

Bangladesh Energy Regulatory Commission
TCB Bhaban (3rd Floor), 1, Karwan Bazar, Dhaka-1215

**Bangladesh Energy Regulatory Commission Regulatory Energy Audit
of Generation Facilities Regulations, 2017**

Dhaka
January, 2017

Bangladesh Energy Regulatory Commission
TCB Bhaban (3rd Floor), 1, Karwan Bazar, Dhaka-1215

Notification

Date-----

In exercise of the power conferred by section 59 of the Bangladesh Energy Regulatory Commission Act, 2003 (Act No 13 of 2003), the Bangladesh Energy Regulatory Commission hereby adopts the following regulations pursuant to sub-section a & b of section 22 of the Act.

1. Short title and commencement:

- a. This regulation shall be called the Bangladesh Energy Regulatory Commission Regulatory Energy Audit of Generation Facilities Regulations, 2017.
- b. It shall come into force with effect from the date of publication in the Gazette.

2. Definitions:

In this regulation, unless otherwise implied in the subject or context:

- a. "Act" means Bangladesh Energy Regulatory Commission Act, 2003 (Act No 13 of 2003);
- b. "Auditor" means any firm which has professionals capable of conducting energy audit activities in the power plants;
- c. "Commission" means "Bangladesh Energy Regulatory Commission" established under the Act;
- d. "De-rating" means the amount of a generating unit output (MW) that is unavailable because of a partial forced outage;
- e. "Energy" means electricity, gas and petroleum products;
- f. "Energy Audit" means verification, monitoring and analysis of energy use in the machinery, appliances and processes of the institutions using energy and determination of its efficiency and other performance indicators;
- g. "Fiscal Year" means the year starting July 1 and ending June 30 of the following calendar year;
- h. "Forced Outage" means the shutdown of a generating unit for emergency reasons, or a condition in which the equipment is unavailable as a result of an unanticipated breakdown;
- i. "FY-1, FY-2, FY-3" means the most recent fiscal year in the case of FY-1, the second most recent fiscal year in the case of FY-2, and the third most recent fiscal year in the case of FY-3;

- j. "Good Utility Practice" means any of the practices, methods and acts which are approved by or in which a significant portion of the international electric utility industry are engaged. Good utility practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted internationally;
- k. "Greenhouse Gas (GHG)" means any gaseous compound in the atmosphere that is capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere;
- l. "Greenhouse Gas Emissions" means the greenhouse gases emitted from a power plant portrayed in terms of CO₂ equivalent;
- m. "Heat Rate" means the rate at which a generating unit converts the energy in a primary fuel to electricity, usually measured in kCal/kWh;
- n. "Individual" means a company, association or group of persons whether statutory or not;
- o. "Licensee" means an individual who has received a license under the Act for generation of electricity, transmission, marketing, distribution, storage and supply of energy;
- p. "Manual" means Energy Regulatory Audit Manual For Thermal Power Plants approved by the Commission;
- q. Partial Forced Outage means the partial shutdown of a generating unit for emergency reasons, in which a part of the generating capacity is unavailable as a result of an unanticipated breakdown;
- r. "Regulation" means regulations framed under the Act;
- s. "Reserve Hours" means the time that a generating unit is available to operate, but is not operated owing to dispatch instructions;
- t. "Scheduled Maintenance" or "Scheduled Outage" means the shutdown of a generating unit scheduled well in advance even if the schedule changes. Scheduled maintenance and outages do not include forced outages and could be deferred if there were a commercial or system reliability/security of supply reason for doing so.

Definitions of items which are not covered by this regulation will be in accordance with the Bangladesh Energy Regulatory Commission Act, 2003 (Act No 13 of 2003).

3. Application:

These regulations will be applicable for the power plants in the power sector of Bangladesh.

4. Authority:

The Commission has the mandate, among others, to ensure efficiency of plant and equipment. The Commission can carry out its mandate by, among other means, requiring the conduct of energy audits of the facilities of licensees.

