Bangladesh Power Development Board

INTEGRATED MANAGEMENT SYSTEM
(BASED ON ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018 STANDARDS)

PROCEDURE FOR MECHANICAL MAINTENANCE-HIGH SPEED DIESEL

1.0 Purpose

a. To establish effective mechanical maintenance system for the plant and machinery for ensuring continuing process capability
b. To plan and implement mechanical maintenance

2.0 Scope

Applies to whole 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
TR – Trouble Report
CF – Clearance Form
SDE – Sub Divisional Engineer
AE – Assistant Engineer
SAE – Sub-Assistant Engineer
CE- Chief Engineer

4.0 Roles and Responsibility

Tasks in Reference Clause Nos.	Responsibility
5.2	SDE /AE / SAE
5.2 , 5.3 , 5.4	Head of mechanical maintenance,
5.5	Head of electrical maintenance
5.2	Concerned Technical Staff
5.6	Head of Plant / MR

5.0 Procedure

5.1 Plan of the maintenance procedures

Following 3 types of maintenance is carried out

- Breakdown Maintenance
- Schedule maintenance
- Preventive maintenance

5.2 Breakdown Maintenance (On-Load Off-Load**)**

- Concerned operation unit report breakdown or abnormality
- Job allocated to concerned official
- Concerned technician/ official/ engineer check the facility and assess the maintenance task
- Maintenance task is approved
- If the maintenance can be done on load, then it is carried out
- If the maintenance of repair requires to be carried out off load, permission of the concerned authority is taken
- Maintenance work is carried out accordingly
- On completion of Maintenance work, required checking is carried out.
- Maintenance work is recorded

5.3 Schedule Maintenance

- Seek permit from operation department on schedule issue
- Operation gives permit after isolation
- Respective maintenance is done as per procedure following the operation and maintenance manual Gas turbine instruction & maintenance instructions

5.3.1 Relief Valves

- Adjustment of the valve setting is accomplished by an adjusting screw
- Turning the screw into the valve body which increases the spring force (raises opening pressure)
- The relief valve is set to open a the pressure specified on the Device Summary Schematic Piping Diagram
- Annually, all the relief valves listed should be removed and bench-tested against the settings listed on the Device Summary

5.3.2 Solenoid Valves

- If any oil leakage is observed replace the O-ring seals
- Energize the solenoid and check valve operation (a metallic click should be heard and in some cases the valve travel can be seen)
- Sluggish valve operation or excessive leakage can result from dirt. Therefore, periodic disassembly and cleaning of all solenoid valves is desirable when improper operation or leakage is evident

5.3.3 Check Valves, Orifices and Orifice Check Valves

- During a shutdown period, the system is drained, and the valves and orifices are removed to check for evidence of erosion, corrosion, or component deterioration

- Check the orifices for plugging, size and sharpness of the hole
- Check the valve seat for leakage
- Check the condition of the seals, 0-rings or gaskets and replace them if there is any indication of wear

5.3.4 Lube Oil Filters

- The lube oil system filters are changed once a year, regardless of the pressure drop
- The pressure drops are checked under turbine operating conditions with the lubricant at normal operating temperature and at rated flow through the filter
- The main lube filter, which filters the lubricant to the main bearing header are checked for clogging by the pressure drop indication
- Here, the pressure downstream from the filter is maintained by a pressure regulating valve, and the difference in the pressures shown on the gauges before and after the filter will provide a reliable indication of the filter condition
- On gas turbines that are expected to run continuously over long periods of time, dual filter arrangements, with a transfer valve, are usually incorporated into the lube system to facilitate the servicing of the filters without turbine shutdown
- Systems with single-filter arrangements require that the turbine be shut down to service the filters

5.3.5 Fuel Oil Filters

Replace the cartridges of the main (low-pressure) fuel oil filter when the pressure differential reaches 15 psig (1.034 bars), or every 12 months, whichever occurs first

- Close the inlet and outlet valves
- Open the drain and vent valves. (Drain filter thoroughly before removing cartridges.)
- Remove the cover and the old filter cartridges. Insert new cartridges
- Install a new cover gasket if the old one is hard or damaged
- Install the cover and close the drain valve
- Tighten the eyebolt nuts or cap screws to the required value as specified in the Standard Practices section of the Service Manual. (Periodically clean and oil the eyebolts, if they are used.)
- Open the inlet and outlet valves
- Leave the vent valve open to release air, but close when oil appears. - The secondary (high-pressure) filter cartridge is replaced in a similar manner every 12 months, or when the differential pressure reaches 15 psig (1.034 bars).

