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CONSTRUCTION OF AN ALUMINUM SMELTER AND RELATED FACILITIES IN A DEVELOPING COUNTRY

THE BROKOPONDO PROJECT - SURINAME 1/

by

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C O N T E N T S

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I. INTRODUCTORY REMARKS

Aluminum Company of America, or Alcoa, is the world's leader in the aluminum industry. The Company was founded in Pittsburgh, Pennsylvania, U.S.A., in 1888 following the discovery of the electrolytic process for the reduction of metallic aluminum by Charles Martin Hall. At the time it was called The Pittsburgh Reduction Company.

Today, Alcoa has some 44,000 employees, many operating locations and sales offices around the globe. Its assets total U.S. $3.4 billion.

Alcoa's principal operations include bauxite mining, alumina and chemical production, smelting and fabricating aluminum into semi-fabricated and finished products. The Company also has diversified into a variety of businesses related to its basic facilities and technology.

In addition to U.S. production facilities, Alcoa has operating investments in Japan, Mexico, El Salvador, Venezuela, Brazil, Jamaica, the Dominican Republic, Suriname, United Kingdom, Norway, The Netherlands, France, Spain, Australia, Morocco, and Guinea.

Alcoa's relationship with Suriname dates back to 1916 when a wholly-owned subsidiary was established to begin a full scale bauxite mining, exploration and development program in that country. It was called Surinaamsche Bauxite Maatschappij, and was renamed Suriname Aluminum Company (Suralco) in 1958.

This paper concerns itself with the story of expansion of the initial Suriname mining operation into a full scale Power Development, Bauxite Mining, Alumina Refining and Aluminum Smelting Complex known as the Brokopondo Project.

II. PROJECT BACKGROUND

In 1948 Professor W. J. Van Blommenstein, a noted Dutch hydrologist, proposed the harnessing of one of Suriname's major rivers -- the Suriname River -- as a means of providing electrical energy for the further industrial development of Suriname.

Both Suriname and Suralco realized that such a development would have many advantages for Suriname. If other considerations besides electrical power could be incorporated in a joint venture, the total result could make an aluminum plant commercially feasible for Suralco.

Based on this approach, negotiations between the Suriname Government and Alcoa started in 1956 and extended through 1957. Progress was slow, partly due to the complexity of the problems and issues involved. In addition, all provisions of this complicated document had to be expressed to the satisfaction of both parties in two languages, in itself an undertaking which required many months of careful discussion.

As it was, the Brokopondo Agreement was finalized and executed early in 1958.

The Suriname Government bore the costs of preliminary surveys and studies; provided all necessary lands, waters and public roads; ensured and maintained the necessary technical hygiene and sanitation in the reservoir area; and relocated the population and moved buildings from the future reservoir area. Suriname received, in return, the economic benefits and values of a hundred million dollar construction program; a new industry which provided substantial tax revenues and foreign exchange; permanent employment for some 800 technicians and workmen; development of the interior; and 80 million kilowatt hours of electrical energy per year for its own use. This is twice the amount of electricity consumed in Paramaribo in 1962.

Alcoa assumed the responsibility of financing, constructing, operating and maintaining a hydroelectric installation, a 60,000 short ton aluminum smelter, the connecting transmission lines, and eventually an alumina plant of corresponding size. The Company assumed the obligation of conducting a $5 million, 20-year exploration program covering an area of about 2,000,000 hectares. In return, Alcoa received a 75-year extension on existing bauxite concessions. The company also received new

concessions and reserves. An arrangement was made for Alcoa to utilize the Western Hemisphere Trade Corporation tax advantages. And finally, Suriname became associated with the European Common Market, an action which improved Suralco's position with respect to metal and alumina sales within the EEC countries. This, in brief, is a description of the combined package which created the conditions necessary for an aluminum venture in Suriname. This venture proved to be a commercial success for Alcoa, and it moved the country a step further along on its road to industrialization and economic independence.

III. PLANNING THE PROJECT

Immediately following signing of the Brokopondo Agreement on January 25, 1958, planning for the project was started in the Pittsburgh Office of Alcoa.

First the project was broken into major segments for further study as follows:

1. 75 KM Road from Paranam (existing Suralco Mining and Shipping Installation located on the Suriname River) to Afobaka (final site of the Hydro Project).

