



**REPORT OF THE GROUP
FOR
STUDYING RANGE
OF
BLENDING OF IMPORTED COAL WITH DOMESTIC COAL**



**CENTRAL ELECTRICITY AUTHORITY
New Delhi – 110066**

April - 2012

Report of The Group for Studying Range of Blending of Imported Coal with Domestic Coal

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Report of The Group for Studying Range of Blending of Imported Coal with Domestic Coal

1 Introduction

1.1 The gap between demand of coal and indigenous supply is likely to increase with time with indigenous coal supplies not being able to keep pace with the capacity addition in the power sector. Coal shortages are already being experienced and last year (2009-10), about 23 million tons (MT) coal had to be imported against domestic supplies of 351 MT and is expected to increase to over 50 million tonnes in 2011-12. Thus coal imports would require to be continued to bridge the shortfall in indigenous coal supplies to stations designed on indigenous coal besides the requirement for stations based on imported coal. Some utilities have already been firing blended coal in their power stations designed for indigenous coal.

1.2 Secretary (Power) has directed CEA, in a meeting taken by him, to issue an advisory to the effect that all new coal based projects to be ordered except projects based on imported coal will be designed for a blend of domestic and imported coal. Accordingly CEA, vide Office Memorandum **No. CEA/5-41(O6)/Secy-2010/261** dated 02.08.2010 (**Appendix- I**) has constituted a "Group for studying range of blending of imported coal with domestic coal". The composition of the Group is as follows: -

i)	**Sh Suresh Chander, Chief Engineer CEA	Chairman
ii)	*Sh. R. Kumar, General manager BHEL	Member
iii)	*Sh.T.C Chaterjee, Executive Director NTPC	Member
iv)	*Sh. S. Biswas, Scientist-F CIMFR	Member
v)	Sh. S.K.Thakur, Director CEA	Member
vi)	Sh. Alok Saxena, Director CEA	Member
vii)	Sh. Mam Chand, Director CEA	Member
viii)	Sh. V.K.Singh, Director CEA	Member

* As per nominations received from BHEL, NTPC and CIMFR. Sh. S.N Goel Executive Director was the NTPC representative after superannuation of Sh.T.C Chaterjee

** Sh. A.K Gupta Chief Engineer CEA after superannuation of sh. Suresh Chander on 30.9.2010 and Sh. S.K Thakur Chief Engineer I/c wef. 1.09.2011

The Group has been asked to study the range of blending of imported coal with domestic coal before the issue of advisory*.

1.3 The Group had two meetings on 10th August, 2010 and 25th August, 2010 where issues related to impact of coal blending on boiler design and performance, methodologies available for blending, issues regarding compatibility of coals for blending, coal availability scenarios and extent of blending required were discussed. The record notes of discussions of the meetings are enclosed as Appendix -IIA and IIB. The draft report was circulated to the members in Dec-2010 and the comments/observations

* Advisory issued by CEA on 19-04-2011

received from members were discussed and finalized in the meeting of the group on 28th April 2011.

2 Impact of Blended coal Firing on Boiler Performance

2.1 Blending of imported coal with indigenous coal results in change in the aggregate quality of coal to be fired. The main characteristics of coal that affect boiler design are ash content, volatile matter, moisture content, fixed carbon, gross calorific value (GCV), Hardgrove Grindability index (HGI), coal reactivity and ash fusion characteristics. In the context of blending of two coals, properties such as ash content, GCV, fixed carbon, moisture content are additive in nature but other characteristics are non-additive. Typical Indian power boilers supplied by BHEL are designed for high ash Indian coal and thus the furnace is typically higher by about 20% as compared to boilers sized for imported low ash coal. The GCV of coal considered for design is about 3300 kcal/kg. The performance guarantees are based on design coal; however, BHEL supplied boilers are capable of giving rated output with coal quality variation of about 1000 kcal/kg (say from 3000 to 4000 kcal/kg)

2.2 It would be appropriate to discuss here the impact of blending of coal on design/performance of boilers as well as the areas to be looked into while blending two coals with widely varying characteristics

- a. High ash content in coal influences furnace sizing. It also leads to requirement of more number of mills and influences sizing of PA fans, Air Pre-Heaters and ESP, besides size of Coal Handling and Ash Handling plants. Indian coal contains high quantum of abrasive ash necessitating lower flue gas velocities and larger spacing of pressure parts to minimize the flue gas erosion. Further, heat is retained in the ash and released slowly in the SH,RH and Economiser zone. On the other hand, for low ash non-erosive coal, pressure parts can be closely arranged leading to compact design of boiler. Large proportion of blending of imported coal of very low ash content, in boilers designed for high ash coal, could affect the heat transfer profile between the radiative and convective sections of the boiler and may lead to difficulty in attaining rated main steam and reheat steam temperatures.
- b. Coal with very high moisture content derates the capacity of mills and requires higher quantum of heat for coal drying in the mill thus necessitating higher hot air temperature at mill inlet and thus impacting sizing of economizer and air pre-heater. If low moisture coals are used, heat required to dry the coal is less thus air passing through the airheater would be less resulting in higher flue gas exit temperature.
- c. Fixed carbon and Volatile Matter provide an insight into the reactivity of coal. FC/VM ratio which is called as fuel ratio indicates the combustion characteristics of the coal. When the ratio is more than

1.5, combustion would be difficult and if the ratio is less than 1.5, it is easy to burn. Imported coal with higher volatile matter requires careful handling particularly in summer as it is prone to catch fire. Lower mill outlet temperature of 50-55 deg C needs to be maintained for such coals as compared to 75 - 90 deg C temperature for indigenous coal. Thus, when firing blended coal, having a component of high Volatile Matter, mill inlet temperature has to be maintained carefully, to ensure drying of coal while taking care to avoid mill fire.

- d. Hardgrove Grindability Index (HGI) is important from grinding considerations and large variation in HGI poses problem of selective grinding of one coal over another and difficulty in achieving desired coal fineness for proper combustion and affects the mill output.
- e. Compatibility of ash characteristics is most important while blending coals because ash characteristics determine the slagging/fouling characteristics of coal and also its erosion and corrosion potential. Thus, important ash characteristics like the ash fusion temperature, base/ acid ratio, iron/calcium ratio, iron content, silica/alumina ratio should be known before hand to examine the compatibility of coals for blending.

2.3 Coal is imported in India from varied sources such as Indonesia, South Africa, Australia and their characteristics vary with source. Typical salient characteristics of these coals are given in enclosed **Appendix-III** .

2.4 Compatibility of coals used for blending needs to be ensured to avoid problems in boiler operation due to large variations in aggregate/individual coal quality from acceptable design limits. For this, characteristics of both the domestic and imported coals should be examined for compatibility and if necessary, combustion tests may also be carried out beforehand. Slagging/fouling characteristics of ash should be carefully considered as high slagging coals may impose a limitation on reaching the rated capacity/load besides furnace cleaning and ash handling. When slagging coals are blended, it is necessary to conduct site trials, to establish a safe percentage of blending. Blending should be done cautiously and performance of boiler should be observed for any adverse performance.

2.5 Following observations need to be particularly made during firing of blended coal:

- a) Deposits on heat transfer surfaces of water wall and convection pass - should be loose and easily removable.
- b) It should be ensured that heat flux is fully regained after wall/soot blowing.,
- c) Rise in furnace exit temperature - should not be high as this may increase the SH/RH spray levels.
- d) Rated steam parameters must be achievable
- e) Furnace temperatures shall be observed through view holes/peep holes by pyrometers

- f) Mill outlet temperature should be monitored and achievable as per the quality of coal fired.
- g) There should be no abnormal increase in the following
 - SH/RH spray
 - NOX and CO emissions
 - Unburnt carbon in bottom and fly ash
 - Acid dew point of flue gases at air heater outlet

3 Blending methodologies

3.1 Various methodologies used for blending of imported and domestic coals are described below in brief. More details are given in enclosed **Appendix-IV**.

- a) *Separate layering of imported and domestic coal in stockyard or blending in beds*

This method leads to thorough mixing of coals and is widely practiced in several developed countries. However, this requires that entire coal quantity should first be stacked and coal receipts in the station follow specific identified sequence.

- b) *Blending on conveyors by silo*

In this method, the imported coal is stored in a dedicated silo and is fed from this silo through an accurately weighing gravimetric feeder so as to enable varying of imported coal quantity. This is an expensive system. In a very large station, such an arrangement may require separate silo for each coal handling plant as feeding imported coal to different CHPs from single silo may pose layout constraints.

- c) *Blending by ground hoppers or emergency reclaim hoppers*

In this method domestic coal is fed from wagon tippler/track hopper /stockyard and stacked imported coal is fed from ground hoppers with the help of dozers.

- d) *Blending of two streams of coal on conveyor belt*

This method involves blending of i) both coals reclaimed by reclaimers or ii) reclaiming of imported coal from reclaimers and domestic coal from track hoppers/wagon tipplers. Blending is carried out by feeding both imported and domestic coal simultaneously on conveyor belts and mixing takes place at the transfer points. However, accurate blending is not possible with this methodology.

Another method for use of two different coals is by adopting mixed firing i.e. *dedicating one or two mills for firing imported coal and remaining mills on domestic coal*. Thus the mill settings for these mills can be made as per the requirements of imported coal and it addresses most of the problems in milling

such as coal fineness due to selective grinding, mill outlet temperature etc. The higher calorific value of imported coal may lead to greater heat loading in the particular burner zone. However, this is taken care of by proper control of coal quality being fed through feeder control and using lower mills (normally mill B/C) for imported coal. It also offers the advantage that, based on any problem or abnormal operating conditions being experienced, the imported coal feed can be appropriately controlled.

4 Infrastructural Requirements

4.1 Use of blended coal would require creation/augmentation of following Infrastructure at power stations as well as at ports and for transportation.

- a) With large quantity of coal imports envisaged, it would be important to ensure that adequate infrastructure for coal import is available at the ports so as to avoid bottlenecks.
- b) If blending of imported coal is envisaged at all power stations, large cross country movement of coal would be required from ports to distant power stations at pit head. Thus, corresponding augmentation will be required in the coal transportation infrastructure of railways to ensure that uninterrupted coal movement to power stations takes place and intermediate storages at ports which adds to cost of handling are reduced to minimum.
- c) Imported coal is generally transported from ports to the power stations in the Box-N wagons. As pit head stations are designed to normally receive coals from MGR systems through bottom discharge BOBR wagons, it is desirable that Railways should acquire more BOBR wagons to transport imported coal to such stations.
- d) At the power stations also, facilities would require to be created for unloading and handling of imported coal. As mentioned above, imported coal is generally transported from ports to the power stations in the Box-N wagons. As pit head stations are designed to normally receive coals from MGR systems through bottom discharge BOBR wagons, handling facilities for Box-N wagons would have to be created unless Railways agree to transport coal in BOBR wagons. The existing stations may face lay out constraints in creation of such additional facilities like wagon tippler, additional track/conveyer for unloading of Box-N wagons etc.

5 Experience with Blending so far

5.1 A large number of Indian power utilities are already using imported coal for blending. Generally, stations have been blending 10-15% of imported coal by weight. The fact that utilities have been using imported coal for

blending for several years gives a comfort that these utilities have experience of using blended coal and also of handling imported coal. Mostly imported coals being used in India have very high volatile matter necessitating special precautions in handling, storing and firing these coals. These utilities would have also created systems/facilities for handling and using imported coal, though these facilities may require augmentation depending on quantity of imported coal required to be used.

