

**TECHNICAL PAPER ON ISSUE-24**

Data is collected from a chemical industry, which is having a cogeneration plant and a process plant. The product from process plant is result of a chemical exchange reaction that requires huge quantity of thermal energy and electrical energy. The cogeneration plant consists of coal fired boilers and double extraction condensing turbines which supply steam and electrical power to a process plant. The plant is connected to the state electricity grid so that electrical power can be imported/exported depending on the operating conditions. The plant uses HSD/FO as a start up and for flame stabilization. The data of consumption of fuels, steam and electrical energy generated etc. for the year 04-05 is used.

The raw data available is converted in to fruitful form by utilizing excel work sheets and Annexures 1 to 5 are developed. These Annexures are used for the data entry of form-1. After development of these only it has become easy to fill all the data.

While filling Form-1 following are the observations

- 1) Our contract demand is in MVA. Hence MD is given in MVA instead of KW as given in form-1
- 2) Under own generation the sum of electricity units utilized in the cogeneration plant and process plant are given. This is obtained by subtracting the units exported including colony from the total units generated by Turbo generators. However for the generation of these units, the coal and oil required are accounted under the coal & oil head consumptions as these cannot be accounted separately for electricity generation. This problem arised as the fuel consumed is being utilized for heat energy as well as electrical energy. Hence while accounting total fuel and electricity consumption in terms of KWH the own electricity units generated are not considered.
- 3) As the form – I is for total energy consumption and energy consumption for unit of production, the form –I is extended by adding the following.

Specific energy consumption in Kwh/kcal of cogeneration plant & specific energy consumption of process plant with reference to actual energy consumed by process plant and with reference to total energy consumption of CPP. Similarly specific energy cost of cogeneration plant & process plant is given. By separating the cogeneration plant and process plant it is helpful to monitor the performance of both independently so that preventive measures can be taken easily. However

combined energy indicators given are useful for assessing the total performance of the product & for assessing the final product cost.

Regarding data required for forms 2 & 3, the energy audit conducted by the internal teams during the financial year beginning is considered. All the energy conservation opportunities identified by team members along with opportunities cost and savings are considered.

Annexure –6 is developed for generating the data to fill the forms-2 & 3. The energy savings of steam are converted in to GCAL by considering the enthalpy of steam and electricity is converted in to KWH/MU. The costs are calculated using the specific energy cost in Rs/GCAL and export cost per KWH. The specific energy cost for the year 03-04 and export energy cost of Rs.2.5 are considered for arriving energy saving costs.

After development of the annexure-6 form-2 is filled taking the energy conservation schemes already adopted and form-3 with total proposed schemes. Life cycle is considered based on the life of the new equipment or remaining life of the plant whichever is minimum. The energy saving schemes adopted should be monitored at regular intervals for ensuring the savings anticipated. However the changes in operational conditions/ design criteria should be considered. Industries may be asked to submit the monitoring data of energy schemes adopted every year.

I believe that this issue made energy auditors & energy managers to give a thought how the available data can be converted in to reportable form, which is also useful for monitoring the energy consumption levels and saving opportunities.

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**Form - 1**  
**Format for Information regarding Total Energy Consumption and Energy Consumption per Unit of Production**

Name of the company : CHEMICAL PLANT

Full Address :

Contact Person :

Email address :

Telephone/ Fax numbers :

Plant Address :

A. Power and Fuel Consumption 2004/ 2005

1. Electricity

(a) Purchased

Contract demand	<u>10 MVA</u>
Connected load	<u>60 MVA</u>
Annual consumption	<u>31,54,000 kWh</u> (Ref. Annex-1 Col 8)

Total cost	<u>Rs 1,41,93,000 Lakhs</u> (Ref. Annex-2 Col 9)
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(b) Own Generation

(i) Through diesel generator

Annual generation	<u>NA</u> kWh
Annual diesel consumption	<u>NA</u> kilo liters
Total fuel costs	<u>NA</u> Rs. Lakhs