2. Hydroelectric Project at Afobaka.

3. Alumina Refining Plant at Paranam.

4. Aluminum Smelter at Paranam.

5. Power Transmission Line Afobaka to Paranam.

6. Increased port and storage facilities at Paranam to handle flow and storage of materials for all projects and for future shipping needs of the new production facilities.

Essentially all materials and equipment for the project were shipped into Suriname. All deliveries were by ship with discharge at Paranam on the Suriname River. Materials and equipment were marshalled at Paranam for transport to the hydro site by the new road. Until the road was available, all personnel, materials, and equipment had to be transported by river to Afobaka, a slow and expensive exercise due to conditions on the upper Suriname River. Construction of the road to Afobaka was the No. 1 priority.

Suralco, already in the bauxite mining business in the Paranam and Moengo areas, had some equipment. Road construction began immediately, using available dozers, graders, and scrapers. Key Suriname personnel trained in the use and maintenance of the equipment were transferred from the Mining operation. Initial work was under the supervision of an Alcoa Construction Manager and several engineers transferred to Suriname.

With road construction underway, attention was turned to a study of methods for design and construction of the total project. Paramount consideration was to reap maximum economic effect for Suriname.

First considered was the classical way of completing such a project -- through competitive bidding and large construction contractors. Because of ties between Suriname and The Netherlands, in-depth studies were made of available contractors, material and equipment suppliers from that country. Certain conditions, listed here, led us to depart from normal competitive bidding for the project.

1. All design would be done in the Pittsburgh Office of Alcoa.

2. Design would go on while construction was under way.

3. Maximum use of Suriname labor would be made.

4. Labor rates, rates of expenditure, etc., would be controlled so as to have minimum economic impact on Suriname.

A plan was formulated which held for the life of the project.

A. Material and equipment for Project -- bid competitively on world-wide basis.

B. Suralco would function as its own contractor. It would carry all labor on own payrolls, would train all personnel using seconded expatriate experts as trainers and supervisors. The company would start early training in phases -- first on road construction, second on Hydro construction, third on Refining and Smelter construction. Finally, trained personnel would receive additional training to prepare them for permanent jobs in Operation of Hydro Project, Refining Plant, and Smelter and related facilities.

C. Alcoa would perform all design work in the Pittsburgh Office, using Harza Engineering Company as consultant on the Hydro Project.

IV. DESIGN OF PROJECT AND DESCRIPTION OF FACILITIES

The purpose of this paper is to look at the construction of an Aluminum Smelter in a developing country. Yet it is necessary to consider briefly related elements which had a direct impact on the Smelter Project, particularly as regards training and use of labor.

A. Paranam-Afobaka Road

Design of this 75 KM road, including bridge and drainage structure, was done by Alcoa engineers. It was based on field survey and soil data obtained by field crews in Suriname. The road is heavier than required for normal use; it was designed to handle the construction equipment, materials and the heavy transformers, turbines, and generators later installed in the Brokopondo Powerhouse.

The road was designed to be constructed totally of local materials available along the R/W. The surface was a granular laterite material. No other surfacing was provided.

The alignment of the road was controlled in part by the parallel location of transmission line. The road served to transport materials for tower and line construction and to provide access for line maintenance.

B. Hydro-electric Project and Transmission Line

The total design of this project was done in the Pittsburgh Office of Alcoa with Harza Engineering Company as consultant. On signing of the Brokopondo Agreement, considerable data and studies were obtained from the Brokopondo Bureau covering early engineering work. Studies by Alcoa and Harza located the dam at Afobaka upstream of the original Government location.

The Brokopondo Dam is an earth and rock fill with sloping impervious core, complete with concrete spillway and powerhouse section.

Some statistics:

Main Dam

Length -- Earth Section	5464 feet
Length -- Concrete Section	936 feet
Total Length	6400 feet
Height	218 feet

Saddle Dikes

Total of 4 miles in length of heights of 2 feet to 92 feet.

Reservoir

600 sq.miles surface area

4,700 sq.miles drainage area

90 in./yr. average annual rainfall

13,700 cfs average annual runoff

Powerhouse

6 Turbines and Generators each rated @ 30,000 KW, 13.8 KV, 3 phase 60 cycle 240 RPM

Installed capacity -- 210,000 KVA @ .857 PF = 180,000 KW

@ Maximum Head = 200,000 KW

@ Minimum Head = 155,400 KW

Transmission Line

(a) Step up transformers at dam from generating voltage of 13.8 KV to 161 KV.

