric furnace of closed type used for this process is one developed by Elkem Co. of Norway and Chiyoda Kogyo Co. of Japan has the right to build it in Japan as well as to construct it in foreign countries in the form of reparation, with a loan in yen, or under technical asistance or cooperation offered from Japan.

This process has been operating at Doniambo Smelter of Société Le Nickel, New Caledonia, with poor working results, and was adopted at Shibata Works of Pacific Metals Co. in 1965 for the first time in Japan; since then many smelters in Japan have come to adopt this method. The principal change of ferronickel smelting facilities in Japan is shown in Table – 10.3.

Table 10-3 Principal Change of Ferronickel Smelting Facilities in Japan

Year	Production (In net weight of nickel-Ton)	Change of facilities
1952		Nippon Mining started the production in one blast furnace. Nippon yakin restarted luppe process with two kilns.
1953	1,657	
1954	2,261	Nippon Mining adopted oxygen purification process.
1955	2,878	Nippon Mining started No. 2 furnace.
1956	5,655	Nippon Mining started No. 3 furnace. Hiuga Smelter started production with sintering - open electric furnace.
1957	7,513	Nippon Mining started No. 4 furnace. Toyama Smelter started production with sintering - open electric furnace.
1958	3,133	
1959	9,031	Pacific Metals started operation (with 7 units of open electric furnaces).
1960	15,006	Nippon Mining expanded its furnaces. Hiuga Smelter increased open electric furnaces.
1961	15,648	
1962	8,303	
1963	15,823	Shimura Kako started production with open electric furnace.
1964	21,363	
1965	19,239	Pacific Metals installed 7,500 K.V.A. Elkem system electric furnace in Shibata Works. Toyama Smelter increased open electric furnace.
1966	25,486	Pacific Metals installed 5,000 K.V.A. open electric furnace in Hachinohe Works.
1967	36,344	Pacific Metals installed 18,000 K.V.A. Elkem system electric furnace in Hachinohe Works. Nippon Mining started production by luppe method with kiln. Nippon Yakin increased 4 kilns.
1968	38,500	Pacific Metals installed 12,000 K.V.A. Elkem system electric furnace in Shibata Works. Hiuga Smelter installed 15,000 K.V.A. Elkem system electric furnace.
1969	50,356	Pacific Metals installed 25,000 K.V.A. Elkem system electric furnace in Hachinohe Works . Hiuga Smelter increased Elkem furnace. Shimura Kako installed two 8,150 K.V.A. Elkem furnaces in Date Works.
1970	66,855	Nippon Mining installed 30,000 K.V.A. Elkem furnace. Hiuga Smelter increased two 25,000 K.V.A. Elkem furnace, Pacific Metals installed 40,000 K.V.A. Elkem system electric furnace in Hachinohe Works.
1971	78,209	

It may be seen from Table – 10.3 that all manufacturers of ferronickel in Japan except Nippon Yakin Co. adopt the electric furnace system either wholly or partially, and that the recent increases of facilities in particular depend on the kiln-electric furnace system (Elkem method).

Characteristics and Problems of this Process are as follows;

1) The heating of ores by kiln is made usually up to 1,000^{o}C and if the heating is made to higher temperature, heated ores stick easily to each other.

2) The powdery ores become granulated to some extent and the lump ores are broken by the heat becoming uniformly grained in the kiln.

3) The thermal efficiency is high resulting in the reduction of power consumption because the calcined ores in red heated condition are charged directly in the electric furnace.

4) The nickel content of ore is low in general and most of energy is consumed to melt the gangue minerals of the ore.

5) The temperature in the electric furnace is easily controlled.

6) The power cost accounts for a high ratio in the production cost and thus the lower unit power cost means a higher profitability. As the power consumption per ton of ore is from 550 to 650 kWH, the higher the nickel content is, the more it is advantageous.

10.3.2 Blast Furnace Process

The balst furnace process is operated at Saganoseki Smelter of Nippon Mining Co., Ltd. Though it is possible to operate the process on a larger scale the present capacity of production is 8,800 tons (in weight of pure nickel) per annum with four units of blast furnaces, as limited by the process of increasing the facilities. Recently the Works increased 30,000 K.V.A. electric furnace of Elkem system which has the capacity to produce 7,700 tons (in weight of pure nickel) per annum comparing to the capacities of four units of blast furnaces.

Characteristics and Problems of this Process are as follows;

1) Strong briquette or sintered ores are required in order to provide an improved furnace draft.

2) More quantity of flux such as limestone and silica is used to control slag component as compared with that used in the electric furnace process.

3) Cokes of good quality is required to use as a reducing agent.

4) The thermal efficiency of furnace is high and the exhaust gas is used for pre-heating of hot air and power generating.

10.3.3 Krupp-Renn Method

The Krupp-Renn method has been operated at Oeyama Works of Nippon Yakin Co. since 1942. Ores, anthracite, silica sand and limestone crushed into fine powder and mixed thoroughly and are formed into pellets, which are heated in the rotary kiln to the maximum temperature of about 1,300°C to produce luppe. The luppe is further crushed to separate into pure luppe and slag by means of gravity or magnetic separation.

Characteristics and Problems are as follows;

1) Only the rotary kiln is used with a resultant reduction in the equipment investment.

2) It is necessary to crush and mix thoroughly the materials to be charged in the rotary kiln.

3) The recovery percentage of smelting (from 88% to 90%) is somewhat lower than that for other methods.

Since Nippon Yakin Co. consumes all produced ferronickel luppe by itself and does not sell it as a product, it constitutes no problem even though the product does not meet the Japanese Industrial Standard.

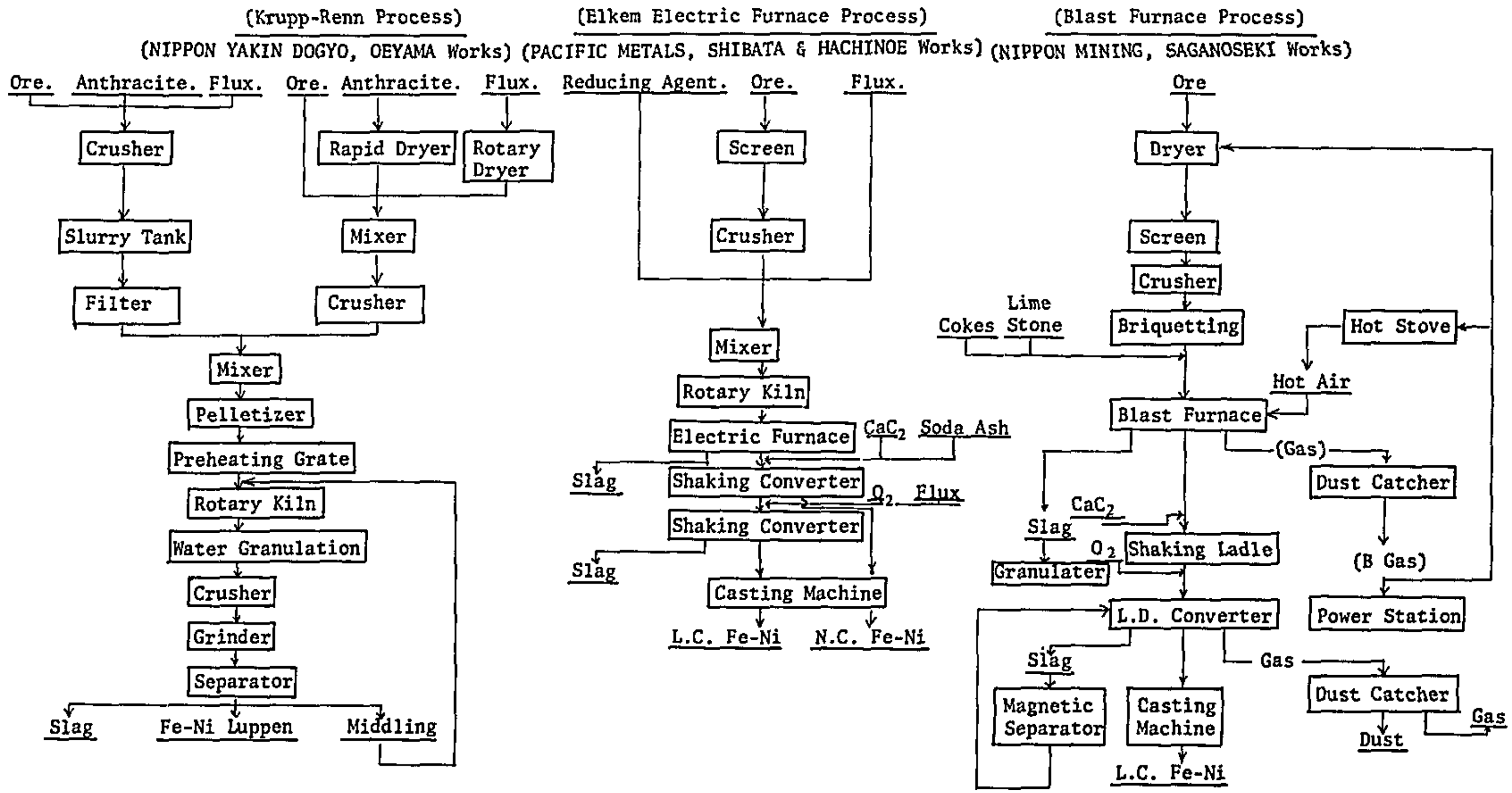
10.3.4 Preferential Reduction Process

When the low-grade ore is smelted by any of the methods described above, the nickel content of product obtained is low due to low ratio of Ni to Fe in the ore and the product cannot be used as it is. It is so arranged that nickel in ore is reduced preferentially to decrease the reduction ratio of iron and at the same time to increase the nickel content of product. The preferential reduction process can be used for both the low-grade garnierite and laterite ores and so far it has been applied to the laterite ores of low nickel content. The LM method of Greece and Hanna method of U.S.A. are the typical examples of commercial seales of this process. Other various processes proposed include the Strategic Udy, Falcon, U.S. Bureau of Mine, and Takakuwa methods, etc.

1) LM Method

The LM method originated from the study by Prof. L. Moussoulos of Greece is operated now at the Larymna Works in that country. Crushed ores are charged in the kiln together with reducing agent to reduce iron oxide in

Fig. 10-1 Typical Fe-Ni Smelting Process in Japan

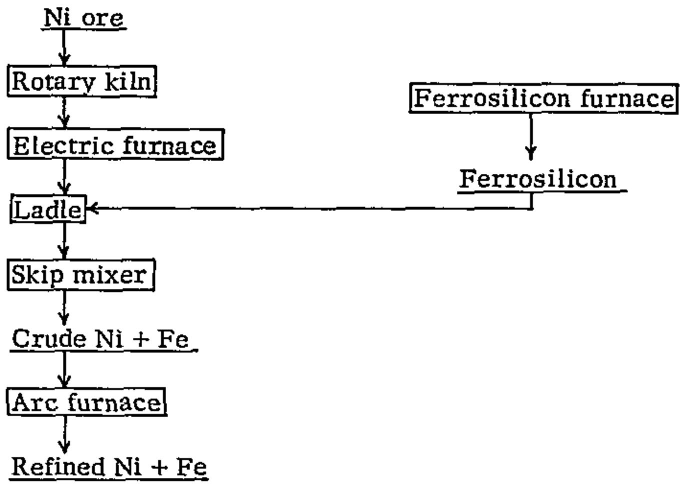


the ores. Then calcined ores and the reduced ores are charged in the electric furnace and nickel oxide is reduce by metallic iron which is reduced by the above kiln. The metallic iron turns into iron oxide and forms slag. The ore used in Greece at present is the laterite ore containing about 1.6% of Ni, 35% of Fe, and from 3.0% to 10.0% of SiO_2.

2) Hanna Method

The Hanna method is operated at Riddle Mine of Hanna Nickel Smelting Co. of U.S.A., of which process chart is shown in Fig. – 10.2.

Fig. – 10.2 Process Chart of Hanna Method



The ore is low-grade garnierite containing 1.5% of Ni, from 8% to 15% of Fe, from 25% to 38% of MgO, and from 45% to 55% of SiO_2. The ore, dried and then added with dust coal or saw dust as a reducing agent, is charged in the kiln, by which about 50% of Fe_2O_3 is reduced to FeO. The ore while it is hot is charged in the electric furnace for melting; the melted ore in a ladle is transferred to the skip mixer and at the same time ferrosilicon is added to it to reduce nickel. The above process is repeated several times to reduce nickel thoroughly. After slag is separated, the product is refined by the arc furnace for removing phosphorus.

The method is troublesome requiring complicated operations and is not suitable to a mass production.

3) Other Methods

In the Udy method developed by Strategic Udy Co. of U.S.A., most of nickel is reduced and Fe^{III} reduced to Fe^{II} in the rotary kiln and they are quick-melted by the electric furnace. Slag is processed in a separate electric furnace to reduce pig iron. It is said that the test operation was made with a furnace of 1,000 KVA, and it will be a profitable method to process the laterite ore of high iron content. In Japan some methods based on the same principle have been published and is now under investigation. A test operation of a method is under way in Dominica by Falconbridge Co. to reduce nickel preferentially in a vertical furnace and melt it by a electric furnace.

10.4 Refining Process of Ferronickel'

Ferronickel produced by the Krupp-Renn method is used without refining as a material to manufacture stainless steel and etc., but that produced by the blast furnace or electric furnace processes is generally refined to sell it on the market.

The standards of ferronickel of Japan and Le Nickel Co. are shown respectively in Table – 10.4 and 10.5.

Table – 10.4 Japanese Industrial Standard of Ferronickel

Kinds	Symbol	Ni+Co	C	Si	Mn	P	S	Cr	Cu
High-carbon ferronickel	FNiH	18.0-23.0	>3.0	<2.0	<0.5	<0.30	<0.05	<2.0	<0.10
Medium carbon ferronickel No.1	FNiM1	23.1-28.0	<0.25	<0.5	<0.5	<0.03	<0.03	<0.10	<0.10
Medium carbon ferronickel No.2	FNiM2	18.0-23.0	<0.25	<0.5	<0.5	<0.03	<0.03	<0.10	<0.10
Low-carbon ferronickel No.1	FNiL1	>28.0	<0.02	<0.3	<0.5	<0.02	<0.03	<0.10	<0.10
Low-carbon ferronickel No.2	FNiL2	23.1-28.0	<0.02	<0.3	<0.5	<0.02	<0.03	<0.10	<0.08
Low-carbon ferronickel No.3	FNiL3	18.0-23.0	<0.02	<0.3	<0.5	<0.02	<0.03	<0.10	<0.08

Table 10-5 Standard of Ferronickel, S.L.N.

(In %)

Kinds	Ni+Co	S	C	Si	P
FN1	>20	<0.04	<0.04	<0.04	<0.04
FN2	>20	<0.04	1.5-2.0	-3.0	0.03-0.04
FN3	>20	<0.30	1.5-2.5	3.0-3.5	0.03-0.04

A refining process is required to meet these standards, which is divided generally into decarburizing and desulfurizing processes.

The desulfurization is processed by adding carbide and soda ash to molten crude ferronickel by a low frequency induction furnace, shaking converter or KR type desulfurizer; which are used respectively by various smelters. The shaking converter originated by Prof. B. Kalling of Sweden was developed by G.H.W. of Germany and the rights for its manufacture and sale on the market in Japan are vested in Pacific Metals Co. and Okura Trading Co., Ltd. The manufacturing technique by means of the shaking converter was exported to Doniambo Smelting Works of New Caledonia by Pacific Metals Co.

The decarburization is processed with oxygen being blown in using the shaking or LD converter in general. The LD converter process is operated at Saganoseki Smelter of Nippon Mining and it is now a generalized technique for the steel making furnace in a large scale.

10.5 System adopted for the Present Project

Among various methods described briefly in the above, the kiln-electric furnace system is suitable to process the ores from Pomalaa area in view of the sale of the product under the existing circumstances. The kiln-electric furnace system is also capable to process the low-grade laterite ore by preferential reduction, but this process is now under investigation.

It is reasonable that ANTAM has determined to adopt the kiln-electric furnace system as a suitable method to treat low grade garnierite ore.

10.6 Processing of Ore from Pomalaa Area by Wet Smelting Method

The product of the present Project is ferronickel and, therefore, the wet smelting method to produce metallic nickel or nickel oxide does not come into consideration here. However, it is difficult to determine which is more profitable the wet smelting method to produce metallic nickel and nickel oxide and the electric furnace method to produce ferronickel when the low-grade laterite ore is processed in future. The judgement will be made by the techniques now being developed, that is, through the technical establishment of preferential reduction method; the process of making high grade nickel concentrate such as segregation process.

At present the extraction methods of low-grade laterite ore include reduction-ammonia leaching method (Nicaro method) operated in Cuba and Czechoslovakia, and pressure-sulfuric acid leaching method operated in Moa Bay, Cuba. At Surigao in Philippines, Marinduque Mining and Industrial Corporation has published a plan to process the low-grade laterite ore containing 1.22% of Ni, 0.1% of Co, and 38.4% of Fe to produce annually 34,200 tons of pure metallic nickel, 3,300 tons of nickel and 1,650 tons of cobalt as the forms of sulfides. The scale of this plan may be measured by comparing to the production of Japan composed of about 13,400 tons of metallic nickel and 78,000 tons of ferronickel per annum.

10.7 Proper Scale of Production by Kiln-Electric Furnace Process

The capacities of Elkem electric furnace varies widely and at present the units of various capacities ranging from 7,500 KVA to 40,000 KVA are operated in Japan.

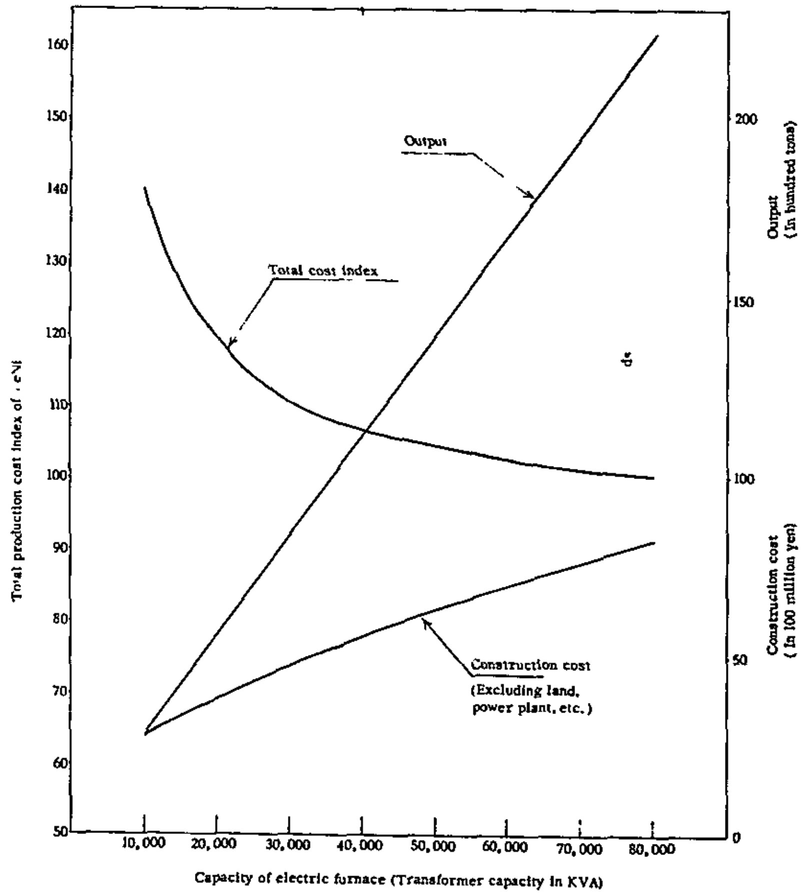
The productivity becomes more advantageous in proportion to the greater capacity of furnace. An example of the relations of capacity to total production of ferronickel, construction cost and output is shown in Fig. – 10.3 for the electric furnaces operated in Japan. It is an example of trial calculation made on various assumptions and the relations will of course varies with the change in ore grade and various prime units used. The comparison of the furnace of 20,000 KVA to that of 30,000 KVA shows that the total cost index for the latter is lower by 8% than the former, that is, the latter is more advantageous than the former. Therefore it is seen that the electric furnaces to be constructed newly are increasing their capacities more and more.

