PROMEEC - Industry Activities in the Lao PDR

Nam Ngum 1 Hydro Power Plant

Present by

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Experience and Application of Energy Efficiency and Conservation in Nam Ngum Hydro Power Plant

Installed capacity 155 MW
Number of Units : 5

Background

– Dam Site is Located on the Nam Ngum river about 75 km to the north of Vientiane Capital City.

Background

Reservoir

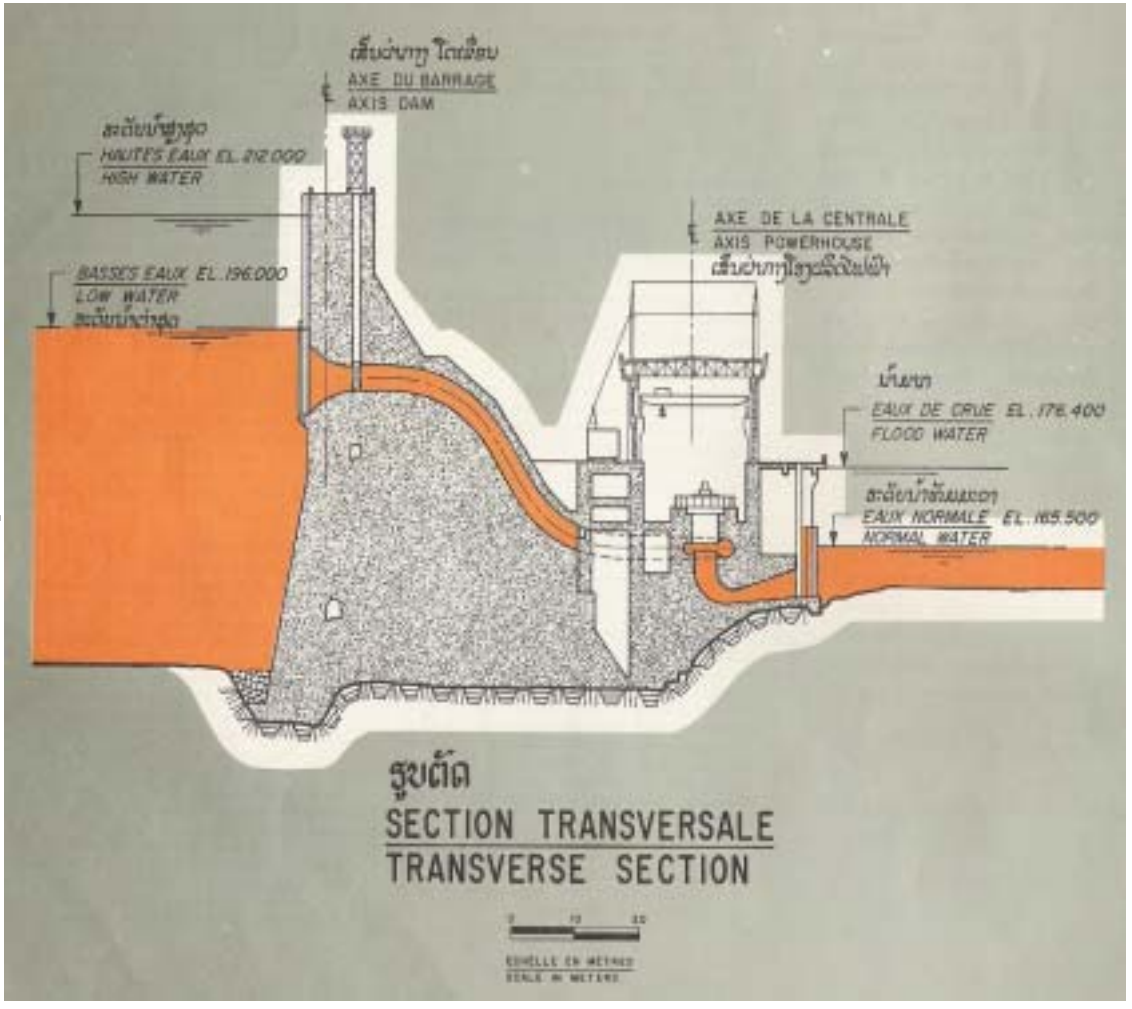
rainage area	: 8,460 km²
ormal Max. water level	: 212.00 masl
aw down water level	: 196.00 masl
eservoir surface	: 370 km²
t 212.0 masl)	
torage capacity	: 7,030,000,000 m³
t 212.0 masl)	
ctive storage capacity	: 4,700,000,000 m³

