Regn No: _____

Name: _____

(To be written by the candidates)

7th NATIONAL CERTIFICATION EXAMINATION – Nov. 2008
FOR
ENERGY MANAGERS & ENERGY AUDITORS

PAPER – 1:	**General Aspects of Energy Management & Energy Audit**		
Date: 22.11.2008	Timings: 0930-1230 HRS	Duration: 3 HRS	Max. Marks: 150

Paper 1

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 or Black HB Pencil, as per instructions

1	Secondary energy sources are a) coal b) thermal energy found in earth's interior c) potential energy due to earth gravity ✓ d) LPG, petrol & diesel
2	List the Sector which is not a Designated consumer as per the EC Act ✓ a) Glass b) Iron & Steel c) Thermal Power plants d) Chlor-alkali
3	Select the correct statement with respect to Nitrogen Oxide (NOx) ✓ a) it is formed during high temperature combustion process from the oxidation of nitrogen in the air and/or fuel b) it does not irritates the respiratory system c) in the absence of sunlight, it reacts with hydrocarbons to form ozone d) it combines with water vapour to form nitrogen
4	Choose the correct statement with respect to greenhouse gases a) they makeup only 10 percent of atmosphere b) methane and nitrous oxide are not greenhouse gases ✓ c) carbon dioxide is responsible for about 55-60 percent of the "enhanced greenhouse effect" d) the escape of slow moving re-emitted infrared radiation from the earth is accelerated by the greenhouse gases

Paper 1

5	Name the Act, which is proposed to bring the qualitative transformation of the power sector: a) Regulatory Commission Act 1998 b) Indian Electricity Act 1910 c) Energy Conservation Act 2001 d) Electricity Act 2003
6	Twenty barrels of crude oil is equivalent to------ litres a) 1600 litres b) 3200 litres c) 20,000 litres d) 4100 litres
7	When the current and voltage are in the same phase in an alternating current system, it is caused mainly due to a) pure resistive load b) pure capacitive load c) pure inductive load d) none of the above
8	The rate of energy transfer from a higher temperature to a lower temperature is measured in a) kCal b) Watt c) Watts per Second d) none of the above
9	A single phase induction motor is drawing 5 Ampere at 200 Volts. If the operating power factor of the motor is 0.80 and the motor efficiency is 60%, then the mechanical shaft power output of the motor is a) 1.0 kW b) 0.80 kW c) 0.48 kW d) 0.83 kW
10	A 15 kW motor is drawing 7.5 kW. If the rated efficiency of the motor at full load is 0.9, the % loading of the motor is. a) 50% b) 45% c) 90% d) none of the above
11	The term missing in the following equation for a 3 phase AC supply: Reactive Power = 1.7321 x V x I x _____ a) Cos Ø b) tan Ø c) cot Ø d) sine Ø
12	Calculate amount of electricity required to heat 1 bucket (15 lit) of water from 30 to 60^0C a) 450 kWh b) 0.52 kWh c) 1 kWh d) 2 kWh
13	Identify the substance having the highest specific heat from the following a) Lead b) Mercury c) Water d) Alcohol
14	The ideal role of an energy manger is a) To conduct energy audits in industries b) Intermediate player between top management, energy and cost centres of the plant c) In charge of the captive power plant and mediator between plant and Electricity boards d) Liaison with fuel suppliers
15	Energy manger should be well versed with a) Manufacturing and processing skills b) Managerial and technical skills c) Technical and marketing skills d) Managerial and commercial skills
16	Energy management does not include a) energy conservation b) fuel substitution c) reduction of waste d) decreasing unavoidable losses