In Japan, various works adopted the electric furnaces of comparative small size to make the engineers to increase their experiences and to become skillful in operation, and after which the furnaces of greater capacity have been installed gradually. If such condition is attained and the sufficient supply of nickel ore and the market for product are secured satisfactory, it is of course advantageous to construct the furnaces of large scale from the first step.

As for the present Project, it will be wise to start with a electric furnace of 20,000 KVA in view of the employment of engineers and the present conditions of nickel market, though the ore can be secured in sufficient quantity.

It goes without saying that the plant of this 20,000 KVA unit makes some profits. The data are available to demonstrate the profitability as described in the paragraph dealing with the economic aspect.

Fig. -10. 3 Capacity of Electric Furnance to Total Production Cost of Ni + Co, Construction Cost and Output



10.8 Test Operation with Garnierite Ore from Pomalaa Area

At the request of ANTAM the test and study on the possibility of concentrating the low-grade garnierite ore from Pomalaa area were conducted by Australian Mineral Development Labolatories, Adelaide, in 1970 and Institute of Metallurgy in Bandung, Indonesia, from 1968 to 1970 but no successful method was found.

A basic test on the smelting by an electric furnace was requested to Elkem of Norway in 1970. ANTAM who assured the possibility of smelting by the Elkem method requested Pacific Metals Co. in August, 1970, to conduct the feasibility study including the test operation of ore concentration. The test operation was carried out with 9,600 tons of garnierite ore containing 1.29% of nickel in average at Shibata Works of Pacific Metals Co. for about one month, divided into three terms, from October 16 to November 13, 1970.

The tests in the first and second terms were conducted on the ores containing 1.33% and 1.65% of nickel by the ordinary kiln-electric furnace process. In the third test the ore containing 1.55% of nickel was processed by the selective pre-reduction process. The ratio of Ni + Co to total Fe ranged from 1 : 6.3 to 1 : 6.8 which are lower than about 1 : 5 of the ores being processed in Japan at present.

As a result of the test operation it was demonstrated that the ore in question can be processed by the ordinary kiln-electric furnace method on the commercial base and various prime units on the operation were obtained to use as the basic data to prepare the Feasibility Report. The results of the test were examined minutely by the Survey Mission; however, they are not shown in this report in compliance with the strong desire of ANTAM and Pacific Metals Co.

Any conclusion was not drawn from the test operation by the selective pre-reduction process due to short test period. It is necessary to continue the test further for commercialization; the results of test show that it is one of the feasible method to be developed in future.

The approximate effect of ore grade on the production cost is shown in Table – 10.6 in terms of cost indices for 1.8%, 2.0% and 2.4% of nickel content on the basis of production cost = 100 when the ore containing 2.2% of nickel is processed by the electric furnace of 20,000 KVA proposed for the present project.

Table – 10.6 Ni Ore Grade and Production Cost Index of Ferronickel.

Ni content of ore (in %)	Index of production cost
1.8	120
2.0	110
2.2	100
2.4	90

The above table shows that the higher the ore grade is, the more it is advantageous.

XI. SMELTING FACILITIES.

11.1 Production Plan

The export of nickel ore (containing 2.2% or more of Ni + Co) being mined in Pomalaa Area under the joint exploration by SUNIDECO and ANTAM is expected to end by May of 1975, and it has been ascertained that only ore of low nickel content will be left in the environs of the present stopes.

The typical chemical constitution of the nickel ore from Pomalaa Area as analyzed by ANTAM is shown in Table – 11.1.

Table – 11.1 Chemical Constitution of Nickel Ore from Pomalaa Area

(In %)

Ni+Co	Fe	Cr	SiO_2	MgO	S	Al_2O_3	CaO	Water of crystallization
1.60	10.85	0.40	48.92	18.05	0.02	1.19	3.15	7.69
1.62	13.0	0.62	43.30	22.23	0.03	1.62	0.00	9.50
1.70	15.38	0.92	44.24	17.17	0.02	2.30	1.27	8.81
1.81	11.26	0.59	40.48	18.84	0.02	5.01	2.86	10.21
1.98	15.25	0.66	38.06	15.92	0.00	2.29	0.00	9.38
2.10	10.0	0.70	44.10	22.56	0.01	1.75	0.00	9.75
2.14	13.0	0.64	44.68	16.94	0.02	2.60	2.68	8.50
2.19	15.2	0.68	36.76	16.08	0.02	5.34	2.68	10.67

Accordingly, ANTAM has prepared, as its business plan after the production of exportable nickel ore having been completed, a project to smelt the low-grade nickel ore to turn out ferronickel at Pomalaa. The plan of ANTAM is to produce ferronickel of about 20,000 tons, or 4,000 tons in weight of pure nickel, annually from 250,000 tons (in dry weight) of the low-grade ore on the presumption that the average chemical constitution of the ore is as shown previously in Table – 10.2 with the ore reserve estimated at about 10 million tons.

For the production of ferronickel, the electric furnace method of Elkem system has been selected and one unit of 20,000 KVA electric furnace will be installed as nucleus equipment, based on the chemical constitution of ore shown above.

The planned chemical constitution of ferronickel to be produced is shown in Table – 11.2.

Table – 11.2 Chemical Constitution of Ferronickel to be Produced

(In % of Weight)

	Ni	Co	C	Si	Cr	P	S	Cu	Fe
Crude Fe-Ni	17.0	0.24	2.3	3.5	1.9	0.02	0.15	0.06	Bal
H.C. Fe-Ni	17.0	0.24	2.3	3.5	1.9	0.02	0.02	0.06	Bal
L.C. Fe-Ni	20.0	0.45	0.01	0.02	0.1	0.01	0.01	0.06	Bal

The productivity is planned at 80% for the first year of operation, 90% and 95% respectively for the second and third years, and 100% for the fourth year and thereafter, taking into account the skill in the operating technique and some safety factor.

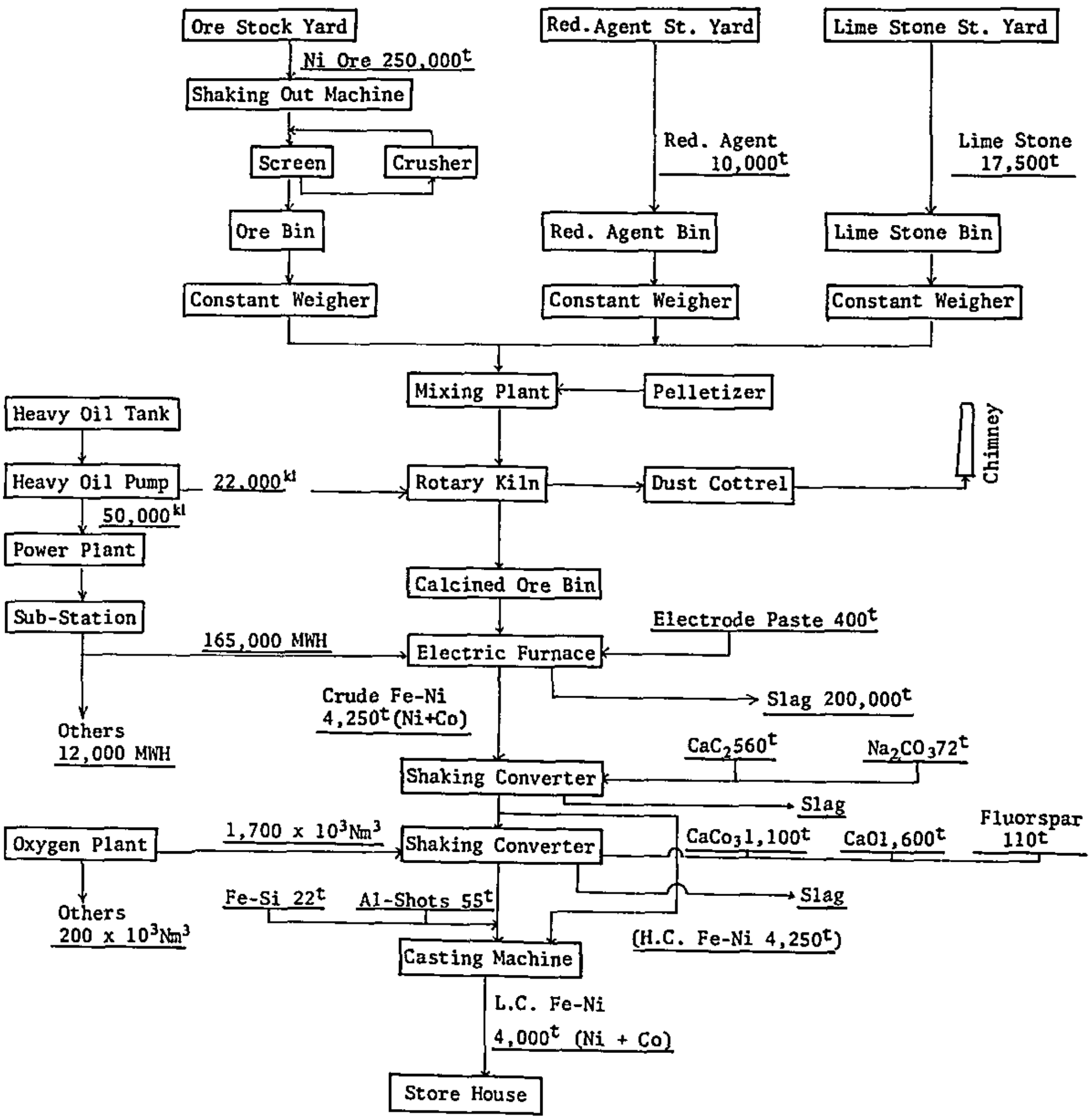
The most important thing to achieve the object of the Project losing no time is to improve the rate of operation as soon as possible and thus the operation will become profitable at an early date. This allowance for the starting of operation seems much redundant to our way of thinking, though it can be understand that a high safety factor is allowed in view of the first experience for ANTAM in such operation. We wish and expect that the production programme could be brought to its full operation considerably sooner than as planned under the appropriate instruction by our engineers and the zealous endevour by the engineers of ANTAM.

The concept of production process and the material balance are shown in Fig. – 11.1. The prime units of various materials and energies are shown in Table – 11.3.

Table – 11.3 Prime Units of Various Materials and Energies in Production Process

Name	Annual consumption	Per ton of Ni ore	Per ton of L.C.Fe-Ni	Per ton of pure Ni	Remarks
Ni ore	$250,000^{t}$	-	12.5^{t}	62.5^{t}	
Reducing agent	10,000	40.0^{kg}	0.5	2.5	
Limestone	21,800	87.2	1.09	5.45	$3,200^{t}$ for quick-lime included
Quicklime	1,600	6.4	80.0^{kg}	400^{kg}	
Electrode paste	400	1.6	20.0	100	
Calcium Carbide	560	2.24	28.0	140	
Soda ash	72	0.29	3.6	18	
Fluorspar	110	0.44	5.5	27.5	
Ferrosilicon	22	0.09	1.1	5.5	
Aluminum shot	55	0.22	2.8	13.8	
Electric power	$180,000^{MWH}$	720^{KWH}	9.0^{MWH}	45.0^{MWH}	3,000 MWH for general houses included
Heavy oil	$72,000^{kl}$	288^{l}	3.6^{kl}	18.0^{kl}	
Oxygen	$1,900 \times 10^{3}$ Nm^{3}	7.6^{Nm^3}	95.0^{Nm^3}	475^{Nm^3}	
Industrial Water	$27,920 \times 10^{3t}$	111.7^{t}	$1,396^{t}$	$6,980^{t}$	3,490 t/hr, 2,200 t/hr for power plant included
Circulating water	$21,920 \times 10^{3}$	87.7	1,096	5,480	2,740 t/hr, 1,800 t/hr for power plant included
Make-up feed	$6,000 \times 10^{3}$	24.0	300	1,500	750 t/hr, 400 t/hr for power plant included

Fig. 11-1 Concept of Production Process and Material Balance



11.2 Condition of Plant Location

The optimum conditions of plant location are

1) That the transportation and taking in of raw materials are easy;

2) That the carrying out and shipment of products are easy;

3) That it is conveniently located to access to and to receive the services of utilities;

4) That the working environment for employees is good; and

5) That the exhausted matters from plant can be disposed easily.

Taking these conditions into consideration, ANTAM has a plan to construct the plant at the location shown in a separate chart, "Layout of Facilities in Pomalaa Area." The plant is located within a distance of about 4 km even from the farthest excavation site of raw ores and about 1.5 km from the existing jetty and also about 2.0 km from the new jetty under plan where the construction equipments and materials are to be landed and the products shipped. The location well meets other conditions and may be regarded as optimum.

11.3 Plant Layout

The plant site of about 180 thousand m^2 has been secured taking into account the future expansion and the plant layout has been planned as shown in the separate chart, "Plant Layout Plan." The land is now under preparation, of which 30% have been completed.

The principal facilities of the plant including are situated in the approximate

1) Ore stock yard;

2) Ore treatment plant;

3) Rotary kiln plant;

4) Electric furnace plant;

5) Refining plant;

6) Casting equipment; and

7) Store house for products;

are situated in the approximate center of site, in adjacent to them the facilities such as power plant, substation and heavy oil tanks are arranged, with other incidental equipments are provided around them.

The layout seems desirable as the one series of facilities can be increased in future by arranging them almost symmetrically with the existing facilities.

However, it will be more preferable to change the position of the field to flow out slag produced from the electric furnace with that of the rotary kiln. Because such field can be used jointly by another electric furnace when increased in future and it will be more convenient to carry out slag having been cooled and crushed.

11.4 Plant Construction

11.4.1 Plant and Equipment

The smelting plants and equipments being planned, their principal specifications and dimensions, and the estimated amount of equipment investment are shown in Table – 11.4 and 11.5.

The equipment plan for the smelting plant of ANTAM has been formed modeling after the plant of 25,000 KVA working now at Hachinohe Works of Pacific Metals Co., Ltd. (to produce about 35,000 tons of ferronickel annually). The fact that the model plant is working favorably makes us to convince that a satisfactory results will be attained by the zeal and mastery in technique of engineers of ANTAM under the technical guidance for both construction and operation to be rendered from Japan.

The cardinal points of successful smelting operation are the appropriate treatment of ore and the constant supply of good calcined ore to the electric furnace, and those of inproving the rate of operation are the burning and control of electrode. It is desired that a sufficient attention should be given to these points in designing the equipments.

11.4.2 Construction Schedule

The original plan for constructing the plant schedules to complete in 26 months after the equipments have been ordered. This schedule seems reasonable in view of the import of the machines and materials to be made from Japan, the construction works at a remote site of Pomalaa and the labor efficiency of local workers.

The construction schedule prepared by ANTAM is shown in Table – 11.6, to which some remarks are made below.

It is necessary to complete the facilities to supply, in particular, electric power, water and fuel as soon as possible and conduct the test operations of them carefully. Initial troubles are apt to occur on the piping and wiring systems at the starting time of operation, and the special care should be taken of them.

In order to make a favorable start of operation for the smelting by means of the electric furnace, the facilities to deal with material, in particular such as rotary kiln and its accessory equipment necessary to process ore, should be completed at least one or two months prior to the completion of electric furnace so that a sufficient confidence can be gained for producing the calcined ore of good quality.

For reference a construction schedule which the Survey Mission recommends is attached as Table – 11.7.