Dam

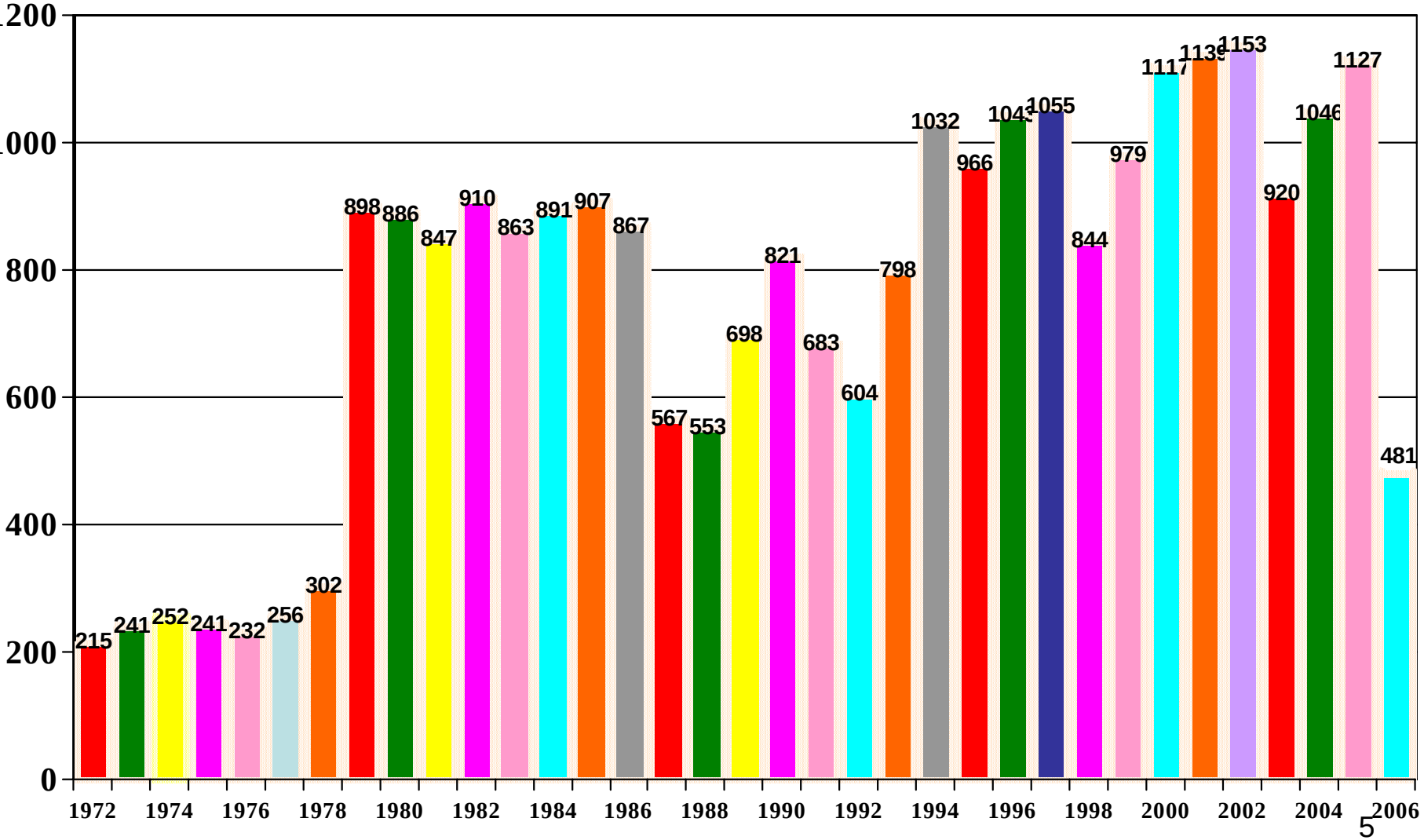
ype	: Mass-Concrete gravity
eight	: 75 m
ength	: 468 m
olume	: 350,000 m³
pillway	: Radial gate (12.5x10)x4 Nos.
sign flood	: 3,800 m³/sec