- 5.2** The operating experience of firing imported coal as available from few utilities varies considerably. MAHAGENCO and KPCL had adopted the methodology of mixing domestic and imported coal on the conveyer belt. However it is reported that it is difficult to mix two different coals of varying heat values which results in uncontrollable combustion parameters and also resulted in high unburnt carbon loss. It was also reported by the utilities that high volatile matter of imported coal required special precautions and mill temperature were required to be kept lower, as keeping mill temperature as per Indian coal could lead to mill fires. Some utilities are also known to have installed carbon monoxide sensors in mills to prevent mill fires with imported coal.
- 5.3** Based on the experience with mixed coal firing, Mahagenco and KPCL have been using the methodology of firing one or two mills with imported coal. It is reported that with this methodology the unburnt carbon loss has reduced to normal limits and problems of milling have been solved. Normally "B" and "C" mills are used with imported coal and feeding rate is controlled to limit overall heat loadings in burner areas. No problems of clinkering etc have been reported. KPCL is presently using Indonesian coal and had also been using South African coal last year.
- 5.4** Gujarat Electricity Board (GEB) is also reported to be using separate mill firing for imported coal. However in stations where there are no arrangement for simultaneous stacking and feeding coal, imported coal is being fed directly to the units as and when received. Thus small quantity of imported coal is fed in all the bunkers. This however leads to layering of domestic and imported coal in bunkers and results in sudden change in coal quality.
- 5.5** Blending with imported coal (10-15% by weight) is being carried out at Farakka, Kahalgaon and Talcher TPS of NTPC where the coal quality is poor and aggregate design coal quality is being achieved through blending. NTPC have been using method of blending coal on conveyer belt. However, the proportion of blending cannot be controlled accurately with this methodology. The practice of dedicated mill firing with imported coal is not being adopted by NTPC as trials for such operation at Talcher TPS in the past have led to clinkering in the burner zone of mill firing imported coal. Write up on operating experience of firing imported coal as received from NTPC is given at **Appendix-V**.

- 5.6** A study for blending of imported coal and domestic coal by firing imported coal in dedicated mills was carried out by BHEL at Unit-4 of Raichur thermal power station of KPCL. The imported coal being used is Indonesian coal having moisture content of about 25-30 % and high volatile matter of 30 to 35 %. The GCV on as received basis is in the range of 5000 to 5400 kcal/Kg. The domestic coal is being received from number of sources and has GCV ranging from 2700 to 4400 kcal/kg. The study was carried out and completed. During the study, the impact of various blend ratios and mill combinations on boiler operation and efficiency were studied. As per observations, even with imported coal firing in 4 mills (A, B, C, D) and indigenous coal in one mill (E), no slagging / deposits or clinker formation was observed in the furnace. However, both the indigenous coal and the imported coal had very high moisture content of about 30% due to rainy season. Under identical test conditions of zero tilt, the steam outlet temperature was lesser by 10-15 °C. The rated steam parameters were also being achieved with tilt; however the impact on efficiency would have to be studied as coal flows were high despite higher GCV of imported coal. Part of this could be due to very high moisture content of coals. Also these observations are with respect to specific coal (Indonesian coal with high moisture) and the performance would have to be studied in summer months when the moisture in coal would be lower and ambient temperature would be high. Similar studies may be carried out with other coals like South African or Australian coals to gather confidence of using them in various blends.

As explained above, Blended coals have been successfully fired in the boilers designed by BHEL for Indian coals. While blending of imported coal upto 30% by weight is reported to be carried out at Dahanu TPS, many other stations have reported blending imported coal in the range of 10 to 15%. Generally, it should be possible to blend upto 10-15% imported coal on weight basis (25% on heat value basis) in existing boilers designed for indigenous coal.

6 Approach for Future

- 6.1** From the discussions in the foregoing paras, it is seen that blended coal is being used by several utilities; the extent of blending possible depends on boiler design and the characteristics of domestic coal and imported coal used for blending. The inter play of all these factors determines the extent of blending possible. It is also important to know the characteristics of imported coal as well as domestic coal in advance to examine the compatibility based on key characteristics for boiler design.
- 6.2** Possible blending limits in the existing units would be restricted based on boiler design and candidate coals proposed. Considering the experience so far, it is felt that it should generally be possible for existing stations based on indigenous coal (including those already ordered) to blend imported coal **upto 15% (by weight)**. However, it may not be possible for all the stations to blend imported coal e.g. stations getting very good quality of domestic coal, stations facing layout constraints etc.

For new units, it is possible to design boilers for any blend of domestic and imported coal. However it is felt that the blending limits for design of these units should be so chosen as to enable requisite normal operation capability with 100% indigenous coal so that in the event of availability of domestic coal in future, these plants can continue to operate at rated load without the need for imported coal. With this in view, the maximum blending limits for Indian coal & typical imported coal with GCV of around 5000 kcal/kg would be in the range of 30% (by weight). However some specific coals from Indonesia are having high slagging tendency. It is preferable to restrict the blending to 20% by weight only whenever such coals are blended with Indian coals. When 30% blending by weight is to be fired in boiler with imported coals, the following specific guidelines shall be followed in respect of ash analysis of imported coals.

Parameter	Suggested Guideline	Remarks
1. Base/ acid ratio	< 0.4	= $(\text{Fe}_2\text{O}_3 + \text{CaO} + \text{MgO} + \text{Na}_2\text{O} + \text{K}_2\text{O}) / (\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{TiO}_2)$
2.Sulphur slagging	< 2	=Base/ acid ratio x % sulphur)
3.Iron calcium	< 0.3	= $\text{Fe}_2\text{O}_3/\text{CaO}$)
4. Silica Alumina ratio	< 2.8	= $\text{SiO}_2/ \text{Al}_2\text{O}_3$)
5. Na_2O	< 2.5	
6. Fe_2O_3	< 15	
7.Initial deformation Temp	>1150 Deg C (In reducing atmosphere)	

6.3 However the above traditional slagging indices relating to ash deposition have been found to be unreliable when applied to blends . Averaging the coal properties may not be adequate when interactions between the inorganic components of coals with different rank in the blend occur.

6.4 Typical coal demand availability estimates in the year 2016-17 also indicate a blending requirement of about 15 to 25% for plants sourcing coal from CIL/SSCL. It is, therefore, felt that the future power stations, which are based on coal from CIL, should be designed to fire a blend of domestic and imported coal, with capability to give rated output with 100% Indian coal

6.5 For future stations, blending methodology can be designed and facilities for blending can be planned in advance. However the impact of blending

coals of different hardness on final size distribution and compositional distribution of the pulverized coal is not yet fully established

- 6.6** In case of existing stations, however, the choice of blending methodology would vary from station to station and would depend on the facilities available in the coal handling plant, additional space available for creation of facilities etc. In case of wide variation in quality parameters like HGI and volatile matter, the preferred choice could be firing dedicated mills with imported coal. Facilities for blending would have to be created in the stations required to use blended coal, if not done already. The minimum facilities required would be facilities for unloading imported coal from Box-N wagons, maintaining separate stockpile for imported coal and arrangement for simultaneous feeding of imported coal from stockpile and indigenous coal from the track hopper or vice versa. However as large pithead stations generally receive coal through MGR/BOBR wagons, efforts should be made to supply imported coal to these stations through BOBR wagons only as far as possible.
- 6.7** For the existing boilers, certain modifications may be required in operating procedures and changes in settings of mill temperature, fuel air and secondary air dampers, burner tilt etc may have to be made by the stations to evolve optimal operation with blended coal. If required additional sensors/probes may be installed in consultation with BHEL/boiler supplier for monitoring of temperature profile across various heat transfer surfaces. A write up on aspects to be taken care of during firing of blended coal; covering compatibility criteria in regard to characteristics of coals, typical precautions to be taken in regard to operation, observations to be made, changes required in settings of mills, dampers etc. received from BHEL, is annexed at **Appendix-VI**.

7 Recommendations

- 7.1** About 10-15% blending of imported coal by weight (15-22% on heat value basis) can generally be carried out in typical existing Indian power boilers designed for low quality Indian coals without envisaging any major problems. The choice of blending methodology would vary from station to station and would depend on the facilities available in the coal handling plant, additional space available for creation of facilities etc. Facilities for blending would have to be created in the stations required to use blended coal, if not done already. The minimum facilities required would be facilities for unloading imported coal from Box-N wagons, maintaining separate stockpile for imported coal and arrangement for simultaneous feeding of imported coal from stockpile and indigenous coal from the track hopper or vice versa. However as large pithead stations generally receive coal through MGR/BOBR wagons, efforts should be made to supply imported coal to these stations through BOBR wagons only as far as possible.
- 7.2** It is possible to design future boilers for any blend of domestic and imported coal. However, it is important to know the characteristics of



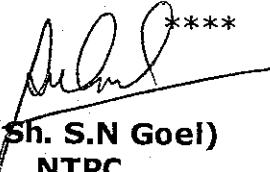
imported coal as well as domestic coal in advance to study the compatibility based on key characteristics and design the boiler accordingly.

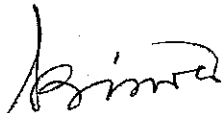
Considering the coal shortages envisaged, it is recommended that future power stations, which are based on sourcing coal from CIL, should be designed to fire a blend of domestic and imported coal. The blending limits for design of the new units should be so chosen as to enable requisite normal operation capability with 100% indigenous coal so that in the event of availability of domestic coal in future, these plants can continue to operate at rated load without the need for imported coal. With this in view, the maximum blending limits for Indian coal & typical imported coal with GCV of around 5000 kcal/kg would be in the range of 30% (by weight).


7.3 While firing blended coal, guidelines given in Appendix-VI may be kept in view.

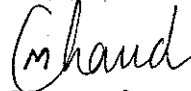
7.4 If most of the power stations are required to blend imported coal, large cross country movement of coal would be required from ports to distant power stations at pit head. Thus, corresponding augmentation will be required in the transportation capacity of railways to ensure that uninterrupted coal movement to power stations takes place. Further, imported coal is generally transported from ports to the power stations in the Box-N wagons. As pit head stations and some Rail fed stations are designed to normally receive coals from MGR/IR systems through bottom discharge BOBR wagons, it is desirable that Railways should acquire more BOBR wagons to transport imported coal to such stations.

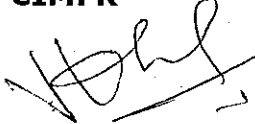

(Sh. R Kumar)
BHEL

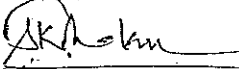

(Sh. S.N Goel)
NTPC


(Sh. Subhasis Biswas)
CIMFR


(Sh. Alok Saxena)
CEA


(Sh. Mam Chand)
CEA


(Sh. V.K Singh)
CEA


(S.K Thakur- CEA)
Chairman



भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सचिव का कार्यालय
सेवा भवन, आर० के० पुरम्,
नई दिल्ली - 110 066



(आई.एस.ओ. : 9001:2000)

No.CEA/5-41(06)/Secy-2010/261

Dated: 02.08.2010

ORDER

Subject: Constitution of a Group for studying the range of blending of imported coal with domestic coal -reg.

Secretary (Power) in the meeting taken on 17th July, 2010 to review the capacity addition programme of the 2nd quarter of 2010-11 has directed that CEA will issue an advisory to the effect that all new coal based projects to be ordered will be designed for a blend of domestic and imported coal. For this purpose, it has been decided to constitute a Group for studying the range of blending of imported coal with domestic coal before issue of the advisory.

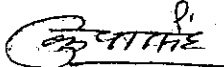
Accordingly, a Group is hereby constituted for studying the range of blending of imported coal with domestic coal with the following composition:

- | | |
|---|------------|
| 1. Sh. Suresh Chander, Chief Engineer (TE&TD) | - Chairman |
| 2. Sh. S.K. Thakur, Director (TPI) | - Member |
| 3. Sh. Mam Chand, Director (TPM) | - Member |
| 4. Sh. V.K. Singh, Director (IRP) | - Member |
| 5. Sh. Alok Saxena Director (OM) | - Member |
| 6. Representative of NTPC | - Member |
| 7. Representative of BHEL | - Member |
| 8. Representative of CFRI, Dhanbad | - Member |

The Group may co-opt any other members as it may deem fit.