Hydraulic Supply Filters

- The hydraulic supply system filter should be changed when the pressure drop across the filter is 60 psig (4.1 bars), or once a year regardless of the pressure drop
- The pressure drop is check under turbine operating conditions with the hydraulic fluid at operating temperature and at rated flow through the filter
- The rated flow can be assumed to be realized during maximum transient conditions, such as at the instant of hydraulic trip out of the gas turbine
- Under steady-state conditions, there will be only a small flow through the filter and any differential pressure indicated on the system gauge will probably be small and not a true indication of the condition of the filter
- It is unlikely, however, that these low-flow filters will foul before the recommended annual change out of the filter cartridge
- On gas turbines that are expected to run continuously over long periods of time, dual-filter arrangements with a transfer valve are usually incorporated into the hydraulic supply system to facilitate servicing of the filters without turbine shutdown
- Systems with single-filter arrangements require that the turbine be shut down to service the filters

Air Filters (Air Extraction Valve)

- Open the filter petcock and drain off all moisture accumulation
- If the amount of moisture appears to be excessive, the petcock can be left cracked open for a continuous bleed or the frequency-of the blow down inspection can be increased
- The filter is opened up and inspected on a scheduled basis
- Clean the Porous-Stone tube in any oil solvent and blow out clean and dry
- Clean the inside of the filter housing

Air Conditioners

- Clean dust and dirt from the condenser and evaporative coils
- Clean condensate drip pan
- Wash or replace the air filter
- Functionally check the operation oil the thermostat and air conditioner

Space Heaters

- Check electrical continuity and verify proper operation of the space heaters
- Clean dust from the thermostats, heating elements and fan blades
- Lubricate the fan motors per the "Lubrication Guidance Chart" in the Standard Practices Section of the Inspection and Maintenance Instruction

Accessory and Turbine Compartment Vent Fans

- Check fan wheel for buildup of foreign material or excessive wear from abrasion. Both can cause vibration and create a serious safety hazard
- Any buildup of foreign material is removed
- If wheel shows excessive wear, replace it immediately
- Check all setscrews and bolts for tightness, and mounting security
- Lubricate fan motors per "Lubrication Guidance Chart" in the Standard Practices Section of the Inspection and Maintenance Instruction

Unit Piping Systems (Fuel, Oil, Water and Air)

- A walk-around visual inspection should be made to check piping systems for leaks, loose hardware, loose hangers, leaky gaskets, valve packing leaks, vibration of piping, to make sure vents are functioning and to make a general check for security of the systems
- Necessary action is taken to correct any abnormalities found

5.3.6 Lube System

Lube Oil Pumps

- Check the lube oil pumps for excessive vibration
- Check the thrust bearings and bearing seal for wear.
- Check the clearance of the wear ring
- If wear. has increased this clearance to 0.016 inch (0.04 cm) the wear ring should be replaced

Lube Oil Tank

- Check the internal tubing and piping of the lube oil tank for peeling of paint and loose fittings
- Check the pipe hangers for loose or missing hardware
- Carefully inspect each pump intake screen (especially on the main pump) for foreign material and loose hardware
- Check the sludge removed from the bottom of the tank for the presence of unusual material
- Make sure the inside of the tank is thoroughly clean before refilling

Lube Oil Properties

- For instructions on determining lube oil physical properties and periodic sampling and testing, refer to the Lube Oil System text in this service manual

Heat Exchangers

- Check the heat exchanger for leakage, efficient operation and foreign matter contamination
- Exchangers are subject to fouling (scale, sludge deposits, etc.) and should be cleaned periodically, depending on specific conditions

