BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION NO. 164/2018

(EARLIER O.A. NO. 276/2013)

WITH

EXECUTION APPLICATION NO. 22/2018

IN

O.A. NO. 276/2013

IN THE MATTER OF:-

ASHWANI KUMAR DUBEY APPLICANT(S)

VS.

UOI & ORS. RESPONDENT(S)

INDEX

NAZIMUDDIN
SCIENTIST -E
CENTRAL POLLUTION CONTROL BOARD
PARIVESH BHAWAN, EAST ARJUN NAGAR,
DELHI-110032

DATE: 28.02.2020
PLACE: DELHI

Report of the Central Pollution Control Board

(in compliance of Order dt 05.11.2019of Hon'ble National Green Tribunal, Principal Bench in O.A.164/2018 (Earlier O.A. 276/2013) Ashwani Kumar Dubey Vs. Union of India & Ors)

1. Directions to CPCB in Order dated 05.11.2019

Hon'ble National Green Tribunal in Original Application No. 164/2018 (Earlier O.A. 276/2013) - Ashwani Kumar Dubey Vs. Union of India & Ors passed Order dated 05.11.2019 which included various observation and directions regarding i) disposal of power plants' ash in mounds, ii) backfilling of power plants' ash in abandoned mines, and iii) de-silting and restoration of Rihand reservoir, as below:

> "Para 7: The matter has been put up today mainly for consideration of the report filed on 29.10.2019 by Justice Rajesh Kumar dealing with the issue of management of fly ash by thermal power stations and the damage caused to Rihand reservoir which is a source of water for operation of thermal power plants and other industries and also for drinking purposes by the inhabitants. The Committee observed that the capacity of the reservoir was reduced due to draining of effluents and fly ash which required **de-silting.**
>
> ...
>
> The Committee prepared its agenda on the subject (for meeting of the Committee held on October 22, 2019 at 11 AM in Circuit House at Prayagraj) as follows:
>
> ...
>
> 6. *To provide opinion about option of developing* ***mounds of Ash Dyke*** *as done by NTPC Thermal Power Plant, Dadri, where green cover has been developed by covering it with the top soil.*
>
> ...
>
> 8. *Preparation of DPR for project of* ***de-silting the Rihand Reservoir*** *and bearing of such expenditure by Thermal Power Plants of the area on polluter pay principle.*
>
> Para 8: The deliberations of the Committee have been summed up as under:
>
> *"Thermal Power Plants — Ash Utilization: ...*
>
> Para 9: In view of above, the Committee observed that the fly ash could be managed by developing a **fly ash mound.** The Committee has made following recommendations:
>
> *(1) All the Thermal Power Plants are directed to get their Fly Ash Dykes inspected by the* ***third party agencies*** *who are* ***Technical expert to certify that their Fly Ash Dykes are technically sound and structurally sustainable and file an affidavit*** *in this regard along with the certificate of the third party agencies.*
>
> ...
>
> *(6) U.P. Pollution Control Board under whose jurisdiction the Rihand Reservoir comes is directed to prepare a D.P.R. for* ***de-silting of Rihand Reservoir*** *for its restoration to its original form.*
>
> Para10. We are of the view that the recommendations on **the subject of development** of fly ash **mounds** and **filling up of abandoned mines** are issues which need to be examined by experts with regard to the safeguards necessary in the process, after studying the impact of environment. It is only after such a study that the development of mounds and filling up of abandoned mines can be undertaken. **If there are pre-existing guidelines of MoEF&CC/CPCB on the subject, the same may be followed.**

Para 11: As regards **de-silting of Rihand reservoir, the same needs to be undertaken on scientific basis** and cost recovered in the manner apportioned by CPCB. Apart from de-silting, structural improvement of the dykes needs to be simultaneously taken up. ... **The issue of developing fly ash mounds and filling up of abandoned mines may also be got examined by the CPCB** from its Expert Committee.

...