5. Objectives of Energy Audit:

The Energy Audits provides a systematic approach for decision making in the area of energy management. With respect to power plants, regulatory energy **audits starts** with operational aspects, such as collection and analysis of data and information on gross energy generation, fuel consumption, outages, overall efficiency of the plant, availability of the plant, auxiliary consumption, fuel supply system, environmental emissions and impacts, etc. The audit also makes a review of the financial performance of the power plant. On the basis of these data and information, key performance indicators (KPIs) are derived and compared with design values and/or established industry benchmarks as a means for gauging power plant performance. Recommendations are made consistent with the audit findings to improve power plant performance and efficiency including improvement in financial management

6. Benefits of Energy Audit:

The Energy Audit results in overall improvements in power plant performance and efficiency with associated reductions in the cost of power through implementation of the findings of the energy audit owing to, but not limited to, the following:

- a. Improved power plant efficiency through identification of areas of excess loss in power generation and delivery process.
- b. Increased net power generation through more efficient operation of major components and reduced auxiliary power consumption.
- c. Increased reliability and availability through improved operation and maintenance planning and practices.
- d. Improved power plant control through identification and rectification of errors in instrumentation and metering.
- e. Improved financial performance resulting in financial discipline and cost rationalization.
- f. Reduced emission of greenhouse gases (GHG).

7. Methodology for carrying out regulatory energy audits:

- a. The Licensees shall prepare a list of power plants under their ownership and operation within 60 days of the beginning of each fiscal year based on apparent unsatisfactory performance in respect of efficiency, availability and cost of power generation. The licensees will provide list of such power plants to **the** Commission. The Commission shall select power plants for energy audit from the list and ask the licensees to engage an auditor with relevant expertise to undertake the energy audit following the regulatory energy audit manual adopted by the Commission.
- b. The selected auditor will use the manual as a guide and visit the power plants, collect the required data and information, analyze the data and information, and compute the key performance indicators and provide a comparison with industry standards/design parameters. The auditor will also inspect the various components of the power plants and observe operations to gauge performance relative to legal and statutory requirements in Bangladesh and 'Good Utility Practice'. On the basis of its analyses, the auditor will make recommendations to improve power plant performance and efficiency.
- c. The auditor selected to conduct the regulatory energy audits will visit the power plant, interview plant management and operating personnel, observe performance of the various components of the plant and collect data and information necessary to assess the performance and efficiency of the power plant.
- d. The attached Forms-1 through 6 shall be used to present the collected information on salient features of the power plant, energy generation, auxiliary consumption, fuel consumption, scheduled outages, forced outages, greenhouse gas emissions¹, instrumentation and metering, etc., necessary to develop the key performance indicators and recommendations for improved performance and

¹ All the Power plants in Bangladesh are not fitted with equipment to measure greenhouse gas emissions directly. Therefore, it is necessary to determine levels of greenhouse gas emissions based on currently accepted methodologies in the industry and measuring equipment calibrated to international standards. The calculations should be based on the carbon content of the primary fuel and the fuel conversion efficiency of the power plant being audited. The auditors will be responsible for supplying the necessary emissions testing equipment and making the calibration and testing records and results available to the Commission.

efficiency. The auditor may use additional forms if deemed necessary to collect and analyze the data/information.

- e. The efficiency of a power plant can be determined by the direct and indirect method. The direct method is the ratio of output at the generator terminal to the fuel input. The indirect method involves the step- by- step analysis of different components of the plant. As the power plants have different cycle processes, the cycle diagram is the basis of analysis when using the indirect method. In other words through Mass-Balance analysis with measured and calculated parameters can identify efficiency and areas of excess loss. Required data tables will have to be used for the presentation and comparison. In this case Manual will be a guide.
- f. The auditors of the firm will make an analysis of the financial performance of the power plant and review the following documents during the audit:
 - 1) Accounts manual, and budgets
 - 2) Property records
 - 3) Depreciation
 - 4) External independent audit reports and work papers (looking especially at the adjustments that the company chose not to make despite auditor's recommendations)
 - 5) General and subsidiary ledgers
 - 6) Internal audit reports
 - 7) Invoices and list of property units
 - 8) Monthly or quarterly operating/financial reports and trial balances
 - 9) Organizational charts, payroll records and property tax statements
- g. Based on the review and analysis of the above and other relevant documents, the auditors will provide observations and recommendations on the following:
 - 1) evaluation of power plant financial management
 - 2) principles of orderliness,
 - 3) existence, adequacy and effectiveness of internal control system
 - 4) internal audit department
 - 5) store management,
 - 6) Independent inventory report,

