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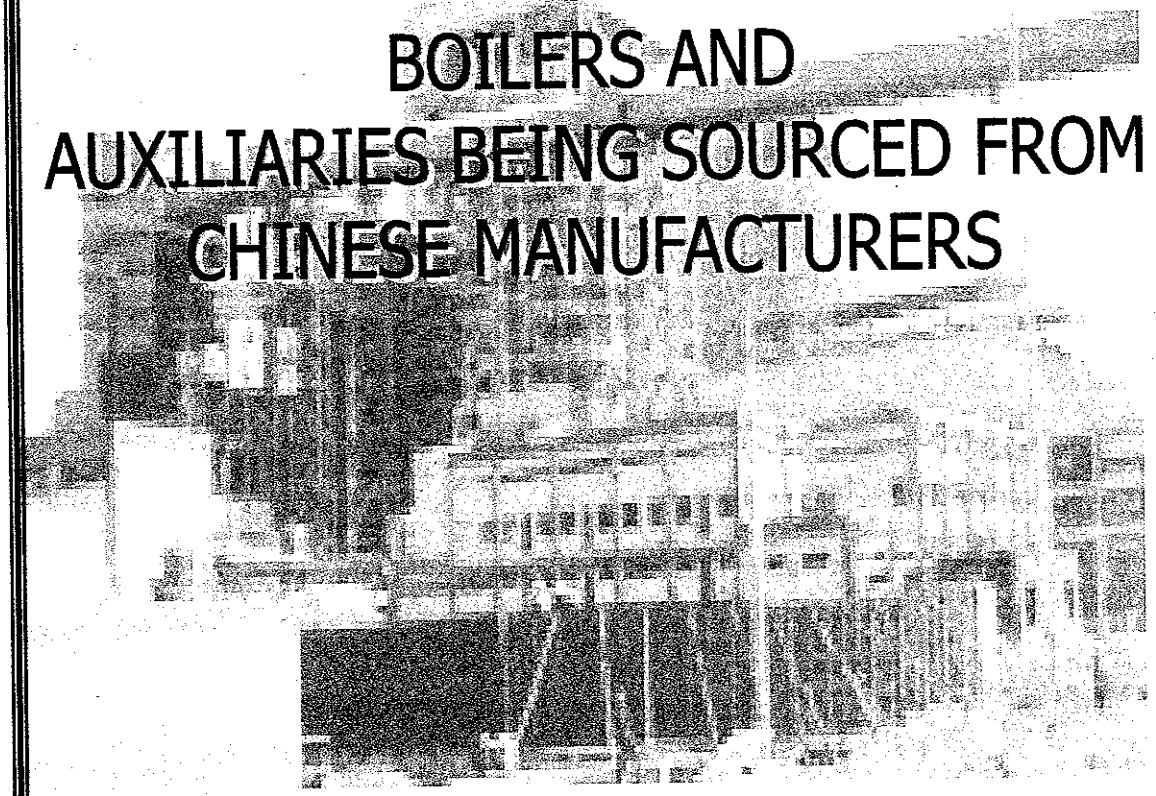
REPORT OF THE COMMITTEE TO STUDY

DESIGN FEATURES OF BOILERS AND AUXILIARIES BEING SOURCED FROM CHINESE MANUFACTURERS



Central Electricity Authority
New Delhi

September 2008

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Disclaimer :
The report is based on the information as supplied to the Committee by the utilities referred to in the report and other details as obtained through interaction with their engineers. The Committee accepts no liability for any loss suffered by any one stemming from any conclusion, based on the data supplied & used in preparing this report.

Central Electricity Authority
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September 2008

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As Chairman of the Committee, I would like to place on record my special appreciation for the contribution of the Committee members viz. Shri D.K. Jain, Executive Director (Engg.) NTPC, Shri Suresh Chander, Chief Engineer (TETD) CEA and Shri A.K. Gupta, Chief Engineer (TRM) CEA for their very valuable contribution during the deliberations of the Committee and the drafting of the Report.

Last but most important, the work of the Committee could be completed only with the cooperation, support, encouragement and guidance provided by Shri Rakesh Nath, Chairperson, CEA at every step.

New Delhi
September, 2008

(V.S. Verma)
Member (Planning) and
Chairman of the Committee

1.0 BACKGROUND:

1.1 There has been increasing participation from international manufacturers including China in construction of main plant equipments for thermal power projects in India. As per the information available, currently a capacity of 1200 MW in Central Sector, 2700 MW in State Sector, 15000 MW by IPPs and 3000 MW as Captive Power Plants have been commissioned / are under construction with boiler, TG and auxiliaries supplied by Chinese manufacturers. A list of such power projects under construction / commissioned by State/private sector utilities is enclosed at Appendix III.

1.2 CEA has been receiving queries from IPPs, financial institutions and power utilities about the performance of main plant equipment of coal fired thermal power projects sourced from China. In order to study the design features of the steam generator and auxiliaries such as coal pulverisers, draft fans and electrostatic precipitators etc. being sourced from China, CEA constituted a Committee vide office order No. CEA/5-41(01)/Secy/2008/2 dated 7th January, 2008 (copy enclosed at Appendix I) under the chairmanship of Member (Planning), CEA consisting of representatives from CEA & NTPC.

1.3 Technical details in regard to design features of boilers and auxiliaries being offered/supplied by the Chinese manufacturers covering furnace, heating surfaces, air-heaters, coal preparation & firing system, mills, fans, ESP etc. were requested from concerned utilities who have procured or are in advanced stage of procurement of main plant equipment from China. These include Durgapur Projects Ltd., WBPDCL for Sagardighi, HPGCL for Yamunagar and Hissar, Lanco and Adani Power. Detailed questionnaire (copy enclosed at Appendix II) was sent to the above utilities and the data as received was analysed. Visits were made to recently commissioned projects viz. Durgapur TPP (1x300 MW) of DPL, Yamunanagar TPP (2x300 MW) of HPGCL and Sagardighi TPP (2x300 MW) of WBPDCL to make an assessment of their performance and the design features provided, the layout arrangements, maintenance aspects etc.

1.4 Major Chinese manufacturers were asked, vide CEA's letters dated 7th August, 2008 (copy enclosed at Appendix IV), to furnish operational performance, details of their units installed in China and elsewhere. Any special design features conceived and incorporated in the boilers being supplied to India for burning low grade coal were also sought. The information sought also included the details in regard to the design standards, quality features and test procedures followed for the units being supplied to India. **However, no information has been received from Chinese manufacturers in this regard.**

2.0 FACTORS INFLUENCING BOILER DESIGN AND PERFORMANCE

2.1 COAL QUALITY

2.1.1 The indigenous coal as received by the power stations is generally of poor quality with low gross calorific value (GCV about 3000 kcal/kg) and high ash content

(about 35 – 40%). Ash characteristics of such coal show high abrasive behaviour due to high alpha quartz silica present in the coal. The coal as received at site also has wide variations in its quality, size, moisture and also contains non-coaly matter such as shales, stones, metallic tramp iron pieces etc. Typical range of quality of Indian coal is given below:

Gross calorific value	:	4500 - 3000 kcal/kg
Ash	:	34 – 45 %
Moisture	:	6- 15%
Volatile matter	:	20-25%

In contrast, it is understood that the coal as used by Chinese utilities is of much better quality with low ash (10-20%) and higher GCV (>4000 kcal/kg). The coal quality parameters ought to be stipulated in the specifications clearly to enable the boiler designers to take these into account for design purposes.

2.1.2 The typical ash characteristics of Indian coals are :

Characteristics	Range/value
SiO_2	54 to 60%
Al_2O_3	27 to 31%
Fe_2O_3	3 to 5%
TiO_2	0.3 to 0.5%
CaO	1 to 3%
MgO	0.5 to 1.5%
Chloride as Cl	0.03 to 0.06%
Sulphate as SO_4	0.1 to 0.2%
Alkalies as NaOH	<0.01 mg/kg
Chromium as Cr	25 to 28 mg/kg
Mercury as Hg	<0.002 mg/kg
Lead as Pb	<0.1 kg/kg
Cadmium as Cd	<0.01 mg/kg
Nickel as Ni	71 to 95 mg/kg
Zinc as Zn	84 to 86 mg/kg
Copper as Cu	56 to 60 mg/kg
Ash Initial deformation temperature	1100^0 C (Typical)
Ash fusion temperature	$1170\text{-}1210^0$ C (typical)
Hemispherical temperature	1400^0 C (Typical)

2.2 EFFECT OF COAL/ ASH CHARACTERISTICS ON BOILER DESIGN

Coal/ash characteristics govern design of almost every major component of the boiler and also have significant influence on their performance. Some of the main boiler components that need special attention are discussed below.

2.2.1 Boiler Furnace Design

The furnace which serves as an enclosure of the combustion chamber and heat exchange surface area (to enable heat transfer to the water and steam) is formed by

the tubes of water walls carrying mixture of steam and water. The main factors affecting the furnace sizing and generally adopted for boiler design for burning Indian coal with characteristics described in the preceding paras are as follows:

i)	Maximum net heat input (NHI) per unit : plan area of furnace		$5x10^6$ kcal/hr/m^2
ii)	Maximum burner zone heat release rate :		$1.36x10^6$ kcal/hr/m^2
iii)	Maximum furnace cooling factor	:	$1.8x10^5$ kcal/hr/m^2
iv)	Minimum furnace residence time	:	1.75 seconds.
v)	Gas velocity (average)	:	10m/sec (maximum)
vi)	Furnace exit gas temperature (FEGT)	:	60°C below initial deformation temperature (IDT) of ash

2.2.2 Superheater (SH) & Reheater (RH) Tube Materials and Design Features

i) Following are the preferred tube materials as specified for the maximum metal temperature of the tube surface as is expected to attain during plant operation (These materials are defined in various Indian and International codes of practice) :

a)	Above 400°C and upto and including 550°C	:	Alloy steel - ASTM A213, T11/T22/T91
b)	Above 550°C and upto590°C	:	T91/ stainless steel
c)	Above 590°C	:	T92/ stainless steel

ii) Tube spacing is determined based on the fouling properties of the coal and also to avoid choking due to ash deposits. Typical values of tube spacing are specified as under:

Minimum transverse pitch of elements in heating surfaces in the direction of gas flow	a) 762mm in banks/ sections placed in area where gas temperature exceeds IDT b) 600mm in the banks/ sections where temperature exceeds FEGT

iii) The thickness of the SH/RH tubes is calculated to meet the requirements of Indian Boiler Regulations (IBR) and international Standards such as ASME B31.1 .

2.2.3 Economiser

i) With a view to avoiding plugging due to high ash content of coal, the economizer tubes are specified as plain tube type instead of finned tubes. Similarly, the tubes are also arranged in-line rather than staggered arrangement to allow passage of large quantity of ash to flow through the tube bank without choking.

ii) To prevent erosion especially with reference to high ash quality and its abrasive nature, areas of bends etc. are provided with protective baffles/ shields at appropriate places. Such provisions could be critically reviewed after initial one/ two years of operation. Additional provisions are made as required after a thorough examination of the erosion patterns.

2.2.4 Coal Pulverisers (Mills)

i) Due to poor coal quality, its wide variation and high abrasion characteristics, it is generally stipulated to have two numbers of coal pulverisers as standby when using performance coal and one coal pulveriser as standby while using worst coal. Thus, the numbers of mills required as a matter of practice work out to be generally one additional as compared to the those steam generators using consistent and better quality of coal.

ii) The materials of grinding components of the mills are selected to give an operating life of minimum 5000 hours between two consecutive failures / replacement. After development of new abrasion resistant materials this life expectancy has now being achieved in India by and large. This has been possible after lot of indigenous R&D on these materials.

2.2.5 Forced Draft (FD), Induced Draft (ID), Primary Air (PA) Fans

i) Type of these fans normally specified for Indian power stations using indigenous coal for higher unit ratings are as under:

FD fans: Axial
ID fans: Radial (Axial for large size above 500 MW)
PA fans: Axial

ii) For determining fan sizing (head and flow), margins are specified to account for variation in coal quality, system leakages and performance deterioration over a period of time. The margins followed as per the established good engineering practice are spelt out subsequently in the report.

2.2.6 Electro-Static Precipitators (ESPs)

Indian coals have high ash electrical resistivity (of the order of $3x10^{13}$ ohm-cm) which leads to considerable difficulty in ESP design, resulting in physically larger sized equipment. In addition, the high inlet dust concentration due to high ash content of coal necessitates higher efficiency requirements for the ESP (of the order of 99.9 % and above) to meet environmental emission stipulations for the

suspended particulate matter (SPM). The following aspects are required to be taken care of while designing the ESPs:

- High specific collecting area (Minimum specified 240 $m^2/m^3/s$ with 300 mm and 180 $m^2/m^3/s$ with 400 mm collecting plate spacing) for the Indian coal.
- One field spare with worst coal firing
- Large capacity of ESP hoppers (generally specified minimum 8 hrs. storage) to allow sufficient time for maintenance etc.
- Proper gas distribution at ESP inlet

The present technology available in India is able to reduce the outlet dust concentration to values even lower than 50 mg/Nm^3.

3.0 OBSERVATIONS AND TECHNICAL FEATURES OF CHINESE BOILERS

3.1 Following are the major manufacturers of boiler and Turbine–Generator (BTG) in China:

a) M/s Dongfang Electric Corporation (DEC)
b) M/s Shanghai Electric Corporation (SEC)
c) M/s Harbin Power Electric Corporation (HPEC)

It is understood that the technology for manufacture of the BTG equipment by the above manufacturers has been provided by the reputed international manufacturers detailed below. However, the details regarding the extent of technical support from the technology provider and commercial terms could not be made available.

Company	Type/size of unit	Boiler	Turbine	Generator
Dongfang DEC	300 MW (sub-critical)	Self design	Self design	Self design
	600 MW (sub-critical	Self design	Self design	Self design
	600 MW (supercritical)	Babcock-Hitachi	Hitachi, Japan	Hitachi, Japan
	1000 MW (supercritical)	Babcock-Hitachi	Hitachi, Japan	Hitachi, Japan
Shanghai SEC	300 MW (sub-critical)	ABB-CE,USA	Westinghouse,USA	Westinghouse,USA
	600 MW (sub-critical)	ABB-CE,USA	Westinghouse,USA	Westinghouse,USA
	600 MW (supercritical)	Alstom, France	Westinghouse-Siemens	Westinghouse-Siemens
	1000 MW (supercritical)	Alstom, France	Siemens,Germany	Siemens,Germany

Company	Type/size of unit	Boiler	Turbine	Generator
Harbin HPEC	300 MW (sub-critical)	ABB-CE,USA	Westinghouse,USA	Westinghouse,USA
	600 MW (sub-critical	ABB-CE,USA	Westinghouse,USA	Westinghouse,USA
	600 MW (supercritical)	Babcock, UK	MHI, Japan	Siemens, Germany
	1000 MW (supercritical)	MHI, Japan	Toshiba, Japan	Toshiba, Japan

CE : Combustion Engineering, USA (New Alstom)
MHI : Mitsubishi Heavy Industries, Japan

The above type of sub-critical boilers are in operation in China for long time. In India, majority of boilers have been supplied by BHEL which are of Combustion Engineering (CE) USA design with tangential firing arrangement. Babcock design of boilers with front and rear wall firing are also under operation in India at various utilities.

3.2 Each of the three major boiler manufacturers of China are having manufacturing capacity of BTG equipment of around 30,000 MW/year. A large number of sub-critical 300/600 MW units are in operation in China. Also, many supercritical units of 600 MW range are also in operation. Presently, China is focusing on installation of 1000 MW super-critical units in their country.

