(10) Total length of transmission line abt. 28.0km

For the design of the Project, following Japanese Standards shall be applied in principle. However, in order to avoid any difficulties for incoming transmission line to be connected to the existing power plant, due consideration is to be made for the application of such Japanese Standards.

Japanese Industrial Standards (JIS)
Standards of Japan Electrical Council (JEC)
Standards of Japan Electrical Manufacturer's Association (JEM)
Standards of Japanese Electric Wire & Cable Maker's Association (JCS)
Standards for Electrical Facilities
Engineering Standards for water gates and steel tubes

5.3 BASIC DESIGN

5.3.1 Arrangement of Facilities

Arrangement for each facilities shall be determined by taking into consideration the installed capacity of the electric power plant, topographical condition, access to the Site, as well as the size of each structure.

(1) Intake dam

In order to secure safe water flow of 640m^3/s, design flood discharge, and to divert water during the construction work, the location of the Dam has been placed at the point 180m upstream from the waterfall where the width of riverbed is sufficient and the slope of the banks on both side is not steep.

(2) Water intake and desiltation pond

Water intake and desiltation pond is designed with for easy operation and maintenance and also for saving construction costs.

(3) Route of aqueduct

As a result of the inspection carried out on the spot, the route of the aqueduct has been decided to take place on the right side of Sarakata River for the reason below:

1) Both sides of the river where the route of the aqueduct is passing through are forming very sharp cliffs and the cliff on the left side of the river is particularly steep. Taking the passing altitude of the aqueduct into account, it is less costly if the aqueduct is constructed on the right side of the river since it can save the exacavation volume.

2) As a temporary road for the construction of the aqueduct and for the general maintenance work after the completion of the electric power plant is necessary, on the topographical point of view the right side of the river will be suitable.

3) The suitable place for the construction of the power plant has been secured on the right side of the river.

(4) Location of head tank, penstock and power plant

In order to protect the equipment and civil structures from falling rocks and landslide, the location the power plant has been selected about 660m downstream of the waterfall where the slope is gentle and stable. In addition, the place where the water flow hits directly as less as possible has been selected taking possible raise of the water level when the river is flooded as well as water erosion.

(5) Route of transmission line

The route of transmission line has been planned along the existing road in order to secure easy maintenance during and after the construction work and also for minimizing the clear-cutting of natural forests.

5.3.2 Civil Structures

(1) Intake dam

There is a site approximately 180 meters to the upstream of the waterfall where the riverbed width is wider than at upstream and downstream portions, and the slopes of both banks is gentle. The intake dam was designed to be located at this Site, so that (1) the design flood discharge of 640 m3/second can be safely discharged, and (2) the water can be diverted easily during the construction work. The dam is a concrete gravity structure with overflow spillway. A gated sand flush structure, by which sediment can be discharged by natural flow to the downstream side, is located on the right bank. An approach road will be constructed from the dam to the power station which will be located on the right bank. The dam crest and bridge will be a road to cross the Sarakata River.

(2) Intake structure and sedimentation pond

The intake structure and the sedimentation pond will be constructed on the right bank of the intake dam. The decision to construct these facilities on the right bank is dictated by the selection of the water way route, as described later.

The intake structure is aligned perpendicular to the direction of the river in order to prevent debris directly striking or clogging the intake screen. The sedimentation pond is located immediately behind the water intake structure, and the spillway sill is set at an elevation where it is not affected by the rise of downstream water level in the event of flood flow. The sedimentation pond is designed to reduce the velocity of flow in the pond in order to permit deposition of sediment, and the sediment is flushed from the sand flush gate which is located at the end of the sedimentation pond.

(3) Headrace

The route of the headrace has been selected based on the Site survey and is located on the right bank of Sarakata River due to the following reasons.

1) The possible route for the headrace is through steep cliffs on either the right bank or the left bank of the river, but it is more steeper on the left bank. Considering the elevation at which the headrace passes, the volume of excavation can be reduced resulting in cost saving if the headrace is located on the right bank.

2) A road is required for the construction work of the headrace and for inspection after the power station is completed. The terrain on the right bank is more suitable for construction of a road.

3) A suitable location for the power station is found on the right bank.

The headrace will be constructed by excavating rock. The structure will be an open culvert of rectangular cross section and made of concrete taking into consideration the volume of flow, gradient, head loss, construction conditions, construction period and ease of maintenance of compelted structure. At locations where there are danger of falling rocks, the culvert will be provided with, concrete covers.

The maximum velocity in the headrace was set at 1.5 m/sec, and the gradient 1/1,000.

(4) Head tank and spillway

A head tank will be constructed at the inlet of the penstock. The depth of water at the entrance to the penstock will be larger than the penstock diameter to prevent entrainment of air into penstock.

A free overflow type spillway will be provided on the side of the surge tank in order to release water when the power station

is shut down. There will also be a sand flush gate in order to release sediment that flows into the head tank.

The spillway will be steel structure, and the water will be discharged into the natural riverbed.

(5) Penstock

The route of the penstock was aligned where the gradient of the land is gentle taking into consideration stability of the penstock. The penstock will be made of mild steel with welded joints. Anchor blocks will be provided at the bending points of penstock as well as at the top and end, and saddle blocks will be provided at straight sections.

(6) Power station and tailrace

The location of the power station has been selected at a site where the slope is gentle to protect the power station equipment and structures from falling rock and landslides. This location is so selected that the river water flow does not directly hit the power station foundation in view of the rise of river water level during flood and erosion caused by river flow.

The power station building will be a 2 storied, reinforced concrete structure. The water turbine-generators and their auxiliaries will be installed on the ground floor of this building, and there will be an additional space on this floor where one unit of water turbine generator can be assembled and repaired. The second floor will accommodate the switchboard room, office room, spare parts warehouse and the main transformer (outdoor type).

The water turbine-generator will be installed at sufficiently high elevation in order to prevent damage by the rise of river water level during flood.

The tailrace will be a unlined open channel excavated in rock. However the section at the outlet of the tailrace will be

provided with concrete mat in order to enhance the stability of the tailrace structure.

5.3.3 Facilities

(1) Electrical facilities

The design of the electrical facilities of this Project must be carefully coordinated with the existing facilities because this power station will be interconnected to the existing diesel power station by an interconnection transmission line. The facilities will be designed with due consideration on economy and easiness of maintenance.

In the Republic of Vanuatu, the standard electrical system is as described below.

High distribution voltage	3 phase, 5.5 kV
Low distribution voltage	3 phase 4 wire, 380/220 V
Frequency	50 Hz
Allowable frequency fluctuation	±2%
Allowable voltage fluctuation	±7%
Generating facility	5 units of diesel generators (installed capacity: 1,080 kW)

The water turbine-generators have been selected based on the following conditions.

1) The water turbine-generators will be normally operated in parallel with the existing diesel generators, but the water turbine-generators will have priority in providing output. That is, Hydroelectric Power Station will be operated at its maximum capacity and the deficiency of supply will be supplemented by diesel generators. At nighttime when the power demand is small, the diesel generators will be shut down and only Hydroelectric Power Station will be operated. As a result, Hydroelectric Power Station will be continuously operated except when it is shutdown for inspection or due to equipment failure.

2) On the other hand, when Hydroelectric Power Station is shutdown for inspection or due to equipment failure, the diesel power station will have to be operated independently.

The water turbine is selected in principle based on the effective head and water discharge. The diagram illustrating this selection based on effective head and water consumption is given in Figure 5.3.1.

According to this diagram, Francis turbine or cross flow turbine is suitable in view of the design parameters of this Project. It has been judged, however, that Francis turbine is more suitable for the Project which demands continuous operation for a long period because it has the following advantages.

- High turbine efficiency - Little noise
- Much more Francis turbines have been manufactured and operated than cross flow turbine, and little failures have been experienced. As this Project is a run-of-river type with small fluctuation of head and constant water flow, there is little risk of cavitation.
- As the runner and other parts of Francis turbines are standardized, a rare event of equipment failure can be repaired without problem.

Concerning the type of the generator, an induction generator could be a choice. However, since an induction generator cannot be operated without interconnection with other power station, synchronous generator has to be selected.

The number of generator units shall be 2, since it is desirable that at least one generator unit is available when the other is stopped for inspection or fails, and for reason of economy.

The major parameters of the water turbines and generators are given below.

Water Turbine:

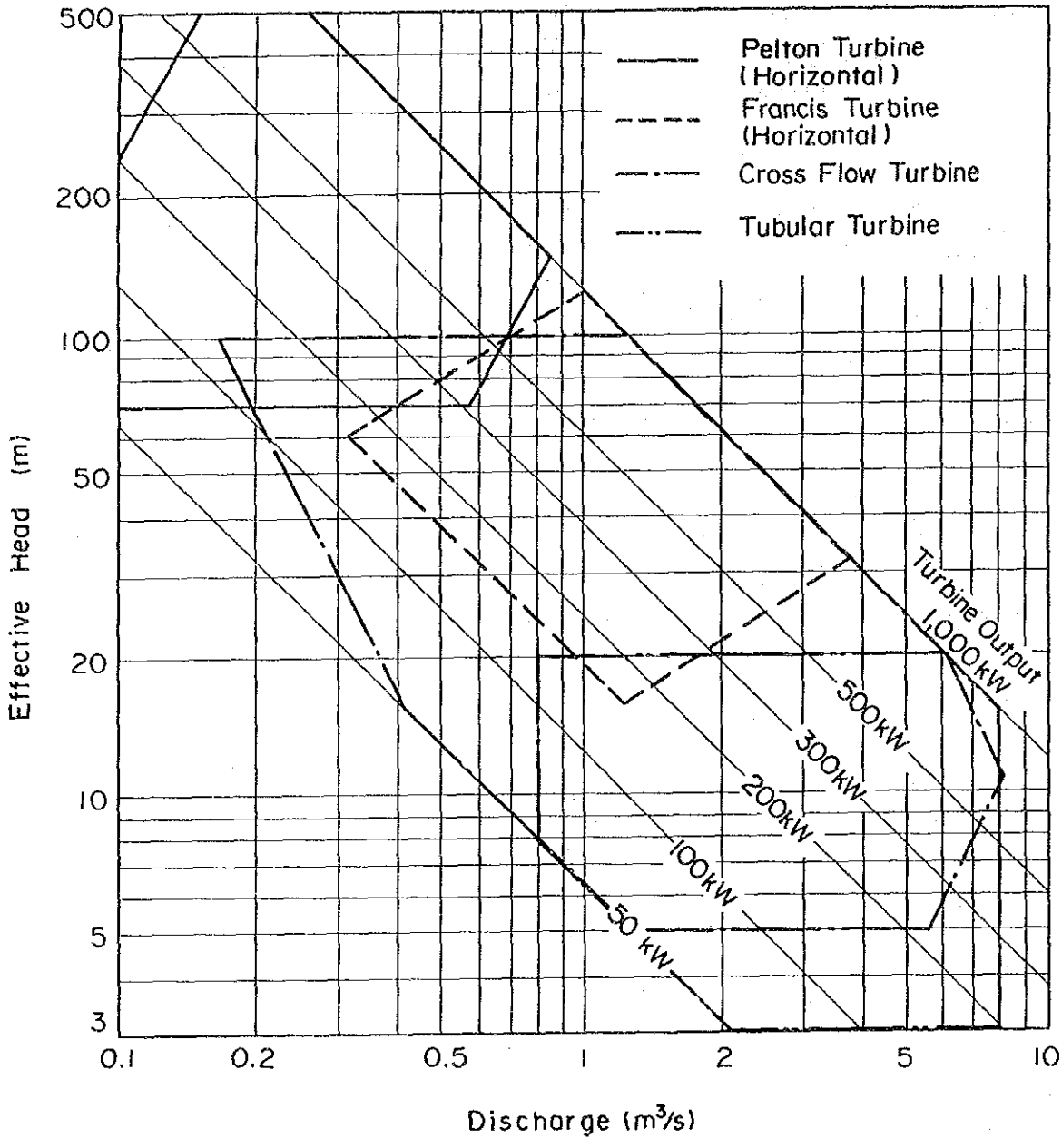
Type Horizontal shaft Francis turbine

Output	330 kW
Rotating Speed	750 rpm
Number of Unit	2 units

Generator:

Type	3-phase AC brush-less synchonous generator
Output	375 kVA, 0.8 power factor (lag)
Frequency	50 Hz

Fig 5.3.1 Selection Figure of Water Turbine Type



(2) Transmission and distribution facilities

A transmission line will be constructed from the step-up transformer to be installed adjacent to the new power station to the step-down transformer to be installed in the existing diesel power station which is located near the center of load area. The transmission line will be operated at predetermined voltage.

The expansion of distribution lines is left to the Republic of Vanuatu since distribution systems in the city is in fairly good order, and therefore this work is not included in the scope of this Project.

Connection of the new transmission line and distribution lines branching off from the line that may be constructed in the future is to be implemented by the Republic of Vanuatu.

1) Selection of transmission line route and its length

The route of the transmission line has been selected with due consideration on the harmony with the natural and social environments of the areas along the route, and technical feasibility of construction work.

Specifically, particular considerations have been given on the following items.

i) Harmony with the natural environment

- Deforestration of natural forests and afforestration areas are to be minimized.

ii) Harmony with the social environment

- Residential and public facilities are evaded.
- Lands having high productivity or lands which restoration is difficult are evaded.
- The transmission line route is coordinated with the regional development plans.

iii) Technical harmony

- The facilities have high safety.
- The construction cost is economical.
- The construction work is easy.
- The transmission line can be completed according to the predetermined schedule.
- The maintenance work is easy.

The above factors have been duly taken into consideration in developing the design and construction plan of the transmission line. The transmission route, which is illustrated in a separate map named "Transmission Line Route", has been selected based on detailed survey of natural and social environmental status of the areas along the route, and upon detailed consultation with administrative authorities of the Republic of Vanuatu and local communities.

The transmission line runs to the north from the Site of the new hydroelectric power station along the construction road (approximately 3.0 km) for the dam and power station, and hence parallel to the main road from Luganville to Tanafo.

A section of this line from the power station site to the dam access road, approxiamtely 1.0 km in length, passes through a dense forest area. Therefore, even if the transmission line is constructed along the access road, it is expected that trees will grow with time to approach or contact the transmission line conductors, although there would not be such problem during the construction work and for some time after commissioning of the power station. Such trees may cause frequent line faults. Therefore, insulated conductors must be used for this section, and at the same time electrical fault prevention measure must be provided.

From the junction point of the new access road for construction work and the existing main road, the transmission line will be constructed along the main road from Luganville to Tanafo.

This distance will be approximately 25.0 km.

It is conceivable to route the transmission line on a straight line connecting the new power station and the load area of Luganville, with the objective of reducing the overall length of the transmission line and minimizing the line materials required, such as conductors, support structures and insulators. However, the line will pass through dense forest area, making construction work more difficult and making it necessary to cut a large amount of natural trees. Therefore, it has been judged that it is more economical, in terms of the overall construction cost, to construct the transmission line along the main road. In addition, it is naturally more desirable to have the transmission line routed along the main road from the standpoint of maintenance work.

The total length of the transmission line will be approximately 28.0 km. In general, the line passes through pasture lands having little undulation, and it is expected that both construction work and maintenance work will be easy with this route.

2) Design of transmission line

(a) Electrical system of the transmission line

i) Transmission voltage

The voltage class of the transmission line can be selected from 5.0 kV and 15.0 kV which are adopted in the existing distribution lines, or the intermediate and higher voltage class; 11.0 kV and 22.0 kV, respectively.

An economic comparison has been conducted to compare the economy of transmission lines having rated voltage of 5.0 kV, 11.0 kV, 15 kV and 22.0 kV and it has been concluded that the most economical result can be obtained by selecting a transmission voltage of 22.0 kV.

(b) Safety factor and wind load of the transmission line

The safety factor and wind load values used in designing the transmission line are equivalent to or higher than the existing facilities, and the following values are adopted.

i) Safety factor

Item	Design Value
Support Structure (Pole)	2.0
Conductor	2.0
Insulator	2.5
Support Structure Guy Wire	2.5
Ground Wire, etc.	2.5

ii) Wind load

Item	Design Value
Support Structure (Pole)	120 kg/m^2
Conductor	150 kg/m^2

(c) Selection of conductor type

i) Adoption of insulated conductor

Insulated conductors shall be employed in the sections of transmission lines that pass the following areas.

- Urban areas

  By adopting insulated conductors, electric faults caused by proximity or contact of new transmission line conductors to buildings and structures can be prevented. Also, electrical injury to people who accidentally touch the transmission line can be prevented.

- Areas where trees and grasses are dense and they cannot be cleared

  Insulated conductor can minimize fire hazard or electrical fault caused by contact of new transmission line conductors to trees, etc.

ii) Adoption of aluminum cable steel reinforced and aluminum cable aluminum clad steel reinforced

For transmission line conductors, both aluminum cables and copper cables are available. While copper cable is superior in terms of electrical and mechanical characteristics, the price of aluminum cable is less than 60% of copper cable. For this reason, aluminum cables are generally used.

Although the size of aluminum cable has to be somewhat larger (in cross section) than cooper cable for a given application due to inferior electrical performance, this does not reverse the economic superiority of aluminum cable.

To make up for the inferior mechanical characteristics, the aluminum cable is reinforced by steel cable wound at the center of the cable, to make the reinforced aluminum cable mechanically stronger than copper cable.

Superior mechanical characteristics makes it possible to use a large span (distance between support structures), thereby reducing the number of support structures which account for a major portion of the construction cost (material cost), and enabling construction of more economical transmission lines. For this reason, aluminum cable steel reinforced shall be employed.

The drawback of the aluminum cable steel reinforced is that the steel wires at the center of the cable tends to corrode. Generally in areas where factors that accelerate corrosion, such as salt and air contaminants, are not severe, this corrosion is prevented by galvanizing the steel wires. The proposed transmission line route in this Project is on an island in the Pacific Ocean, where air contains abnormally high amount of salt, and it is difficult to prevent corrosion of steel wire by the galvanizing mentioned above. Therefore, aluminum cable reinforced by aluminum clad steel wires, generally termed aluminum cable aluminum clad steel reinforced, shall be adopted.

iii) The conductor types adopted for this transmission line are presented in the table below.

Item	Conductor type and size
Insulated conductor	ACSR-OE 58mm^2 Outdoor type, aluminum cable steel reinforced with polyethylene insulation
Bare conductor	ACSR/AC 58mm^2 Aluminum cable aluminum clad steel reinforced

(d) Support structure type and selection of standard span

i) Support structure type

The support structures (electric poles) shall be concrete poles, except for some sections of the line. The adoption of concrete poles is based on the following reasons.

- The proposed transmission line route in this Project is on an island in the Pacific Ocean, and therefore, concrete pole which is superior in corrosion resistance and has sufficient strength to withstand strong gales such as typhoon is required.

- As most part of the transmission line route is located adjacent to roads, transportation and erection of heavy concrete poles can be performed without problem.

- The mechanical strength of concrete pole is especially superior to that of other support structures (wooden pole, steel pipe pole, H-shaped steel pole), thereby enabling a long span design.

This means that the number of poles can be reduced, and the construction cost can be reduced.

At the vicinity of the power station where the transmission line route is not aligned along the access road, but passes through mountainous area, jointed steel pipe poles shall be adopted as support structure.

This is due to the following reasons.

- As the jointed steel pipe poles can be split into short pieces, it facilitates transportation and erection in places where the materials have to be carried by men.

As the span between support structures becomes short in order to compensate for lower mechanical strength, more support structures are required in such sections. However, the sections where the joint steel pipe poles have to be adopted are short, and this option is more economical than constructing roads for the purpose of erecting concrete poles.

Concerning the corrosion resistance, the joint steel pipe poles shall be heavily galvanized steel, having thick galvanize coating (zinc), shall be used to deal with corrosion.

ii) Selection of standard span

The standard span, which is the standard horizontal distance between two adjacent support structures (poles), shall be selected based on the following conditions.