(ii) Through steam turbine/generator

Annual generation	<u>31,25,08,000 kWh</u> (Ref. Annex-1 Col 11)
Fuel used <sup>1</sup>	<u>C/C</u>

(iii) Through Gas Turbine

Annual generation	<u>NA</u> kWh
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2. Coal quality (Gross calorific value)

Annual consumption	<u>4,900 kCal/kg</u>
Total coal costs	<u>4,65,851</u> Tonnes (Ref. Annex-2 Col 2)
	<u>Rs. 69,87,76,500 Lakhs</u> (Ref. Annex-2 Col 6)

3. Oil

(i) Furnace oil

Annual consumption	<u>1430 kilo liters</u> (Ref. Annex-2 Col 3)
Annual costs	<u>Rs 2,22,75,110. Lakhs</u> (Ref. Annex-2 Col 7)

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<sup>1</sup> State which type of fuel or energy was used (C = coal, B = biomass, O = oil, G = gas, E = electricity). If coal was saved state which grade i.e. C/I = imported, or C/F coal of grade F.

- (ii) Low Sulphur Heavy Stock (LSHS)
  - Annual consumption NA Tonnes
  - Annual costs NA Rs. Lakhs
- (iii) Hot Heavy Stock (HHS)
  - Annual consumption NA Tonnes
  - Annual costs NA Rs. Lakhs

4. Diesel Oil

- (i) High Speed Diesel (HSD)
  - Annual consumption **559 kilo liters** (Ref. Annex-2 Col 4)
  - Annual costs **Rs.1,30,68,302** Lakhs(Ref. Annex-2 Col 8)
- (ii) Light Diesel Oil (LDO)
  - Annual consumption NA kilo liters
  - Annual costs NA Rs. Lakhs

5. Gas

- (i) Compressed Natural Gas (CNG)
  - Gross calorific value NA kCal/NM<sup>3</sup>
  - Annual consumption NA NM<sup>3</sup>
  - Annual costs NA Rs. Lakhs
- (ii) Liquefied Petroleum Gases (LPG)
  - Gross calorific value NA kCal/kg
  - Annual consumption NA Tonnes
  - Annual costs NA Rs. Lakhs
- (iii) Piped Natural Gas (PNG)
  - Gross calorific value NA kCal/NM<sup>3</sup>
  - Annual consumption NA NM<sup>3</sup>
  - Annual costs NA Rs. Lakhs

6. Biomass

- Average moisture content, as fired NA %
- Average Gross calorific value, as fired NA kCal/kg
- Annual consumption NA MT
- Annual biomass costs NA Rs. Lakhs

B. Product mix specifications<sup>2</sup>

Product name 1: <b>ELECTRICAL&amp;HEAT ENERGY</b>	<b><u>12,95,519.8 GCAL</u></b> (Ref. Annex-3 Col 14)
Product name 2: <b>CHEMICAL-A</b>	<b>242 TONS</b>
Product name 3: _____	_____ (units)
Product name 4: _____	_____ (units)

<sup>2</sup> For example if you are a cement manufacturing unit producing different grades of cement, you may like to say under product name 1: OPC grade – XXX Tonnes and under product name 2: Portland slag cement– XXX Tonnes and so on.

C. Specific Energy Consumption

Product name 1: **ELECTRICAL&HEAT ENERGY**                    **2070 KWH/GCAL** (Ref.Annex-4 Col 5)

Product name 2: **CHEMICAL-A**

a) With reference to actual energy consumed by process plant)

**4.42 GCAL/Kg** (Ref.Annex-4 Col 9)

b) with reference to total energy consumption of CPP excluding Product-1 energy

**7.88 GCAL/Kg** (Ref.Annex-5 Col 10)

C. Specific Energy Costs

Product name 1: **ELECTRICAL&HEAT ENERGY**                    **595.95 Rs/GCAL** (Ref.Annex-4 Col 6)