3.3 From the data offered for some of the plants bid by Indian and Chinese bidders, it is observed that the guaranteed efficiencies for steam generator offered by Chinese manufacturers are generally of the same order as compared to those of indigenously manufactured boilers. These are as given below :

	250/300 MW	**500/600 MW**
Indigenous Manufacturer	87.44 %(250 MW)	86.74 %(500 MW)
Chinese Manufacturer	87.10 %(300 MW)	87.16 %(600 MW)

It is to mention that for a given fuel quality to be burnt and the ambient conditions, unit size generally do not affect the boiler efficiency levels. This only depends on the combustion and heat transfer technologies that are available at a particular point of time.

3.4 In order to assess the technical data of 300 MW and 600 MW sub-critical boilers supplied/being supplied to India for use with Indian coal by Chinese suppliers, technical details as received from utilities in respect of various components of boiler are compared with the typical preferred design values as under :

3.4.1 Boiler Furnace

A comparative statement of various important furnace parameters is given below:

a) 300 MW units

Parameter	Typical preferred Design values	Yamunanagar, HPGCL (2x300 MW)	Durgapur, DPL (1x300 MW)	Sagardighi, WBPDCL (2x300 MW)	Lanco-Amarkantak MP (300 MW)	Adani- Mundra 2x330 MW, Ph-I (Imp. Coal GCV=6000, Moisture 10%) Gujarat	Adani Mundra 2x330 MW , Ph-II (Imp. Coal GCV=4500-5500, Molsture 25%) Guajrat
Boiler Make	Not applic able	SEC, Shanghai	DEC, Dongfang	DEC, Dongfang	DEC, Dongfang	Babcock & Wilcox Beijing Co. Ltd.	Babcock & Wilcox Beijing Co. Ltd.
Furnace (DXW) (m)	Not applicab le	14.12x 16.1	13.74x14.7	13.74x14.7x	13.74x14.7	12.3x14.11	12.9x15.6
Furnace volume (m^3)	Not applic able	10426	NA *	NA *	8878	7679	10106
Firing Arrangement	Tange ntial/ Oppos ed wall	Tangential	Tangential	Tangential	Tangential	Opposed wall fired	Opposed wall fired
Max. Net Heat Input per unit plan area (kcal/hr/m^2)X10^6	5.0	3.25	NA *	NA *	3.39	4.065	3.564
Maximum burner zone heat release rate (kcal/hr/m^3) x10^6	1.36	1.062	NA *	NA *	3.58**	1.29	0.97
Max. Furnace cooling factor (kcal/hr/m^2)X10^5	1.8	1.472	NA *	NA *	NA@	1.74	1.60
Minimum Residence time for fuel particles in the furnace (sec)	1.75	2.65	NA *	NA *	2.2	1.93	2.37
Max.Gas velocity (m/s)	10	10	NA *	NA *	10	NA@	NA@
Max.Furnace Exit Gas Temp (^{0}C)	1040 (typ) 60^0 C below ash IDT.	1011	NA *	1040	1035	1013	987

NA – Not available with developer.

Note: * Data regarding these important factors stipulated as part of specification for furnace sizing are not available with project authorities for **Durgapur and Sagardighi Project**. This data is important to ensure the correct sizing of the furnace.

@ Some important data is also not available with private developers.

** The value is very high and appears to be erroneous (in case of 600 MW at Lanco.- Anpara 'C' unit, this value is 1.07x10 kcal/hr/m^3). This needs to be verified by the developer.

b) 600 MW units

Parameter	Typical preferred Design values	Hissar, Haryana, HPGCL	Anpara-C, UP, Lanco
Boiler Make	Not applicable	SEC Shanghai	DEC Dongfang
Furnace (DXW) (m)	Not applicable	17.83x21.082	16.744x20.7
Furnace volume (m^3)	Not applicable	22543	19470
Firing Arrangement	Tangential Front & rear	Tangential	Front & rear
Max. Net Heat Input per unit plan area (kcal/hr/m^2)X10^6	5.0	3.99	3.804
Maximum burner zone heat release rate (kcal/hr/m^3) x10^6	1.36	1.326	1.072
Max. Furnace cooling factor (kcal/hr/m^2)X10^5	1.8	1.884	<2.65
Minimum Residence time for fuel particles in the furnace (sec)	1.75	2.33	Later
Max.Gas velocity (m/s)	10	10	12
Max.Furnace Exit Gas Temp (^{0}C)	1040 (typ), 60^0 C below ash IDT.	1040	100^{0}C less than IDT

From the above tables it is seen that the various factors considered for furnace sizing of the units for which data have been made available are largely complying with the values normally envisaged for the indigenously designed boilers for Indian coal. However, there are certain variations in furnace sizes as provided by Chinese boiler manufacturers for different projects. These are individual manufacturer's best possible assessments and such variations are not ruled out. It is observed that furnace size for 300 MW units is more in case of Yamunagar units as compared to Durgapur, Sagardighi and Lanco-Amarkantak. Similarly in case of 600 MW units at Hissar, the furnace size is bigger than that of Anpara 'C'. Sizing variations result due to various assumptions made by the designers for different design inputs.

A comparison is made as under for furnace sizes in case of Yamunanagar (300 MW) & Hissar (600 MW) with corresponding data available for 250/500 MW indigenous units.

	250 MW (Indigenous)	300 MW (Yamunanagar)	500 MW (Indigenous)	600 MW (Hissar)
Furnace size(m)	15.24 x 11.50 x 46.863	16.1 x 14.12 x 53.208	19.177 x 15.197 x 62.628	21.082 x 17.85 x 69.355
Furnace Volume(m3)	7290	10426	18750.6	22543
Volume ratio	Base (1.0)	1.43	Base (1.0)	1.20

It is seen that furnace sizes are comparable to the one that are provided by indigenous boiler manufacturer for similar tangentially fired boilers. However, any generic design issues could be best known after these units operate for an initial period of about one to two years.

3.4.2 Superheaters and Reheaters

a) 300 MW Units

Parameter	Yamunanagar, Haryana	Durgapur, DPL	Sagardighi, WBPDCL	Lanco-Amarkantak, MP	Adani-Mundra 2x330 MW, Ph-I (Imp. Coal GCV=6000, Moisture 10%)	Adani Mundra 2x330 MW, Ph-II (Imp. Coal GCV=4500-5500, Moisture 25%)
Super-heater tube Material	SA210-A, SA213 -T11, T22, T23, T91 and TP347H	SA210-C, 15CrMoG, 12Cr1MoVG SA 213 T91 and TP347H	SA210-C, 15CrMoG, 12Cr1MoVG SA 213 T91 and TP347H	SA210-C, 15CrMoG, 12Cr1MoVG SA 213 T91 and TP347H	SA210-C, 15CrMoG, 12Cr1MoVG SA 213 T91	SA210-C, 12Cr1MoVG SA 213 T91
Tube pitching	NA	NA		NA	NA	NA
Re-heater tube material	SA 213 T22/T91	NA	12Cr1MoVG SA213MT91	SA 210C/ SA213T91/ SA213T22	SA 210C/ SA213T91/ SA213T22	SA106C/ SA213T91/ SA213T22

NA – Not available with developer.

b) 600 MW Units

Parameter	Hissar, Haryana, HPGCL	Anpara-C, UP, Lanco
Super-heater tube Material	SA 213 T11/T22/T91	210C/15CrMoG 213 T23 213 T91/TP347
Erosion allowance(mm)	1.0 & 0.6	0.5
Tube pitching	Not Available	Not Available
Re-heater tube material	SA 213 T22/T91	210C/15CrMoG 213 T23 213 T91/ TP347

NOTE: To avoid choking of the gas flow paths of pendant heating surfaces falling in the passage of flue gases, it is a normal practice to provide higher pitching distance between tubes. The details regarding tube pitching were sought from the utilities, but the same could not be provided by them. It is also not clear whether the specification prepared by the utilities envisaged any such requirement.

The choice of material for boiler pressure parts is primarily governed by the maximum metal temperature to which the pressure part is likely to be subjected. These are defined in various codes/standards including Indian Boilers Regulations (IBR).

As per the Indian Boiler Act, all boilers to be installed in India must follow the requirements of IBR. All materials of construction, tube thicknesses and all other components like power cycle piping and their construction features have to be in accordance to IBR. These are dully inspected and approved by Chief Inspector of Boilers of the concerned State or their authorized third party agencies. The manufacturing of components and materials selected are also required to be approved. Accordingly, no deviation is expected from the standard practices in these areas.

3.4.3 Economizer

Economizers provided in Chinese boilers are non-steaming type, using plain tube with in-line arrangement which is a preferred configuration to avoid choking of passages in view of the high ash content of Indian coal. Protections are also provided at suitable places to avoid erosion due to high ash content.

3.4.4 Coal Pulverisers (Mills)

a) 300 MW Units

Parameter	Yamunanagar, Haryana HPGCL	Durgapur, DPL	Sagardighi, WBPDCL	Lanco-Amarkantak, MP	Adani-Mundra 2x330 MW, Ph-I (Imp. Coal GCV=6000, Moisture 10%)	Adani Mundra 2x330 MW, Ph-II (Imp. Coal GCV=4500-5500, Moisture 25%)
Type	HP 1003 Bowl mill	Bowl mill	ZGM123N Bowl mill (Tyre type)	ZGM123N Bowl mill (Tyre type)	NA	NA
Number per boiler	6	6	6	6	NA	NA
Maximum capacity, T/hr	60	48.8	55	57.17	NA	NA
Material of grinding parts - Rollers - Grinding rings	High Chrome ZG 270 5W	NA	NA	NA	NA	NA
Feeder type & size	Gravimetric 60 T/hr	Gravimetric 60 T/hr	Gravimetric 77 T/hr	Gravimetric 70 T/hr	NA	NA
Life of Grinding elements	5000 hrs	NA	6000 hrs	NA	NA	NA

NA – Not available with developer.

b) 600 MW Units

Parameter	Hissar, Haryana, HPGCL	Anpara-C, U.P., Lanco
Type	HP 1103, Bowl Mill	NA
Number per boiler	8 (eight)	8 (eight)
Capacity T/hr.	75.3	NA
Material of grinding parts - Rollers - Grinding rings	Material with hardness 610 BHN(Min) 610 BHN(Min)	NA
Feeder type & size	Gravimetric 90 T/hr	Gravimetric (not less than 36")
Life of Grinding Elements	6000 hrs	8000 hrs

NA – Not available with developer.

The broad parameters of mill performance include life of grinding elements, coal fineness & mill throughout. The type of mills used in these units are of proven design. However, the operational feed back so far obtained indicate that in some units, the number of mills being used for full load operation are more than what should be required as per design conditions. It requires further analysis and observation for prolonged period of operation to know the actual behaviour specially with reference to the quality of coal being supplied.

The coal quality as received at project sites is reported to be very poor and contains large quantity of extraneous materials such as stones, shales and metallic parts. This affects mill performance and also results in large quantity of mills reject. The mill reject system, though not a part of the main plant equipment, needs to be designed appropriately for removal & transportation of mill rejects to appropriate place. This system has been engineered and supplied by Indian consultants/suppliers in case of the three plants visited.

3.4.5 Fans

a) 300 MW Units

Parameter	Typical preferred Design values	Yamunanagar, Haryana, HPGCL	Durgapur DPL	Sagardighi, WBPDCL	Lanco-Amarkantak, MP	Adani-Mundra(330 MW) Imported coal Ph-I	Adani-Mundra(330 MW) Imported coal Ph-II
ID Fans - Type - No./boiler	- -	Radial 2+1	NA NA	Radial 2	Radial 2	NA NA	NA NA
ID Fans (contd.) - Test block flow(m^3/s) - Test block Head (Pa) - Margin Flow - Margin head - Speed (rpm) - Motor Rating(KW)	- - 20% 30-44% - -	303.2 4787 20% 30% 950 2240	NA NA NA NA 989 2500	283.49 6572.6 20% 44% 960 2800	NA NA 20% 44% 750 2800	NA NA NA NA NA NA	NA NA NA NA NA NA

Parameter	Typical preferred Design values	Yamunanagar, Haryana, HPGCL	Durgapur DPL	Sagardighi, WBPDCL	Lanco-Amarkantak, MP	Adani-Mundra(330 MW) Imported coal Ph-I	Adani-Mundra(330 MW) Imported coal Ph-II
FD Fans							
- Type	-	Axial	NA	Axial	Axial	NA	NA
- No./boiler	-	2	2	2	2	NA	NA
- Test block flow(m3/ s)	-	122.8	138.05	142	NA	NA	NA
- Test block head(Pa)	-	4426	3996	3995.5	NA	NA	NA
- Margin on Flow	20%	20%	NA	20%	20%	NA	NA
- Margin on head	30-44%	30%	NA	30%	44%	NA	NA
- Speed(rpm)	-	1470	990	990	1490	NA	NA
- Motor Rating (kW)	-	800	800	800	710	NA	NA
PA Fans							
- Type	-	Centrifugal	NA	Axial	Axial	NA	NA
- No./boiler	-	2	2	2	2	NA	NA
- Test block flow m^3/s	-	99.2	84.29	73.7	82.43	NA	NA
- Test block head	-	16804 Pa	18713 Pa	13429 Pa	1558mmWC	NA	NA
- Margin on Flow	25%	25%	NA	20%	25%	NA	NA
- Margin on head	30%	40%	NA	30%	30%	NA	NA
- Speed(rpm)	-	1480	1490	1490	1485	NA	NA
- Motor rating(kW)	-	2500	2000	2000	2000	NA	NA

NA – Not available with the developer.

b) 600 MW Units

Parameter	Typical preferred Design values	Hissar, Haryana, HPGCL	Anpara-C, UP, Lanco
ID Fans			
- Type	-	Axial	Axial
- No./boiler	-	2	2
- Test block flow	-	642.8 m^3/s	NA
- Test block head	-	5172 Pa	NA
- Margin on Flow	20%	40%	20%
- Margin on head	30-44%	20%	44%
- Speed(rpm)	-	745	NA
- Motor rating(kw)	-	4200	5500

FD Fans			
- Type	-	Axial	Axial reaction
- Number per boiler	-	2	2
- Test block flow	-	244.3 m3/s	NA
- Test block head	-	4211 Pa	NA
- Margin on Flow	20%	31 %	20%
- Margin on head	30-44%	25 %	44%
- Speed(rpm)	-	985	NA
- Motor rating(kW)	-	1400	2000
PA Fans			
- Type	-	Axial	Axial
- Number per boiler	-	2	2
- Test block flow	-	176.3 m3/s	NA
- Test block head	-	16244 Pa	NA
- Margin on Flow	20%	25 %	20
- Margin on head	30-44%	30 %	30
- Speed(rpm)	-	1490	NA
- Motor rating(kW)	-	3650	4400

NA – Not available with the developer.