- Safety factor of conductor

The maximum service horizontal tension of the conductor shall be so designed that the tension applied to the support point of conductor under the worst condition (under low temperature and during typhoon) is no more than 50% (safety factor of 2 or more) of the minimum tensile load (breaking load) of the conductor.

Also, the maximum service horizontal tension of the conductor shall be so designed that the horizontal tension of the conductor under normal condition (under average temperature and with no wind) is approximately 20% or less of the minimum tensile load (breaking load).

- Conductor loading condition

The loading conditions under various air temperature for the calculation of the safety factor of conductor shall be set as given in the table below.

Loading Conditions under Different Temperature

Air Temperature	Loading Direction and Load Type	
	Vertical	Horizontal
Maximum 40°C (High temperature season)	Self-weight of conductor	50% of wind load under gale applied to projected area of conductor.
Minimum 10°C (Low temperature season)	Self-weight of conductor	Wind load of gale (typhoon) applied to projected area of conductor.
Average 25°C (Normal condition)	Self-weight of conductor	None

- Conductor height

The height of the conductor above ground surface (vertical distance) shall be as given in the table below.

Item	Height
Above Ground Surface	5.0 m
Above Road Crossing	6.0 m

- Minimum distance between conductor and other structures

Item	Separation Distance
Building	5.0 m
Telephone Line	5.0 m
High and Low Voltage Lines	1.0 m
Plants (trees, etc.)	1.0 m

- Calculation of conductor sag

The parabolic approximation equation is used in calculating the conductor sag.

The standard span of the transmission line under the conditions stipulated above (conductor safety factor, conductor loading condition, conductor height and distance between ground wire and other structures) is set as given below.

Transmission Line Route	Standard Span
Mountainous Terrain	50 m
Flat Land	80 m

(e) Insulator type

The insulators of the transmission line shall have sufficient insulation performance so that they can withstand the contamination level (salt deposition of 0.5 mg/cm2 or more) because the transmission line will be installed near sea shore, and shall be suspension insulators (JIS C 3801) or line post insulators (JIS C 3812) or insulators having equivalent or superior performance.

As for the mechanical performance, the insulators for conductors of tension poles (tension insulators) shall

withstand 2.5 times of tensile strength of the conductor at the supporting point, and insulator that suspend conductors (suspension insulator) shall withstand 2.5 times of the composite load of vertical load and horizontal load of the conductor.

Insulators that support conductors (support insulator) shall withstand 2.5 times the horizontal load or vertical load that is applied to the axial direction of insulators.

(f) Equipments

i) Transformer

A step-up transformer of a capacity that matches the generator output shall be installed at the outgoing circuit of the power station. At the receiving end, a step-down transformer matching the voltages of existing transmission and distribution lines shall be installed.

An isolator, an overcurrent circuit breaker, and a lightning arrester shall be installed on the secondary side of the step-up transformer. An overcurrent circuit breaker shall be installed on the secondary side, and an isolator and an overcurrent circuit breaker shall be installed on the secondary side of the step-down transformer.

The transformers shall have no exposed charged parts, and appropriate earth work shall be provided.

ii) Isolators

Isolators shall be installed at the sending end and receiving end of the transmission line, for the following reasons.

- In order to operate the electrical equipment and transmission line safely.

- The transmission line must be shut down when electrical equipment or line is to be repaired. For this purpose, the transmission line shall be divided into a number of sections, and line switches shall be provided at boundaries of these sections.

iii) Overcurrent circuit breakers

The device which automatically cuts off the transmission line (overcurrent circuit breaker) shall be provided at appropriate locations in order to protect the generators, transformers and line conductors in the event that an electric fault occurs on the transmission line.

iv) Lightning protection device

- Lightning arresters

Lightning arresters shall be provided at the location where line switches and transformers are installed at the sending end and receiving end of the transmission line, in order to protect electrical equipment and line from lightning stroke.

It is assumed that the number of thunderstorm days (IKL; Isokeraunic Level) in a year in the Republic of Vanuatu is 50 days per year, which is the value of IKL generally observed all over the world.

- Ground wire

The transmission line shall be equipped with overhead ground wire (earth line) which runs parallel with conductors, to prevent lightning from directly striking the conductors.

(g) Transmission line conductor arrangement

The conductor arrangement is illustrated in Drawing List.

(3) Dam bridge, gate, screen and penstock

The gates, screens and penstock which belongs to the civil works are as follows:

(a) Dam bridge

- steel girder (height of girder: 80 cm)
  number of girders: 2
  span: 10 m : 4 spans

- handrail (length of bridge 40.0 m,
  length of approach 20.0 m) : 120 m

(b) Flush-gate of dam

- gate (height 2.0 m, width 2.0 m) and winch : 1 set

(c) Intake screen and gate

- screen (height 2.2 m, width 5.5 m) : 1 set
- gate (height 2.2 m, width 2.0 m) and
  manual winch : 1 set

(d) Gate of sedimentation pond

- gate (height 0.5 m, width 0.5 m) and winch : 1 set

(e) Headtank screen, gate and outlet pipe

- screen (height 4.5 m, width 6.4 m) : 1 set
- gate (height 1.0 m, width 1.0 m) and winch : 1 set
- outlet pipe
  (diameter 1.0 m, thickness 6 mm, length 35.0 m): 1 set

(f) Penstock

- penstock steel pipe
  (diameter 1.2 m, thickness 6 mm, length 69.5 m
  branch pipe) : 1 set

(g) Screen for tailrace

- screen (height 2.0 m, width 3.0 m) : 2 sets

5.3.4 Considerations on Environment

(1) Change of environment by utilization of water for power generation

In this Project, it is planned to utilize an effective head with a short waterway. For this purpose the intake dam is to be constructed at the upstream of an existing waterfall, and the power plant is to be located at the downstream of this fall.

With this design, there is concern that the waterfall may become dry during the dry season, but the duration of this dry season is approximately 50 days. Therefore, when this waterfall becomes a sight seeing site in the future, one generator unit of the power station may have to be stopped, or the whole power station units will have to partially run in order to secure the minimum amount of water for the natural waterfall.

The power supply capacity of the grid can be assured by increasing the output of Luganville Diesel Power Station when the output of the hydroelectric power station has to be restrained.

For more than 300 days during a year, sufficient amount of surplus water can be discharged from the intake dam even when both generating units of the power station are operated. Therefore, there is no risk that the water flow between the intake dam and the downstream of the fall is substantially changed nor plant life is affected thereby.

(2) Changes to the upstream of intake dam

By constructing the intake dam, the water level of Sarakata River will be raised by 6.8 m from the present water level, and the backwater of the pond created by the dam will reach 800 m to the upstream. However, the valley which will be affected by the water impoundment is narrow and the areas where plant life is affected by impoundment of water is very small. It is expected that plant life will not be affected by the storage of water behind the intake dam.

There are no people living in this area, and there is no danger of influencing the livelihood of people by impoundment of water, and in addition, it may bring economical benefit to the people of Tanafo by culture of freshwater shrimp and other fishes in the water.

After the intake dam is completed, it will serve as a road to reach bank of Sarakata River, and this is expected to provide substantial convenience to the inhabitants of Tanafo village in the future.

(3) Changes in downstream of power station and water contamination

As this power station is a run-of-river type, natural flow is secured throughout the year on the downstream of the power station. Therefore, there should be no effect on fish and plant life of the river that might be caused by fluctuation of water flow.

As this power station does not discharge any contaminated waste water to the river, there is no risk of contaminating the river water. As it has become a common practice to employ oil-less metals for guide vane bearing and similar parts, there is no possibility of grease and similar substance contained in the water discharged from the power plant.

(4) Noise of power station

The noise generated by a hydroelectric power station is much smaller than that of a thermal power station, and the noise of

this power station will present no noise problem. In addition, as this power station is located at a bottom of a canyon which is 30 m below the surrounding plateau, noise pollution will not cause adverse effect on animals in the existing pasture land which is located on the plateau on the left bank of the river.

The plateau on the right bank of the river is currently a virgin field. Even if this land is used in future for pasture or other purposes, there will be no noise pollution, similar to the plateau on the left bank of the river.

As stated above, no environmental problem will be created by the construction of Sarakata River Hydroelectric Power Station.

5.4 PLAN FOR CONSTRUCTION WORK

5.4.1 Principle of Construction Work

In this Project for the construction of the hydraulic power station, due considerations should be made on how to construct the structure and facilities economically which guarantees the required efficiency and quality, within the fixed period.

The principles for constrution work are as follows:

(1) Procurement of labor

Fundamentally, the labor needed for this construction work will be procured in the Republic of Vanuatu. However, the procurement of experts such as foremen, electricians, mechanicians, operators of heavy construction machines, miners, reinforcing-bar placers, plumbers are difficult therefore such skilled labors are to be supplemented from other countries.

(2) Dispatching of skilled labor

Among the skilled labors mentioned above, those who are required to have technical ability and skills, particularly the electricians, mechanicians and foremen who will be in charge of, for example, installing and adjusting of water turbine, generator, transmission line cannot be secured in the Republic

of Vanuatu or even from third countries, thus securing and dispatching of these experts will come from Japan.

(3) Procurement of material and equipment for construction work

Priority is to be given to the securing of the necessary construction equipment from Vanuatu. However, since the performance and the reliability of such equipment will give serious consequences to construction schedule, it might be necessary to consider to secure some of main machines from Japan. In addition, as to the material needed for construction, since most of the materials are imported products, the decision on the suppliers will be made upon due consideration and comparative examination of the function and the durability and cost of each materials.

(4) Employment of local enterprises

As for the opportunity to utilize the local enterprises, some subcontracts with those local enterprises for a part of the facilities (for the construction work of the facilities including control of quality and schedule) might be considerd, however since the construction of the hydraulic power plant is the first experience in this country, it is difficult to employ this kind of arrangement. Therefore, only the procurement of labor and the equipment for preparing concrete or leasing of the construction equipment can be possible.

5.4.2 Supervision Plan for Construction Work

Main subjects of this supervision include content of quality, schedule and safety.

Furthermore, the transfer of technology to local engineers during the supervision of the construction will be also positively executed. Table 5.4.1 shows the contents of the consultants' scope of work and Fig. 5.4.1 shows its organization chart.

(1) Definite design

Before starting detail design work, the consultant will dispatch to Vanuatu the following engineers for about 1 month

to conduct detail site investigations. (Project manager, geologist, surveyor, electrical engineer and transmission line engineer)

Vanuatu counterpart engineers will participate in the field investigations, and discuss and coordinate the Project features with the consultant engineers. After return to Japan, the consultant will prepare detail designs, tender documents, invite tenderers and evaluate tenders received.

(2) Construction supervision

To perform supervision of construction, the consultant will assign the following personnel at the Project Site.

Project manager (1) : From start to construction to completion of works

Geologist (1) : From time to time

Electrical engineer(1): From start of installation to completion of tests of electromechanical equipment

Transmission line engineer (1): From start of construction to completion of works

Testing engineer (1) : During the testing period

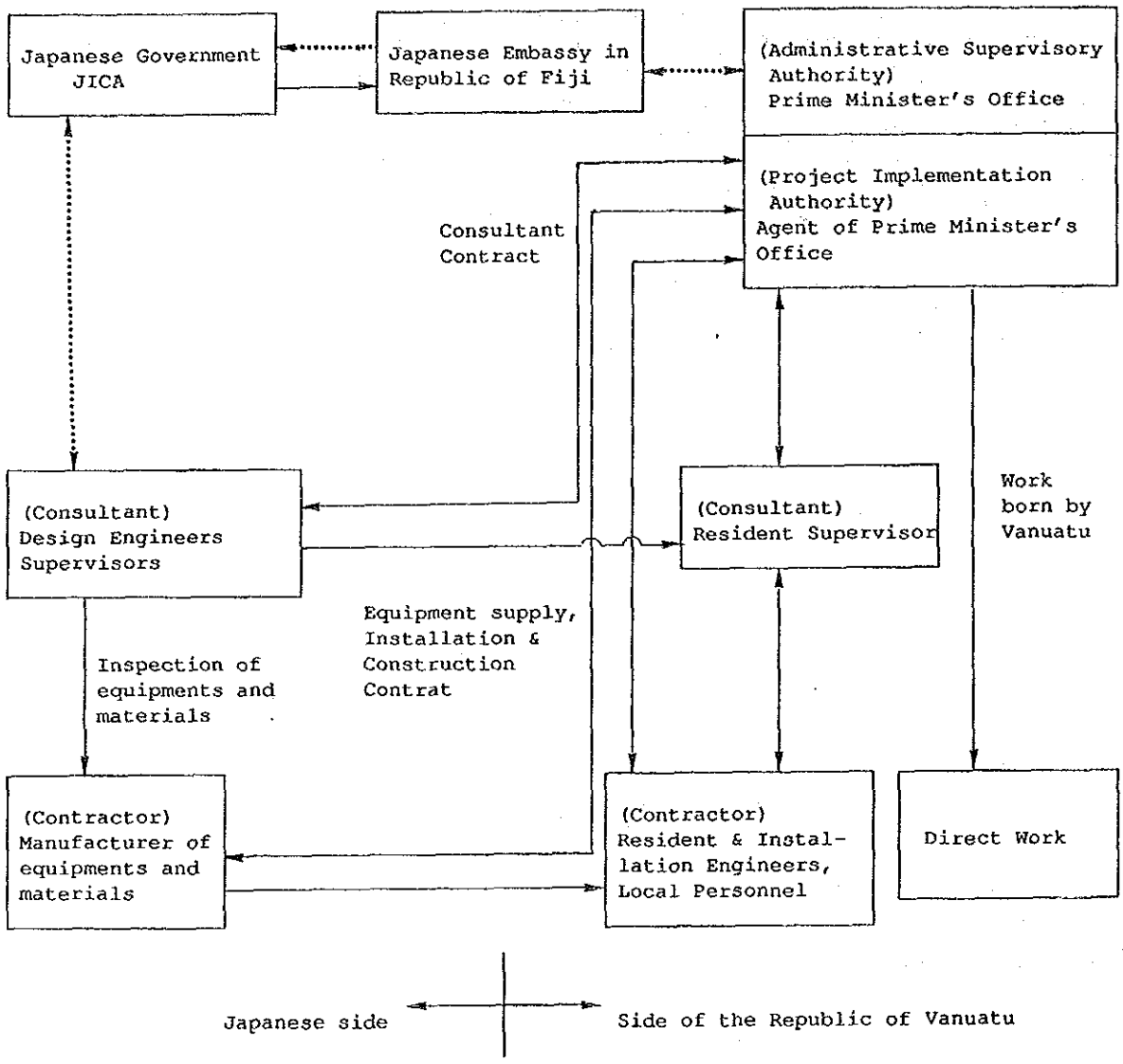
The consultant will assign civil, electrical and transmission line engineers as required in Japan to perform design work, monitoring of manufacturing schedule and quality control of equipment selected for this Project.

In order to achieve effective transfer of technology in the fields of civil engineering, geology, power generation and transmission line, the Vanuatu Government must assign their counterpart personnel in these various fields.

Table 5.4.1 Contents of Consultants' Scope of Work

Item	in Vanuatu	in Japan
Definite design	Site investigation, discussions with the Governemnt of the Republic of Vanuatu and gathering of various data	Detail design, preparation of bid documents and evaluation of bids
Construc-tion super-vision	Control of construction schedule, Control of quality, Control of safety on the construction works, Transfer of technology	Approval of design and manufacturing drawings and control of schedule Control of quality in manufacturing

Fig. 5.4.1 Organization Chart of Project Implementation



: Work based on Contract
: Liaison and Coordination

5.4.3 Procurement Plan of Equipment and Material

The equipment and material required for the construction of the Projected electric power plant are principally considered to be procured locally. However, no equipment and material is produced in the Republic of Vanuatu except timbers and aggregate for concrete which do not require any processing.

Although, materials for the civil work such as cement and reinforcing bars are available even in the Republic of Vanuatu, all of them are imported in small lots, therefore judging from the quantity needed and the cost, the procurement of those materials in this country is difficult for this Project.

The equipment and the material for the power plant, transmission lines, gates and penstock are not produced in this country therefore, it is necessary to procure this equipment and material from the third countries or from Japan.

(1) Materials for the civil structures

The main materials needed for the construction of the civil structures are cement, reinforcing bars and aggregates for concrete, therefore the cement and the reinforcing bars are to be procured from Fiji and aggregate for concrete is to be secured locally.

(2) Equipments and materials needed for the power plant, transmission lines, gates and penstock

Taking the performance and quality and delivery period into consideration, the main equipments and materials are to be procured from Japan.

Table 5.4.2 shows share of the procurement of main equipments and materials.

Table 5.4.2 Share of the Procurement of Main Equipment and Materials

Local procurement	Procurement from the third countries	Procurement from Japan
Aggregate for concrete (gravel and sand), timbers, gasoline and kerosene	Cement, Deformed bars	Turbines and accessories, generators, control panel, transformers, transmission lines, gates, screens, penstock and other miscellaneous materials for civil works

5.4.4 Execution Procedure

Figure 5.4.2 shows the Milestone of the Project. Considering the size of this Project, the construction will be divided into two phases.

(1) The details of the procedures on each phase are as follows:

(a) First phase (for 12 months from contract agreement till completion of construction)

- detailed design
- construction of access road between the existing road and the dam site (to be done under the responsibility of the Republic of Vanuatu)
- construction of civil structures (dam, sedimentation pond, headrace, head tank, penstock and power house)
- installment and tests of turbine, generators and accessories (for one unit, 300 kW)
- construction of transmission line and test

(b) Second phase (for 11.5 months from contract agreement till completion of construction)

- detailed design
- construction of permanent road between dam and power station
- installment and test of turbine, generator, and accessories (for one unit, 300 kW)

(2) The share of the works between two countries

Japan	The Republic of Vanuatu
. Procurement and supply of necessary materials and equipments for the civil works concerning dam, headrace, penstock and power station as well as the construction works. . Manufacturing, supply and installation and test of electricity generating facilities such as turbines, generators and transformers. . Procurement, supply, construction, test of materials and equipments concerning transmission line . Surface and inland transportation . Detailed design, management of construction procedures	. Construction of access road from the existing road to the dam. . Offering of the land for the construction of power plant . Offering of the land for the construction of transmission line . Clear-cutting works of the forest for facilities

5.4.5 Approximate Cost Born by the Government of Vanuatu

In implementing this Project under Japanese Grant Aid Program, the approximate required cost to be born by the Government of Vanuatu is estimated as follows:

1) Aquisition of lands	4,030	thousand VT	(approx. 5 million yen)
2) Access load	13,540	thousand VT	(approx. 17 million yen)
3) Felling	1,670	thousand VT	(approx. 2 million yen)
4) Others (land rental)	280	thousand VT	(approx. 0.4 million yen)
Total	19,250	thousand VT	(approx. 24.4 million yen)

Fig. 5-4-2 PROJECT IMPLEMENTING SCHEDULE

Field Work (Abroad)
Work in Japan

Descriptions \ Months	1992					1993												1994													
	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	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	28	29	30	31
Construction Stage								First Stage (300 kW)															Second Stage (300 kW)								
Government of Japan			Cabinet Meeting	--Exchange of Notes											Cabinet Meeting	--Exchange of Notes															
Design, Preparation of Tender Documents			Consultant Contract	Land Survey												Consultant Contract															
Tendering																															
Tender Evaluation																															
Contract Signing, Meeting, Check for Approval Drawings									Contract Signing											Contract Signing											
Manufacturing, Shop Tests																															
Shipping, Transportation									Civil Equip.						Civil, Transmission Equip.		Generating Equip.									Generating Equip.					
Civil Work									Preparation Work																						
Installation of Equipment, Field Tests																															
Generating Equipment																		Preparation Work										Preparation Work			
Transmission Equipment																	Preparation Work														
Civil Equipment																															
Taking Over																				Taking Over (300kW)									Taking Over (300kW)		

CHAPTER 6

PROMOTION OF ELECTRIFICATION

AND

REDUCTION OF ELECTRICITY TARIFF

CHAPTER 6 PROMOTION OF ELECTRIFICATION AND REDUCTION OF ELECTRICITY TARIFF

With the introduction of hydroelectric power station, fuel oil consumption can be substantially reduced. The amount equivalent to this saving of fuel is the benefit of the hydroelectric power station, and said amount will be the fund for promoting electrification as well as for reducing electricity tariff.