- 7) cost effectiveness,
 - 8) budget variance
- h. The auditors will also compute the cost of electricity generation broken down by various components, such as depreciation, fuel cost, operation and maintenance costs etc. and check appropriateness of the costs.
 - i. The auditors will compare total generation cost, fuel consumption cost, operation & maintenance cost for the last three years and draw inferences on the variations.
 - j. The Commission may alternatively assign its own officers to conduct energy audits, or advise the utilities to undertake energy audits of the power plants themselves. In such cases, Commission or power plant staff will conduct the audit and submit reports consistent with the requirements set out in this regulation. Based on the recommendations of the audit report, the Commission may direct the licensees to undertake necessary measures for implementation of the recommendations.

8. Key performance indicators (KPIs):

Based on the analysis of the collected data, information, statistics, etc. the following KPIs will be computed to assess and compare the performance of the power plant versus design values and industry benchmarks. The KPIs will be computed using the attached Forms 7 through 10.

- Heat Rate (Efficiency)
- Availability Factor
- Equivalent Forced Outage Rate
- Auxiliary Consumption
- Available Capacity
- Greenhouse Gas Emissions

9. Comparison of KPIs with design values and industry benchmarks:

The KPI comparison to power plant design values and industry benchmarks will be presented in a format consistent with Form 11.

10. Energy audit recommendations:

The auditor will make recommendations based on the findings of the audit consistent with improved power plant performance and efficiency, and legal and statutory requirements of Bangladesh.

11. Liability:

The power plant managers and personnel will ensure that the auditors have adequate opportunity to conduct the energy audit in a comprehensive and efficient manner without jeopardizing the safety of power plant personnel and equipment, and in a manner that does not interfere with the safe, reliable and economic operation of the integrated power system.

The power plant manager is liable for the safety of the auditors, as well as the power plant personnel and equipment during the conduct of the energy audit.

12. Expertise of Auditor:

The auditors will have the following adequate experience relating to a power plant:

- Power plant operations
- Power plant maintenance
- Power plant environmental control and reporting requirements
- Power plant instrumentation, control and metering
- Determination and reporting of power plant key performance indicators
- International power plant efficiency and performance benchmarking
- Conducting power plant energy audit.
- Financial review and analysis

13. Cost Recovery

The licensees shall maintain proper accounts of all money spent in the conduct of energy audits and the cost recovery shall be through tariff to be determined by the Commission.

***By the Order of the Commission
Secretary***

Energy Audit of Power Plant

Salient Features of Plant

1	Name of Power Plant	
2	Date of Commissioning	
3	Gross Capacity as per Design (MW)	
4	Auxiliary Consumption as per Design (MW)	
5	Net Capacity as per Design (MW)	
6	Net Capacity at Commissioning (MW)	
7	Current Net Capacity (MW)	
8	Current Gross Capacity (MW)	
9	Gross Heat Rate as per Design (kCal/kWh)	
10	Gross Heat Rate at Commissioning (kCal/kWh)	
11	Name of Manufacturer	
12	Year of Manufacture	

Name and Signature of the Auditor

Date:

**Energy Audit of Power Plant
Record of Forced Outages**

Name of Power Plant:

Fiscal Year	Forced Outage Hours	Partial Forced Outage Hours	De-rating (MW)	Equivalent Partial Forced Outage Hours²	Primary Reason(s) for Shutdown/De-rating
FY-1			----- MW to ----- MW		
FY-2			----- MW to ----- MW		
FY-3			----- MW to ----- MW		

Name and Signature of the Auditor

Date:

² Equivalent Partial Forced Outage Hours = $\sum((\text{De-rating}/\text{Gross Capacity}) * \text{Partial Forced Outage Hours})$. As for example, if the plant has a partial forced outage that limits its output to 50% of capacity for 2 hours, the equivalent partial forced outage hours will be equal to $0.5 * 2 = 1$ hour. Summation of all such events during the FY will be the Equivalent Partial Forced Outage Hours.