Table 11-4 Summary Of Pomalaa Fe-Ni Project Cost Estimate

(In Equivalent US Dollars)

Item of Equipments	C.I.F.	Installation	Civil Works	Others	Total	Remarks
1. Ore Stock Yard	-	-	58,620	-	58,620	
2. Screening, Crushing & Mixing Plant	560,000	54,000	71,070	-	685,070	
3. Rotary Kiln Plant	1,920,000	300,000	316,900	-	2,536,900	
4. Electric Furnace Plant	2,600,000	370,000	615,370	-	3,585,370	
5. Refining Plant	1,800,000	74,000	128,450	-	2,002,450	
6. Store House for Products	-	-	125,730	-	125,730	
7. Store House for Miscellaneous Articles	-	-	76,520	-	76,520	
8. Store House for Reducing Agents	-	-	108,130	-	108,130	
9. Analytical Laboratory	150,000	-	105,820	-	255,820	
10. Power Plant and Sub-Station	3,780,000	225,000	429,760	-	4,434,760	
11. Oxygen Plant	600,000	165,000	43,970	-	808,970	
12. Water and Oil Supply Systems	1,000,000	545,000	102,000	-	1,647,000	
13. Jetty	-	-	260,390	-	260,390	
14. Electric Wiring Works	473,000	140,000	54,270	-	667,270	
15. Brick Works	855,000	140,000	-	-	995,000	
16. Land Levelling, Road Building and Drainage Works	-	-	190,000	-	190,000	
17. Air Strip	-	-	300,000	-	300,000	
18. General Buildings, Houses & Company Residences	-	-	1,000,000	-	1,000,000	
19. Unloading, Transportation & Storing	-	-	-	170,000	170,000	
20. Steel Structure Materials	1,589,000	-	-	-	1,589,000	
21. Miscellaneous	200,000	50,000	-	3,080,000	3,330,000	
22. Contingency Reserve	-	-	-	2,173,000	2,173,000	
Grand Total	15,527,000	2,063,000	3,987,000	5,423,000	27,000,000	

Table 11-5 Equipments and Equipment Investment for Pomalaa Ferronickel Smelting Plant

Equipment	Specifications	Machines (C.I.F.in $)	Installation cost (In $)	Civil Works costs (In $)	Miscellaneous (In $)	Total (In $)	Remarks
1. Ore Stock Yard	Indoor yard 2,400 m^2 Outdoor yard 1,600 m^2			58,620		58,620	
2. Screening, Crushing, & Mixing Plant		560,000	54,000	71,070		685,070	
1) Shaking-out Machine	80-120^t/h, 37KW 1unit						
2) Single Toggle Crusher	30t/h, 30KW 1unit						
3) Ripple Flow Screen	80-120t/h, 15KW 1unit						
4) #/ Impeller Breaker	30-40t/h, 75KW 1unit						
5) #/ Conveying Equipment	80-120t/h, 1,800^W × 5,400^L						
6) Reducing Agent & Limestone Hopper	60^t × 3units						
7) Ni Ore Hopper	100^t × 2units						
8) Weigher for Coal & Limestone	0.5-5 t/h × 3units						
9) Weigher for Ni Ore	10-100 t/h × 2units						
10) Pelletizer	80 t/h, 5.5$^{m\phi}$, 110KW 1unit						
11) #2 Conveying Equipment	80-120 t/h, 900^W × 94,700^L						
3. Rotary Kiln Plant		1,920,000	300,000	316,900		2,536,900	
1) Rotary Kiln	4$^{m\phi}$ × 90^m, 31 t/h, 355KW 1unit						
2) Oil Burning Unit	C heavy oil 4 t/h, 1set						
3) Instrumentation	1set						
4) Dust Treatment Equipment	75,000$^{Nm^3}$/h multi-cyclone-EP 2 sets						
4. Electric Furnace Plant		2,600,000	370,000	615,370		3,585,370	
1) Furnace Body	15$^{m\phi}$ × 5.6^{mH} 1unit						
2) Secondary Current Supply Equipment	42,000 A 1suit						
3) Electrode Hoist & Electrode Holder	Soederberg sys. 1.5$^{m\phi}$, 50^t						
4) Hood & Coolong System	1suit						
5) Charging Bin & Chute	9bins, 15chutes						
6) Furnace Cover & Furnace Gas Exhausting	1suit						

Equipment	Specifications	Machines (C.I.F.in $)	Installation cost (In $)	Civil Works costs (In $)	Miscellaneous (In $)	Total (In $)	Remarks
7) Tapping Equipment	1 suit						
8) Hot Charge Transport Equipment	10 container, etc. 1 suit						
9) Electrode Case & Case making Equipment	1 suit						
10) Electric Furnace Transformer	20,000KVA 30kv/500v/6.3kv 1 unit						
11) Electrical Equipment for 30KV Circuit	1 suit						
12) 5,000KVA Capacitor Equipment	$1,500^{KVA} \times 2$, $1,000^{KVA} \times 2$ condensers						
13) Panel.	1 suit						
14) D.C Power Source Equipment	D.C.110^{V},30^{AH} battery, 1 suit						
5. Refining Plant		1,800,000	74,000	128,450		2,002,450	
1) Desulphurizing Shaking Converter.	Agitator type, 3.7^{KW} 1 unit						
2) Oxidizing Shaking Converter	Horseshoe type 15^{t},100^{KW} 1 unit						
3) Casting Machine	14-55t/hingot 100Kg1 strand						
4) Crane Equipment	$50/15^{t}$ SP. 13.8^{m} 2 units						
6. Store House for Product	2,268 m^2			125,730		125,730	
7. Store House for Miscellaneous Articles	648 m^2			76,520		76,520	
8. Store House for Reducing Agent	1,296 m^2			108,130		108,130	
9. Analytical Laboratory		150,000		105,820		255,820	
1) Chemical Analysis	C Analyser, Balance,Photometer etc.						
2) Sampling	1 suit						
3) Fluorescent X-ray Analyzer	1 suit						
4) Crushing & Grinding of Sample	1 suit						
5) Drying of Sample	1 suit						
6) Others	Instruments, Chemicals etc.						
10. Power Plant & Sub-station		3,780,000	225,000	429,760		4,434,760	
1) Plant	Total output 22,500 kw, 1 suit						

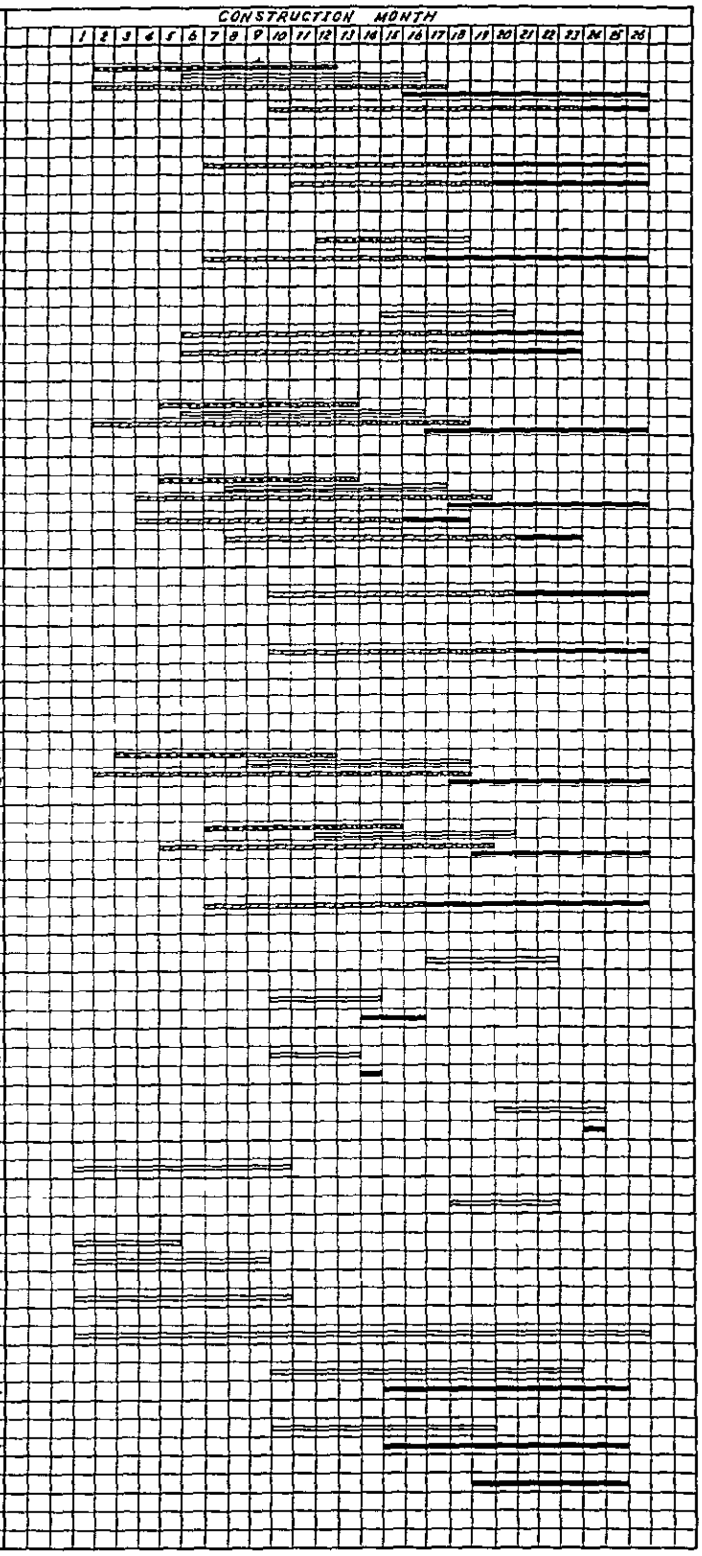
Equipment	Specifications	Machines (C.I.F. in $)	Installation cost (in $)	Civil Works costs (In $)	Miscellaneous (In $)	Total (In $)	Remarks
2) Engine	Diesel						
3) Generator	3ϕ, 50^{HZ}, $5,700^{KW}$ × 5 units						
4) Switch Gear	Cubicle type 7.2^{KV}, 500^{MVA} 1 suit						
5) Control Equipments	Centralysed control systm, Data logging						
6) House Service Power Equipments	1 suit						
7) Main Transformer	$6,000^{KVA}$ × 1 unit $25,000^{KVA}$ × 1 unit						
8) Switch Gear	3.6^{KV}, 100^{MVA} & 36^{KV}, $1,500^{MVA}$ 1 suit						
9) Control Equipments	Centralysed control system						
10) Station Service Power Equipments	1 suit						
11. Oxygen Plant	MG type, Medium pressure, $300^{Nm^3/h}$, O_2 99.7 % $1,600^{Nm^3/h}$, pressure $12^{Kg/cm^2}$	600,000	165,000	43,970		808,970	
1) Air Filter							
2) Air Compressor							
3) Drain Separator							
4) Pre-cooler							
5) Air Separator							
6) Expansion Engine							
7) Heating Units							
8) Buffer Tank (for Oxygen Gas Compressor)							
9) Oxygen Gas Compressor							
10) Oxygen Gas Storage Tank							
11) Oxygen Gas Reducing Device							
12) Measuring Instruments							
13) Safety Device							
14) Piping Materials & Valves							
12. Water & Oil Supply System		1,000,000	545,000	102,000		1,647,000	
1) Oil Storage Tanks	$5,000^{kl}$ ×2, $1,000^{kl}$ ×1, $1,500^{kl}$ ×1, 50^{kl} ×2						
2) Transfer Pumps with Filters & Flow Meters for Oils	Heavy oil $150m^3/h$ ×$5kg/Cm^2$×2, $10m^3/h$ ×$5kg/Cm^2$×2 Diesel oil $150m^3/h$ ×$5Kg/Cm^2$×2						

Equipment	Specifications	Machines (C.I.F. in $)	Installation cost (in $)	Civil Works costs (In $)	Miscellaneous (In $)	Total (In $)	Remarks
3) Sea Water Pumps	$900^{m^3}/h \times 70^{mWC} \times 3$, $170^{m^3}/h \times 70^{mWC} \times 1$						
4) River Water Pumps	$350^{m^3}/h \times 80^{mWC} \times 2$						
5) Elevated Tank & Pumps	$500^{m^3} \times 40^{mH} \times 2$, $1,000^{m^3}/h \times 70^{mWC} \times 2$						
6) Cooling Tower & Pumps	$800^{m^3}/h$, $43°C \rightarrow 33°C \times 1$, $800^{m^3}/h \times 40^{mWC} \times 2$						
7) Piping Materials for the above items	1 suit						
13. Jetty	$18^{mW} \times 52^{mL}$, $5,000^{DWT}$ & $3,000^{DWT}$			260,390		260,390	
14. Electric Wiring Works	about 230^t	473,000	140,000	54,270		667,270	
15. Brick Works	about $2,880^t$	855,000	140,000			995,000	
16. Land Levelling, Road Building & Drainage Works				190,000		190,000	
17. Air Strip	To be extensioned about 600^m			300,000		300,000	
18. General Buildings, Houses & Company Residence				1,000,000		1,000,000	
19. Unloading, Transportation & Storing					170,000	170,000	
20. Steel Structure Materials	Steel materials, about $3,700^t$, Other construction materials about $10,000^t$	1,589,000				1,589,000	
21. Miscellaneous		200,000	50,000		3,080,000	3,330,000	
1) Others		(200,000)	(50,000)				
2) Training					(200,000)		
3) General Expenses					(88,000)		
4) Consulting Fee					(150,000)		
5) Engineering Fee					(1,005,000)		
6) Supervising Fee					(1,337,000)		
7) Feasibility Study					(300,000)		
22. Contingency Reserve					2,173,000		
Sub-Total		15,527,000	2,063,000	3,987,000	5,423,000	27,000,000	
23. Interest					2,078,570	2,078,570	
24. Working Capital					1,320,000	1,320,000	
25. Capital Investment for Mining					220,000	220,000	
Grand Total					9,041,570	30,618,570	

Table II-6. POMALAA FERRONICKEL SMELTING PROJECT
TENTATIVE CONSTRUCTION SCHEDULE

(PN ANEKA TAMBANG)

CAT NO.	NAME	EQUIPMENT & WORKS
I-A	ELECTRIC SMELTNIG FURNACE PLANT	FOUNDATION & BUILDING
		ELECTRIC SMELTING F. TRANSFORMER
	REFRACTORIES	LINING
		ELECTRODE (PASTE)
	ELECTRIC WIRING	FOUNDATION
		WIRING FROM SUB-STATION TO FOR TRANS. & CAT I
I-B	ORE HANDLING PLANT	FOUNDATION & BUILDING
		SCREENING & CRUSHING PLANT
		MIXING PLANT
	ROTARY KILN PLANT	FOUNDATION & BUILDING
		ROTARY KILN PLANT
	REFINING PLANT	FOUNDATION & BUILDING
		REFINING PLANT
		OVER HEAD CRANE
		CASTING MACHINE
	WATER SUPPLY	PIPING SYSTEM
	OIL SUPPLY	PIPING SYSTEM
	ELECTRIC WIRING	WIRING FROM SUB-STATION TO CAT I & OXYGEN PLANT etc
II	POWER PLANT AND SUB-STATION	FOUNDATION & BUILDING
		POWER PLANT & SUB-STATION
	OXYGEN PLANT	FOUNDATION & BUILDING
		OXYGEN PLANT
	ELECTRIC WIRING	WIRING (CAT II)
III	ORE STOCK YARD	FOUNDATION & BUILDING
	STORE HOUSE FOR PRODUCTS	FOUNDATION & BUILDING
		EQUIPMENT
	STORE HOUSE FOR MISCELLANEOUS ARTICLES	FOUNDATION & BUILDING
		EQUIPMENT
	ANALYSIS ROOM	FOUNDATION & BUILDING
		EQUIPMENT
	JETTY	FOUNDATION & CIVIL WORK
	STORE HOUSE FOR REDUCING AGENTS	FOUNDATION & BUILDING
	LAND LEVELLING	ELECTRIC FURNACE ROTARY KILN, REFINING PLANT
		OTHER CIVIL WORKS
	ROAD & DRAINAGE WORKS	CIVIL WORKS
	GENERAL BUILDING & HOUSE AT FACTORY	FOUNDATION & BUILDING
	WATER SUPPLY	FOUNDATION & BUILDING
		MAIN PARTS OF EQUIPMENT
	OIL SUPPLY	FOUNDATION & BUILDING
		MAIN PARTS OF EQUIPMENT
	ELECTRIC WIRING	WIRING (CAT III)

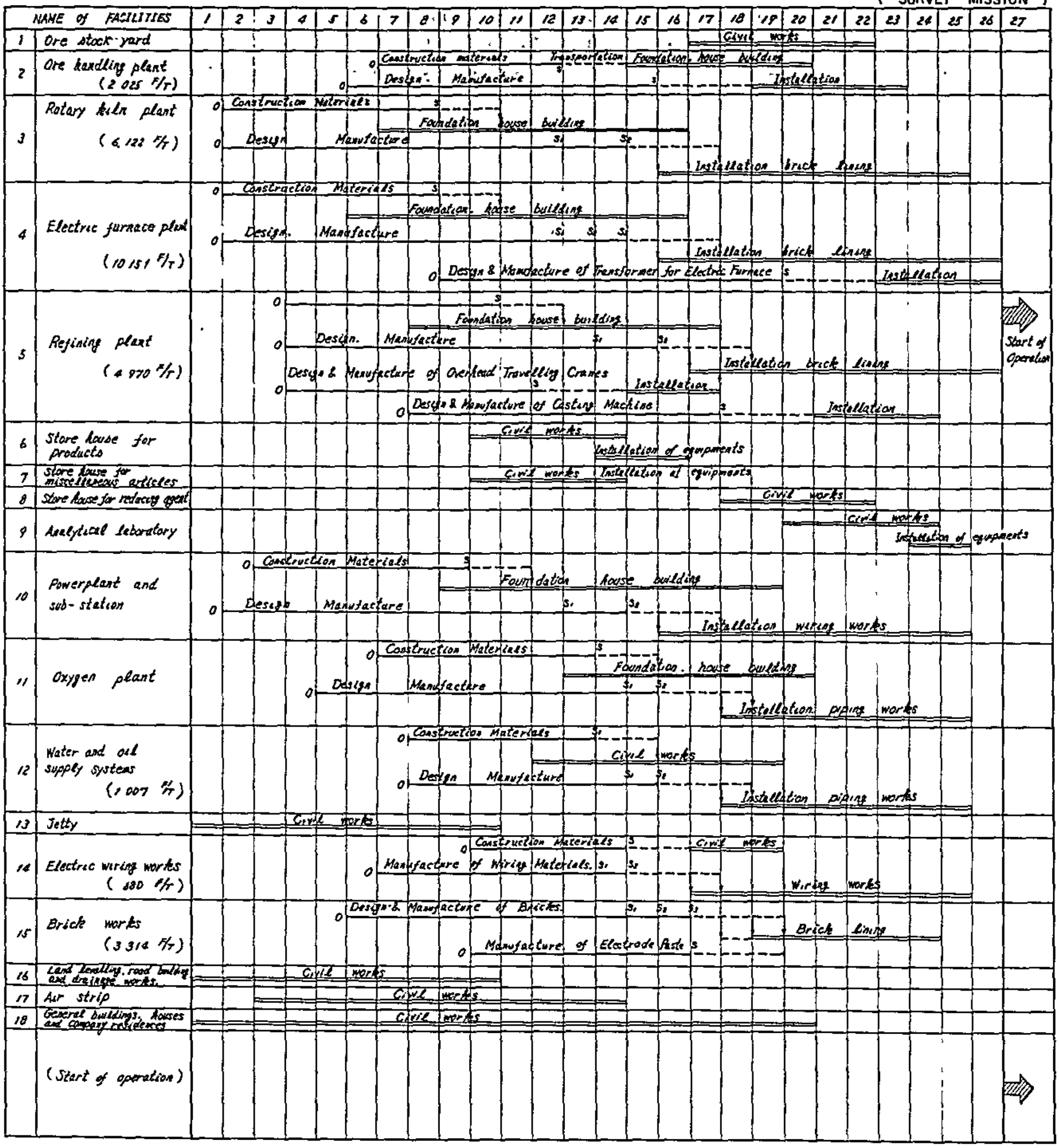


"REMARKS"

- MANUFACTURING PERIOD OF MATERIALS FOR BUILDING AND CIVIL WORK
- MANUFACTURING PERIOD OF EQUIPMENT AND MACHINERY
- CONSTRUCTION PERIOD OF BUILDING, CIVIL WORK AND FOUNDATION AT SITE
- ERECTION AND INSTALLATION PERIOD OF EQUIPMENT AND MACHINERY AT SITE
- INLAND TRANSPORTATION IN JAPAN, CUSTOMS CLEARANCE FOR EXPORT. SHIPPING OVER SEA TRANSPORTATION CUSTOMS CLEARANCE FOR IMPORT AND INLAND TRANSPORTATION AT SITE

Table II-7. POMALAA Fe-Ni SMELTING PLANT CONSTRUCTION SCHEDULE

(SURVEY MISSION)



Remarks

- ——— Design, manufactures and Processing
- - - - - Transportation
- ═══ Work at site
- O Ordering
- S Shipping

11.5 Port Facilities

The existing jetty for shipping of Ni ore runs out into sea about 600 m from the shore and has the ore stock yard of about 5,000 m^2 at its point, from where a barge is loaded with ore by means of the belt conveyor of about 150 m long and 900 mm wide (speed = 1m/sec., motor capacity = 25 kW x 2 units, handling capacity = about 2,400 t/day). The coral reefs develop so densely around the jetty appearing on the water at low tide that no ship greater than barge or launch can come alongside the jetty.