In this report, concrete electrification program is established, and the fund to implement the program is the saving in fuel consumption (revenues) and the balance of revenues is to be appropriated to reducing electricity tariff.

The source of the fund for the electrification program is Vanuatu Government's share of UNELCO's revenues from sale of electricity which is based on new electricity tariff according to agreement between Vanuatu Government and UNELCO and the ratio of actual energy generation between this hydroelectric project and existing diesel electric plant.

Two methods were considered for the electrification and for reducing electricity tariff.

Method No. 1 (Parallel method):

In this method, promotion of electrification and reduction of electricity tariff are implemented in parallel. Hence, the electrification is completed within 10 years starting from 1994, and at the same time, the electricity tariff is reduced from 1994.

Method No. 2 (Series method):

In this method, priority is given to electrification and the current average per unit tariff of 31.58 VT/kWh is maintained and be reduced after completion of the electrification program.

6.1 BENEFITS OF INTRODUCTION OF HYDROELECTRIC POWER STATION

The benefits (saving of foreign currency) of fuel oil saving during 10 years starting from 1994 (start up of hydroelectric power station) is shown in Table 6.1.1. In this case, the hydropower supply ratio (ratio of energy supply between hydroelectric power station and diesel power station) is assumed as 75%, 80%, and 85% respectively. If priority is given to the operation of the hydroelectric power station to increase the hydropower supply ratio, the benefits of fuel oil saving can be further enhanced.

Table 6.1.1 Benefits of Foreign Currency Saving
(during 10 years after staring operation)

Hydropower supply ratio (%)	75	80	85
Quantity of fuel oil saving (kl)	11,071	11,810	12,548
Amount of saving (10^6 VT)	593	633	672
Amount of foreign currency saving (10^6 US$)	4.428	4.724	5.019

(Evaluated at 40 ¢/l)

The objects of this Project can be achieved by investing the above saved amount (benefits) for the electrification program as well as to reduce electric tariff which are described in and after Section 6.2.

6.2 PROMOTION OF ELECTRIFICATION AND ESTABLISHMENT OF AVERAGE UNIT ENERGY

6.2.1 Cost of Electrification in Method No. 1 and New Unit Sales Price of Electricity

The cost for the electrification in Method No. 1 (Parallel method) and the new unit sales price of electricity are shown below:

(1) Procedure and cost of electrification

(a) Procedure of electrification

840 unelectrified households are electrified in the 10 years period from 1994 to 2003. In the first stage, 490 households are electrified during 3 years from 1994 to 1996. In the second stage, 350 households are electrified during the period of 1997 to 2003.

(b) Cost of electrification

First stage	(490 households)	24.76 million VT
Second stage	(350 households)	89.29 million VT
Total	(840 households)	114.05 million VT

Details are shown in Table 6.2.1.

Table 6.2.1 Electrification in Method No. 1

Year / Items	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Electrification fund (Million VT)	8.93	9.47	10.03	10.64	11.28	11.95	12.67	13.43	14.23	15.09	117.72
Number of households electrified (Houses)	163	163	164	50	50	50	50	50	50	50	840
Cost of electrification works (Million VT)	7.76	8.33	8.77	10.64	11.28	11.95	12.67	13.43	14.23	15.09	114.05
Balance (Million VT)	1.17	1.24	1.26	0	0	0	0	0	0	0	3.67

Note: Electrification fund and electrification cost are based on 1991 prices plus price escalation of 6% annually

By budgeting 8.93 million VT (included in electricity tariff) in 1994 as funds for the electrification program, 117.72

million VT can be accumulated in 10 years as funds for electrification on the basis of 6% annual growth of demand. The cost of electrification in the 10 years is a total of 114.05, leaving a balance of 3.67 million VT.

(2) New unit sales price of electricity

The new unit price is based on generation cost (sum of fixed cost and variable cost) and energy sold (on 1994 basis) and according to variation in hydropower supply ratio (70% to 85%) as follows:

Hydropower supply ratio (%)	75	80	85
Fixed cost (Million VT) (1)	58.24	58.24	58.24
Variable cost (Million VT) (2)	15.37	12.30	9.22
Total generation cost (Million VT) (3) = (1) + (2)	73.61	70.54	67.46
Energy sold (MWh) (4)	3,112.00	3,112.00	3,112.00
Average unit sales price (VT/kWh) (3) ÷ (4)	23.66	22.67	21.68

Note: Unit sales price is fixed for 10 years from 1994
. These new unit sales price of 23.66 to 21.69 VT/kWh are cheapter by about 28% on the average compared to the present rate of 31.58 VT/kWh.

6.2.2 Cost of Electrification in Method No. 2 and New Unit Sales Price of Electricity

Procedure and cost of the electrification in Method No. 2 (Series method) and the new unit sales price of electricity are shown below.

(1) Procedure and cost of electrification

(a) Procedure of electrification

The unelectrified households (840 houses) are to be electrified during 3 years from 1994 to 1996 (280 households per year).

(b) Cost of electrification

The total cost for the electrification is 94.78 million VT.

Details are shown in Table 6.2.2.

Table 6.2.2 Electrification in Method No. 2

Year / Items	1994			1995			1996			1997		
Hydropower supply ratio (%)	75	80	85	75	80	85	75	80	85	75	80	85
Energy sales revenue (Million VT)	33.60	36.67	39.75	35.62	38.87	42.14	37.75	41.20	44.66	40.02	43.67	47.34
Number of electrified households (Houses)	280			280			280			-		
Cost of electrification works (Million VT)	29.77			31.56			33.45			-		
Balance (Million VT)	3.83	6.90	9.98	4.06	7.31	10.58	4.3	7.75	11.21	40.02	43.67	47.34

Note: Electrification fund and electrification cost are based on 1991 prices plus price escalation of 6% annually

- The unit sales price of electricity in Method No. 2 is maintained (31.58 VT/kWh) until completion of the electrification program, and the energy sales net revenues can be fully used for the implementation of the electrification (from 1994 to 1996). There will be plus balance (surplus) each year even if always kept plus even after conducting annual 280 households are electrified annually.

(2) New unit sales price of electricity

The electrification of the unelectrified 840 households is completed in 1996.

The new unit sales price based on the principle of cost from 1997 onward is as follows:

Unit Sales Price Based on Cost

1997 basis

Hydropower supply ratio (%)	75	80	85
Fixed cost (Million VT)	58.73	58.73	58.73
Variable cost (Million VT)	18.31	14.65	10.98
Total generation cost (Million VT)	77.04	73.38	69.71
Energy sold (MWh)	3,706.00	3,706.00	3,706.00
Average unit sales price (VT/kWh)	20.79	19.80	18.81

Note: Unit sales price is fixed for 7 years from 1997

However, with the above unit sales prices, there will arise a shortage of funds to finance the electrification program, and the difference between the present tariff of 31.58 VT/kWh is great and the difference in tariff compared to that of Port Vila is excessive. Therefore, the unit price is raised to the amount in Method No. 1.

As a result, it is necessary to adopt a fixed cost (1997 basis) which includes the government's revenues (10.64 million VT). The new unit sales price calculated on this basis is given in Table 6.5.1.

Table 6.5.1 Average Unit Sales Price of Method No. 2

1997 basis

Hydropower supply ratio (%)	75	80	85
Fixed cost (Million VT)	69.37	69.37	69.37
Variable cost (Million VT)	18.31	14.65	10.98
Total generation cost (Million VT)	87.68	84.02	80.35
Energy sold (MWh)	3,706.00	3,706.00	3,706.00
Average unit sales price (VT/kWh)	23.66	22.67	21.68

Note: Unit sales price is fixed for 7 years from 1997

Details of the fixed cost on 1997 basis are as follows:

Government's share of revenuew:	10.64 million VT
UNELCO's net income:	33.56 million VT
Personnel expenses for hydroelectric power station:	16.15 million VT
Maintenance and repair cost for hydroelectric power station:	9.02 million VT
Total:	69.37 million VT

6.3 COMPARISON BETWEEN METHOD NO.1 AND METHOD NO.2

A comparison between Methods No. 1 and No. 2 is shown in Table 6.3.1.

Table 6.3.1 Comparison between No. 1 and No. 2 Methods

	Method No. 1			Method No. 2		
	*75%	80%	85%	75%	80%	85%
Electrification of un-electrified households in Lluganville city	To be completed in 10 years from 1994			To be completed in 3 years from 1994		
Average unit sales price (VT/kWh)	Fixed for 10 years from 1994			31.58 for 3 years from 1994 As follows from 1997		
	23.66	22.67	21.68	23.66	22.67	21.68
Accumulation of funds after completion of electrification program	10.64 million VT/year (1977 price) 6% annual increase after 1997			11.90 million VT/year (on 1997 basis)		
Reaction of consumers	Reduce electricity tariff immediately after commissioning hydro power plant. Good response by un-electrified households, low income family and people already received electricity service.			Electricity tariff not reduced 3 years after commissioning of hydro power plant. Present consumers not satisfied, but good response by unelectrified households.		
Electricity tariff compared to that of Port Vila (31.58 VT/kWh in Port Vila)	reduced by 25.1%	reduced by 28.2%	reduced by 31.3%	No reduction for first 3 years As follows from the 4th year		
				reduced by 25.1%	reduced by 28.2%	reduced by 31.3%

* Hydropower supply ratio

6.4 BASIC DATA

The basic data and calculation methods used in Chapter 6 are shown below:

	Item	Symbol	Value
1.	Price escalation	E	6%
2.	Energy sales - 1994	D4	3,112 MWh
3.	Growth of demand	Di	6%
4.	Energy loss	P_L	10%
5.	Thermal efficiency of diesel power station	ηn	30.6%
6.	Calorific value of fuel oil	Oc	10,200kcal/kg
7.	Specific gravity	Os	0.85kg/l
8.	Price of fuel oil	Op	53.6 VT/l
9.	Price of lubricant	Lp	150 VT/kg
10.	Imported unit price of fuel oil	Oi	40 ¢/l
11.	Hydropower supply ratio	α	70%
			80%
			85%

A. Calculation of Benefits of Foreign Exchange Saving in Table 6.1.1

(1) Fuel oil saving in 1994

$$\frac{1}{0.9} \times \frac{\alpha \times 860}{\eta n \times Oc} \times \frac{1}{Os} \times D_4 \qquad *1$$

$\alpha = 75\%$

$$\frac{1}{0.9} \times \frac{0.75 \times 860}{0.306 \times 10,200} \times \frac{1}{0.85} \times 3,112 = 840 \text{ (kl)}$$

(2) Total fuel oil saving in 10 years from 1994

$$*1 \times \frac{(1 + Oi)^{10} - 1}{Di} \qquad *2$$

$\alpha = 75\%$

$$\frac{1}{0.9} \times \frac{0.75 \times 860}{0.306 \times 10,200} \times \frac{3,112}{0.85} \times \frac{(1 + 0.06)^{10} - 1}{0.06} = 11,071 \text{ (kl)}$$

(3) Saving of foreign exchange

$*2 \times \frac{0i}{100}$ (US$)

= 75%

$11.071 \times 0.4 = 4.428 \times 10^6US

B. Basis Data of Table 6.2.1

(1) Electrification funds (1994 base)

490 households in electrified districts 23.3 million VT
(40,000 VT x 490 homes)

350 households in unelectrified districts 66.0 million VT
(188,570 VT x 350 homes)

Total (840 households) 89.3 million VT

Based on 10 years electrification program,
amount required in 1994 8.93 million VT

C. Basic Data of New Unit Sales Price of 6.2.1 (2)

(1) Details of fixed cost (1994 base)

Electrification cost 8.93 million VT

UNELCO's net revenues 28.18 million VT
(22.33 million VT x 1.06^4)

Energy sales revenues (1)	71.19 million VT
Fuel cost (2)	47.53 million VT
Lubricant cost (3)	1.33 million VT
Net revenues ((1)-(2)-(3))	22.33 million VT (1990 base)

Power station staff personnel expenses 13.56 million VT
(10.74 million VT x 1.06^4)

(see Table 6.4.1)

Power station maintenance staff personnel
expenses (1994 base) 7.57 million VT
(6.00 million VT x 1.06^4)

6 million VT (at 1990 base, 0.6% of
construction cost of power station)

Total 58.24 million VT

Table 6.4.1 Personnel Expenses for Staff of Sarakata Hydroelectric Power Station

1990 basis Unit: Vatu

Classification	Rank	Annual wage	Person	Total
General manager	P15-2	993,912	1	993,912
Deputy general manager	P10-3	634,368	2	1,268,736
Chief operator of shift	P7-3	490,824	4	1,963,296
Chief daytime service engineer	P6-1	434,496	1	434,496
Shift operators	P5-1	400,728	8	3,205,824
Daytime service engineer (electrical)	P3-1	340,680	1	340,680
Daytime service engineer (civil)	P3-1	340,680	2	681,360
Clerical staff	P3-3	362,568	1	362,568
Clerical helper	P2-1	312,504	1	312,504
Driver	P2-3	331,320	2	662,640
Laborer	P1-1	256,296	2	512,592
Total	-	-	25	10,738,608

(2) Details of variable cost (1994 basis)

$$\frac{1}{0.9} \times \frac{(1-\alpha) \times 860}{\eta n \times Oc} \times \left(\frac{Op}{Os} + \frac{Lp}{100}\right) \times D4$$

$\alpha = 75\%$

$$\frac{1}{0.9} \times \frac{(1-0.75) \times 860}{0.306 \times 10,200} \times \left(\frac{53.6}{0.85} + \frac{150}{100}\right) \times 3,112 = 15.37 \text{ millionVT}$$

D. Basic Data of Table 6.2.2

(1) Revenues from sales of energy are as follows:

1994 base, in million VT

Hydropower supply ratio	75%	80%	85%
Total revenues from sales of energy (1)	98.28	98.28	98.28
Fixed cost (2)	49.31	49.31	49.31
Variable cost (3)	15.37	12.30	9.22
Generating cost (4) = (2) + (3)	64.68	61.61	58.53
Net revenues from sales of energy (5) = (1) - (4)	33.60	36.67	39.75

Total revenues from sales of energy (1) 31.58 VT/kWh x D4
= 31.58 x 3,112 = 98.28 million VT

Fixed cost - UNELCO revenues 28.18 million VT
(22.33 million VT x 1.06^4)

Personnel expenses of hydroelectric plant 13.56 million VT
(10.74 million VT x 1.06^4)

Maintenance cost of hydroelectric plant 7.57 million VT
(6.00 million VT x 1.06^4)

Total 49.31 million VT

Variable cost

$$\frac{1}{0.9} \times \frac{(1-\alpha) \times 860}{n \times Oc} \times \left(\frac{Op}{Os} + \frac{Lp}{100}\right) \times D4$$

(2) Electrification cost (1994 base)

$$8.93 \text{ million VT} \times \frac{280 \text{ homes}}{840 \text{ homes}}$$

E. Basic Data of Table 6.5.1

(1) Details of fixed cost (1997 base)

	(million VT)
Government's revenues from energy sales	10.64
UNELCO's net revenues	
22.33 million VT x $(1.06)^7$	33.56
Personnel expenses of hydroelectric power plant	
10.74 million VT x 1.06^7	16.15
Maintenance cost of hydroelectric power plant	
6.0 million VT x 1.06^7	9.02
Total	63.37

(2) Energy sales (1997) See Table 4.2.5.

CHAPTER 7

PROJECT BENEFITS,

AND CONCLUSIONS AND RECOMMENDATION

CHAPTER 7 PROJECT BENEFITS, AND CONCLUSIONS AND RECOMMENDATION

7.1 SAVING OF IMPORTED FUEL OIL AS YARDSTICK OF BENEFITS OF THIS PROJECT

By the introduction of hydropower, it is estimated that the following amount of fuel oil can be saved annually.

Hydropower supply ratio	Necessary quantity of fuel oil	Quantity of fuel oil saving
Without hydropower	1,120 kl	-
75%	280 kl	840 kl
80%	224 kl	896 kl
85%	168 kl	952 kl

The total quantity and value of fuel oil saving at 6% demand growth during 10 years from 1994 are shown below.

Hydropower supply ratio (%)	75	80	85
Quantity of fuel oil saving (kl)	11,071	11,810	12,548
Amount of foreign currency saving (10^6 US$)	4.43	4.72	5.02

(Evaluated at 40 ¢/l)

Since the fuel oil is currently imported by UNELCO, the above foreign currency saving does not directly have any influence on the efforts of the Government to save foreign exchange.

However, from 2010 onward when the Government is scheduled to directly undertake the electric power supply industry, the above foreign currency saving resulting from saving of fuel oil can greatly

contribute to the financial position of the Government of the Republic of Vanuatu.

As a matter of information, the total amount of petroleum products imported in the Republic of Vanuatu in 1990 is; heavy oil: 4,985 kl, gasoline and diesel oil: 15,605 kl, kerosene: 1,365 kl, Total: 21,955 kl; of which UNELCO consumed 6,728 kl in Port Vila and 888 kl in Luganville; total: 7,616 kl, which accounts for 35% of the total imported quantity.

7.2 REDUCTION OF ELECTRIC POWER RATE AND ELECTRIFICATION OF UNELECTRIFIED HOUSEHOLDS IN LUGANVILLE CITY UTILIZING BENEFITS ACHIEVED

As means of distributing to the region the benefits realized by the Sarakata hydroelectric project, the following 2 methods were recommended in Chapter 6.

Method No. 1: Promotion of electrification concurrently reducing electricity tariff. That is, in the 10 years period from 1994, electrify about 840 households not electrified in the city of Luganville and adjoining districts, and reduce electricity tariff from 1994.

Method No. 2: Give priority to electrification of unelectrified households, and reduce electricity tariff after this program is completed. In this case, 3 years will be required to complete the electrification program, and during this 3 years time the present electricity tariff will be maintained and reduce electricity tariff from the 4th year.

7.2.1 Distribution of Benefits by Method No. 1

(1) Electrification of unelectrified households

The revenues to the Government of Vanuatu from the Sarakata hydroelectric plant, computed at 1994 price basis, is estimated to be 8.93 million VT. This revenue, on the assumption that growth rate of demand is 6% annually, will become a total of 117.71 million VT in the 10 years period from 1994. If this

revenue is allocated to electrification of unelectrified households, about 840 low income level households will be electrified in the year 2003.

(2) Reduce electricity tariff

The average per unit energy sales price of UNELCO Luganville power station was 28.90 VT/kWh in 1990, of which fuel oil cost accounted for 67% or in monetary term 19.28 VT/kWh.

By the commissioning of the hydroelectric plant, the average unit energy sales price is estimated to be as follows on the assumption that growth rate of demand for energy and price escalation of products relating to energy supply is 6%.

Hydropower supply ratio	Average unit sales price	Remarks
75%	23.65 VT/kWh	Average unit sales price in 1990;
80%	22.67 VT/kWh	28.90 VT/kWh
85%	21.68 VT/kWh	

If the per unit electricity rate is reduced as shown above and kept stable over a long period, it will enable low income level households to purchase electricity which would contribute to the betterment of the livelihood of the people and also contribute greatly to the development of the region.

7.2.2 Distribution of Benefits by Method No.2

(1) Electrification of unelectrified households

In this method the Government's share of revenues (benefit) from 1994 is disbursed with priority to electrification program. The Government's share of revenues and disbursements for electrification each year are given in the following table.

Item \ Year	1994			1995			1996		
Hydropower ratio (%)	75	80	85	75	80	85	75	80	85
Government's revenues (10^6 VT)	33.60	36.67	39.75	35.62	38.87	42.14	37.75	41.20	44.66
No. of homes electrified	280			280			280		
Electrification cost (10^6 VT)	29.77			31.56			33.45		
Balance (10^6 VT)	3.83	6.90	9.98	4.06	7.31	10.58	4.30	7.75	11.21

As shown in the above table, if the Government's share of revenues (benefit) are disbursed to the electrification program, 840 unelectrified households can be electrified in a 3 years period from 1994.