Installed capacity

stalled capacity	: 155 MW
umber of units	: 5
nit No.1&2	: @ 17.5 MW
nit No. 3, 4&5	: @ 40 MW
aximum head	: 45.5 m
inimum head	: 28.5 m
urbine	: Vertical Francis Type



• Energy Generation from 1972 to 2006
Nam Ngum Power station



Rerf. 02/PROMEEC/01/02
Energy Audit in Lao PDR-PROMEEC
NamNgum I Hydropower plant
Audits: January 28 through February 1, 2002

1.	**Two Experts:**	**The Energy Conservation Center, Japan**
	1. Mr. Yasunori SERIZAWA	**General Manager Japan international energy & environment cooperation center (ECCJ).**
	2. Mr. Nobunari KAWAMOTO	**Technical expert International engineering department (ECCJ).**
2.	**Tree Representative each from:**	**Cambodia, Indonesia and Myanmar.**
	1. Mr. CHAN SOCHEAT	**Hydropower engineer Ministry of industry, MINE & Energy department of energy Technique**
	2. Mr. SUBYANTORO S.	**Head of Supporting Industries Division Ministry of energy and mineral resources directorate general of electricity and energy utilization directorate of new and renewable energy and energy conservation.**
	3. Mr. U AYE WIN	**Executive Engineer (HYDEL) Myanma Electric Power Enterprise.**

Recommendation from Audits "ECCJ"

- **(1) Increasing the power output**

  *** Adoption of new runner**

  *** Repairs of running water parts**

  *** (stay vanes, guide vanes, draft tube and casing)**

  *** Painting of penstock (Some parts)**

  Increase in efficiency of the Generator, Main transformer and main circuit.

  Increase in efficiency of the Turbine.

- **(2) Savings in Power Consumption for station Service**

  *** Intermittent operation for pressure pumps for governors**

  *** Turning off lights for maintenance and check**

  *** Use of inverter-control fluorescent lamps**

- **(3) Draw up a highly reliable operation plan for reservoir**

  *** The installation of robot rain gauges**

Selecting the Equipment Audited "ECCJ"

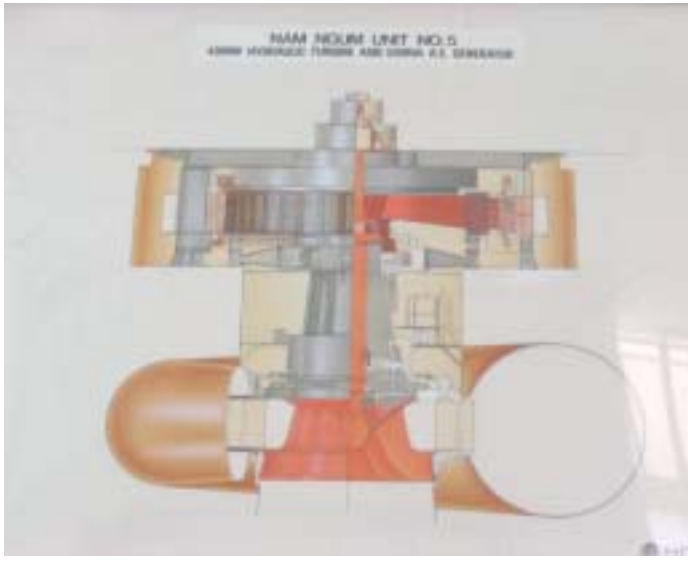
- **Unit 5, on other hand, has never had any overhaul. Hence, this unit may presumably be at the most advanced condition of deterioration over time.**
- **Thus unit 5 was selected for auditing.**
- **No.5 unit in Nam Ngum Hydro Power Plant**

1. Turbine :

Output	**: 53000 kW**
Type	**: Vertical Francis**
Effective head	**: Max. 45.5 m, standard: 37 m, Min. 28.5m**
Flow rate	**: Max. 128.5 m^3/s, standard : 117.1 m^3/s**
Rotation speed	**: 136.0 rpm**
Manufacturer	**: Hitachi Ltd.**

2. Generator :

Rated output	**: 50000 kVA**
Rated voltage	**: 11 kV**
Rated power factor	**: 0.8**
Frequency	**: 50 Hz**
Manufacturer	**: Hitachi Ltd.**
3. Start of operation	**: 1984**



(1) Increasing the power output

Status of implementation

Runner cavitations repairs of No.5 unit

(April 24, 2003)

Subject : Repairs Welding Procedure

Runner

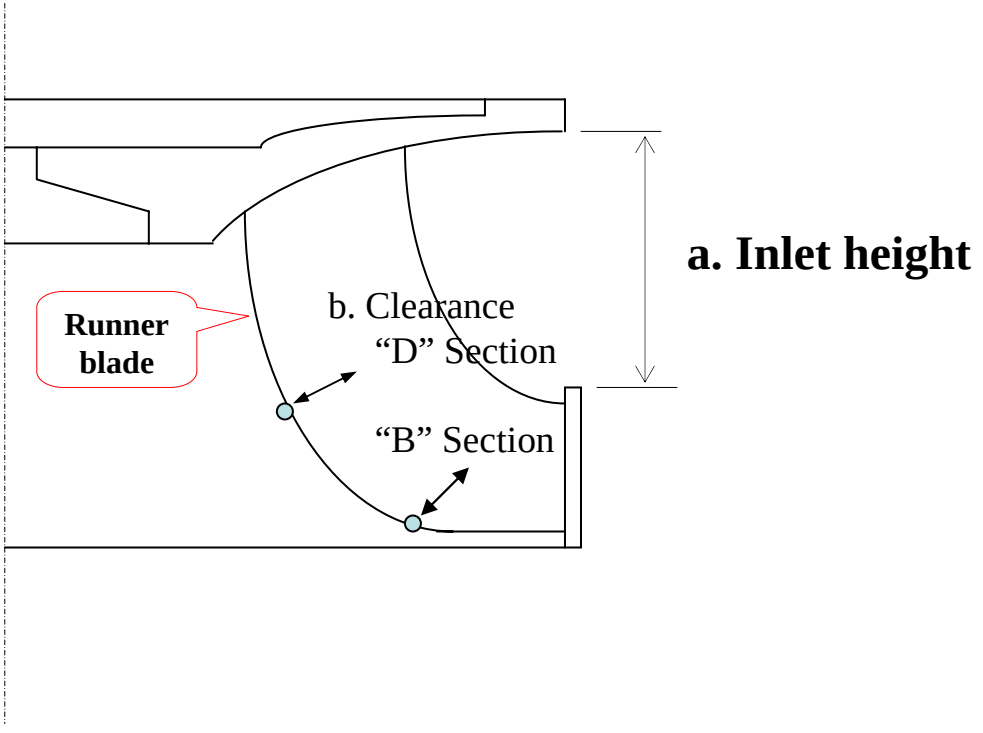


Fig.1. Measuring position for distortion

Measuring cavitations depth

Tool

a. Cavitations depth about 10mm.