Para15: **The CPCB may give its reports on the subject of development of flyash mounts and back filling of the abandoned mines and also cost apportionment for de-silting and restoration of Rihand reservoir** preferably by 31.12.2019. CPCB will be at liberty to consult/associateany expert/institution for the purpose."

2. Pre-existing guidelines of CPCB on ash disposal in mounds

There already exist guidelines on disposal of power plant ash in mounds. CPCB in association with IIT-Delhi prepared and published these guidelines - "**Alternate Coal Ash Transportation and Disposal System for Thermal Power Plants**" in May 2003 (**Annexure-I**). Third and fourth chapters of these guidelines describes in detail various ash transportation systems from plant to ash disposal site and various ash disposal systems, namely ash disposal in ash ponds and **ash disposal in mounds**.

In case of transportation of ash from power plant to ash pond, the three options are – the Low Concentration Slurry Disposal (LCSD) in which the ash slurry contains only 10-15% ash by weight and the rest is water, the Medium Concentration Slurry Disposal (MCSD) in which the ash slurry contains 40-50% ash by weight, and the High Concentration Slurry Disposal (HCSD) in which the ash content can be in the range of 60% or more. Whereas, in case of transportation to ash from power plant to ash mound, dry disposal method is used wherein only small amount of water is sprinkled on ash just to keep the ash moist so that it is not air borne during transportation.

In sub section 4.4.4 of the guidelines the final closure and post closure stabilisation provisions for **ash mounds**, which include requirement of developing green cover, are described. Considering that the observation of the Oversight Committee in this regard is in respect of **ash ponds** of power plants around Rihand reservoir, it is submitted that in sub section 4.4.1 of the guidelines the final closure and post closure stabilisation provisions for **ash ponds**, which include requirement of developing green cover, are described.

3. Pre-existing guidelines of CPCB on backfilling of ash in abandoned mines

There already exist guidelines on backfilling of ash in abandoned mines. CPCB prepared thes guideline - "**Guidelines for Disposal/Utilisation of Fly Ash for Reclamation of Low Lying Areas and in Stowing of Abandoned Mines/Quarries**" in context of a reference from MoEF&CC and forwarded these guidelines to MoEF&CC in May 2019. MoEF&CC has issued an Office Memorandum date 28th August 2019 to stipulate special condition in the Environmental Clearances of Thermal Power Plants and Coal Mines that the guidelines prepared by CPCB shall be followed during disposal of ash in mines (**Annexure-II**).

In this context Hon'ble NGT has passed an order in O.A. 117/2014 also that "*CPCB Guidelines of May 2019 for Utilization/Disposal of Fly ash for Reclamation of Low Lying Areas and in Stowing/Back filling of Abandoned Mines/Quarries may be complied.*"

4. Cost apportionment for de-silting/restoration of Rehand Reservoir

The Committee headed by a retired judge of High Court observed in its report to NGT that '*the capacity of the reservoir was reduced due to draining of effluents and fly ash which required de-silting*' and desired that '*DPR for project of de-silting the Rihand Reservoir be prepared and such expenditure be born by Thermal Power Plants of the area on polluter pay principle.*' The said committee further recommended to NGT that '*U.P. Pollution Control Board under whose jurisdiction the Rihand Reservoir comes is directed to prepare a D.P.R. for de-silting of Rihand Reservoir for its restoration to its original form.*'

In consideration of the above Hon'ble NGT has observed that '*the de-silting of Rihand reservoir needs to be undertaken on scientific basis and cost recovered in the manner apportioned by CPCB*' and directed that '*CPCB may give its reports on ... cost apportionment for de-silting and restoration of Rihand reservoir preferably by 31.12.2019. CPCB will be at liberty to consult / associate any expert/institution for the purpose.*'

The possible causes of silting in the Rihand reservoir are-i) sediment loading due to natural phenomenon, ii) enhanced sediment loading in surface runoff due to coal mining activities in the area, and iii) the ash released with overflow of ash ponds or surface runoff from ash pond area of power plants over the years and the ash released during any ash dyke breach episodes.