(2) Reduction of electricity tariff

After the electrification program of Luganville city is completed, the average per unit electricity tariff can be reduced to the level described in Method No.1.

7.3 CONCLUSION

In the Republic of Vanuatu public electricity supply is available only in the 2 cities of Port Vila on Efate Island and Luganville on Espiritu Santo Island.

In these 2 cities electricity is supplied by UNELCO under an agreement for generation and supply of electricity with the Government of Vanuatu which is a shareholder of UNELCO.

However, electricity supplied by UNELCO is expensive as electricity is generated by diesel engine generators using high cost imported fuel oil. For this reason, it is almost impossible for low income level households to receive electricity service and is an impediment to the industrial development of the republic.

Luganville City which is located in the region where the request of the Government of Vanuatu for cooperation of the Government of Japan in the development of this hydroelectric project is currently supplied electricity from UNELCO's diesel engine power plant (rated capacity 1,080 kW, dependable capacity 830 kW). However, electricity tariff is high and consumers wishing to receive electricity service are charged 80% of the cost for connection. Therefore, only 840 households or 60% of the total households in the city of Luganville are electrified. Consumers with captive generating plants in the city are not able to switch to public supply system because of the high cost of electricity.

At the present time electricity supply service is available only in the city of Luganville and adjoining districts, and factories, hotels, school, etc. located outside of the service territory are depending on high cost captive generating plants.

The Government of Vanuatu, under the Second National Development Plan 1987-1991, is promoting a program of self sustaining economic development, and one of the top priority program in the plan is the reinforcement and expansion of the energy sector. Particularly, in respect to electric power, the aim is to reduce dependence on petroleum and the pillar of the program is to develop hydroelectric power utilizing water resources of the republic.

With this objective in mind, the Government of Vanuatu is anxious to improve infrastructures, including harbor, roads and other facilities to promote the industrialization of Luganville City and adjoining districts in Espiritu Santo, the largest island of the republic in order to mitigate the influx of population to the capital city and to promote regional development. In the improvement and expansion of power supply facilities, the Government has marked the development of hydroelectric power on the Sarakata River flowing nearby the city of Luganville and has placed top priority in the realization of the Project.

If a hydroelectric power station is constructed on the Sarakata River with Grant Aid Cooperation, capital cost need not be included in the generating cost, and it will become possible to supply low cost elec-

tricity to the City of Luganville and adjoining districts, thereby development of industries and improvement of living standard of the people can be anticipated.

Benefits, direct and indirect, which this Project will create are the following.

(1) With the commissioning of this hydroelectric plant, operating hours of the existing diesel power plant can be curtailed resulting in the possible saving of 840 kl annually (45 million VT) of imported fuel oil, contributing to the improvement of international balance of payment.

(2) Electrification of 840 home in and near the city of Luganville will become possible. At present there are about 500 families (about 2,500 people) living in Tanafo Village which is close to the dam site. In the future, when it becomes possible for these people to burden the east of electricity, electrification of this village and adjacent areas will also become possible.

(3) The present electricity tariff of 31.58 VT/KWh can be reduced by about 25%, and this reduced rate may be maintained for a period exceeding 10 years.

As a policy to prevent the influx of population to the capital city of Port Vila, the Government of Vanuatu is directing its attention to the development of the city of Luganville, and by the construction of this hydroelectric project, electricity tariff in Luganville can be reduced and the reduced tariff may be maintained over a long period. This approach is in line with the Government's policy.

(4) Management of the electric utility industry in the Republic of Vanuatu is assigned to UNELCO in which the Government holds only 20% interest, but by the commissioning of this hydroelectric project, it will enable the Government to increase its interest in UNELCO.

(5) By reducing electricity tariff and implementing electrification program, it will facilitate schools, hospital and small scale

industries, at present relying on expensive captive power plant, to convert to receive electricity from the public supply system, and will also contribute to raising the standard of education and medical service of residents of the region and activating the economic activities of the region.

The population that will benefit from this Project, as stated above, will be directly the approximately 7,000 people at present living in the city of Luganville and adjoining districts. However, with the promotion of electrification of Tanafo Village and progress of urbanization program being implemented by the city of Luganville and by attracting industries into the region, it is assumed that the population in the city and adjoining districts will rapidly grow in the future and the people that will benefit from the Project is estimated to be about 15,000 in the year 2010.

In summary, the implementation of this Project will have great significance to the national development policy of the Government of Vanuatu, and it is judged that this Project is justified for Grant Aid Cooperation of the Government of Japan.

7.4 RECOMMENDATION

As the Sarakata hydroelectric project to be constructed with the Grant Aid Cooperation of the Government of Japan is to be put under the direct control of the Government of Vanuatu, it is essential that the Vanuatu Government establish an appropriate organization to administer the Project prior to the implementation of the Project and also make basic agreement with UNELCO on the operation and maintenance system of the completed hydroelectric plant and on the criteria for establishing a new electricity tariff.

In order to complete this Project within a specified period after signing Exchange of Note, it is necessary that acquisition of land and construction of access roads that are to be undertaken by the Government of the Republic of Vanuatu be completed before start of construction of the Project.

Operation and maintenance of hydroelectric power station is the first experience both for the Government and UNELCO. Hence, it is desirable

that operation and maintenance staff for the hydroelectric power station should be selected beforehand by the Government and from the start of construction of the works, the staff should receive necessary education and training in the operation and maintenance of hydroelectric plant.

To clearly identify the benefits created by the hydroelectric power station, it is desirable that a separate electric tariff system be applied to Port Vila and Luganville as stated earlier in this Report.

It is necessary for the Government to complete arrangements in advance through discussions with UNELCO so that the extension of power transmission and distribution lines, electrification of unelectrified households, etc. can be systematically implemented by using the funds accumulated from the share of revenues to the Government from the operation of the hydroelectric power station.

It is essential that the Government of Vanuatu be dispatched trainees to Japan as soon as possible for on-site training at hydroelectric power stations in Japan so that the hydroelectric power station can be satisfactorily operated and perform its full functions.

Japanese experts to provide guidance and training in the operation and maintenance of hydroelectric power plant and management of electric utility should be dispatched to Vanuatu.

DRAWING LIST

DRAWING LIST

1. GENERAL LAYOUT

2. INTAKE DAM & SEDIMENTATION BASIN

   Plan, Profile & Sections

3. HEADRACE CANAL

   Typical Section

4. HEAD TANK, PENSTOCK & POWER HOUSE

   Plan, Profiles (1-2)

5. HEAD TANK, PENSTOCK & POWER HOUSE

   Plan, Profiles (2-2)

6. SCOPE OF THE PROJECT

7. TRANSMISSION LINE

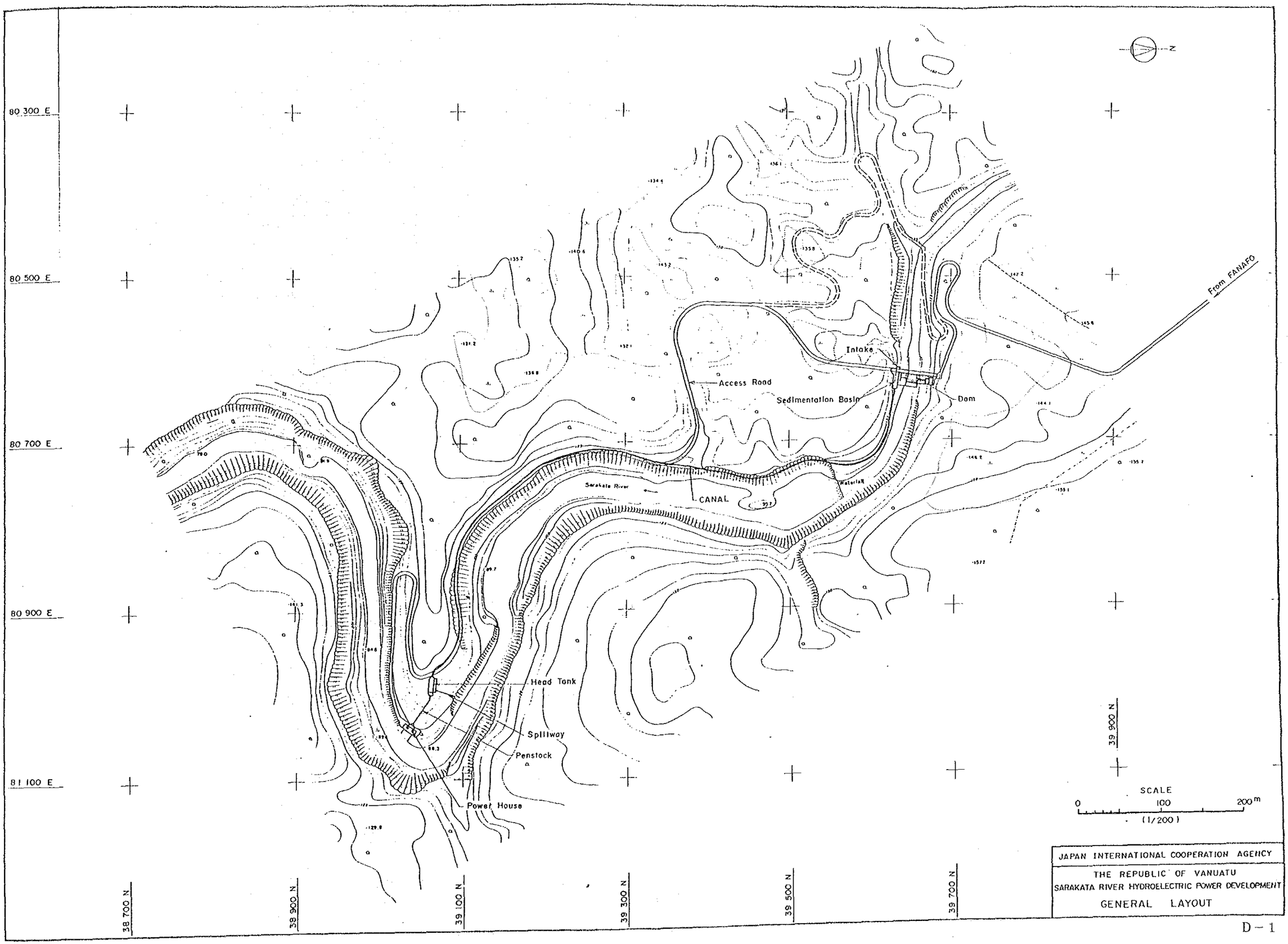
   Arrangement of Supporting Structure (Type-A)

8. TRANSMISSION LINE

   Arrangement of Supporting Structure (Type-B)

9. TRANSMISSION LINE

   Arrangement of Supporting Structure (Type-C)

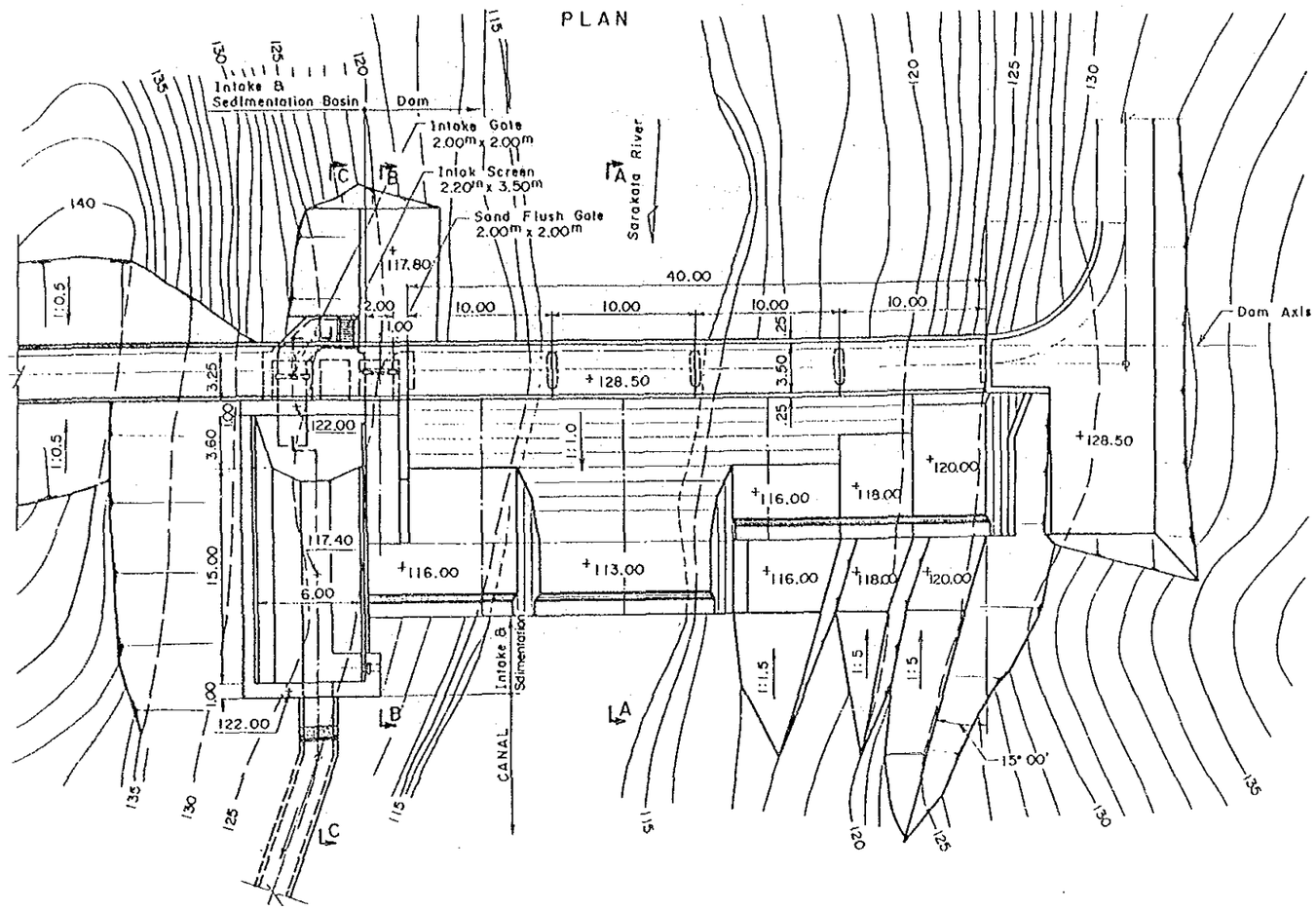


JAPAN INTERNATIONAL COOPERATION AGENCY

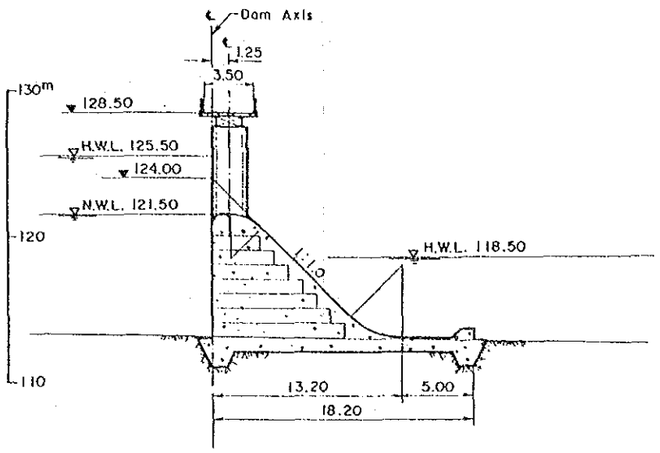
THE REPUBLIC OF VANUATU
SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT

GENERAL LAYOUT

PLAN



SECTION A – A



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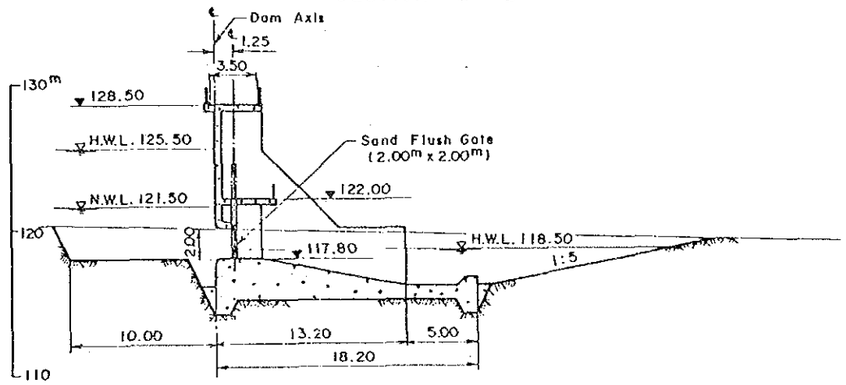
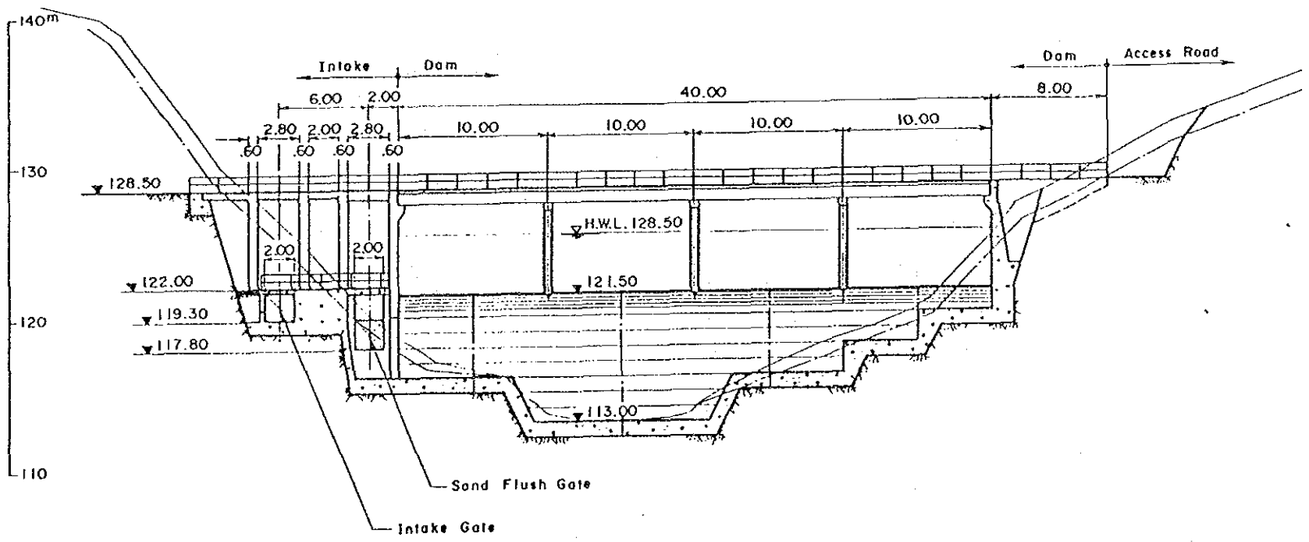


PROFILE
(Down Stream Side)