Product name 2: **CHEMICAL-A**

With reference to total energy cost of CPP excluding Product-1 cost

**2593 Rs/Kg** (Ref.Annex-5 Col 11)

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## Form - 2

### Format for reporting status of implementation of energy conservation measures based on business plan of the company

Sl. No.	Description of measure	Category <sup>3</sup>	Investment (Rupees)	Verified savings <sup>4</sup> (Rupees)	Verified energy savings	Units <sup>5</sup>	Fuel <sup>6</sup>
1	Maintenance of steam traps	1	5 lakhs	92,79,001.6	13180.4	GCAL	C/O
2	Improvement of Impellers & Air registers maintenance for better furnace stability & oil reduction	1	5000/-	9834.88	13.97	GCAL	C/O
3	Installation of automatic combustion control	2	5000/-	1,39,18,502.4	19770.6	GCAL	C/O
4	Improved furnace draft controller	2	5 lakhs	9,834.88	13.97	GCAL	C/O
5	Replacement of HPMV lamps with sodium vapour lamps	3	10,000/-	83,000	33,200	KWH	E
6	Installation of VSDs to TG condensate pumps	4	6 lakhs	12,45,000	4,98,000	KWH	E
7	Stage removal of Boiler water pumps	5	4 lakhs	58,10,000	23,24,000	KWH	E
8	Common headering of oil pumps	5	2 lakhs	2,49,000	99,600	KWH	E
9	Review of operation strategy and stopping of auxiliary cooling water pumps	5	NIL	31,12,500	12,45,000	KWH	E
10	Trimming of process cooling water pumps	5	3 lakhs	57,06,250	22,82,500	KWH	E
11	Reduction of air pressure from 8 bar to 6 bar	6	NIL	3,52,750	1,41,100	KWH	E
12	Improvement of Insulation of Steam pipes	7	3 lakhs	1,39,18,502.4	19770.6	GCAL	C/O
13	Heating of condensate from the process effluent	8	6 lakhs	92,79,001.6	13,180.4	GCAL	C/O
14	Transformers management	9	NIL	12,45,000	4,98,000	KWH	E
15	Optimization of excess air/reduction of blow down by improving water chemistry	12	2 lakhs	92,79,001.6	13,180.4	GCAL	C/O

<sup>3</sup> Use "C" number of form 3 as reference

<sup>4</sup> First year

<sup>5</sup> Use conventional energy, volume or mass units with proper prefix k = 10<sup>3</sup>, M = 10<sup>6</sup>, G = 10<sup>9</sup>

<sup>6</sup> State which type of fuel or energy was saved (C = coal, B = biomass, O = oil, G = gas, E = electricity). If coal was saved state which grade i.e. C/I = imported, or C/F coal of grade F.

### Form - 3

## Executive Summary of appraised Energy Conservation potential as identified in energy auditor report

C. No.	Area of improvement and modification	Investment Lakh Rs.	First year energy <sup>7</sup> savings					First year cost reduction <sup>8</sup> , Lakh Rs.					Life cycle years <sup>9</sup>
			oil	gas	coal	electricity	other	oil	gas	coal	electricity	other	
1.	Better house keeping measures	10.05	4 kl/day				2MT/h steam	.098				9.28	3
2.	Installation of improved process monitoring and control instrumentation, or software	10.1	4 kl/day				3MT/h steam	.098				13.9	10
3.	Measures in the area of lighting	0.1				33.2 Mwh					0.83		2
4.	Sizing, changing and controlling electric motors including variable speed drives	6				498 Mwh					12.45		10
5.	Retrofitting, modification or sizing of fans, blowers, pumps, including duct systems	28				8042.7 Mwh					201		10
6.	Performance improvement of compressors and compressed air distribution system	2				473 Mwh					11.8		10
7.	Improved insulation against heat or cold losses	3					3MT/h steam					13.9	3
8.	Recovery of waste heat for process heat or power generation	10					2MT/h steam					9.28	
9.	Loss reduction in transformers and power distribution within firm	NIL				498 Mwh					12.45		
10.	Fuel switching measures from fossil to fossil or fossil to renewable energy	NIL				NIL					NIL		

<sup>7</sup> Use commercial units of litre, kg, tons, normal cubic meter, kWh or MWh and indicate the unit. Indicate the anticipated potential in energy savings.

