Bangladesh Power Development Board

INTEGRATED MANAGEMENT SYSTEM
(BASED ON ISO 9001:2015, ISO 1400:2015 & ISO 4500:2018 STANDARDS)

PROCEDURE FOR GENERATION – COMBINED CYCLE POWER PLANT

1.0 Purpose

a. To determine and plan its processes and define the functions that are necessary for providing generation of electric power that can continue to meet the needs and expectations of customers
b. To plan and control in accordance with the organization's strategy
c. To run the process" under controlled conditions which shall include
   - ✓ The availability of up to date information from customer regarding the load, outage etc.
   - ✓ the availability of information that describes the characteristics of the product,
   - ✓ the availability of plant supplier's document, work instructions, as necessary,
   - ✓ the use of suitable equipment,
   - ✓ the availability and use of monitoring and measuring equipment,
d. To monitor, measure and review activities.
e. To ensure a method for safe and quality generation.

2.0 Scope

Applies to all Combined Cycle Power Plant Power Station of Integrated Management System of Bangladesh Power Development Board (BPDB).

3.0 Terms & Definition

Definition

None

Abbreviations

BPDB – Bangladesh Power Development Board
MR – Management Representative
SAE – Sub Assistant Engineer
AE – Assistant Engineer
SDE – Sub Divisional Engineer

4.0 Roles and Responsibility

Tasks in Reference Clause nos.	Responsibility
5.0, 5.1	XEN/SDE/ AE
5.2, 5.2.1, 5.2.1.1, 5.2.2, 5.2.3, 5.2.3.1, 5.2.3.2	AE/SAE
5.3, 5.4,	MR

5.0 Procedure

5.1 Plan of the operational procedures

Operations and control of Generation services of these Generators are detailed below which is followed by the Plants according

Scheduling of Capacities and Energy:

- Plant has installed capacity; Beside BPDB sets the target availability on the basis of joint dependable capacity test of the plant. Power
- Station submits Monthly report of Generation and availability of the plant to BPDB and PGCB. Power Station also submits day by day hourly availability of net Generation availability to NLDC.

Declared Capacity Notification:
To enable the plant to give final schedules of requirements, SNPL shall notify the NLDC, by 12 hours each day, of the Declared Capacity .available during each hour of the following day. However, the plant may notify NLDC, not less 12.00 hours prior to its scheduled occurrence, of any reasonable modification to the Declared Capacity schedule.

5.2 Start up

- Before Starting the Unit, Check that; Cool down Operation is running. Lubricating oil level is normal. Cooling water level is normal. Lubricating oil circuit is healthy (Ac/Dc). Control oil circuit is healthy. Turning system and hydraulic circuit is healthy. Hydraulic supply system is healthy (Ac/Dc). Cooling and sealing air circuit is healthy. Cooling water circuit is healthy. Fuel gas circuit is healthy. Ventilating and Heating circuit is healthy. Fire protection system is ready
- Before starting the unit ensures that possible maintenance and service operations have been finished, ail cover and protecting shields are to be mounted and all people have left the unit compartment and other risk areas

5.2.1 GT Starting

5.2.1.1 Normal Start (Automatic)

- Turbine in standby. Put the Operation mode selector to "AUTO" target from the unit control display. Protection system checks ready to start permissive. Confirm the "AUTO" mode by giving "EXECUTE COMMAND".
- Confirm "START" order by giving "EXECUTE COMMAND".
- As soon as "START" command is executed, following things will happen: Cooling water pump starts (88 WC-1 or WC-2). Lube oil pump starts (88 QA).

Generation rotor jacking oil pump starts (88 QB). Pressure switch 63 QT2 permits turning gear pump 88 TG to start. Master Protective "4" energized.

