CHAPTER-II

OBSERVATIONS OF NO.1 AND NO.2 GENERATING UNITS

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The following are observations obtained from the investigation of the respective items of generating equipment:

2.1 Hydraulic Turbines

2.1.1 Specifications of Hydraulic Turbines

- Maximum output	: 15,500 kw
- Maximum rated head	: 45.5 m
- Maximum discharge	: 55.4 cu.m/sec.
- Rated speed	: 176.5 rpm
- Type	: Vertical shaft Francis turbine
- Year of manufacture	: 1971

2.1.2 Outline of Observations

Investigation of the inside of the hydraulic turbine was done after making it empty by dewatering. A hydraulic turbine expert entered into the spiral case and draft tube to carry out visual inspection and measurement by instrument. The guide vanes on which severe corrosion has occurred have to be replaced with new ones. However, speed of progress of corrosion was certainly slowed down. It can be expected that the hydraulic turbines may continue the present operating condition if the repair will be done in latter half of next year, provided that a proper watch should be paid daily and periodical inspection should be done under stoppage condition of the turbines.

Speed governor system and pressure oil system are almost satisfactory as far as the external view and operating condition are concerned. It is recommended, however, to overhaul these systems when the repair of guide vanes of the hydraulic turbine will be carried out.

2.1.3 Observations by Components

a) Discharge Ring and Draft Tube

Paint that was applied by power station staff in September 1979 on corroded and/or pitted surface near fixing portion of air admission pipe on the discharge ring and draft tube remains mostly as it is. From this fact, paint coating will presumably be effective for preventing surface of the said portion from progress of corrosion. (Refer to PHOTOS-1 and 2.)

Interior surface of the upper draft tube steel liner is properly protected by paint which was originally applied. No wear was observed on the draft tube steel liner by measurement using an ultrasonic thickness meter. (Refer to PHOTO-3.)

A crack was found on air admission pipe of No.2 unit. (Refer to PHOTO-4.)

Lower protective liner on discharge ring corroded already to an extent that this liner is to be replaced.

b) Runner

Condition of the runner and runner cone is free from corrosion. However, the runner was remarkably covered with mud which causes development of a noise due to Carman vortex. (Refer to PHOTOS-5, 6 and 7.) The mud has to removed periodically.

As far as visual inspection of runner coupling through balance hole on the runner is concerned, corrosion has perhaps occurred. Therefore, this part has to be inspected, in case of overhaul, to establish an appropriate countermeasure to be taken. (Refer to PHOTO-8.)

c) Spiral Case and Speed Ring

Interior surface of the spiral case as well as the mandoor are in almost good condition generally. Exfoliation of paint is not serious. (Refer to PHOTO-9.)

Many depressions are distributed over surface of stay vanes. Depth of several depressions has already reached about 3 mm. These dep-

ressions are probably caused by corrosive characteristic of water.
Paint coating would likely be effective for preventing progress of corrosion. (Refer to PHOTO-10.)
An appropriate countermeasure will be necessary for repair of these depressions.

A hollow was observed between the speed ring and the bottom ring. Water passing through this hollow toward backside of the bottom ring would bring a harmful influence on function of No.2 hydraulic turbine unit. A proper repair is needed. (Refer to PHOTO-11.)

d) Guide Vanes

Remarkable corrosion was observed on surface of all guide vanes in both No.1 and No.2 units, especially on upper/lower surface and on shutter surface. (Depth of corrosion has reached 14 mm in maximum value and 4.5 mm in mean value).

The guide vanes are unable to shut off water flow due to distribution of corrosion. Then runner does not cease its rotation even after complete closure of the guide vanes. The existing guide vanes have eventually to be replaced with new ones. (Refer to PHOTOS-12 and 13.)

e) Head Cover

Inspection of the head cover was done only for the upper side surface in view of its structure. (The lower side surface can not be seen unless overhaul of the hydraulic turbine would be carried out.) Joint parts of the head cover and various piping thereon are all in good condition. (Refer to PHOTOS-14 and 15.)