<sup>8</sup> Anticipated cost savings in the first year based on anticipated fuel savings.

<sup>9</sup> Estimate the predicted life of the measure, meaning the number of years the level of first year energy savings or even larger amounts will materialise.

C. No.	Area of improvement and modification	Investment Lakh Rs.	First year energy savings					First year cost reduction, Lakh Rs.					Life cycle years
			oil	gas	coal	electricity	other	oil	gas	coal	electricity	other	
11.	Improvement of prime mover performance such as gas, steam, water, turbines or internal combustion engines	400				24.9 MU					622		10
12.	Improvement of steam boilers and reduction of losses in steam distribution lines	2					2MT/h steam					9.28	10
13.	Modernization measures with benefits of energy consumption reduction	200					4MT/h steam					186	10

Name of the company :

Full Address :

Contact Person :

Email address :

Telephone/ Fax numbers :

Plant Address :



## ANNEXURE-II

### COST OF ENERGY MIX (MONTHLY BASIS)

COST OF COAL /TON IN Rs.	1500
COST OF FO/KL IN Rs.	15577
COST OF HSD/KL IN Rs.	23378
COST OF ELECTRICAL ENERGY IMPORT IN Rs	4.5
COST OF ELECTRICAL ENERGY EXPORT IN Rs.	2.5

MONTH & YEAR 1	COAL CONSUMED IN TONS 2	FO CONSUMED IN KL 3	HSD CONSUMED IN KL 4	ELECTRICAL ENERGY IMPORTED IN KWH 5	COST OF COAL CONSUMED IN RS 6	COST OF FO CONSUMED IN RS 7	COST OF HSD CONSUMED IN RS 8	COST OF MD CHARGES 9	COST OF ELECTRICAL ENERGY IMPORTED IN RS 10	TOTAL COST OF ENERGY CONSUMED IN RS 11(5+6+7+8+10)
Apr-04	39046	110	51	194000	58569000	1713470	1192278	1560000	873000	63907748
May-04	38585	135	69	226000	57877500	2102895	1613082	1691625	1017000	64302102
Jun-04	41987	50	25	204000	62980500	778850	584450	1560000	918000	66821800
Jul-04	42422	80	30	198000	63633000	1246160	701340	1560000	891000	68031500
Aug-04	42833	120	13	198000	64249500	1869240	303914	1560000	891000	68873654
Sep-04	25736	340	193	370000	38604000	5296180	4511954	1604304	1665000	51681438
Oct-04	40265	140	40	706000	60397500	2180780	935120	1581879	3177000	68272279
Nov-04	39962	0	25	192000	59943000	0	584450	1560000	864000	62951450
Dec-04	41531	120	28	198000	62296500	1869240	654584	1560000	891000	67271324
Jan-05	38920	130	34	268000	58380000	2025010	794852	1759134	1206000	64164996
Feb-05	34861	205	47	200000	52291500	3193285	1098766	1560000	900000	59043551
Mar-05	39703	0	4	200000	59554500	0	93512	1560000	900000	62108012
	<b>465851</b>	<b>1430</b>	<b>559</b>	<b>3154000</b>	<b>698776500</b>	<b>22275110</b>	<b>13068302</b>	<b>19116942</b>	<b>14193000</b>	<b>767429854</b>

## ANNEXURE-III

### PRODUCTION IN GIGA CALORIES (MONTHLY BASIS)

ENTHALPY OF HPRC STEAM IN KCAL/KG	235.3
ENTHALPY OF LPRC STEAM IN KCAL/KG	100
ENTHALPY OF HP STEAM IN KCAL/KG	672.4
ENTHALPY OF LP STEAM IN KCAL/KG	667.3