- A light sludge or scale coating on either side of the tube greatly reduces its effectiveness
- A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary
- Since the difficulty of cleaning increases rapidly as the scale thickens or deposits increase, the intervals between cleanings should not be excessive
- To clean or inspect the inside of the tubes, remove only the necessary tube-side channel covers or bonnets, depending on the type of exchanger construction
- To clean or inspect the outside of the tubes, it may be necessary to remove the tube bundle. (Fixed tube sheet exchanger bundles are non-removable)
- If an exchanger tube should develop a leak, it may be possible to plug the tube in the heat exchanger and continue using the bundle
- Consult with manufacturer for information concerning how many tubes may be plugged in a given heat exchanger and still have the heat exchanger perform satisfactorily in gas turbine service
- The tapered plug material which is selected should be compatible with the heat exchanger bundle material
- Stainless steel plugs are compatible with stainless steel heat exchanger tubes
- Brass plugs are recommended for 90-10 copper- nickel tubes or for brass tubes or for admiralty metal tubes
- These plugs are installed in the leaking tube .at the tube sheet using a nylon or rawhide hammer to prevent inadvertent damage

Radiator and Header Assemblies

- For maximum effectiveness of the overall cooling system, the fins of the fin-tube radiator assemblies must be kept free of bugs, lint, oil film and other debris
- The fins should be cleaned in the direction opposite to normal flow. For most gas turbine packages, normal flow is from outside to inside.
- Washing with water or a commercially available radiator fin cleanser will be adequate
- Refer to the paragraphs on Cooling Water System maintenance for information relative to fouling of the inside o the radiator tubes
- Check the radiator also for leakage, corrosion, erosion, o damage to the fins or tubes. Refer to the "Cooling Water System" tab in the Service Manual for cleaning the radiators

Lube Oil Immersion Heaters

- These steel sheath heaters are designed for non-circulating for application with a watt density of 20 watts per square inch (3.1 watts per cm^2)
- The heaters have to be fully immersed [2 in. (5 cm) minimum; in a liquid while energized
- If the heaters have been subjected to abnormal conditions, causing low insulation resistance, apply a rated voltage (maximum 250 volts) to the heater for 15 minutes and repeat the test
- The heating cycle is to be repeated until the insulation meets or exceeds 50,000 ohms, (Insulation resistance is to be measured by means of a high resistance voltmeter, using a 250-volt direct current circuit.)

Dresser Couplings

- Check the couplings for oil leakage due to aging and heat
- Replace seals as needed. Lubricate seals prior to each assembly of seals
- See Lubrication Guidance Chart in the Standard Practices section, in this inspection and maintenance instruction for proper lubricant

5.3.7 Cooling Water System

Cooling System Checks

- Cooling system fouling, with consequent performance degradation, must be checked periodically, even though the system is properly rust inhibited
- Removing the waterside head of the lube oil heat exchanger and inspecting the tubes will indicate the general amount of fouling that has occurred in the whole system
- Fouling of the fin-tube radiators will probably be the most severe, since the tubes are the smallest in the system
- A maximum of 10% of the tubes in each heat exchanger can be plugged to eliminate water leaks
- The leaks in the on-base water-to-air heat radiator may be repaired at a local automotive radiator repair shop
- This method is preferred to plugging the tubes, since the system performance is not seriously affected
- Plugging the heat exchangers will reduce system performance and result in more frequent cleaning.
- Cleaning of the cooling water system can be accomplished as follows
    - Use either 2 or 3% by volume of formic acid, or 3 to 4% by volume of sulfuric acid to fill the cooling water system. Muriatic acid is not a/lowed.

- Circulate the solution through the cooling water system for two hours. Then drain the system.
- Flush the system completely with water. If any discoloration remains, repeat the cleaning Procedure.
- After the system has been properly cleaned, refill with distilled water and the recommended amount of magnesium chromate or ethylene glycol mixture. For detailed instructions, refer to the Cooling Water System text in this service manual

Flow Checks

- Design flow rates for the water circuits with the temperature-actuated valves in the open position are listed on "Cooling Water Schematic Piping Diagram" in the turbine service manual
- These design flow rates are based on 100% turbine speed. If the turbine is not operating at rated speed, calculate a correct flow as follows:
- Flow at actual speed = (actual speed/ rated speed) X flow at rated speed
- When the flow check is made, it is suggested that a single test gauge be installed to read the pressures both upstream and downstream o the orifice
- The gauges should be valve so that each pressure can be read individually
- This procedure will eliminate gauge errors which could occur when two separate gauges are used
- Runs of pressure lines should be as short as possible
- Use of a mercury manometer is not recommended. Mercury will react destructively with copper and brass in system components if it is allowed to enter into the cooling water system

Flow versus Pressure Drop

- The flow coefficient K for flange taps is determined experimentally

5.3.8 Water Tank

- Examine the internal surface of the tank for cleanliness and the presence of algae or foreign matter
- If water leaks consistently from the tank-fill opening with little change n ambient conditions, check the pressure cap for the proper opening pressure setting
- Check for a missing cap gasket, poor gasket surface or damaged filler neck sealing surface
- The pressure setting should be within ±15% of the pressure cap rating
- The vacuum valve should open between zero psig (0 bars) and 1/2 psi (0.035 bars) vacuum
- On off-base units, check for leakage at the tank cover and gasket

On-Base Cooling Water Radiator Fans

- Annually check the cooling water radiator fans, the fan housings anc the motors for cleanliness vibration, noise, blade damage rust and corrosion, and mounting bolt security
- Make sure there are no obstructions in the inlet and outlet ductwork and that screens are clean
- For detailed information on the inspection, maintenance disassembly and reassembly of the fan, refer to the instructions under the "Cooling Water System" tab in the service manual

Gear-Driven Cooling Water Pump

- Check the pump for seal leakage either when running or stopped
- Leakage is usually visible along the pump shaft and/or from the drain port on the seal mounting flange
- If there is unusual leakage, it is an indication that foreign material has become lodged between the faces of the seal. This should be corrected before further pump operation
- If the leakage is profuse, it is a good indication that the seal is worn and should be replaced
- Check the internal cleanliness of the mechanical seal cooling water circulating line. If this line gets clogged, the seal can overheat and result in a pump failure
- Check the cleanliness of the abrasive separator in the seal cooling line
- Whenever the pump is disassembled for any reason, the impeller-to-wear-ring clearance should be checked
- If the clearance exceeds twice the value recommended by the pump manufacturer, the wear ring should be replaced and reworked to restore the manufacturer's recommended clearance values This will restore pump efficiency insofar as this clearance is concerned
- Whenever the pump is disassembled, all parts of the pump, especially the impeller shaft sleeve and wearing parts o the 'mechanical seal should be checked and replaced, if worn Refer to the "Cooling Water System" tab in the service manual

5.3.9 Liquid Fuel Forwarding System

Centrifugal Pump (88FD)

- Check the discharge pressure o the pump against that specified on the Schematic Piping Diagram
- Check the pump for unusual or excessive noise while operating

- Check the mechanical shaft seals for excessive leakage and replace if necessary
- Check the shaft for free rotation, without rubbing or binding
- Check the fit between the pump and motor shafts for tightness and freedom from vibration
- Check the connection joints of the casing for oil leakage and replace gaskets if the leaks are excessive
- At annual turbine shutdown, check the seal cooling oil line and connection fittings for internal cleanliness by removing and cleaning

Fuel Oil Heaters (23FH) and Temperature Switches (26FH)

- Check to assure that the fuel oil is being maintained within the temperature limits specified on the Schematic Piping Diagram Device Summary
- If the heaters are not operating properly, or if the oil temperature is not being maintained, check the power and control circuits
- If necessary, test the heating elements and replace any that are I burned out
- Check the setting of the temperature switches and adjust them if necessary
- Thermostats should be checked in heated or cooled oil bath, using an accurate thermometer as a standard

5.3.10 Fuel Oil System

Fuel OH Stop Valve

- Check the connections at the fuel oil and trip circuits oil lines for evidence of leaking
- Check the valve stem for signs o' stickiness, sluggishness, or failure to move within the time cycles specified in the Control Specifications
- For detailed instructions, refer to the service manual under the "Fuel System" tab

Main Fuel Pump

- Check the shaft of the main fuel pump for leakage of the seal and replace it if necessary
- On universal pump units (Roper Pumps), check the calibration of the fuel pump bypass valve
- On Denison Pumps, check the calibration of the fuel pump stroke, in accordance with the information in the Control Specifications

Flow Divider

- Check the flow divider for unusual noises and external leaks
- Check the output pressure of the flow divider, in accordance with the instructions in the Control Specifications
- Check the fuel flow divider starting motor for cleanliness, dryness and proper operation

- Vacuum out ventilating openings and windings occasionally

Fuel Nozzle Selector Valve

- Check the tubing connections around the fuel nozzle selector valve assembly for excessive leakage
- Tighten fittings if necessary
- Check the valve for smooth operation of the stem by turning the selector to all positions
- Check for secure mounting of valve

False Start Drain Valve

- Check for proper operation of the valve during startup and shutdown
- The valve should not be venting while the turbine is operating
- The valve should start to close at between 19 and 22 psig (1.34 and 1.52 bars) and fully close at between 29 and 32 psig (2.0 and 2.21 bars)
- Check the fuel oil and compressor discharge piping and tubing connections for leakage of oil and air
- Check the condition of the diaphragm in the valve actuator annually and replace if worn

5.3.11 High-Pressure Control Oil System — Hydraulic Supply

Main Hydraulic Supply Pump (Shaft-Driven)

- Visually inspect the pump for seal leakage at the shaft and mounting flange
- Check the pump for noise and vibration
- Check the inlet and discharge connections for leakage and/or loose connections
- To assure trouble-free pump operation and a trouble-free hydraulic system, it is important to maintain the system in a clean condition. Sludge, water, dirt or contaminants of any kind are potential for trouble

Auxiliary Hydraulic Supply Pump

- Maintenance is limited to the pump operations which do not require a complete system or pump teardown, such as for leaks or sticky valves
- First, tighten all screws or fittings around the leakage area. If the pump still leaks, it may be necessary to replace a gasket, or O-ring.
- If the pump does not operate properly, or if there is evidence of damage, it should be overhauled in accordance with the instructions in the service manual under the "Hydraulic Supply System" tab
- Before reassembly, make sure the all parts are clean and free from lint or other foreign matter
- All parts must be washed in cleaning fluid, such as Stoddard solvent (or equivalent)

- All 0-rings and gaskets should be Kept clean and carefully examined for cuts and other damage Replace all damaged parts

Hydraulic Supply Manifold

- Leakage problems on the manifold will generally result from damaged O-rings between the components and the manifold plate
- Care must be used in reseating a part to the manifold to avoid pinching or otherwise damaging the seals
- All tubing connections and device connections should also be checked for leakage
- The manifold should be cleaned and wiped down. This will help in detecting any further leakage problems

Air Bleed Valves(s)

- The air bleed valve(s) should automatically bleed any air present in the discharge lines as the pump is started
- As soon as the system reaches 35 psig (2.41 bars) and a steady stream of oil is present, the valve should close

5.3.12 Cooling and Sealing Air System

Piping System

- Using the Cooling and Sealing Air Piping Schematic as a guide, check that all orifice-flange plates are in their respective locations
- if not already done, it may be wise to identify the orifice size on the tab of the plate and locate the tab n the most convenient and accessible location for viewing when assembled
- When union orifices are used, verify that the orifice is in position in the union by observing that the tab protrudes through the hole

Compressor Bleed Valve

- These valves should operate freely with no evidence of sticking
- Where sticking is evident, lubricate the spring and inner cylinder of the air actuator of the valve with a spray lubricant WD-40 or an equivalent high-temperature, anti-seize lubricant on *a* planned shutdown
- Remove the air connection from the valve, spray the lubricant into the actuator and exercise the valve several times

Compressor Discharge Pressure Transmitter

- Check that the transmitter is calibrated within the limits described in the Control Specification.

5.3.13 Starting System

Diesel Engine

- Following Maintenance Procedures in the Starting Equipment section of this service manual Starting Clutch

- Visually inspect the spline and clutch jaws for signs of uneven wear, nicks, burrs or other physical damage
- inspect the hydraulic cylinders for leakage
- inspect the linkage, pins and hardware for security
- Check the clearances of the clutch jaws in the engaged and disengaged positions
- Check the limit switch to see that le switch is operating at the roper setting

Torque Converter

- Check torque converter unloading solenoid valve 20TV plunger for | freeness of operation
- Apply silicon grease to plunger rod

Ratchet System

- Check ratchet pump motor (88HR) for cleanliness of commutator and brush condition
- Check relief valve setting (VR-5) and obvious oil leakage of external piping
- Ratchet pump should show no signs of overheating

Accessory Gear Train

- Through the various inspection openings, visually inspect the gears for pitting, scoring, galling or broken teeth
- On scheduled major inspections, remove the accessory gear case cover and check the condition of the gears and bearings
- Prior to complete reassembly, inspect lube oil spray with pump operational in regard to oil nozzle plugging and direction of oil spray

5.3.14 Over speed Protection System (Mechanical)

Hydraulic Trip System

- Turbines operating on single fuel should maintain a steady pressure level. An indication of a decay in the pressure level could mean a leak in the hydraulic trip system or at the stop valve
- Turbines operating on dual fuel should have the pressure and type of fuel recorded. Pressure levels with the same fuel should remain steady. Levels can be significantly different between gas and liquid fuels

Over speed Trip Assembly

- Check the over speed trip assembly for quick and positive trip action and smooth reset capability
- Manually trip and reset the device monthly
- In addition, the complete over speed protection system should be tested annually, as required by the Turbine Control Specification
- For detailed instructions of the complete system check, see the paragraph that follows under Over speed Bolt Assembly

- Record findings on appropriate inspection Form

5.3.15 C02 Fire Protection System

System Package Lagging

- The joints in the lagging panels roof doors, and base should be inspected for tightness
- If the joints are not tight, the loss o C02 will be too great to be replenished
- The concentration of C02 will no build up inside the compartments to the required value
- The easiest way to make the inspection .is to stand inside each compartment on a bright, sunny day with the lights off
- No light should be visible through the joints
- Particular attention should be paid to all doors
- The joint between the generator compartment and the back side of the exhaust plenum plus the joint between the generator and the turbine base should be checked in particular
- In general, joints which are not tight should be fitted with new gaskets. Doors can be tightened by adjusting the striker plates

High-Pressure System

- The $C0_2$ system should be visually inspected to see that it is in proper working order
- The pressure gauges on the pilot-operated cylinders should be checked to be sure the cylinders are at the proper pressure
- The pressure is dependent on the cylinder temperature. At 50°F (10°C) the pressure should be about 650 psig (44.8 bars); at 70°F (21 °C), about 840 psig (57.9 bars); at 105°F (41°C), about 1,250 psig (86.2 bars).
- Check the dampers to assure they are unobstructed and properly latched

High-Pressure Storage Cylinders

- Disconnect the discharge heads from all cylinders and the solenoid pilot valve assemblies from the Pilot cylinder
- Weigh each cylinder. If a cylinder shows more than 10% loss in net weight, it should be refilled or replaced
- The empty and full weights of all cylinders are permanently stamped on the cylinder valve bodies
- Each time the cylinders are weighed, the date and net weight should be recorded on the attached tag

Fire Detectors

- Any physical damage to fire detectors such as but not limited to distortion, dents and twisting will cause the fire detectors to lose their calibration and

serviceability. If any physical damage is found on the fire detectors they should be replaced

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- If the fire detectors are functioning properly, they will pick up relay 45FTX to trip the turbine
- The fire alarm bell in the accessory compartment should ring and the fire flag on the annunciate should drop
- Two separate tests are necessary to ensure that the high-pressure C02 system is ready for operation
- These tests are: (1) Solenoid Pilot Valve test, and (2) “Puff test. Description of the test procedure can be found in the Accessory and Auxiliary Section of the service manual

Temperature Control System: Exhaust Thermocouples (Control and Over temperature)

- Daily reading of the exhaust thermocouples will aid in monitoring the combustion system and in detecting faulty thermocouples
- Changes in the combustion system will be detected easily after a normal pattern of temperature has been established
- Diverging temperatures in the exhaust system usually indicate deterioration of the combustion chamber or poor fuel distribution (dirty fuel nozzles)
- Below normal thermocouple readings indicate thermocouple deterioration
- On the MS-5001 unit, the expected range of exhaust temperature spread is 45°F ±25°F (7.2°C ± -3.89°C).
- Investigation is recommended in the exhaust temperature readings have a spread of 70°F (21.1°C) or have changed 25°F (-3.89°C) from initial or last reading
- It is important when reviewing exhaust temperature readings to observe any *trend* which may indicate deterioration of the combustion system
- Gradual and/or sudden temperature excursions should be investigated as soon as possible to determine validity of the readings
- Faulty thermocouples should be replaced as soon as feasible

5.3.16 Flame Detection and Protection System

Flame Detectors

- A presence-of-flame signal is a Prerequisite to continuation of the start-up sequence
- During operation, the system must detect the absence of flame to trip the gas turbine. The absence-of-flame signal is very critical to the protection of the gas turbine and of associated heat-recovery equipment (when furnished)
- With the system connected, place an ultraviolet source in front of the sensors and check that the internal relays operate as indicated by using an ohmmeter or equivalent at the contacts
- Note that a paper match flame should be detected an approximately 18 inches (45.72 cm) and the sensor should provide an orange flickering glow
- If the flickering glow persists after removal of the flame, the sensor has failed and should be replaced
- If no flickering glow occurs in the presence of flame, the sensor may have failed but proper operation of the electronics should be assured