The TA/DA and other expenses shall be borne by the respective organizations of the members of the Group.

The Group shall submit its Report alongwith its recommendations within 6 (Six) weeks of issue of this Order.



(K.P. Singh)

Secretary

Tel. No.26108476

To:

- ✓ 1. Sh. Suresh Chander, Chief Engineer (TE&TD)
2. Sh. S.K. Thakur, Director (TPI)
3. Sh. Mam Chand, Director (TPM)

4. Sh. V.K. Singh, Director (IRP)
5. Sh. Alok Saxena, Director (OM)

Copy with the request to nominate a representative as member of the above Group and intimate to Chief Engineer (TE&TD), CEA, the Chairman of the Group, Sewa Bhawan, R.K Puram, New Delhi - 110 066 (Tel. No. 011-26103488, E-mail- schander1950@yahoo.co.in.) to:

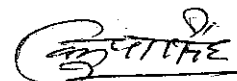
1. CMD, NTPC, SCOPE Complex, Lodi Road, New Delhi.
2. CMD, M/s BHEL, BHEL House, Siri Fort, New Delhi - 110 049.
(Fax No. 011- 26493659)
3. Director, Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad, Jharkhand-826 015. (FAX No.0326-2296025, E-mail- director.cimfr@nic.in)

Copy for information to:

1. SA to Chairperson, CEA
2. SA to Member (Thermal), CEA
3. SA to Member (Planning), CEA

Copy for kind information to:

The Secretary, Ministry of Power, S.S. Bhawan, Rafi Marg, New Delhi-110001.



(K.P.Singh)

Secretary

Tel. No.26108476

केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
तापीय यांत्रिकी एवं अभियांत्रिकी विभाग
Thermal Engineering & Technology Development Division
नवम तल सेवा भवन ,राम कृष्ण पुरम नई दिल्ली-110066
9th Floor (South) Sewa Bhawan, R. K. Puram New Delhi-110066

No. CEA/TETD-TT/2010/F-9/

Dated : 16.08.2010

Subject : Record notes of discussions of the meeting of the 'Group for studying the range of blending of imported coal with domestic coal'.

Dear Sir,

Please find enclosed herewith record notes of discussions of the meeting of the above Group held in CEA on 10th August, 2010. The next meeting of the Group is tentatively proposed for 25th August, 2010 at 15.00 hrs in CEA & the convenience for the same may please be confirmed.

Encl.: As above.

sc
16/8
(Suresh Chander)
Chief Engineer

To :

1. Shri R. Kumar, G.M., Engg. Fossil Boiler, Building 214, Bharat Heavy Electricals Limited, Tiruchirapalli- 620014.
Fax no. 0431- 2520056
2. Shri T.K. Chatterjee, Executive Director (Fuel Mgmt.), NTPC, Room No. 301 R&D Building, A-8A, Sector-24, NIODA- 201301 (U.P.)
Fax no. 0120- 2410633
3. Shri Subhasis Biswas, Scientist 'F', Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad, Jharkhand- 826 015.
Fax no. 0326- 2296025
4. Shri S.K. Thakur, Director (TPI), CEA
5. Shri Alok Saxena, Director (OM), CEA
6. Shri Mam Chand, Director (TPM), CEA
7. Shri V.K. Singh, Director (IRP), CEA

Copy to: Shri N.K. Bansal, G.M., Power Sector Technical Services, BHEL H.Q.,
3rd Floor, KRIBHCO Bhawan, A-8-10, Sector- 1, NOIDA- 201301 (U.P.)
Fax no. 0120- 2536807

Record notes of discussions of the first meeting of the “Group for studying the range of blending of imported coal with domestic coal” held in CEA on 10th August, 2010

1. The meeting was preceded by a presentation made by Sh. R. Kumar, GM (Engg.), BHEL, Tiruchy on boiler design with wide range of coals, which was also attended by Chairperson CEA , CE (IRP), CE(TPM), CE(OM) and other CEA officers.

Chairperson CEA, in his opening remarks, stated that due to mismatch between pace of thermal capacity addition and growth in coal mining, coal shortages are already being felt and being mitigated by import of coal. Coal shortages are expected to aggravate further in future. Captive coal mining has also not picked up as expected due to problems such as forest clearances. It is, thus, imperative that future boilers are designed to fire mix of indigenous and imported coal so as to prevent loss of generation on account of coal shortages. He added that a number of private sector power companies have been acquiring coal assets abroad and increased use of imported coal would also preserve national coal resources leading to better energy security for future.

The Presentation by BHEL covered broad design philosophy of the power boilers and impact of coal quality variations on various components of boiler. The main points brought out were as under:

- a. BHEL boilers are designed for high ash Indian coal and thus the furnace is typically higher by about 20% as compared to boilers sized for imported low ash coal. High ash content influences furnace temperature due to shielding of radiations. It also leads to requirement of more number of mills and influences sizing of PA fans, air pre-heaters and ESP. Abrasive properties of ash also leads to severe erosion which is taken care of by adopting lower flue gas velocities and specific protections for erosion.
- b. Indian power boilers are generally designed for a coal of about 3300 kcal/kg design coal on which performance guarantees are provided. However, the boilers are capable of giving rated output with large coal quality variation of about 1000 kcal/kg (from 3000 to 4000 kcal/kg). Blended coals have been successfully fired in boilers designed by BHEL for Indian coals. While, blending of imported coal upto 30% by weight is carried out at Dahanu TPS, many other stations have been blending imported coal in the range of 15 to 20%.
- c. Indian coals and imported coals have distinctly different characteristics and blending should be done cautiously and boiler performance should be observed for any adverse effect. Slagging/fouling characteristic of ash should be carefully considered as high slagging coals may impose a limitation on reaching the rated capacity. When slagging coals are blended, it is necessary to conduct site trials, to establish a safe percentage of blending.

2. After the presentation a meeting of the Group was held. A list of participants is enclosed as Annexure-1. The following points emerged out of the discussions:

a. Sh. Alok Saxena, Director (OM) and Sh. V.K. Singh, Director (IRP), CEA would together work out scenarios for power development and coal availability in future (in short, medium and long term) so as to assess the extent of coal shortage anticipated which is to be bridged through blending with imported coal. This would help in determining the extent of coal blending required for future projects. While, evolving the above scenario the following issues would also be considered :

- Some stations are already designed for 100% imported coal and some of the future coastal power stations could be designed for 100% imported coal.
- Stations fed through captive coal mining would not be using imported coal for blending.
- Supplying imported coal to pit-head stations (having facility of unloading BOBR wagons) would necessitate creation of additional facilities for unloading of BOX-N wagons.
- The impact of coal distribution policy and fuel supply agreement (FSA) signed by the utilities with Coal India Ltd. For existing stations envisage firm coal supplies.

(Action: CEA)

b. Two possible options for plant design are available. The plant can be designed for Indian coal with capability to fire blended coal. Alternately, the plant can be designed for blend of Indian and imported coal as has been done by BHEL for Krishnapatnam TPS for 70:30 blend of indigenous and imported coal. Second option would lead to more optimal design and possible savings in the plant cost. These options would be further deliberated in the next meetings in the light of coal shortage scenarios. BHEL would furnish key design parameters of boilers designed for 100% indigenous coal and boiler designed for 70:30 blend.

(Action: BHEL)

c. It is possible to design boilers for use of any blend of coal but the characteristics of both the domestic and imported coal are required to be informed in advance to the boiler supplier. Also, both the coals namely domestic and imported coal should be compatible with respect to the key characteristics for which combustion tests may require to be done. BHEL and CFRI would bring out the issues/ coal characteristics that are required to be considered for determining compatibility of coals for blending which would help in framing guidelines for selecting the coals for blending.

(Action: BHEL/CFRI)

- d. The broad range of internationally available coal quality which could be possible candidates for import and blending also needs to be kept in view. Only low sulphur coals can be used, thus, broad coal quality parameters for internationally available low sulphur coals may be examined with a view to identify the broad spectrum of coals with which blending may be required. NTPC and O.M. Division of CEA would furnish the information regarding characteristics of imported coals.

(Action: NTPC/CEA)

- e. CFRI was of the view that a data bank of compatibility matrix of indigenous v/s imported coals needs to be created in the country which would serve as a guidelines to the utilities.

- f. Discussions were also held regarding optimal methodology for blending. Blending in India was being done either through mixing two streams of coal on the belt or allocating one mill dedicated to 100% imported coal. In developed countries, blending is done in the stockyard. The relative advantages/short comings of these approaches would be further discussed by the group so as to evolve preferred blending methodology.

- g. NTPC representative could not attend this meeting. NTPC would be requested to share their experience in using blended coal with the group in the next meeting giving extent of blending, methodology of blending, operational problems and constraints presently faced, if any, in the use of blended coal so that the same can be addressed in the design of future boilers.

(Action: NTPC)

3. Date for next meeting of the Group was tentatively fixed as 25th August, 2010.

Annexure-I

List of participants in the first meeting of the "Group for studying range of blending of imported coal with domestic coal" held in CEA on 10th August, 2010

CEA

1. Sh. Suresh Chander, Chief Engineer (TE&TD)
2. Sh. S.K.Thakur, Director (TP&I)
3. Sh. Alok Saxena, Director (OM)
4. Sh. V.K.Singh, Director (IRP)
5. Sh. Sanjay Sharma, Director (TE&TD)

BHEL

6. Sh. R.Kumar, General Manager
7. Sh. N.K.Bansal, General Manager
8. Sh. Anil Verma, AGM
9. Sh V Sitaraman, Manager

CFRI

10. Sh. S. Biswas, Scientist 'F'

केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
तापीय यांत्रिकी एवं अभियांत्रिकी विभाग
Thermal Engineering & Technology Development Division
नवम तल सेवा भवन, राम कृष्ण पुरम नई दिल्ली-110066
9th Floor (South) Sewa Bhawan, R. K. Puram New Delhi-110066

No. CEA/TETD-TT/2010/F-9/

Dated : 31.08.2010

Subject : Record notes of discussions of the Second meeting of the 'Group for studying the range of blending of imported coal with domestic coal'.

Dear Sir,

Please find enclosed herewith record notes of discussions of the Second meeting of the above Group held in CEA on 25th August, 2010 for your kind information and necessary action please.

Encl.: As above.

o/c
Suresh
31.8.10
(Suresh Chander)
Chief Engineer

To :

1. Shri R. Kumar, G.M., Engg. Fossil Boiler, Building 214, Bharat Heavy Electricals Limited, Tiruchirapalli- 620014. Fax no. 0431- 2520056
With the request to furnish the information as per item 9 of the enclosed record notes of discussions within one week.
2. Shri T.K. Chatterjee, Executive Director (Fuel Mgmt.), NTPC, Room No. 301 R&D Building, A-8A, Sector-24, NIODA- 201301 (U.P.) Fax no. 0120- 2410633
With the request to furnish the information as per item 10 of the enclosed record notes of discussions within one week.
3. Shri I.K.Rajdeva, G.M (O.S.), NTPC, A-8A, Engineering Office Complex (EOC), Sector-24, NOIDA- 201301 (U.P.) Fax no. 0120- 2410012
With the request to furnish the information as per items 2 & 3 of the enclosed record notes of discussions within one week.
4. Shri Subhasis Biswas, Scientist 'F', Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad, Jharkhand- 826 015. Fax no. 0326- 2296025

4. Shri S.K. Thakur, Director (TPI), CEA
5. Shri Alok Saxena, Director (OM), CEA
6. Shri Mam Chand, Director (TPM), CEA
7. Shri V.K. Singh, Director (IRP), CEA

Copy to: Shri Anil Verma, A.G.M., Power Sector Technical Services, BHEL H.Q.,
3rd Floor, KRIBHCO Bhawan, A-8-10, Sector- 1, NOIDA- 201301 (U.P.)
Fax no. 0120- 2536807

Record notes of discussions of the 2nd meeting of the "Group for studying range of blending of imported coal with domestic coal" held in CEA on 25th August, 2010

The list of participants is enclosed at Annexure -1.