**Energy Audit of Power Plant
Record of Scheduled Maintenance**

Name of Power Plant:

Fiscal Year	Hours of Shutdown	Major Works Done
FY-1		
FY-2		
FY-3		

Name and Signature of the Auditor

Date:

Energy Audit of Power Plant

Record of Energy Generation, Gas Consumption and GHG Emissions

Name of Power Plant:

	FY-1	FY-2	FY-3
Gross Energy Generation (GWh)			
Auxiliary Consumption (GWh)			
Net Energy Generation (GWh)			
Quantity of Gas Consumed (Million Cubic Meters)			
Calorific Value of Gas (KCal/CM)			
Total GHG Emissions (Tons of CO₂ equivalent)			

Name and Signature of the Auditor

Date:

Energy Audit of Power Plant

Record of Energy Generation, Diesel Oil (HSD) Consumption and GHG Emissions

Name of Power Plant:

	FY-1	FY-2	FY-3
Gross Energy Generation (GWh)			
Auxiliary Consumption (GWh)			
Net Energy Generation (GWh)			
Quantity of HSD Consumed (Million litres)			
Calorific Value of HSD (kCal/kg)			
Calorific Value of HSD (kCal/litre)			
Total GHG Emissions (Tons of CO₂ equivalent)			

Name and Signature of the Auditor

Date:

Energy Audit of Power Plant

Record of Energy Generation, Furnace Oil Consumption and GHG Emissions

Name of Power Plant:

	FY-1	FY-2	FY-3
Gross Energy Generation (GWh)			
Auxiliary Consumption (GWh)			
Net Energy Generation (GWh)			
Quantity of Furnace Oil Consumed (Million litres)			
Calorific Value of Furnace oil (kCal/Kg)			
Calorific Value of Furnace oil (kCal/litre)			
Total GHG Emissions (Tons of CO₂ equivalent)			

Name and Signature of the Auditor

Date:

Energy Audit of Power Plant

Record of Energy Generation, Coal Consumption and GHG Emissions

Name of Power Plant:

	FY-1	FY-2	FY-3
Gross Energy Generation (GWh)			
Auxiliary Consumption (GWh)			
Net Energy Generation (GWh)			
Quantity of Coal Consumed (Million Tons)			
Calorific Value of Coal (kCal/kg)			
Total GHG Emissions (Tons of CO₂ equivalent)			

Name and Signature of the Auditor

Date:

**Energy Audit of Power Plant
Record of Annual Outages**

Name of Power Plant:

Fiscal Year	Operating Hours³	Maintenance Hours⁴	Forced Outage Hours⁵	Equivalent Partial Forced Outage Hours⁶	Reserve Hours⁷	Total Hours⁸
A	b	c	d	e	f	G
FY-1						
FY-2						
FY-3						

Name and Signature of the Auditor

Date

³ Total number of hours the unit was operated

⁴ Total number of hours the unit was on scheduled maintenance.

⁵ Total number of hours the unit was in forced outage state

⁶ Equivalent Partial Forced Outage Hours: As defined in Form-2

⁷ Total number of hours the unit was capable of running, but not operated owing to dispatch instructions

⁸ Total hours in the fiscal year (8760 hours in normal years and 8784 hours in a leap year)

**Energy Audit of Power Plant
Record of Meter Testing**

Name of Power Plant:

Meters	Date of last test	Results of test	Corrective actions (if any)
Energy (kWh) meter at generator terminal			
Energy (kWh) meter at high voltage side of unit transformer			
Fuel supply meter for supply to plant			
Calorific value of fuel			

Name and Signature of the Auditor

Date:

Energy Audit of Power Plant
Heat Rate /Efficiency of Power Plant

Fuel: Gas

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	Gas consumed (Million SCM⁹)	Gas consumed per unit generation SCM/kWh	Calorific value of gas (LHV¹⁰) kCal/SCM	Heat Rate (kCal/kWh)	Efficiency (%)
A	B	C	d=c/b	e	f=d * e	g= (860/f)*100
FY-1						
FY-2						
FY-3						

Signature:

Name:

Designation:

⁹ SCM is Standard Cubic Meter of gas volume measured at 15° C and 1 atmosphere.