- As soon as Master Protective "4" energized, following things will happen: Auxiliaries & Turbine compartment ventilation fan starts (88 BA and 88 BT). Hydraulic oil pump starts (88 HQ). Torque converter at maximum torque (within 10 seconds). After 1 second of Master Protective "4" energized, cranking motor starts (88 CR). After 2 second, torque converter drain valve energized (20 TU). Turbine shaft break away/14 HR).
- As soon as Turbine shaft starts to rotate, Speed Relay 14HR drops down. Drop down setting is 3 to 5 rpm & pick-up setting 1 to 4 rpm.
- With dropping of 14HR the following will happen: Turning will stop. Compressor inlet guide vanes (IGV) solenoid 20TV energizes. Slowly the Turbine shaft speed increases.
- As speed increases, speed relay 14 HM energized (make turbine speed up to 20%, 480+30 rpm), following will happen: Generator rotor jacking oil pump stops (88 QB). Torque converter at mini torque (88 TM). Turbine vent timer starts counting 1 -minute time.
- As soon as 1 -minute vent time finishes & firing speed (20% of shaft speed) stabilized, the following will happen: Ignition transformer energized (95 TR-12 & 13). Pressure control valve-SRV & Fuel control valve-GCV are in operation. Spark plugs energized for 1 minute. Flame appears within 1 minute of ignition time. It is detected by flame detectors.
- Water cooling fan starts (88 FC). Load compartment ventilation starts (88 VG). Exhaust frame fan-1 starts (88 TK-1), after 10 seconds of it, exhaust frame fan-2 starts (88 TK-
- After flame detection, within 1 minute, FSR reaches to warm-up level & starts to increase slowly to allow more fuel to enter into GT combustion system to increase the shaft speed.
- When the shaft speed reaches to 50% (14 HA), lube oil mist separator (88 QV) starts. At 70% of the shaft speed (2100 rpm), starting clutch will be disengaged & cranking motor stops (88 CR).
- Before 80% of the shaft speed found, IGV (inlet guide vanes will open from 34° to 57°
- At 95% of the shaft speed, speed relay 14HS picks-up and following will happen:
    - Hydraulic oil pump stops (88 HQ).
    - Lube oil pump stops (88 QA).
    - Compressor bleed valve close (20 CB solenoid valve energized).

Opening of the IGV (inlet guide vanes) from 55° to 60° complete. Opening (82°) is affected during loading.

- At 100.3% shaft speed, "complete sequence" will appear. Speed control will take the FSR control.
- After coming at full speed with no load, "synchro permissive" will appear.

- Turn synchronization switch (43 S) of generator control panel to "AUTO" & following things will happen: "Synchronization in sequence" will appear.
- Breakers close (52 G). Load increases automatically to Spinning Reserve Load.
- To increases load from Spinning Reserve Load to Pre-selected load, turn the Master Control Switch to "START". Select the required load (Basjijoac Peak load pre-selected load).

5.2.2 Manual Start

- Before starting the unit checks all auxiliary systems and performed the necessary operation to make the unit ready for starting and ensure the down operation
- Fuel selection switch is set at the right option (Gas / liquid fuel).
- Master Selector switch for starting is set at the cranking mode.
- Press the push button switch to start up.
- Raise the turbine speed and sequence I complete
- Gas turbine operation manual Gas turbine operation manual
- Regulate the generating voltage to match with bus voltage.
- Regulate the Generator frequency to match with bus frequency. Synchronization complete. Raise the load.
- Select the Required Load point unit at base load/Leak load/Pre-selected.

5.2.3 GT Shut Down

5.2.3.1 Normal Shutdown (Automatic)

- Turbine in Base loads with Gas fuel.
- Confirm "STOP" order by giving "EXECUTE COMMAND" & following things will happen: "Complete sequence" light off & "Sequence in progress" light up; Load decreases. IGV (inlet guide vanes) gradually close from 82° to 60°.
- Load reaches near 0 megawatt, Breaker trips (52 G) on reverse power & following things will happen:
    - FSR will be set to MINI FSR & excitation breaker will open. Compressor bleed valve open (20 CB). IGV (inlet guide vanes) close at 60°.
- GT shaft speed drops down slowly. At 94% of TNH Speed of shaft speed relay 14HS drops down. Dropping of 14HS will cause the following actions:
    - Lube oil pump starts (88 QA).
    - Hydraulic oil pump starts (88 HQ).
    - Generator rotor jacking oil pump starts (88 QB).
- Inlet guide vanes (IGV)" will slowly close from 57° to 34° in accordance with the decreasing value of GT ambient temp, and corrected speed