Under the present Project it is intended to make shipment of Fe-Ni instead of Ni ore and therefore the shipping weight will decrease from the present 600-800 thousand tons of Ni ore to about 20 thousand tons of Fe-Ni per year. It is also proposed to construct a new jetty (18 m wide and 52 m long) projecting into sea 200 m farther than the existing jetty to improve the shipping efficiency by bringing ships of from 3,000 to 5,000 D.W.T. class alongside it. For this new jetty, the depth of water required is about 6 or 7 m and no dredging is necessary at this location.

The construction of connecting road to the proposed jetty is under way.

The jetty which will be used to land the equipments and materials necessary for the construction of plant should be completed by the time when these articles begin to arrive and be so constructed as to bear the maximum weight, or about 50 tons, per lot of equipment.

11.6 Industrial Water

The consumption of water for the industrial purposes is as follows.

1)	Rotary kiln and electric furnace	700 m^3/hr.
2)	Power plant	2,200 m^3/hr.
3)	Oxygen plant	100 m^3/hr.
4)	Refining plant	400 m^3/hr.
5)	Miscellaneous (including drinking water)	90 m^3/hr.
	Total	3,490 m^3/hr.

Of the above total, 2,740 m^3/hr. are to be used as circulating water and thus the necessary make-up feed is assumed to amount to about 800 m^3/hr.

In this connection, the Komoro river which flows at a distance of about 1,500 m to the southwest of the proposed plant site has a discharge of about 1,200 m^3/hr. even in the dry season without any great fluctuation of discharge throughout the year, and it will supply a sufficient make-up feed for the Project for the time being. However, in order to provide against the expansion of production scale and any change in discharge or abnormal low water of the river in future, it is desirable to plan the construction of dammed reservoir of suitable capacity in the upper stream, so that the supply of water to the plant can be made by natural flow.

Table – 11.8 Quality of River Water

	Komoro R.	Huko Huko R.
Electric resistance	4,800Ω/cm	5,400Ω/cm
P. H.	8.4	8.1
Chroline ion	6.5 ppm	5.6 ppm
Sulphate ion	9.9 "	8.2 "
Overall hardness	137.9 "	82.6 "
Calcium hardness	5.1 "	7.1 "
Magnesium hardness	132.8 "	75.5 "
Residual after evaporation	168.0 "	112.0 "
Fe ion	0.1 "	0.4 "

In addition, the Huko Huko River flows with a discharge of about 5,000 m^3/hr. at a distance of about 4 km to the east of the proposed plant site and its water may be available for the industrial use.

It is supposed that the under ground water is relatively rich; the test wells are now being digged at two or three points, theresults of which will determine the possibility of using under ground water for such purpose.

Judging from the above it seems possible to insure a sufficient supply of industrial water provided that a plan is prepared for the future construction of appropriate reservoir.

11.7 Power

11.7.1 Electric Power

The electric power load plays an important role in the Fe-Ni smelting by the Elkem system electric furnace.

The necessary electric power has been estimated for the Project as follows.

Electric furnace	17,000 kW
Electric motors	4,000 kW
Miscellaneous	1,500 kW
Total	22,500 kW

In Pomalaa Area there is no electric generating facilities which can provide such a great quantity of power and, on the other, the supply of electric power in Indonesia as a whole is always insuffcent to meet the demand; this it is impossible to rely upon the feed from external facilities different from Japan where the generation-transmission networks are developed all over the country.

In planning the construction of large-scale plant as contemplated by this Project, therefore, it is vital to include the provision of an independent power plant. For instance now, The Pomalaa Mines operates the diesel engine generator sets shown in Table – 8.6 above to supply the power for pumps, conveyors and lighting.

The conceivable equipments for independent power plnat are

1) Steam turbine generator;

2) Diesel engine generator; and

3) Gas turbine generator.

The steam turbine generator has a falt in that it requires to provide boiler facilities and the generating cost is expensive where there is no other demand for steam; while the gas turbine generator is low in its fuel efficiency unless a unit of considerably great capacity is equipped, resulting in a higher generating cost. In conclusion, it is advisable to adopt the diesel engine generation system since the heavy oil for fuel is available at low cost in Indonesia.

For this Project, it has been planned to install five diesel engine generators of 5,700 kva to meet the power demand of 22,500 kW, with four units working regularly and one unit being a standby.

In future the increase in the power load can be dealt with by the electricity purchased from the transmission network which will have been completed by that time in Indonesia. There will be no way but to rely upon the independent power plant system until then.

The unit price of electric power is $0.007 per kwh on the basis of price of heavy oil at RP.7 per litre.

11.7.2 Fuel

The consumption of heavy oil as fuel principally for the rotary kiln plant and electric power plant has been estimated for this Project as follows.

1) For rotary kiln plant;

2.75 kl/hr. x 8,000 hr./year = 22,000 kl/year

2) For power plant;

22,500 kW x 8,000 hr./year x 0.275 l/kwh = 50,000 kl/year

Total 72,000 kl/year

The fuel plan of the Project is as follows. The domestic heavy oil to be purchased from P.N. Pertamina is transported directly from the refinery at Balikpapan or Sungai Gerong or carried by a small tanker of ANTAM through the transit base at Makasar to the new jetty; from where the oil pumped up is sent through pipe system into the storage tanks in the tank yard. Four storage tanks, including two units of 5,000 kl and each one unit of 1,500 kl and 1,000 kl in capacity, are to be constructed to store the oil for two months' consumption.

The new jetty having the water depth of about 6 m can bring the tankers up to 5,000 tons alongside it taking the opportunity of high tide. If two units of pump with a capacity of 150 t/hr is used it will take 17 or 18 hours to carry the oil in a tanker to the storage tank on land.

The purchase price of heavy oil at Pomalaa is estimated at RP. 7 per litre.

11.8 Miscellaneous Subsidiary Materials

The quantities and unit prices of miscellaneous subsidiary materials necessary for this Project are shown in Table – 11.9. They are estimated on the basis of 4,000 tons per year of Fe-Ni in net weight of Ni (or 20,000 tons per annum in gross weight) to be produced by processing 250 thousand tons per year in dry weight of ore containing 18% of Ni + Co.

Table – 11.9 Consumption and Unit Price of Miscellaneous Subsidiary Materials

Name	Consumption (t / year)	Unit price ($ / t)	Remarks
Reducing agent	10,000	25	Wood charcoal or anthracite
Limestone	18,600	4	To be transported by sea from Wawo, 80km northwest of Pomalaa
Quicklime	1,600	16	3,200t in terms of limestone
Electrode paste	400	100	To be imported
Calcium carbide	560	110	"
Soda ash	72	80	"
Oxygen	1,900,000 Nm^3/Y	0.07 $/$Nm^3$	To be supplied from generating unit of 300 Nm^3/hr
Fluorspar	110	60	To be imported
Ferrosilicon	22	225	"
Aluminum shot	55	625	"

Semi-anthracite or sub-bituminous coal produced in Sumatra may be used as a reducing agent in the rotary kiln. Though these coals present no problem in the supply of necessary quantity, the semi-anthracite coal contains as high as 1.7% of sulphur and is not suitable to restrain the sulphur content of Fe-Ni at 0.1% or less; also it has a fault that it is highly inflammable for which no satisfactory solution is not found as yet now. On the other, as it is more economical than sub-bituminous coal (in terms of unit price of carbon content) there is a room to consider the use of it balancing with the cost of desulfurization in refining process.

Wood charcoal is another reducing agent. Most of the raw wood used in Malaysia is the wasted gum trees, but as such trees are scarecely planted in Po malaa Area, other trees will have to be cut down to use them as material. If the charcoal is manufactured at site of Pomalaa Area it is necessary to earmark about $250,000 to the equipment for making and about $23 per ton as a cost of charcoal. Therefore, the charcoal is considerably expensive than the anthracite, while the charcoal making at site is advantageous in that it provides a new employment for the local inhabitants as well as a reliable source of charcoal supply. ANTAM is much interested in the charcoal making at site and is now making a comparative study.

Limestone is richly deposited in the southern part of Sulawesi Island and its outcrops are noticed at various places from the aircraft. It is planned by ANTAM to transport the limestone excavated from Wawo Area about 80 km to the northwest of Pomalaa to the plant by sea. Quicklime is to be manufactured from this limestone by burning it at site of Pomalaa.

A great volume of oxygen is used in the smelting process for removing carbon in manufacturing low carbon ferronickel. The decarburization process requires the constant supply of oxygen of necessary purity (99.7%) and pressure, and it is planned to construct a oxygen generation equipment of 300 Nm^3/hr in the premise of plant. As the oxygen is used intermittently, a high pressure oxygen gas holder is necessary in order to maintain the gas at a required pressure.

At present The Pomalaa Mines uses the oxygen filled in bombs purchased from P.T. Aneka Gas Industry in Makasar at a rate of 100 bombs per month for repair and other uses.

All other subsidiary materials must be imported from abroad since non of them is produced in the country.

11.9. Other Conditions in Environs

Though the convenience of communication should be regarded as a condition of plant location it may not be reasonable to take such condition into account as the mine of this kind is usually situated in the mountains where are hard of access.

Pomalaa Area is situated near the southwest coast of Southeast Sulawesi Province, Sulawesi Island, to where the land transport is very difficult and it cannot but rely upon the air or sea transport. Only means of sea transportation is to use the ore ship arriving twice or so per month or the small launches of ANTAM.

As for air transportation, fortunately there is an airfield only with a air strip of about 800 m long in the premise of The Mines which allows a light plane to take off and land. However, the light plane must be chartered specially from the Indonesian Air Force and therefore it cannot be used except a particular occasion. Taking an opportunity of this Project, ANTAM has a plan to widen and extend the air strip to about 1,400 m so that the airplanes of YS-11 class can take off and land.

11.10 Indigenous Contractor

The principal contractors whom ANTAM intends to employ for the present Project are P.N. Hutama Karya having its head office in Djakarta and P.T. Barata having its head office in Surabaya.

The outline of these firms are described in the following.

11.10.1 P.N. Hutama Karya

P.N. Hutama Karya who engages principally in the civil engineering and construction is the most great and substantial company in Indonesia. The company who had been a subsidiary of Beton Maatschappij N.V. of Holland was incorporated as a enterprise managed by the Government of Indonesia in 1961. Since then the company undertook most of the great construction projects in Indonesia and has grown into a leading construction company.

The projects which were completed by the company in the recent three years are shown in Table – 11.10.

The amounts of construction completed in the past ten years are shown in Table – 11.11 by class.

Table 11-10 LIST OF PROJECTS COMPLETED DURING PAST 3 YEARS.

No	Name of Projects	Name of Owner	Location of Projects	Kind of Projects	Year of Execution	Contract Price in US$ Equivalent.
1	Spinning Factory	States Textile Industry Corporation	Bekasi	Factory	1969	275,336.64
2	Spinning Factory	States Textile Industry Corporation	Palembang	"	1969	258,622.37
3	Glass & T.L. Factory	P.T. Philips Mitsui Coy	Surabaja	"	1969	226,666.20
4	Glutamate Acid Factory	P.T. Sasa Fermentation Corporation	Gedangan Surabaja	"	1970	119,382.14
5	Steam Power Plant	Dept. of Public Works and Power	Djakarta	"	1970	85,305.64
6	Tonasa Portland Cement Factory	Dept. of Industry	Makassar	"	1970	21,771.65
7	Textile Factory Tjiratjas	P.T. Centex	Djakarta	"	1971	533,167.59
8	Cold Wire drawing & Heliport for Steel Plant Proj. Tjilegon	P.T. Krakatau Steel	Tjilegon	"	1971	423,352.15
9	Upgrading of Cement Factory	M.K.I.	Surabaja	"	1971	410,500.-
10	Upgrading of zinc Factory	P.T. Tombak Mas	Surabaja	"	1971	218,598.63
11	Zinc Factory	Mitsubishi Coy. Ltd.	Semarang	"	1971	121,210.11
12	Power Project Batang Agam	Dept. of Public Works and Power	Padang	"	1971	119,365.07
13	Philips Factory	P.T. Philips	Surabaja	"	1971	54,504.79
14	Crumb Rubber Factory	Panatraco Ltd.	Djambi	"	1971	53,439.15
15	Textile Mill Office Building	State Textile Industry Corp.	Palembang	"	1971	43,181.45
16	B.N.I. Building	State Bank of Indonesia	Palembang	Building	1971	942,742.81
17	Office Building	Bank of Indonesia	Samarinda	"	1971	536,042.42
18	Office Building	Bappenas	Djakarta	"	1971	319,712.82
19	Tjisokan Prestressed Concrete Bridge	Dept. of Public Works and Power	Tjiandjur	Bridge	1971	440,712.44
20	Flood Control Gate	Flood Control Project Officer	Djakarta	"	1971	316,501.86
21	Water Treatment Plant	Directorate of Health Technology	Djakarta	Water Treatment Plant	1971	1,871,275.-
22	Water Treatment Plant	Dept. of Public Works and Power	Padang	Water Treatment Plant	1971	258,684.18
23	Water Treatment Plant	Directorate General of Sea Communication	Pandjang	"	1971	254,310.88
24	Brantas Delta Irrigation	Dept. of Public Works and Power	Djawa Timur	Irrigation	1971	419,162.41
25	Kelara Irrigation	- " -	Makassar	"	1971	863,994.58

P. N. HUTAMA KARYA :

Table – 11.11 Amounts of Construction Completed by P.N. Hutama.Kărya from 1961 to 1971

Class	Amount of construction completed
Building	$ 8,505,436
Factory	2,018,392
Housing	1,112,101
Office (building)	276,146
Road	2,349,604
Bridge	2,703,220
Water treatment equipment	2,681,886
Steam power plant	1,632,109
Irrigation facilities	1,543,889
Landscaping facilities	258,949
Hedge	71,186
Foundation	111,244
Airport	1,901,823
Wharf	153,174
Miscellaneous structures	483,785
Total	25,802,944 (About ¥77.4 hundred million)

The sales on construction works and profits in the recent three years are shown in Table – 11.12.

Table – 11.12 Sales on Construction Works and Profits in the Recent 3 Years

Year	Sales	Profit
1968	1,116,647,265 RP	18,534,840 RP
1969	2,591,532,490	79,131,752
1970	4,683,457,125	187,716,750
(1972-estimation)	(6,200,000,000)	

It is understood from the above tables that the volume of orders has grown rapidly year by year and the company has been making profit steadily.

The company employs about 500 employees whose classifications by capacity and occupation are shown in Table – 11.13.

The tools and equipment of the company are shown in Table – 11.14. They include no equipment nor tool which require any special skill for handling but those necessary for the civil engineering and building contractor are completed in a general way. The company owns 2 trailers of 40 t capacity to transport heavy articles; it is capable of driving piles of from 10 m to 60 m; it has the record of performance in placing of concrete at a rate of 1,500 m^3 per day in terms of solid placing, but the capacity will be about 100 m^3 per day for the placing of reinforced concrete of the plant to be built under this Project.

Table 11-13 Classification by Capacity and Occupation of Employees of P.N. Hutama Karya

1. Senior technical staff	
Civil engineer	55
Mechanical engineer	5
Bachelor of Road Engineer	2
Bachelor of Engineer	3
Bachelor of Electrical Engineer	2
Total :	67
2. Technical Staff	
Technical High School	44
Technical School	26
Trained Workers	56
Total :	126
3. Senior Administrative Staff	
Economics	5
Lawyers	2
Finance specialist	-
Business Administration	2
Others	8
Total :	17
4. Administrative Staff	
Senior High School	38
Junior High School	16
Elementary School	69
Senior Economic High School	8
Vocational Courses	8
Trained Workers	7
Total :	146
5. Superintendants	
Technical High School	21
Technical School	19
Vocational Education	-
Trained Workers	11
Total :	51
6. Heavy Equipment Operators	
Technical School	6
School for skilled labour	2
Special course	-
Trained operators for pavement const	8
" " " earthmoving	14
" " " mechanical work	10
" " " building const	11
Total :	51
7. Mechanics	
Technical School	10
School for skilled labour	3
Special course	-
Trained workers	12
Total :	25
8. Workers	
Elementary School	6
Unskilled but not illiterate	10
Illiterate	-
Total :	16

TOTAL NUMBER : 499 persons

P.N. Hutama Karya.-

Table 11-14

P N. HUTAMA KARYA

TOOLS AND. EQUIPMENT

No.	Name	Quantity	Capacity
1.	: Concrete Mixer :	70	: 350 Litre
2.	: Concrete Mixer :	30	: 400-750 Litre
3.	: Compressor :	30	: 300-600 cuft/min, rating 7 atm
4.	: Jack Hammer :	115	: Ø 1"
5.	: Concrete Vibrator :	125	: Ø $1\frac{3}{8}$" - Ø 2"
6.	: Stamper :	30	: 60 - 150kg
7.	: Pile Driver :	11	: 10 - 30m, 6 ton
8.	: Concrete Lift :	15	: 1 ton
9.	: Hoisting Equipment :	25	: 1 ton
10.	: Steel Bar Cutter :	40	: $\frac{1}{2}$" - $1\frac{1}{2}$"
11.	: Waterpump :	130	: 1" - 8"
12.	: Road Roller :	7	: 10 ton
13.	: Electric Welding Machine :	25	: 200 - 400 Amp
14.	: Oxygen Welding Machine :	30	:
15.	: Truck :	40	: 5 ton
16.	: Dumptruck :	7	: 4 ton
17.	: Pick-Up :	28	:
18.	: Generator :	30	: 5 - 95 KVA
19.	: Surveying Equipment :	100	: (Waterpas/Theodolite)
20.	: Loader :	5	:
21.	: Tower Crane :	1	: 3.3 ton
22.	: Crawler Crane :	1	: 6 ton
23.	: Mobile Crane :	1	: 2.5 ton
24.	: Bulldozer :	10	: 100 - 400 HP
25.	: Stone Crusher :	2	:
26.	: Motor Grader :	3	: 0.5 - 3.5 cu.meter
27.	: Excavator :	8	: as a crane 20 ton
28.	: Scraper :	2	: 20 cu. yard
29.	: Trailer :	2	: 40 ton
30.	: Winch :	20	: 0.25 - 1.50 ton
31.	: Drilling Equipment :	2	: "SCHRAM" type : DR-176R(PNTRK)
32.	: Weight Batcher :	6	: 1 - 1.5 ton.

P.N. HUTAMA KARYA.-

P.N. Hutama Karya carried out or is carrying out various construction projects at various places of Indonesia and in addition to its head office at Djakarta has its branch offices at Bandung, Semarang and Surabaya of Djawa Island, Balikpapan of Kalimantan Island, Makasar of Sulawesi Island, Denpasar of Bali Island, Djajapura of West Irian, and Padang, Djambi, Palembang and Tandjung Karang of Sumatra Island to operate its business activities.

During its field investigation the Survey Mission could inspect the construction work of the fourth kiln for the cement plant of P.T. Semen Gresik in Surabaya (cement productive capacity is increased to 500 thousand tons per annum after completion), and that of the second phase expansion of the thermal power plant in Tandjung Perioek (two generators of 50,000 kW are increased to generate 150,000 kW in total after completion).

11.10.2 P.T. Barata Metalworks & Engineering Ltd.

P.T. Barata which was established in May, 1971, by uniting P.N. Barata, P.N. Sabang Merauke and P.N. Peprida has its head office at Surabaya with machine shop and design and construction departments included in it; it has the machine shops and design departments at Tegal, Semarang, Banjuwangi, Makasar, Djakarta, Bandung, Sukabumi and Medan.

The technical staff of the company is composed of 25 men in charge of mechanics, 5 men in charge of electricity, 5 men in charge of metallurgy, 11 men in charge of civil engineering, 4 men in charge of chemistry and 1 man in charge of architecture, and almost all of them are the engineers who graduated from the Technical Institute of Bandung or Surabaya.

The employees on the register assigned to the works and design departments at various places are composed of about 2,400 mens as shown in Table – 11.15.

Table 11.15 Employees on the Register Assigned to Works and Design Department

Surabaja	1,298	(Including 28 engineers)
Tegal	122	(" 1 ")
Sukabumi	119	(" 4 ")
Djakarta	321	(" 6 ")
Bandung	408	(" 4 ")
Banjuwangi	29	(" 2 ")
Makasar	15	(" 2 ")

The principal business activities of P.T. Barata are as follows.

1) Designing, manufacture, assembly, installation and maintenance of machineries and steel structures.

2) Designing and execution of electric wiring and piping works.

3) Designing, execution and supervision of various civil engineering works.

4) Technical instruction, designing, execution and supervision of various construction projects.

5) Export and import and general trading business.

The production capacities of various departments are shown in Table – 11.16.

Table – 11.16 Production Capacities of Various Departments

Departments	Production capacity	Remarks
1. Steel casting	300 t/year	Surabaja
2. Iron casting	1,500 t/year	Surabaja ..... 1,000t Bandung 500t
3. Non-ferrous metal casting	300 t/year	Surabaya ..... 200t Bandung 100t
4. Machine manufacture and machining	1,400 t/year	Surabaja ..... 800t Djakarta ..... 200t Bandung ...... 200t Tegal .... 100t Sukabumi 100t
5. Manufacture of bolt, nut and rivet	150 t/year	Surabaya
6. Engineering and Consulting	1,500 million RP/year	
7. Steel construction	3,000 t/year	Surabaya ..... 1,000t Djakarta ..... 600t Bandung ...... 600t Tegal .... 400t Sukabumi 400t
8. Erection and installation	3,000 t/year	Surabaya ..... 1,500t Djakarta ..... 600t Bandung ...... 500t Tegal .... 200t Sukabumi 200t
9. Manufacture of roadroller	200 unit/year	Surabaya

The sales of the company in the recent four years are as follows.

1967	$ 715,000
1968	$1,000,000
1969	$2,250,000
1970	$3,850,000

The actual volume of orders on principal works since 1963 is shown in Table – 11.17.

Table – 11.17 Actual Volume of Orders on Principal Works since 1963

Name	Content	Quantity
1. Steel tower for high-tension transmission line of P.L.N.	Designing, manufacture and assembling	667 units 4,600^{t}
2. Parliament's secretary Building in Kjakarta	Manufacture and erection	200^{t}
3. Pantja Sila gymnasium in Surabaya	Designing, manufacture and erection	75^{t}
4. Pulp building of paper factory in East Djawa	"	1,000^{t}
5. Penstocks for hydraulic power plant of P.L.N.	Designing and manufacture	200^{t}
6. Steel bridges in South Sulawesi	"	355^{t}
7. Steel bridges in central Sulawesi	Designing and manufacture	600^{t}
8. Oil and water storage tanks of P.L.N. and etc. in Kalimantan		3,000m^{3}
9. Sluice gates for irrigation	Manufacture and installation	1,000^{t}
10. Senajan athletic stadium in Djakarta	Execution of work	
11. Television tower in Djakarta	"	
12. Steam power plant in Surabaya	Execution of work and installation of equipments	2,500^{t}
13. Steam power plant in Palembang	Execution of work and installation of boiler	750^{t}
14. Steam power plant in Djakarta	Execution of work and installation of boiler, turbine and generator	1,000^{t}
15. Paper and pulp factory in Banjuwangi	Construction, execution of work, and civil engineering work	
16. Rayon pilot plant in Bandung	"	
17. Rice-cleaning mill in central Java	Construction, and execution of work	
18. Crumb Rubber Factory	Designing, manufacture and erection	
19. Paper and pulp factory in South Sulawesi	Civil engineering work	50% of total
20. Cement factory in South Sulawesi	"	"
21. Petrochemistry project of Gresik	Subcontractor to Consindit Spa. of Italy	
22. Technical Institute of Surabaya	Civil engineering work	

During the field investigation the Survey Mission inspected the main works of P.T. Barata, extension work of thermal power plant in Tandjung Perioek, and erection of new repair shop house for The Pomalaa Mines of ANTAM. The shops of its main works arranged in a spacious premise have introduced large-sized working machines and intend to equip with a complete set of machine tools; it is supposed that the company has a considerable capability.

In addition to the actual performance shown above the company constructed almost all of 52 sugar refineries managed by the government in Djawa island and has contracted to undertake alone the maintenance and repair of these refineries; also it is constructing a thermal power plant in Tandjung Perioek mobilizing about 250 workers.

The results of the investigation made by the Survey Mission on the two principal companies among the principal indigenous contractors are as described in the above. Judging from their technical staff consisting of excellent engineers in Indonesia, the equipments maintained by them, and the quality of their construction works already completed and under way the Survey Mission is convinced that they are technically qualified to undertake and complete the construction of nickel smelting plant proposed by ANTAM.

If the Survey Mission may be allowed to wish so much, it is desired that there will be a technical elaboration or improvement of the temporary works, technique of concrete placing, welding of steel structures, accuracy of processing and consideration to safety in the execution of civil engineering works. These points may well be overcome by the instruction of engineers to be sent from Japan and the proper training of employees of the contractors.

11.11 Equipment Investment and Cost of Production

The total investment estimated for this Project is $30,618,570, of which $27,000,000 are invested in relation to the equipment. The amounts of investment by equipment item are shown in Tables – 11.5 and 11.6 above.

As all of the machines and equipments and construction materials are to be imported from Japan, they have been calculated by C.I.F. values.

The installation cost on site of machines and equipments accounts for 14.8% of equipment price (excluding the construction materials). The ratio seems to be somewhat lower compared with that prevailing in Japan and this may be due to the facts that relatively few machines and equipments are so difficult as expected from their weights and that the wages of domestique workers are lower than those in Japan.

ANTAM has prepared the funds programme with an allowance of about 20% to provide for the fluctuation in prices and others to finance the equipment investment which includes a contingency of $2,173,000 (about 8% of $27,000,000).

If it is estimated on the basis of the actual results of plant construction in the past in Japan, the cost to construct a smelting plant with equipment of about 20,000 k.v.a. will be about $14,000,000. If the equipment investment for the Project is reduced to the level of construction in Japan it will be about $16,000,000, and further if the rise in prices of equipments and construction materials thereafter in Japan is taken into account, it may be regarded as a reasonable construction cost in the main. A remarkable point of this Project to be compared with the similar project in Japan is that the construction cost becomes higher due to transportation cost and import charges because the equipments of power plant, jetty and air strip, technical instruction and most of machines, apparatus and materials must be imported from abroad.

The cost of production is described in the chapter dealing with the economic aspect of the Project.

XII. CONDITIONS OF CONSTRUCTION AND OPERATION IN POMALAA AREA.

The descriptions about the locations of mine and smelting plant, port facilities and industrial water are made in the above. Some necessary matters relating to other construction and the operation of plant are dealt with in the following. The Survey Mission could stay in Pomalaa only for two days, shorter period than scheduled, because of interupted flight of light plane due to bad weather, and therefore many of the remarks below are those spoken principally by the staff of ANTAM.

12.1 Southeast Sulawesi Province

Southeast Sulawesi Province occupies about 38,140 km^2 (about half of Hokkaido in Japan) of the peninsula lying in the southeastern part of Sulawesi Island and it is said that its population is about one million (that of Hokkaido is a little less than 6 millions). The capital of Province is Kendari, of which population is about 240 thousands including that of surrounding areas.

The Province is divided into four Counties of Kendari, Kolaka, Muna (its capital is Raha) and Buton (its capital is Bau Bau) and Pomalaa belongs in Kolaka County of which population is about 100 thousands.

The public peace in the Province was bad until about eight years before because of the activities of terrorists and rebels. The infrastructures which have not been equipped so far are gradually improved recently.

12.2 Industry of Southeast Sulawesi Province

Southeast Sulawesi Province is blessed with a vast fertile land not yet developed and only a part of the land is cultivated by the inhabitants to grow coconut, banana and other fruits. It is desired to develop a large-scale agriculture to produce maize, cotton, peanut, coffee, and rubber. The Province is also blessed with forest resources including teak and etc. but the forestry is not developed. Its inshore is the fishing-ground to catch tuna fish, lobster, oyster and seaweeds, and P.T. Indonesia Pearl Ltd. was established to operate the fishery of natural pearls but the product is small.

Needless to say no industry is operated except the charcoal-making and baking of bricks for house on a small scale. The governor of Southeast Sulawesi Province intends to create an industry to process the agricultral products and timbers produced in the area.

Nickel ore is mined in Pomalaa Area but it has not found in any other area. It is said that gold is deposited in Kasipute and Boepinang districts of Buton County and Tinagea and Tinobu districts of Kendari County, and that oil is deposited in Wawoni, Kabaena and Buton, asphalt in Bau-Bau area, iron ore in Asera area of Kendari County and chromite in Kolaka area. Any other ores except nickel ore are almost unexploited in general and the development of mineral resources is the problem to be solved in future.

12.3 Transportation and Communication

There are the national road of 185 km from Kendari to Kolaka, of which 71 km is a paved road, the provincial road of 139 km and the county road of 1,723 km. The road between Kendari and Kolaka is maintained relatively in good condition and it takes about eight hours to travel it by jeep.

Many of the inhabitants live near the coast and use the vessels of from 1 ton to 100 tons as a means of transportation.

The provincial harbour equipped with a quay of 90 m long and water depth of 5 m or 6 m is in Kendari and used for the domestic and foreign trades. Every county operates a small harbour at the location of county office which constitutes a distributing of local products. In Kolaka County there is Pomalaa Port in addition to the county harbour. Timber, rottan, copra and ebony are handled through the county harbours.

P.N. Pelni, the government-managed shipping company, and a private-managed shipping firm respectively operates a regular service once a week

between Kendari and other locations of county offices. Many coral reefs lie around the jetty of Pomalaa and a close attention is required in operating an ore ship. The hydrographic chart of Pomalaa Port is shown in Fig. – 12.1. The work to extend the existing jetty beyond the coral reefs is under way.

The airmail service is operated regularly once a week between Makasar and Kendari by P.N. Garuda Indonesia Airways. P.T. Zamrud Airlines (Makasar) operates the chartered service via the same route. As stated previously Pomalaa has the air port equipped only with runway and the chartered military plane takes about one hour to connect between Pomalaa and Makasar at present.

No post office service nor telegram and telephone services are available at Pomalaa. The telegram service is provided between Kendari and Bau-Bau and between Kendari and Makasar, with the telephone service only between Kendari and Makasar. The connection between ANTAM of Pomalaa and its Makasar branch office is made by private wireless. The mails from Pomalaa are transported via Makasar to where are brought on board the ore ship of SUNIDECO.

No reception of television or radio signal is impossible at Pomalaa; only the reception of shortwave radio signal is possible by a high-fidelity shortwave receiver.

At present the public peace is maintained thoroughly and two constables are posted at Pomalaa and about fifty constables at Kolaka where a troop is also stationed.

There is a bank at Kendari but not at Pomalaa.

Pomalaa area belongs administratively to Kendari, Province of Southeast Sulawesi and the process of various documents have to be conducted at Kolaka or Kendari. Though the persons in charge of various operations are assigned at Pomalaa Mining Station of ANTAM, almost of commercial and other activities are carried out depending on the office at Makasar.

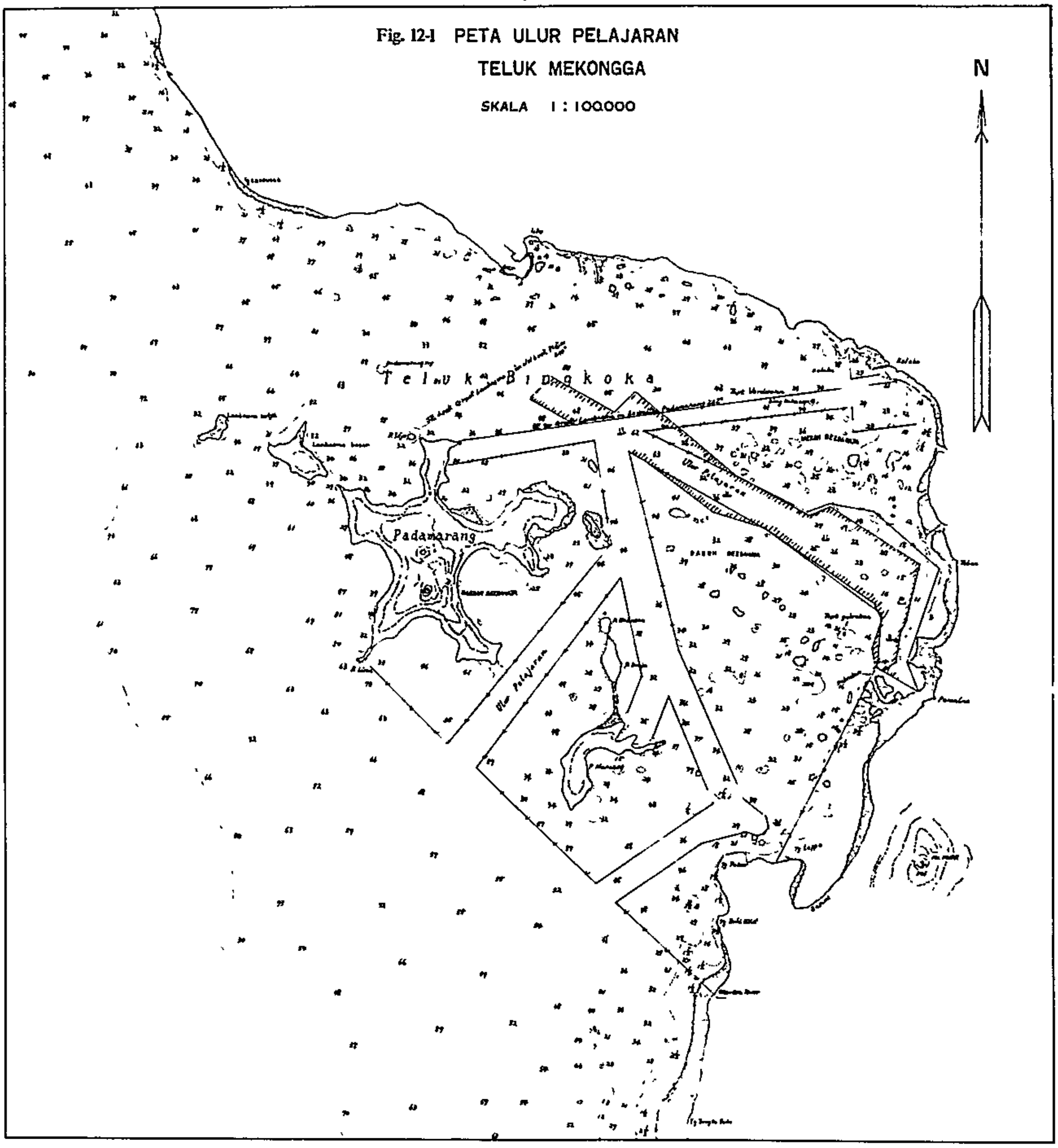


Fig. 12-1 PETA ULUR PELAJARAN
TELUK MEKONGGA
SKALA 1 : 100.000

12.4 Climatic Condition

Any climatic data is unavailable for Pomalaa area and those of Makasar is shown in Table – 12.1.

Table – 12.1 Climatic Data of Makasar

Latitude = 03°04'S
Longitude = 119°32'E
Ground height = 14.00m
For 10 years from 1956 to 1965

Month	Air temperature (°c)			Humidity (%)			Wind direction	Wind speed (in Knots)	Percentage of possible sunshine	Amount of rainfall (in mm)
	Maximum	Mean	Minimum	Maximum	Mean	Minimum				
Jan.	29.0	25.7	23.4	92	85	79	E	5	46	572
Feb.	29.3	25.7	23.2	92	86	75	E	5	31	563
Mar.	29.7	26.4	23.5	89	83	72	E	5	52	379
Apr.	31.5	27.2	24.2	89	79	66	E	5	31	177
May.	31.5	27.0	23.5	89	81	66	E	4	64	242
Jun.	32.1	27.0	22.5	86	77	62	E	5	40	87
Jul.	31.5	26.6	22.3	88	78	59	W	5	42	68
Aug.	31.8	26.3	21.7	86	72	54	W	5	52	49
Sept.	32.9	27.0	21.8	84	68	48	W	6	54	35
Oct.	32.2	27.2	22.7	85	72	53	W	5	45	127
Nov.	31.2	26.5	23.3	88	81	66	E	4	37	275
Dec.	29.2	25.7	23.1	91	86	73	E	5	51	614
Year	31.0	26.4	22.7	88	79	64	E	5	45	3,188

It is supposed that the climate of Pomalaa is the same of that of Makasar. Though the amount of rainfall is very large but the raining seldom continues throughout the day, but an intensive rainfall of short duration is brought by squall. The ground composed of laterite drains well and does not cause any difficulty for the construction work. The amount of the annual rainfall of Makasar is 3,188 mm and it is understood that it is very heavy comparing with the precipitation of 1,658 mm in the annual mean of past 20 years for Tokyo, Japan.

As seen from Table – 12.1, the highest temperature of 32.2°C occurs in October and the annual mean of the highest temperature is as high as 31.0°C; while it becomes cool after sunset with the temperature lowered to 22°C or 23°C in mornings and evenings and is far milder than the midsummer of Japan. The direct sunshine is very strong in the daytime so that the workers work only from 7 o'clock in the morning to 2 o'clock in the afternoon. There is a fear for the workers to be sunstruck if they work long hours under the direct sunshine.

The Survey Mission stayed in field at about the end of rainy season and in spite of much rainfall the drainage condition seemed to be good.

Wind will not cause any difficulty, as this area is out of the area influenced by typhoon and westerlies. The strength of wind pressure is taken as 100 kg/m^2 for designing of building. The houses of inhabitants are built very simply with slender timbers and roofed with palm leaves, and this tells that there is no damage due to wind.

Earthquakes are frequent in the northern part of Sulawesi Island but seldom in the south. The concrete chimney and sheathing constructed by Sumitomo Mining Co. during World War II, still stand solid, judging from which it seems that the foundation is considerably stabilized and any serious earthquake did not occur in the past 30 years.