MONTH & YEAR 1	PROCESS STEAM-1 TO PROCESS PLANT IN TONS 2	PROCESS STEAM-2 TO PROCESS PLANT IN TONS 3	PROCESS STEAM-1 RETURN CONDENSATE FROM PROCESS PLANT IN TONS 4	PROCESS STEAM-2 RETURN CONDENSATE FROM PROCESS PLANT IN TONS 5	ELECTRICAL ENERGY TO PROCESS PLANT IN MU 6	EXPORT IN MU 7	PROCESS STEAM-1 ENERGY SUPPLIED IN GCAL 8	PROCESS STEAM-2 ENERGY SUPPLIED IN GCAL 9	PROCESS STEAM-1 RETURN CONDENSATE ENERGY RECEIVED IN GCAL 10	PROCESS STEAM-2 RETURN CONDENSATE ENERGY RECEIVED IN GCAL 11	ELECTRICAL ENERGY TO PROCESS PLANT IN GCAL 12	ELECTRICAL ENERGY EXPORTED INCLUDING COLONY IN GCAL 13	TOTAL ENERGY PRODUCTION OF CPP IN GCAL 14(8+9-10-11+12+13)
Apr-03	174983	10218	117239	3371.9	19.71	0.138	117658.57	2250.0956	27586.24	337.19	16950.6	366.36	109302.19
May-03	173098	9047	115976	2985.5	20.806	0.226	116391.1	1992.2308	27289.07	298.55	17893.2	442.04	109130.9
Jun-03	179011	11178	119937	3688.7	21.63	0.078	120367	2461.4962	28221.26	368.87	18601.8	314.76	113154.92
Jul-03	182623	12875	122357	4248.8	22.354	0.108	122795.71	2835.1909	28790.7	424.88	19224.4	340.56	115980.32
Aug-03	176528	14023	118274	4627.6	21.57	0.038	118697.43	3087.9908	27829.82	462.76	18550.2	280.36	112323.4
Sep-03	112433	13132	75330.1	4333.6	13.09	0.344	75599.949	2891.7846	17725.17	433.36	11257.4	543.52	72134.123
Oct-03	178239	18152	119420	5990.2	19.768	0.288	119847.9	3997.2338	28099.56	599.02	17000.5	495.36	112642.4
Nov-03	173610	18086	116319	5968.4	19.154	0.075	116735.36	3982.7	27369.79	596.84	16472.4	312.18	109536.06
Dec-03	180902	18013	121204	5944.3	19.616	0.288	121638.5	3966.6247	28519.38	594.43	16869.8	495.36	113856.44
Jan-04	175342	17795	117479	5872.4	19.06	0.1167	117899.96	3918.6192	27642.84	587.24	16391.6	348.042	110328.15
Feb-04	163173	17351	109326	5725.8	17.764	0.08	109717.53	3820.8464	25724.39	572.58	15277	316.48	102834.92
Mar-04	181357	18911	121509	6240.6	19.894	0.0533	121944.45	4164.3724	28591.11	624.06	17108.8	293.518	114296
						<b>1.833</b>							<b>1295519.8</b>