However, there may be corrosion in the shaft sealing part (stuffing box), for which visual inspection was impossible in view of the structure, due to water splash coming from seal part. (Refer to PHOTO-16.)
Drainage of sealing water flowing out from the shaft sealing part was designed to be done through holes passing through stay vanes. But, these holes were already blocked out by algoid material in an early time after commissioning. Then, small pump which was installed temporarily is being

used for drainage purpose.

f) Speed Governor System and Pressure Oil System

As far as the external appearance of these systems is concerned, operating condition is deemed satisfactory. No corrosion was found on copper tubing. (Refer to PHOTOS-17 and 18.)

Considering accumulative operating hours of these systems, overhaul is strongly recommended.

2.2 Generators

2.2.1 Specifications of Generators

- Rated capacity	: 17,500 KVA
- Rated voltage	: 11,000 V
- Rated current	: 919 A
- Rated frequency	: 50 Hz
- No. of poles	: 34
- Rated Speed	: 176.5 rpm
- No. of phases	: 3
- Rated power factor	: 0.86
- Type	: Totally enclosed ventilation hood with air coolers, umbrella type
- Year of manufacture	: 1971

2.2.2 Outline of Observations

Inspection by visual check and palpation was done for the generators. It was concluded that No.1 and No.2 generator units were in good condition while there were several minor observations thereon.

2.2.3 Observations by Components

a) Stator Core and Stator Coil

All stator wedges were loosened by aging, and, then, they have to be replaced with new ones.

b) Rotor

Spider and yoke have become dirty by spattering of lubricating oil.

c) Bearing

Oil leakage is found out from fixing surfaces of oil deflector and guide bearing frame. From this observation, rubber packing may be ruined partially. Then, the said packings must be replaced.

Oil leakage is also found in both No.1 and No.2 units from terminal plates of search coil for guide bearing.

Search coil for guide bearing in No.2 unit was out of order.

Lubricating oil has become dirty.

d) Exciters and Collector Ring

No particular observations were found out while surface of commutator is to be made smooth by rubstone.

e) Others

Bearing bracket, upper end bracket, air cooler units, brake, etc. are all in satisfactory condition.

2.3 Other Electrical Equipment

2.3.1 Object

- Main transformer
- 110 KV switchgear equipment
- Control boards
- Overhead travelling crane

2.3.2 Outline on Observations

Although the generating equipment in the Nam Ngum Power Station have been operated continuously since putting into service, no fatal conditions were fortunately found out. It is recommended, however, to replace and

renew several components, service lives of which are regarded as eight to ten years. Moreover, it is noted that hydrogen sulfide will give a bad influence to switchboard apparatuses and will shorten durability of electrical components. In this sense, a careful inspection should be done periodically to replace the said components with new ones before trouble will occur.

2.3.3 Observations by Components

a) Main Transformer

Continuous dropping-down of insulation oil is seen in No.2 main transformer tank. Though leaking volume of oil itself is not so much, an appropriate measure should be taken as soon as possible.

Several detectors in fire extinguisher may be damaged by rust and should be replaced with good ones.

Flexible jointers between generator main lead bars and low tension bushings are already spoiled and should be replaced with good ones.

b) 110 KV Switchgear Equipment

i) 110 KV Disconnecting switch

Remote control system was damaged completely due to cut of the solenoid.

ii) Power fuse mechanism

Hook mechanism for power fuse is out of order.

c) Control boards

The following switchboard apparatuses are out of order and should be replaced with good ones:

i) Main Control Board

- Wattmeter (Type SR36)	2 Nos.
- Temperature indicator with amplifier (Type SR36)	2 Nos.
- Change-over switch (Type QM53A)	1 No.

ii) Sub board

- Current setting rheostat in AC/DC panel (Type S50) — 2 Nos.
- Voltage setting rheostat in AC/DC panel (Type S50) — 2 Nos.

iii) Governor Cabinet

- Wattmeter (Type S36) — 2 Nos.
- Position indicator for guide vane opening and load limiter positions including selsyn transmitter and receiver — 4 sets each

iv) 11 KV main cubicle

- Safety valve for air blast circuit breaker — 1 No.

v) Automatic voltage regulator

- Motor bearing for timer — 1 No.
- Gasket for rheostat driving motors — 6 sets
- Diode arrester — 10 Nos.

vi) Storage battery — 53 cells

vii) Automatic control panel

- Auxiliary relay (Type A70-4XPH) — 80 Nos.
- ditto (Type A70-4KXPH) — 20 Nos.

d) 100/40-ton Overhead Travelling Crane

One collector roller for trolley wire is damaged.