It may be mentioned that margins provided on flow and head of the draft fans constitute an important sizing criterion for their troublefree operation. **The margins provided in the Chinese equipments are observed to be in the range of 20-25% on flow & 30-44% on head. These are in line with normal good engineering practice.**

3.4.6 Electro-static Precipitator

a) 300 MW Units

Parameter	Typical preferred Design values	Yamunanagar, HPGCL	Durgapur, DPL	Sagardighi, WBPDCL	Lanco-Amarkantak MP	Adani-Mundra(330 MW) Imported coal Ph-I	Adani-Mundra(330 MW) Imported coal Ph-II
No. of ESP per boiler	-	2	NA	2	2	NA	NA
No. of electric fields in series	-	7	NA	7	6	NA	NA
Minimum Specific collection area (m^2/ m^3/s)	240 (300 mm spacing)/ 180 (400 mm spacing)	228	NA	287.5	208	NA	NA
Gas flow BMCR (m^3/s)		544	NA	456.4	463	NA	NA
Treatment time (s)	20 (min)	44	NA	46.765	31.46	NA	NA
Gas velocity(m/s)	1.0 (max)	0.709	NA	0.62	0.858	NA	NA
Aspect ratio	1.5 (min)	2:1	NA	2:1	1.8	NA	NA

Parameter	Typical preferred Design values	Yamunanagar, HPGCL	Durgapur, DPL	Sagardighi, WBPDCL	Lanco-Amarkantak MP	Adani-Mundra(330 MW) Imported coal Ph-I	Adani-Mundra(330 MW) Imported coal Ph-II
Type of discharge electrodes	-	Spike type	NA	Tubular bar bed wire(1-3 field) Spiral wire (4-7 field)	RSB(1-4 field) Spiral wire (5th – 6th Field)	NA	NA
Particulate Emission (Worst coal, all fields in service mg/Nm^3)	100	100 (with one field out of service)	NA	<50	50	NA	NA

NA: Not available with developer

b) 600 MW Units

Parameter	Typical preferred Design values	Hissar HPGCL	Anpara-C Lanco
No. of ESP per boiler	4	4	4
No. of electric fields in series	-	8	NA
Specific collection area (m^2/m^3/s)	240 (for 300 mm collecting electrode spacing)	260	NA
Treatment time(sec)	20 (min)	NA	NA
Gas velocity(m/s)	1.0 (max)	0.744 (max)	<1
Aspect ratio	1.5 (min)	1.5	NA
Type of discharge electrodes	-	Spiral	NA
Electrode spacing(mm)	300/400	300 field x6+400x2 field	NA
Particulate Emission (Worst coal, all fields in service mg/Nm^3)	100	80	NA

NA: Not available with developer

It is observed that the design parameters are in line with the current practices. However, the actual performance of ESPs would be known only after sustained operation for a longer period. The present emission levels as reported from one of operating power plants of 300 MW capacity (Appendix VI) indicates suspended particulate matter (SPM) level of 57.55 mg/Nm^3 in one unit which is well within the requirement of emissions standards. However, the SPM in the other 300 MW unit is reported to be 313.84 mg/Nm^3 which is high. This is to be attended by appropriate adjustments for proper functioning. The functioning of ESPs generally get stabilized when all the fields are in service and all controls are functional. Plant authorities need to be take note of such variations in performance and take remedial measures wherever required.

4.0 FEEDBACK GATHERED FROM OPERATING UTILITIES IN INDIA.

4.1 The visits were made to the following power stations commissioned recently, which have main plant equipment sourced from Chinese manufacturers:

i) **Yamunanagar TPP** (2x300 MW) (BTG supplied by M/s SEC)
ii) **Durgapur TPP** (1x300 MW) (BTG supplied by M/s DEC)
iii) **Sagardighi TPP** (2x300 MW) (BTG supplied by M/s DEC)

The visits were made to have an overview of the plant features, interact with plant engineers regarding their experience during erection, commissioning and also to get feedback regarding plant operational behavior. Detailed reports of the visits are enclosed at Appendix VIII, IX and X.

4.2 Above utilities were requested to furnish operational performance details indicating problems/constraints faced in operation & maintenance, equipment failures, incidence of tube failures, major causes of unit trippings, any constraint in achieving rated load on sustained basis, emission levels etc. Information has been received only from **Yamunanagar** and **Sagardighi TPPs** (Appendix V and VII). No information has been received from **Durgapur TPP**.

4.3 Based on the visits and other information received, the following observations are made:

4.3.1 Performance

i) Coal Pulverisers (Mills)

It was observed that at **Yamunanagar TPP**, five mills were required to be put in operation at full load condition instead of requirement of four mills even when operating with coal with calorific value near its design value. Generally, the fifth mill is required to be operated only when using worst coal. Quantity of mill rejects is also high. The mill grinding capacity would accordingly need checking and review.

ii) At **Sagardighi TPP**, trippings of unit no. 1 have been experienced due to boiler tube failures. Incidents of tube failures have been reported for economizer, reheater and water wall tubes. Three incidents of tube failures (platen SH, LTSH and water walls) have been reported at **Yamunanagar TPP**.

iii) Problems reported at **Yamunanagar TPP** in respect of failure/damage of some components are indicated below:

a) Failure/damage of oil guns.
b) Damage to fabric compensator bellows (expansion bellows)
c) Leakage in ceramic bends installed in pulverized coal pipes
d) Failure of scanners due to low pressure developed by scanner air fan

e) Leakages and passing in high pressure valves (e.g. emergency blow down, start up vents etc.) installed in the boiler area.
f) Frequent outage in first three fields of ESP due to snapping of emitting electrodes.

The problems are being looked into by equipment manufacturer (OEM) and the EPC contractor.

All the above problems could be categorized as initial teething problems and are generally resolved by adjustments, modifications, etc., during the course of initial operation.

4.3.2 Issues Related to Boiler Area Layout

i) Mill area was found to be highly congested in case of **Yamunanagar TPP**. Difficulty of access to the mill grinding elements and motors for maintenance could be seen. OEM has proposed some modifications in the adjoining structures for ensuring access for maintenance etc.

ii) The pyrite hoppers of the coal mills C&D have been provided facing each other at **Yamunanagar TPP** thus making it difficult to carry out poking and maintenance of hoppers. The seal air fans have been located in an area making it difficult to have an access for maintenance etc.

iii) The platforms provided around the boiler area at some places were not having adequate through passage at **Yamunanagar TPP**. Difficulties are also being faced in maintenance of various equipment like oil guns, burners, valves and furnace inlet pulverized coal gates. Through passage is considered important from the point of view of attending to various equipment like burners, scanners, dumpers etc. for operation & maintenance as well as easy escape during emergency.

iv) At **Sagardighi TPP**, boiler drain piping was obstructing the ground movement. Various drain pipes which are site routed were not properly located resulting in restrictions in movement.

The above issues are generally taken care of at the time of specification preparation and during the erection stage by the owner's consultant and their site supervision engineers. It appears that there has been inadequate attention to these areas from the utilities side. Some of these could still be attended, e.g. at **Sagardighi TPP,** during the discussions, the Chinese side agreed to at least lay the drain piping etc. appropriately in consultation with the site engineers and owner's consultant.

4.3.3 Erection Issues

i) It is reported that the boiler structure of bolted construction in Chinese boilers provided with high alignment accuracy have resulted in reduction in construction time. Further, supplies were made in a sequential manner with receipt of complete material including platforms & stairs for a group of activities/dispatch unit, resulting in erection convenience and faster erection.

The equipment received were also properly protected in weather proof packages and adequately painted.

ii) During the visits to the project sites, some deficiencies were observed in erection works such as various drain lines were not properly routed, pipe insulation works not aesthetically done, cables hanging loose etc. These were the responsibilities of EPC contractors and owner's site engineers. Accordingly, there is an urgent need to have close coordination among EPC contractor, utility site engineers and their site supervisors/consultant to take care of such local site issues. More active and sincere participation of owner's O&M engineers with the equipment suppliers and their erection and commissioning teams would result into lesser problem areas.

4.3.4 Operational Performance of the Units

i) The details of generation and corresponding PLF (post COD) considering the period for which these units have been in operation (excluding the planned shut down period required for various adjustments for PG test, period required for attending to various problems etc.) is given hereunder:

Project	Unit	Synch Date	COD	PLF (%)			
				May '08	June 08	July 08	Aug 08
Yamuna Nagar	U#1	13.11.07	14.4.08	69.57 (22/5- 31/5)	80.05 (1/6 - 18/6)	70.58 (3/7- 31/7)	53.96* (1/8 - 31/8)
	U#2	29.3.08	24.6.08	-	65.0 (25/6 – 31/6)	68.46 (1/7 – 16/7) (28/7 – 31/7)	75.0 (1/8 – 31/8)
Durgapur	U#7	24.11.07	30.4.08	-	31.0 (1/6 - 21/6)	40.1 (6/7 - 31/7)	81.04 (1/8 - 31/8)
Sagardighi	U#1	21.12.07	1.9.08	-	-	72.69 (13/7- 27/7)	75.23 (10/8- 31/8)
	U#2	20.7.08	Yet to be achieved	-	-	-	-

*The low p.l.f. is reported due to very poor coal quality resulting in problems in coal handling/ milling plant

Detailed generation data for the above plants is enclosed at Appendix-XI. These units have been in operation for a short period and it would not be appropriate to draw any conclusions from this data. However, some operational problems observed are given in the succeeding paras.

ii) Secondary fuel oil consumption has been found to be high in all the three projects. It was observed that oil was being fired as a support fuel in the boiler even upto 80% load which normally should have been withdrawn at 40-50% load. This kind of operation is being resorted to from the point of view of saving the units from shut down due to flame failure on account of bad quality of coal having very high ash content and moisture. It may be added here that the boiler operation without oil support at loads beyond 40-50% is required to be demonstrated before plant handing over. The committee members are of the opinion that the oil consumption could be actually reduced. At **Durgapur Unit** 7, the seven number of oil guns were withdrawn on the suggestion of the

committee during the plant visit and the unit continued to operate at high load without oil support.

iii) It was observed that ESP was not being taken into service even at higher loads when the oil was also being co-fired. Normally, ESP is taken into service when two mills are in operation. It was probably with the apprehension that with oil firing, soot may get deposited on the ESP electrodes which may affect the demonstration of efficiency of ESP during its performance guarantee test. In order to arrest the dust emission under all conditions, it is desirable to withdraw oil support at the earliest.

iv) It was observed that superheater and re-heater spray flows were more than the design values which need to be looked into.

v) Many of the control loops were found to be not put on 'auto' mode at the time of visit. It is essential that before the plant is handed over, all the control loops are made functional in 'auto' mode.

4.3.5 Turbine and Auxiliaries

During interaction with the project authorities, following issues also emerged in respect of turbine systems.

i) At **Sagardighi** project, one of the blades in 4th stage of LP rotor along with corresponding shroud on the packet of six blades had broken when the turbine was running on full load on 22nd April, 2008. This has led to shut down for about three months. Rotor has since been repaired and unit put back into operation. The root cause analysis of failure is, however, awaited from OEM.

ii) A few other problems reported in turbine systems are indicated below:

a) Boiler feed pump mechanical seal system trouble at **Sagardighi TPP**
b) Condensate extraction pump thrust bearing failure at **Sagardighi TPP**
c) BFP discharge valve leakage at **Yamunanagar TPP**
d) Both plate heat exchangers (PHEs) for turbine lub oil system and cooling water system kept in service instead of normal requirement of only one PHE at **Yamunanagar TPP.**

The problems indicated at (ii) above are considered to be of routine nature and need to be attended appropriately during the course of operations of the unit.

4.3.6 Boiler Bottom Ash Removal and Handling System :

The conventional water sealed boiler bottom hoppers have been provided both at Yamunanagar and Sagardighi TPPs by the Indian suppliers. These systems have not been commissioned with care and giving lot of leakage problems etc. These needs to be attended. The Durgapur TPP plant has been provided with the dry bottom ash removal system supplied by M/s Magaldi, an Italian company. This type of system is provided for the first time in India and is found to be superior to the existing system. This also enhances the efficiency of operation of boiler marginally and is

reported to be operating trouble free. Adoption of such system needs to be encouraged in Indian power stations for future units.

5.0 OTHER IMPORTANT ISSUES

5.1 ROLE OF UTILITIES CONSULTANTS/ENGINEERS

During interaction with the project authorities of the three operating stations, it has emerged that there has been substantial lack of participation by the utilities during the course of project execution in the areas of technical specifications, detailed engineering, quality inspection at works, erection supervision, training of O&M personnel, etc. Due to the fact that main power plant equipments are being sourced for the first time in the country from China, it is of utmost importance that the utilities play an active role at various stages. Some deficient areas are given below:

i) Important equipment drawings/ technical data/ documents were not available with the **Sagardighi** and **Durgapur** projects. Design data was also not available with some IPPs sourcing the equipment from Chinese manufacturers.

ii) While there has been participation by **Yamunanagar TPP** engineers during the inspection at manufacturer's works for important equipment such as boiler feed pump, turbine rotors, generator rotors, HP heaters, boiler drum, digital control system etc., there has been no such participation of project engineers from **Sagardighi TPP** and **Durgapur TPP**.

iii) Some of the site related problems identified in the Report would have been avoided with more active participation of project engineers during erection & commissioning stage. The lack of adequate number of trained manpower at all the stations has also been observed.

iv) It is highly desirable that adequate number of trained O&M engineers are posted at site at the earliest and involved in commissioning activities so as to get familiarized with the plant behaviour.

5.2 COMPLIANCE TO INTERNATIONAL STANDARDS

Chinese manufacturers, in general, are manufacturing as per their engineering practices and following their national Standards in regard to materials etc. These Standards are in Chinese language and their English versions are not available. Although it has been observed that the design details of the boiler & its auxiliaries are complying with the good engineering practices and meeting the IBR standards, there is a need for Chinese manufacturers to establish that the standards followed by them are equivalent to proven international Standards.

The detailed design specifications need to be evolved and specified before ordering the equipment. The technical compliance also needs to be ensured by the owners engineers. It would also be prudent for the utility engineers /consultants to have good understanding of Chinese engineering practices, equipment specifications and standards followed during material selection, manufacturing & testing with their compatibility with international Standards.

5.3 COAL QUALITY

Concerns have been expressed by the equipment manufacturers about the bad quality of coal and the presence of extraneous non coaly matter in the coal being received at **Durgapur TPP**. It is also reported by **Sagardighi TPP** that coal quality as actually received has GCV of only 2300 kcal/kg with ash content of 60% which is much inferior to the worst coal specified (GCV= 3200 kcal/kg, Ash 45%). This coal is almost unfit to be burnt in the pulverized coal fired boilers.

Use of poor quality coal is projected to cause damage to mill components and boiler parts. Though run-of-mine (ROM) coal is generally found to have such quality related problems, the utilities should also endeavour to take some corrective actions through monitoring at coal supply point, removal of ferrous material by metal detectors and manual removal of non-coaly matter. It would be desirable to have coal of consistent quality within the specified range.