Paper 1

17	Having an energy policy a) shows top management commitment b) satisfies mandatory provisions of EC Act c) indicates energy audit commitments d) satisfies mandatory requirement of environment policy
18	The enthalpy of air can be found out from a) PERT Chart b) Sankey diagram c) Psychrometric chart d) Mollier Chart
19	Water in a tank is heated from 30°C to 70°C by using steam indirectly in a heat exchanger. If 10 kgs of steam is used at a latent heat of 540 kCal/kg, the amount of water heated will be a) 200 litres b) 135 litres c) 300 litres d) 2000 litres
20	The total monthly electricity bill for a plant is Rs. 10 lakhs out of which Demand charges are Rs. 2 lakhs. Find out the unit electricity charges/kWh for 200000 Units consumption/month a) Rs. 3.5 b) Rs. 4 c) Rs. 3.8 d) Rs. 6
21	A 500 MW power plant boiler uses 300 tonnes of coal per hour at 88% boiler efficiency. A combustion optimization system retrofitted in the boiler improves its efficiency to 89% at the same level of steam generation. The resultant coal savings would be a) 3 TPH b) 3.4 TPH c) 17.7 TPH d) none of the above
22	Energy supplied by combustion of fuel is equal to a) mass of fuel consumed x its calorific value b) mass of fuel consumed x its density c) mass of fuel consumed x its specific heat d) mass of fuel consumed x temperature difference
23	The temperature of -40°C expressed in Fahrenheit is a) 32°F b) -40°F c) 72°F d) None of the above
24	An oil fired packaged boiler is converted to wood fired. Which of the following will be true? a) Reduction in steam generation rate b) Reduction in excess in air c) Reduction in dust emissions d) reduction in flue gas flow rate
25	An oil fired boiler operates at an excess air of 15%. If the stochiometric air to fuel ratio is 14 and oil consumption is 1000 kg per hour then the mass of flue gas leaving the boiler chimney in kg/ hour would be a) 17100 b) 16100 c) 15000 d) 16000
26	A 100 mm diameter pipe is carrying water at a velocity of 1.5 m/s. The flow rate in the pipe is. a) 42.4 m^3/hr b) 540 m^3/hr c) 66.67 m^3/hr d) 150 m^3/hr

Paper 1

27	Energy monitoring and targeting is built on the principle of "_____". a) "production can be reduced to achieve reduced energy consumption" b) "consumption of energy is proportional to production rate" c) "you cannot manage what you do not measure" d) none of the above.
28	Costs associated with the design, planning, installation and commissioning of a project are: a) variable costs b) capital costs c) salvage value d) none
29	An analysis which helps to bring into focus the positive and negative forces in an organisation is a) energy policy b) energy action planning c) energy analysis d) force field analysis
30	What does the concept of time value of money imply a) present value of money b) future value of money c) discounting of cash flows d) all of the above
31	The Internal Rate of Return (IRR), of an investment is calculated by a) selecting a discount rate so that NPV = 0 b) equating total discounted costs with total discounted benefits c) making sure the benefit / cost ratio equals unity d) all of the above
32	In a cumulative sum chart, if the graph is going up, it means a) energy consumption is increasing b) energy consumption is reducing c) specific energy consumption is increasing d) nothing can be said
33	In the material balance of a process which component will not be considered on the input side a) chemicals b) recycled products c) air & water d) by product
34	The ratio of annual net cash flow to capital cost is _____ a) Net present value b) Internal rate of return c) Return on investment d) Discount factor
35	A factor that reflects the risk of the project while evaluating the net present value for the expected future cash flow is: a) Discount rate b) Internal rate of return c) Capital Cost d) All of the above
36	A contract in which the costs are paid from all or part of the energy cost savings is called a) performance contract b) traditional contract c) extended technical guarantee contract d) guaranteed savings performance

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Bureau of Energy Efficiency

37	The annual energy consumption of a plant in the reference year 2006/2007 was 1 Lakh GJ. In the next year 2007/2008 it was 1.2 Lakh GJ. Calculate the plant energy performance (PEP), assuming no change in product mix and output quantity. a) –20% b) 20% c) –19.8% d) none of the above
38	A path is characterized by 4 parameters such as ES = earliest start time, EF= earliest finish time, LF = latest finish time, LS = latest start time. A path is critical if for all the activities in the path a) ES=EF and EF=LF b) ES=LS and EF=LF c) ES=LS and EF=LS d) LF=EF and EF=LS
39	Which of the following statements about critical path analysis (CPA) is true? a) The critical path is the longest path through the network b) The critical path is the shortest path through the network c) Tasks with float will never become critical d) The network should remain constant throughout the project
40	The major difference between CPM and PERT is a) CPM provides graphic and PERT does not b) CPM is an expansion of PERT c) PERT is an expansion of CPM d) CPM uses fixed time estimates while PERT uses three time estimates
41	The network model that allows for randomness in activity completion times is called a) CUSUM b) CPM c) PERT d) Gantt chart
42	A CUSUM graph follows a random fluctuation trend and oscillates around. a) 100 b) 100% c) 0 d) none of the above
43	The fixed energy consumption of a company is 2000 kWh per month. The line slope of the energy (y) versus production (x) chart is 0.3. The energy consumed in kWh per month for a production level of 90,000 tons/month is a) 180,000,000 b) 27,000 c) 29,000 d) 88,000
44	Assume project A has an IRR of 30% and NPV of Rs. 150,000 and project B has an IRR of 55% and NPV of Rs 25,000. Which project would you implement first if financing is available and project technical life is the same? a) Neither A nor B b) B c) A d) cannot be decided
45	The Calorific Value of coal is 4,200 kCal/ kg. Find out the oil equivalent of 1000 kg of coal if the Calorific Value of oil is 10,000 kCal/ kg a) 42,000 kg b) 96 kg c) 420 kg d) 128 kg
46	The ozone depletion process is due to a) Carbon Dioxide b) chlorine atoms destroying ozone molecules c) UV light breaking the ozone d) CFC molecule destroying ozone molecules
47	The commitment period for emission reductions of industrialized countries as per Kyoto protocol is a) since 2001 b) 2008 – 2012 c) there is none d) 2012 -2022

Paper 1

48	In CDM terminology CER means a) Carbon Emission Reduction b) Clean Environment Rating c) Certified Emission Reduction d) Carbon Emission Rating
49	India comes under which of the following category as per Kyoto protocol a) Annex I Parties b) Annex 2 Parties c) Annex 1 & 2 Parties d) Non Annex Parties
50	Under the Kyoto Protocol India has to cut emissions by a) 0% b) 5% c) 8% d) none of the above

-------- 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	Investment for an energy proposal is Rs.18 lakhs. Annual savings for the first two years is Rs. 4 lakhs each and subsequent two years Rs. 6 lakhs each and fifth year is Rs. 7 lakhs. Considering cost of capital as 10%, what is the net present value of the proposal? Is it worth investing in this project ?
	NPV = $-18/(1.10)^0 + 4/(1.10)^1 + 4/(1.10)^2 + 6/(1.10)^3 + 6/(1.10)^4 + 7/(1.10)^5$ -18 + 3.64 + 3.31 + 4.51 + 4.1 + 4.35 = -18 + 19.91 = +1.91 lakhs It is worth investing in the project
S-2	In a heat exchanger steam is used to heat 5 KL/ hour of furnace oil from 30° C to 90° C. The specific heat of furnace oil is 0.22 kCal/ kg/°C and the density of furnace.oil is 0.95. a) How much steam per hour is needed if steam at 4 kg/cm^2 with Latent heat of 510 kCal/ kg and sensible heat of. 143 kCal/ kg is used. b) if steam cost is Rs.3.50/ kg and electrical energy is Rs.5/kWh, which type of heating would be more economical in this particular case
	Total heat required = m Cp ΔT = (5 x1000x 0.95) * 0.22 * (90-30) = 62,700 kcal/hr Total heat of steam = 653 kcal/kg a) Amount of steam required = 62700/653 = 96 kg/hr Steam cost = 96 x Rs.3.50 = Rs.336 b) Amount of electricity required = 62700/860 = 72.9 kWh = 72.9 x Rs. 5 = Rs.364.5 Steam heating will be more economical
S-3	Define Sustainable development and give two examples of how it can be practiced in day to day life ?

	Sustainable development is often defined as 'development that meets the needs of the present, without compromising the ability of future generations to meet their own needs'. Any relevant answer related to Saving energy and Reducing wastes
S-4	In a textile stenter the input is 2000 kg of wet cloth per hour. The cloth contains 65% moisture at inlet and 5 % moisture remains in the output cloth. Find out the quantity of moisture removed per hour.
	1000 kg of wet cloth contains 2000 x 0.65 = 1300 kg of moisture And 2000 x (1-0.65) = 700 kg of bone dry cloth As the final cloth contains 10% moisture, the moisture in the product is 700/0.9 = 777 kg The moisture removed is 1300 – 777 = 523 kg/hr
S-5	What do you understand by energy management and energy efficiency ?
	ENERGY MANAGEMENT: The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. One definition of energy management is: "The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions" The objective of Energy Management is to achieve and maintain optimum energy procurement and utilisation, throughout the organization and: • To minimise energy costs / waste without affecting production & quality • To minimise environmental effects. **ENERGY EFFICIENCY** Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.
S-6	State any five components of the electricity bill charged to industrial consumers by an electric supply company.

	• Maximum demand charges • Energy charges • Power factor penalty or bonus • Electricity duty charges • Time of the day (ToD) tariffs • Meter rentals • Lighting and fan power consumption • Penalty for exceeding the contract demand • Surcharges
S-7	A thermal power plant uses 0.65 kg of coal to generate one kWh of electricity. If the coal contains 52% carbon by weight, calculate the amount of CO2 emissions/ kWh under complete combustion conditions. The Thermal power plant has saved 500000 kWh in a year in auxiliary power consumption by adopting energy conservation measures. Find out the amount of CERs (ton of CO_2/year) they would gain if the project comes under CDM
	$C + O_2$ ----------→ CO_2 12 32 44 1 kg of carbon gives 44/12 kg of carbon dioxide CO_2 emissions/kwh = 0.65x 0.52 x 44/12 = 1.24 kg of CO_2/kwh • Amount of Carbon emissions reduced by Unit = 500000 x 1.24 = 620 ton of CO_2/year = 620 CERs
S-8	In a industry's electrical system what is meant by load factor ? The energy consumed by a plant was 24,000 kWh over a day. The maximum load recorded during this time was 1600 kW. What is the load factor for that day
	It is the ratio of average load to maximum load. In other words, it is the ratio of energy consumed during a given period of time to the maximum energy demand if maximum load is maintained throughout that time period Load factor = 24,000/ (1600 x 24) = 62.5 %

-------- 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 The following are the cash flows for retrofitting of a cooling tower project.

YEAR	0	1	2	3	4
Cash flow	-12,30,000	3,00,000	4,00,000	4,00,000	4,00,000

Calculate the IRR for the project

Answer

$$0 = \frac{CF_0}{(1+r)^0} + \frac{CF_1}{(1+r)^1} + \ldots + \frac{CF_n}{(1+r)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} \quad (1)$$

$$\text{-12,30,000} = \frac{3,00,000}{(1.08)^1} + \frac{4,00,000}{1.08^2} + \frac{4,00,000}{1.08^3} + \frac{4,00,000}{1.08^4}$$

IRR = 8. %

L-2 A process industry is consuming the following energy per day

3000 kg of furnace oil for thermic fluid heater
5000 kg of coal and 3000 kg of rice husk for boiler
15,000 kWh of Purchased electricity from grid
10,000 kWh of self generated electricity through DG sets

Calorific values of fuels:

Furnace oil : 10,000 kCal/kg
Coal : 5000 Kcal/kg
Rice husk : 3000 Kcal/kg
HSD : 10,500 kCal/kg

Specific fuel consumption of DG sets: 3 kWh/kg of HSD

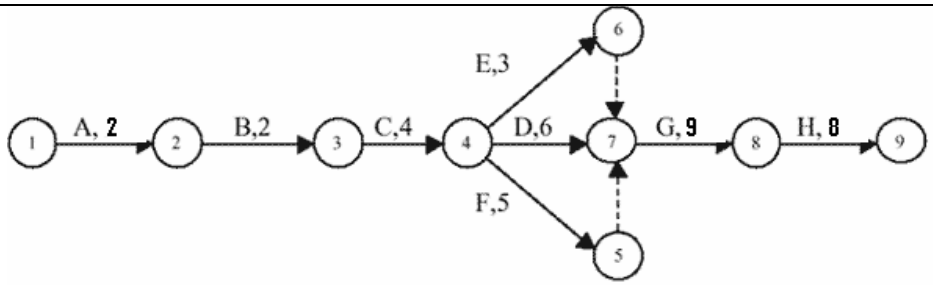
Calculate input energy consumption in terms of Metric Tonne of Oil Equivalent for the industry.

Diesel consumption = 10,000/3 = 3333.3 kg of Diesel per day

(3000 x 10000) + (5000 x 5000) + (3000 x 3200) + (15,000 x 860) + (3333.3 x 10,500)

	MTOE = $\frac{(3 \times 10^7) + (2.5 \times 10^7) + (0.9 \times 10^7) + (1.29 \times 10^7) + (3.5 \times 10^7)}{10^7}$ **= 11.19 Metric Tonnes of Oil Equivalent per day**
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	-	2
B	A	2
C	B	4
D	C	6
E	C	3
F	C	5
G	D, E, F	9
H	G	8



b) The Duration of the Project = 31 days

c) The Critical Path = 1-2-3-4-7-8-9

L-4 Write short notes on

a) Designated consumers
b) Standards and labeling
c) Energy conservation building codes
d) Role of certified energy manager

a) Designated consumers

The main provisions of the EC Act on designated consumers are:

a. The government would notify energy intensive industries and other establishments as designated consumers;