2.4 Waterway Facilities

2.4.1 Object

- Tailrace stoplogs
- Tailrace gantry crane
- Intake gate leaf
- Intake stoplogs (interchangeable with tailrace stoplogs)
- Intake gantry crane

2.4.2 Outline of Observations

Utmost efforts were concentrated in investigation of tailrace stoplogs because dewatering in draft tube of the hydraulic turbine had ended in failure repeatedly in past time. Considering the worst case, the following arrangement and plan have been incorporated in the field investigation:

- Participation of professional divers to confirm actual conditions in threshold and guide frames under water and to observe poise of stoplogs in the position.
- Participation of welding experts to make partial modification of the stoplogs.
- Preparation of special device and new rubber packings to make watertightness more sure.

Needless to say, it was indispensable to dewater the draft tube and the spiral case of both of the hydraulic turbines completely in order to make it possible to investigate inside of the turbines.

In fact, dewatering could be achieved successfully by diver's operation and partial modification of side roller alignment of the stoplogs. The existing rubber seal on the tailrace stoplogs was good for dewatering the hydraulic turbine at that time.

2.4.3 Observations by Components

a) Stoplogs

Coating of tar epoxy peeled off partially and may lead to rust. Nothing particular was found out in structure of main body of the stoplogs. Although the existing rubber seals were fit for use during the investigation, they are nearing its service life. Then, all of the rubber seals are to be replaced with new ones prior to repair of the hydraulic turbine.

b) Gantry Cranes

Routine maintenance has been carried out properly. However, several problems were observed on electrical components such as low insulation resistance in induction motor, unstable operation of auxiliary relay, damage on cabtyre cable of power source circuit, etc. These problems are to be

cleared and be remedied.

c) Intake Gate Leaf

A fairly big amount of water leakage was once observed in spite of full closure of the gate leaf during the investigation. Then, watertightness function is to be examined.

CHAPTER-III

REPAIR ITEMS

CHAPTER-III REPAIR ITEMS

3.1 Purport

As referred to in the precedent chapters, several pages were devoted to deal with observations on generating equipment including equipment and facility other than the hydraulic turbines. It is no exaggeration to say, however, that most items of repair are concerned with the hydraulic turbine.

Based on the results of investigation, the repair items were established as given hereunder. Among these, several items were decided with reference to past experience on power stations similar to the Nam Ngum Power Station although the actual conditions on the relevant portions could not be inspected in view of structures around them.

The repair items are classified into the following two categories:

Group A: Items which require repair as soon as possible.

Group B: Items which are recommended to be repaired simultaneously with repair of Group A

3.2 Classification of Repair Items

Group A

A-1 For Hydraulic Turbine

- A-1-1 Replacement of guide vanes
- A-1-2 Replacement of lower protective liner
- A-1-3 Repair weld on speed ring
- A-1-4 Repair weld on stay vanes
- A-1-5 Paint on interior surface of spiral case
- A-1-6 Partial repair weld and paint on head cover
- A-1-7 Repair weld on bottom ring
- A-1-8 Replacement of cover for main shaft flange
- A-1-9 Paint on runner cone
- A-1-10 Paint on interior surface of upper draft tube steel liner
- A-1-11 Replacement of cooling water piping running in turbine pit
- A-1-12 Replacement of rusted bolts and nuts.

A-2 For generator

A-2-1 Replacement of all stator wedges

A-2-2 Change of lubricating oil

A-3 For Main Transformer

A-3-1 Oil Leakage preventive work

A-3-2 Replacement of detectors for fire extinguisher

A-4 For Other Electrical Equipment

A-4-1 Replacement of operating mechanism of 110 KV disconnecting switch

A-4-2 Change of hook mechanism for power fuse

A-4-3 Replacment of damaged switchboard apparatuses

A-4-4 Replacement of collector roller in 100/40-ton overhead crane

Group B

B-1 For Hydraulic Turbine

B-1-1 Improvement of main shaft seal

B-1-2 Modification of lubrication system for guide vane spindle bearing

B-1-3 General inspection and repair

B-2 For generator

B-2-1 General inspector and repair

CHAPTER-IV

SCHEME OF REPAIR

CHAPTER-IV SCHEME OF REPAIR

Group	No.	Item	Present Condition	Scheme of Repair
A-1 Hydraulic Turbine	A-1-1	Guide vanes	- Severe corrosion on surface (Refer to Clause 2.1.3 d).)	- The existing guide vanes will be replaced with stainless steel made ones.
	A-1-2	Lower protective liner	- Severe corrosion - The liner for No.1 unit has mostly been swept away. (Refer to Clause 2.1.3 a).)	- The existing lower protective liner will be replaced with stainless steel made ones.
	A-1-3	Speed ring	- Hollow is found in fitting part of bottom ring to speed ring. (Refer to PHOTO-16.)	- Machining will be done after repair weld. (Refer to drawing "Plan for field fabrication" in APPENDIX-IV)
			- Hollow is found between speed ring and lower protective line	- Machining will be done after repair weld.

Group	No.	Item	Present Condition	Scheme of Repair
	A-1-4	Stay vane	- Many depressions are distributed on the surface	- Unevenness will be ground and anti-rust paint will be coated.
	A-1-5	Interior surface of spiral case	- Paint peeled off partially.	- Tar epoxy paint will be applied after removal of the existing paint by sand blast.
	A-1-6	Head cover	- Interior surface (Lower side surface) may be corroded.	- After repair welding and smoothing, anti-corrosive paint will be applied.
	A-1-7	Bottom ring	- Hollow is found in fitting part of the bottom ring to speed ring. (Refer to Clause 2.1.3 c).)	- Caulking material will be filled.
	A-1-8	Cover for main shaft flange	- Corrosion may occur.	- The existing cover will be replaced with stainless steel made one.

Group	No.	Item	Present Condition	Scheme of Repair
	A-1-9	Runner cone	- Paint peeled off partially.	- After removal of the existing paint by sand blast, anti-corrosive paint will be applied.
	A-1-10	Draft tube	- Same as above	- Same as Item No.A-1-5.
	A-1-11	Cooling water	- Corrosion may occur partially	- Several parts will be replaced and anti-corrosive paint will be applied.
	A-1-12	Various bolts and nuts	- Corrosion is found (Refer to PHOTOS-14 and 15.)	- Replacement with good ones and anti-corrosive painting to be applied.
A-2 Generator	A-2-1	Stator wedge	- The stator wedges are loosened by aging.	- The existing wedges will be replaced with new ones.
	A-2-2	Lubricating oil	- The oil became dirty.	- Replace with new oil.

Group	No.	Item	Present Condition	Scheme of Repair
A-3 Main Transformer	A-3-1	Tank	- Oil leakage (dropping) is observed.	- Replace the gasket.
	A-3-2	Fire detector	- The detector is out of order by rust.	- Replace with good one.
A-4 Other Electrical Equipment	A-4-1	110 KV disconnecting switch	- Remote control mechanism is out of order.	- Replace with new one.
	A-4-2	Power fuse	- Hook mechanism is out of order.	- Replace with new one.
	A-4-3	Switchboard apparatuses	- Several items are out of order	- Replace with new ones.
	A-4-4	Overhead crane	- Collector roller is broken.	- Replace with good one.

Group	No.	Item	Present Condition	Scheme of Repair
B-1 Hydraulic Turbine	B-1-1	Main shaft Seal	- Large quantity of sealing water is flowing out from the seal.	- A new type of main shaft seal will be adopted instead of the existing seal.
	B-1-2	Lubrication system for guide vane spindle	- Grease lubrication system is used.	- Greaseless lubrication system will be adopted.
	B-1-3	General inspection for various parts		
B-2 Generator	B-2-1	General inspection for various parts		