1. Shri Suresh Chander, Chief Engineer, CEA and Chairman of the group welcomed the participants and initiated the discussions. As the last meeting was not attended by NTPC, he gave a brief overview of the objectives of the group and issues discussed in the last meeting. He then invited NTPC to share their experiences about coal blending.
2. NTPC stated that blending with imported coal (10-15% by weight) is being carried out at Farakka, Kahalgaon and Talcher TPS where the coal quality is poor and aggregate design coal quality is being achieved through blending. Stations such as Ramagundem, Singrauli where the coal quality is otherwise good are not using any blending of imported coal. NTPC was requested to give a write up on feed back on specific operational problems faced in their stations with use of imported coal and modifications/changes made in operating procedures (like mill temperature settings, damper settings etc) for use of imported coal.

(Action: NTPC)

3. NTPC made a brief presentation on the blending methodology being used and the salient points brought out are as under:-
 - a. Following four methods of blending are possible:
 - i) Blending by mixing of two streams of coal on conveyor belt (Imported coal reclaimed from reclaimers and domestic coal from track hoppers/wagon tippers or both coals reclaimed by reclaimers)
 - ii) Blending by ground hoppers
 - iii) Blending in stockyard
 - iv) Blending on conveyors by silo
 - b. NTPC have been using method of blending coal on conveyor belt. However, the proportion of blending cannot be controlled accurately with this methodology. Blending in stockyard i.e. stacking of indigenous and imported coal in layers is not practiced because this would first require stacking of all coal received before layering. Also, it would significantly increase the auxiliary power consumption for coal feeding due to more running hours of CHP.
 - c. NTPC suggested that as a long term blending solution, the imported coal may be fed to a dedicated silo and should be fed from this silo through an accurately weighing gravimetric feeder alongwith provisions for online GCV determination of imported coal so as to enable varying of imported coal quantity based on the GCV. NTPC also informed that they have started procuring variable speed, reclaimer wheels for imported coal to facilitate accurate blending.

- d. The practice of dedicated mill firing with imported coal is not being adopted by NTPC as trials for such operation at Talcher TPS in the past have led to clinkering in the burner zone of mill firing imported coal.

NTPC was requested to furnish a detailed write up on blending methodologies.

(Action: NTPC)

4. Shri Sanjay Sharma Director CEA stated that practice of using dedicated mill for imported coal is being adopted by some state utilities and has in fact become the preferred choice of utilities over the methodology of blending on the belts because it offers better control in milling and in firing imported coal.
5. It was also felt by some members that the suggested arrangement of dedicated silo by NTPC would require separate silo for each coal handling plant as feeding imported coal to different CHPs from single silo may pose layout constraints. Further, GCV variation in imported coal is not expected to be significant and thus arrangements for online determination of GCV does not appear to be necessary.
6. Shri Chatterjee E.D NTPC stated that problems of logistics and infrastructural aspects are involved in use of imported coal. The wagon unloading time goes up significantly due to BOX-N wagons in rainy season due to caking of imported coal. The pit head NTPC stations are designed for coal receipt by MGR and use of imported coal has necessitated the creation of facilities for unloading of Box-N wagons. The BOBR wagons are not available in requisite numbers and NTPC has even offered to share the cost of wagons. Also with the increased blending requirements of about 30% projected, augmentation of facilities would be required for handling imported coal and this may not be possible in some stations due to layout constraints.
7. The projection of coal requirements and coal availability worked out by CEA were discussed. It is seen that by 2016-2017 about 30% blending of imported coal (by weight) may be required if blending is adopted by all the utilities linked to indigenous coal.
8. BHEL stated that they are designing 800 MW supercritical boilers for Krishnapatnam station for a blend of 70:30 indigenous and imported coals. The imported coal considered is the Indonesian coal with high moisture and high volatile matter. The boilers are under design stage.

BHEL added that based on their experience with Indian boilers, it should be possible to blend upto 20% imported coal by weight (30% by heat value) for subcritical boilers designed on indigenous coal. For supercritical boilers, because of the variable evaporation point imported coal upto 30% by weight (45% by heat value) can be blended. CFRI representatives felt that compatibility of both the coals would also have to be ensured.

9. It was agreed that BHEL would furnish a write up on impact of various coal characteristics on boiler design and performance and compatibility criteria to be adopted while selecting the imported coal for blending with Indian coal being used.

[Action BHEL]

10. Typical specifications for coal import adopted by NTPC are as under:

PARAMETER	UNIT	ACCEPTABLE RANGE
Total Moisture (ARB)	%	10-20 Max.
Ash (ADB)	%	8-20
Fixed Carbon (ADB)	%	30-50 Typical
Volatile Matter (ADB)	%	25-45
Sulphur (ADB)	%	0.70- 0.90 Max.
Gross Calorific Value (ADB)	KCal/ Kg	5800-6500
HGI	-	45-60
IDT under reducing atom. °C	°C	1100- 1250
Size	MM	0-50

However, above are under review in consultation with CIL considering the coal availability in the international market. NTPC was requested to furnish characteristics of various imported coals. This information will help in giving some idea about spectrum of coals available for imports to the Committee which may be examined for recommendations regarding compatibility by this group.

[Action NTPC]

11. Summarizing the discussions Shri Suresh Chander Chief Engineer CEA, requested that members may please furnish the information required within 2 weeks. He also invited NTPC to witness Study on blending by firing imported coal in dedicated mill being conducted at Raichur TPS in September first week .

The meeting ended with thanks to the Chair.

Annexure-I

List of participants in the second meeting of the "Group for studying range of blending of imported coal with domestic coal" held in CEA on 25th August, 2010

CEA

1. Sh. Suresh Chander, Chief Engineer (TE&TD)
2. Sh. S.K.Thakur, Director (TP&I)
3. Sh. Alok Saxena, Director (OM)
4. Sh. Sanjay Sharma, Director (TE&TD)
5. Sh. Ishan Sharan, Dy. Director (IRP)
6. Sh. Ashish Gupta, A.D., TE&TD
7. Sh. Sunit Kumar Gupta, A.D., TE&TD

NTPC

8. Sh. T.K. Chatterjee, Executive Director (Fuel Mgmt.)
9. Sh. I.K. Rajdeva, G.M. (Operation Services)
10. Sh. Vinay Kumar, DGM
11. Sh. D.K. Saha, DGM
12. Sh. B.N. Jha, DGM
13. Sh. P.K. Gupta, Chief Design Engineer

BHEL

14. Sh. S. Chandrasekaran, Addl. General Manager, BHEL (Tiruchy)
15. Sh. Anil Verma, Addl. General Manager, BHEL (PSTS)

CFRI

16. Sh. S. Biswas, Scientist 'F'
17. Dr. Ashis Mukherjee, Scientist 'E'

Typical characteristics of Indonesian coals

Specification	Type 'A'	Type 'B'	Type 'C'
Total Moisture (AR)%	14 Max.	20 Max.	12 - 25
Inherent Moisture (AD)%	10 Max.	12 Typical	10 - 18
Ash (AD)%	12 Max.	8 Max.	7 - 8
Fixed Carbon (AD)%	45 Approx.	40 – 45 Typical	By Difference
Volatile Matter (AD)%	39 - 45	38 – 44 Typical	30 – 42
Sulphur (AD)%	0.9 – 1.0	0.70 Max.	0.5 – 0.6
Gross Calorific Value (AD) KCal/ Kg	6200 - 6400	5800 - 6500	5400 - 6200
Hardgrove Grindability Index (HGI)	35 - 45	40 - 55	45 - 65
Ash Fusion Temperature ⁰ C	1250 1300 1350	1250 1300 1350	1150 1200 1250
Size mm	0 - 50	0 - 50	0 – 50
Country of origin	Indonesian	Indonesian	Indonesian
<u>Ash Analysis (%) Approx</u>			
SiO ₂	46.68	42.38	46.10
Al ₂ O ₃	36.19	24.13	26.29
Fe ₂ O ₃	5.88	11.90	13.46
TiO ₂	2.67	1.72	1.99
CaO	1.40	8.15	4.18
MgO	3.30	4.75	2.25
K ₂ O	0.43	0.58	0.66
Na ₂ O	0.49	0.30	0.16
P ₂ O ₅	0.80	0.20	0.267
SO ₃	2.04	7.00	3.73
Mn ₃ O ₄	0.03	0.19	0.194

**Typical Indonesian coal Quality received at Power Station "X"
using imported Coal**

Parameter	Value
Total Moisture (%)	18-26
Volatile Matter (%)	27-33
Ash (%)	6-11
Sulphur (%)	
Gross Calorific Value Kcal/ Kg	4600-5400

SOUTH AFRICAN THERMAL COAL

			TYPICAL	REJECTION
Total Moisture	ar	%	9.0	> 12.0
Size		mm	50 x 0	
Proximate Analysis (adb)				
Inherent Moisture	ad	%	3.0	
Ash	ar	%	14.5	> 15
Volatile Matter	ar	%	24	< 22
Fixed Carbon	ar	%	by difference	
Total Sulphur	ar	%	0.8	> 1.0
Specific Energy	NAR	kcal/kg	6000	< 5800
	GAR	kcal/kg	6220	
	GAD	kcal/kg	6630	
Hardgrove Index			50	
Ultimate Analysis (daf)				
Carbon	daf	%	71.50	
Hydrogen	daf	%	4.00	
Nitrogen	daf	%	1.70	
Oxygen	daf	%	6.90	
Ash Fusion Temperature				
Deformation		C	1300	< 1250
Spherical		C	1450	
Hemispherical		C	1480	
Flow		C	1540	
Ash Analysis				
SiO ₂		%	50.0	> 12
Al ₂ O ₃		%	27.0	
Fe ₂ O ₃		%	3.5	
CaO		%	9.2	
MgO		%	1.5	
Na ₂ O		%	0.2	
K ₂ O		%	0.6	
TiO ₂		%	1.7	
P ₂ O ₅		%	2.3	
SO ₃		%	2.50	
Other			1.50	

GLADSTONE THERMAL COAL (USA.)