- Speed level decreasing from 70% (14 HC) to 50% (14 HA) till it reaches Blow out speed level (35%).
- After 5 second, loss of flame detected & Master protective "4" drops out which causes:
    - Hydraulic oil pump stops (88 HQ).
    - Gas fuel stop solenoid valve de-energized (20 FG). Exhaust frame fan stops 88 TK-1 & 88 TK-2.
    - If temperature low, load compartment ventilation stops (88 VG). Super-package ventilation fan (88 BT) stops & again will start 60 minutes later.
- Speed level decreasing till speed relay 14 HM drops out will cause the following actions:
    - At 2% of speed. Turning gear pump starts (88 TG). Torque convertor drain valve energized (20 TU).
    - Torque convertor blades in turning position Gas turbine operation manual
- After completion of cool-down time as detected by 62CD, give a 2nd "STOP" order from the main display of the interface computer to stop the Turning sequence following as: Turning gear motor stops (88 TG). Torque converter drain valve de-energized (20 TU). Torque converter blades in position maximum torque.
- Zero speed detected (14 HR) & will cause: IGV solenoid valve de-energized (20 TV). Generator rotor jacking oil pump stops (88 QB). If wheel-space temperature low", super package ventilation fan stops (88 BT). Lube oil pump stops (88 QA). Cooling water pump stops (88 WC-1 OR 2). Turbine stops and will go to "STAND-BY" mode.

5.2.3.2 Normal Shut down (Manual)

- Manually Decrease the load with Governor control switch Lower/Raise (70r4/CS) on "Lower"
- When the load about 1 MW, Open manually generator breaker with generator breaker switch 52G/CS
- Give the STOP order with the Master control switch-1 7 shutting down sequence will follow automatically.
- Ensure the Cool down operation with turning gear.

5.3 Internal Audit and review

- Procedure for Generation- Combined Cycle Power Plant and its effectiveness after implementation of its decisions will be checked and reviewed during internal audits.
- Review consideration will be raised in MRC Meeting for decision
- Corrective actions will be taken to improve the system on the basis of review

5.4 Environmental Aspect, Impact & Controls

Any activity at the plant, whether it is carried out for ensuring quality of service or meeting requirement of the interested parties, there will be some environmental aspects associated with it. It is a requirement of the IMS of BPDB to identify those environmental aspects, evaluate their impact and determine necessary controls.
While carrying out the activities and operation, the employees of BPDB need to exercise appropriate and predetermined controls so as to prevent or mitigate any adverse impact that may be associated with the activity or the process.
Some examples of environmental aspects associated with the procedure for Generation-Combined Cycle Power Plant are as below:

Sl Nos.	Aspect	Impact	Controls
1.	Release of NOx -	Causes chronic lung disease, impacts tree growth	1. Injection of water or steam into the combustion zone, a control technology that lowers flame temperature, 2. Implement dry low NOx combustion (DLN), a technology that uses staged combustion and lean-premixed fuel-air mixtures, and 3. Catalytic combustion
2.	Release of Carbon dioxide	GHG emission	1. Carbon Capture, Utilization, and Storage (CCUS) Plan 2. CO2 Scrubbing
3.	Water consumption from River & Ground Water Source	Depletes Natural Reserve	1. Follow 'Water Consumption Procedure' 2. Wastewater reuse from other source such as municipal wastewater reuse
4.	Warm water rejection to river	Contaminates natural reserve & impacts wildlife / aquatic life	1. Implement cooling canals, open-water algae bioreactors, spray ponds, and modified solar updraft towers
5.	Natural Resource (gas) consumption and depletion	Natural Source Depletion	1. Run engine at set operating parameters. 2. Perform routine maintenance to ensure efficient function. 3. Match the quality of fuel and check it it matches with the original parameters while construction of the plant.