¹⁰ LHV is Lower Heating Value of gas.

Energy Audit of Power Plant
Heat Rate /Efficiency of Power Plant
Fuel: Diesel (HSD)

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	Total Fuel consumed (Million litre)	Fuel consumed per unit generation (litre/kWh)	Calorific value of HSD kCal/litre	Heat Rate (kCal/kWh)	Efficiency (%)
A	B	C	d=c/b	e	f=d * e	g= (860/f)*100
FY-1						
FY-2						
FY-3						

Signature:

Name:

Designation:

Energy Audit of Power Plant
Heat Rate /Efficiency of Power Plant
Fuel: Furnace Oil (FO)

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	Total Fuel consumed (Million litre)	Fuel consumed per unit generation (litre/kWh)	Calorific value of FO kCal/litre	Heat Rate (kCal/kWh)	Efficiency (%)
A	B	C	d=c/b	e	f=d * e	g= (860/f)*100
FY-1						
FY-2						
FY-3						

Signature: -----

Name: -----

Designation: -----

Energy Audit of Power Plant
Heat Rate /Efficiency of Power Plant

Fuel: Coal

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	Total Fuel consumed (Million Ton)	Fuel consumed per unit generation (kg/kWh)	Calorific value of Coal (kCal/kg)	Heat Rate (kCal/kWh)	Efficiency (%)
A	B	C	$d=c/b*1000$	e	$f=d * e$	$g= (860/f)*100$
FY-1						
FY-2						
FY-3						

Signature:

Name:

Designation:

Energy Audit of Power Plant
Availability Factor and Forced Outage Rate

Name of Power Plant:

Fiscal Year	Service Hours¹¹	Main-tenance Hours¹²	Forced Outage Hours¹³	Reserve Hours¹⁴	Total Hours¹⁵	Equiv-alent Partial Forced Outage Hours¹⁶	Equiv-alent Forced Outage Rate (%)¹⁷	Availability Factor (%)¹⁸
A	B	c	D	e	f	g	h	I
FY-1								
FY-2								
FY-3								

Signature:

Name:

Designation:

¹¹ Total number of hours the unit was operated.

¹² Total number of hours the unit was on scheduled maintenance.

¹³ Total number of hours the unit was in Forced Outage state.

¹⁴ Total number of hours the unit was capable of running but not operated owing to dispatch instructions.

¹⁵ Total number of hours in the fiscal year 8760 hours in a normal year and 8784 hours in a leap year

¹⁶ Equivalent Partial Forced Outage Hours: As defined in Form-2

¹⁷ Equivalent Forced Outage Rate = $((d+g)/(d+g+b)) * 100$

¹⁸ Availability Factor = $((f-(c+d+g))/f) * 100$

Energy Audit of Power Plant

Auxiliary Consumption

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	Auxiliary Consumption (GWh)	Net Generation (GWh)	Auxiliary Consumption (%)
a	B	C	d=b-c	e=(c/b)*100
FY-1				
FY-2				
FY-3				

Signature:

Name:

Designation:

Energy Audit of Power Plant

Greenhouse Gas Emissions

Name of Power Plant:

Fiscal Year	Gross Generation (GWh)	GHG Emissions (Tons of CO₂ Equivalent)	GHG Emissions (grams CO₂ equivalent/kWh)
A	b	c	d=c/b
FY-1			
FY-2			
FY-3			

Signature:

Name:

Designation:

Energy Audit of Power Plant

KPI Comparison

Name of Power Plant:

No.	Key Performance Indicator	Power Plant Performance	Design value	Industry Benchmark
1.	Gross/Net Heat Rate (kCal/kWh)			
2.	Auxiliary Consumption (% of Gross generation)			
3.	Availability Factor (%)			
4	Equivalent Forced Outage Rate (%)			
5	Current Gross Capacity (MW)			-
6	GHG Emissions (grams CO ₂ equivalent/kWh)		-	

Signature:

Name:

Designation: