16th NATIONAL CERTIFICATION EXAMINATION FOR ENERGY MANAGERS & ENERGY AUDITORS – September, 2015

PAPER – 1: GENERAL ASPECTS OF ENERGY MANAGEMENT & ENERGY AUDIT

Date: 19.09.2015 Timings: 0930-1230 HRS Duration: 3 HRS Max. Marks: 150

General instructions:

- *Please check that this question paper contains **11** printed pages*
- *Please check that this question paper contains **64** questions*
- *The question paper is divided into three sections*
- *All questions in all three sections are compulsory*
- *All parts of a question should be answered at one place*

Section – I: OBJECTIVE TYPE **Marks: 50 x 1 = 50**

(i) Answer all **50** questions
(ii) Each question carries one mark
(iii) Please hatch the appropriate oval in the OMR answer sheet with Black Pen, as per instructions

1.	Which one is not a consequence of global warming a) rise in global temperature b) rise in sea level c) food shortage and hunger d) <u>fall in global temperature</u>
2.	Which of the following will not be a major component of mass balance a) steam b) water c) raw materials d) <u>lubricating oil</u>
3.	Which of the following terms does not refer to specific energy consumption a) kWh/ton b) kCal/ton c) kJ/kg d) <u>kg/kCal</u>
4.	Which of the following GHGs has the longest atmospheric life time a) CO_2 b) Sulfur Hexafluoride (SF_6) c) CFC d) <u>Per FluoroCarbon (PFC)</u>
5.	Which of the following comes under mandatory labeling programme a) diesel Generators b) induction motors <u>c) tubular Fluorescent Lamps</u> d) LED lamps
6.	Transit time method is used in which of the instrument a) lux meter b) <u>ultrasonic flow meter</u> c) pitot tube d) fyrite
7.	To improve the boiler efficiency, which of the following needs to be done

	a) maximize O_2 in flue gas b) <u>maximize CO_2 in flue gas</u> c) minimize CO_2 in flue gas d) maximize CO in flue gas
8.	The simplest technique for scheduling of tasks and tracking the progress of energy management projects is called a) <u>Gantt chart</u> b) CPM c) PERT d) WBS
9.	The ratio of wind power in the wind actually converted into mechanical power and the power available in the wind is about a) 75% b) <u>59%</u> d) 44% e)10%
10.	The quantity of heat required to raise the temperature of 1 kg of water by 1 ^{O}C is termed as a) latent heat b) one kilojoule c) <u>one kilo calorie</u> d) none of the above
11.	The present value of Rs. 1,000 in 10 years' time at an interest rate of 10% is a) Rs. 2,594 b) <u>Rs. 386</u> c) Rs. 349 d) Rs. 10,000
12.	The number of moles of water contained in 54 kg of water is ---------- a) 2 **b) <u>3</u>** c) 4 d) 5
13.	The monthly electricity bill for a plant is Rs. 100 lakhs which accounts for 45% of the total monthly energy bill. How much is the plant's monthly energy bill a) <u>Rs 222.22 lakhs</u> b) Rs 45 lakhs c) Rs 138 lakhs d) None of above
14.	The major share of energy loss in a thermal power plant is in the a) generator b) boiler c) <u>condenser</u> d) turbine
15.	The ISO standard for Energy Management System is a) ISO 9001 b) <u>ISO 50001</u> c) ISO 140001 d) None of the above
16.	The indicator of energy performance in a thermal power plant is a) heat rate (kCal/kWh) b) % aux. power consumption c) specific coal consumption d**)** <u>all the above</u>
17.	The fixed energy consumption for the company is 1,000 kWh. The slope in the energy – production chart is found to be 0.3. Find out the actual energy consumption if the production is 80,000 Tons a) <u>25,000</u> b) 24,000 c) 26,000 d) 23,000
18.	The cost of replacement of inefficient compressor with an energy efficient compressor in a plant was Rs 50 lakhs. The net annual cash flow is Rs 12.5 lakhs. The return on investment is a) 15% b) 20% c) <u>25%</u> d) 19.35%
19.	The contractor provides the financing and is paid an agreed fraction of actual savings achieved. This payment is used to pay down the debt costs of equipment and/or services. This is known as a)traditional contract b) extended technical guarantee/service c) performance contract d) <u>shared savings performance contract</u>