b. Inspection photo recorded

Measuring position for distortion

Distortion during repair

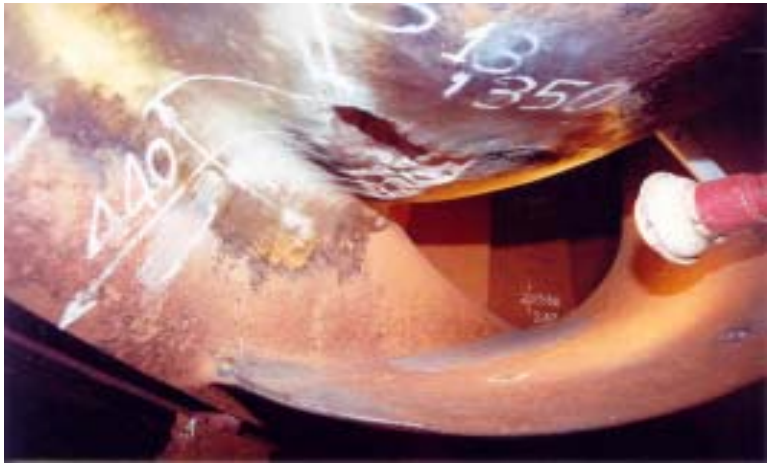
a. **Inlet height each 90 degrees**

- **Pass, Scale 0.5 mm**
- **before and after work.**

b. **Outlet clearance “B” & “D” sections of each vane**

- **Pass, Scale 0.5 mm**
- **Before and after work.**

Cavitations repair

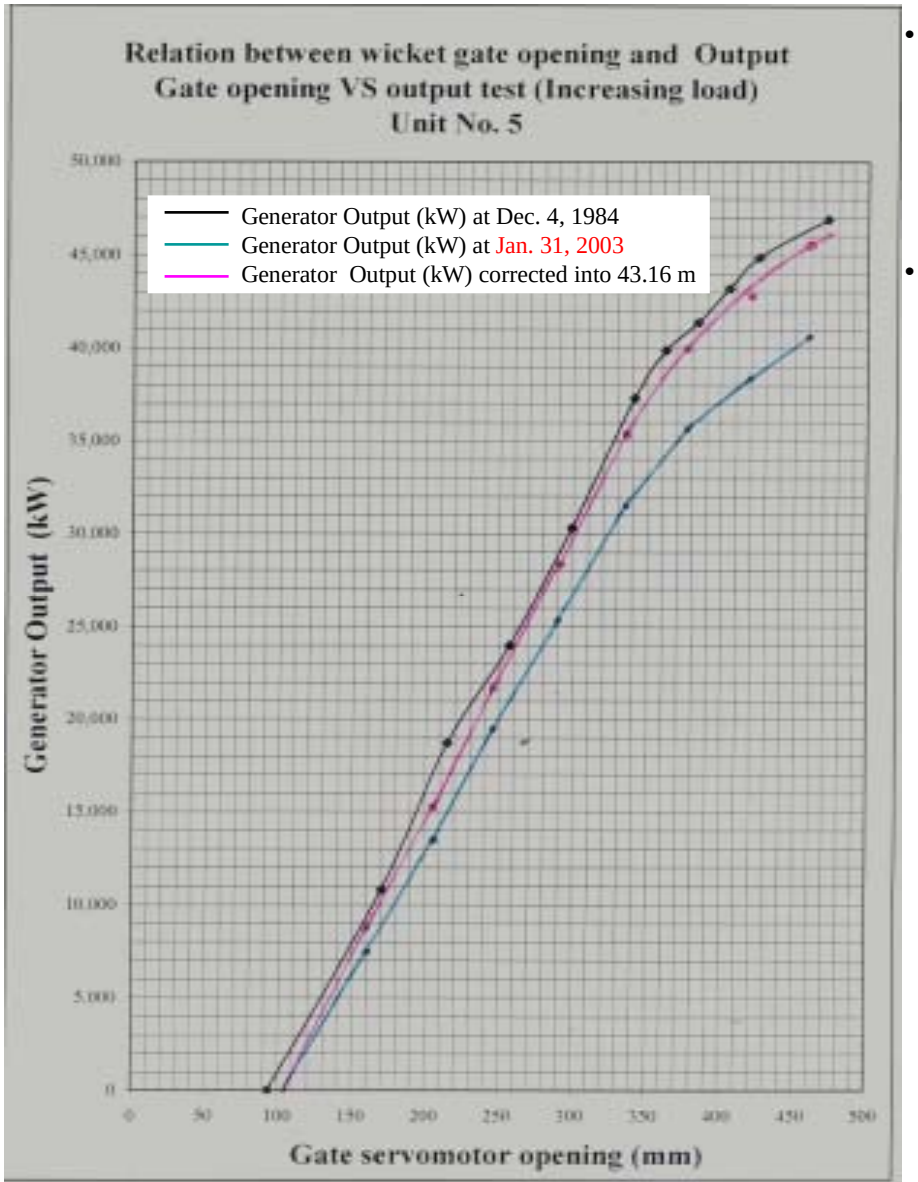


- Grinding
- Heating with gas flame

- Cavitations damaged area

(1) Increasing the power output

Relation between Generator Output and Guide Vane Opening test



- The values of generated output, shown above as the test results, are converted into original test head to allow comparison with the output at the start of operation. Assuming that the characteristics of turbines are identical: 43.16 m and 40.05 m, the figures were corrected based on the following formula.
- Correction formulas that correct 40.05m (at the test date Jan.31, 2002) into 43.16 m (at commencement time dated Dec. 4, 1984) are as follows :

$Pa / Pb = (Hta / Htb)^{1.5}$

Where: Pa : Output after correction (kW)
Pb : Output (kW)
Hta : Head (43.16 m)
Htb : Head (40.05 m)

$Pa = (Hta / Htb)^{1.5} \times Pb$
$= (43.16/40.05)^{1.5} \times Pb$
$= 1.12 \times Pb$

Pb at 100 % gate opening is 40,800 kW

Therefore ;

Pa = 1.12 x 40,800 = 45,696 (kW)

This value (45,696 kW) is 97.4 % of the commencement time value (46,920 kW).

That is 2.6 % decrease than the original values.

(ECCJ Audited) Recommended Technology/Practice

(1) Increasing the power output

Repairs of running water parts

*** Runners cavitations repair No.5 unit.**

Audited estimated of energy savings (No.5 unit)

a. Power output in 2000 records 322,003,500 kWh/year

b. Turbine efficiency decrease than the original 2.6%

c. Turbine efficiency increase after repairs of runner 2%

d. The increased output after improvement will be as follows:

322,000,000 x (2.6%+2%) = 14,812,000 kWh ~ 15 million kWh/year.

e. The unit price of electricity export 0.029 US$/kWh

f. The income is estimated increase per year :

14,812,000 x 0.029 = 429,780 (USD) ~ 430,000 USD/year.

(ECCJ Audited) Recommended Technology /Practice

(2) Savings in Power Consumption for station Service

*** Intermittent operation for pressure pumps for governors.**

Audited estimated savings in power Consumption for station service

Operating hours on 2000 records 7,928.32 h.

The annual saving in power consumption for station service :

8,760 - 7,982.32 = 831.68 hours/y

The load on the pressure pump during unloading 10 kW/h.

831.68 hours/y x 10 kW/h = 8,316.8 kWh

Furthermore, assuming that the same condition applies to Nos. 3&4, and half of that amount applies to Nos. 1 &2 units, Total annual saving in electricity consumption in the plant would be :

8,316.8 x 4 = 33,267.2 kWh/year

Governor operating oil has been control daily routine check and ordinary checks every hours of each unit No.1, 2, 3, 4 & 5 and maintain check oil leakage and air leakage every day.

Intermittent operation for pressure pumps for governors.

The pressure oil pumps on-load intervals longer

- **The seal parts of servomotor**
- **Distributing valves**
- **Oil pressure tank**

No oil leakage

Pressure Pumps of Unit No. 3, 4 & 5

Intermittent operation for Air Compressor for governors, CB, DS and etc.

The air compressor pumps on-load intervals longer

- Air valve

- Union pipe

No-air leakage

Air Compressor for Circuit Breaker 115 kV, Disconnecting Switch 115 kV and etc.

Air Compressor for Governors of Unit No. 1, 2, 3, 4 & 5

(ECCJ Audited) Recommended Technology/Practice

(2) Savings in Power Consumption for station Service

*** Turning off lights for maintenance and check**

Audited estimated annual energy savings turning off lights.

a. Assuming that outdoor lights is turned off 5 kW/h.

b. The hours of turned off 4,000 h/year.

c. Assuming that outdoor lighting of 5 kW is turned off, the annual energy savings will be as follow:

5 kW/h x 4,000 hours/y = 20,000 kWh/y

2. Turning off lights for maintenance and check.

- Turn off the lights (used "Luxe meter")