## ANNEXURE-4

### ENERGY INDICATORS (MONTHLY BASIS)

MONTH & YEAR 1	TOTAL ENERGY CONSUMPTION OF CPP IN KWH 2	TOTAL COST OF ENERGY CONSUMED BY CPP IN Rs. 3	TOTAL ENERGY PRODUCTION OF CPP IN GCAL 4	SPECIFIC ENERGY CONSUMPTION OF CPP IN KWH/GCAL 5(2/4)	SPECIFIC ENERGY COST OF CPP IN RS/GCAL 6(3/4)	ELECTRICAL ENERGY EXPORTED INCLUDING COLONY IN GCAL 7	MONTHLY ENERGY CONSUMPTION BY PROCESS PLANT IN GCAL 8(4-7)	SPECIFIC ENERGY CONSUMPTION OF PROCESS PLANT IN GCAL/KG 9
Apr-04	224568069.8	63907748	109302.19	2054.561485	584.6886325	366.36	108935.83	4.3574332
May-04	222482627.9	64302102	109130.9	2038.676744	589.2199368	442.04	108688.86	4.3475544
Jun-04	240318883.7	66821800	113154.92	2123.804106	590.5337567	314.76	112840.16	4.5136064
Jul-04	243203581.4	68031500	115980.32	2096.938355	586.5779643	340.56	115639.76	4.6255904
Aug-04	245811488.4	68873654	112323.4	2188.426351	613.1728028	280.36	112043.04	4.4817216
Sep-04	153309883.7	51681438	72134.123	2125.344807	716.4631086	543.52	71590.603	4.2112119
Oct-04	232246116.3	68272279	112642.4	2061.800142	606.0975175	495.36	112147.04	4.4858816
Nov-04	228181883.7	62951450	109536.06	2083.166801	574.7098262	312.18	109223.88	4.3689552
Dec-04	238572767.4	67271324	113856.44	2095.382285	590.8433814	495.36	113361.08	4.5344432
Jan-05	223955441.9	64164996	110328.15	2029.902993	581.5831771	348.04	109980.10	4.3992043
Feb-05	201797093	59043551	102834.92	1962.340156	574.1585738	316.48	102518.44	4.1007376
Mar-05	226462674.4	62108012	114296	1981.370078	543.3961993	293.51	114002.48	4.5600992
AVERAGE				<b>2070.142859</b>	<b>595.9537397</b>			<b>4.415536595</b>

## ANNEXURE-5

### PRODUCT-2 PERFORMANCE WITH RESPECT TO CPP

MONTH & YEAR	TOTAL ENERGY CONSUMPTION OF CPP IN KWH	TOTAL ENERGY CONSUMPTION OF CPP IN GCAL	TOTAL COST OF ENERGY CONSUMED BY CPP IN Rs.	ELECTRICAL ENERGY EXPORTED INCLUDING COLONY IN GCAL	ELECTRICAL ENERGY EXPORTED INCLUDING COLONY IN MU	COST OF ELECTRICAL ENERGY EXPORTED INCLUDING COLONY IN GCAL	MONTHLY ENERGY CONSUMPTION BY PROCESS PLANT WITH REFERENCE TO TOTAL ENERGY CONSUMPTION OF CPP IN GCAL	MONTHLY ENERGY COST BY PROCESS PLANT WITH REFERENCE TO TOTAL ENERGY COST OF CPP IN Rs	SPECIFIC ENERGY CONSUMPTION OF PROCESS PLANT WITH REFERENCE TO TOTAL ENERGY CONSUMPTION OF CPP IN GCAL/KG	SPECIFIC ENERGY COST OF PROCESS PLANT PRODUCT WITH REFERENCE TO TOTAL COST OF CPP IN RS/KG
Apr-04	224568069.8	193128.54	63907748	366.36	0.426	1065000	192762.2	62842748	7.71049	2514
May-04	222482627.9	191335.06	64302102	442.04	0.514	1285000	190893	63017102	7.63572	2521
Jun-04	240318883.7	206674.24	66821800	314.76	0.366	915000	206359.5	65906800	8.25438	2636
Jul-04	243203581.4	209155.08	68031500	340.56	0.396	990000	208814.5	67041500	8.35258	2682
Aug-04	245811488.4	211397.88	68873654	280.36	0.326	815000	211117.5	68058654	8.4447	2722
Sep-04	153309883.7	131846.5	51681438	543.52	0.632	1580000	131303	50101438	7.7237	2947
Oct-04	232246116.3	199731.66	68272279	495.36	0.576	1440000	199236.3	66832279	7.96945	2673
Nov-04	228181883.7	196236.42	62951450	312.18	0.363	907500	195924.2	62043950	7.83697	2482
Dec-04	238572767.4	205172.58	67271324	495.36	0.576	1440000	204677.2	65831324	8.18709	2633
Jan-05	223955441.9	192601.68	64164996	348.04	0.4047	1011750	192253.6	63153246	7.69015	2526
Feb-05	201797093	173545.5	59043551	316.48	0.368	920000	173229	58123551	6.92916	2325
Mar-05	226462674.4	194757.9	62108012	293.51	0.3413	853250	194464.4	61254762	7.77858	2450
AVERAGE									<b>7.88</b>	<b>2593</b>