Typical Guaranteed

Total Moisture	ar	%	13.5	
Size		< 50mm	100%	
Proximate Analysis (adb)				
Inherent Moisture	ad	%	6.0	
Ash	ad	%	15.0	
Volatile Matter	ad	%	21.0	
Fixed Carbon	ad	%	58.0	
Total Sulphur	ad	%	0.8	
Specific Energy	ad	kcal/kg	6450	
Specific Energy	gar	kcal/kg	5,935	
Hardgrove Index			65	
Ultimate Analysis (daf)				
Carbon	daf	%	73.90	
Hydrogen	daf	%	4.60	
Nitrogen	daf	%	1.70	
Oxygen	daf	%	by difference	
Ash Fusion Temperature				
Deformation		C	1165	
Spherical		C	1200	
Hemispherical		C	1230	
Flow		C	1260	
Ash Analysis				
SiO ₂		%	53.0	
Al ₂ O ₃		%	19.6	
Fe ₂ O ₃		%	14.6	
CaO		%	4.2	
MgO		%	1.45	
Na ₂ O		%	0.62	
K ₂ O		%	1.31	
TiO ₂		%	1.0	
Mn ₃ O ₄		%	0.17	
P ₂ O ₅		%	1.3	
SO ₃		%	2.23	

BRISBANE THERMAL COAL (AUSTRALIA)				
			Typical	Guaranteed
Total Moisture	ar	%	12.0	
Size		<38mm	100%	
		< 2mm	20%	
Proximate Analysis (adb)				
Inherent Moisture	ad	%	7.5	
Ash	ad	%	12.5	
Volatile Matter	ad	%	39.2	
Fixed Carbon	ad	%	40.8	
Total Sulphur	ad	%	0.45	
Specific Energy	ad	kcal/kg	6300	
Specific Energy	gar	kcal/kg	5,994	
Hardgrove Index			40	
Ultimate Analysis (daf)				
Carbon	daf	%	68.50	
Hydrogen	daf	%	5.50	
Nitrogen	daf	%	0.95	
Oxygen	daf	%	12.20	
Ash Fusion Temperature				
Deformation		C	1320	
Spherical		C	1550	
Hemispherical		C	1570	
Flow		C	>1600	
Ash Analysis				
SiO ₂		%	58.5	
Al ₂ O ₃		%	33.7	
Fe ₂ O ₃		%	1.6	
CaO		%	1.49	
MgO		%	1.0	
Na ₂ O		%	0.51	
K ₂ O		%	0.21	
TiO ₂		%	1.48	
Mn ₃ O ₄		%	0.01	
P ₂ O ₅		%	0.04	
SO ₃		%	0.60	

NEWCASTLE THERMAL COAL (AUSTRALIA)					
				12% Ash	15% Ash
Total Moisture	ar	%		9.5	9.5
Size		mm		50 x 0	50 x 0
Proximate Analysis (adb)					
Inherent Moisture	ad	%		3.0	3.0
Ash	ad	%		12.0	14.9
Volatile Matter	ad	%		33.4	31.1
Fixed Carbon	ad	%		51.6	51.0
Total Sulphur	ad	%		0.49	0.70
Specific Energy	ad	kcal/kg		6900	6,700
Specific Energy	gar	kcal/kg		6,438	6,251
Hardgrove Index				51	50
Ultimate Analysis (daf)					
Carbon	daf	%		72.40	71.00
Hydrogen	daf	%		5.42	4.50
Nitrogen	daf	%		1.98	1.60
Oxygen	daf	%		9.55	7.60
Ash Fusion Temperature					
Deformation		C		1380	1,350
Spherical		C		1450	1,450
Hemispherical		C		1480	1,470
Flow		C		1540	1,500
Ash Analysis					
SiO ₂		%		73.0	72.0
Al ₂ O ₃		%		16.0	18.0
Fe ₂ O ₃		%		4.0	4.0
CaO		%		1.6	1.0
MgO		%		1.2	0.6
Na ₂ O		%		0.62	0.30
K ₂ O		%		0.87	0.90
TiO ₂		%		0.74	0.82
Mn ₃ O ₄		%		0.03	0.04
P ₂ O ₅		%		0.21	0.35
SO ₃		%		1.20	1.00

Sub : Blending Methodologies of Imported and Domestic Coals

Various Methods of Blending

1. Blending in Beds

In this method different types of coal are stacked in horizontal layers one above the other (Exhibit - A). Each layer is of constant height. The layers are along longitudinal beds. Number of layers of each type of coal decides the mixing ratio. Blending is achieved during reclaiming. Further homogenization of two types of coal takes place in transfer points. This method has the advantage that only one system to be run to bunker blended coal.

The major disadvantage of this type of blending is that entire quantity of coal has to be first stacked and then reclaimed. This causes increased handling of coal & duration. Stacking of mixed coals in yard may also lead to spontaneous combustion and ignition of coal. Another disadvantage of this method is that it is very difficult to alter the blend composition once the bed has been constructed.

Moreover, this method is not suitable when the ratios of coals to be blended are less than 1:3 as in the case of NTPC.

2. Blending by Silos:

In this method a silo of suitable capacity and having feeder at the bottom to discharge coal at controlled rate is constructed over conveyor belt (Exhibit - B and F). Imported coal is filled in the silo, which is added on to the conveyor carrying domestic coal in the desired ratio.

Blending can be achieved very accurately by this method. However, to implement this type of blending silos, conveyor belts, gravimetric feeders will have to be installed and capital cost is high.

3. Blending by Ground Hopper:

In this method imported coal is to be first stacked in yard near ground hoppers. During blending domestic coal is to be fed from track hopper/wagon tippler/stockyard and imported coal is to be fed from ground hopper with the help of dozers (Exhibit-E). Quantity of imported coal for blending is to be controlled through belt feeder speed/VF stroke.

However, all stations of NTPC do not have ground hoppers. Wherever this facility is available such blending procedure can be used.

4. Blending on moving belt

a) Both coals reclaimed by reclaimers

In this method both domestic and imported coals are first stacked in stockyards of different stacker reclaimers (exhibit – C). Blending is achieved by reclaiming coal from both reclaimers and mixing them at a common transfer point.

This method is advantageous when coal supply is of varying properties. Blending ratio can be changed at any time based upon the types of coals received.

However, in this method also the entire coal is first required to be stacked.

In the pilot study carried out at Rihand it was observed that such type of blending method severely affected track hopper-2 evacuation and rake detention increased substantially. During unloading of rakes, bunkering of blended coal was not possible. Bunkering of blended coal could be done either in Stage-I or Stage-II at a given time. CHP and Stacker Reclaimer operating hours also increased substantially leaving little time for maintenance. Increase in auxiliary power consumption of CHP is another disadvantage.

b) Imported coal reclaimed from reclaimers and domestic coal from track hopper (Exhibit – D)

This method is the most widely used method of coal blending as this involves minimum handling of coal and operating time required for bunkering is least. Whereas method 3(a) is applicable only for Rihand-II and many other stations, this method can be used for both stages.

For this method the belt weigher reading of domestic coal should be available to stacker-reclaimer operator who can vary quantity of coal being reclaimed at desired blending ratio. Further homogenisation takes place in transfer points and coal bunkers.

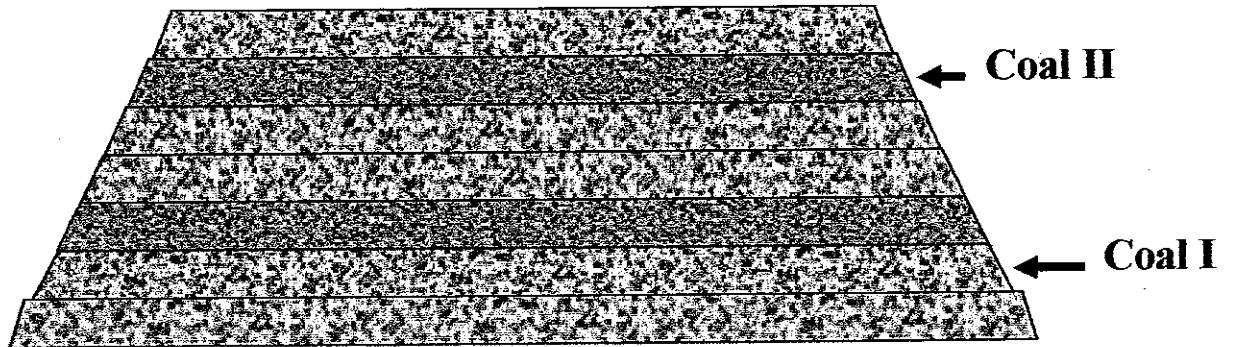
Sub : Comparison of Various Methods of Blending of Imported and Domestic Coals

Various Methods of Blending

Sr. No.	Blending Method (Exhibit No)	Brief Description	Point/place of Blending	Advantages	Disadvantages	Applicability to NTPC
1	Blending in Beds (Exhibit No. A)	Stacking of two types of coals in yard in layers-one above the other.	-Blending during reclaiming -Homogenisation in transfer points	Only one system to be run for bunkering blended coal	-Entire coal to be stacked first. -More running hours of CHP & more APC -Mixing in yard may lead to fires - Not possible to change blend ratio after bed construction	Not tried yet
2	Blending by Silo (Exhibit No. B and F)	Imported coal from silo is mixed with domestic coal carried by conveyor below the silo	-On conveyor below silo -Homogenisation in transfer points	-Very accurate blending ratio can be achieved. -Blending ratio can be varied any time	High capital cost	Facility available in NTPC
3	Blending by Ground Hopper	Imported coal is dozed to ground hopper. Domestic coal is fed directly from Track Hopper/Wagon Tippler	-At common transfer point -Homogenisation in transfer points	Ground hopper as additional source of reclaiming.	Feeding rate is not accurate	Facility available in some of the stations
4	Blending on moving belt					
a	Both reclaimed coals by reclaimers (Exhibit No. C)	Two types of coals are stacked in yards of different stacker reclaimers	-At common transfer point -Homogenisation in transfer points	Blending ratio can be changed at any time	-Entire coal to be stacked first & more APC. -More running hours of CHP	Tried in Rihand. Not found suitable

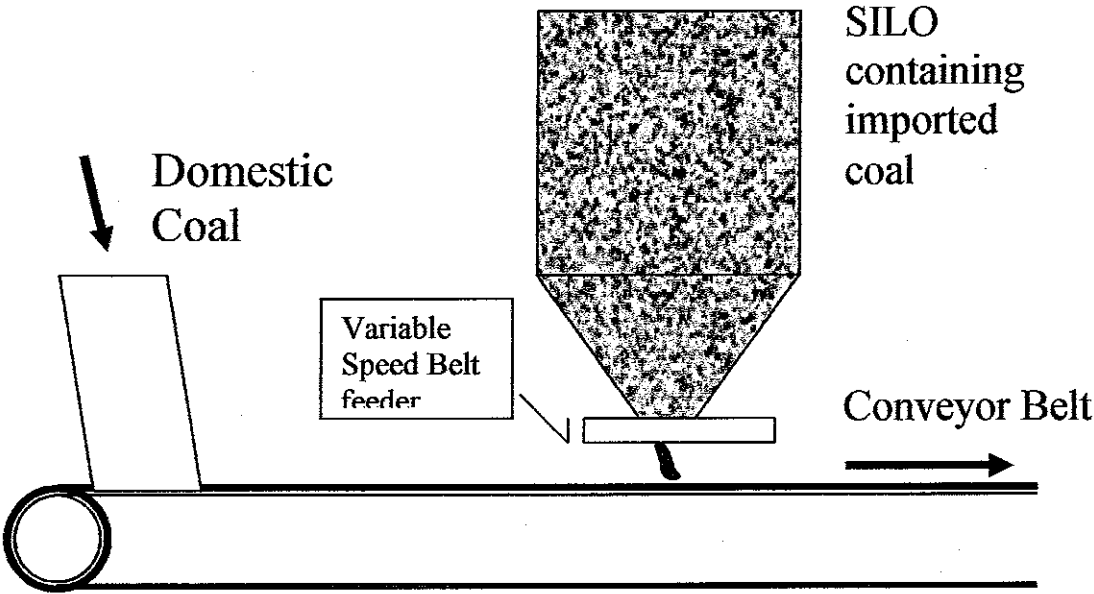
b	Imported coal reclaimed from reclaimers and domestic coal from track hopper (Exhibit No. D)	Imported coal is reclaimed from yard. Domestic coal is fed directly from Track Hopper/ Wagon Tippler	-At common transfer point -Homogenisation in transfer points	Blending ratio can be changed at any time Only imported coal need to be stacked.	Not very accurate method	Adopted in NTPC stations
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Exhibit - A



Blending in Beds

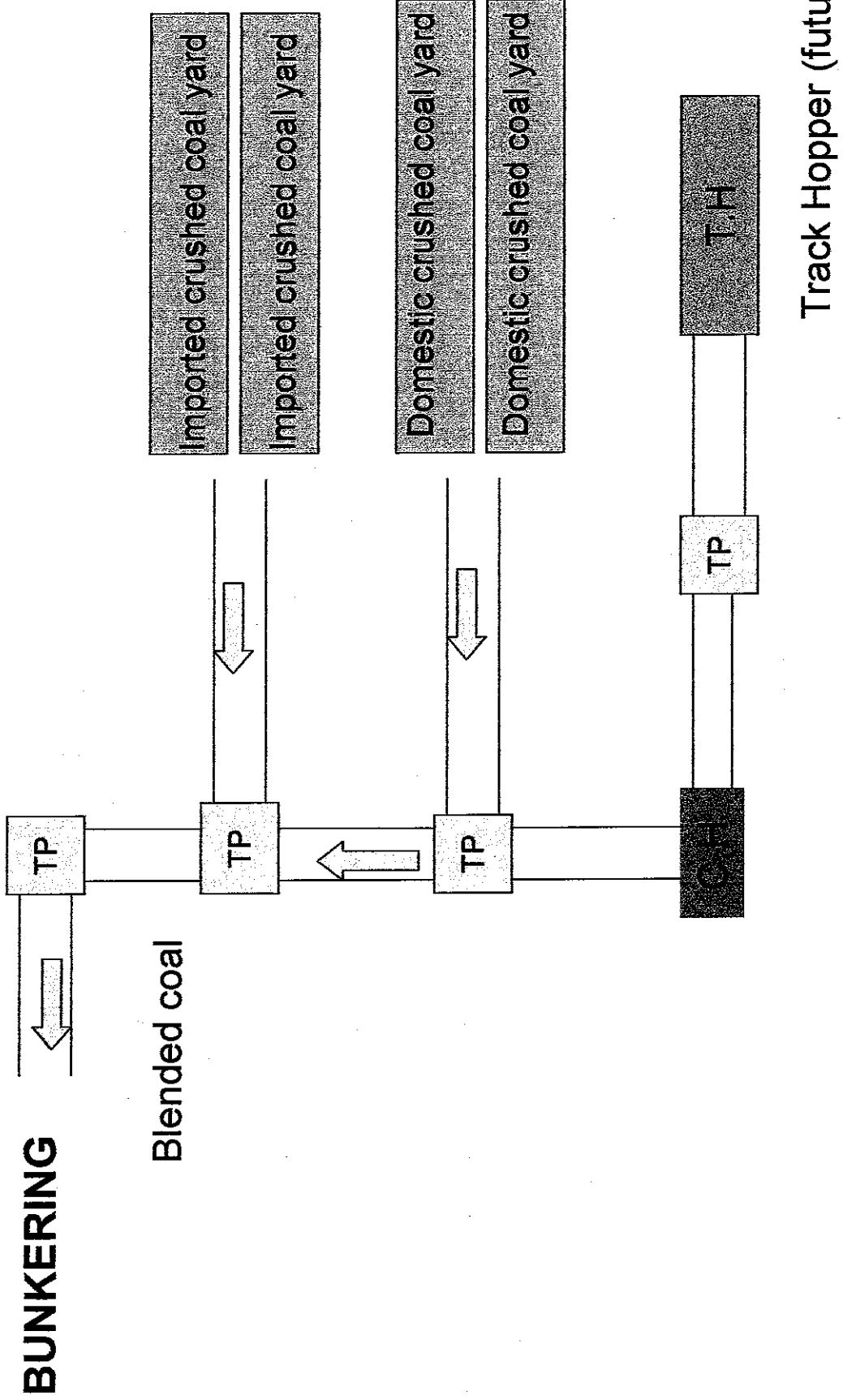
Exhibit - B



Blending by Silos

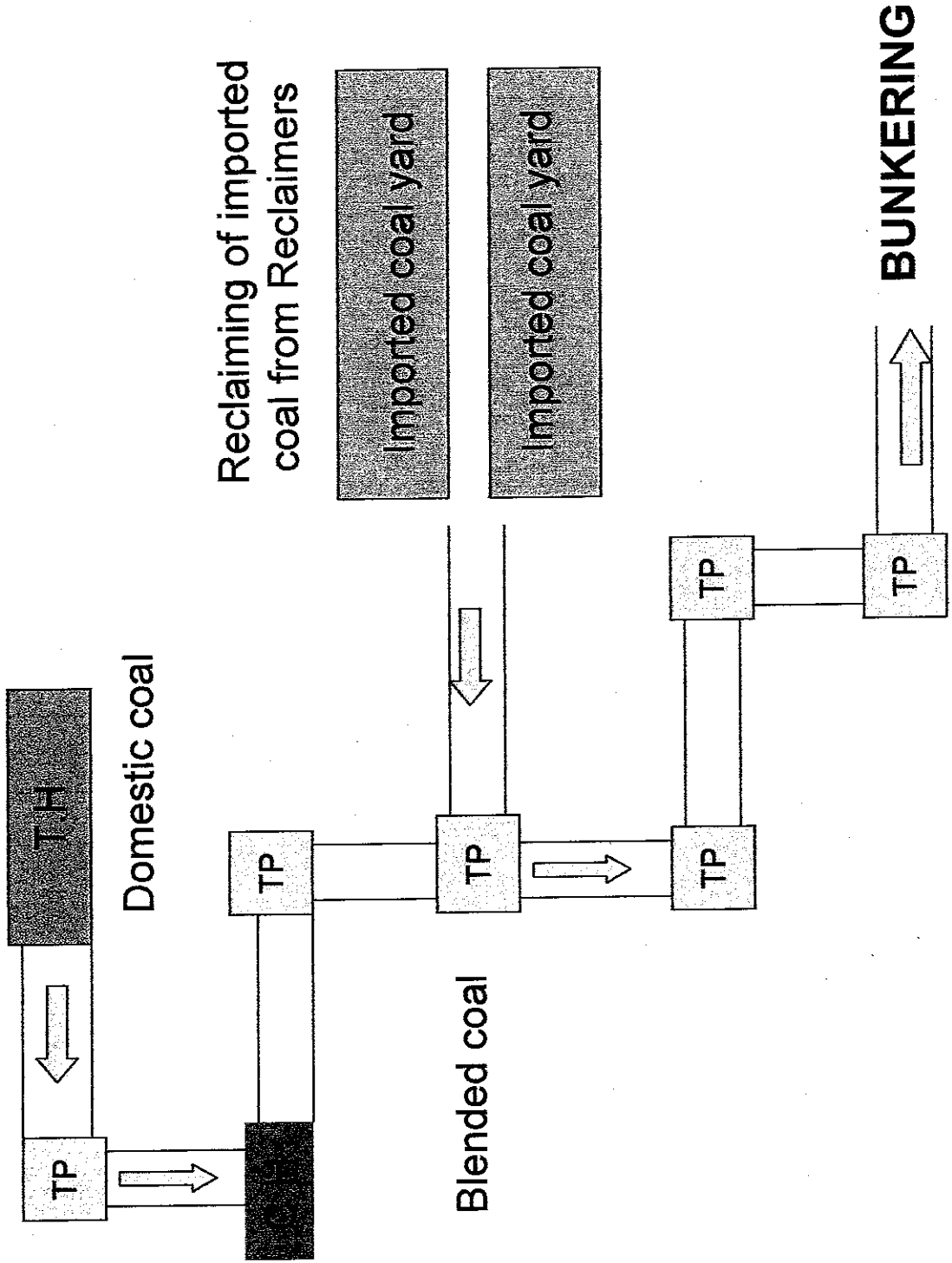
BOTH COALS RECLAIMED BY RECLAIMERS

Exhibit - C



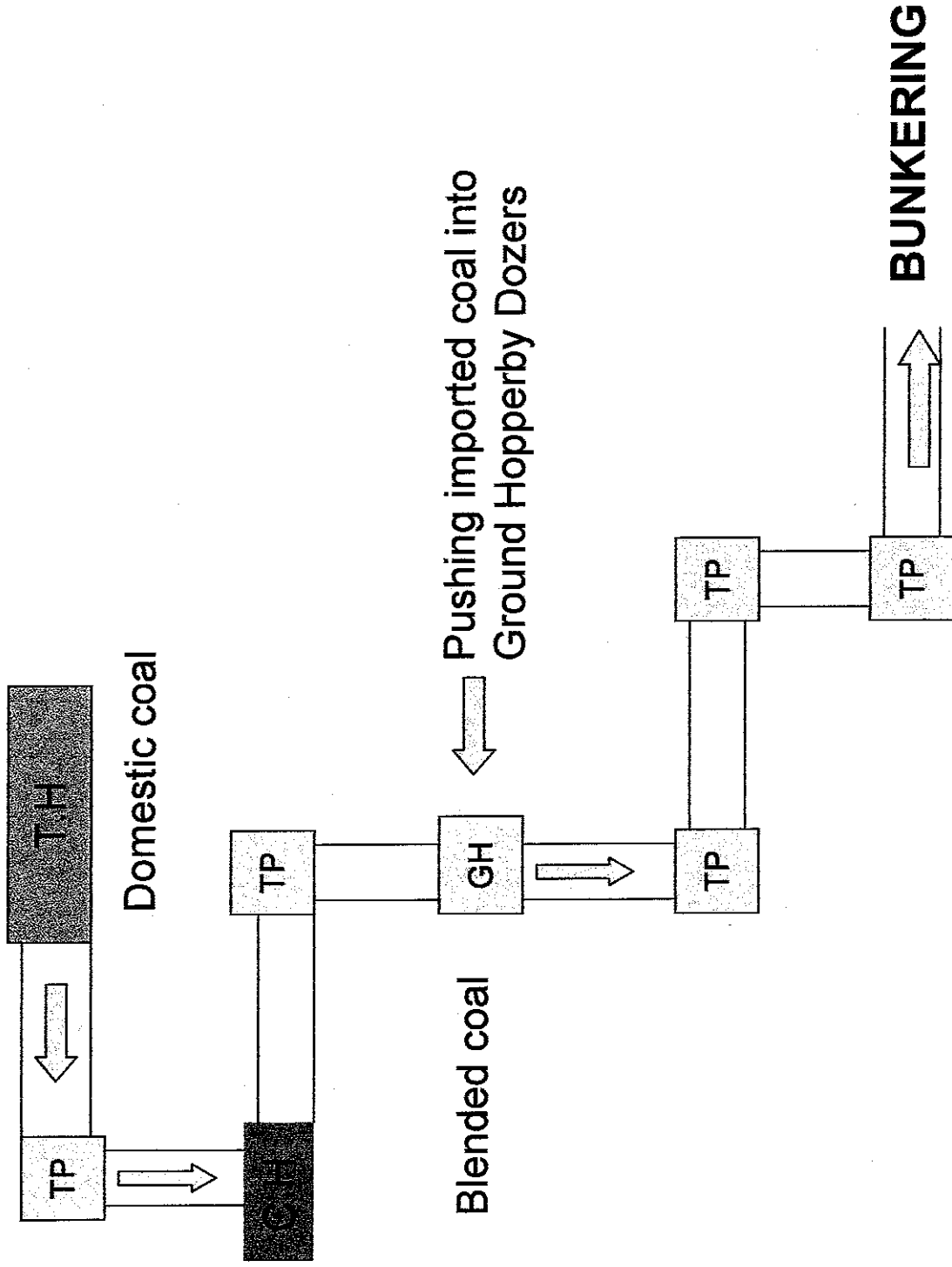
IMPORTED COAL RECLAIMED FROM RECLAIMERS AND DOMESTIC COAL FROM TRACK HOPPER

Exhibit - D



IMPORTED COAL RECLAIMED FROM RECLAIMERS AND DOMESTIC COAL FROM TRACK HOPPER

Exhibit - E



Subject : Experience of Using Blended Coal in NTPC Stations

Blended Coal having 10-15% imported coal is being used in some of the NTPC stations.

1. While using blended coal care is always taken to ensure that pulverized coal & air mixture is not lean in order to avoid fires in mills.
2. In order to avoid mill fires because of high Volatile Matter (VM) of imported coal, mill outlet temperature is also maintained at lower values. This increases flue gas exit temperature causing higher dry flue gas losses.
3. When blended coal is fired in the furnace, there is a tendency of clinkering. Therefore, higher values of 'Excess Air' are maintained to reduce chances of clinkering. This increases dry flue gas losses.
4. Furnace temperature in the firing zone is regularly monitored with the help of pyrometer as heat liberated in this zone of furnace, while firing blended coal, is normally more.
5. Due to lower HGI of imported coal, there is a reduction in mill output. PF fineness is also affected.
6. Due to higher VM component in the imported coal there is fast deterioration in its heat value when stacked in the yard. Stacked coal is also more prone to fires.
7. Imported coal cannot be blended beyond a certain ratio to safeguard operational instability, viz, too high flame temperature inside furnace and clinkering.
8. Whenever a mill is to be taken under shutdown, coal feeding to its bunker is stopped and it is emptied before shutting it down.

IMPACT OF COAL CHARACTERISTICS ON BOILER DESIGN & PERFORMANCE AND COMPATIBILITY CRITERIA FOR COAL BLENDING

INTRODUCTION

India has huge reserves of coal deposits Coal will continue to be the main fuel for electrical power generation for many more years due to the abundant availability and the low cost. However, most of the Indian coals as supplied to the Power stations are generally of the high inert - low heating value type. (i. e. HHV < 3500 Kcal/Kg, Ash > 40%, Ash + Moisture > 50%) and the thrust is and will be on the development of methods to be adopted for using this coal in the most efficient manner and with least atmospheric pollution.

Currently there is a shortage of coal supply from a single source to the power plant. This calls for getting coals from different sources including the sources from other countries resulting in firing different coals or their blends in a boiler which had been designed for a particular range of Indian coals. This report briefs about the impact of various coal characteristics on boiler design and performance and the compatibility criteria for coal blending.

A) COAL QUALITY CHARACTERISATION

Traditionally coal quality is characterized by the type and rank. Very young coals like peat/lignite are termed as low rank coals and highly aged coals like Anthracites, which have undergone near complete metamorphosis is called high rank coals. Low rank coals are of the low heating value, high moisture, high reactive type and the high rank coals are of the higher heating value, low moisture, low reactive type. The low rank coals exhibit absolute ease of pulverisation (high HGI) and the high rank coals exhibit lesser degree of ease of pulverization (medium to low HGI).

Indian coals generally exhibit a fair amount of porosity and can be classified under ASTM ranking High volatile Bituminous B/C to sub-bituminous - A/B category. In India, the maximum ash plus moisture being specified for the worst coal is about 60% with a higher heating value as low as 2800 kcal/kg (11.72 MJ/kg).

Proximate Analysis

The fuel ratio, Fixed Carbon (FC) to Volatile Matter (VM), is generally used for judging the characteristic of the coal with respect to its combustibility. In the absence of any other petrography related information, this characteristic provides some insight into the combustibility behavior of the coal. The general rule is that lower the fuel ratio (fixed carbon/volatile matter) the better it is for combustion, Ignition stability, etc. The fineness of coal grind and the excess air levels to be adopted are normally decided based on FUEL RATIO, the coal rank and past knowledge (if any) on the use of this specific (mine, seam and location) coal for similar application(s).

Ultimate Analysis

Ultimate Analysis is used for making combustion calculations dealing with combustion air requirements and gas quantum produced. It is also used for calculating the partial pressure of tri atomic gases (typically CO₂ & H₂O) which influences the emissivity and hence

the radiant heat transfer in radiant and semi-radiant heat transfer sections of the boiler. The theoretical flame temperature is also arrived at by using ultimate analysis data in conjunction with the heating value (calorific value) of the coal and the excess air.

Ash chemical analysis and ash fusion temperatures

These data provide indicators as to the characteristics of the coal ash. Based on these, to a reasonable extent one can judge whether the coal will be of the slagging type, whether the ash is likely to cause deposits on the SH, RH sections, whether the coal ash is likely to be corrosive or not etc. The base to acid ratio is used in conjunction with iron content and the ash fusion temperatures for sizing of the furnace so that the furnace and the heat transfer sections downstream can be free of ash deposit and bridging problems. The Silica plus Alumina content in conjunction with the ash quantum and the quartz content, to some extent, is indicative of the erosion potential of the fly ash.

Hard Grove Index (HGI)

The coal HGI decides the ease with which the coal can be pulverised. The higher the HGI index, it is easier to pulverise the coal and vice versa. HGI influences the size and number of the mills to be adopted. Hard Grove Index of Indian coals generally vary from 48 to 65.

YGP Index

YGP Index is a measure of the coal's abrasive nature. The YGP index is greatly influenced by the contaminants in the coal like shale content, inclusion of dirt bands, mixing up of over burden/under burden material while mining the coal etc. Good mining and re-claim practices can minimize abnormal increase in the YGP index of the as fired coal in the power station.

B) IMPACT OF COAL QUALITY ON DESIGN

Furnace design

Satisfactory performance of boilers greatly depends on a fairly accurate estimation of furnace exit gas temperature. The furnace exit gas temperature prediction depends greatly on the estimation of the overall heat transfer in the furnace which in a pulverized coal fired furnace is complex. The main mode of heat transfer in furnace is by radiation and is entirely determined by the characteristics of the temperature field in furnace, the radiation properties of the flame and the fouling/slagging of water walls with deposits. Ash in the fuel affects the radiative properties of the flame and the condition of heat transfer on the walls of the furnace. Ash deposits on water wall tubes lead to a high thermal resistance due to low thermal conductivity of the layer. The radiation of the high temperature flame core is shielded to a great extent by a cooler wall gas layers leading to radiation suppression which lead to the reduction of the heat absorption and higher furnace exit gas temperature.

Another factor is the ratio of combustible matter (FC + VM) to non combustible matter (Ash + Moisture). The lower this ratio with in a coal rank, the poorer is the combustion behavior, since, for a given mass of fuel less amount of heat is generated and more amount of heat is spent on heating the non-combustible portion. This leads to lesser rate of heating up of the particle, lower peak temperature and increased time for burning. The increase in the gas temperature is due to decrease in the burning intensity in the furnace

caused by slow down of combustion or screening of the furnace walls from the hot centre combustion gases by an optically thick cold gas layer along the wall. Very high ash level decreases the combustion stability of coal and call for oil for stabilizing the flame.

In the combustion process, the coal particles are heated up rapidly in the initial phase leading to devolatilisation of the coal and rapid burning and heating up of the residual char + mineral matter content of the coal. This char combustion takes place at a relatively slower rate upto the end point of combustion. The stability of the flame front is dependent upon the amount of volatiles associated with the low temperature tar constituent of the coal.

Completeness of combustion is dependent upon the char burnout characteristics (principally decided by char porosity) of the coal under consideration. Both these factors are not clearly brought out by the Proximate Analysis results. Better understanding of the coal characteristics based on petrography, Thermo Gravimetric Analysis, etc help in estimation of furnace performance more accurately.

Superheater/Reheater/Economiser Design

Ash in Indian coal has a low tendency to foul due to the lesser sodium content ($< 2\% \text{Na}_2\text{O}$). The heat absorption in convective sections, especially in the second pass, is observed to be more than the prediction made by conventional methods of calculation due to the presence of high ash quantity in the gas stream. The erosion of tubes with high ash coals is of great concern. The material loss due to erosion is proportional to the total ash quantity and is an exponential function of flue gas velocity. The presence of huge silica and the alpha quartz content makes the ash very erosive in nature. Due to the high ash content in Indian coals, the flue gas velocity is reduced to lower level ($< 12 \text{ m/s}$) to reduce the erosion. The first tube of the bank heating surfaces facing the gas stream is provided with additional thickness to withstand erosion to some extent. Also a cassette baffle arrangement is provided between tube bends and the enclosure walls to avoid laning of gas and consequent erosion of tube bends in the second pass of the boiler. Screen tubes are generally protected with sacrificial sleeves where higher gas velocities are expected.

For most of the Indian coals, a furnace outlet temperature (typically Platen SH outlet temperature) of $1150 - 1200^\circ\text{C}$ is found to be optimum. In regions where the gas temperature is below this, the tubes can be kept at close pitching without the possibility of bridging between assemblies.

Pulverisers

Indian coal with low calorific value calls for huge quantity of coal to be ground leading to more no. of bigger size mills. The YGP index is used to estimate the wear life of mill wear parts. In addition to YGP index, other data like quartz in coal may provide additional insight into erosion potential of the pulverised coal and its ash.

Higher the rock/extraneous material content and its size in the incoming raw coal, lower is the wear life of pulveriser grinding elements as these higher density extraneous materials (quartz, clay, pyrites, etc.) do not leave the pulveriser until ground finer than the coal particles, thus causing the increased wear rate of the mill grinding elements and other mill wear parts. To obtain increased life of the wear parts, currently pulveriser designs incorporate special wear resistant features for the wear parts. Considering the medium volatile content and high inert (ash + moisture) content in the Indian coal, it is normal to adopt the pulverized fuel mixture temperature of $85 \text{ to } 90 \text{ Deg C}$ so that the tempering air

quantity is reduced resulting in higher heat pickup in the air heater and increased boiler efficiency. If the total moisture content of the coal is high, it will need high air temperature for drying the coal in the pulveriser. The amount of air needed is basically decided by the mill size and the mill loading adopted. If the coal is of low grade, then it may be worthwhile to lower the air coal ratio as far as possible and increase the mill inlet air temperature, so that the rate of heating up of the primary combustion zone (in which the quantity of primary air plays an important role) is enhanced. Total moisture content also affects the mill capacity beyond a particular value and different mill manufacturers have different criteria or guidelines on this issue. It is seen that the capacity drops when the moisture content of raw coal goes beyond 12% to 13%.

The number of pulverisers required depends on the calorific value, the mill capacity and the standby requirements.

Air heaters

Regenerative air preheaters are widely used owing to the compactness and better heat transfer efficiency. Air heater design has been constantly upgraded over the years to give satisfactory service with the highly erosive ash coals. The erosive nature of the ash will tend to reduce the seal life and cause increased leakage. Currently double seal arrangement is adopted in certain cases to reduce the air heater leakage.

Fans

The primary air (PA) requirement increases with low grade coals, thereby warranting bigger PA fans. Axial reaction fans are chosen for the PA application which gives higher efficiency over wide range of operating conditions warranted by the wide range coal quality. ID fans are provided with replaceable wear liners considering the erosive nature of ash in the flue gas stream. However with the continuous lowering of the particulate emissions that could be achieved by modern day dust collectors, the erosion in ID fans is becoming less severe. It should be possible to use ID fans of axial reaction type with clean flue gases, so that improved efficiencies and lesser power consumption could be realized.

Dust collector

Calorific value and the ash content of coal decide the quantum of ash that has to be handled. Electrostatic precipitator and bag filters can be efficiently employed for achieving the desired particulate emission limits. As the Sulphur in the Indian coals is less (approx 0.5 % only), the resistivity of the ash is higher calling for larger size of electrostatic precipitators.

C) IMPACT OF COAL QUALITY ON BOILER PERFORMANCE

The predicted performance of the boiler will coincide with the actual performance provided the coal fired resembled closely with the design coal and the operating conditions are maintained as per the suggested O & M procedures. However during normal operation of the plant the coal fired is likely to vary from the design coal. The boiler performance will obviously deviate from the expectation sometimes leading to higher SH/RH spray or shortfall in achieving the rated SH/RH steam temperatures and high airheater exit gas temperature etc. The wider the variation in coal properties from the design coal, the greater will be the deviation in boiler performance from the normal value. If the coal parameters are likely to change completely from the design coal for long duration, certain boiler modification may also be required.

D) COAL BLENDING

Coal blending in power stations is mainly adopted to improve the quality of coal being fired. The low-grade coals can be mixed with better grade coal without deterioration in thermal performance of the boiler. Coal blending can be carried out at different points along the transport chain: at coal mines, at coal cleaning plants or at power plants. At the power plant blending can take place in stock piles, bins, bunkers, on belt conveyors or in separate grinding mills.

Coal blend properties are calculated as weighted average of determined values for the individual coal used for blending. The volatile matter, moisture, ash, fixed carbon, carbon, hydrogen, sulphur, nitrogen, oxygen and maceral contents and heating values are additive. For blends between coals of widely differing ranks, the additive rule may not be 100% applicable for deciding the Volatile matter and ash content of blended coal based on VM and ash contents of constituent coals. Hence caution to be exercised while using additive properties of volatile matter and ash content. The ash fusion temperatures and Hard Groove Index are generally non-additive. Blending decisions should be based on the knowledge of the specific behavior of a given pair of coals, rather than an assumption of linear variation of properties with blend traction.

To decide to blend or not, it is very important to understand the composition of the coals that are to be blended. This means one will have to understand the origin of coal, the organic and inorganic chemistry of coal, and the behavior of the coals in questions. Some interaction between the constituent coals can occur, especially in petrographically heterogeneous coals or coals with different ash chemistry which may not be desirable.

It has been found from field data that even if the blended coal closely resembles the design coal for the boiler, the blend need not perform the same way. A blend that performs satisfactorily in one boiler will behave differently in another boiler of similar design, where operating conditions differ and in some cases, even in boiler of the same design blending can result in serious problems if the design coal and the coal use for blend are incompatible. This is mainly due to the transformation of inorganic particles during combustion and the way in which the organics are dispersed in coal.

Coals are blended to alter their chemical characteristics. During this process some of the physical characteristics become undesirable. Blending hard and soft coals will lead to difficulty in pulverization. The pulveriser performance is likely to follow the harder coal.

A limitation to blending coals is the compatibility of the coals themselves, and problems are more likely when blending petrographically different coals or coals with different ash chemistry. The presence of more inert macerals may reduce the combustion efficiency. Some combinations of coal ash can produce low melting eutectics, affecting the slagging and fouling behavior. Non-additive properties make blend evaluation for power generation inherently complex. More work is required on understanding how the inorganic components of coals in the blend interact and how it affects ash behavior including its emissivity, reflectivity, and thermal conductivity.

Generally as the sulphur content decreases, fly ash resistivity increases, thereby decreasing the ESP collection efficiency. Similarly a reduction in Fe_2O_3 , K_2O and Na_2O or increase in CaO , MgO and SiO_2 will increase the fly-ash resistivity, affecting the ESP collection efficiency.

Recommended Criteria for Blending

Blending decisions should be based on the knowledge of the specific behavior of a given pair of coals, rather than an assumption of linear variation of properties with blend traction.

- I. Firing of mix of coal either in the blended form or firing the individual coal at different elevation (co-firing) must be based on following coal characteristics guidelines.
 - a. The desired imported coal to be blended with Indian coal should be as closely as rank as that of Indian coal for which the boiler has been designed. Wider variation in the rank may lead to restriction in blending proportion.
 - b. The HGI of the two coals must be in the narrow range (less than 20). So that preferential grinding can be avoided.
 - c. The ash chemistry of the component coals must be compatible so that ash related problems like deposition (slagging and fouling) could be handled effectively. The blended coal with Iron/Calcium molar ratio of 1.0 may be avoided.
 - d. In order to reduce slagging, % CaO and Na₂O in ash of the constituent coals in the blend shall be less than 10% and 1% respectively. Similarly the % Fe₂O₃ shall be less than 7.
 - e. The raw coal size distribution for the two coals to be blended shall be the same.

Notes of Caution

- II. Since some of the combustion related phenomena like Milling, Ignition, Flame stability, Heat release rate, Char burn-out, slagging and fouling are non-additive characters, the overall boiler performance cannot be predicted from data of component coals. Only basic fuel properties like ash content, VM, Moisture, Carbon, Hydrogen, Sulphur of blended coal can be predicted from source coal data.
- III. Lab scale evaluation of blended coals could not always be extrapolated to field prediction. The difficulties in 100% perfect blending of raw coals similar to Lab scale blending, preferential grinding in the mill, differences in operating conditions of the boiler and testing conditions at lab could attribute to the difficulties in predicting the performance of blended coals. However, pilot scale evaluation provides useful information for prediction of combustion behavior of blended coal in field trial.
- IV. A blend should not be assessed on one or two properties alone. All aspects of a blend's behavior and its effect on all components of the power station, from the stockpile to stack, should be considered before the most appropriate blend composition is arrived at based on experience gained from through actual firing.
- V. A limitation to blending coals is the compatibility of the coals themselves; problems are more likely when blending petrographically different coals or coals with different ash chemistries.
- VI. The impact of blending coals of different hardness on the final size distribution and compositional distribution of the pulverized coal is still not understood.

- VII. Blending has to be done cautiously and observing the boiler for any adverse performance. The recommendations for one boiler for a particular Indian and imported coal combination are not applicable for other boilers with other fuel combinations. However, based on the feedback from earlier trials, a blend up to 20% of imported coal with Indian coal would not pose any major problem in the boiler.

E) Effect of Ash analysis on Coal Blending:

While coal blends containing coals of similar ash chemistry and rank have been successfully fired, coals with different ash chemistry or rank, when blended, the operational behaviour with respect to deposition is not understood in its entirety. Determination of when a particular blend of coals with the associated ash analysis will cause problem is extremely important. In this regard, the following guidelines shall be followed in respect of ash analysis of imported coals.

1. Base/ acid ratio < 0.4 ($= (\text{Fe}_2\text{O}_3 + \text{CaO} + \text{MgO} + \text{Na}_2\text{O} + \text{K}_2\text{O}) / (\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{TiO}_2)$)
2. Sulphur slagging index < 2 ($= \text{Base/ acid ratio} \times \% \text{ sulphur}$)
3. Iron calcium ratio < 0.3 ($= \text{Fe}_2\text{O}_3/\text{CaO}$)
4. Silica Alumina ratio < 2.8 ($= \text{SiO}_2/ \text{Al}_2\text{O}_3$)
5. Na_2O < 2.5
6. Fe_2O_3 < 15
7. Initial deformation Temp > 1150 Deg.C (In reducing atmosphere)

However the above traditional slagging indices relating to ash deposition have been found to be unreliable when applied to blends. Averaging the coal properties may not be adequate when interactions between the inorganic components of coals with different rank in the blend occur. For example blending coals with a high content of CaO or Alkaline elements to coal with acidic ash, aggravates the problem associated with slagging.

F) OPERATIONAL EXPERIENCE

There is a large variety of imported coal being fired in the country along with Indian coals. There is large variation in the properties and size of imported coal. Hence it is difficult to have a uniform guideline for firing blended coal.

For high volatile coal, there has to be extra caution in storage, milling and firing system to avoid fire and explosions. Suitable Mill inerting system has to be provided.

Coals with high fixed carbon to volatile matter ratio (more than 1.5) are generally difficult to burn completely. This results in higher unburnt fly ash and bottom ash. The boiler parameters and secondary air dampers have to be tuned to reduce combustibles in ash.

Blended coals have been fired by two methods:

- 1) Blending of coal (In Coal handling plant)
- 2) Bunker wise filling of coal(Independent mills for each type of coal)

1. OPERATIONAL EXPERIENCE OF FIRING BLENDED COAL (In Coal handling plant)

- Accurate blending ratio is needed with accuracy of 2%.
- 15% blending is always possible in existing boilers with no need for lab and site study. For higher % of blending (>15%), the lab study followed by field trails are must. The lab study should be done with various ratios of blended coal.
- Uniform blending shall be achieved by possible better methods to avoid localised higher % blending.
- Site trail in steps of 5% from 15 % blending (by heat input) shall be conducted with performance monitoring.
- So far 35% to 50% blending (by heat input) could be achieved.
- Normally more than 35% blending is not possible in the Boilers with Tube Mill due to minimum flow requirement of tube Mill and possibility of bypass mill air flow taking the powdered coal directly.
- Upto 50% blending is possible in the Boiler with Bowl mill based on VM and Moisture content of coals.
- The blending of coal calls for windbox damper setting adjustments based on field study.
- With blended coal firing, no control logic change is needed in Mill firing as the weighted average of blended coal VM shall not exceed more than 32%
- The requirement of LRSB operation in blended coal firing is essential in the platen SH and RH area.
- Blending of coal as mentioned above would be the preferred mode of operation. However, it requires additional facilities man power, space and time. Because of which it is not preferred at power stations.

2. OPERATIONAL EXPERIENCE OF FIRING BLENDED COAL(MILLWISE)

The present method of firing coal is to put it in one or two bunkers of a unit. Balance bunkers are filled with Indian coal. It is a combination firing with some elevations with Indian coal, one or two elevations with imported coal. This method is easy to follow as coal is received; it is fed into the bunker.

This model has been followed by several power stations up to 210 MW with bowl mill with no apparent problem. For tube mills, this method is not recommended due to chances of mill fire in idle mill

The potential areas of concern while firing imported coal are:

- 1) Fire in milling system, bunker and coal yard.

- 2) Slagging, heavy deposit in boiler
- 3) Ash build up and bridging of S-panel
- 4) Inability to achieve rated steam parameters
- 5) High RH & SH spray
- 6) High unburnt in fly ash and bottom ash
- 7) Corrosion

Anyone of the above can happen, so a watch on these issues has to be kept while firing blended coal.

Trials can be started with 5% heat value of imported coal. The quantity can be gradually increased in steps of 5% up to 20%. After prolonged operation with 20% blending if required the proportion can be increased further.

Conclusion

Blending of coals is expected to grow in the years to come due to shortage in domestic coal production. Since the combustion aerodynamic environments of a boiler furnace could not be simulated in a lab, the results of the laboratory experiments are to be carefully extrapolated and wherever required, more elaborate field trials are to be conducted.

Compatibility of coals for blending would have to be assured and blending with coals with large variation from design coal may pose performance problems. Lab scale evaluation of blended coals could be carried out to decide the limit of blending ratio. This could be followed by field trial starting from 10% of imported coal with incremental steps of 5%. Design elevation heat loading and/or minimum air flow limit the blending ratio. Adequate care should be exercised before increasing the percentage of blending to realize the benefits of coal blending.

While blending, it is necessary to ensure uniform blending to have homogeneous mixture of the two coals being blended and accordingly blending arrangements are to be done preferably in CHP.

Primary / Secondary air proportion needs to be adjusted during the trials to have better burner performance. Proper care is to be taken for storage of imported coal in yard to avoid spontaneous ignition if high volatile matter is present in the coal.

Central Electricity Authority
Office of Secretary (CEA)
2nd Floor, North Wing Sewa Bhawan
Ram Krishna Puram New Delhi-110066

No. CEA/TE&TD-TT/2011/F-901-111

Dated: 19th April, 2011

To

All State Power secretaries, Thermal Power Generating Cos./Project developers
and Manufacturers of large power boilers As per list

**Sub: Blending of imported/high GCV coal with low grade indigenous coal –
Design of new boilers for Blend Ratio of 30:70 imported/high GCV
coal: indigenous coal– reg.**

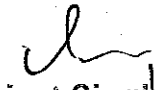
Dear Sir,

As you may be aware, there exists large gap between projected demand and supply of indigenous coal to keep pace with the large generation capacity addition programme in the 12th Plan and beyond. Imported coal is being used by several utilities and may continue, so as to bridge the shortfall in indigenous coal supplies to the coal based power stations.

Coal quality is a major input parameter for design of a power plant boiler. Large coal quality variations may not be readily accommodated in a plant and may also lead to loss of efficiency. It is thus considered prudent that all future coal fired thermal power stations to be set up in the country shall be so designed as to enable use of higher percentage of imported/high GCV coal as may be required.

Accordingly, all power generating companies, power project developers and power equipment manufacturers are hereby advised that for the purpose of design of boilers for all future indigenous coal based thermal power plants, a stipulation shall be made that the boilers (including auxiliaries) shall be designed for **blend ratio by weight of 30:70 (or higher) imported/high GCV coal: indigenous coal**. The station facilities shall also be designed for unloading, handling and blending of imported/high GCV coal.

Yours faithfully


(Amarjeet Singh)
Secretary CEA

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