12.5 Labour Condition

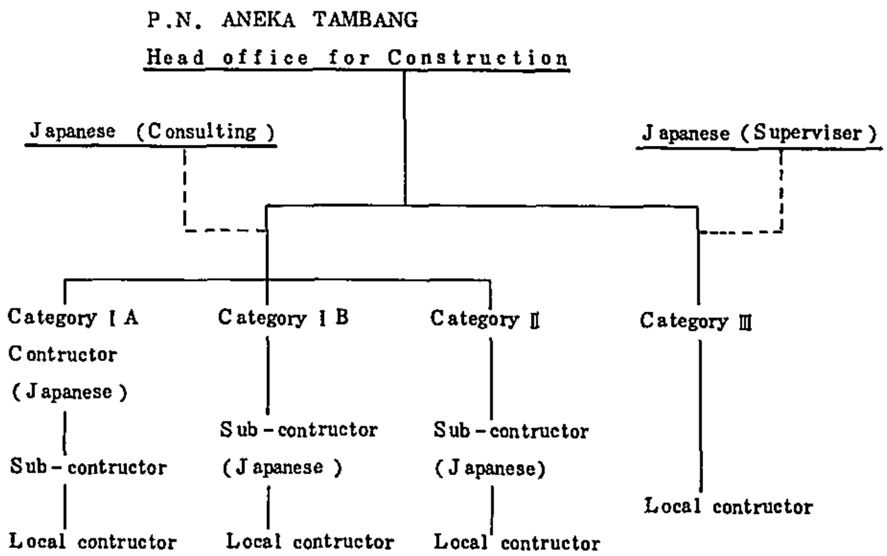
It seems easy to employ the day-labourers from a community around Pomalaa and many workers are employed at present for loading of ores and for other simple works. However, the workers for the smelting operation proposed under the Project should be those comparable at least to the graduates of high school and they will have recruited from Makasar, Sulabaya and Djakarta areas. It seems there is no difficulty in recruiting these workers as the labour force is sufficient in Indonesia as a whole.

It is necessary to dispatch about 100 persons at the maximum from Japan as supervisors of the construction works under way. The operation staff of the local contractors will be sent to the site from Djawa Island. The supply of residences, establishement of shopping center of daily necessities, organization of mail transportation, speed-up of communication, and regularization for transporting necessities of living, fresh foodstaffs and other sundry goods have been scarcely completed by now, and the works on them should be started immediately.

12.6 Organization of Contractors under Construction

Fig. – 12.2 shows the organization of contractors which is assumed by the basic agreement between ANTAM and Pacific Metals Co. P.T. Barata (for machine processing, installation and civil engineering and construction works) and P.N. Hutama Karya (for civil engineering and construction works) will be selected from among the local contractors. As stated previously they have the satisfactory abilities to be awarded with such contract.

Fig. – 12.2 Organization of Contractors for Construction Works



12.7 Employees for Operation of Plant

The number of employees necessary for the normal operation after construction period is 677 persons in total, as shown in Table – 12.2, composed of 274 for mine and 403 for smelting plant. The number of the employees for the smelting work is greater by about 30% then those in Japan, but it will be inevitable by the difference of the level of skillfulness. Though this number is small one compared with the present total number, 870, total employees of the mining station may be rather increased, because the operation of the present mine for exportable ores will be continued.

The remarks of Ranks I, II, and III shown on Table – 12.2 refer to the rating of wages. The approximate criteria of these Ranks are as follows. Rank I is applied to the graduate of university who has a long experience in job; Rank II is applied to the graduate of university who has a short experience in job, and the graduate of junior college or high school who has a long experience in job; Rank III is applied to the graduate of high school or employee having no school training.

The average amounts of wages of each Rank are shown in sessions of the economic aspects.

It is planned in compliance with the agreement between ANTAM and Pacific Metals Co. to send a considerable number of employees to Japan for training them prior to the start of operation. The training schedule is shown in Table – 12.3. The training schedule will be necessary in order to prevent any troubles in the starting of operation.

The management organization of the plant is shown in Table – 12.4.

Table 12-2 PERSONNEL FORMATION

Department & Section	Rank I	Rank II	Rank III	Total
1. Management				
General Manager	1			
ASS. Gen. Manager	1			
Secretary	1			
Total	3			3
2. Mining Department				
Manager	1			
Administration		1	2	
Driver & Office Boy			3	
(Sub-total)	1	1	5	(7)
A) Exploration Section				
Chief Section	1			
1) Exploration Sub-Section				
Chief		1		
Foremen			3	
Laborer			24	
2) Surveying Sub-Section				
Chief		1		
Surveyor		3		
Drafter		2		
Laborer			10	
(Sub-total A)	1	7	37	(45)
B) Mining Section				
Chief Section	1			
Assistant		1		
Mining Foremen			3	
Road Foremen			1	
Mining & Road Crew			15	
Driver (Dump-truck)			18	
" (Bulldozer)			5	
Driver (Grader)			3	
" (Power Shovel)			5	
" (Road-roller)			4	
(Sub-total B)	1	1	54	(56)
Total	3	9	96	108
3. Smelting Department				
Manager	1			
Administration		1	2	
Driver & Office Boy			3	
(Sub-total)	1	1	5	(7)
A) Raw Material Section				
Chief	1			
Assistant	1			
Foremen		3		
Crew		3	55	
(Sub-total A)	2	6	55	(63)
B) Smelting Section				
Chief	1			
Assistant	1			
Foremen		3		
Crew		3	67	
(Sub-total B)	2	6	67	(75)
C) Refining Section				
Chief	1			
Assistant	1			
Foremen		3		
Crew		3	36	
(Sub-total C)	2	6	36	(44)
Total	7	19	163	189

Department & Section	Rank I	Rank II	Rank III	Total
4. Auxiliary Plants & Maintenance Dep.				
Manager	1			
Administration		1	3	
Driver & Office Boy			3	
(Sub-total)	1	1	6	(8)
A) Electric Power Plant				
Chief	1			
Assistant		1		
Foremen		3		
Crew			23	
(Sub-total A)	1	4	23	(28)
B) Oxygen Plant				
Chief	1			
Assistant		1		
Foremen		3		
Crew			9	
(Sub-total B)	1	4	9	(14)
C) Transportation				
Chief	1			
Administration		2		
1) Sea Transportation				
Chief		1		
Tugboat Captain		4		
" Engineer		4		
" Crew			12	
Barge			6	
2) Land Transportation				
Administration			1	
Crew			6	
(Sub-total C)	1	11	25	(37)

Department & Section	Rank I	Rank II	Rank III	Total
D) Maintenance Section				
Chief	1			
Assistant	1			
Administration		1	3	
1) Mining Equipments				
Foremen		1		
Crew		2	16	
2) Smelting Plant				
Chief	1			
Assistant		1		
Foremen		2		
Crew			8	
3) Auxiliary Plants				
Chief		1		
Foremen		1		
Crew			2	
4) Transportation				
Foremen		2		
Crew			15	
5) Civil Works				
Foremen		1		
Crew			12	
(Sub-total D)	3	12	56	(71)
Total	7	32	119	(151)
5. Engineering Department				
Manager	1			
Administration		1	2	
Driver & Office Boy			2	
(Sub-total)	1	1	4	(6)

Department & Section	Rank I	Rank II	Rank III	Total
A) Engineering Section				
Chief	1			
Assistant	1			
Staff		5	3	
(Sub-total A)	2	5	3	(10)
B) Material				
Chief	1			
Foremen		3		
Crew			16	
(Sub-total B)	1	3	16	(20)
C) Inspection				
Chief	1			
Crew		1	2	
(Sub-total C)	1	1	2	(4)
D) Laboratory				
Chief	1			
Foremen		3		
Crew			13	
(Sub-total D)	1	3	13	(17)
E) Production Control				
Chief	1			
Crew		1	2	
(Sub-total E)	1	1	2	(4)
Total	7	14	40	61
6. General Affairs Department				
Manager	1			
Administration		1	1	
Driver & Office Boy			2	
(Sub-total)	1	1	3	(5)

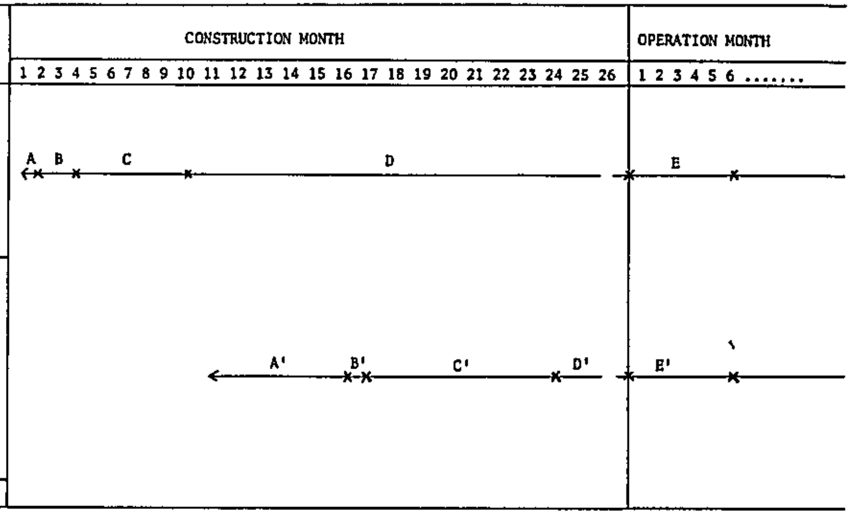
Department & Section	Rank I	Rank II	Rank III	Total
A) General Affairs Section				
Chief Section	1			
1) Secretariat		1		
Member		1	7	
2) Welfare		1	5	
3) Safety & Security		1	10	
4) Housing		1	12	
(Sub-total A)	1	5	34	(40)
B) Personnel Section				
Chief	1			
Member		2	5	
(Sub-total B)	1	2	5	(8)
C) Finance Section				
Chief	1			
1) Accounting		6	5	
2) Budgeting		2	2	
3) Auditing		2	2	
(Sub-total C)	1	10	9	(20)
D) Health Section				
Chief	1			
Assistant	1			
Member		8	12	
(Sub-total D)	2	8	12	(22)
E) Business Section				
Chief	1			
Staff		3		
1) Purchasing		1		
Staff		2	3	
2) Sales		1		
Staff		1	2	

Department & Section	Rank I	Rank II	Rank III	Total
3) Warehouse		1		
Member		2	28	
(Sub-total E)	1	11	33	(45)
Total	7	37	96	140
7. Makasar Representative				
Chief	1			
Assistant		1		
Member		3	13	
Total	1	4	13	18
Grand Total	35	115	527	677

Department	Mining Personnel				Smelting Personnel			
	Rank I	Rank II	Rank III	Total	Rank I	Rank II	Rank III	Total
1. Management	1	0	0	1	2	0	0	2
2. Mining Department	3	9	96	108	-	-	-	-
3. Smelting Department	-	-	-	-	7	19	163	189
4. Auxil. & Maintenance Dep.	2	10	46	58	5	22	73	100
5. Engineering Department	3	7	20	30	4	7	20	31
6. General Affairs Department	3	18	48	69	4	19	48	71
7. Makasar Representative	0	2	6	8	1	2	7	10
Total	12	46	216	274	23	69	311	403

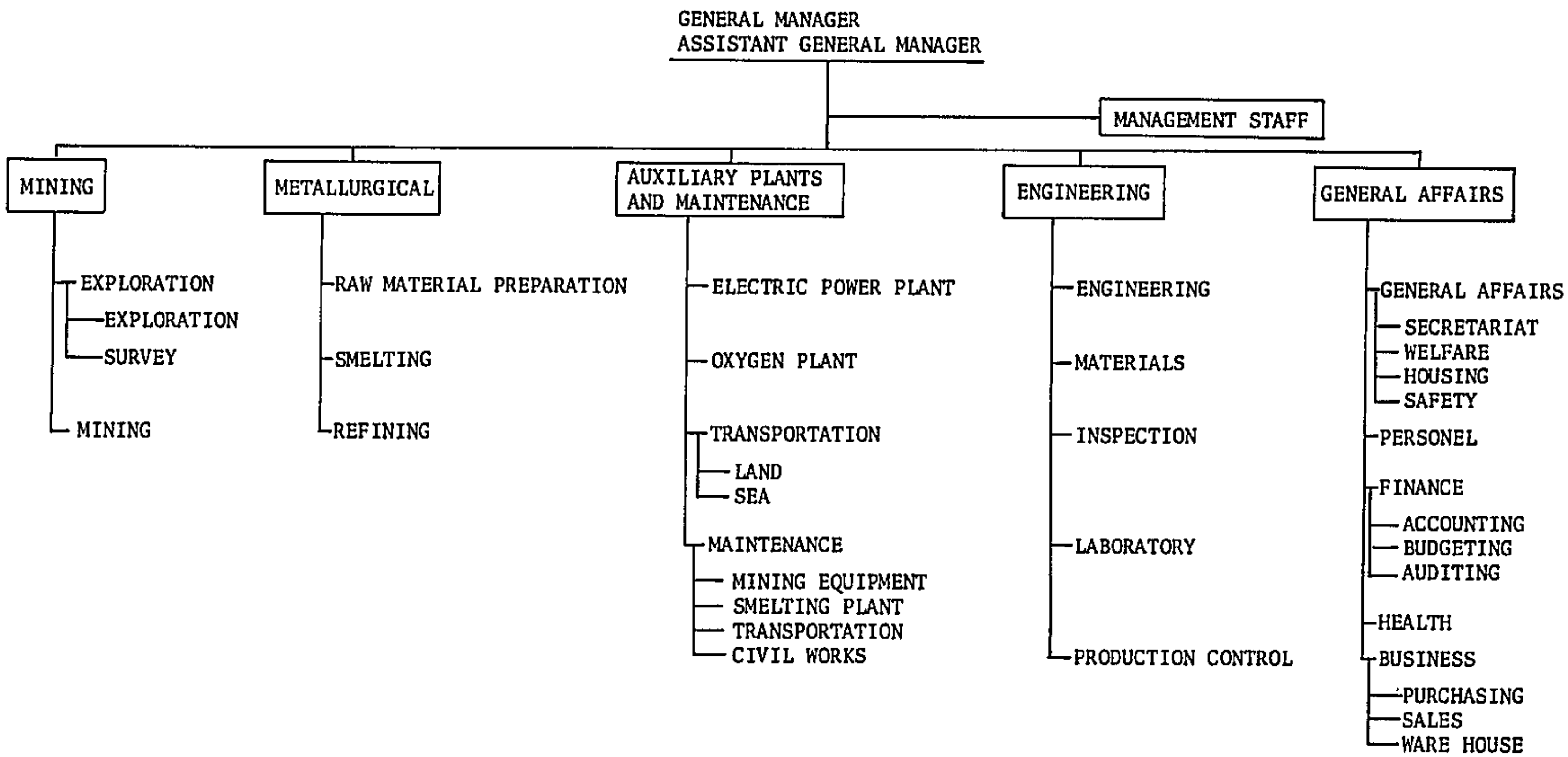
Table 12-3 TRAINING SCHEKULE OF ANTAM'S PERSONNEL

FUNCTION	NUMBER AND QUALIFICATION						
	TOTAL	MINING	METAL-LURGICAL	MECHA-NICAL	ELECTRI-CAL	CHEMI-CAL	BUSINESS
ENGINEERS & STAFF							
RAW MATERIAL PREPARATION	1	1	-	-	-	-	-
ROTARY KILN	3	-	3	-	-	-	-
ELECTRIC FURNACE	3	-	3	-	-	-	-
REFINING PLANT	3	-	3	-	-	-	-
POWER PLANT	2	-	-	1	1	-	-
MAINTENANCE	5	-	-	3	2	-	-
ANALYTICAL LABORATORY	1	-	-	-	-	1	-
BUSINESS & GENERAL AFFAIRS	2	-	-	-	-	-	2
TOTAL	20	1	9	4	3	1	2
FOREMEN							
RAW MATERIAL PREPARATION	3	3	-	-	-	-	-
ROTARY KILN	3	-	3	-	-	-	-
ELECTRIC FURNACE	3	-	3	-	-	-	-
REFINING PLANT	3	-	3	-	-	-	-
POWER PLANT	3	-	-	1	2	-	-
OXYGEN PLANT	3	-	-	3	-	-	-
MAINTENANCE	3	-	-	2	1	-	-
ANALYTICAL LABORATORY	3	-	-	-	-	3	-
TECHNICIAN FOR CONSTRUCTION	5	-	-	5	-	-	-
TOTAL	29	3	9	11	3	3	0



NOTE :
A = Orientation Course in Djakarta
A'= Vocational Courses at Pomalaa
B=B'= Japanese Language Training at the Association for Overseas Technical Scholarship in Japan
C=C'= Practical Training at PAMCO's Factory and/or Maker's Factory
D=D'= Join in Pomalaa Construction
E=E'= Practical Training at Pomalaa Plant

Table 12-4 Management Organization of Plant



XIII. ECONOMIC ASPECT

It is stated in the above mainly about the technical feasibility of the Project. To be realizable the Project must be feasible economically as well.

Therefore the Survey mission has studied the Project in detail from the economic point of view, of which results are explained hereinafter.

In order to study the economic profitability the costs of production and selling must be estimated in detail. The contents of production cost is analysed and the reasonableness of each cost item is examined in the following. The data about the total fund needed to implement the Project, the amount of fund to be raised and the method of raising fund which the Survey Mission could hear from the persons concerned of ANTAM, Department of Mining, BAPPENAS, and Bank Dagan Negara are also reported herewith.

13.1 Necessary Fund and its Raising

As stated repeatedly ANTAM planned at first to implement the Project with its own fund, but it has been changed to cover a part of the fund with the Yen Credit (fund in foreign currency) in compliance with the strong desire of the Indonesian Government and in particular BAPPENAS.

The necessary expenditures (shown in Table – 13.1) divided into two parts, one to be covered by the Yen Credit and another to be covered by domestic currency, are shown in Table – 13.2. The amounts of fund which become necessary to be raised with the progress of construction works are shown in Table – 13.3.

13.1.1 Necessary Fund

The total amount necessary for the whole project is estimated at $30,467,480 shown in Table - 13.1 and its details is as fallows.

1) Cost of Smelting Facilities

The cost of smelting facilities is as described in paragraph 11 dealing with smelting facilities and the total amount of machine cost is $13,938,000 in c.i.f. value

2) Material Cost

As the Project might be implemented on Semi-Turn-key base, it is planned to import the construction materials from Japan with the tatal amount of $1,589,000 in c.i.f. value.