20.	PERT/CPM provides which of the following benefits a) predicts the time required to complete the project b) shows activities which are critical to maintaining the schedule c) graphical view of the project d) all the above
21.	Input fuel of fuel cell a) petrol b) hydrogen c) nitrogen d) natural gas
22.	In India power sectors consumes about_____% of the coal produced a) 75% b) 50% c) 25% d) 90%
23.	In an industry the average electricity consumption is 5.8 lakhs kWh for the period, the average production is 50,000 tons with a specific electricity of 11 kWh/ton for the same period. The fixed electricity consumption for the plant is a) 58000 kWh b) 30000 kWh c) 80000 kWh d) none of the above
24.	In a drying process, moisture is reduced from 60% to 30%. Initial weight of the material is 200 kg. Calculate the weight of the product a) 104 b) 266.6 c) 130 d) 114.3
25.	In a DG set, the generator is consuming 400 litres per hour diesel oil. If the specific fuel consumption of this DG set in 0.30 litres/kWh at that load then what is the kVA loading of the set at 0.6 power factor a) 1200 KVA b) 2222 KVA c) 600 KVA d)1600 KVA
26.	In a 50 Hz AC cycle, the current reverses directions _____ times per second a) 50 times b) 100 times c) Two times d) 25 times
27.	If we heat the air without changing absolute humidity, % relative humidity will a) increase b) decrease c) no Change d) can't say
28.	If the pressure of water is 0.7 kg/cm^2 then boiling point will be approximately a) 100 b) 73 c) 114 d) Can't say
29.	If heat rate of power plant is 860 kcal/kWh then the cycle efficiency of power plant will be a) 41% b) 55% c**) 100%** d) 86%
30.	If air consists of 77% by weight of nitrogen and 23% by weight of oxygen, the mean molecular weight of air is a) 11.9 b) 28.8 c) 17.7 d) insufficient data
31.	How much power generation potential is available in a run of river mini hydropower plant for a flow of 40 liters/second with a head of 24 metres. Assume system efficiency of 60% a) 5.6 kW b) 9.4 kW c) 4.0 kW d) 2.8 kW
32.	Fuel cell using methanol as anode and oxygen as cathode is

	a) proton exchange membrane fuel cell b) phosphoric acid fuel cell b) alkaline fuel cell d) direct methanol fuel cell
33.	For expressing the primary energy content of a fuel in tonnes of oil equivalent (toe) which of the following conversion factors is appropriate a) toe=1x10^6 kcal b) toe=116300 kwh c) toe=41.870 GJ d) all the above
34.	For calculating plant energy performance which of the following data is not required a) current year's production b) reference year's production c) reference year energy use d) capacity utilization
35.	ESCerts cannot be a) bought b) sold c) banked for next cycle d) traded directly between DCs
36.	Energy intensity is the ratio of a) fuel consumption / GDP b) GDP/fuel consumption c) GDP/ energy consumption d) energy consumption / GDP
37.	Costs associated with the design, planning, installation and commissioning of a project are a) variable costs b) capital costs c) salvage value d) none of the above
38.	At standard atmospheric pressure, specific enthalpy of saturated water, having temperature of 50 ^{O}C will be _____ kcal/kg a) 1 b) 50 c) 100 d) Can't say
39.	AT & C losses means a) administration transmission and commercial b) aggregate technical and commercial c) average technical and commercial d) none of the above
40.	As per primary commercial energy consumption mix in India, the fuel dominating the energy production mix in India is a) natural gas b) oil c) coal d) nuclear energy
41.	An oil-fired boiler operates at an excess air of 6 %. If the stoichiometric air fuel ratio is 14 then for an oil consumption of 100 kg per hour, the flue gas liberated in kg/hr would be a)1484 b) 1584 c) 106 d) 114
42.	An activity has an optimistic time of 15 days, a most likely time of 18 days and a pessimistic time of 27 days. What is the expected time a) 60 days b) 20 days **c**) 19 days d) 18 days
43.	Among which of the following fuels, the difference between the GCV and NCV is maximum a) coal b) furnace Oil c) natural gas d) rice husk
44.	A waste heat recovery system costs Rs. 54 lakhs and Rs. 2 lakhs per year to operate and maintain. If the annual savings is Rs. 20 lakhs, the payback period will be