(b) Two parallel transmission lines from powerhouse to Paranam switchyard; towers of aluminum construction; and ACSR conductor.

Quantities

Concrete --

Powerhouse and Spillway Section	476,500 cy

Earth and Rock Fill --

11,013,000 cy including saddle dikes of	1,382,000 cy

C. Refining and Smelting Plants and Related Facilities at Paranam

Design of the Alumina Refining Plant and the Aluminum Smelting Plant also was done at Alcoa headquarters.

Once the decision was firm on the early construction of a Refining Plant, design was scheduled to provide this facility to match start-up of the Smelter. Originally the Refining Plant was authorized as a two-digestor unit capable of production of 400,000 tons per year of alumina.

Before the first two digestors were in operation, the plant was expanded to a capacity of 800,000 tons per year.

Bauxite feed to the Refinery is a blend of bauxite from the Paranam and Moengo areas. Paranam bauxite is transported to the plant by large truck haul units while Moengo bauxite is transported by barge to the Paranam site. Design of all mining, haulage, unloading, and storage facilities also was done in Alcoa's Pittsburgh Office.

During early design stages of the Smelter, consideration was given to both prebaked and V.S. Soderberg designs. Final decision was for the V.S.S. design. Size of Smelter, improbable expansion of Smelter due to power limitations, and lower capital costs in the Carbon Plant, plus other considerations controlled this choice.

The Smelter consists of two potlines, of 76 pots each, housed in two buildings of 38 pots each. A full basement design was utilized similar to other Alcoa Soderberg installations in Mexico and Brazil. Alcoa's latest environmental controls were incorporated. The carbon plant is quite simple as briquetted paste is shipped to Paranam from Alcoa plants in Texas. The Ingot Plant was designed to produce remelt ingot, extrusion billet and sheet ingot for shipment to North and South America and Europe.

A port was designed with three basic facilities.

(a) The original dock for loading of bauxite was redesigned to provide for loading of bauxite, unloading of oil and caustic, and unloading of all construction equipment, materials and machinery required for the total project. Included in design were bulk cement storage tanks to be used later for bauxite. A gantry crane used during construction of concrete sections of the dam was later used on the dock at Paranam.

(b) A second dock was designed to handle shipment of bulk alumina. Alcoa collaborated with Soros Associates in the design of this facility.

(c) A third dock was built to handle unloading of bauxite transported from Moengo. This dock also was provided with facilities for unloading of propane.

Design work included all amenities and shops and storerooms required for the various facilities. Also included were temporary facilities, construction camps, aggregate and concrete plants, construction shops, etc.

V. EXECUTION OF THE PROJECT -- USE OF PLANNED PHASED CONSTRUCTION AND CONTROL OF EXPENDITURES

GENERAL OUTLINE SCHEDULE

1.	Brokopondo Agreement Signed	Jan. 25, 1958
2.	Road and Hydro Site Investigations Started	Early 1958
3.	Started Construction of Camp and Construction Facilities at Afobaka	Dec., 1958
4.	Started Construction of Road (Existing Equipment)	Jan., 1959
5.	New Construction Equipment Arrived	July, 1959
6.	Road Officially Opened to Traffic	Aug. 26, 1960
7.	Start Hydro Construction	Aug. 26, 1960
8.	Final Diversion of River	Feb. 6, 1963
9.	Final Closure	Feb. 1, 1964
10.	First Gen. Unit on Line	Sept. 1, 1965
11.	Last Gen. Unit Installed	Dec. 1, 1965
12.	Start Refining and Smelting Construction	July 17, 1963

13.	Start Up First Refinery Unit	Aug. 1, 1965
14	Start Up Second Refinery Unit	Sept. 1, 1965
15.	Start Up First Potline	Sept. 1, 1965
16	Total Smelter Complete	Oct. 9, 1965
17.	Paranam Dock Construction Complete	July 1, 1964
18.	Alumina Dock Construction Complete	Jan., 1968

EXECUTION OF THE PROJECT

Basic Infrastructure and Temporary Construction Facilities

At the time of the signing of the Brokopondo Agreement, access to the various sites was by road from Paramaribo to Paranam, the site of the Refining Plant and Smelter, and by river to the Hydro site at Afobaka.

The main headquarters of the Suralco Construction staff was established in Paramaribo. Later, as the project progressed, the staff moved to the various construction sites. The only function remaining in Paramaribo was the office of the General Manager of Construction.

Since Paranam would be the unloading point for all cargo destined for all projects, and because of heavy activity at this site during construction of both the Smelter and Refining Plants, Paranam was made the main construction headquarters. Work was started early in 1959 there on installation of warehouse and office facilities.

The lines of communications were direct telex and telephone from the Paramaribo Office to the U.S. and Europe. During most of the construction period, all communications with the various sites was by radio only.

Housing was in short supply in Paramaribo. Hence, one of the first projects in 1958 was a small housing development for staff personnel. This work was done by local contractors. The homes were simple ranch style designed for occupancy by American families. The exterior was concrete block with corrugated aluminum roofing. This

development was completed in 1960. An English speaking school was operated for children of staff families.

During 1959 and 1960, a construction camp was built at Afobaka. It included bachelor staff quarters, bachelor workers' quarters, mess halls, recreation facilities and all related facilities required by the large construction force. A small group of houses and some mobile homes provided housing for the supervisory staff.

In 1960 and 1961, work at Afobaka changed pace with the installation of the construction plant for the project. During this period, a heavy-haul bridge was built across the Suriname River downstream of the dam site. Aggregate crushing and screening plants and a concrete batch plant were constructed. In addition, work was completed on warehouse buildings, fabrication shops, and heavy equipment R & M shops. Essentially all these facilities were in place prior to official start of construction of the Hydro Project on August 26, 1960 on which date the road was opened to traffic.

During this early period, progress was made in training of skilled personnel, particularly carpenters, ironworkers, electricians, plumbers, masons, etc.

Housing Plan For Project

Housing of personnel for various projects was as follows:

Staff

1. Paramaribo Houses -- families with children of school age.

2. Paranam Houses and Trailers -- families without children or with pre-school age children.

3. Afobaka Houses and Trailers -- selected key management personnel without children.

4. Staff Houses Paranam and Afobaka -- bachelor staff and visitors.

Workers

1. No housing was provided for construction workers at Paranam. Personnel were transported by bus to Paramaribo.

2. Construction camp at Afobaka and road construction sites provided for bachelor accommodations only. Personnel were transported to Paramaribo every two weeks first by river and later by bus.

Road Construction

The first survey work on the 75 KM road linking Paranam to Afobaka was begun late in 1958. Road construction started in January of 1959. Equipment was borrowed from existing mining operation at Paranam until the first ship load of Caterpillar equipment arrived in July, 1959.

Road construction was carried out from four locations: Paranam, Afobaka, and from two intermediate sites -- one at Berg-en-dahl which provided close access to the Suriname River. The road was officially opened to traffic on August 26, 1960; however, some finishing operations extended to January, 1961. Two years were required to build the road. This project provided the training for native workers in operation and maintenance of heavy earth moving equipment. A seasoned crew was ready to tackle the large earthmoving job ahead at the dam.

Hydro Project

Along with construction of the construction camp and construction plant, considerable engineering work was accomplished such as surveys, core drilling, location of borrow areas to enable design of dam to progress.

The rainy seasons had considerable effect on the construction schedule of the dam. The dam was an earth and rock fill structure with sloping clay impervious core. The main mass of the fill was a sand material available from borrow pits on the far side of the river. This material could be placed

during the rainy season. Crews alternated placing clay in dry periods and sand fill during wet periods. By use of this design, utilizing local materials, the Hydro project was completed in five years.

During this phase of the work, additional skills were developed in operation of heavy earth and rock equipment, fabrication and placement of reinforcing steel, operation of concrete and aggregate plants, placement of mass concrete and mechanical and electrical installation of equipment in the power house.

Manning the Project

Before discussing the Refining and Smelting phases, it would be well to interrupt and describe how all this work was manned.

The top management of the Suralco construction division was provided by seconding Alcoa construction and engineering personnel to the project. Some staff Europeans and Surinamers were obtained from Alcoa's mining division.

Work had not progressed very far in initial road construction -- the first major construction effort -- before Alcoa realized some basic skills were required. Consequently, a construction team was obtained from Wassom Coal Company of Evansville, Indiana to staff the operation and maintenance of the road project.

Additional key teams from other U.S. contractors were integrated with the Suralco Construction Division at the Hydro site.

1. Construction of heavy-duty bridge across Suriname River, Afobaka -- Vogt & Conant Company of Cleveland furnished key supervisory personnel.

2. Grout Curtain at Dam -- Key supervisory personnel from Sprague & Haywood.

3. Earth & Rock Dam -- S. J. Groves of Minneapolis furnished key supervisory personnel.

4. Concrete Section of Dam -- Al Johnson Construction Company of Minneapolis furnished key personnel for concrete work, also operation of aggregate plants and batch plant.

5. Equipment Installation - Power House -- Oberle-Jordre furnished key personnel.

6. Penstocks -- Chicago Bridge & Iron Company furnished key personnel.

Work at the Smelter and Refining Plants at Paranam made use of management teams from Groves, and Johnson on earth and concrete work respectively. Oberle-Jordre personnel handled installation of boilers, turbines and generators in the Refining Plant Power House. National Valve and Manufacturing Company of Pittsburgh furnished key personnel for fabrication and installation of all process piping. Chicago Bridge and Iron furnished key personnel for all tank erection. Key electrical supervisory personnel were recruited from Swanson-Nunn of Evansville, Indiana.

Management Contracts

Identical management contracts were negotiated with all U.S. contractor groups. In each instance, the contractor furnished a general superintendent and various trade superintendents for all phases of the work.

All the personnel obtained from contractor sources were long time employees of the contractor and had worked together on similar construction projects. All personnel were highly experienced in their respective specialty and were capable of training and directing work.

All contractor personnel were carried on Alcoa payrolls at the contractors' normal salary plus a Foreign Service Premium plus all Alcoa's standard fringe benefits.

Placing these key people on Alcoa's payroll made it easier to integrate them into proper positions in the Suralco Construction Organization, reporting to Suralco's Construction Managers.

In addition to furnishing key personnel, each contractor was obligated to furnish back-up from their home office as required to keep the project on schedule. Usually this service consisted of consulting as required in specialty areas and field visits by contractor's home office management at intervals during the project. Contractors were paid for the services of key personnel at a percentage of the seconded personnel salaries as profit.

In general, we found this method of operation to be most effective and very satisfactory.

Payrolls

All Suriname workers were hired by Suralco and carried on Suralco Construction payrolls at uniform rates based on Suralco's over-all wage policy.

All Suriname and Dutch National Staff personnel were carried on a Suralco Construction payroll.

All Alcoa seconded personnel and all personnel obtained from the contractors were carried on a Pittsburgh Payroll of Alcoa.

This method for staffing and organizing the project provided the following advantages:

1. Better control of project (one organization).
2. Better use of man power.
3. One set of employment conditions for total project.
4. Ability to better control rate of expenditures.

Construction Equipment

Suralco purchased all the construction equipment and tools for the projects.

The heavy equipment pool was supervised by a key group that controlled the priority of equipment for various projects and provided and operated maintenance shops skilled in preventative maintenance as well as mechanical overhaul work. Considerable money was saved and equipment life extended by the operation of equipment servicing and lubricating crews under the supervision of an experienced mechanical engineer.

Some items of equipment and small trucks were rented from Paramaribo to supplement Suralco's main equipment pool.

Construction of Refining and Smelting Plants

At Paranam, early facilities such as warehouses and offices were started in early 1959.

In 1962, work was started on rebuilding the existing dock at Paranam to handle the construction equipment for Afobaka and the new facilities to be constructed at Paranam. The old dock was removed in sections to permit construction of a new sheet pile cell dock while maintaining ability to continue to ship bauxite. These new facilities were completed in July of 1964. At an early stage, alumina tanks were built which were used first to store bulk cement for the projects.

In July of 1963, a number of trained construction workers were transferred from Afobaka to Paranam to staff the construction of the Refining and Smelting Plants. The 4 to 4½ years of training and experience at the dam provided a high level of skilled workers. Nevertheless, additional skills had to be developed for Paranam. The principal areas of new training were in welding for tank construction and fabrication and erection of process piping and fabrication and welding of aluminum bus bar.

Construction of both plants proceeded simultaneously, each under the direction of a Construction Manager. The first refining digestor unit went into operation in August of 1965 with operation of the first section of the first

potline on September 1, 1965. Work on the initial 2-Unit Refining Plant and 2-Potline Smelter was essentially completed in October of 1965 -- 2 1/3 years after start of construction.

The second potline, although completed in the Fall of 1965, did not actually start operations until 1967 due to water conditions at the Hydro Plant. Lower than average rainfall aided considerably during construction of the project; however, the lower precipitation slowed down the filling of the reservoir and consequently the start up of Potline No. 2.

VI. TRAINING OF NATIVE LABOR FOR CONSTRUCTION

All training was accomplished "on the job" with native labor learning while working.

Equipment operators for bulldozers, scrapers, graders, power shovels, draglines, and heavy haul trucks were trained on the equipment by the American supervisory force. As soon as the natives were fully trained, the total operation of the equipment fleet was taken over by the Suriname operators. Americans served in a non-working, supervisory position. A short retention span among the native operators required short periodic refresher courses on the equipment. This kept the level of skills at an acceptable level.

Mechanics for heavy equipment also were trained on the job in maintenance shops. Training of good mechanics and first level mechanic supervisors was slow and required more time than training of operators. Sufficient mechanics were trained to handle preventive maintenance and equipment overhaul. In addition to key American Supervisory Mechanics, the operations were staffed with top Mechanical Superintendents, Spart Part Experts, and Mechanical Engineers to insure proper R & M and Lubrication of the various equipment.

Carpenters, ironworkers, electricians, masons, and skilled construction labor were trained on the job.

Carpenters were trained first in the framing of simple wood structures in construction camps and temporary facilities. Later these same men were trained in construction and setting of forms for concrete, and a small group was instructed in finish carpentry work.

Electricians were taught the use of tools and materials on simple house wiring of the construction camp buildings. Later their training was expanded to power distribution systems, equipment wiring in the construction plant and finally on permanent electrical installations in the power house at Afobaka.

Similarly, ironworker-rigger training started with reinforced steel fabrication and setting. Later, experience was gained in the rigging and erection of equipment for the construction plant. Ultimately, the men went on to advanced work in the setting of turbines, generators, and transformers.

The same on-the-job training was applied to all other crafts.

With this type of instruction and experience behind them, crews transferred easily from the Hydro Project to the Smelter-Refining Project. Organization and execution of the various phases of construction at Paranam proceeded smoothly.

Additional training in several new areas was necessary at Paranam.

It was decided to set up a complete pipe fabrication shop rather than ship fabricated process pipe from the U.S. NAVCO trained a group of Surinamers in the fabrication, welding, and installation of process piping.

A special school was set up to train welders for the great number of tanks needed for the Refining Plant. C.B. & I. trained some very good welders for this work. Again, it was necessary to requalify welders periodically to insure their skills were always adequate.

The totel supervisory force engaged in supervision, engineering, and training was quite low compared to the labor employed on the project.

Peak employment was approximately 3400, including a staff of about 140. Of the 140 staff, 25 were involved in administration, accounting, warehouse, engineering, and similar occupations, leaving about 115 American expatriates directly concerned with the supervision and training of the native construction crews.

Safety Training

Training in Safety was an important part of all on-the-job instruction. Safe working habits were stressed from the start of a new worker's experience on the job. The Safety Department was headed by a U.S. Safety Professional with trained Suriname associates. The results on the total project were much better than the construction industry's averages achieved in the United States. As proof of this record, we quote from a 1964 report from the Project: "In August, 1964, 3,100 workers of the Construction Division at Afobaka and Paranam completed Seven Million Safe Man Hours." -- a remarkable record.

VII. PHASING FROM CONSTRUCTION TO OPERATIONS

Key operating managers and engineers were assigned to the Suriname Project nine months to a year prior to scheduled start up. In the early period, this group planned the manning of the project for the Operation Phase and worked closely with Construction on equipment installation. During this association, operating management took full advantage of the skills of many Suriname workers. Plans were made to transfer key Suriname supervisory personnel and workers to the Operating group for training prior to start of operations. Some Suriname personnel were sent to Alcoa plants for instruction. In general, however, most training was accomplished on site.

In general, the best performers on the construction work were offered the best jobs in Operations. In all, the transition took place without major problem.

The Positive Effects of the Brokopondo Agreement:

Apart from the obvious benefits to the national Suriname economy such as the increase of employment, taxes, local purchases, capital expenditures, Suralco's fully integrated facilities have also had a very positive effect on Suriname's balance of trade.

According to calculations made for the Suriname Plan Bureau, the "added value" effect of these products, which is the export value less the value of materials imported for their production, amounted to more than $35,000,000 a year for the 11-year period 1966-1976.

Mention should also be made of the contribution by Suralco in training and developing its people and adding to the educational level in Suriname. During the initial stages of the Brokopondo construction, the number of U.S. technical people employed by Suralco hit a peak of 117 in 1965, and by 1976 the number of U.S. technicians had been reduced to 26, largely resulting from this training and development program.

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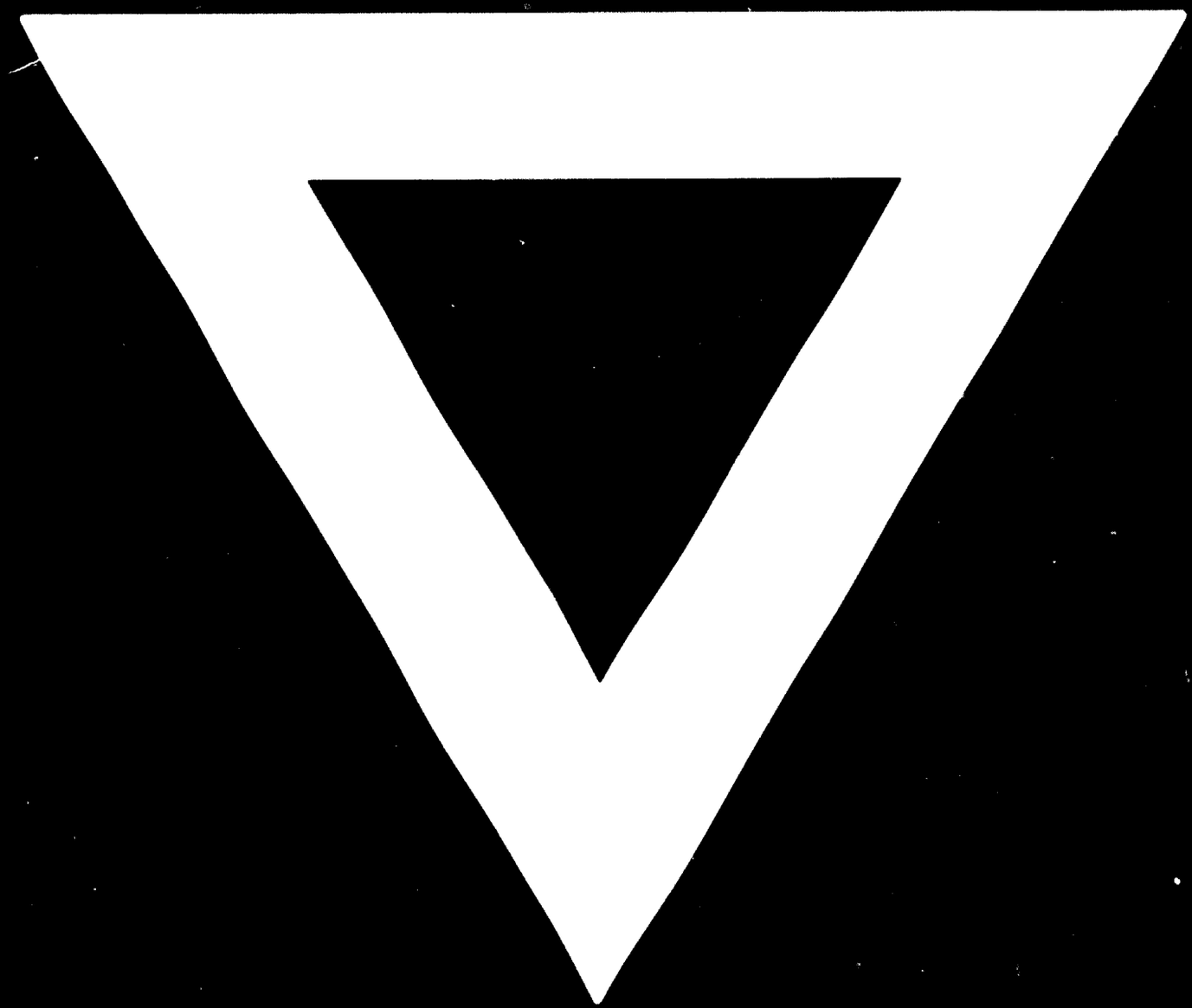

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