- Schedule to the Act provides list of designated consumers which covered basically energy intensive industries, Railways, Port Trust, Transport Sector, Power Stations, Transmission & Distribution Companies and Commercial buildings or establishments;
- The designated consumer to get an energy audit conducted by an accredited energy auditor;
- Energy managers with prescribed qualification are required to be

	appointed or designated by the designated consumers; • Designated consumers would comply with norms and standards of energy consumption as prescribed by the central government. **b) Standards and labeling** Standards and Labeling (S & L) has been identified as a key activity for energy efficiency improvement. The S & L program, when in place would ensure that only energy efficient equipment and appliance would be made available to the consumers. The main provision of EC act on Standards and Labeling are: • Evolve minimum energy consumption and performance standards for notified equipment and appliances. • Prohibit manufacture, sale and import of such equipment, which does not conform to the standards. • Introduce a mandatory labeling scheme for notified equipment appliances to enable consumers to make informed choices • Disseminate information on the benefits to consumers **c) Energy conservation building codes** The main provisions of the EC Act on Energy Conservation Building Codes are: • The BEE would prepare guidelines for Energy Conservation Building Codes (ECBC); • These would be notified to suit local climate conditions or other compelling factors by the respective states for commercial buildings erected after the rules relating to energy conservation building codes have been notified. In addition, these buildings should have a connected load of 500 kW or contract demand of 600 kVA and above and are intended to be used for commercial purposes; • Energy audit of specific designated commercial building consumers would also be prescribed.
L-5	a) For complete combustion of 1 kg of a typical coal 10 kg of air is required. Calorific value of coal is 4200 kCal/kg with ash content of 25%. What is the quantity (in kg/hr) flue gas generated by burning 100 kg coal/ hr? b) The furnace oil consumption in a boiler generating steam is 160 kg/hr and the total losses in the boiler is 22%. Calculate the amount of steam generated per hour by considering 600 kCal is required to generate 1 kg steam. Consider GCV of furnace oil as 10000 kCal/kg.
	a) Flue gas generated by burning the coal in the presence of air is: Flue gas quantity (per kg of coal) : combustion air + quantity of fuel- ash : 10 + 1 - 0.25 : 10.75 kg Quantity of flue gas by burning 5 kg of coal : 100x 10.75 = 1075 kg.

	b) FO consumption rate = 160 kg/hr GCV of FO = 10000 Kcal/kg Total Input energy = 160 x 10000 = 1600000 Kcal/hr Total Loss @ 22% = 1600000 x 0.22 = 352000 Kcal/hr Total energy available to generate steam = 1600000 x 0.78 = 12488000 Kcal/hr Total steam generated = 12488000 / 600 = 20813 kg/hr
L-6	An autoclave contains 1500 cans of pea soup. It is heated to an overall temperature of 100°C. If the cans are to be cooled to 40°C before leaving the autoclave, how much cooling water is required if it enters at 15°C and leaves at 35°C ? The specific heat of pea soup and the can metal are respectively 4.1 kJ/kg°C and 0.50 kJ/kg°C. The weight of each can is 75 g and it contains 0.50 kg of pea soup. Assume that the heat content of the autoclave walls above 40°C is 1.6 x 10^4 kJ and that there is no heat loss through the walls.
	Heat Entering: Heat in cans = weight of cans x specific heat x temperature above datum = 1500 x 0.075 x 0.50 x (100-40) kJ = 3.375 x 10^3 kJ Heat in can contents = weight pea soup x specific heat x temperature above datum = 1500 x 0.45 x 4.1 x (100 - 40) = 1.845 x 10^5 kJ Heat in water = weight of water x specific heat x temperature above datum = w x 4.186 x (15-40) = -104.6 w kJ. **Heat Leaving:** Heat in cans = 1500 x 0.075 x 0.50 x (40-40) (cans leave at datum temperature) = 0 Heat in can contents = 1500 x 0.50 x 4.1 x (40-40) = 0 Heat in water = w x 4.186 x (35-40) = -20.9 w **HEAT-ENERGY BALANCE OF COOLING PROCESS; 40°C AS *DATUM LINE*** Heat Entering (kJ) / Heat Leaving (kJ) Heat in cans 3375 — Heat in cans 0 Heat in can contents 184500 — Heat in can contents 0

	Heat in autoclave wall	16000	Heat in autoclave wall	0
	Heat in water	-104.6 w	Heat in water	-20.9 W
	Total heat entering	203875 -104.6 w	Total heat leaving	-20.9 W
	Total heat entering =		Total heat leaving	
	203875 – 104.6 w =		-20.9 w	
		w =	2436 kg	
	Amount of cooling water required = 2436 kg.			

-------- End of Section - III ---------