Table 13-1 Total Amount of Necessary Fund

(In U.S.$)

Items	C.I.F.	Installation	Civil Works	Others	Total	Remarks
Ore stock yard			58,620		58,620	
Screening, crushing and mixing plant	560,000	54,000	71,070		685,070	
Rotary kiln plant	1,920,000	300,000	316,900		2,536,900	
Electric furnace plant	2,600,000	370,000	615,370		3,585,370	
Refining plant	1,800,000	74,000	128,450		2,002,450	
Store house for product			125,730		125,730	
Store house for miscellaneous articles			76,520		76,520	
Store house for reducing agent			108,130		108,130	
Analytical laboratory	150,000		105,820		255,820	
Power plant and sub-station	3,780,000	225,000	429,760		4,434,760	
Oxygen plant	600,000	165,000	43,970		808,970	
Water and oil supply systems	1,000,000	545,000	102,000		1,647,000	
Jetty			260,390		260,390	
Electric wiring works	473,000	140,000	54,270		667,270	
Brick works	855,000	140,000			995,000	
Land levelling and road building and drainage works			190,000		190,000	
Air strip			300,000		300,000	
General buildings, houses & Company residences			1,000,000		1,000,000	
Construction material	1,589,000				1,589,000	
Others (Drying machine, etc.)	200,000	50,000			250,000	
Unloading transportation, storing				170,000	170,000	
Miscellaneous expenses				3,080,000	3,080,000	Details shown on attached paper
Contingency reserve				2,173,000	2,173,000	'1,000,000 = interest on loan
Total	15,527,000	2,063,000	3,987,000	5,423,000	27,000,000	

(Other necessary fund)

Interest on loan = $ 1,927,480
Working fund = 1,320,000
Mine facilities = 220,000

Grand total $30,467,480

Table 13-2 Necessary Funds by Foreing Currency and Rupiah

(Fund in Foreign Currency)

Items	1st yr. (12 mos.)	2nd yr. (12 mos.)	3rd yr. (2 mos.)	Total (26 mos.)	Remarks
Machines	13,588,000	350,000	-	13,938,000	
Materials	1,589,000	-	-	1,589,000	
Engineering fee	366,840	221,090	417,070	1,005,000	
Supervising fee	-	587,650	169,350	757,000	
Total	15,543,840	1,158,740	586,420	17,289,000	

(Fund in Rupiah)

Installing work	50,000	1,663,520	349,480	2,063,000
Civil engineering work	2,282,250	1,654,750	50,000	3,987,000
Unloading transportation	56,720	84,960	28,320	170,000
Technical training	150,000	50,000	-	200,000
General expense	95,200	95,200	47,600	238,000
Supervising fee	56,300	415,620	108,080	580,000
Contingency	-	-	1,173,000	1,173,000
Interest on fund in foreign currency	1,224,380	1,449,750	253,350	2,927,480
Total	3,914,850	5,413,800	2,009,830	11,338,480
			Total	28,627,480

Note: Other fund in rupiah

Working fund (Stock of ores and materials = 421,000 Ni-Co products = 899,000)		1,320,000
Mine facilities (Construction cost of residences already completed)		220,000
Investigation expenses (already expended for the project)		300,000
	Total	1,840,000
	Grand Total	30,467,480

Table 13-3 Demand for Fund in Foreign Currency by Month (during Construction Period)

(In U.S.$)

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total	Remarks
Screening, crushing, and mixing plant					560,000																							560,000	
Rotary kiln plant	1,920,000																											1,920,000	
Electric furnace plant	2,600,000																											2,600,000	
Refining plant			1,800,000																									1,800,000	
Analytical laboratory																	150,000											150,000	
Power plant and sub station	3,780,000																											3,780,000	
Oxygen plant				600,000																								600,000	
Oil supply system									333,000																			333,000	
Water supply system									667,000																			667,000	
Electric wiring works						473,000																						473,000	
Brick works						855,000																						855,000	
Construction materials	1,589,000																											1,589,000	
Others																	200,000											200,000	
Total	9,889,000		1,800,000	600,000	560,000	1,328,000			1,000,000								350,000											15,527,000	
Engineering fee	201,000			55,280			55,280			55,280			55,280			55,270			55,270			55,270			55,270		361,800	1,005,000	
Supervising fee																25,140	29,450	45,710	45,860	84,690	69,100	76,660	117,530	93,510	95,800	73,550		757,000	
Total	201,000			55,280												80,410	29,450	45,710	101,130	84,690	69,100	131,930	117,530	93,510	151,070	73,550	361,800	1,762,000	
Grand Total	10,090,000		1,800,000	655,280	560,000	1,328,000	55,280		1,000,000	55,280			55,280			80,140	379,450	45,710	101,130	84,690	69,100	131,930	117,530	93,510	151,070	73,550	361,800	17,289,000	

3) Cost of Installing Work

The amount allotted to the installing works of various machines at site is $2,063,000, which is equivalent to about 15% of the machine cost.

4) Cost of Civil Engineering Work

It is composed of land readjustment of plant site, foundations to install machines, improvement of airfield, extention of jetty , erection of buildings and residences, and etc. The Total amount allotted to it is $3,987,000.

5) Consultant Fee during Construction Period

The consultant services and fees during the construction period are as follows.

(a) Design fee (¥68,300,000)

Preparation of overall plan and basic specifications. Calculation of construction cost and arrangement with the manufactures. Basic designing service of plant houses and etc.

(b) General Supervision Fee (¥7,500,000)

Overall supervision of manufacture of materials, including inspection.

(c) General Expense (¥60,700,000)

Administration of construction department on the spot. Cooperation expenses of Japanese manufacturers.

(d) Compensation of persons dispatched to the field (¥173,043,000, to which $244,500 is added as the Rupiah fund for payment on the spot)

General supervision: 15 men, or 212 man-months.

Civil engineering work supervision:
11 men, or 137 man-months.

Total ---- ¥309,543,000 ($1,005,000) + $244,500

The basic agreement of ANTAM and Pacific metals Co. provides that the services to be offered by the latter are not uniform for every processes of the entire plant but are divided into the following categories in accordance with respective necessities.

(i) Category-IA : The production facilities which are directly subjected to the technical know-how of the consultant. The principal items include rotary kiln, electric furnace, and incidental equipments, the installation of which to be conducted starting from the sixteenth month after the commencement of construction works is carried out by the Japanese engineers on the full responsibility of the consultant. – 285 man-months

(ii) Category-IB : The production facilities which are subjected to the technical know-how and installed on the ANTAM's own responsibility under the instruction and supervision of Japanese engineers. The main items are screening, crushing, mixing and refining plants of which installation is started from the sixteenth month after the commencement of construction works. – 115 man-months

(iii) Category-II : Power plant, transformer, and oxygen plant, not subjected to the technical know-how which are installed by the manufacturers on the ANTAM's responsibility.
– 50 man-months for Power plant
– 7 man-months for oxygen plant

(iv) Category-III : Other works to be conducted on the ANTAM's responsibility which include house building, foundation, and other works. The expenditures under the categories -I.A, I.B, and II are covered by the funds in foreign currency and Rupiah, of which the supervising expenses are as shown in Table – 13.4.

Table – 13.4 Supervising Expenses classified by Category

Category	Fund in foreign currency	Fund in rupiah
I-A	450,000 ($)	200,000 ($)
I-B	197,000	85,000
II	110,000	50,000
Total	757,000	335,000

6) Other Expenses

Other expenses breaks down as follows

(a) Unloading and transportation expenses ($170,000))

The expenses to unload machines and materials at Pomalaa Port and to transport them to the site.

(b) Technical training expenses ($200,000)

The expenses for the technical training of ANTAM's staffs in Japan. It is planned to send 20 persons of engineers and staffs for six months from July, 1972, and 29 foremen for six months in 1973 to Japan for practical training in various factories.

(c) Interest on loan ($2,927,480)

Interest payable on loan in foreign currency for the construction period (at interest rate of 9%)

(d) Contingency ($1,173,000)

About 4% of necessary fund.

(e) Working fund ($1,320,000)

$421,000 to cover the stock of ores and materials for from one to three months' supply and $899,000 to cover one month's stock of products.

(f) Investigation expenses ($300,000)

$170,000 to cover the expenses for survey of ore deposit carried out previously for the Project and $130,000 to cover the test expenses for commercialization of ore processing conducted at Shibata Works of Pacific Metals Co.

(g) Expenses for mine facilities ($220,000)

Costs to construct buildings and residenses the construction of which is under way for the Project.

The total amount of fund necessary for the Project is $30,467,480, of which $17,289,000 is in foreign currency and $13,178,480 in Rupiah. (If the fund already expended is reduced the necessary fund in Rupiah is $11,338,480. See Table - 13.2.)

13.1.2 Amounts of Fund in Foreign Currency by Item of Equipment

The monthly amounts of fund in foreign currency which become necessary with the implementation of construction schedule are estimated as shown in Table – 13.3. The necessary machines and equipment will be ordered after the fund in foreign currency has be allocated to them. In order to achieve the smooth progress of construction works and to avoid waste of the fund it is desired that the fund in foreign currency will be allocated in accordance with the above Table.

13.1.3 Fund in Rupiah

ANTAM makes it its most important policy to complete the Project and can reserve $11,335,000 as internal fund for the Project in the years from 1972 to 1974 as shown on the Resources and Uses of Funds (Table – 13.5). Judging from the income and expenditure condition of ANTAM the fund in Rupiah necessary for the Project can be financed from the company's own fund.

Any insufficiency of the working fund will be financed temporarily by Bank Dagang Negara who has given a letter to ANTAM to insure such loan. A copy of the letter is attached herewith.

At present ANTAM sells the ores mined from Pomalaa Mine. Principally the civil engineering works such as levelling of land for plant site, building of residences and construction of jetty has been already carried out under the Project with its own fund in Rupiah.

Thus a part of the fund in Rupiah for the first year has been expended under the Project. If the construction works are carried out while the mining and selling of nickel ore are continued at Pomalaa, no trouble seems to occur about the raising of fund.

The project has been included in the first class projects under the development plan of 1972 by the Department of Mining, BAPPENAS who desires to implement the Project earnestly. From this side it is expected that if the borrowing of fund in Rupiah is necessary a strong support will be given to the Project by the government agencies concerned.

Table – 13.5 Estimated Income and Expenditure, P.N. ANEKA TAMBANG (In US.$)

RESOURCES AND USES OF FUNDS

		1972	1973	1974
I.	INCOME			
	1. BAUXITE	5,935,510.-	5,935,510.-	5,816,810.-
	2. TJIKOTOK GOLD	783,800.-	783,800.-	783,800.-
	3. NICKEL ORE	8,249,770.-	10,917,510.-	9,180,350.-
	4. REFINERY PLANT	416,800.-	416,800.-	416,800.-
	5. IRON SAND	1,186,550.-	1,280,610.-	1,280,610.-
	TOTAL :	16,572,430.-	19,334,230.-	17,478,370.-
II.	PRODUCTION COSTS			
	1. OPERATION COSTS	11,692,740.-	12,531,900.-	10,924,370.-
	2. DEPRECIATION	3,044,400.-	4,873,360.-	4,827,780.-
	TOTAL :	14,737,140.-	17,405,260.-	15,752,150.-
III.	GROSS PROFIT	1,835,290.-	1,928,970.-	1,726,220.-
IV.	CORPORATION TAX	825,880.-	868,040.-	776,800.-
V.	NET PROFIT	1,009,410.-	1,060,930.-	949,420.-
VI.	DEPRECIATION	3,044,400.-	4,873,360.-	4,827,780.-
VII.	PENSION FUNDS	171,480.-	164,630.-	164,230.-
VIII.	CASH BEGINNING OF 1972	1,792,770.-	-	-
IX.	AVAILABLE FUNDS	6,018,060.-	6,098,920.-	5,941,430.-
X.	INVESTMENT IN VARIOUS-UNITS EXCEPT FERRONICKEL	2,724,910.-	2,372,770.-	1,625,730.-
	AVAILABLE FOR FERRONICKEL :	3,293,150.-	3,726,150.-	4,315,700.-

Total available for Ferronickel (1972-1974)	US$. 11,335,000.-
PROJECT AID	US$. 15,365,000.-
TOTAL :	US$. 26,700,000.-

BANK DAGANG NEGARA,
Head Office,
Djakarta,
March 21, 1972

Subject: Application for the short term loan

To: Director,
P.N. Aneka Tambang

Dear Sir,

We have the pleasure to express herewith our basic agreement to your application for the short term loan of Rps. 352,750,000 by your letter No. 1319–Dir/E/2.57 dated March 20, 1972.

When you need to borrow the fund actually please arrange with us through our Gambir Branch in Djakarta.

Yours sincerely,

H.M. Widarsadipradja
Director

Omar Abdalla Drs. Ec.
Director

Copies–

Audit Department

Credit Department

Domestique Department

Foreign Department

Djakarta, Gambir Branch

13.2 Cost of Production

As stated previously it is proposed under the Project to produce ferro-nickel of 4,000 tons per year, in weight of pure Ni, by processing 250,000 tons per year, in dry weight, of ores containing 1.8% of Ni + Co and from 12% to 15% of Fe.

ANTAM has the experience in mining the ores over ten years and recently it produces the ores at a rate of from 600 to 800 thousand tons per annum. It has the adequate abilities to deal with both the equipment and technique; therefore the replacement of mining machines can be made gradually while the production is continueing under the Project.

In the smelting field, some Japanese engineers are to stay on the spot to provide the technical instruction to the staff and on the other hand ANTAM sends its excellent engineer to Japan for technical training (20 men will be sent in 1972 and 29 men in 1973); much is expected from these arrangements to have the staff master the smelting technique.

The outside transactions for selling and operation are made by the head office in Djakarta. But the administrative expense of head office is not debited directly to the cost of production in accordance with the policy of ANTAM. The operation and management of the mine and works is carried out by Pomalaa Mining Station; the Makasar Office belonging to the Station deals with the carrying in of materials and goods and the export of products (the expenses on these operations are debited to the cost as administrative expense).

The payments of Royalties (of the technical know-how) and of technical instruction fee to the Japanese engineers are made in the initial five years and the redemption of construction cost and the payment of loan in foreign currency and interest are made in the first 10 years after the start of operation.

The details of production cost are described in the following.

13.2.1 Direct Cost

1) Mining cost

The mining cost is \$2.85 per ton in dry weight of ore as described in paragraph–9.

2) Cost of electric power and subsidiary materials for smelting

The amounts of these costs are shown by item in Table – 13.6.

Table – 13.6 Costs of Electric Power and Other Subsidiary Materials for Smelting

Items	Quantity	Unit price	Annual amount
Heavy Oil for Kiln	22,000KL	18.5$	407,000$
Electric Power	165,000KWH	7	1,155,000
Electric Paste	400t	100	40,000
Coal	10,000t	25	250,000
Limestone	18,600t	4	74,400
Quicklime	160t	16	25,600
Calcium Carbide	560t	110	61,600
Sodium Carbonate	72t	80	5,760
Fluorspar	110t	60	6,600
Ferrosilicon	22t	225	4,950
Aluminum Shots	55t	625	34,380
Oxygen	190,000m^3	0.07	133,000
		Total	2,198,290
	(for 4,000 t/yr. of pure Ni)		

3) Repair and Maintenance costs

The amount is $355,000 per annum which is equivalent to about 3% of the net equipment investment.

4) Labour cost for smelting

The amount is $545,400 per annum against the number of workers referred to in paragraph – 12. Though the amount is higher by from 20% to 30% than that of the similar works in Japan it may be reasonable in view of the difference in the skill of operation and the religion and custom.

In estimating the labour cost the amounts of salary are presumed to be 65,000 Rps./mo. of Rank-I, 40,000 Rps./mo. of Rank-II and 35,000 Rps./mo of Rank-III for the first year of operation allowing for annual increase of 3% in the second year and thereafter so that the average amounts of ten years will be 75,000 Rps./mo. of Rank-I, 45,000 Rps./mo. of Rank-II, and 40,000 Rps./mo. of Rank-III. (For the explanation of ranks, see paragraph – 12.)

Table – 13.7 Labour Cost for Smelting

Classification	Number	Unit price	Amount
Rank-I	23 men	75,000 Rp/M.	1,725,000 Rp/M.
Rank-II	69	45,000	3,105,000
Rank-III	311	40,000	12,440,000
Total	403		17,270,000
			207,240,000 Rp/Y.
		$1= Rp. 380	545,400 $/Y.

Though the present exchange rate is 415 Rps./$, the above figure is adopted so as to be on the safety side.

13.2.2 Fixed Cost

1) Administrative expense and others

The annual amount of administrative expense is shown in Table – 13.8.

Table – 13.8 Administrative Expense and Others

Items	Amount
Insurance expense (fire and burglary insurances)	1,800 ($)
General repairing expenses (of buildings, vehicles, etc.)	180,000
Electric power charge (of residences 12,000 k.w.h×@ 7.00)	84,000
Industrial water (20,000 kl /d @1.25 Rp. /kl)	25,000
Welfare expenses	8,000
Office and admistrative expenses (of Pomalaa Mining Station and Makasar Office)	120,000
Total	418,800

2) Royalty

It has been arranged that the Royalty is paid ¥30,000 per ton of product and the total amount shall not exceed ¥600 million. Therefore, the average amount of royalty per ton (in weight of pure Ni) for ten years can be calculated by dividing ¥600 million ($1,948,052) by the total production of ten years.

3) Instruction fee of production technique

It is planned that the Japanese engineers are sent to the field to train the indigenous engineers for the initial five years of operation and the details of the plan are shown in Table – 13.9. The fees are paid following those paid in the construction period and the total amount is $1,326,000 with the average payment of $2,000 per one man per month.

Table – 13.9 Instruction Fee of Production Technique

Year	Term	Nr. of instructors				Amount
1 st year						($)
(Preparation / Stable operation)	3 mos.	13 men		- 13	man-mos.	
		41	"	-123	"	
(Performance guaranty test)	1 mos.	41	"	- 41	"	
(Commercial operation)	3 mos.	41	"	- 78	"	
(")	5 mos.	12	"	60	"	
Total				315	"	630,000
2nd year	12 mos.	11	"	132	"	264,000
3rd year	"	8	"	96	"	192,000
4th year	"	5	"	60	"	120,000
5th year	"	5	"	60	"	120,000
Total				348	"	
Grand Total				663	man-mos.	1,326,000

4) Investigation expense

The investigation expenses include the payments which have been made so far for the exploration of mine and the test operation of ore processing conducted by Pacific Metals Co. at its Shibata Works. These payment are debited as the expenditures for the Project and will be redeemed over ten years.

(a) Exploration of ore deposit (First Stage)

The exploration was carried jointly by ANTAM and SUNIDECO from 1968 to 1969 and for the time being it is not intended to use the ore developed for the Project (Rps. 15,000,000).

(b) Second stage exploration

The exploration was conducted solely by ANTAM (Rps. 45,000,000).

(c) Test operation made by Pacific Metals Co. at its Shibata Works (Rps. 50,000,000)

Rps. 110,000,000 ($300,000) in total is redeemed over ten years at $30,000 per annum.

13.2.3 Interest on Working Fund

The interest are born on the fund borrowed to stock the materials and machine parts. The necessary expenditures and interests shown in Table – 13.10 have been estimated on the assumption that one or two months' supply will be stocked for those which can be aquired in the country and three months' supply for those which must be imported from Japan or other country.

Table – 13.10 Interest on Working Fund

		($)
Ore	1 month'supply	59,400
Product	1 "	899,100
Coal	1 "	22,500
Limestone	1 "	6,200
Heavy Oil	2 "	222,000
Electrode paste	3 "	10,000
Calcium carbide	3 "	15,400
Sodium carbonate	3 "	1,440
Quicklime	1 "	2,150
Fluorspar	3 "	1,650
Ferrosilicon	3 "	1,250
Aluminium	3 "	8,600
Auxiliary materials	3 "	62,500
Total		1,312,190

Annual interest rate = 12%

Annual interest = $157,460

13.2.4 Depreciation

For depreciation purpose the machines and equipments, materials, installing work cost, and engineering and supervising fees for construction are divided into the two groups; one mainly of machines and equipments is depreciated by the fixed percentage method over ten years and other of civil engineering works, jetty, buildings, and etc. by the same method over twenty years. The calculation of depreciations is as follows.