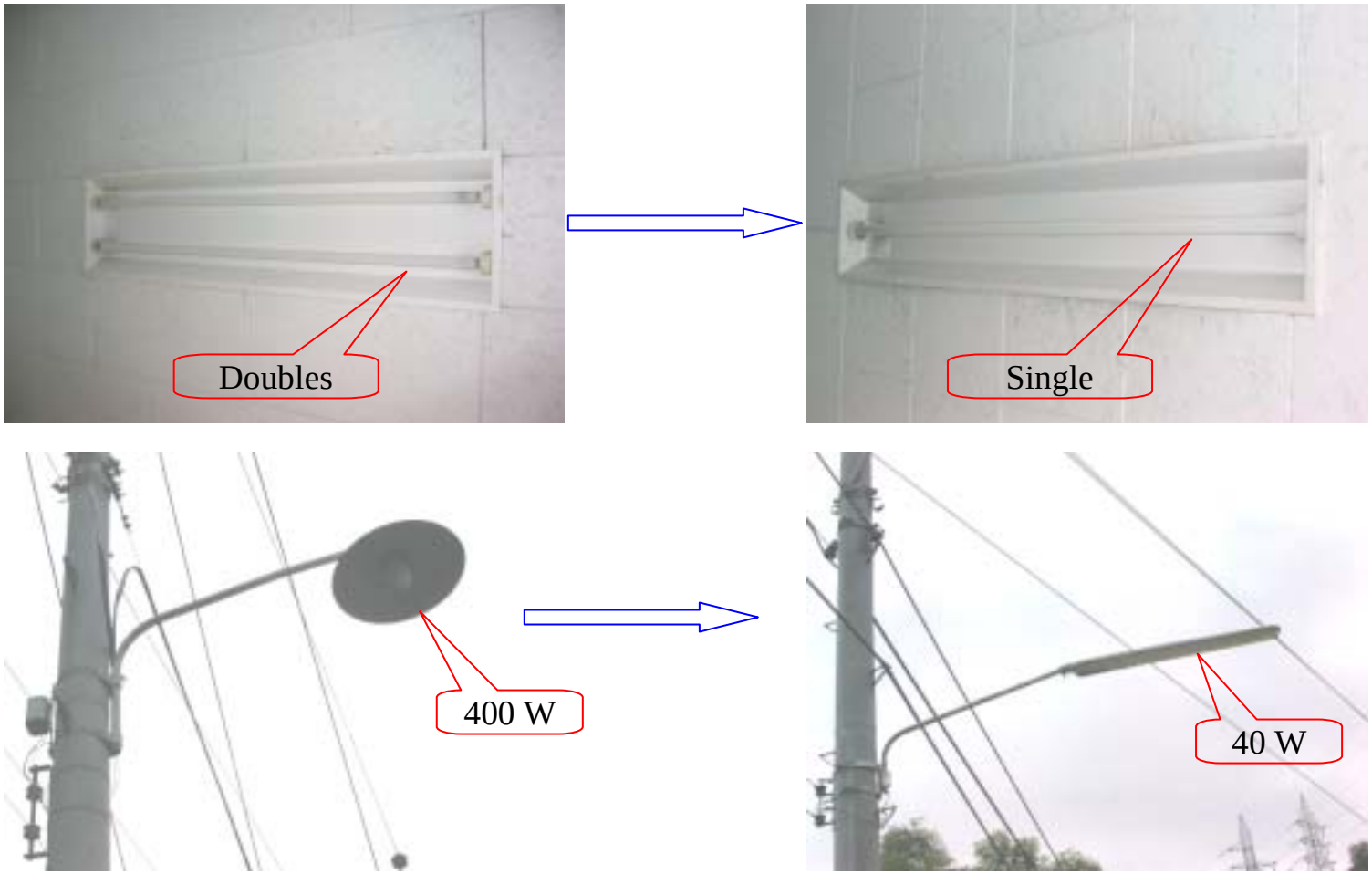
- The outdoor lights existing 400 W change to 40 W.

- Turn off the lights for outdoor switch yard equipment area.

- Reduce number of light.

- Turn off the air condition before left office.

Reduce number and capacity



(ECCJ Audited) Recommended Technology/Practice

(2) Savings in Power Consumption for station Service

*** Use of inverter-control fluorescent lamps**

Audited estimated .

a. **Assuming fluorescent lamps 200 Nos.**

b. **Capacity 40 W**

c. **The hours of the year 8,760 h**

d. **The inverter control system electricity savings of 25 %.**

40 W/h x 200 x 8,760 h/y x 25 % = 17,520 kWh

e. **The adoption of all the plans described above would lead to annual total savings in electricity consumed in the plant estimated as follows:**

33,267.2kWh + 20,000kWh + 17,520kWh = 70,787.2 kWh

3. **Use of inverter-control fluorescent lamps (Not yet)**

- Under feasibility study

- Reduce number and capacity

CONCLUSION

(1) Increasing the Power Output **Audited estimated of energy savings (No.5 unit)**

The power output estimated to increase by approx. 15 million kWh/year

The income is estimated to increase by US$ 430,000 per year

(2) Savings in Power Consumption for station Service

- **Intermittent operation for pressure pumps for governors : 33,267 kWh/y**
- **Turning off lights for the outdoor reduce the number and capacity : 20,000 kWh/y**
- **Use of inverter-control fluorescent lamps : 17,520 kWh/y (Not yet) " Under feasibility study"**

Annual total savings electricity consumed in the plant estimated as follows: 33,267.2kWh + 20,000kWh = 53,267 kWh/y

Power consumption for hydropower station service accounts for no more than 1% of total generated output by the station, and this is very small as compared with that by a thermal power plant.

(3) The installation of robot rain gauges (Not yet).

Thank-You very much for your kind attention