Scanner Lens

- The scanner lens should be cleaned with a dry cloth as often as necessary on a regular schedule
- No repair of any sort should be attempted on the scanner or switch assembly
- If damaged or defective, it should be replaced and returned to the factory
- Control System Adjustments for testing of flame detectors with the unit in operation

Inlet Air Systems Maintenance and System Equipment: Refer to the Maintenance Section of the Manufacturer's Operation and Maintenance material included in the Operation & Maintenance Manual

5.4 Preventive maintenance

- Prepare long-term preventive maintenance plan, at least for 3 years for major facilities
- Concerned authority approves preventive maintenance plan
- Resources and spares are mobilized to carryout preventive maintenance
- Where applicable, plant shutdown is solicited
- Plan/ Scheduled maintenance is modified to adjust with the approval of shut down
- Maintenance work is carried out following approved plan
- Necessary checks are performed after maintenance work

5.5 Maintenance Records

- All maintenance jobs are recorded in maintenance register

- Machine history cards are maintained and maintenance records, specially breakdown reports, are recorded.
- Equipment check list are prepared and carrying out routine checks

5.6 Implementation & Review

- Procedure for Maintenance and its effectiveness after implementation will be checked and reviewed during internal audits.
- Actions are taken on the basis of review.

5.7 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 Mechanical Maintenance-High Speed Diesel are as below:

Sl Nos.	Aspect	Impact	Controls
1.	Disposal of Metal / Plastics parts, which are not recycled	Soil pollution	1. Follow the waste management plan
2.	Oil / Lubricants disposal	Soil pollution	1. Work and dispose as per the chemical disposal plan
3.	Usage of Chemical during overhaul	Soil / Water Pollution	1. Work and dispose as per the chemical disposal plan 2. Provide Necessary Training
4.	Oil filled clothes(Jute)	Soil pollution	1. Follow the waste management plan
5.	Oil Spill	Soil pollution	1. Use Secondary Containment
6.	Sludge from tanks	Soil pollution	1. Follow the waste management plan
7.	Electrode disposal	Soil pollution	1. Follow the waste management plan
8.	Carbon Powder - Soil	Soil pollution	1. Follow the waste

	Pollution		management plan
9.	Water bearing chemical discharged from radiator	Soil / Water Pollution	1. Discharge as per 'Effluent water Quality' guidelines

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.

5.8 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 Mechanical Maintenance-High Speed Diesel are as below:

Sl Nos.	**OHS Hazard**	**Controls**
1.	Failure of PTW Process	1. Provide Necessary Training 2. Active Supervision of activity
2.	Wrong Use of tools	1. Provide Necessary Training 2. Active Supervision of activity
3.	Wrong use of Lifting equipment	1. Provide Necessary Training 2. Active Supervision of activity. 3. Maintain adequate PPE whilst at worksite
4.	Dropped object	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite
5.	Fall	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite
6.	Expose to Chemicals	1. Provide Necessary Training 2. Maintain adequate PPE whilst at

		worksite
7.	Entrapment	1. Provide Necessary Training 2. Active Supervision of activity. 3. Maintain adequate PPE whilst at worksite
8.	Cold Burn	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite
9.	Chemical Burn	1. Provide Necessary Training 2. Maintain adequate PPE whilst at worksite 3. Maintain adequate housekeeping
10.	Manual Handling	1. Provide Necessary Training
11.	Electric Shock	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
12.	Wrong Startup	1. Alarm 2. Ensure a Permit to Work is issued as per guidance before personnel is sent for work
13.	Improper re-assembly of equipment	1. Provide Necessary Training 2. Active Supervision of activity
14.	Noise	1. Staff must wear Earmuff whilst at worksite
15.	Heat Stress	1. Provide Necessary training 2. Schedule proper work plan

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

- Service Manual
- Inspection and Maintenance Instruction
- Audit Report

7.0 Appendix

None

8.0 Revision History

SI No.	Revision Number	Section	Change Made	Date of Revision