6.0 CONCLUSION:

Major Chinese manufacturers of main plant equipment were asked vide our communication dated 7.8.2008 to furnish the design features of their boilers, data about operational performance of their units, Standards followed during manufacturing and testing procedures etc. India is an emerging market in view of the huge generation capacity addition programme. In this context it was expected that Chinese equipment manufacturers would be more forthcoming and transparent in providing technical details. However, there has been no response from them till date. Few utilities also could not furnish the complete technical design data as was desired from them as these are surprisingly not available with them. As such the report is based on the information made available by the utilities in regard to sub-critical units under operation/construction. The observations are also made based on the visits to the operating plants in India and interaction with the plant engineers. Following are the major findings of the committee. The remedial measures are also enunciated wherever possible.

i) The technical particulars relating to major design features of boiler and their auxiliaries like fans, mills and ESP of 300/600 MW Chinese units of sub-critical design to the extent available were examined and found to be in line with the good engineering practices. The design efficiencies of Chinese boilers are also found to be comparable to 250/500 MW units commissioned in India. However, some of the utilities do not have complete information about important technical particulars.

ii) The units in operation have been commissioned recently and are under stabilization phase. However, during this period of operation some incidences of boiler tubes failures, high secondary fuel oil consumption, poor mill performance, problem in water leakage in boiler bottom ash removal system etc. have been experienced. Some of these are typical to the initial period of operation and would need to be attended to. Others are related to quality of coal being supplied and would need appropriate remedial measures.

iii) Initial 1-2 years of operation of any plant are critical and will bring out inherent generic deficiencies, if any. The scheduled statutory inspection of boilers would

also bring out the effect of poor quality of coal on various boiler components for any remedial measures to be taken as required.

iv) In some of the plants, aspects related to layout of plant & equipment in mill area, access platforms in boiler area, ducting layout and site routed drain piping were found not in order which may result in difficulties in attending to the equipment during maintenance. This area ought to have been looked into by owner's engineers/consultants at the detailed engineering stage. Adequate care needs to be taken in future, as required.

v) There is a need to have due diligence during stage of specification finalization and detailed engineering by the utilities/consultants. Reference can also be made to the Standard Specification prepared by CEA for Main Plant package of sub-critical units with unit size of 500 MW and above, which is being made available to the utilities. Areas of specification preparation, detailed engineering, inspections/testing etc. would need to be adequately addressed by the utilities to minimize O&M problems.

vi) A detailed comprehensive quality plan for ensuring quality at works and at site identifying customer hold points and test procedures and Standards needs to be defined and implemented for each major equipment/system. Some of the utilities were found lacking in this regard. Strict adherence to specifications regarding quality related aspects needs to be ensured.

vii) Some of the plants were found to be continued to be operated by the Chinese engineers/operators in accordance with the contractual requirements. However, adequate number of Owner's engineers were not posted at site. This is a matter of concern. The utilities need to deploy their O&M engineers during project execution stage at site so as to have exposure to the equipment behaviour during later stage of plant operation. Proper training of O&M engineers in plant operation for the type of equipment/ technology is also recommended in consultation with OEM. Adequate number of experienced and trained manpower needs to be made available well before commissioning of the unit. It is also recommended that design engineers of owners/consultants are deputed for familiarization, training and interaction at the manufacturer's works to enable them to get acquainted with Chinese Standards and practices before the beginning of actual supplies. & well

viii) In view of the fact that important information in respect of design features of boilers supplied to India, data about performance of operating units in China using low grade coal, Standards followed during manufacturing and testing procedures etc., have not been made available by the Chinese manufacturers and also sufficient data is not available with owners of plants in India, it is desirable that a team with Committee members/experts may urgently be deputed to visit Chinese manufacturing works, design institutes as well as few power stations operating with low grade coal. During the visit detailed interactions can be held with equipment designers, system engineers and plant operators and this will provide in-depth information about the quality assurance plan being followed by the manufacturers in China.

ix) It would be desirable that English version of their technical Standards & test procedures are made available to the utilities for better understanding and rigid compliance.

x) As large number of units are being sourced from Chinese manufacturers, it is advisable that the Chinese equipment manufacturers establish spares & services facilities in India for quick & effective response. One of the Chinese manufacturer (M/s Dongfang Electric Corporation) has already initiated action in this regard.

10/9/08
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10.09.08
(V.S. VERMA)
Member (Planning), CEA
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(आई.एस.ओ.: 9001:2000)

No.CEA/5-41(01)/Secy-2008/ 2

Dated: 07.01.2008

Revised Office Order

Subject: Constitution of a Committee to review Design Features of Boilers being sourced from Chinese Manufacturers

In supersession of this Office Order of even No. dated 03.01.2008, the Revised Office Order is hereby issued to constitute the committee comprising of the following members to look into the design features of Boilers being supplied by Chinese Manufacturers to suit Indian Coals with high ash content:-

1. Shri V.S. Verma, Member (Planning), CEA - Chairman
2. E. D. (Engg.), NTPC - Member
3. Shri A. K. Gupta, C.E. (TRM),CEA - Member
4. Shri Suresh Chander, C.E. (TE&TD), CEA -Member (Convener)

The Committee may co-opt any other member, if required.

ıe Terms of Reference of the Committee are:-

1. To study the design features/specifications of Boilers and auxiliaries such as Pulverizers, Fans and ESP being sourced from China with reference to high ash Indian Coals.
2. To give suggestions on the issues arising out of the above study.

The Committee shall submit its recommendations within two months from the date ssue of this Office Order.

7/1/08

(D. S. Arora)
Secretary ,CEA
Phone No. 26108476

Boilers & Auxiliaries details for _____ Thermal Power Project (-----x ----- MW units)

SYSTEM	DESCRIPTION	Details
Coal Quality	Proximate analysis (%) Fixed carbon Volatile matter Moiture Ash	
	Ultimate analysis (%) Carbon Hydrogen Oxygen Nitrogen Sulphur Ash	
Boiler Parameters	Pressure SH outlet Kg/cm^2 (g) Temperature SH outlet °C Flow rate TPH FW Temp. at Eco inlet °C	
Furnace	Type	
	Explosion / implosion withstand capacity @ 67 % yield strength	
	Minimum Residence time for fuel particles in the furnace (sec)	
	Furnace Depth/Width (m)	
	Furnace area (m^2) Plan area (m^2) EPRS (effective projected radiant surface) (m^2)	
	Furnace volume (m^3)	
	Max. NHI (Net Heat Input) per plan area (kcal/hr/m^2)X10^6	
	Max. Heat Liberation rate (kcal/hr/m^3)	
	Burner zone Heat release rate (kcal/hr/m^2)X10^6	
	Burner firing arrangement (Tangential/ Front)	
	Max. FEGT value (°C)	
	Heat input per burner X 10^5 (kcal/hr)	
	Max. Furnace cooling factor (kcal/hr/m^2)X10^5	
	Gas velocity limit(m/s)	
	Provision of wear bars in furnace hopper	
	Furnace hopper designed for full of ash	
Waterwall	No. of front tubes	
	Tube size (OD X t)	
	Additional thickness margin (mm)	
	Material	
	Total projected area of tubes (m^2)	
	Provision of faciated tubes	
	Total Weight of waterwall tubes	
	Weight of furnace tubes other than waterwall	

SYSTEM	DESCRIPTION	Details
Waterwall headers	No. of headers and sizes	
	Material	
Drum	Size	
	Material	
	Construction	
	Design pressure (Kg/cm^2)	
	Design metal temp. (^oC)	
	Water capacity at MCR conditions (in seconds) between normal and lowest water level permitted	
Super-heater	Type Stage-I Stage-II Stage-III	
	Material of specification Stage-I Stage-II Stage-III	
	Effective heating surface area (M^2) Stage-I (LTSH) Stage-II (DIVN. PANEL)/Final SH(FSH) Stage-III (PLATEN)	
Super-heater	Total no. of tubes and total weight in tonnes Stage-I (LTSH) Stage-II (DIVN. PANEL)/Final SH(FSH) Stage-III (PLATEN)	
	Depth of tube banks (m. max)	
	Erosion allowance (mm on leading tube & mm balance)	
	Maximum average flue gas velocity in SH section/tube banks with transverse pitching 600 mm or less (m/s)	
Reheater	Material Specification Front Rear Total circumferential heating surface area (m2) Front Rear Total weight in tonnes Front Rear	
Headers	Material Spec. and sizes SH RH	

SYSTEM	DESCRIPTION	Details
	Location (outside/inside gas path) SH RH Thermocouple for SH/RH	
Economizer	Type	
	Erosion allowance	
	Space provision for additional Economizer	
	Material spec. & configuration	
	Gas side effective heating surface are (m^2)	
	Total weight in tonnes	
	Maximum gas velocity through tube banks of economizer (m/s)	
Boiler structure	Total weight of structure Whether bolted or welded	
SGWC Pump	No. of pumps operating.	
	No. of pumps standby	
Air Heater	Primary + Secondary Air Heater type or Trisector type	
	No. of air heaters / boiler ♦ Primary ♦ Secondary	
	Material spec. & composition ♦ Cold end elements (Primary + Secondary) ♦ Intermediate elements ♦ Upper hot element	
	Flue Gas temp. at air heater outlet (corrected)	
	Areas of elements (per heater, m^2) ♦ Hot end (Primary) ♦ Int. end (Primary) ♦ Cold end (Primary)	
	Total effective heating surface (Primary) m^2	
	Air pre heater leakage	
	Areas of elements (per heater, m^2) ♦ Hot end (Secondary) ♦ Int. end (Secondary) ♦ Cold end (Secondary)	
	Total effective heating surface (Secondary) m^2	
	Type of seals Radial / Circumferential / Axial	
	♦ Pressure drop in APH	

SYSTEM	DESCRIPTION	Details
Draft Plant	Manufacturer ♦ FD fan ♦ ID fan	
	Type and flow control ♦ FD fan ♦ ID fan	
	Number of fans per boiler ♦ FD fan ♦ ID fan	
	Margin on FD Fan :- Flow (%) Head (%) Margin on ID Fan :- Flow (%) Head (%)	
	Normal fan speed (rpm) and size of motor (KW) ♦ FD fan ♦ ID fan	
Soot Blower	Manufacturer of ♦ Blowers ♦ Control Equipment	
	Type	
	Furnace blowers Type/Make/Number	
	No. of soot blowers	
	Super-heater blowers Type/Make/Number	
Coal Preparation & Firing System	**Coal feeders**	
	Manufactures	
	Type	
	Feeder size (mm)	
	Normal capacity (T/hr.)	
	Maximum capacity (t/hr.)	
	Method of output control	
	Type of drive	
	Raw coal weighers method of measurement	
	Coal Pulverizers	
	Manufacturer	
	Type	

SYSTEM	DESCRIPTION	Details
	Number per Boiler	
	Max. capacity (T/hr.) Design coal Worst coal	
	Speed of mill (rpm)	
	Max permissible loading	
	Coal Fineness (%) a. Through 200 mesh b. Through 50 mesh	
	Guaranteed wear life (hrs) a. Classifier Cone b. Classifier vanes c. Seals d. Mill discharge valve e. Grinding elements	
	Coal pipe size mm x mm Velocity in Coal Pipe m/sec Max. Min. Type & Thickness of lining in coal pipes	
Primary and Seal Air Fans	Manufacturer PA Fan Seal Air Fan	
	Type ♦ PA fan ♦ Seal air fan	
	No. of fans/boiler ♦ PA fan ♦ Seal air fan	
	Mounting of seal air fan	
	Margin on :- Flow (%) Head (%)	
	Test block flow (cub.m/s) ♦ PA fan ♦ Seal air fan	
	Test block head (mmwc) ♦ PA fan ♦ Seal air fan	
	Normal speed of fan ♦ PA fan ♦ Seal air fan	

SYSTEM	DESCRIPTION	Details
	Size of motor (KW) ♦ PA fan ♦ Seal air fan	
	Material of construction of impeller blades ♦ PA fan ♦ Seal air fan	
Coal Burners	Type	
	Make	
	No. of coal burners fed by each pulverizer	
	Total number of coal burners	
	Turn down ratio	
	Burner tilt in degrees	
Fuel Oil Preparation & Firing System	Fuel oil Pressuring Pumps	
	Manufacturer	
	Type ♦ Heavy Oil ♦ Light oil	
	No. of fuel oil pumps ♦ Heavy Oil ♦ Light oil	
	No. of standby pumps ♦ Heavy Oil ♦ Light oil	
Oil Burners	Manufacturer	
	Type	
	Design data No. of oil burners	
	Elevation of Boiler burners	
	Atomizing medium	
	Scavenging medium	
	Turndown ratio	
Ducting Details	Plate thickness (mm) Air ducts Gas ducts	
Thermal Insulation	Insulating Material for temperatures < 350 ^{0}C Insulating Material for temperatures > 350 ^{0}C Bulk density of material (Kg/sq.m) < 350 ^{0}C Bulk density of material (Kg/sq.m) > 350 ^{0}C	

SYSTEM	DESCRIPTION	Details
Electro Static Precipitator (ESP)	Manufacturer's model number	
	Dimensions (associated with one boiler)	
	a) width (across gas flow) (m)	
	b) Flange to flange length (in direction of gas flow) (m)	
	c) Height between bottom of hoppers to support level (m)	
	d) Height between support level to top of monorail steel (m)	
	e) Height between top of insulator compartments to top of monorail (m)	
	No. of electrical fields in series	
	Collection efficiency	
	Particulate emission mg/Nm^3 i) with worst coal firing with all fields in service ii) with design coal firing with all fields in service. iii) with design coal firing with one field out of service.	
	Number of ESPs per boiler	
	Number of gas streams per boiler	
	Maximum bus voltage (KV)	
	Average bus voltage (KV)	
	Installed power per set of ESPs of one steam Generator (MW)	
	Specific collection area (m2/m3/s), corresponding gas flow (m3/s)	
	Total active collection are (m2)	
	Treatment time (sec) and the corresponding gas flow (m3/s)	
	Gas velocity through ESP (M/sec.)	
	Aspect Ratio	
	Effective migration velocity	
Electro Static Precipitator (ESP)	**PRECIPITATOR CASING**	
	Material	
	Plate thickness (mm)	
	Design pressure (mmWC)	
	Design temperature (°C)	
	GAS DISTRIBUTION SYSTEM	
	Method of ensuring uniform gas distribution	
	Number of distribution plates/ screens	
	DISCHARGE ELECTRODES	
	Type	

SYSTEM	DESCRIPTION	Details
Electro Static Precipitator (ESP)	Material of the electrodes	
	COLLECTING ELECTRODES	
	Material	
	Size of Electrodes a) Width (mm) b) Height (mm) c) Thickness (mm)	
	Effective height & width in contact with gas (m)	
	ELECTRODE RAPPING EQUIPMENT	
	Discharge Electrodes	
	Type	
	Number of rapping gear shafts per gas stream	
	Location of drive (top / side)	
	Number of hammers per shaft	
	Collecting Electrodes	
	Type	
	Number of rapping gear shafts per gas stream	
	Number of hammers per shaft	
	Weight of single hammer (kg)	
	Accessibility / Location	
	Time for single rapping cycle	
	INSULATOR SYSTEM	
	Insulator	
	Type & make	
	Material	
	TRANSFORMER RECTIFIER SETS	
	Type	
	Manufacturer	
	Rating (KVA)	
	No. per field per gas stream	
	No. of bus sections per field per gas stream	
	Method of cooling and type of cooling liquid	
	DUST HOPPER	
	No. per field per gas stream	
	No. per ESP of one boiler	

SYSTEM	DESCRIPTION	Details
	Material	
	Plate thickness (mm)	
	Side angle (degrees)	
	Valley angle (degrees)	
	Storage capacity of each hopper (hours)	
	Volumetric storage capacity of each hopper (m3)	
	ESP MANAGEMENT SYSTEM / CONTROLLERS	
	No. of rapper controllers per unit	
Layout	Unit Pitching	
	No. of floors (Total platform area) m^2	
	No. of levels of interconnections with TG building and Mill bay	
	Location of Mills	
	No. of lift landings in boiler	
	Location of Fans	