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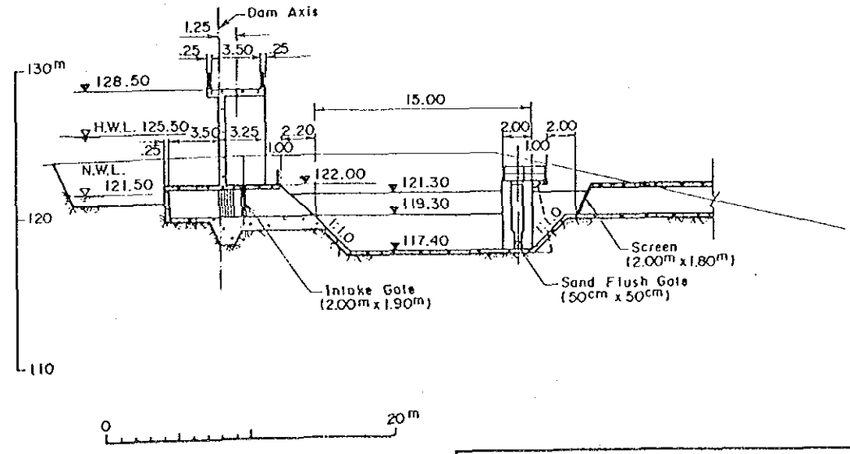
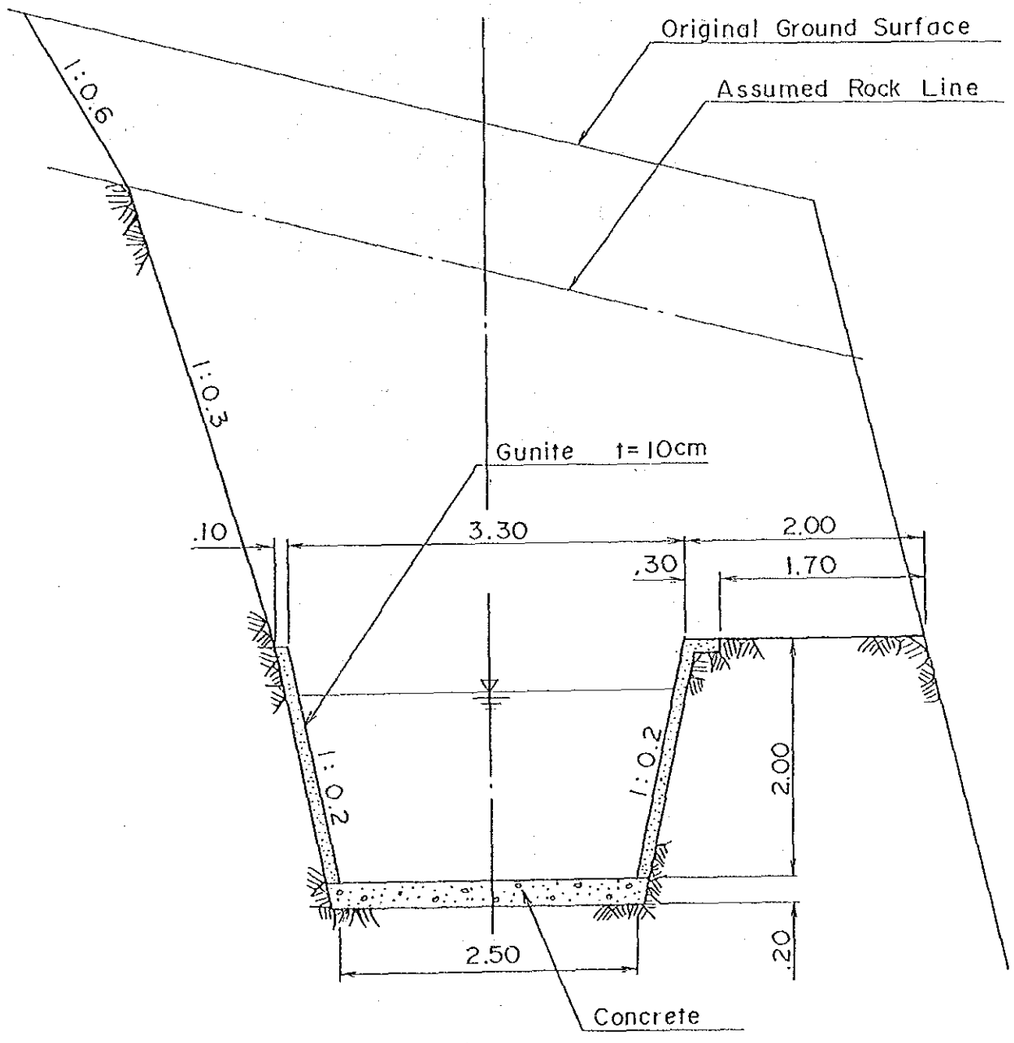
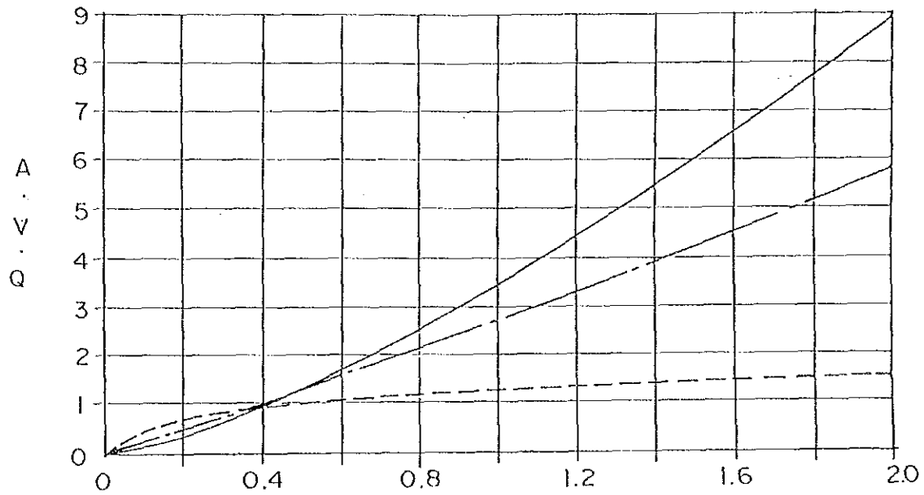


JAPAN INTERNATIONAL COOPERATION AGENCY
THE REPUBLIC OF VANUATU SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT INTAKE DAM & SEDIMENTATION BASIN PLAN, PROFILE & SECTIONS

TYPICAL SECTION



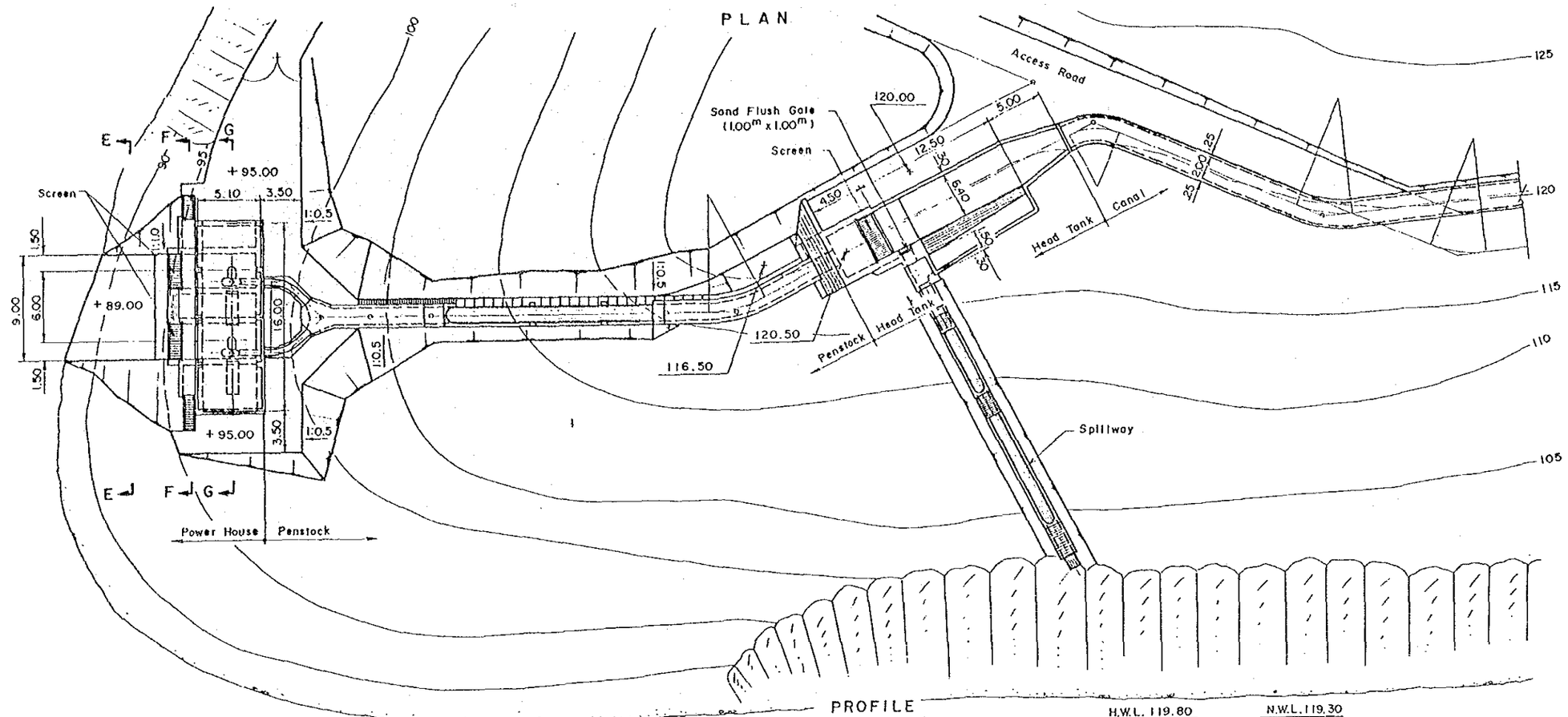
HYDRAULIC CHARACTERISTIC CURVE



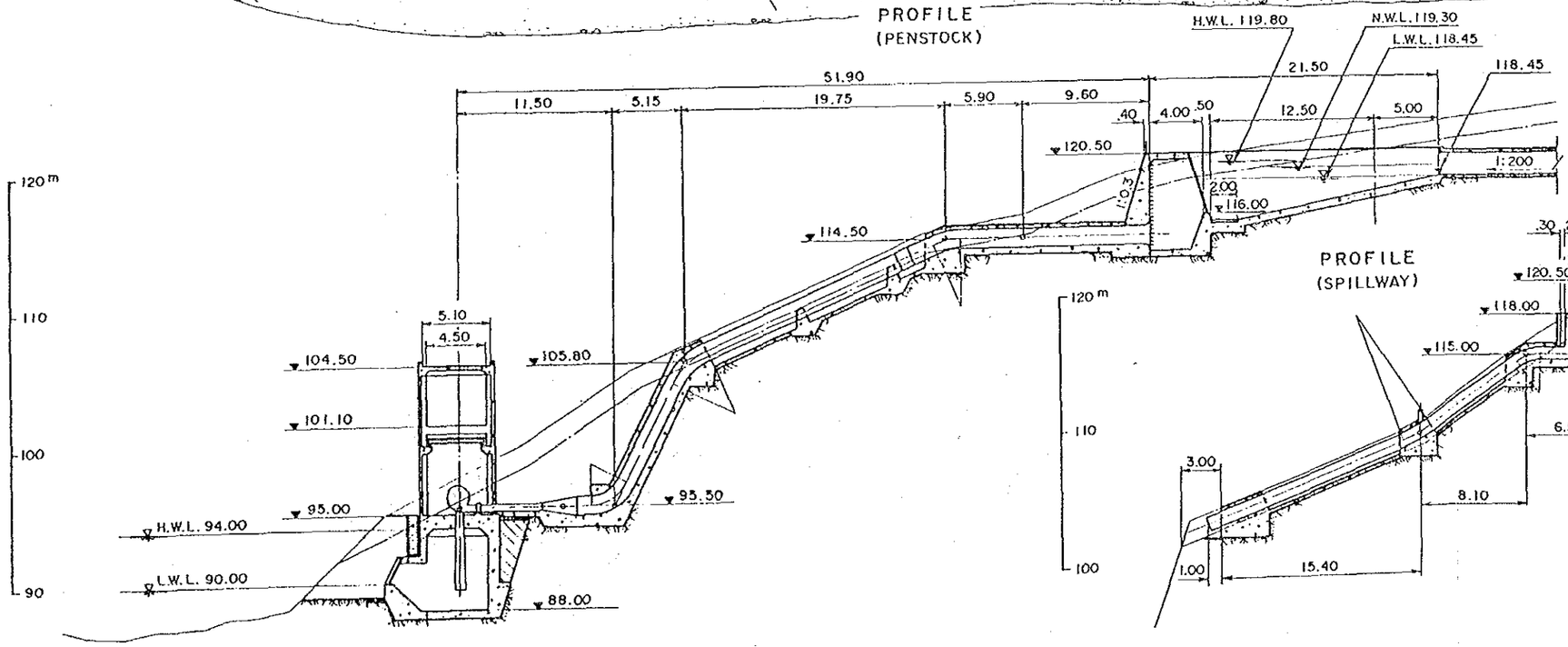
I : 1/1,000
n_c : 0.014
n_g : 0.022
b : 2.50 m

JAPAN INTERNATIONAL COOPERATION AGENCY
THE REPUBLIC OF VANUATU SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT HEADRACE CANAL TYPICAL SECTION

PLAN



PROFILE
(PENSTOCK)



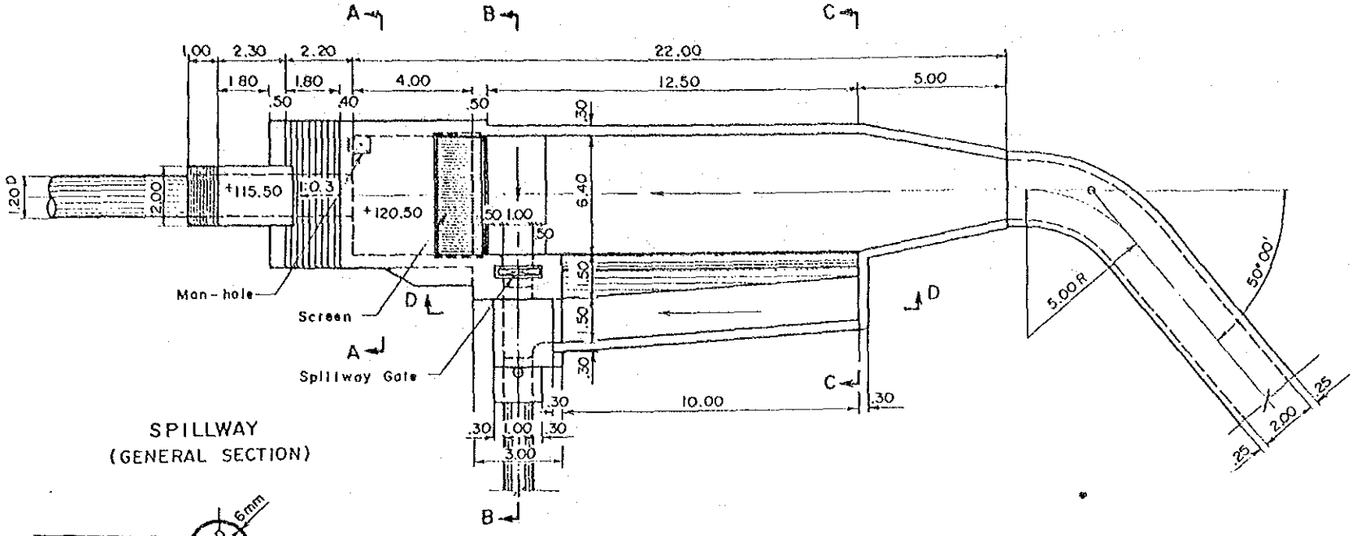
PROFILE
(SPILLWAY)

SCALE
0 10 20 m
(1/200)

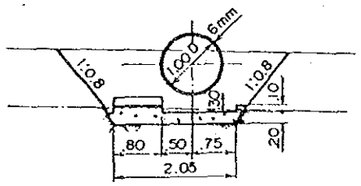
JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF VANUATU
SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT
HEAD TANK, PENSTOCK & POWER HOUSE
PLAN & PROFILES (1-2)

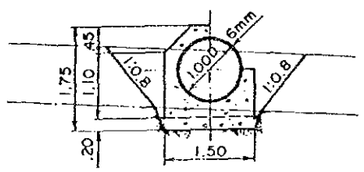
PLAN (HEAD TANK)



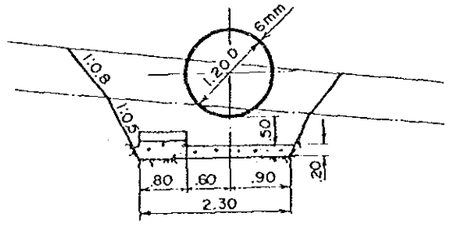
SPILLWAY (GENERAL SECTION)



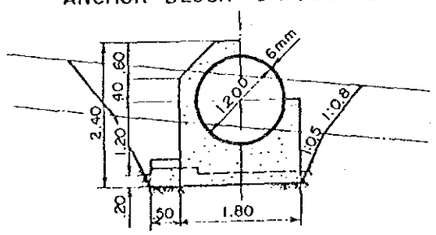
ANCHOR BLOCK SADDLE BLOCK



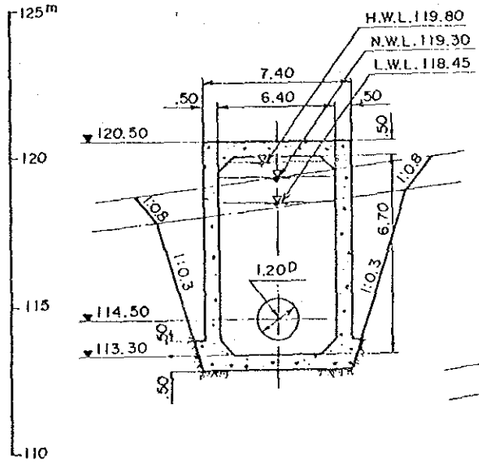
PENSTOCK (GENERAL SECTION)



ANCHOR BLOCK SADDLE BLOCK



SECTION A – A



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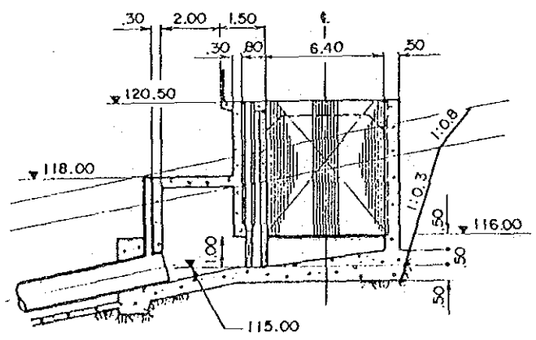
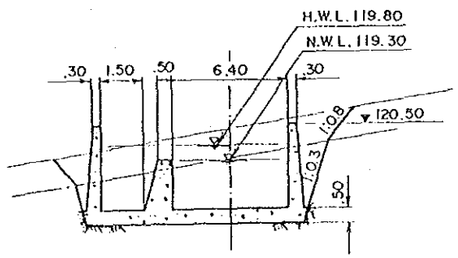
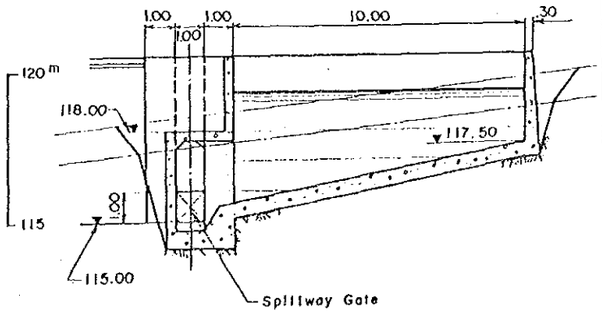


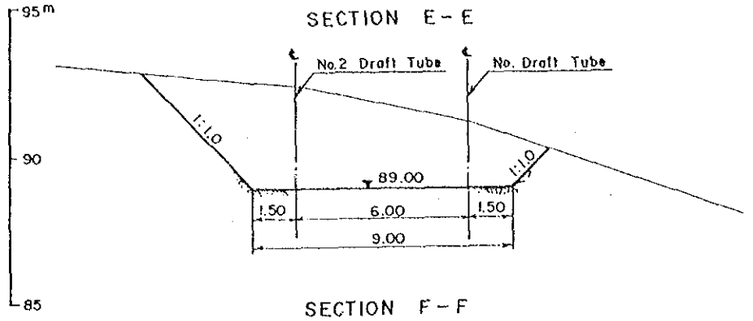
SECTION C – C



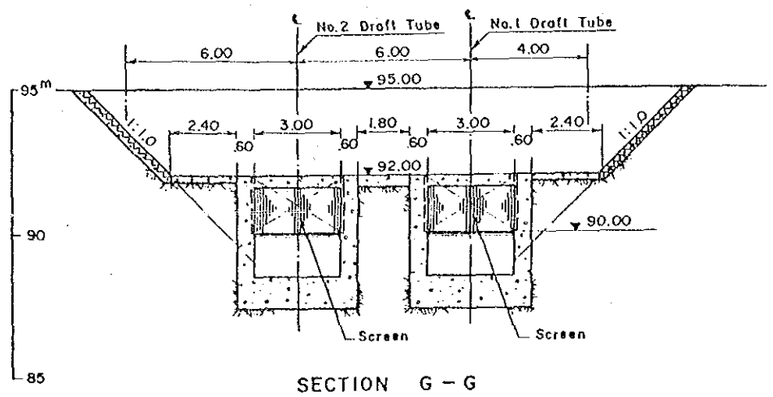
SECTION D – D



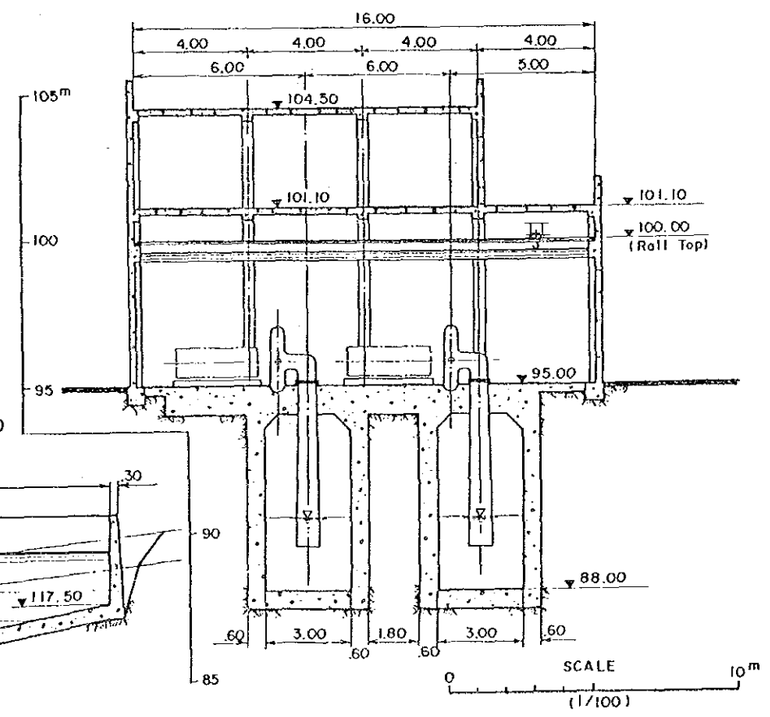
SECTION E – E



SECTION F – F

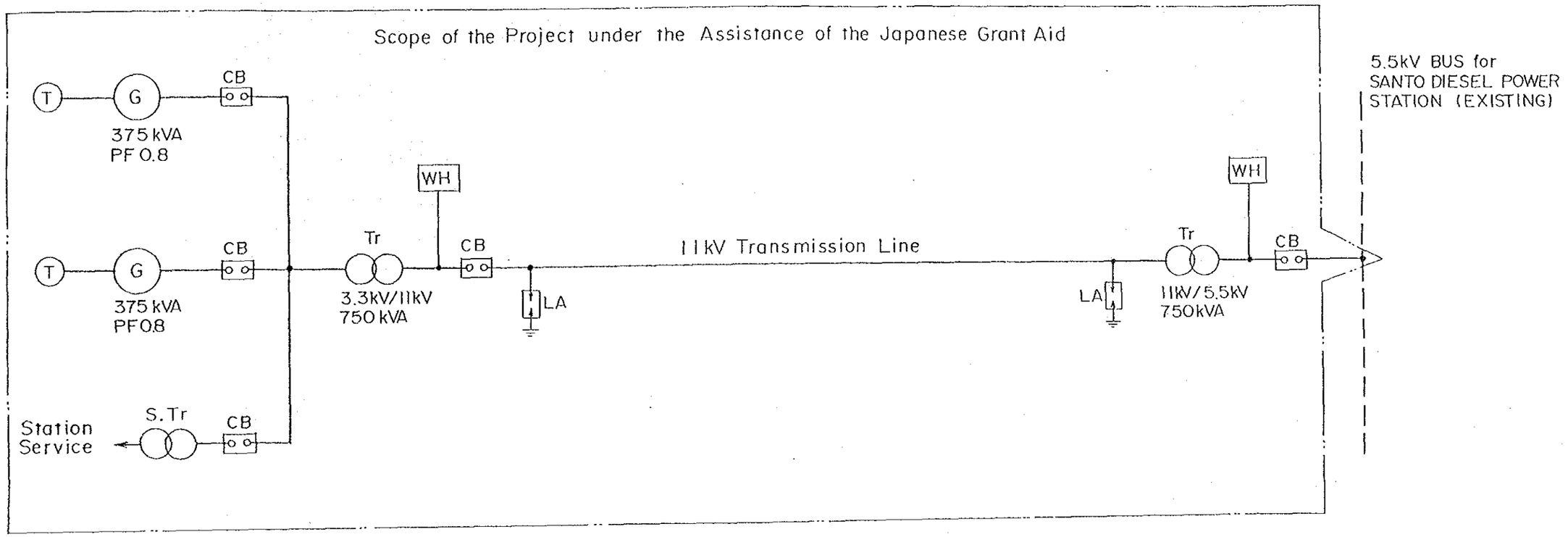


SECTION G – G



JAPAN INTERNATIONAL COOPERATION AGENCY
THE REPUBLIC OF VANUATU SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT HEAD TANK, PENSTOCK & POWER HOUSE PLAN & PROFILES (2-2)

SINGLE LINE DIAGRAM OF THE PROJECT



SARAKATA HYDRAULIC
POWER STATION

SANTO DIESEL
POWER STATION (Existing)

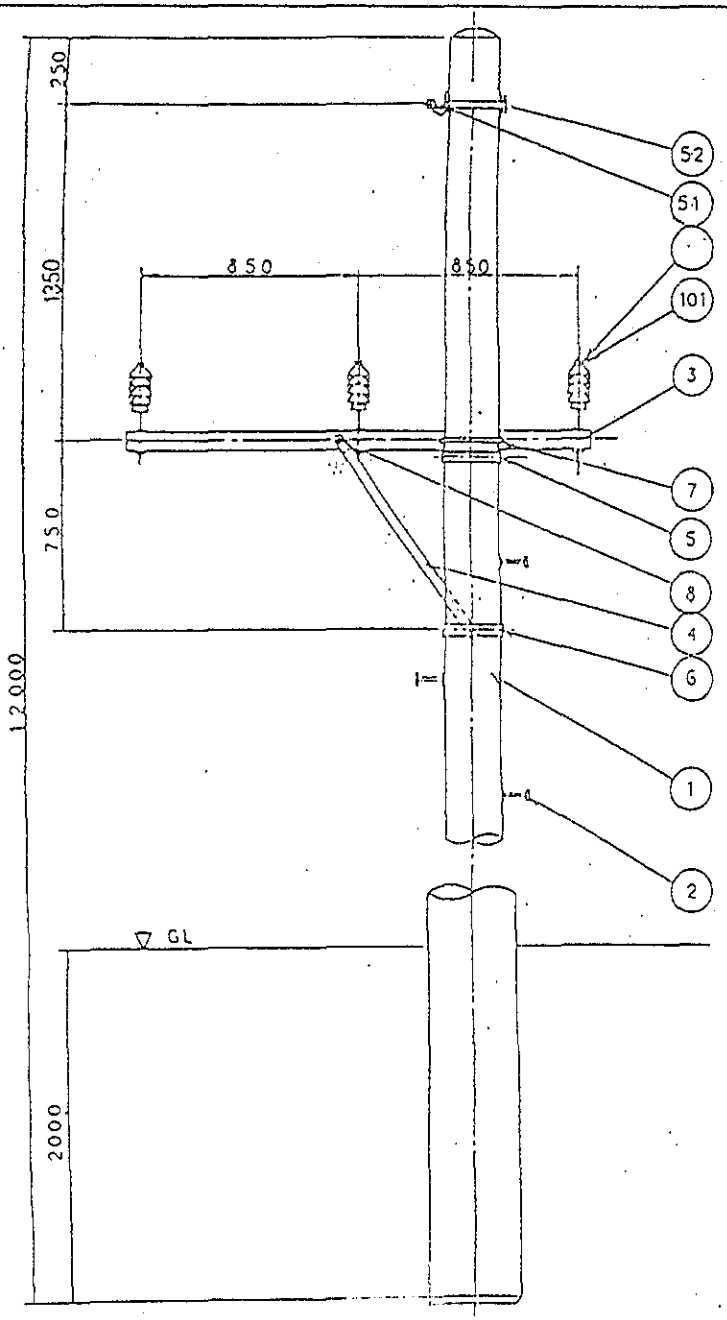
REMARKS

G : Generator
T : Turbine
CB : Circuit Breaker
Tr : Transformer
LA: Lightning Arrester
WH: Watthour Meter

JAPAN INTERNATION COOPERATION AGENCY

THE REPUBLIC OF BANUATU
SARAKATA RIVER HYDROELECTRIC POWER PROJECT

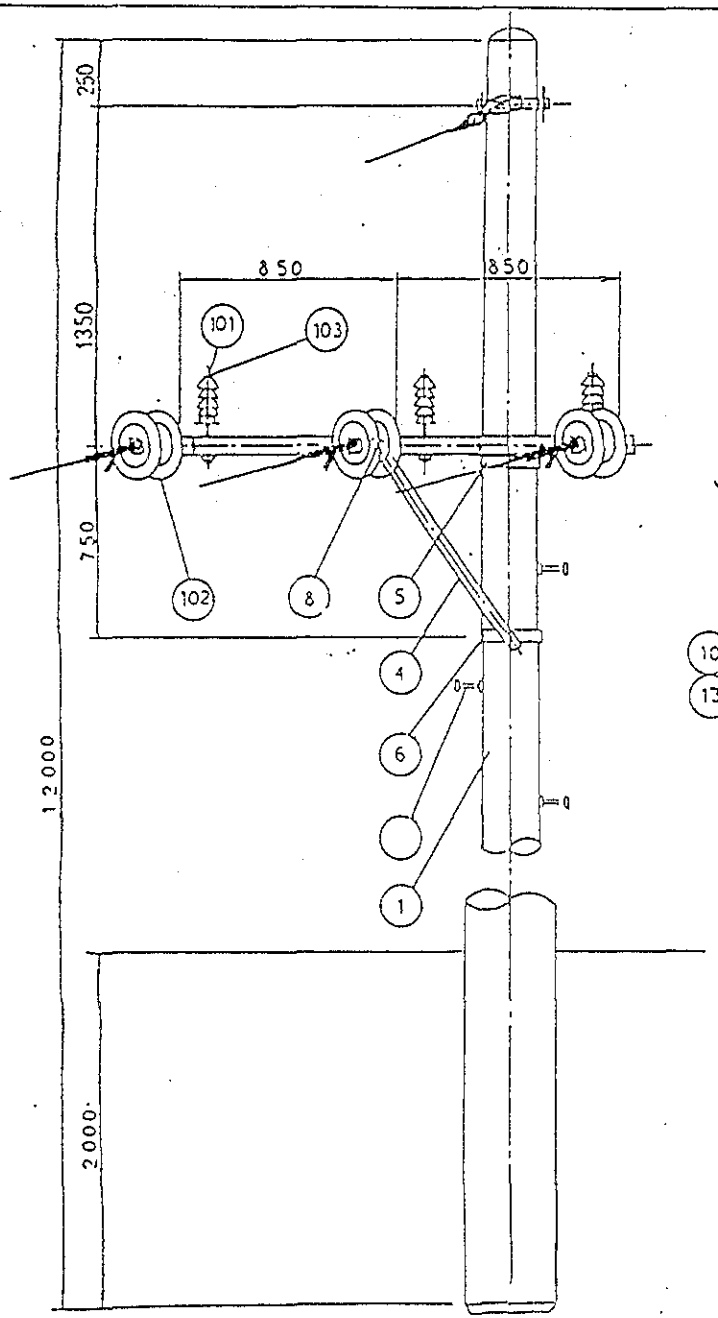
SCOPE OF THE PROJECT

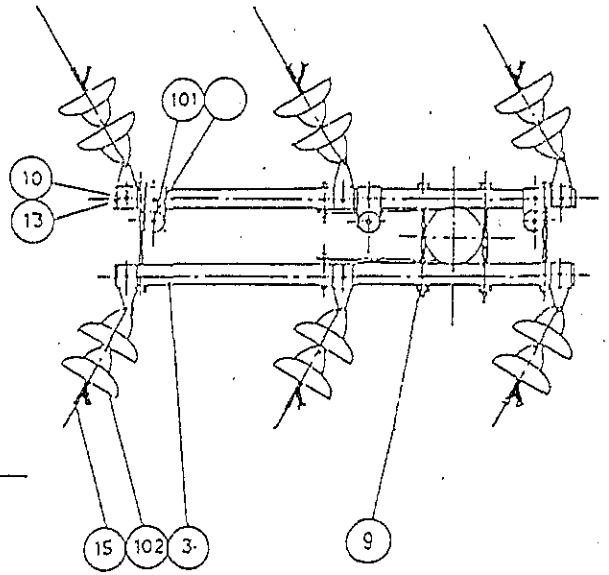


PART NO.	ITEM NO.	DESCRIPTION	QTY:	DRG.NO.
101		LP-10. INSULATOR 11KV	3	
52		BOLT NUT WITH V.S.V M16X260	1	
51		SUSPENDER FOR O.G.V.	1	
8		BOLT NUT WITH V.S.V M12X120	1	
7		U-BOLT FOR CROSSARM	1	
6		BAND FOR BRACE	1	
5		BAND FOR ARM SUPPORT	1	
4		CROSSARM BRACE	1	
3		CROSSARM 75X75X1800	1	
1		CONCRETE POLE	1	

Supporting Structure Arrangement of Transmission Line

Type-A

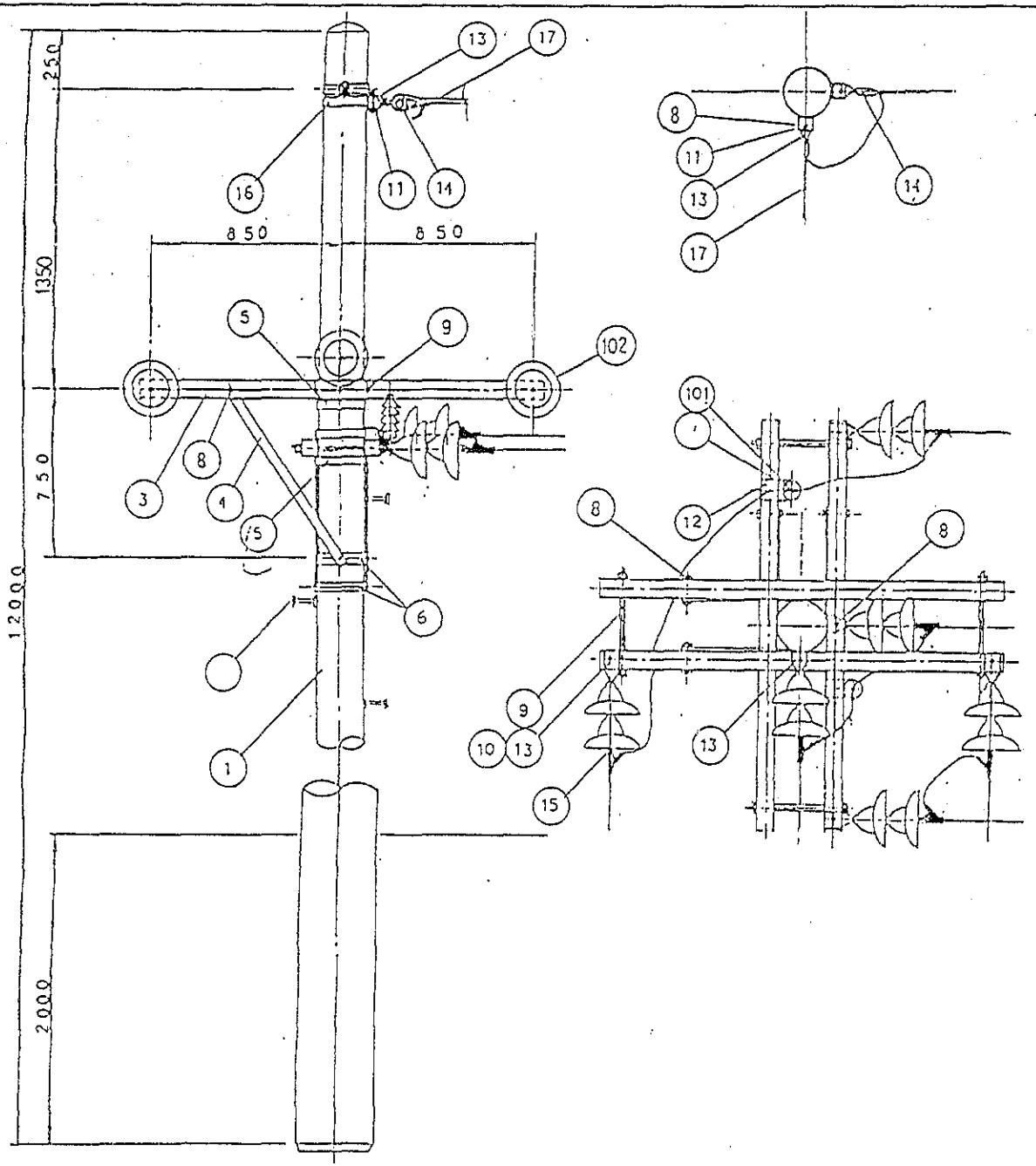




PART NO.	ITEM NO.	DESCRIPTION	QTY	DRG.NO.
102		TENSION INSULATOR	12	
101		PIN INSULATOR	3	
17		PREFORMED GRIP DEAD END	2	
16		BAND FOR O.G.V.	1	
15		CLAMP FOR O/H LINE CABLE	6	
14		CLAMP FOR O.G.V.	2	
13		TWIST STRAP	16	
12		BRACKET FOR PIN INSULATOR	3	
11		BRACKET FOR O.G.V.	2	
10		BOLT NUT WITH V.S.V M16X140	6	
9		D.A.B NUT WITH V.S.V M16X400	4	
8		BOLT NUT WITH V.S.V M12X120	4	
6		BAND FOR BRACE	1	
5		BAND FOR ARM SUPPORT	1	
4		CROSSARM BRACE	2	
3		CROSSARM 75X75X1800	2	
1		CONCRETE POLE	1	

Supporting Structure Arrangement of Transmission Line

Type-B



PART NO.	ITEM NO.	DESCRIPTION	QTY	DRG. NO.
102		TENSION INSULATOR	12	
101		PIN INSULATOR	2	
17		PREFORMED GRIP DEAD END	2	
16		BAND FOR O.G.V.	4	
15		CLAMP FOR O/H LINE CABLE	6	
14		CLAMP FOR O.G.V.	2	
13		TWIST STRAP	16	
12		BRACKET FOR PIN INSULATOR	2	
11		BRACKET FOR O.G.V.	4	
10		BOLT NUT WITH V.S.V M16X140	4	
9		O.A.B NUT WITH V.S.V M16X400	8	
8		BOLT NUT WITH V.S.V M12X120	8	
6		BAND FOR BRACE	2	
5		BAND FOR ARM SUPPORT	2	
4		CROSSARM BRACE	4	
3		CROSSARM 75X75X1200	4	
			32	
1		CONCRETE POLE	1	