Machines and equipments;

Price of machines	13,938,000 ($)	
Interest on the above	2,660,680	
Installing cost	2,063,000	
Total	18,661,680 x $\frac{1}{10}$	= 1,866,170 ($)

Civil engineering works, buildings, and others;

Price of materials	1,589,000 ($)	
Civil engineering works	3,987,000	
Others	4,540,890	
Total	10,116,890 x $\frac{1}{20}$	= 505,850 ($)
Grand total	28,778,570 ($)	2,372,020 ($)

The depreciation per year is $2,372,020.

13.2.5 Interest on Construction Fund

If the construction fund is raised by means of the loan in foreign currency and the principal of $17,289,000 is redeemed over ten years at the interest rate of 9%, the interest for ten years is $8,558,050, or $855,810 per annum.

13.2.6 Average Production Cost per Annum for 10 Years

The average cost of production per annum is shown in Table – 13.1 which has been calculated from the elements of production cost described in the above by dividing them into the direct and fixed costs.

In the above calculation the total production in ten years has been assumed at 38,600 tons in order to calculate the average production cost per ton of pure Ni. This total production has been worked out on the bases of operating efficiencies of 80% (3,200 tons) for the first year of operation, 90% (3,600 tons) for the second year, 95% (3,800 tons) for the third year, and 100% (4,000 tons) for the fourth year and thereafter.

Table – 13.11 Average Production Cost per Annum

Items	Amount	Cost per ton
Direct cost		
	($)	($)
Mining cost	687,560	178.12
Costs of electric power and subsidiary materials	2,121,350	549.57
Repair and maintenance costs	355,000	91.97
Labour cost	545,400	141.30
Fixed cost		
Administrative expense and others	418,800	108.50
Royalty	194,810	50.47
Instruction fee of production technique	132,600	34.35
Redemption of investigation expense	30,000	7.77
Interest on working capital	151,950	39.37
Depreciation	2,372,020	614.51
Interest on construction fund	855,810	221.71
Total	7,865,300	2,037.64

13.3 Selling Price and Market

In July 1971 a ferronickel import contract was made between ANTAM and SUNIDECO, according to the contract, the whole ferronickel to be produced under the Project (4,000 tons per annum in pure Ni) will be imported to Japan, so that the implementation of the Project is secured. In this connection documents to the effect as shown below have been exchanged between ANTAM and SUNIDECO. It is expected that the project to develop nickel resource is promoted under the stronger friendly relations between Indonesia and Japan. The documents say,

1) In view of the cooperation of ANTAM and SUNIDECO in the past year, the maintenance and furtherance of friendship between the two companies will promote the interest of nickel industry in Indonesia and Japan.

2) ANTAM guarantees to SUNIDECO at various occasions that the ores confirmed by the joint exploration of the two companies will not be used for the Project and that it will cooperate with SUNIDECO so that the latter's own project may be completed successfully.

The selling price of ferronickel is to be determined as f.o.b. price Pomalaa per metric ton of Ni + Co content basing on the price of Port Colborne quoted for electrolytic nickel by INCO (of which the selling price is regarded as the standard price on the international nickel market) upon the negotiation between ANTAM and SUNIDECO. By the way, in July, 1971, when the contract was made f.o.b. Pomalaa price of $2,785.54 per ton was proposed on the basis of the price quoted by INCO.

Due to the recess in the business cycle after that, conditions are prevailing unfavourable to determine the future price of Pomalaa nickel. At present the quotation by the manufacturers of Japan is ¥1.2 million per ton of Ni + Co content on delivery to consumer's factory and if the f.o.b. price, Pomalaa, is worked out on the basis of the above price a level of $2,700 will be suggested. For the present purpose the income and expenditure are calculated on the basis of this price.

13.4 Profitability

The profitability is calculated on the basis of the production cost and selling price described in the above. In Indonesia the export tax is levied at 10% of selling price and the corporate income tax of 45% is charged to the profit before tax.

As shown in Table – 13.12, the income and expenditure averaged for ten years after the start of production show $1,514,500 in profit before tax against 3,860 tons of product selled. This amount is equivalent to 14.5% of the sale and yields a sufficient profit even after covering the initial necessary expenditures including loyalty and technical instruction fees incidental to the start of operation. The profit after reduction of these initial expenditures as well as the corporate income tax still yeild $832,980 in net profit which corresponds to 8% of the sale; it is a net profit of $215.80 per ton of pure Ni + Co.

This means that the start of operation under the Project will guarantee the income in annual average of $10,422,000 in foreign currency, which is greater than the annual income of about $9,000,000 from the selling of Pomalaa ore (from 600 to 800 tons in weight), for a long period. This will enable the Pomalaa Mine to transfer technically from the export of primary product to that of secondary product and thus to pave a broad way to the long term development of nickel resource in the future.

The estimated production account by year is shown in Table – 13.13 and the estimated balance of funds in Table – 13.14 for 10 years after the start of operation.

Table – 13.12 Estimated Income and Expenditure by Annual Average

Items	Amount ($)	Amount per t ($)	Profit ratio (%)
1. Income	(3,860t in net weight of pure Ni+Co)		
Sales of ferronickel	10,422,000	2,700	100
Export tax	1,042,200	270	10
Net income	9,379,800	2,430	90
2. Expenditure			
Production cost	4,637,470	1,201.42	44.5
Depreciation	2,372,020	614.51	22.8
Interest on construction fund	855,810	221.71	8.2
Total	7,865,300	2,037.64	75.5
3. Profit (before tax)	1,514,500	392.36	14.5
4. Corporate income tax	681,520	176.56	6.5
5. Net profit	832,980	215.80	8.0

13.5 Break-even Point

The profit and loss break-even point on the basis of the estimated production account for ten years is shown in Fig. – 13.1. The break-even point, P, is plotted by taking the sale ($10,422,000), S, on the abscissa and the variable costs ($4,358,060), V, including export tax, mining, power, material and repair expenses and interest on working capital and the fixed costs ($4,549,440), F, including administrative expense, loyalty, depreciation and other fixed expenses on the ordinates. It represents $7,900,000 which corresponds to the sale of 2,950 tons (@$2,700 per ton) or $2,050 per ton against the sale of 3,860 ton of product.

Fig. 13-1 Break-even Point

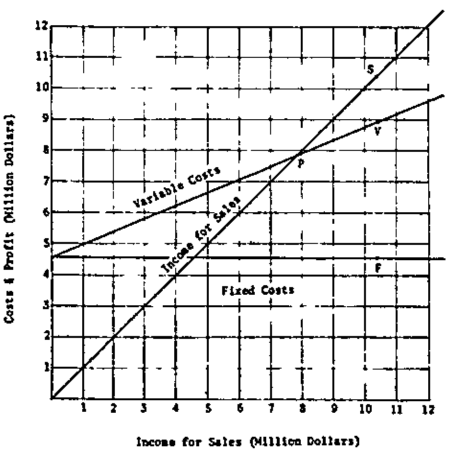


Table 13-13 Estimated Production Account for 10 Years

(In U.S.$)

Year	1	2	3	4	5	6	7	8	9	10	Total	Annual average	Per ton	Remarks
Operating efficiency	80	90	95	100	100	100	100	100	100	100		96.5		
1. Income	(3,200t)	(3,600t)	(3,800t)	(4,000t)	(4,000t)	(4,000t)	(4,000t)	(4,000t)	(4,000t)	(4,000t)	(38,600t)	(3,860t)		
Sales of ferronickel	8,640,000	9,720,000	10,260,000	10,800,000	10,800,000	10,800,000	10,800,000	10,800,000	10,800,000	10,800,000	104,220,000	10,422,000	2,700	
Export tax	864,000	972,000	1,026,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	10,422,000	1,042,200	270	10% of exporting price
Net income	7,776,000	8,748,000	9,234,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	93,798,000	9,379,800	2,430	
2. Expenditures														
Mining cost	570,000	641,250	676,870	712,500	712,500	712,500	712,500	712,500	712,500	712,500	6,875,620	687,560	178.12	
Materials, and electric power	1,758,630	1,978,460	2,088,370	2,198,290	2,198,290	2,198,290	2,198,290	2,198,290	2,198,290	2,198,290	21,213,490	2,121,350	549.57	
Repair and maintenance	200,000	250,000	300,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	3,550,000	355,000	91.97	
Labour cost	478,100	491,600	505,000	518,500	532,000	547,600	572,300	585,800	599,900	623,200	5,454,000	545,400	141.30	
Administrative expense	418,800	418,800	418,800	418,800	418,800	418,800	418,800	418,800	418,800	418,800	4,188,000	418,800	108.50	
Royalty (know-how)	311,680	350,640	370,120	389,600	389,600	136,460					1,948,100	194,810	50.47	
Technical instruction fee	630,000	264,000	192,000	120,000	120,000						1,326,000	132,600	34.35	
Redemption of investigation expense	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	300,000	30,000	7.77	
Interest on working fund	125,960	141,710	149,590	157,460	157,460	157,460	157,460	157,460	157,460	157,460	1,519,480	151,950	39.37	
Total	4,523,170	4,566,460	4,730,750	4,945,150	4,958,650	4,601,110	4,489,350	4,502,850	4,516,950	4,540,250	46,374,690	4,637,470	1,201.42	
Depreciation	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	23,720,200	2,372,020	614.51	
Interest on construction fund	1,556,010	1,400,410	1,244,810	1,089,210	933,610	778,000	622,400	466,800	311,200	155,600	8,558,050	855,810	221.71	
Total of expenditures	8,451,200	8,338,890	8,347,580	8,406,380	8,264,280	7,751,130	7,483,770	7,341,670	7,200,170	7,067,870	78,652,940	7,865,300	2,037.64	
3. Profit or loss (Δ)	Δ675,200	409,110	886,420	1,313,620	1,455,720	1,968,870	2,236,230	2,378,330	2,519,830	2,652,130	15,145,060	1,514,500	392.36	
4. Corporate income tax	-	184,100	398,890	591,130	655,070	885,990	1,006,300	1,070,250	1,133,920	1,193,460	6,815,270	681,520	176.56	45% of profit
5. Net profit	-	225,010	487,530	722,490	800,650	1,082,880	1,229,930	1,308,080	1,385,910	1,458,670	8,329,790	832,980	215.80	

Table 13-14 Estimated Balance of Funds for 10 Years

(In U.S.$)

Year	1	2	3	4	5	6	7	8	9	10	Remarks
Sales (after reduction of export tax)	7,776,000	8,748,000	9,234,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	9,720,000	
Production cost	8,451,200	8,338,890	8,347,580	8,406,380	8,264,280	7,751,130	7,483,770	7,341,670	7,200,170	7,067,870	
Profit or loss(Δ)	Δ 675,200	409,110	886,420	1,313,620	1,455,720	1,968,870	2,236,230	2,378,330	2,519,830	2,652,130	
Corporate income tax	-	184,100	398,890	591,130	655,070	885,990	1,006,300	1,070,250	1,133,920	1,193,460	
Net profit	Δ 675,200	225,010	487,530	722,490	800,650	1,082,880	1,229,930	1,308,080	1,385,910	1,458,670	
Funds credited from other account											
Net profit	Δ 675,200	225,010	487,530	722,490	800,650	1,082,880	1,229,930	1,308,080	1,385,910	1,458,670	
Depreciation	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	2,372,020	Credited from production cost
" (on mining assets)	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	"
Redemption of investigation expense	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	"
Interest on working fund	125,960	141,710	149,590	157,460	157,460	157,460	157,460	157,460	157,460	157,460	"
Total	2,052,780	2,968,740	3,239,140	3,481,970	3,560,130	3,842,360	3,989,410	4,067,560	4,145,390	4,218,150	
Necessary Funds											
Redemption of loan (in foreign currency)	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	1,728,900	
Mining facilities	8,210	413,510	164,600	74,440	505,160	158,370	176,410	74,440	219,770	160,680	Replacement of mining facilities
Buildings and others	-	393,650	103,390	-	300,530	103,390	-	-	103,390	-	
Total	1,737,110	2,536,060	1,996,890	1,803,340	2,534,590	1,990,660	1,905,310	1,803,340	2,052,060	1,889,580	
Balance of fund	315,670	432,680	1,242,250	1,678,630	1,025,540	1,851,700	2,084,100	2,264,220	2,093,330	2,328,570	

XIV. PROBLEMS AND CONCLUSION

As mentioned above, we reported the findings concerning with the circumstances why the Project has been proposed by Indonesia, the reserves and sorts of ores, smelting processes and equipments, infrastructures, and the economic feasibility.

It can be concluded that the project is feasible and profitable, but it must be mentioned that many problems are involved in the construction and operation of the plant. Though they seemed as minor problems if taken up individually, they must be solved in advance or thoroughly to carry out the Project successfully. These problems are described in the following.

14.1 Infrastructures

The Pomalaa Mining area lies along the seacoast; and the smelting plant is near to the port, so transportation is very convenient. The conditions of the location of Pomalaa is sufficiently enough for the construction of the smelter. However, it is better to open the regular lines by air and sea between Makasar and Pomalaa, or to pave the road between Makasar and Badjoa (on the opposite bank of Pomalaa), and to open the bay route between Badjoa and Pomalaa in order to achieve a successful operation of the modern plant. The regular services for communication must be arranged in Pomalaa area.

14.2 Labour Condition

In general the difference of wage is very great between the upper and lower grades of Indonesian workers and many Japanese workers will stay in Pomalaa for a long time to attend to the construction. The welfare and amusement facilities must be provided by the ANTAM itself as differed from the urban area. In these conditions, a conflict of sentiment is apt to occur due to the difference in quantity of living conditions in these workers and such conflict tends to develop into a serious problem.

In selecting the staff sent from Japan, gentle persons should be preferred and they should be thoroughly disciplined before leaving for Indonesia and it should be avoided to select the persons who cannot keep the good human relations with Indonesian peoples for reasons of difference in manners and habits.

As a matter of Indonesian side, the welfare and other facilities which will give varieties to the living of peoples should be established for the sake of the workers of both countries.

Also the staffs and facilities relating to the police and preservation of peace should be arranged in advance and liability for any accidents must be cleared before the construction will be started.

14.3 Technical Problems

The technical problems are discussed in the relevant paragraphs and omitted here. The priority should be given to the utilities such as power plant, supply of water and others in scheduling the construction works and a thorough attention should be paid to the mining and ore bedding to insure a uniform grade of ores; an attention must be paid also to the fact that unit costs for production will be higher if iron content of the ore becomes higher.

Under present conditions there will be no problem about the water source. However, it will be preferable to plan the construction of a reservoir with a considerable capacity in the near future as the volume of water of Komoro River is not enough.

14.4 Fund

As stated in the paragraph dealing with the economic aspects, the reserve of exportable ore is small and it is necessary to complete the construction works until the reserve is exhausted. It is anticipated that the profitability of ANTAM becomes worse and the financing from its own fund to the Project will become difficult, when the export of nickel ore becomes impossible.

14.5 Demand and Supply of Nickel

SUNIDECO has made a contract with ANTAM to buy the entire product for ten years from 1974 in order to continue their long standing friendship into the future. The market conditions of Japan are not favourable at present, so the nickel of 4,000 tons from Pomalaa will be considered too heavy.

However, it goes without saying that the continuation of the said contract is desirable in order to keep the friendly relations between Indonesia and Japan.

14.6 Development of Nickel in Future

The Project has been formulated solely by ANTAM and the technical assistance is to be provided by Japan and the products are taken over by SUNIDECO. As there is a huge resource of low-grade laterite ore in Pomalaa area, a further project should be promoted to construct another smelting plant when the demand and supply of nickel turns to improve.

Annex Table – 1 Itinerary of Survey

Date	Content
Feb. 29 (Tue.)	Left Haneda by JAL 711 Flight; arrived Djakarta.
Mar. 1 (Wed.)	Made arrangement at Japanese Embassy; had a talk with the president and executives of ANTAM.
2 (Thu.)	Met with the Minister of Mining at the Department of Mining; made arrangement at the head office of ANTAM.
3 (Fri.)	Heard general circumstances from the Director of Development and Planning Bureau at the Department of Mining.
4 (Sat.)	Had a discussion at the head office of ANTAM.
5 (Sun.)	
6 (Mon.)	Left Djakarta by chartered plane (Beechcraft); arrived Makasar; left for Pomalaa but returned enroute to Makasar due to bad weather.
7 (Tue.)	Left Makasar by chartered plane; though reached over Pomalaa but again returned to Makasar being unable to land due to the fail of flap.
8 (Wed.)	Inspected the port facilities of Makasar and P.T. ANEKA GAS INDUSTRY. (Goto and Takeuchi met with the Governor of Southeast Sulawesi Province.)
9 (Thu.)	Left Makasar by the ore ship of SUNIDECO, "Lennia Maru", stayed overnight in the ship.
10 (Fri.)	The ship anchored in the offing of Pomalaa; investigated Pomalaa Ni Mine-lot and various facilities of Pomalaa Mining Station.
Mar. 11 (Sat.)	Investigated various facilities of Pomalaa Mining Station; had a talk with the Superintendent and other staffs of Pomalaa Mining Station; left Pomalaa by the ore ship of SUNIDECO, "Noumea Maru", stayed overnight in the ship.
12 (Sun.)	The ship anchored outside of Makasar Port; made arrangement at Makasar Branch of ANTAM.
13 (Mon.)	Left Makasar by Garuda Airline; arrived Surabaya; inspected P.T. Semen Gresik; had a talk with the president and executives of P.T. BARATA.
14 (Tue.)	Inspected the thermal power plant of P.N.P.L.T.U. Perak.

Date	Content
15 (Wed.)	Inspected the head office and machine shop of P.T. BARATA; Left Surabaya by Garuda Airline; arrived Djakarta.
16 (Thu.)	Inspected ANTAM, P.P. Unit Logam Muria and Tandjung Periuk thermal power plant; had a discussion at ANTAM.
17 (Fri.)	Made the arrangement with BAPPENAS and O.E.C.F.; has a discussion at ANTAM.
18 (Sat.)	Reported the outline of results of investigation to the president and executives at ANTAM; heard the state of Ni development in Indonesia from the Director of Development and Planning Bureau, Department of Mining.
19 (Sun.)	
20 (Mon.)	Had a discussion at ANTAM; adjusted data.
21 (Tue.)	Heard the situations at the head office of P.N. Hutama Karya; had a discussion at ANTAM; adjusted data.
22 (Wed.)	Had a discussion at ANTAM; adjusted data; reported the outline of results of investigation to the Vice President and the Director of Mining and Industrial Bureau at BAPPENAS and had a discussion.
23 (Thu.)	Had the last discussion at ANTAM.
24 (Fri.)	Inspected Bandung Geological Research Institute and Mining Research Institute.
25 (Sat.)	Reported the outline of results of investigation to the Japanese Embassy.
26 (Sun.)	Left Djakarta by JAL 710 Flight; arrived Haneda.