	a) 8 years b) 2.7 years c) 3 years d) 10 years
45.	A process requires 10 Kg of fuel with a calorific value of 5000 kcal/kg. The system efficiency is 80% and the losses will be a) 10000 kcal b) 45000 kcal c) 500 kcal d) 2000 kcal
46.	A centrifugal pump draws 12 m^3/hr. Due to leakages from the body of the pump a continuous flow of 2 m^3/hr is lost. The efficiency of the pump is 55%. The flow at the discharge side would be a) 12 m^3/hr b) 10 m^3/hr c) 5.5 m^3/hr d) 6.6 m^3/hr
47.	A 400W lamp was switched on for 10 hours per day. The supply volt is 230V (current= 2 amps & PF= 0.8). What is the energy consumption per day a) 3.68 kWh b) 6.37 kWh c) 0.37 kWh d) 4.0 kWh
48.	20 m^3 of water is mixed with 30 m^3 of another liquid with a specific gravity of 0.9. The volume of the mixture would be a) 47 m^3 b) 48 m^3 c) 50 m^3 d) 53 m^3
49.	100 tons of coal with a GCV of 4200 kcal/kg can be expressed in 'tonnes of oil equivalent' as a) 42 b) 50 c) 420 d) 125
50.	1 kg of wood contains 15% moisture and 7% hydrogen by weight. How much water is evaporated during complete combustion of 1 kg of wood a) 0.78 kg b) 220 grams c) 0.15 kg d) 0.63 kg

……. End of Section – I ……..

Section – II: SHORT DESCRIPTIVE QUESTIONS **Marks: 8 x 5 = 40**

(i) Answer all **Eight** questions
(ii) Each question carries **Five** marks

S-1	A gas fired water heater heats water flowing at a rate of 20 litres per minute from 25^0 C to 85^{o}C. If the GCV of the gas is 9200 kcal/kg, what is the rate of combustion of gas in kg/min (assume efficiency of water heater as 82%)
	Solution: Volume of water heated = 20 liters/min Mass of water heated = 20 Kg/min Heat supplied by gas * efficiency = Heat required by water. … 1 mark Mass of gas Kg/min * 9200 * 0.82 = 20 Kg/min * 1 kcal/Kg/^{o}C)* (85-25)^{o}C

	… 1 mark Mass of gas Kg/min = (20*1*60)/ (9200*0.82) = 0.159 Kg/ min. …. 3 marks
S-2	Calculate the net present value over a period of 3 years for a project with the following data. The discount rate is 12%.

Year	Investment (Rs)	Savings (Rs)
0	75,000	
1		25,000
2		75,000
3	50,000	75,000
4		35,000

	Ans: NPV = - 75,000 + 25,000/(1+0.12) + 75,000/$(1+0.12)^2$ + (75,000 – 50,000)/$(1+0.12)^3$ …… 3 marks = -75,000 + 22,321 + 59,789 + 17, 794 = 24,904 Rs. …… 2 marks
S-3	In a process plant, an evaporator concentrates a liquor containing solids of 6% by w/w (weight by weight) to produce an output containing 30% solids w/w. calculate the evaporation of water per 500 kgs of feed to the evaporator.
	Solution : Inlet solid contents = 6 % Output solid contents = 30% Feed = 500 kgs Inlet solid content in kg in feed = 500 x 0.06 = 30 kg …… 1 mark Outlet solid content in kg = 30 kg …… 1 mark Quantity of water evaporated = [500 – {(30 / 30) x 100}] = 400 kg. …… 3 marks
S-4	List down at least five schemes of BEE under the Energy Conservation Act – 2001
	Ans: Schemes of BEE under the Energy Conservation Act - 2001 are as follows: • Energy conservation building codes (ECBC) • Standards and labeling (S&L) • Demand side management (DSM) • Bachat Lamp Yojana (BLY) • Promoting energy efficiency in small and medium enterprises (SME's) • Designated consumers • Certification of energy auditors and energy managers

	….. (5 marks for any of the above five schemes)
S-5	What parameters are measured with the following instruments? a) Pitot tube b) Stroboscope c) Fyrite d) Psychrometer e) Anemometer
	Ans: a. Pitot tube — Static, Dynamic and Total Pressure of Gas b. Stroboscope — Speed, RPM c. Fyrite — CO_2 % or O_2 % d. Psychrometer — Dry Bulb Temperature and Wet Bulb Temperature e. Anemometer — Air or wind velocity …… (1 mark each)
S-6	What are ESCerts and explain the basis for their issue and trading under PAT scheme ?
	PAT scheme provides the option for industries who achieve superior savings to receive energy savings certificates for this excess savings, and to trade the additional certified energy savings certificates with other designated consumers (energy intensive industries notified as Designated Consumers under the Energy Conservation Act and included under PAT Scheme) who can utilize these certificates to comply with their specific energy consumption reduction targets. Energy Savings Certificates (ESCerts) so issued will be tradable at Power Exchanges. The scheme also allows units which gain ESCerts to bank them for the next cycle of PAT, following the cycle in which they have been issued. ….. (5 marks)
S–7	Pressure of a nitrogen gas supplied to an oil tank for purging is measured as 100 mm of water gauge when barometer reads 756 mm of mercury. Determine the volume of 1.5 kg of this gas if it's temperature is 25 ^{0}C. Specific gravity of mercury: 13.6. Take R = 8.3143 kJ/(kMol x K)
	Ans: Nitrogen pressure = 100 mm of Water Gauge = 100 / 13.6 = 7.353 mm of Hg **…..** (0.5 mark) Absolute Temperature, T = 25 + 273 = 298 K, Mass = 1.5 kg & Barometric pressure = 756 mm of Hg. Absolute pressure = 756 + 7.353 = 763.353 mm of Hg **…..** (0.5 mark) Pressure, P = Density, (kg/m^3) x Gravity, g (m/s^2) x Mtr of Liquid, h (Mtr) / 1000 = (13,600 x 9.81 x 0.763)/1000 = 101.79 kPa

	….. (1.5 marks) Molar mass of Nitrogen = 28 kg/kMol. Number of kMol, n = Mass / Molar Mass = 1.5/ 28 = 0.0536 kMol **……**(1 mark) Using the ideal gas equation and putting the above values; PV = nRT 101.79 x V = 0.0536 x 8.3143 x 298 V = 1.395 m^3 **…..** (1.5 marks)
S–8	Distinguish between designated agency and designated consumer as per energy conservation act 2001
	Ans: Designated Agency: Designated agency means an agency which coordinates, regulates and enforces of Energy Conservation Act 2001within a state. ..… (2.5 marks) Designated Consumer: Designated consumer means any users or class of users of energy in the "energy intensive industries and other establishments" specified in Schedule as designated consumer. ..… (2.5 marks)

……. End of Section – II ……..

Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 6 x 10 = 60

(i) Answer all **Six** questions
(ii) Each question carries **Ten** marks

L - 1	a) A furnace heating steel ingots is fired with oil having a calorific value of 10,500 kCal/kg and efficiency of 75%. Calculate the oil consumption per hour when the throughput of the furnace is 50 TPH and the temperature of the finished product is 600 ^oC. Take ambient temperature as 30 ^oC and Specific Heat of Steel as 0.12 kCal/kg ^oC b) In Steel industry, different types of gases are generated during steel making process. Volumetric Flow rate and Calorific Values of each gases are:

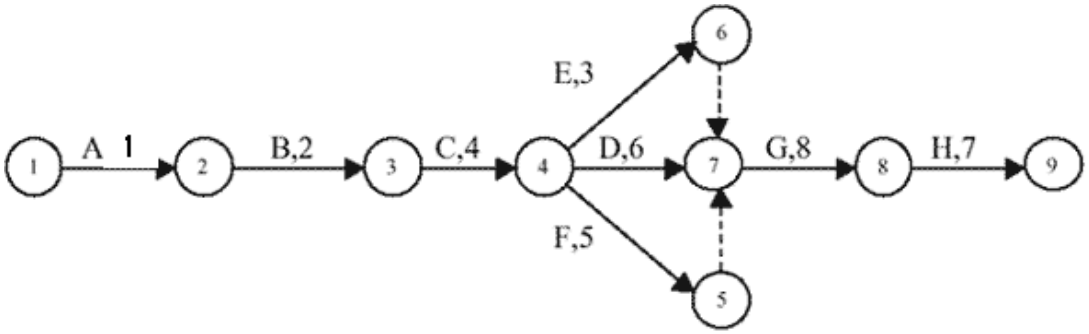
Type of Gas	Flow (SM^3/hr)	CV (kCal/SM^3)
Coke Oven Gas	75,000	4,000
COREX Gas	50,000	2,000
BOF Gas	55,000	1,500
Blast Furnace Gas	80,000	700

	All these gases are mixed in the gas mixer before combustion. Find out the Calorific Value (in kCal/SM^3) of mix gas.
	Ans: a) Oil Consumption / hr $= \frac{50\ (TPH) \times 0.12\ (kCal/kg\ ^oC) \times (600 - 30)\ (^oC)}{0.75\ (\%) \times 10{,}500\ (kCal/kg)}$ = 0.43 TPH (5 marks) b) Total flow of Mix Gas = 75,000 + 50,000 + 55,000 + 80,000 = 2,60,000 SM^3/hr (1 mark) CV of Mix Gas = [(75,000 x 4,000) + (50,000 x 2,000) + (55,000 x 1,500) + (80,000 x 700)] / 2,60,000 = 2,071 kCal/SM^3 (4 marks)
L – 2	A) Briefly explain the following terms with respect to energy management? I. Normalizing II. Benchmarking B) Explain the meaning of Fuel and Energy substitution with examples.
	Ans: A) I) Normalizing: The energy use of facilities varies greatly, partly due to factors beyond the energy efficiency of the equipment and operations. These factors may include weather or certain operating characteristics. Normalizing is the process of removing the impact of various factors on energy use so that energy performance of facilities and operations can be compared. …… (3 marks) II) Benchmarking: Comparison of energy performance to peers and competitors to establish a relative understanding of where our performance ranks. …… (2 marks) B) Fuel and Energy substitution with examples:

	Substituting existing fossil fuels/energy with more efficient and / or less cost/less polluting fuel. ….. (1 mark) Few examples of fuel substitution ▪ Natural gas is increasingly the fuel of choice as fuel and feedstock in the fertilizer, petrochemicals, power and sponge iron industries. ▪ Replacement of coal by coconut shells, rice husk etc. ▪ Replacement of LDO by LSHS …… (2 marks) Few examples of energy substitution ✓ Replacement of electric heaters by steam heaters. ✓ Replacement of steam based hot water by solar systems. …… (2 marks)
L - 3	The details of activities for a pump replacement project is given below: a) Draw a PERT chart b) Find out the duration of the project c) Identify the critical path.

Activity	Immediate Predecessors	Time (days)
A	-	1
B	A	2
C	B	4
D	C	6
E	C	3
F	C	5
G	D, E, F	8
H	G	7

Ans:

	 …..(6 marks) Duration = 28 days ….. (2 marks) Critical Path: A-B-C-D-G-H ….. (2 marks)
L – 4	The production capacity of a paper drying machine is 500 TPD and is currently operating at an output of 480 TPD. To find out the steam requirement for drying, the Energy Manager measures the dryness of the paper both at inlet and outlet of the paper drying machine which found to be 60% and 95% respectively. The steam is supplied at 4 kg/cm^2, having a latent heat of 510 kCal/kg. The evaporated moisture temperature is around 100 ^{0}C having enthalpy of 640 kCal/kg. Plant operates 24 hours per day. Assume only latent heat of steam is being used for drying the paper and neglect the enthalpy of the moisture in the wet paper. i) Estimate the quantity of moisture to be evaporated per hr. ii) Input steam quantity required for evaporation per hr.
	Ans: Output of the drying machine = 480 TPD with 95% dryness. Bone dry mass of paper at the output = 480 x 0.95 = 456 TPD …. (2 marks) Since the dryness at the inlet is 60%, Total mass of wet paper at the inlet = (456 x 100) / 60 = 760 TPD …..(2 marks) Moisture evaporated per hour = (760 – 480)/ 24 = 11.67TPH ….(3 marks) Mass of Steam, m = (11.67 x 640)/ 510 = 14.6 TPH …..(3 marks)
L - 5	Use CUSUM technique to develop a table and to calculate energy savings for 8 months period. For calculating total energy saving, average production can be taken as 6,000 MT per month. Refer to field data given in the table below.

Month	Actual SEC, kWh/MT	Predicted SEC, kWh/MT
May	1311	1335
June	1308	1335
July	1368	1335
Aug	1334	1335
Sept	1338	1335
Oct	1351	1335
Nov	1322	1335
Dec	1320	1335

Ans

Month	Actual SEC, kWh/MT	Predicted SEC, kWh/MT	Diff = (Act - Pred) (- = Saving)	CUSUM (- = Saving)
May	1311	1335	-24	-24
June	1308	1335	-27	-51
July	1368	1335	33	-18
Aug	1334	1335	-1	-19
Sept	1338	1335	3	-16
Oct	1351	1335	16	0
Nov	1322	1335	-13	-13
Dec	1320	1335	-15	-28

…..(7 marks)

Savings in energy consumption over a period of eight months are 28 x 6000 =<u>1,68,000 kWh</u>

…..(3 marks)

L-6 Write short notes on?

1. Time of the day tariff
2. Comparative label
3. Endorsement label
4. Benefits of ISO 50001

Solution:

1) In Time of the Day Tariff (TOD) structure incentives for power drawl during off-peak

hours and disincentives for power drawl during peak hours are built in.

- Many electrical utilities like to have flat demand curve to achieve high plant efficiency.
- ToD tariff encourage user to draw more power during off-peak hours (say during 11pm to 5 am, night time) and less power during peak hours. Energy meter will record peak and off-peak consumption and normal period separately.
- ToD tariff gives opportunity for the user to reduce their billing, as off peak hour tariff is quite low in comparison to peak hour tariff.
- This also helps the power system to minimize in line congestion, in turn higher line losses and peak load incident and utilities power procurement charges by reduced demand

….. (2.5 marks)

2) Comparative label: allow consumers to compare efficiency of all the models of a product in order to make an informed choice. It shows the relative energy use of a product compared to other models available in the market.

….. (2.5 marks)

3) Endorsement label: define a group of products as efficient when they meet minimum energy performance criteria specified in the respective product schedule/regulation/statutory order.

….. (2.5 marks)

4) ISO 50001 will provide the following benefits

- A framework for integrating energy efficiency into management practices
- Making better use of existing energy-consuming assets
- Benchmarking, measuring, documenting, and reporting energy intensity improvements and their projected impact on reductions in greenhouse gas (GHG) emissions
- Transparency and communication on the management of energy resources
- Energy management best practices and good energy management behaviours
- Evaluating and prioritizing the implementation of new energy-efficient technologies
- A framework for promoting energy efficiency throughout the supply chain
- Energy management improvements in the context of GHG emission reduction projects.

….. (2.5 marks)

……. End of Section – III ……..