Supporting Structure Arrangement of Transmission Line

Type-C

APPENDIX

APPENDIX CONTENTS

APPENDIX-1.
KEY PERSONNEL WITH WHEN THE SURVEY MISSION MET

Key Personnel with when the Survey Team Met

Date	Place	Name and Title
April 23	Ministry of Land	Mr. Edwin ARTHUR (Director, Ministry of Land) Mr. Jean TRANUT (Deputy Director, Ministry of Land) Mr. Michael SHARP (Principal Surveyor, Ministry of Land)
	Prime Minister's Office Energy Unit	Mr. Leo MOLI (Counterpart during Basic Design Study)
April 24	U N E L C O	Mr. Jacques BURLATS (Director, UNELCO Vanuatu Head Office) Mr. Philippe MEHRENBERGER (Ingenieur Electrician, UNELCO)
April 25	Is. Espiritu Sant Luganville City	Mr. Havo MOLI (Assistant Secretary SANTO/MALO, Local Government) Mr. Moli JANJEA (Energy Unit, Santo Power Plant Site Counterpart)
April 26	Proposed Construction Site of Hydroelectric Power Station	Mr. Tari BULUK (The Chief of Tanafo Village) Mr. Timothi WELES (The Second Chief of Tanafo Village)
	Luganville City	Mr. Havo MOLI (Assistant Secretary of SANTO/MALO, Local Government)

Date	Place	Name and Title
April 29	Prime Minister's Office	Mr. Joe NATUMAN (First Secretary of Prime Minister's Office) Mr. Cedric MORTIMER (Director of Geology & Mines) Mr. Stan COMBS (Pranning Adviser, National Planning Office) Mr. Tieevc DUKSTOA (Hydrologist Dept. of Geology) Mr. Jean - Piere NIRUA (Director of National Planning Office) Mr. Giddeon RONOLEO (2nd Secretary of Prime Minister's Office)
	Prime Minister's Office	Mr. Father Walter Hyde LINI (Prime Minister) Mr. Joe NATUMAN (First Secretary)
May 3	Prime Minister's Office	Mr. Joe NATUMAN (First Secretary of Prime Minister's Office) Mr. Jean - Piere NIRUA (Director of National Planning Office)
May 6	National Planning Office	Mr. Stam COMBS (Planning Adviser, National Planning Office)
	UNELCO	Mr. Jacques BURLATS (Director, UNELCO Vanuatu Head Office)
May 8	Port and Marin Department	Mr. Norris HAMISH (Director, Port and Marine Department) Tel 2-2339, Port Vila, Vanuatu

Date	Place	Name and Title
May 8	Ministry of Agriculture	Mr. Philip John Dovo (Director, Department of Agriculture, Livestoch & Horiticulture) Tel 2-2525
May 10	Public Works Department	Mr. John S. McFARLANE (Deputy Director, Public Works Department)
	Vanuatu Meleorogical Service	Mr. Mike BERGIN (Assistant Director Forecasting Services, Vanuatu Meteorological Service.)
	Department of Forestry	Mr. David Wood (Department of Forestry, Forest Utilization Officer)
May 13	B. P. Oil Co.	Mr. Rajendra NANDAN (Manager, BP South-West Pacific Limited)
	Mobil Oil Co.	Mr. Jacques NIOTEAU (Area Manager, Ballande Vanuatu Agent)
	Shell Oil Co.	Mr. Andrew SINGH (Area Manager, Shell Pacific Vanuatu)
	SMET / ARBE	Mr. Alex PALAVI (Director Adjoint, Spie Batignolle Groupe)
May 14	UNELCO	Mr. Mare SEYDOUX (Group Director for The Pacific of UNELCO) Mr. Jacques BURLATS (Director of UNELCO Vanuatu Branch)
May 15	National Planning and Statistics Office	Mr. Stan Combs (Planning Adviser of NPSO)

Date	Place	Name and Title
May 17	Prime Minister's Office and Others	Mr. Joe NATUMA (First Secretary, Prime Minister's Office) Mr. William MAHIT (Hanourable Minister of Land) Mr. Harold C. QUALD (Hanourable Minister of Trad) Mr. Edwin ARTUR (Director of Survey Department) Mr. Jean P. NIRUA (Director of National Planning and Statistics Office) Mr. Stan COMBS (Planning Adviser, NPSO)
May 21	Embassy of Japan Republic of Fiji	His Excellency Yashuo HORI Mr. Takeshi TANABE (Third Secretary)
	JICA Fiji Office	Mr. Hideaki ITO (Director of JICA Fiji Office) Mr. Shunichi MIZUOCHI (Assistant Resident Representative)

APPENDIX-2.
MEMBER LIST OF
THE SURVEY MISSION

Member List of Survey Team

Name	Designation	Organization
Haruo SUZUKI	Leader	Deputy Managing Director Grant Aid Project Management Dept., Japan International Cooperation Agency (JICA)
Ichita YAMAMOTO	Project Coordinator	First Basic Design Study Division Grant Aid Study and Design Dept. (JICA)
Shozo YUZAWA	Hydropower Planner	EPDC International Limited
Toshiro WAKAMORI	Electric Power Planner and Economist	EPDC International Limited
Yasuo ONDA	Electric and Mechanical Engineer	EPDC International Limited
Toshihiko MITSUDA	Civil Engineer	EPDC International Limited
Takanori OMORI	Transmission and Distribution Engineer	EPDC International Limited
Yutaka KOKUFU	Surveyor	PASCO International Incorporated

APPENDIX-3.
SURVEY SCHEDULE

Survey Schedule

No.	Date	Day of week	Description	Stay
1	April 22	Mon.	Leave Narita (Tokyo) 20:30 FJ-303	In flight
2	23	Tue.	Arrive in Nadi 7:00 Leave Nadi 11:00 NF-105 Arrive in Port Vila 11:40 14:00 Courtesy call on Ministry of Land. Discussion with the Land Survey Department on site survey method. 16:00 Visit to Prime Minister's Office Discussion with Counterpart.	Port Vila
3	24	Wed.	8:00 Detail Discussion with Land Survey Dep. 9:00 Visit to UNELCO-Vanuatu Office explanation of the objectives of the JICA Survey Mission.	Port Vila
4	25	Thu.	Leave Port Vila to Luganville Check of the survey instruments and others.	Luganville
5	26	Fri.	One party on the JICA Mission starts the field survey of site till May 18, 1991. Courtesy call on Santo Local Government and Luganville City Office. Visit to beef refinery and check the power and energy demand. Visit to South Pacific Fishing Co., Ltd. and check the power and energy demand.	Luganville
6	27	Sat.	Move from Luganville to Port Vila Discussion of the survey result and review of schedule.	Port Vila
7	28	Sun.	Survey Mission internal meeting	Port Vila
8	29	Mon.	Courtesy call on the Prime Minister's Office and submit the Inception Report and Questionnaires 15:30 Courtesy call on Prime Minister	Port Vila

No.	Date	Day of week	Description	Stay
9	April 30	Tue.	Move from Port Vila to Luganville. Meeting with site survey members. Visit to Project site.	Luganville
10	May 1	Wed.	Labor day. Survey Mission internal meeting.	Luganville
11	2	Thu.	Transmission line route check. Visit to UNELCO Sant Power Station. Move from Luganville to Port Vila.	Port Vila
12	3	Fri.	Signing of the Minute of Discussion.	Port Vila
13	4	Sat.	Survey Mission internal meeting	Port Vila
14	5	Sun.	- ditto -	Port Vila
15	6	Mon.	Visit to Planning Office to check the answering schedule for Survey Mission's Questionnaire. Visit to UNELCO-Vanuatu Office. Discussion about power supply condition of UNELCO.	Port Vila
16	7	Tue.	Transmission survey and power demand survey members move from Port Vila to Luganville. One party stay in Port Vila for data collection.	Port Vila
17	8	Wed.	Visit to Prot and Marine Office and get Tariff Book. Visit to Department of Agriculture, Livestock & Horticulture and surveyed development plan of Agriculture.	Port Vila
18	9	Thu.	National Holiday	Port Vila
19	10	Fri.	Visit to Department of Forestry and surveyed development plan of Sant Island forestation. Visit to Vanuatu Meteorological Service and get Meteorological data of Sant Island.	Port Vila
20	11	Sat.	Data arrangement.	Port Vila
21	12	Sun.	- ditto -	

No.	Date	Day of week	Description	Stay
22	May 13	Mon.	Survey for fuel oil supply condition for the power plant. Visit to SMET to study the construction capability of hydroelectric power plant.	Port Vila
23	14	Tue.	Meeting with the Group Director for the Pacific of Lyannoise der Eoux, and confirm the contents of the concession for Generation and Public Supply of Electric Power in Luganville.	Port Vila
24	15	Wed.	Visit to national Planning Office and received answer for Survey Team's Questionnaire.	Port Vila
25	16	The.	Check of the Power Supply Contract between the Government and UNELCO supplied by National Planning Office.	Port Vila
26	17	Fri.	Reporting to Government main officials about the result of site survey and express Mission's gratitude for the cooperation extended by the officials.	Port Vila
27	18	Sat.	Site survey members of JICA Survey Mission came back from the site.	Port Vila
28	19	Sun.	Survey Mission internal meeting	Port Vila
29	20	Mon.	Leave Port Vila 10:00 FJ801 Arrive in Nandi 13:20 Leave Nandi 15:20 FJ801 Arrive in Suva 17:00	Suva
30	21	Tue.	Explanation to the Embassy of Japan and JICA Fiji Office for the result of the site survey.	Suva
31	22	Wed.	Move from Suva to Nadi by car	Nadi
32	23	Thu.	Leave Nadi 07:10 FJ-302 Arrive in Narita 12:15	

APPENDIX-4.
MINUTES OF DISCUSSIONS

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY
ON
THE PROJECT FOR SARAKATA RIVER HYDROELECTRIC
POWER DEVELOPMENT IN THE REPUBLIC OF VANUATU

Based on the results of the 1990 Preliminary Study, the Japan International Cooperation Agency (JICA) decided to conduct a Basic Design Study on the Sarakata River Hydroelectric Power Development Project (`the Project`) and sent to Vanuatu a study team headed by Mr. Haruo Suzuki, Deputy Managing Director, Grant Aid Project Management Department, JICA.

The team commenced its study from April 22nd, 1991 and will terminate on May 20th.

The team has held discussions with officials of the Government of Vanuatu and conducted a field survey in the study area of Espiritu Santo.

In the course of discussions and field survey so far made, both parties have confirmed the main items as described on the attached sheets.

Port Vila, May 3, 1991

Mr. Haruo SUZUKI
Leader
Basic Design Study Team

Mr. Joe NATUMAN
First Secretary,
Office of the Prime Minister

ATTACHMENT

1. OBJECTIVE

The objective of the Project is to supply inexpensive electricity to the residents in and around Luganville through constructing hydroelectric power facilities and thereby contribute to the improvement of standard of living of the residents in Espiritu Santo Island.

2. PROJECT SITE

The Project site is located in the area near Tanafo in the middle reach of the Sarakata River. Key area map appears in Annex I.

3. RESPONSIBLE ORGANIZATION FOR THE PROJECT

The Office of the Prime Minister of the Government of Vanuatu is responsible for the implementation of the Project.

4. ITEMS REQUESTED BY VANUATU SIDE

After discussions with the JICA team, Vanuatu side finally requested the following:

(1) A Grant aid for the installation of hydroelectric power facilities , namely:

a) Intake dam
b) Desilting Basin
c) Canal
d) Head Tank
e) Penstock
f) Power Station
g) Turbine and Generator
h) Transmission Lines
i) Access Road

(2) Technical cooperation related to:

a) On-the-job training to both engineers and operators during the construction and operation periods

b) Training in the fields of operation and management of hydropower development facilities

However, the definite components of the Project may need to be further studied in Japan.

5. PREPARATORY ARRANGEMENTS TOWARDS THE REALIZATION OF THE PROJECT

Vanuatu side explained to the team that:

(1) In order to secure the land for the Project, Lands Department of Vanuatu Government will discuss with the customary land owners. Land will be made available by means of lease or payment of compensation after declaring the site public land.

(2) In order to ensure proper administration, operation and maintenance of the Project, Vanuatu side plans to establish a new organization or form a joint venture between the Vanuatu Government and UNELCO. New tariff could thus be worked out reflecting the lower cost of power generation by the Project.

6. JAPAN'S GRANT AID SYSTEM

Vanuatu side has deepened their understanding on the Japanese Grant Aid System through the team's explanation on JICA's brochure and its guidelines for Procurement.

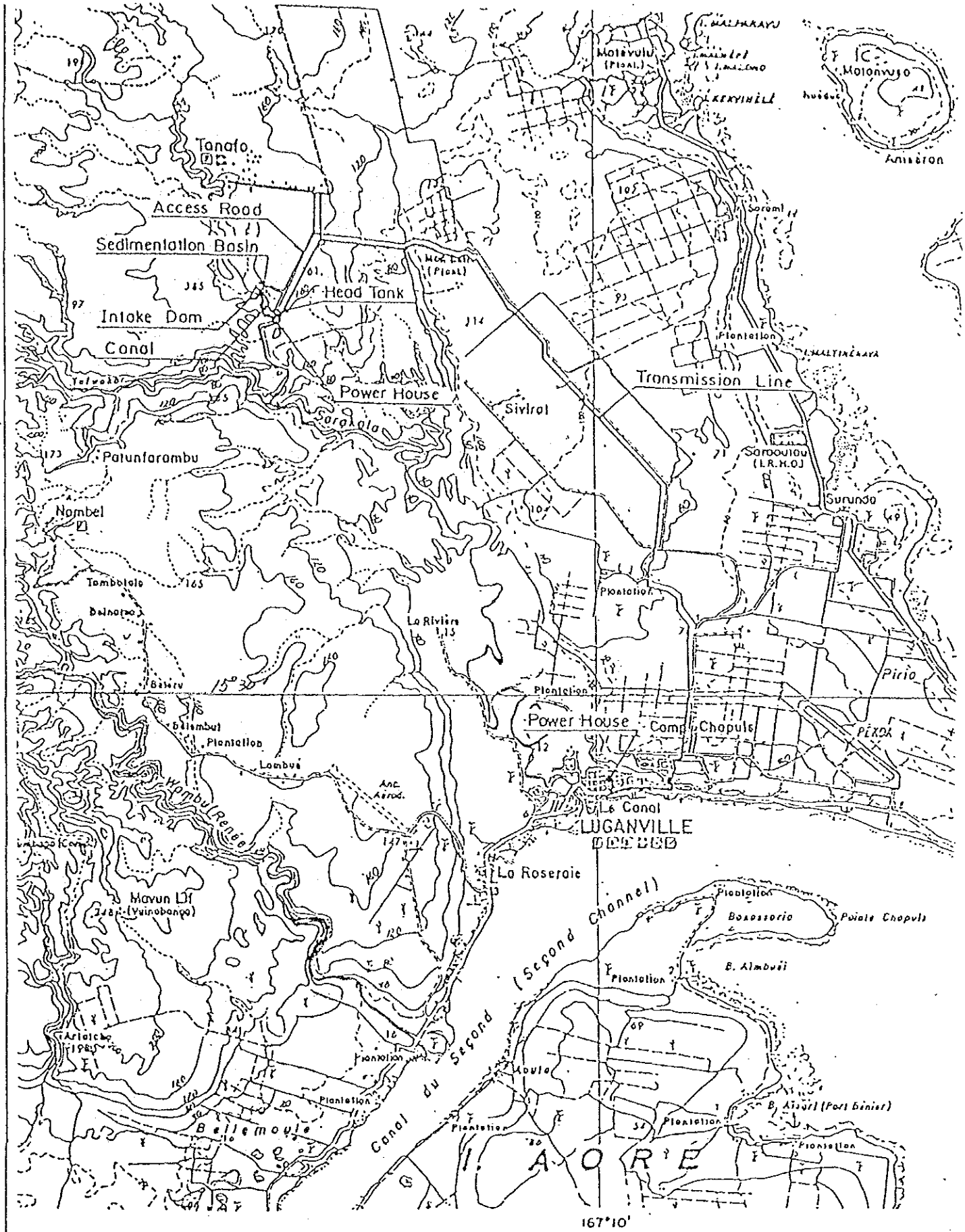
Vanuatu side agreed to take those necessary measures, when a grant aid by the Government of Japan is extended to the Project, as normally stipulated in the Paragraph 6 of the Exchange of Notes as well as those specified in the Annex II (attached).

7. SCHEDULE OF THE STUDY

(1) The consultants will continue their studies in Vanuatu until May 19, 1991.

(2) JICA will prepare the draft report in English and dispatch a mission in order to explain its contents around August, 1991.

(3) In case that the contents of the report is accepted in principle by Vanuatu side, JICA will complete the final report and send it to the Government of Vanuatu by the end of September, 1991.



The Project for Sorokoto River Hydroelectric P
Development In Espiritu Santo Island

(1)Location of Project Site

Fig.

ANNEX I.

A — 12

ANNEX II.

1. To clear, level and reclaim the site prior to commencement of the construction.

2. To undertake incidental outdoor works such as gardening, fencing, gates and exterior lighting in and around the site.

3. To construct the access road to the site prior to commencement of the construction.

4. To bear commissions to foreign exchange bank for its banking services based upon the Banking Arrangement.

APPENDIX-5.
LIST OF COLLECTED PUBLISHED DOCUMENTS

LIST OF COLLECTED PUBLISHED DOCUMENTS

No.	Auuthor/Publisher	Title	Date of Issue
1	South Pacific Commission	Population of Vanuatu	Dec. 1989
2	Luganville Municipality	Consultant's Review of Land Raclaimation Project —Main Storm Sewer Discharge at Seawall —Land Erosion at the Sarakata River Sarakata Flood Prevention Municipal Water Supply and Security	April 1991
3	Luganville Municipal Council	Municipal Development Plan	March 1991
4	National Planning and Statistics Office	Family Income and Expenditure Survey of Urban Areas	1985
5	National Planning and Statistics Office	Report of the Vanuatu Urban Census	1986
6	National Planning and Statistics Office	Second National Development Plan 1987~1991 Volume 1 and 2.	1986

APPENDIX-6.
DATA AND DOCUMENTS SUPPLIED FROM THE GOVERNMENT OF THE REPUBLIC OF VANUATU

6-1. REVISION OF PLANT HIRE RATES BY PUBLIC WORKS

M.ec 1gen.

REPUBLIQUE DE VANUATU
REPUBLIC OF VANUATU

VANUATU
2108
- 2 AUG 1989
PUBLIC WORKS
TRAVAUX PUBLICS

MEMORANDUM

Your Ref. .....
Our Ref. PIR/SS/TP/89/jf

Date 1st August, 1989

from / du Principal Engineer Mechanical

to / à Director Public Works Dept.

REVISION OF PLANT HIRE RATES

Your Memo 2221 dated 28th July refers the following rates for Plant will apply when hiring Plant to the Private Sector.

Bulldozer D7 with operator	VT 8,500 PH
Bulldozer D6 with operator	VT 8,000 PH
Motor Grader with operator	VT 8,000 PH
Track Loading Shovel with operator	VT 8,500 PH
Wheeled Loading Shovel with operator	VT 7,000 PH
V.R. Roller Rubber Tyre Drive with operator	VT 5,000 PH
S.W. Roller with operator	VT 3,500 PH
Back Actor (J C B) with operator	VT 4,000 PH
Tipper Truck with operator	VT 3,500 PH

REPUBLIQUE VANUATU TRAVAUX PUBLICS GOVERNMENT CHEF SERVICE

Mac MILLAN
Principal Engineer (Mech)

DESIGNATION.	DIRECTOR DOAG X	D/DIRECTOR McFARLANE ✓	SECRETARIAT ANN	WORKSHOP McMILLAN	ROADS LANGLO ✓	AJLEE ✓ G S SMITH M E QUARLE
X ORIGINAL & COPY No 21	SANTO KALTAVARA	MALEKULA BARO ✓	TANNA YOSEF ✓	BUILDING L PHILLIP	WAT/S TUKU	STORES/JOHN ACCOUNTS/S WARD/KALORIE
JSM VISA	DISCUSS PROJECT PREPARATION			DISTRIBUTION		F BANGA T EMERSON D BANDA
	REPORT : REPLY THROUGH DIRECTOR			NOT ✓		
	ACTION REPLY DIRECT			FILE		H PETER

New rates applicable from 1 August 1987

6-2. THE DUES, FEES AND CHARGES ORDER NO.10 OF 1990 BY PORT & MARIN DEPARTMENT

REPUBLIC OF VANUATU

THE DUES, FEES AND CHARGES ORDER NO. 10 OF 1990

An Order to prescribe the rates for port dues, pilotage fees, berthing dues, line handling fees, wharfage charges and storage charges.

This is the complete version of the above Order which was signed by the Minister on 16th May, 1990 and come into force on 1st June, 1990.

PORT DUES

1. (1) Port dues payable in respect of every overseas vessel, other than a yacht, which enters a port of entry from any place beyond Vanuatu shall be 20 Vatu per net registered ton.

(2) Port dues payable in respect of every overseas yachts and pleasure crafts which enters a port of entry from any place beyond Vanuatu shall be 6.340 Vatu for any period up to and including 30 days and thereafter a surcharge shall be levied at 90 Vatu per day.

(3) The port dues payable under subparagraphs (1) and (2) shall be payable by the shipping company or shipping agent to the Director of Ports and Marine within one month of invoice date issued in arrears.

(4) Where the port dues referred to under subparagraphs (1) and (2) are not paid within one month of invoice date the port due payable shall be double the rate specified in paragraphs (1) or (2), as the case may be.

PILOTAGE FEES

2. (1) Pilotage fees payable in respect of every vessel, other than an exempted vessel, which uses the services of a pilot within the compulsory pilotage area of Port Vila and Luganville shall be at the rates given below:-

Vessels	Vila	Luganville
between 60 and 100 metres in length	35.211 vatu	21.127 vatu
between 101 and 130 metres in length	43.661 vatu	28.169 vatu
between 131 and 160 metres in length	52.122 vatu	30.986 vatu
between 161 and 200 metres in length	60.563 vatu	33.803 vatu
Over 200 metres	77.465 vatu	46.478 vatu

(2) Pilotage fees payable under subparagraph (1) shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine within one month of invoice date issued in arrears.

(3) Where the pilotage fees referred to under subparagraph (1) is not paid within one month of invoice date the pilotage fee payable shall be double the rates specified in subparagraph (1).

(4) By inserting after subparagraph (1) the following subparagraph:-

"(1a) Any vessel under 60 metres in length which upon the request of its captain or the agent of such vessel uses the services of a pilot shall incurr pilotage fee at the following rates:-

.../2.

(a) Vila 485 Vatu per metre in length;
(b) Luganville 290 Vatu per metre in length.";

TUG SERVICE IN PORT VILA

3. (1) The pilotage fee in Port Vila shall include the services of a tug.

(2) The fee payable in respect of a tug line within the compulsory pilotage area of Port Vila shall be 2.113 Vatu.

TUG SERVICE IN LUGANVILLE

4. The pilotage fee referred to under paragraph 2 (1) in respect of compulsory pilotage area of Luganville shall not include a charge for the services of a tug, but if the services of a tug is provided within that area the pilotage fee includes that service and the fee payable in respect of the tug line referred to in paragraph 3 (2) shall be levied and shall be payable by the shipping company or shipping agent to the Director of Ports and Marine.

SURCHARGE IN RESPECT OF VESSEL AT FAULT

5. Where a vessel is not ready to receive a pilot at the appointed time or where a pilot is detained through the fault of the vessel an additional charge of 8.450 Vatu per hour or part thereof shall be levied and shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine.

STANDBY TIME FOR PILOT, TUG AND MOORING CREWS

6. The pilot, tug and mooring crews shall standby –

(a) for an inward bound vessel at least one hour prior to the expected time of arrival at pilot station.

(b) for an outward bound vessel at least thirty minutes prior to the expected time of departure.

PILOTAGE ON OTHER AREAS

7. Where pilotage operations are carried out at ports other than the port of Vila and Luganville after approval has been granted on request, the fee specified in paragraph 2(1) in respect of the port of Luganville shall apply in addition to other expenses including expenses in transporting the pilot to and from such specified place.

SURCHARGE IN RESPECT OF PILOT AND TUG

8. (1) Where pilotage operations are carried out between 1800 hours and 0600 hours or on Saturdays, Sundays or public holidays the following additional fees shall be levied and shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine :-

(a)	between 1800 hours to 2400 hours Monday to Friday	50%
(b)	On Saturday between 0600 hours to 2400 hours	50%
(c)	between 2400 hours to 0600 hours	100%
(d)	on Sundays and public holidays	100%

(2) An additional fee of 7.062 Vatu per hour or part thereof for the tug on standby shall be levied and shall be payable by the Shipping Company or the Shipping Agent.

PILOT LAUNCH

9. (1) The fee payable in respect of embarking or disembarking a pilot by a pilot launch shall be 6.338 Vatu per hour or part thereof.

(2) In the case of a pilot launch which is used for a purpose other than the purpose of embarking or disembarking a pilot between 1800 hours and 0600 hours an additional charge of 100% of the fee specified under subparagraph (1) shall be payable:

(3) The fee payable under subparagraph (1) shall be levied and shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine within one month of invoice date issued in arrears.

(4) Where the fee referred to under subparagraph (1) is not paid within one month of invoice date the fee payable shall be double the rate specified in subparagraph (1).

BERTHING DUES IN RESPECT OF OVERSEAS VESSELS

10. (1) Berthing dues payable in respect of every overseas vessel which berths at a Government wharf shall be 267 Vatu per metre of length per day or part thereof with a minimum charge of 10.563 Vatu (the nonmal charge).

(2) In the case of an overseas vessel proceeding in or out of Vanuatu waters, which after obtaining the consent of the Harbour Master and the Customs Department, berths at a private wharf, the berthing due payable shall be 50% of the dues specified in subparagraph (1).

(3) Where any overseas vessel :-

(a) returns to a Government wharf from another port in Vanuatu for the sole purpose of loading or unloading, stevedoring or handling equipment; or

(b) comes to a Government wharf to replenish its supplies of fuel and water, the berthing due payable shall be 25% of the amount specified in subparagraph (1).

(4) The berthing dues payable under subparagraph (1) shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine within one month of invoice date issued in arrears

(5) Where the berthing dues referred to under subparagraph (1) is not paid within one month of invoice date the berthing due payable shall be double the rate specified in subparagraph (1).

BERTHING DUES IN RESPECT OF COASTAL VESSELS

11. (1) Subject to subparagraph (5), berthing dues payable in respect of every coastal vessel which berths at a Government wharf for the purposes of loading or unloading cargo or passengers shall be 110 Vatu per metre of length per day or part thereof with a minimum charge of 1.100 Vatu (the nonmal charge).

(2) Where any coastal vessel comes to a Government wharf to replensih its supplies of fuel and water or for purposes other than loading or unloading cargo or passengers, the berthing due payable shall be 55 Vatu per metre of length per day or part thereof with a minimum charge of 550 Vatu.

(3) The berthing dues payable under subparagraph (1) shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine within one month of invoice date issued in arreas.

(4) Where the berthing dues specified in subparagraph (1) is not paid within one month of invoice date, the berthing due payable shall be double the rate specified in subparagraph (1).

(5) All Government vessels are exempted from the requirements of this paragraph.

(6) For the purposes of this paragraph, coastal vessel means a vessel engaged in -

(a) retail or whole sale trading which leaves a port in Vanuatu to visit other ports of the country; or

(b) the carriage of goods or passengers for profit from any port of Vanuatu whether or not to another port of the country.

LINE HANDLING FEES

12. (1) Line handling fees payable in respect of the handling of vessels lines at any Government wharf, or if requested at any other wharf, for vessels berthing and unberthing per hour or part thereof shall be at the rates given below :-

(a)	Length of vessel	Rate
(a)	up to 30 metres	4.225 Vatu
(b)	between 31 metres and 60 metres	7.042 Vatu
(c)	between 61 metres and 130 metres	9.155 Vatu
(d)	between 131 metres and 160 metres	11.971 Vatu
(e)	between 161 metres and 200 metres	14.084 Vatu
(f)	over 200 metres	14.788 Vatu

(2) Where handling of vessels lines are carried out between 1800 hours and 0600 hours or on Sundays or Public Holidays the following additional fees shall be levied and shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine :-

(a)	between 1800 hours and 2400 hours Monday to Friday	50%
(b)	On Saturday between 0600 hours to 2400 hours	50%
(c)	between 2400 hours to 0600 hours	100%
(d)	on Sundays and public holidays	100%

(3) An additional fee of 6.338 Vatu per hour or part thereof shall be levied and shall be payable by the shipping company or the shipping agent for berthing or unberthing staff on standby in excess of one hour.

(4) The line handling fees payable under subparagraph (1) shall be payable by the shipping company or the shipping agent to the Director of Ports and Marine within one month of invoice date issued in arrears.

.../5.

(5) Where the line handling fees referred to under subparagraph (1) is not paid within one month of invoice date the line handling fees payable shall be double the rates specified in subparagraph (1).

WHARFAGE CHARGE FOR LOADING AND DISCHARGING (EXPORT AND IMPORT TONNAGE TAX)

13. (1) Wharfage charges payable in respect of loading and discharging of all cargo to or from an overseas destination passing through the ports of Vila and Luganville or other port which the Minister has by Order declared it as a port for the purposes of loading and discharging cargo shall be at the rates given below based on the cargo manifest and any amending documents :-

(a) imported cargo at 359 Vatu per freight ton.
(b) exported cargo at 179 Vatu per freight ton.

(2) The minimum charge shall be 159 Vatu per freight tonnage on a simple bill of lading.

(3) Notwithstanding the provisions of subparagraph (1), a wharfage charge of 50% of the normal charges as specified in subparagraph (1) and (2) shall be payable in respect of any cargo from any overseas destination intended for exportation as an export commodity from Vanuatu and is exported as such either in its original state or otherwise and provided that at all times the cargo or the goods comprised therein are not removed from the limits of the wharves or such other restricted custom areas as the Director of Customs may in writing specify.

(4) In the event of non-payment of his remuneration or of the charges provided for under subparagraphs (1), (2) and (3) the stevedore shall have the right to retain possession of the cargo until such time as full time as full payment has been made.

(5) The stevedore may arrange :-

(a) for perishable cargo to be transported into a refrigerated warehouse for the account and at the expense of the consignee, and

(b) For non-perishable cargo to be transported into a customs warehouse if the owner of such cargo has not collected them within seven days of their arrival on the wharf.

(6) The wharfage charges payable under subparagraphs (1) and (3) shall be payable by the stevedore to the Director of Ports and Marine within one month of invoice date issued in arrears.

(7) Where the wharfage charges referred to under subparagraph (1) is not paid within one month of invoice date the wharfage charges payable shall be double the rates specified in subparagraph (1).

STORAGE CHARGES

14. (1) Storages charges payable in respect of any cargo stored at Government wharf, warehouse or in the open but within the controlled port areas of Vila or Luganville shall be at the rates; per metric ton or part thereof, given below :-

.../6.

(a)	first five working days	Free
(b)	second five working days	330 Vatu
(c)	third five working days	770 Vatu
(d)	fourth five working days	1.430 Vatu

(2) The storage charges payable under subparagraph (1) shall be payable by the consignee or the shipper to the Director of Ports and Marine within one month from the date the cargo reaches the wharf, warehouse or in the open but within controlled port areas, as the case may be.

(3) Where the storage charges referred to under subparagraph (1) is not paid within one month from the date the cargo reaches the wharf, warehouse or in the open but within the controlled port areas; as the case may be, additional charge of 1.430 Vatu per day per metric ton or part thereof is payable by the consignee or the shipper to the stevedoring contractor.

(4) After a period of three months from the date on which the storage charges are due, the stevedore may with the written consent of the Director of Ports and Marine, take legal proceedings for the forfeiture and sale of goods in question.

(5) In the event of a dispute, the stevedore shall undertake the necessary weighing and measuring operations to establish the charges prescribed by this Order.

(6) If the weights and measurements :-

(a) are greater than those declared, the cost of such weighing and measuring operations shall be borne by the consignee or shipping agent.

(b) are lower than those declared, the cost of such weighing and measuring operations together with that caused by the resulting delay shall be borne by the stevedore.

6-3. MEMORANDUM FOR LAND ACQUISITION PROCEDURE

REPUBLIQUE DE VANUATU
REPUBLIC OF VANUATU

MEMORANDUM

Your Ref. .....
Our Ref. LD: 547/3/GT/mb

Date 13th May 1991

from / du The Acting Director of Lands

to / à The Director, National Planning & Statistices Office
ATTN: STAN COMBS

RE: SARAKATA RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

I refer to your memo ref. 384/3/14 dated 6/5/91 and I have the pleasure in submitting the following land acquisition procedure as requested by the JICA Basic Design Team.

For the implementation of a project in the rural area (eg. the Sarakata H.E.P Site) the following steps are normally taken :

(1) The project developer/investor has to lodge an application to the Rural Land Development Committee, through the Department of Lands, for the issue of a Certificate of Registered Negotiator (or Negotiator Certificate for short). The Rural Land Development Committee comprises representatives of various government departments and agencies especially those whose work relates to land and its development. In the application it would be appreciated for some important information to be provided for a favourable consideration by the Committee. For example, the size of the area of land required; approximate location; type of project to be implemented, source of finance; approximate capital cost of the project; time frame of project and any other relevant information that may be useful for consideration by the Committee.

(2) After screening and consideration by the Committee of the project proposal and if favourably recommended for approval, the Minister of Lands may then issue the certifcate to the applicant. Please note that the certificate is a prerequisite to getting a lease of the land in view. The certificate is, under the land laws of Vanuatu, a right given by the Minister for the holder to negotiate a lease with the custom owners of the land or their representatives.
In some cases where a land is in dispute the Minister of Lands usually acts and sign documents on the behalf of claimants.

(3) We would like to make it clear that the Department of Lands is not a party to any neogtiation except where government projects and involved. However, we could always help, arrange and facilitate neogtiations by the two parties concerned if necessary.

(4) Once the terms and conditions of the project and the lease are agreed upon by both parties, the Department of Land Surveys may the be requested to carry out and produce an official survey plan of the site.

(5) When the plan is ready, it can be bought from the Department of Lands Survey and brought to this office for the eventual preparation of the lease for execution and registration as a final step.

Please be advised that if the project and the lease is to be owned by the Government of Vanuatu i.e to be in its name as lessee, then the above steps are not necessary as the Government cannot issue a certificate to itself. nevertheless, the Government is still required to negotiate with the custom owners for the acquisition of a lease.

An afternative is that if the project is so substantial to warrant the Government to own the land fully, then arrangements may be made to decalre the land to be public. Again it still requires negotiations with the custom owners for this purpose. However, this option has not very often been adopted.

I hope this brief information would be of some help to the understanding of the JICA Basic Design Team.

Republic of Vanuatu
DEPARTMENT OF LANDS
SERVICE DES TERRES

George Tambe
Acting Director of Lands

6-4. VANUATU ELECTRICITY DEMAND - VILA ONLY

VANUATU: ELECTRICITY DEMAND - Vila only

ELECTRICITY USE MEASURES	1985	1986	1987	1988	1989	1990
Maximum Demand (kW)	4,356	4,186	3,961	4,469	4,469	5,318
Demand (Sales) - (kWh)	16,796	16,778	15,671	18,697	20,370	28,120
Installed Capacity (kW)	6,370	6,370	6,370	6,370	8,540	8,540
Load Factor (%)	0.8	0.8	0.8	0.8	0.8	0.8
Generation (MWh)	17,478	17,285	16,518	19,697	21,186	30,122
Average VT per kWh sold	21.21	21.85	23.01	23.59	24.64	24.15
Fuel Consumption (kl)	4,930	4,808	4,587	5,509	5,916	6,728
Percent Losses	3.9	2.9	5.1	5.1	3.9	6.6

APPENDIX-7.
DATA AND INFORMATIONS SUPPLIED FROM UNELCO

UNELCO's existing power stations

(Port Vila)

Engine N°	kW
1	250
2	620
3	620
4	1040
5	1040
6	1400
7	1400
8	2170

(Santo)

Engine N°	kW
1	250
2	250
3	250
4	250
5	80

Monthly energy generation and yearly fuel consumption of UNELCO Santo.

Unit : MWh

(Physical Year)	1984	1985	1986	1987	1988	1989	1990
January	185	173	209	193	190	178	215
February	197	175	207	189	184	175	220
March	216	205	218	201	190	217	252
April	198	195	190	190	191	207	231
May	191	191	185	195	187	203	240
June	190	194	160	180	190	203	219
July	190	202	174	190	200	207	221
August	194	198	173	181	199	218	217
September	194	197	176	189	194	203	220
October	199	211	183	210	189	220	237
November	193	216	191	190	198	214	231
December	209	210	181	183	196	216	233
Yearly total	2356	2367	2247	2291	2308	2461	2736
Monthly average	196	197	187	191	192	205	228

Yearly fuel oil consump. (l)	775 905	777 940	727 670	738 400	747 920	802 899	886 796

Fuel oil : DIESOLINE (SHELL COMPAGNY)

Monthly and yearly energy sold of UNELCO Santo.

Unit : MWh

(Physical Year)	1984	1985	1986	1987	1988	1989	1990
January	163	159	175	172	177	161	203
February	189	175	202	185	173	178	211
March	193	164	176	162	157	175	202
April	187	200	168	169	182	192	217
May	176	169	160	174	161	175	205
June	170	170	137	164	171	183	228
July	166	174	133	167	186	188	189
August	181	175	115	173	173	192	194
September	185	177	166	169	173	173	193
October	185	181	156	174	172	207	223
November	172	199	173	183	175	200	202
December	193	182	164	154	163	178	198
Yearly total	2160	2125	1925	2046	2063	2202	2465
Monthly average	180	177	160	171	172	184	205

Energy sales tariff and breakdown of UNELCO Santo

Category	Number of customers	Tariff Year 1991, from april to june		Breakdown of sale income total Fiscal year 1990	
		Fixed charge (VT/kVA)	Meter charge (VT/kWh)	Fixed charge (kVT)	Meter charge (kVT)
Low voltage supply					
Residential					
under 60 kWh/month	\	0	20.42	0	2151
61 to 120 kWh/month	- 277	0	31.41	0	1063
over 121 kWh/month	/	0	53.40	0	502
Non residential	128	628.20	28.27	8235	25468
Special use	155	596.79	31.41	3455	12394
Official use	5	0	25.13	0	471
High voltage supply	9	785.25	21.04	3545	13902
Total	574	-	-	15235	55951

Power demand forecast in Port Vila and Luganville.

	Port Vila		Luganville	
Year	Max. power (kW)	Sales (MWh)	Max. power (kW)	Sales (MWh)
1991	5771	22 699	630	2 465
1992	6117	24 061	668	2 613
1993	6484	25 504	707	2 769
1994	6873	27 034	750	2 935
1995	7285	28 656	795	3 112

UNELCO SANTO existing transmission and distribution line.

system voltage : High voltage 5.5 Kv 3 phases
Low voltage 380V/220V 3 phases + neutral.

Transmission line

HV - underground	-	1370 m paper isolation 5.5. KV
HV - aerial	-	15960 m copper and Almelec (ASTER)
LV - underground aerial	-	1620 m 16580 m bore copper cable/isolated cables.

New extensions : HV underground 20 KV PR (XPLE)
aerial 75.5 mm² Almelec (ASTER)
LV aerial isolated cable 3x70+54,6+16

. Transformers, 5 500 V/410 V dyn.11

KVA	NOMBRE
Sup. 600 KVA	2
600 - 250 Kva	2
200 - 100 Kva	8
Inf < 100 Kva	12