			4. Conduct audit by energy efficiency experts to help identify equipment and processes with improvement potential
6.	Noise Emission	Surrounding Wildlife Disturbed	1. Implement an acoustic enclosure and pedestal barrier 2. Implement silencing for the air inlet, namely larger (deeper) acoustic baffles.
7.	Electricity Consumption from Ancillaries	Global Warming	1. Ensure Efficient Operation
8.	Use of lubricant	Soil Pollution	1. Follow the waste management plan 2. Work and dispose as per the chemical disposal plan
9.	Leakage of gas from pipeline	Natural Source Depletion	1 . Regular Inspection and monitoring
10.	Water consumption from river & ground water	Natural Source Depletion	1. Wastewater reuse from other source such as municipal wastewater reuse
11.	Warm water rejection to river	Thermal Pollution	1. Monitoring Engine System to ensure it not generating excess heat

The table above provides examples only. The IMS team of each site needs to identify the aspect impact and controls related to specific activities and ensures that the environmental performance of the organization is effectively maintained. For this purpose, the procedure “Environmental Aspect Impact Assessment Procedure” is to be followed and forms “Environmental Aspect Impact Register” is to be filled up by the IMS team.

5.5 OHS Hazard, Risk & Controls

Any activity at the plant, whether it is carried out for ensuring quality of service or meeting requirement of the interested parties, there will be some occupational hazards with it related to the occupational health and safety (OHS) to the workers and employees. It is a requirement of the IMS of BPDB to identify those OHS hazards and determine necessary controls.
While carrying out the activities and operation, the employees of BPDB need to exercise appropriate and predetermined controls so as to prevent or mitigate any adverse consequence that may be associated with the activity or the process.

Some examples of OHS hazards and with the procedure for Generation-Combined Cycle Power Plant are as below:

Sl Nos.	OHS Hazard	Controls
1.	Leaking Gas Supply Pipeline	1. Check LEL detector Status
2.	Possibility of flamable gases/fumes in engine room chamber	1. Follow the 'Prevention of Fire and Explosion' Procedure
3.	Explosion in turbine due to cooling system failure	1. Ensure Regular Maintenance
4.	High Noise Level	1. Staff must wear Earmuff whilst in the Engine room
5.	Slipping due to water spillage on floors	1. Maintain adequate housekeeping. 2. Maintain signage if there is any spill.
6.	dropping / falling object	1. Maintain adequate PPE (e.g. Helmet) whilst at worksite
7.	Electric shock / Electric Arc	1. Ensure a Permit to Work is issued as per guidance before personnel is sent for work 2. Maintain LOTO Procedure 3. Maintain adequate PPE whilst at worksite
8.	Fire / Explosion at worksite	1. Follow the 'Prevention of Fire and Explosion' Procedure
9.	Heat Stress	1. Ensure Heat Stress Training for all the employees 2. Ensure a good work plan
10.	Getting Stuck in moving / Rotating Parts	1. Ensure protocols are maintained, such as not leave loose long hair, or loose long dress 2. Proper signage 3. Maintain barrier / mark area so that when personnel enter that zone, he/she is obliged to take adequate precautions
11.	Chemical Spillage / Burn	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite 3. Ensure good House Keeping
12.	Burn from contact with hot surface	1. Use of Guards to ensure contact can't be made directly 2. Provide Caution Sign 3. Maintain adequate PPE whilst at worksite
13.	Fumes and gases	1. Maintain adequate PPE whilst at

		worksite 2. Ensure a Permit to Work is issued as per guidance before personnel is sent for work
14.	Light from welding	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite 3. Proper Supervision
15.	Unhygienic work environment e.g. canteen, toilet etc.	1. Maintain adequate housekeeping.
16.	Cuts from Material Handling / movement	1. Maintain Material handling Procedure 2. Ensure a Permit to Work is issued as per guidance before personnel is sent for work
17.	Poor Visibility due to improper lighting	1. Maintain adequate housekeeping. 2. Installing adequate Lighting
18.	Lifting heavy objects	1. Maintain Material handling Procedure 2. Ensure a Permit to Work is issued as per guidance before personnel is sent for work
19.	Dusty environment	1. Ensure adequate housekeeping

The table above provides examples only. The IMS team of each site needs to identify the OHS hazards and necessary controls related to specific activities and ensures that the environmental performance of the organization is effectively maintained. For this, the procedure Hazard Identification and Risk Assessment Procedure is to be followed and Hazard Identification and Risk Assessment Register is to be filled up by the IMS team.

6.0 References

a) Gas turbine operation manual

7.0 Appendix

None

8.0Revision History

SI No.	Revision Number	Section	Change Made	Date of Revision

Sl No.	Revision Number	Section	Change Made	Date of Revision