APPENDIX-III

LIST OF PROJECTS ORDERED ON CHINESE COMPANIES FOR LIKELY BENEFITS DURING 11TH/12TH PLAN -- THERMAL

Sl.No.	PLANT NAME	STATE	AGENCY	SECTOR	CATEGORY	UNIT SIZE GROUP	NO OF UNITS/ MODULES	ULTIMATE CAPACITY (MW)	TYPE	BENEFITS 11TH PLAN (MW)	LIKELY YEAR OF BENEFIT	AGENCY
	LIKELY BENEFITS DURING 11th PLAN											
1	RAGHUNATHPUR	WB	DVC	C	UC	600	2	1200	PH	1200	2010-11	REL (Main Equpt by SHANGHAI ELEC, CHINA)
	Sub-total Central									1200		
2	YAMUNA NAGAR U1,2	HARYANA	HPGCL	S	COMND	300	2	600	LC	600	2007-08	REL (Main Equpt by SHANGHAI ELEC, CHINA)
3	HISSAR TPS	HARYANA	HPGCL	S	UC	600	2	1200	LC	1200	2009-10	REL (Main Equpt by SHANGHAI ELEC, CHINA)
4	SAGARDIGHI U 1,2	WB	WBPDCL	S	COMND	300	2	600	LC	600	2007-09	DONG FANG, CHINA
5	DURGAPUR EXT U 7	WB	DPL	S	COMND	300	1	300	LC	300	2007-08	DONG FANG, CHINA
	Sub-total State									2700		
6	ANPARA-C (bid was placed for 1000 MW, however the project promoter has placed order for 1200 MW)	UP	LANCO	P	UC	500	2	1000	PH	1000	2010-11	DONG FANG, CHINA
7	ROSA ST-I	UP	RELIANCE POWER	P	UC	300	2	600	LC	600	2009-11	SHANGHAI ELEC, CHINA
8	JALIPA LIGNITE	RAJASTHAN	RAJ WEST POWER	P	UC	135	8	1080	PH-LIG	1080	2009-10	DONGFANG, CHINA
9	PATHADI (LANCO) U1	CHATTISGARH	LANCO-IPP	P	UC	300	1	300	PH	300	2008-09	DONGFANG, CHINA/ ZELAM, MALAYSIA
10	PATHADI (LANCO) U2	CHATTISGARH	LANCO-IPP	P	UC	300	1	300	PH	300	2009-10	DONGFANG, CHINA/ ZELAM, MALAYSIA
11	ADANI POWER PVT LTD-MUNDRA	GUJARAT	ADANI	P	UC	330	4	1320	COASTAL	1320	2009-11	SCMEC, CHINA
12	JSW ENERGY, RATNAGIRI	MAHARASHTR	JSW	P	UC	300	4	1200	COASTAL	1200	2010-11	SHANGHAI ELEC, CHINA
13	TORANGALLU U1,2	KARNATAKA	JINDAL	P	UC	300	2	600	LC	600	2008-09	SHANGHAI ELEC, CHINA
14	LANCO NAGARJUNA	KARNATAKA	NPCL-LANCO	P	UC	500	2	1015	COASTAL	1015	2009-11	DONGFANG, CHINA
15	STERLITE ENERGY	ORISSA	STERLITE	P	UC	600	1	2400	PH	600	2009-10	SEPCO III, CHINA
16	ADANI POWER PVT LTD-MUNDRA	GUJARAT	ADANI	P	UC	660	2	1320	COASTAL	1320	2011-12	SEPCO III, CHINA
	Sub-total Private									9335		
	Total 11th PLAN									13235		
Sl.No.	PLANT NAME	STATE	AGENCY	SECTOR	CATEGORY	UNIT SIZE GROUP	NO OF UNITS/ MODULES	ULTIMATE CAPACITY (MW)	TYPE	BENEFITS 12TH PLAN (MW)		AGENCY
	LIKELY BENEFITS DURING 11th PLAN											
1	SASAN UMPP	MP	RELIANCE	P	UC	660	6	3960	PH	3960		SHANGHAI ELEC, CHINA
2	STERLITE ENERGY	ORISSA	STERLITE	P	UC	600	3	2400	PH	1800		SEPCO III, CHINA
	Sub-total Private									5760		
	Total 12th PLAN									5760		

UC: Under Construction; COMND: Commissioned

APPENDIX-IV

सत्यमेव जयते

दूरभाष (का) 26106988
TELEPHONE (O) 26172926
TELEFAX (O)

सदस्य
तथा पदेन अपर सचिव भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सेवा भवन, रामकृष्ण पुरम्

MEMBER
& EX-OFFICIO ADDL. SECRETARY TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K. PURAM

नई दिल्ली - 110066
NEW DELHI-110066

No.CEA/MP/2/2008/ 217-219 **7th August, 2008**

Mr. Wen Shugang
President
Dongfang Electric Corporation Ltd.,
333, Shuhan Road, Chengdu
Sichuan 610036
Fax No.028-87583333
0086 28 -

Subject: Operational Performance and Design Details in regard to Boilers being supplied to the Indian Power Plants.

Dear Sir,

As you may be aware that India has an ambitious programme for electricity generation capacity addition in the current Five Year Plan ending year 2012 and beyond. A major portion of this capacity addition is based on indigenous coal which has high ash content. The ash is also of highly abrasive nature. Recently, some of the power plants have ordered the 300/600 MW units on Chinese manufacturers. Some of these have also been commissioned or are in advanced stage of commissioning. More such units are expected to come up in future.

2.0 With a view to ascertaining and finding out if these units perform to the desired level, keeping in view the type of coal being burnt in these power stations, Govt. of India has set up a Committee under my Chairmanship. The Committee comprises of members from CEA and NTPC. It would be desirable if the operational performance and design details in respect of the units in operation in China and in other countries supplied by your company and other Chinese manufacturers are also studied specially if these were designed to burn the high ash content coal.

...2/-

3.0 Accordingly, you are kindly requested to make available the following information on urgent basis:-

(i) Reference list and performance data (Annual Plant utilization factor, availability factor, operating efficiency, design efficiency, basic steam parameters, coal quality etc. in respect of those plants where high ash content coal has been used.

(ii) Reference list of the plants which have been supplied outside China along with their ratings, steam parameters, year of commissioning, type of fuel etc.

(iii) Details of technical collaborations entered into by your company to design and manufacture the 300 MW/600 MW units and also the super-critical units. Kindly also indicate the extent of technical support and the period upto which such collaboration exists/existed.

(iv) Kindly name the Chinese standards as used for design and manufacturing of plants. Whether these are equal to/correspond to the reputed International technical standards.

(v) Whether the English translation of the above Standards are available.

(vi) Specific design features conceived and incorporated in the boilers being supplied to India for burning low grade coal vis-à-vis the boilers designed for Chinese coal.

(vii) Whether the test procedures followed for testing of plants and equipment at manufacturer's works correspond to the international technical standards? Please give details.

(viii) Any other information in support of quality features of the units supplied or being supplied to India.

We would be grateful, if the above information is made available expeditiously and preferably within two weeks time (by 22nd August, 2008). Please also confirm if you could depute experienced technical and responsible technical expert(s) for discussion on the issues in detail, say by 22nd August,2008 or even earlier.

Yours sincerely,

(V.S. Verma)

सत्यमेव जयते

दूरभाष (का० 26106988
TELEPHONE (O) 26172926
TELEFAX (O)

सदस्य
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केन्द्रीय विद्युत प्राधिकरण
सेवा भवन, रामकृष्ण पुरम्

MEMBER
& EX-OFFICIO ADDL. SECRETARY TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K. PURAM

नई दिल्ली - 110066
NEW DELHI-110066

No.CEA/MP/2/2008/ 217-219 **7th August, 2008**

Mr. Zhengjian Hua
President,
Power Company
Power Generation Group
Shanghai Electric Corp.,
188, Linchun Road, Shanghai,
China
(Fax No.8621-54832025)

Subject: Operational Performance and Design Details in regard to Boilers being supplied to the Indian Power Plants.

Dear Sir,

As you may be aware that India has an ambitious programme for electricity generation capacity addition in the current Five Year Plan ending year 2012 and beyond. A major portion of this capacity addition is based on indigenous coal which has high ash content. The ash is also of highly abrasive nature. Recently, some of the power plants have ordered the 300/600 MW units on Chinese manufacturers. Some of these have also been commissioned or are in advanced stage of commissioning. More such units are expected to come up in future.

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(V.S. Verma)

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MEMBER
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CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K. PURAM

नई दिल्ली - 110066
NEW DELHI-110066

No.CEA/MP/2/2008/ 217-219 **7th August, 2008**

The President
Harbin Power Engineering Co. Ltd.,
39, Sanda Dongli Road,
Harbin
China-150 040
(Fax No.0451-82871700)
0086451- 82681689 / 82681723

Subject: Operational Performance and Design Details in regard to Boilers being supplied to the Indian Power Plants.

Dear Sir,

As you may be aware that India has an ambitious programme for electricity generation capacity addition in the current Five Year Plan ending year 2012 and beyond. A major portion of this capacity addition is based on indigenous coal which has high ash content. The ash is also of highly abrasive nature. Recently, some of the power plants have ordered the 300/600 MW units on Chinese manufacturers. Some of these have also been commissioned or are in advanced stage of commissioning. More such units are expected to come up in future.

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Yours sincerely,

(V.S. Verma)

FAX

HARYANA POWER GENERATION COPORATION LTD.
(Regd. Office : Shakti Bhawan, Sector-6, Panchkula)

From

Chief Engineer/Projects,
HPGCL, Panchkula.

To

Sh. A.K. Gupta,
Chief Engineer/TRM,
CEA, 9th floor Sewa Bhawan,
R.K. Puram, New Delhi-110066
Fax No.011-26186904

Memo No. 3595 dt/CE [illegible]

Dated : 21 .08.2008

Subject: Operational performance & design details in regard to boilers sourced from Chinese manufacturers.

Reference your office memo no. CEA/TETD-MP/07/G-31/581 dated 7/8.08.2008 addressed to the M.D., HPGCL on the above subject. The requisite information is as under :-

1. **Range of Coal quality specified- Performance coal and worst coal (Proximate Analysis).**

Particulars	Designed Coal	Worst Coal
Proximate Analysis		
Moisture (%)	15.0	15.0
Ash (%)	34.0	46.0
Fixed Carbon (%)	21.0	19.73
Volatile matter (%)	30	19.27
GCV KCal/KG	4000	3150

2. Coal Quality as actually received (Proximate Analysis).

Month	**Ash (%)**	**Volatile matter (%)**	**Fixed carbon (%)**	**GCV Kcal/KG**
April 08	38.34	19.88	34.60	3831
May 08	39.93	19.04	34.00	3776
June 08	37.18	18.88	36.62	3791
July 08	41.14	19.41	31.37	3610
August 08 upto 20-08-08	40.38	17.36	33.78	3520

3. Performance feedback

a) Problems/constraints faced in achieving rated load on sustained basis:

I) Mill reject handling system is in adequate. It is designed for handling 1% reject whereas the actual reject coal quantity is more .Due to non evacuation of Mill reject in time the Mills get chocked damaging their internals resulting into frequent shut downs of the Mills.

II) The guns provided are not reliable. Coaxial type oil guns have been provided instead of parallel type. The chocking of guns/ puncture of hose pipe is observed frequently.

III) The Scanner air fan are developing only 570 mm wcl pressure against design value of 750 mmwcl pressure resulting into inadequate cooling of flame scanners

during monsoon season.

b) **Constraints in operation and maintenance due to layout or any other reason.**

I) The removal of roller assembly particular installed on boiler side is not possible. The Mills have been installed in front of boiler unlikely the BHEL boiler where the mills are installed at rear of boiler

II) Due to vertical layout of hot air duct, there is obstruction in movement of EOT cranes.

III) Erection of cross beam in D- Row is creating hindrance in maintenance of gear box of coal Mills A, D & F.

IV) Erection of horizontal bracing at 1 meter above coal mill maintenance in 'D- Row' of columns is creating obstruction in maintenance of roller & spring assembly.

V) The layout plan of Mill maintenance platform is very congested. There is no maintenance space available on the platform. The platform is required to be extended upto the C-row of columns and about 1 to 2 mtr. near coal Mill A & F.

VI) The pyrite hoppers of coal mill C&D have been provided just opposite to each other and there is no space available for removal of reject by pocking & maintenance of hoppers (pneumatic reject system of mills).

VII) There is a problem of coal dust is settling down on lub. Oil system of mills which is also ingression into the lub. oil.

VIII) The seal air fan have been installed under the down comer drains/periodic blow down drains. Also adjacent heating system have been installed in vicinity to seal air fan leaving virtually no space for maintenance of seal air fan, provision for EOT crane for maintenance of fans/motors. The difficulty is being faced in approaching the fan by maintenance / operation personnel.

IX) The feeder O/L gate has been installed just below the feeder hopper and above the pulverized pipes. There is no accessibility to this gate for operation & maintenance.

X) Unlike the BHEL Boiler the feed control station, oil control station, steam control & reheat control station have been staggered at various elevation of Boiler resulting into a lot of difficulty as being faced by Boiler Operation personnel while stabilizing the unit.

XI) Firing zone between 22 to 33 meter at corner no.1,2,3 & 4 is very congested. Difficulty being faced in maintenance of various equipments like guns, burner, valves & furnace I/L pulverize coal gate. The gates on particular at corners at 3 & 4 are fouling with down comer pipe. Some of gates could not be opened as the spindle of gate foul with down comer.

XII) The silo of coal reject has been installed near to the boiler on RHS in Unit#1 & on LHS of Boiler in Unit#2. The dust in shape of clouds is developed whenever the reject is removed from silo in trolley for further shifting to yard. Also the conveying pipe getting frequent punctured and reject coal start leaking from punctured pipes. Both, dust and the reject have made the site very dirty .The dust settled on various actuators & other control instruments is causing damage to equipments and number of the actuators have already gone out of service.

XIII) Unlike the BHEL units, the lub. Oil system of Guide Bearing & Support Bearing of APH are installed on the centre section close to the bearing. Due to dusty environment the lub. Oil system functioning is badly effected particularly in case of guide bearing where the suction of lub. oil system is designed with negative head.

XIV) The HFO /LDO supply lines of Unit-I & II are not interconnected.

c) Major causes of unit trippings experienced.

Flame Failure and Boiler Drum Level High/Low

d) Incidents of tube failures.

Date	Area/ No. /Type of failure
20.01.08	Platen super heater EF and G tube from front to rear in fifth right to left
13.03.08	LTSH coil number 36C-37C 38C, 39C, 40C 40D and 41B (8 tubes) form left to right
29.06.08	Water valve left 3 side tube I, IInd and IIIrd form front to rear and reheater outlet tubes Ist and IInd front to rear

Any component/equipment failure and reasons thereof.

i) Frequent failure LOP of APH guide bearing have been observed. Main reason of the failure may be faulty location of pumps in dusty environment.

II) The pedestal of PA Fans have developed cracks specially in PA fan # IA. The cracks have been repaired temporarily under the supervision of SEC. However the reason of these cracks and remedial action is yet to be intimated by REL/SEC.

III) The ceramic bends, installed in pulverized coal pipes have started leaking out. These are guaranteed for a life 20,000 hrs.

IV) The fabric compensator bellows are damaging very frequently. The expansion bellows of coal Mill & PA fan have already damaged; and were repaired by REL through local arrangement.

V) The high pressure valve installed in boiler area are problematic. Frequent leakages & passing has been observed. Failure of important valves like EBD & start up vent are glaring example.

VI) The spike type emitter (unlike spacing type emitter provided by BHEL) installed in Ist three fields are getting damaged very frequently resulting into outage of ESP field and affects the performance of ESP. The repair of spike type emitter is difficult.

4 Mill performance

a) Number of Mills in operation at full load.
Five numbers Mills remained in service at full load.

b) Quantity of Mill rejects.
About 3 %

c) The coal fineness achieved.
Around 75-80%

d) The load upto which oil support is provided and reasons thereof.
Upto 180 MW due to instability of the unit.

5 List of tests/ Inspections carried out at manufacturer's works with the participation of project Engineers is attached at annexure-A.

6. Details of O&M manpower posted at site and their training profile.

A) Staff

Gazetted	120Nos.
Non-Gazetted	208Nos.

B) Training Profile

Sr. No.	Training Imparted	Place of Training	Duration of Training	Training Imparted to Personal		
				XEN	AEE/AE	Total
1	Familiarization with Power Plant	Power Management Institute NTPC Noida	35 days	--	27	27
2	Simulator training for Operation of Power Plant	SEC China	28 days	2	14	16
3	PLC system	GE Fanac Banglore	7 days	-	1	1
4	C&I Honewell System	SEC China	15 days	1	3	4
5	Maintenance of Boiler and Auxiliaries	SEC China	15 days	1	2	3
6.	Maintenance of T.G Equipments	SEC China	15days	-	2	2
7	Maintenance of Electrical Equipments	SEC China	15 days	-	2	2
8	Operation of Power Plant	REL's Thermal Power Plant at Dhanu	7 days	-	26	26
	Total					**81**

7. Any other specific observation about overall performance of the unit.

The unit is presently under stabilization stage and performance is under observation.

Chief Engineer,
HPGCL, Panchkula.

DA/As above

C:C

Chief Engineer, DCRTPP, HPGCL Yamunanagar. This is with respect to his office memo no. Ch-110/YTPP-112 dated 25.08.08. Fax No.-01732-298501.

Annexure – A

2 x 300 MW DCRTPP, YAMUNANAGAR

List of BTG Equipment offered for HPGCL inspection at the sub-vendor works of M/s Shanghai Electric (Group) Corporation , Shanghai , China.

Sr. No.	Name Of Equipment	Quantity	Name of the Test
1.	Boiler Feed Pump & Booster Pump	3 Nos for Unit # 1 3 Nos for Unit # 2	Performance Test NPSH Test & Stripdown Test on 1 Pump.
2.	Turbine Rotors(HIP & LP) of Unit # 1	Unit # 1	Dynamic Balancing Test Overspeed Test
3.	Turbine Rotors (HIP &LP) of Unit # 2	Unit # 2	Dynamic Balancing Test Overspeed Test
4.	Generator Rotor for Unit # 1	Unit # 1	Dynamic Balancing Test Overspeed Test Rotor turn to turn Short Circuit Test
5.	Generator Rotor for Unit # 2	Unit # 2	Dynamic Balancing Test Overspeed Test Rotor turn to turn Short Circuit Test
6.	Condensate Extraction Pump	3 Nos for Unit # 1 3 Nos for Unit # 2	Performance Test NPSH and Stripdown Test on one pump
7.	ESP	Unit # 1	Gas Distribution Test on one unit only.
8.	HP Heaters 6,7 & 8 of Unit # 1	3 Nos for Unit # 1	Hydro Test
9.	HP Heaters 6, 7 & 8 for Unit # 2	3 Nos for Unit # 2	Hydro Test
10.	Boiler Drum Unit # 1	1 No. for Unit # 1	Hydraulic Test
11.	Boiler Drum Unit # 2	1 No. for Unit # 2	Hydraulic Test
12.	DCS # 1	Unit # 1	Factory Acceptance Test
13.	DCS # 2	Unit # 2	Factory Acceptance Test
14.	DEH for Unit # 1(Digital Electro Hydraulic	Unit # 1	Factory Acceptance Test
15.	DEH # 2	Unit # 2	Factory Acceptance Test

HARYANA TEST HOUSE
& Consultancy Services

50 C, Sector 35, Part II, HUDA, Panipat 132 103 (HARYANA)
Ph: (0180) 2698103, (M) 94160 17601, Tele-Fax: 0180 2671112, e-mail: rd.thouse@sify.com
A Recognised Laboratory by Haryana State Pollution Control Board (Under Water Act, 1974 and Air Act, 1981)

Report No: HTH/ DCRTPP/ 08/ 433

Issued to: XEN/ CCD-I, DCRTPP, HPGCL, Yamuna Nagar (HR)	**Party's Ref No:** W.O. No. 20/ XEN/ CCD-I/ MTC-4 **Dated:** 12.03.2008 **Job Order No:** 3280-A, **Dt.** 16.07.2008 **Date of Testing:** 16.07.2008

Sample Description: Stack Emissions (Boiler No.-I) **Dated:** 15.07.2008

TEST REPORT

Sample Particular

1	Type of Industry	:	Power Generation Plant
2	Capacity of Boiler	:	300MW/day
3	Type of fuel used	:	Coal
4	Plant Load	:	198MW
5	Stack height from the ground level	:	275 meter
6	Stack diameter	:	5.15 meter
7	Stack gas temperature, °C	:	142.00
8	Ambient air temperature, °C	:	37.00
9	Avg. Stack gas velocity, m/sec	:	21.35
10	Sampling flow rate, Lt / min.	:	7.00
11	Period of sampling, minutes	:	60.00
12	Volumetric flow rate, Nm^3/ Hr.	:	1219603.40
13	Type of APCM installed	:	E.S.Ps. (28 Nos.)
14	No. of E.S.P's in line	:	27 Nos.

Results:

Sr. No.	Parameters Suspended	Concentration (mg/NM^3)	Pollution Load (kg/day)	Pollution Load (kg/MW)	Standard Limits (mg/NM^3)
1	Particulate Matter (SPM)	57.55 *	1684.52	8.51	150
2	Sulphur dioxide (SO_2)	242.67	7103.07	35.87	--
3	Oxide of Nitrogen (NO_2)	2.55	74.64	0.3770	--
4	Carbon Monoxide (CO) ppm	5.80	--	--	--

* Corrected to 12 % CO_2

$H = 14 (Q)^3$, Where as Q is the Emission rate for SO_2 in Kg/ hr. and H is the Stack Height in Mt.
Carbon dioxide was found to be 9.80 % during monitoring.
Protocol used as per IS-11255 & EPA method.

HARYANA TEST HOUSE PANIPAT

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HARYANA TEST HOUSE
& Consultancy Services

50 C, Sector-25, Part II, HUDA, Panipat-132 104 (HARYANA)
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A Recognized Laboratory by Haryana State Pollution Control Board (Under Water Act, 1974 and Air Act, 1981)

Report No: HTH/ DCRTPP/ 08/ 434

Issued to: **XEN/ CCD-I,** **DCRTPP, HPGCL,** Yamuna Nagar (HR)	**Party's Ref No:** W.O. No. 20/ XEN/ CCD-I/ MTC-4 **Dated:** 12.03.2008 **Job Order No:** 3280-B, **Dt.** 16.07.2008 **Date of Testing:** 16.07.2008

Sample Description: Stack Emissions (Boiler No. 2) **Dated:** 15.07.2008

TEST REPORT

Sample Particular

1	Type of Industry	:	Power Generation Plant
2	Capacity of Boiler	:	300MW/day
3	Type of fuel used	:	Coal
4	Plant Load	:	194MW
5	Stack height from the ground level	:	275 meter
6	Stack diameter	:	5.15 meter
7	Stack gas temperature, °C	:	127.00
8	Ambient air temperature, °C	:	37.00
9	Avg. Stack gas velocity, m/sec	:	21.35
10	Sampling flow rate, LPM/ min.	:	8.00
11	Period of sampling, minutes	:	60.00
12	Volumetric flow rate, Nm^3/ Hr.	:	1146159.42
13	Type of APCM installed	:	E.S.Ps. (28 Nos.)
14	No. of E.S.P's in line	:	12 Nos.

Results:

Sr. No.	Parameters	Concentration (mg/NM^3)	Pollution Load (kg/day)	Pollution Load (kg/MW)	Standard Limits (mg/NM^3)
1	Suspended Particulate Matter (SPM)	313.84 *	8633.06	44.50	150
2	Sulphur dioxide (SO_2)	269.63	7416.94	38.23	--
3	Oxide of Nitrogen (NO_x)	3.43	94.35	0.4863	--
4	Carbon Monoxide (CO) ppm	6.20	--	--	--

* Corrected to 12 % CO_2

$H = 14 (Q)^{\frac{1}{2}}$, Where as Q is the Emission rate for SO_2 in Kg/ hr. and H is the Stack Height in Mt.
Carbon dioxide was found to be 10.20 % during monitoring.
Protocol used as per IS-11255 & EPA method.

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HARYANA TEST HOUSE PANIPAT

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APPENDIX-VII

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

(A Govt. of West Bengal Enterprise)

SAGARDIGHI THERMAL POWER PROJECT

P.O. Monigram, P.S. Sagardighi, Dist. Murshidabad West Bengal, Pin : 742237
Phone No. : (03483) 237003, EPBAX- 237005, 237006, Fax : 237002

Memo No. Sg.TPP/DGM(Comm)/1180 Dated.01.09.2008

To
The Chief Engineer (TRM)
Central Electricity Authority,
Govt. of India,
Thermal Renovation Modernization Division,
9th Floor, Sewa Bhawan, R.K.Puram,
New Delhi – 110 066.
Fax No. 011-26186904

Atten : Mr. A.K.Gupta, Chief Engineer (TRM).

Sub : Operational performance and design details in regard to Boilers sourced from Chine Manufactures.

Ref No. : CEA/TETD-MP/07/G31/576 Dated. 07.08.2008

Dear Sir,

Please note the following information in regards to operational performance of boilers as required by you is furnished below:

1. **Range of coal quality :**

	Symbol	Unit	Design Coal	Worst Coat
HHV	Qgr.ar	Kcal/Kg	4100	3200
Air-dried moisture	M ad	%	1.0	0.7
Volatile content	V daf	%	28.46	17.5
Total moisture	Mt	%	8	15
Total ash	Aar	%	40	45
Ultimate analysis as received (C,H,O.N.S)	Car	%	42	32.3
	Har	%	3	2.3
	Oar	%	5.8	4.5
	Nar	%	0.9	0.7
	Sar	%	0.3	0.2

2. **Coal quality as actually received.**

Description	Unit	Result
M_1	%	3.3
M_{ad}	%	0.81
A_{ar}	%	60.61
V_{ar}	%	17.33
FC_{ar}	%	18.26
$S_{t,ar}$	%	0.11
$Qgr_{,ar}$	J/g	9620
$Q_{net,ar}$	J/g	9030
C_{ar}	%	24.36
H_{ar}	%	2.44
N_{ar}	%	0.63
O_{ar}	%	8.05

Regd. & Corporate Office : New Secretariat Buildings, 6th Floor, "B Block; 1, Kiran Sankar Roy Road, Kolkata-700 001
Telephone : EPBAX 22480912, 22430525, Telefax : + 913322486436, 2210-3991, Telex : 021-4891 PDCL IN
E-mail-wbpdc2@giascl 01.vsnl.net.in

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED
(A Govt. of West Bengal Enterprise)
SAGARDIGHI THERMAL POWER PROJECT
P.O. Monigram, P.S. Sagardighi, Dist. Murshidabad West Bengal, Pin : 742237
Phone No. : (03483) 237003, EPBAX- 237005, 237006, Fax : 237002

Description	Unit	Result
R_{90}	%	-
R_{200}	%	-
HGI	/	58
DT	%	47

3. Performance feed back :

a) Problems / Constraints faced in achieving rated load on sustained basis	i) Poor coal quality. ii) Boiler Feed Pump mechanical seal trouble – seal water temperature high
b) Constraints in operation and maintenance due to layout or any other reason	Not applicable as layout was done by WBPDCL with consultant M/S DCPL
c) Major causes of Unit tripping experience	i) Boiler tube failure ii) Turbine blade failure
d) Incidents of tube failure	i) Economizer tube failure ii) Re-heater tube failure iii) Water wall tube failure
e) Any component / equipment failure and reasons thereof	i) CEP 1A thrust bearing failure – reasoned not known to us. ii) Turbine blade failure – reasoned not known / awaiting DEC reply

4. Mill performance :

a) Number of mills in operation at full load	i) 4 mills with design coal ii) 5 mills with worst coal
b) Coal fineness achieved	i) R_{90}
c) Load upto which oil support is provided & reasons thereof	Oil support required upto 60% of full load for furnace stability

5. List of tests / inspections carried out at manufacturer's works with the participation of project engineers – 3 rd party inspection was done by M/S DEC. Project engineers were not engaged.
6. Details of O&M manpower posted at site and their training profile –

Main Power House	OS – 1, Shift-in-Charge -6, Manager (E.O)-1, Control Engineers-30, Operators - 60
CHP	Sr. Manager -1, Manager-1, Asstt. Manager -6
C&I	Sr. Manager -1, Manager-1, Asstt. Manager -8
AHP	Asstt. Manager – 1, Jr.Mgr.-2, Operators-4
Mech. Maintenance	Sr.Manager-1, Asstt. Manager -4
Outside Power House Mech. Maintenance	Sr. Manager -1, Asstt. Manager – 4
Elec. Maintenance (IPH)	Sr. Manager – 1, Manager -1, Asstt. Manager-8
Elec. Maintenance (OPH)	Sr.Manager-1, Asstt. Manager-6
C&FE	Sr. Manager -1, Asstt. Manager-1

From above 10 engineers got training at China & provision of another 10 is there.

Regd. & Corporate Office : New Secretariat Buildings, 6th Floor, "B Block; 1, Kiran Sankar Roy Road, Kolkata-700 001
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7. Any other specific observation about overall performance of the unit – 1.5 Kl./hr. oil consumption.

8. **Furnace details**

i) Furnace volume	Not available – referred to Dong Fang design department
ii) Maximum net heat input per unit plan area	
iii) Max. Burner zone heat release rate	
iv) Max. Furnace cooling factor	
v) Residence time	
vi) Gas velocity in the furnace	

9. SH/RH/ Economiser Tube pitching details - Not available – referred to Dong Fang design department.

10. **Mills :**

i) Total number of mills	6 nos.
ii) No. of mills normally required with worst coal	5 nos.
iii) No. of mills normally required Design Coal	4 nos.
iv) Material of grinding elements	Not available – referred to Dong Fang design department
v) Guaranteed life of grinding elements	

This is for your information please.

Thanking you,

Yours faithfully,

(J.Banerjee)
Dy. General Manager (Comm.)
Sg.TPP / WBPDCL

Regd. & Corporate Office : New Secretariat Buildings, 9th Floor, "B Block; 1, Kiran Sankar Roy Road, Kolkata-700 001
Telephone : EPBAX 22480912, 22430525, Telefax : + 913322486436, 2210-3991, Telex : 021-4891 PDCL IN
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Report of visit to Yamunanagar Thermal Power Project (2x300 MW) by CEA and NTPC team on 1st June, 2008

1.0 Background

A Committee has been constituted by CEA to study suitability of boilers being supplied by Chinese manufacturers in view of the high ash content of Indian coals and also to assess their performance. It was decided by the Committee to visit recently commissioned projects where main plant equipment has been sourced from Chinese manufacturers. Following team visited Yamunanagar Thermal Power Project on 1st June, 2008 wherein boiler and turbine-generator have been supplied by M/s Shanghai Electric Corporation (SEC), China. M/s. REL is the EPC contractor for the whole project.

CEA

1. Sh. V.S. Verma, Member (Planning)
2. Sh. Suresh Chander, Chief Engineer
3. Sh. A.K. Gupta, Chief Engineer

NTPC

1. Sh. D.K.Jain, ED (Engg.)
2. Sh. R.K. Chaudhary, DGM
3. Sh. Brijesh Mathur, CDE(Mech)

2.0 Discussions

Discussions were held with HPGCL officers led by Sh. R.K.Sharma, Chief of Projects and REL (EPC contractor) team led by Sh. P.K.Bhasin, Project Director. A presentation was also made by REL. Following points emerged during discussions:

i) Unit#1 was synchronized on 13.11.2007 and trial operations for 14 days have been conducted from 31.3.2008 to 14.4.2008. Preparations are being done for conducting PG test. Unit#2 was synchronized on 29.3.2008 and full load has been achieved. Trial operations will be conducted shortly. Both the units were running on load of about 300 MW on the day of visit.

ii) REL stated that all boiler pressure parts have been designed as per IBR regulations and inspected at M/s SEC works, China by M/s ABS – an authorized representative of Chief Inspector of Boiler, Haryana. REL had also engaged M/s Lloyd Register & BVQI as third party inspectors. Besides, inspections have been witnessed by HPGCL engineers on the customer hold points. REL specifically pointed out following aspects in respect of equipment sourced from M/s SEC.

- High quality bolted structures have been supplied with alignment accuracy of 5 to 10 mm. All ceiling girders were supplied in one piece against 3 pieces normally supplied in India. All gusset plates and other attachments were shop welded. This required less efforts during erection.
- Tube panels were of high quality requiring no grinding/adjustments during erection. Burner box & panels, buckstays were received shop assembled requiring no matching effort at site.
- All supplies were sequential. Complete material for a tier, including platforms and stairs was received together resulting in erection convenience.
- Materials like hanger tubes were received well packed in steel boxes and insulation in wooden boxes to ensure no damage during transport.
- SEC is setting up after-sales service centre in Delhi at Vasant Vihar which shall be fully operational by end 2008.

iii) The areas of concern which had been brought out by HPGCL in the report of trial operation of unit 1 were discussed. These issues included non-completion of some auto loops, pending work on various C&I items, RH spray, operation of two vacuum pumps instead of one, unsatisfactory operation of hydra step etc. REL and HPGCL stated that most of the issues had been resolved. Compliance report, duly signed by HPGCL and REL giving present status would be sent by HPGCL to CEA. It was advised that all the pending issues should be settled quickly and HPGCL should prepare a list of essential pre-requisites to PG test which should be completed by REL.

iv) On a query, HPGCL informed that about 260 persons had been posted in Unit#1. HPGCL stated that about 80 engineers had been trained in operation & maintenance. About 27 engineers had been trained with M/s SEC, China. Another 27 engineers had been trained at PMI Noida and equal number at Dahanu for power plant familiarization..

3.0 Visit to site

Visit was made to control rooms of unit 1 &2 and to boiler and turbine area. Following observations were made by the team:

A) M/s SEC scope

The unit was generally operating satisfactorily at or near to its rated load of 300 MW. Various operating parameters such as turbine vibration levels, loadings on draft fans were within limits. However, main steam pressure is around 156.158 as against

rated pressure of 170.23 ata. Some observations as noted /informed during the visit were as under:

i) Some layout problems in the boiler area were observed

- Mill layout was found not amenable to maintenance. Access to mill rollers and mill motor for maintenance was difficult. It was informed that REL in consultation with M/s. SEC is reviewing the modifications required and will respond to HPGCL on this issue.

- Boiler platforms were found to be inadequate at many places e.g., there was not proper access to oil burners. At few places, the clear walkway was not available on the boiler platforms. REL agreed to look into in consultation with HPGCL.

Seal air fans location was not proper.

ii) Superheater spray water flow was high at 97 T/hr (of the order of 10%) which should be of the order of 5%. Reheater spray flow was about 10 T/hr which under normal operating conditions should be nil.

iii) CCTV furnace for flame monitoring was not working.

iv) Many a times five mills (instead of four mills) have to be operated to meet full load requirement. This has been partly due to poor coal quality & partly due to mill rejects.

B) Balance erection activities

i) The mill area in Unit 1 on ground floor as well as feeder floor was found full of coal dust. Leakages of coal need to be attended and house keeping efforts need to be improved upon.

ii) Mill area in Unit-2 was found full of coal rejects. It was informed that coal rejects in Unit-1 had reduced after tuning of mills. Mill rejects were high in Unit #2 and tuning of mills is being taken up to attend to same. However, the problem of excessive mill rejects need to be attended. Further, proper function of mill reject handling system with proper scaling & disposal arrangement shall be assured.

iii) Area around bottom ash hopper was found full of coal dust and water due to leakage. Fly ash evacuation area was also full of ash and water. M/s Indure, the contractor for ash handling system agreed to attend to within next three days.

iv) Cabling was found to be hanging and jumbled at many places. M/s REL agreed to instruct M/s ADS - C&I cabling contractor to properly lay all the cables so as to give it a clean & tidy look.
v) Various drain lines are not properly routed. These need to be attended to wherever feasible. Further, proper insulation shall be provided on these lines.
vi) Training of O&M personnel
vii) Details of delays due to port problems to be furnished by M/s. REL.

4.0 Information required

HPGCL was requested to furnish following information to CEA within a week's time:

i) Compliance report of issues of concern in trial operation report of Unit #1(Page 20 (iii) above)
ii) Tube pitching of superheater /reheater /economizer
iii) Calculations of thickness of pressure parts as submitted to IBR
iv) List of sub- contractors appointed by M/s REL

Report of visit to Durgapur Thermal Power Project (1x300 MW) by CEA and NTPC team on 6th June, 2008

1.0 Background

A Committee has been constituted by CEA to study design features of boilers being supplied by Chinese manufacturers with respect to Indian coal. It was decided by the Committee to visit recently commissioned projects where main plant equipment has been sourced from Chinese manufacturers. Following team visited Durgapur Thermal Power Project on 6th June, 2008 wherein boiler and turbine generator for 7th unit of 300 MW have been supplied by M/s Dongfang Electric Corporation (DEC), China.

CEA

1. Sh. V.S. Verma, Member (Planning)
2. Sh. Suresh Chander, Chief Engineer

NTPC

1. Sh. R.K. Chaudhary, DGM
2. Sh. Prabodh, CDE(Mech.)

2.0 Discussions

Discussions were held with DPL officers led by Sh. S.P. Datta, Managing Director and Sh. A.K. Chakraborty, General Manager. Following points emerged during discussions :

i) The project was divided into three packages. Main plant package comprising BTG, electrical and C&I systems, switchyard, ash handling system, associated civil works was ordered on M/s DEC, China. Water system package and Coal handling system were ordered on VA Tech and Mcnally Bharat and respectively. Marshalling yard was executed by M/s Rites. M/s DPL engaged M/s DCPL as their engineering consultant and M/s NTPC as their consultant for erection supervision and field quality assurance.

Major contractors employed by M/s DEC are given below:

Erection (Boiler- TG, Elect., C&I, Civil):	M/s L&T
Fly ash handling system:	M/s Indure Ltd.
Dry bottom ash handling system:	M/s Magaldi, Italy
Cooling Tower:	M/s Paharpur

ii) Main plant package was ordered on 27th July, 2004 and synchronization and COD dates were scheduled on 31st January, 2007 (30 months) and 30th July, 2007 (33 months) respectively. The unit was actually synchronized on 24th November

2007 (40 months) and COD was declared on 30th April 2008 (45 months). Reasons for the delay were cited as under :

- Delay in payment of advance due to late receipt of clarification from Income Tax department
- Delay in approval of design/drawings due to finalization of applicable standards
- Non-availability of long term visa for the Chinese personnel
- Delay in commissioning of Ash Handling Plant by Indure Ltd.

iii) DPL had posted 7 senior level engineers (DGM to Manager) at the project. Besides they have posted 25 nos. graduate engineer trainees and 15 nos. operator trainees. O&M for one year for the main plant package is included in the contract of DEC. Similarly O&M for coal handling and water package is also being outsourced from OEM.

iv) DPL informed that supplies from DEC were sequential and systematic. DPL were also satisfied with visible quality of equipment and particularly bolted structures which did not require any adjustment during erection. No short cuts/bypass was allowed by DEC during commissioning. Commissioning was first undertaken by OEM (viz. M/s Shenyang for BFP) and then again checked by DEC and DPL.

3.0 Visit to site

Visit was made to unit control room and boiler turbine area. Following observations were made by the team:

i) At the time of visit unit was running at about 170 MW. Unit load was raised upto 300 MW. It was informed that the specific oil consumption was very high as the boiler was being operated with oil support upto 240 MW. During discussions with O&M staff of DEC, it was felt that operators were being over cautious. As per the contract, boiler should operate without oil support beyond 40% load which is to be demonstrated during PG test of the unit. M/s DEC representative stated that same shall be demonstrated as per contract.

ii) It was observed that ESP was not being taken into service due to oil firing. Normally, ESP is taken into service when two mills are in operation. With oil firing, soot may deposit on the ESP electrodes which would affect the efficiency of ESP during P.G. test. It is not advisable to run the unit without ESP as the whole dust in flue gases would be exhausted to the atmosphere. As such it is all the more important that unit should be run without oil support.

iii) Running of turbine, BFP and other motors were found to be quite smooth as noise levels as well as observed vibration readings in control room were quite low.

iv) Many control loops were not on Auto. M/s DPL was advised to ensure that all the control loops are put on auto before PG test.

v) Oil and water leakage was observed at many places. M/s DPL was advised to improve their house keeping. Particularly, the room housing ash handling vacuum pumps was found to be in bad shape.

vi) Bottom ash handling system for this unit has been supplied by M/s Magaldi, Italy. This system is dry type as compared to wet disposal system normally provided in other projects. This system has been performing satisfactorily and gives a clean look to the area.

vii) During visit to control room print out of parameters were collected for review.

4.0 Information required

M/s DPL was requested to furnish following information to CEA within a week's time:

i) Complete information in the format sent by CEA in January, 2008
ii) Calculations of thickness of pressure parts as submitted to IBR
iii) System for quality assurance (approval of quality plan, witnessing of tests at works etc.) adopted for DEC supplies
iv) Tube pitching of superheater /reheater /economizer

Report of visit to Sagardighi thermal power project (2x300 MW) by CEA and NTPC team on 7th June, 2008.

1.0 Background

A Committee has been constituted by CEA to study design features of boilers being supplied by Chinese manufacturers with respect to Indian coal. It was decided by the Committee to visit recently commissioned projects where main plant equipment has been sourced from Chinese manufacturers. Following team visited Sagardighi Thermal Power Project on 76th June, 2008 wherein boilers and turbine generators have been supplied by M/s Dongfang Electric Corporation (DEC), China.

CEA

1. Sh. V.S. Verma, Member (Planning)
2. Sh. Suresh Chander, Chief Engineer

NTPC

1. Sh. R.K. Chaudhary, DGM
2. Sh. Prabodh, CDE(Mech.)

2.0 Discussions

Discussions were held with WBPDCL officers led by Sh. D. Mukhopadhyay, General Manager. Following points emerged during discussions :

i) The project was divided into three packages. Main plant package comprising BTG, electrical and C&I systems, switchyard, ash handling system, associated civil works was ordered on M/s DEC, China. Water system package and Coal handling system were ordered on L&T and Mcnally Bharat respectively. M/s WBPDCL engaged M/s DCPL as their engineering consultant and M/s NTPC as their consultant for erection supervision and civil quality assurance.

Major contractors employed by M/s DEC are given below:

Erection (Boiler- TG, Elect., C&I, Civil) # Unit-1:	M/s TPL
Erection (Boiler- TG, Elect., C&I, Civil) # Unit-2:	M/s L&T
Fly ash handling system:	M/s DCPIS

ii) It was observed that adequate O&M personnel were not posted at site. As such WBPDCL engineers were not well versed with the plant. WBPDCL also did not have enough drawings/documentation of the project. Regarding data of the plant requested by CEA, it was stated by WBPDCL that M/s DEC was not co-operating in furnishing the data. It was pointed out to them that the data required was basic in nature and should have been available with WBPDCL during detailed engineering of the project. WBPDCL stated that there was general reluctance on the part of DEC to make available the data/drawings to them.

iii) They also had not participated in the quality assurance of DEC equipment. Neither any quality plans were reviewed nor any inspection was witnessed at M/s DEC works.

iv) It was informed that Unit# 1 was shut down due to turbine rotor failure. It was expected that blades for affected fourth row are expected shortly from DEC and unit would be restored by first week of July, 2008. Unit#2 is also expected to be synchronized by first week of July, 2008.

3.0 Visit to site

Visit was made to boiler and turbine area. Following observations were made by the team:

i) Turbine

Unit #1 turbine rotor had failed as one of the blades in fourth stage of LP rotor along with corresponding shroud on the packet of six blades had broken when the turbine was running on full load. It was informed that the incident had occurred on 22nd April, 2008 at 7:04 hrs. Unit was running on full load since 21st April and the unit tripped on 22nd April through bearing no. 3 & 4 high vibrations. Just before the tripping, the turbine vibration and other parameters were normal. The turbine rotor was inspected by the team and following was advised to WBPDCL:

- WBPDCL should obtain test reports regarding material composition, UT, MPI, natural frequency of all the blades of LP rotor from DEC.

- The root of the failed blade should be first tested in India by laboratory to be agreed by both WBPDCL and DEC. Afterwards the blade may be sent to DEC for investigation and route cause analysis.

- It was observed that some blades of the 5th row had also been dented due to impact of the failed blade. WBPDCL was advised that UT and MPI test should be conducted on all the blades of LP rotor.

- Erosion marks were found on 5th and 6th row of blades. It was suggested to check the drains of extractions etc.

- Rusting and pitting was observed on the TG rotor. It appeared that the rotor had not been stored properly.

- New diaphragm received was inspected. It was found that welding of the same was not proper. DEC was asked to check the same.

ii) Boiler

- It was observed that there were many pending civil works in Unit 1. WBPDCL was advised to get the same completed fast.

- It was seen that mill bunker emptying arrangement was provided downstream of R C feeder. As such, in the event of fire, the coal would need to be passed through the feeder. WBPDCL was advised that mill emptying chute may be re-located above the feeder and arrangement provided to bring the coal upto ground level.

- Boiler drain piping as provided was found obstructing the movement on the floor. It was informed that piping below 75 mm Nb was routed at site by the erection contractor with the approval of DEC. WBPDCL was advised to discuss the matter with M/s DEC and erection contractor to modify the piping layout suitably.

4.0 Information required

M/s WBPDCL was requested to furnish following information to CEA within a week's time:

i) List of contractors employed in the project by DEC and WBPDCL
ii) Unit parameters at full load
iii) Complete information in the format sent by CEA in January, 2008
iv) List of O&M personnel posted at site
v) Calculations of thickness of pressure parts as submitted to IBR
vi) Tube pitching of superheater /reheater /economizer
vii) Dates of order and scheduled/actual dates of synchronization and COD

STN_NM	UNIT_NM	DT_STABL	GROSS_GEN	Daily Gen
YAMUNA NAGAR TP	1	1-May-2008	0.00	1-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	2-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	3-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	4-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	5-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	6-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	7-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	8-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	9-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	10-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	11-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	12-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	13-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	14-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	15-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	16-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	17-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	18-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	19-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	20-May-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	21-May-2008
YAMUNA NAGAR TP	1	1-May-2008	2.27	22-May-2008
YAMUNA NAGAR TP	1	1-May-2008	2.27	23-May-2008
YAMUNA NAGAR TP	1	1-May-2008	2.27	24-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.49	25-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.25	26-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.15	27-May-2008
YAMUNA NAGAR TP	1	1-May-2008	5.94	28-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.15	29-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.15	30-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.15	31-May-2008
YAMUNA NAGAR TP	1	1-May-2008	6.29	1-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.59	2-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	4.61	3-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.71	4-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.83	5-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.83	6-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.83	7-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	5.76	8-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.36	9-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.62	10-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.22	11-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.27	12-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.27	13-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.27	14-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.24	15-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	6.40	16-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	3.19	17-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	4.45	18-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	19-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	20-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	21-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	22-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	23-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	24-Jun-2008

YAMUNA NAGAR TP	1	1-May-2008	0.00	25-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	26-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	27-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	28-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	29-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	30-Jun-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	1-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	1.05	2-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.16	3-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.16	4-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.16	5-Jul-2008
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YAMUNA NAGAR TP	1	1-May-2008	6.32	7-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	6.37	8-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	6.68	9-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.01	10-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.01	11-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.01	12-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	4.22	13-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.40	14-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.57	15-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	6.63	16-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.74	17-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.74	18-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.74	19-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	6.68	20-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	4.87	21-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.94	22-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.94	23-Jul-2008
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YAMUNA NAGAR TP	1	1-May-2008	6.57	26-Jul-2008
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YAMUNA NAGAR TP	1	1-May-2008	3.19	28-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	5.04	29-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	4.95	30-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.37	31-Jul-2008
YAMUNA NAGAR TP	1	1-May-2008	3.37	1-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.37	2-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	4.96	3-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	5.22	4-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	5.52	5-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	4.71	6-Aug-2008
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YAMUNA NAGAR TP	1	1-May-2008	1.69	12-Aug-2008
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YAMUNA NAGAR TP	1	1-May-2008	0.00	14-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	15-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	0.00	16-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.70	17-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.38	18-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	5.38	19-Aug-2008

YAMUNA NAGAR TP	1	1-May-2008	6.69	20-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.53	21-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.53	22-Aug-2008
YAMUNA NAGAR TP	1	1-May-2008	3.53	23-Aug-2008
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YAMUNA NAGAR TP	1	1-May-2008	3.45	31-Aug-2008
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YAMUNA NAGAR TP	2		2.66	2-May-2008
YAMUNA NAGAR TP	2		2.66	3-May-2008
YAMUNA NAGAR TP	2		2.84	4-May-2008
YAMUNA NAGAR TP	2		2.79	5-May-2008
YAMUNA NAGAR TP	2		0.00	6-May-2008
YAMUNA NAGAR TP	2		0.00	7-May-2008
YAMUNA NAGAR TP	2		0.00	8-May-2008
YAMUNA NAGAR TP	2		0.00	9-May-2008
YAMUNA NAGAR TP	2		0.00	10-May-2008
YAMUNA NAGAR TP	2		0.00	11-May-2008
YAMUNA NAGAR TP	2		0.00	12-May-2008
YAMUNA NAGAR TP	2		0.00	13-May-2008
YAMUNA NAGAR TP	2		0.00	14-May-2008
YAMUNA NAGAR TP	2		0.00	15-May-2008
YAMUNA NAGAR TP	2		0.00	16-May-2008
YAMUNA NAGAR TP	2		0.00	17-May-2008
YAMUNA NAGAR TP	2		0.00	18-May-2008
YAMUNA NAGAR TP	2		0.00	19-May-2008
YAMUNA NAGAR TP	2		0.00	20-May-2008
YAMUNA NAGAR TP	2		1.65	21-May-2008
YAMUNA NAGAR TP	2		2.53	22-May-2008
YAMUNA NAGAR TP	2		2.53	23-May-2008
YAMUNA NAGAR TP	2		2.53	24-May-2008
YAMUNA NAGAR TP	2		0.00	25-May-2008
YAMUNA NAGAR TP	2		0.00	26-May-2008
YAMUNA NAGAR TP	2		0.00	27-May-2008
YAMUNA NAGAR TP	2		1.46	28-May-2008
YAMUNA NAGAR TP	2		4.19	29-May-2008
YAMUNA NAGAR TP	2		4.19	30-May-2008
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YAMUNA NAGAR TP	2		6.22	1-Jun-2008
YAMUNA NAGAR TP	2		6.23	2-Jun-2008
YAMUNA NAGAR TP	2		3.60	3-Jun-2008
YAMUNA NAGAR TP	2		1.53	4-Jun-2008
YAMUNA NAGAR TP	2		0.00	5-Jun-2008
YAMUNA NAGAR TP	2		0.00	6-Jun-2008
YAMUNA NAGAR TP	2		0.00	7-Jun-2008
YAMUNA NAGAR TP	2		0.00	8-Jun-2008
YAMUNA NAGAR TP	2		1.80	9-Jun-2008
YAMUNA NAGAR TP	2		6.93	10-Jun-2008
YAMUNA NAGAR TP	2		7.07	11-Jun-2008

YAMUNA NAGAR TP	2	7.01	12-Jun-2008
YAMUNA NAGAR TP	2	7.01	13-Jun-2008
YAMUNA NAGAR TP	2	7.01	14-Jun-2008
YAMUNA NAGAR TP	2	6.17	15-Jun-2008
YAMUNA NAGAR TP	2	6.42	16-Jun-2008
YAMUNA NAGAR TP	2	6.63	17-Jun-2008
YAMUNA NAGAR TP	2	6.74	18-Jun-2008
YAMUNA NAGAR TP	2	6.60	19-Jun-2008
YAMUNA NAGAR TP	2	6.60	20-Jun-2008
YAMUNA NAGAR TP	2	6.60	21-Jun-2008
YAMUNA NAGAR TP	2	6.51	22-Jun-2008
YAMUNA NAGAR TP	2	6.69	23-Jun-2008
YAMUNA NAGAR TP	2	6.45	24-Jun-2008
YAMUNA NAGAR TP	2	6.20	25-Jun-2008
YAMUNA NAGAR TP	2	2.84	26-Jun-2008
YAMUNA NAGAR TP	2	2.84	27-Jun-2008
YAMUNA NAGAR TP	2	2.84	28-Jun-2008
YAMUNA NAGAR TP	2	6.76	29-Jun-2008
YAMUNA NAGAR TP	2	6.58	30-Jun-2008
YAMUNA NAGAR TP	2	6.51	1-Jul-2008
YAMUNA NAGAR TP	2	6.42	2-Jul-2008
YAMUNA NAGAR TP	2	5.89	3-Jul-2008
YAMUNA NAGAR TP	2	5.89	4-Jul-2008
YAMUNA NAGAR TP	2	5.89	5-Jul-2008
YAMUNA NAGAR TP	2	6.30	6-Jul-2008
YAMUNA NAGAR TP	2	6.09	7-Jul-2008
YAMUNA NAGAR TP	2	6.02	8-Jul-2008
YAMUNA NAGAR TP	2	6.44	9-Jul-2008
YAMUNA NAGAR TP	2	4.68	10-Jul-2008
YAMUNA NAGAR TP	2	4.68	11-Jul-2008
YAMUNA NAGAR TP	2	4.68	12-Jul-2008
YAMUNA NAGAR TP	2	5.71	13-Jul-2008
YAMUNA NAGAR TP	2	5.10	14-Jul-2008
YAMUNA NAGAR TP	2	4.79	15-Jul-2008
YAMUNA NAGAR TP	2	3.03	16-Jul-2008
YAMUNA NAGAR TP	2	0.00	17-Jul-2008
YAMUNA NAGAR TP	2	0.00	18-Jul-2008
YAMUNA NAGAR TP	2	0.00	19-Jul-2008
YAMUNA NAGAR TP	2	0.00	20-Jul-2008
YAMUNA NAGAR TP	2	0.00	21-Jul-2008
YAMUNA NAGAR TP	2	0.00	22-Jul-2008
YAMUNA NAGAR TP	2	0.00	23-Jul-2008
YAMUNA NAGAR TP	2	0.00	24-Jul-2008
YAMUNA NAGAR TP	2	0.00	25-Jul-2008
YAMUNA NAGAR TP	2	0.00	26-Jul-2008
YAMUNA NAGAR TP	2	0.00	27-Jul-2008
YAMUNA NAGAR TP	2	2.43	28-Jul-2008
YAMUNA NAGAR TP	2	5.94	29-Jul-2008
YAMUNA NAGAR TP	2	6.54	30-Jul-2008
YAMUNA NAGAR TP	2	6.50	31-Jul-2008
YAMUNA NAGAR TP	2	6.50	1-Aug-2008
YAMUNA NAGAR TP	2	6.50	2-Aug-2008
YAMUNA NAGAR TP	2	6.35	3-Aug-2008
YAMUNA NAGAR TP	2	6.55	4-Aug-2008
YAMUNA NAGAR TP	2	6.50	5-Aug-2008
YAMUNA NAGAR TP	2	5.17	6-Aug-2008

YAMUNA NAGAR TP	2		6.12	7-Aug-2008
YAMUNA NAGAR TP	2		6.12	8-Aug-2008
YAMUNA NAGAR TP	2		6.12	9-Aug-2008
YAMUNA NAGAR TP	2		5.53	10-Aug-2008
YAMUNA NAGAR TP	2		6.01	11-Aug-2008
YAMUNA NAGAR TP	2		6.07	12-Aug-2008
YAMUNA NAGAR TP	2		4.76	13-Aug-2008
YAMUNA NAGAR TP	2		4.76	14-Aug-2008
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YAMUNA NAGAR TP	2		4.76	16-Aug-2008
YAMUNA NAGAR TP	2		5.72	17-Aug-2008
YAMUNA NAGAR TP	2		4.85	18-Aug-2008
YAMUNA NAGAR TP	2		6.41	19-Aug-2008
YAMUNA NAGAR TP	2		6.62	20-Aug-2008
YAMUNA NAGAR TP	2		4.51	21-Aug-2008
YAMUNA NAGAR TP	2		4.51	22-Aug-2008
YAMUNA NAGAR TP	2		4.51	23-Aug-2008
YAMUNA NAGAR TP	2		5.62	24-Aug-2008
YAMUNA NAGAR TP	2		5.29	25-Aug-2008
YAMUNA NAGAR TP	2		5.75	26-Aug-2008
YAMUNA NAGAR TP	2		6.11	27-Aug-2008
YAMUNA NAGAR TP	2		4.97	28-Aug-2008
YAMUNA NAGAR TP	2		4.97	29-Aug-2008
YAMUNA NAGAR TP	2		4.97	30-Aug-2008
YAMUNA NAGAR TP	2		0.00	31-Aug-2008
YAMUNA NAGAR TP	2		0.00	1-Sep-2008
YAMUNA NAGAR TP	2		0.00	2-Sep-2008
YAMUNA NAGAR TP	2		4.45	3-Sep-2008

D.P.L.	7	1-Jun-2008	6.46	1-Jun-2008
D.P.L.	7	1-Jun-2008	3.00	2-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	3-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	4-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	5-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	6-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	7-Jun-2008
D.P.L.	7	1-Jun-2008	6.42	8-Jun-2008
D.P.L.	7	1-Jun-2008	6.40	9-Jun-2008
D.P.L.	7	1-Jun-2008	6.72	10-Jun-2008
D.P.L.	7	1-Jun-2008	6.83	11-Jun-2008
D.P.L.	7	1-Jun-2008	6.70	12-Jun-2008
D.P.L.	7	1-Jun-2008	6.70	13-Jun-2008
D.P.L.	7	1-Jun-2008	6.70	14-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	15-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	16-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	17-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	18-Jun-2008
D.P.L.	7	1-Jun-2008	3.35	19-Jun-2008
D.P.L.	7	1-Jun-2008	3.35	20-Jun-2008
D.P.L.	7	1-Jun-2008	3.35	21-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	22-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	23-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	24-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	25-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	26-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	27-Jun-2008

D.P.L.	7	1-Jun-2008	0.00	28-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	29-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	30-Jun-2008
D.P.L.	7	1-Jun-2008	0.00	1-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	2-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	3-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	4-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	5-Jul-2008
D.P.L.	7	1-Jun-2008	6.51	6-Jul-2008
D.P.L.	7	1-Jun-2008	6.51	7-Jul-2008
D.P.L.	7	1-Jun-2008	6.11	8-Jul-2008
D.P.L.	7	1-Jun-2008	5.70	9-Jul-2008
D.P.L.	7	1-Jun-2008	0.41	10-Jul-2008
D.P.L.	7	1-Jun-2008	0.41	11-Jul-2008
D.P.L.	7	1-Jun-2008	0.41	12-Jul-2008
D.P.L.	7	1-Jun-2008	6.47	13-Jul-2008
D.P.L.	7	1-Jun-2008	6.78	14-Jul-2008
D.P.L.	7	1-Jun-2008	6.18	15-Jul-2008
D.P.L.	7	1-Jun-2008	6.43	16-Jul-2008
D.P.L.	7	1-Jun-2008	6.54	17-Jul-2008
D.P.L.	7	1-Jun-2008	6.54	18-Jul-2008
D.P.L.	7	1-Jun-2008	6.54	19-Jul-2008
D.P.L.	7	1-Jun-2008	6.24	20-Jul-2008
D.P.L.	7	1-Jun-2008	2.17	21-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	22-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	23-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	24-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	25-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	26-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	27-Jul-2008
D.P.L.	7	1-Jun-2008	0.00	28-Jul-2008
D.P.L.	7	1-Jun-2008	0.05	29-Jul-2008
D.P.L.	7	1-Jun-2008	2.62	30-Jul-2008
D.P.L.	7	1-Jun-2008	6.94	31-Jul-2008
D.P.L.	7	1-Jun-2008	6.94	1-Aug-2008
D.P.L.	7	1-Jun-2008	6.94	2-Aug-2008
D.P.L.	7	1-Jun-2008	0.68	3-Aug-2008
D.P.L.	7	1-Jun-2008	0.03	4-Aug-2008
D.P.L.	7	1-Jun-2008	3.86	5-Aug-2008
D.P.L.	7	1-Jun-2008	0.07	6-Aug-2008
D.P.L.	7	1-Jun-2008	6.22	7-Aug-2008
D.P.L.	7	1-Jun-2008	6.22	8-Aug-2008
D.P.L.	7	1-Jun-2008	6.22	9-Aug-2008
D.P.L.	7	1-Jun-2008	6.44	10-Aug-2008
D.P.L.	7	1-Jun-2008	6.80	11-Aug-2008
D.P.L.	7	1-Jun-2008	7.04	12-Aug-2008
D.P.L.	7	1-Jun-2008	6.79	13-Aug-2008
D.P.L.	7	1-Jun-2008	6.79	14-Aug-2008
D.P.L.	7	1-Jun-2008	6.79	15-Aug-2008
D.P.L.	7	1-Jun-2008	6.79	16-Aug-2008
D.P.L.	7	1-Jun-2008	5.08	17-Aug-2008
D.P.L.	7	1-Jun-2008	6.48	18-Aug-2008
D.P.L.	7	1-Jun-2008	6.48	19-Aug-2008
D.P.L.	7	1-Jun-2008	6.39	20-Aug-2008
D.P.L.	7	1-Jun-2008	6.53	21-Aug-2008
D.P.L.	7	1-Jun-2008	6.53	22-Aug-2008

D.P.L.	7	1-Jun-2008	6.53	23-Aug-2008
D.P.L.	7	1-Jun-2008	6.72	24-Aug-2008
D.P.L.	7	1-Jun-2008	6.94	25-Aug-2008
D.P.L.	7	1-Jun-2008	6.73	26-Aug-2008
D.P.L.	7	1-Jun-2008	6.37	27-Aug-2008
D.P.L.	7	1-Jun-2008	6.19	28-Aug-2008
D.P.L.	7	1-Jun-2008	6.19	29-Aug-2008
D.P.L.	7	1-Jun-2008	6.19	30-Aug-2008
D.P.L.	7	1-Jun-2008	6.91	31-Aug-2008
D.P.L.	7	1-Jun-2008	6.49	1-Sep-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	1-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	2-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	3-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	4-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	5-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	6-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	7-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	8-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	9-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	10-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	11-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	12-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.48	13-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.12	14-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.71	15-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.13	16-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.75	17-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.75	18-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.75	19-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.97	20-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.35	21-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.19	22-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.07	23-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.74	24-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.74	25-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.74	26-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.02	27-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	28-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	29-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	30-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	31-Jul-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	1-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	2-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	3-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	4-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	5-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	6-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	7-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	8-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	0.00	9-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	2.87	10-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.61	11-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.01	12-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.38	13-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.38	14-Aug-2008

SAGARDIGHI TPP	1	1-Jul-2008	5.38	15-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.38	16-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.91	17-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.19	18-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.19	19-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.71	20-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.76	21-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.76	22-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.76	23-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	4.05	24-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.51	25-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.41	26-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.35	27-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.14	28-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.14	29-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	6.14	30-Aug-2008
SAGARDIGHI TPP	1	1-Jul-2008	5.13	31-Aug-2008