The contribution of individual sources might be possible if distinct silt pockets in the reservoir could be found corresponding to effluent discharge points of individual sources. Since, any de-silting exercise will also involve disposal of huge quantity of the dredged material for which the contributors are proportionately responsible, a detailed study to assess sediment volume at various places in the reservoir seems necessary in the first stage, after which further decisions about de-silting may be taken.

UPPCB has informed CPCB that U.P. Irrigation Department has sent a proposal to U.P. Jal Vidyut Nigam Ltd. in June 2019 for Hydrographic Survey for Capacity Assessment of Rihand Reservoir by Central Water & Power Research Station (CWPRS), Khadakwasla, Pune for funding. However, it is observed that the proposal was for reservoir capacity assessment only. The comments received from CWPRS in this respect indicate a study for assessment of reservoir capacity as well as sediment volume will involve acoustic-bathymetry survey and inverse-resistive-profile sub bottom survey. Therefore a revised proposal for the study is required.

As regard contribution of power plants in silting, the actual contribution of each plant will depend on the actual ash pond overflow volume discharged (i.e. total ash slurry volume minus ash water evaporated and re-circulated) over the years and the average ash concentration in the ash pond effluent discharged, as well as the silt released with surface runoff and during any ash dyke breach episodes. In absence of verified records in these respects, an assessment of contribution of each plant by this approach is difficult. Therefore, the contribution of each power plant might also be revealed by the proposed study to assess sediment volume at various places in the reservoir.

To begin with, the total ash slurry volume generated by each plant on the periphery of Rihand reservoir can be considered as the basis of sharing of the cost of the study to assess sediment volume at various places in the reservoir. For this purpose, the information on annual power generation and coal consumption, average ash content, and annual ash generation as well as annual ash slurry generation based on ash to water ratio power plants located in the area surrounding Rihand reservoir has been collected from the power plants and collated (**Annexure III**). Total ash quantity and ash slurry volume generated over the years by individual thermal power plants located on the periphery of Rihand reservoir on the basis of information collected is presented below.

Table 1

Thermal Power Plant	Capacity (MW)	Total **Ash** Disposed in Ash Pond till 31.03.2019 (MMT)	Total **Ash Slurry** Disposed in Ash Pond till 31.03.2019 (MMT)	Relative share in Total **Ash** of plants (multiple of least)	Relative share in total **Ash Slurry** of plants (multiple of least)	Share in Total **Ash** of plants (% of total)	Share in Total Ash **Slurry** of plants (% of total)
Anpara TPS, UPRVUNL	2630	81.313	569.225	31.7	66.3	22.9%	19.6%
Lanco Anpara	1200	10.870	46.395	4.2	5.4	3.0%	1.6%
Renusagar, Hindalco	820	2.564	8.584	1	1	0.7%	0.3%
Singrauli NTPC	2000	89.295	803.654	34.8	93.6	25.1%	27.6%
Vindhyachal NTPC	4760	104.937	953.855	40.9	111.1	29.6%	32.8%
Rihand NTPC	3000	66.136	529.088	25.8	61.6	18.6%	18.2%
Total /Combined	12610	355.115	2910.801	138.4	339	100 %	**100 %**

It is submitted that U.P. Irrigation Department may be directed to coordinate the study to assess sediment volume at various places in the reservoir.

It is further submitted that Anpara TPS and Lanco-Anpara power plants may be directed to stop ash pond overflow discharge into Rihand reservoir.

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PROGRAMME OBJECTIVE SERIES :
PROBES/ 94 /2002 – 03

ALTERNATE COAL ASH TRANSPORTATION AND DISPOSAL SYSTEMS FOR THERMAL POWER PLANTS

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FOREWORD

Flyash, constitutes almost 80% of the total quantity of ash generated from the coal based power plant. Disposal of ash in the slurry form into the ash ponds has been a common practice adopted by the power plants. A study was commissioned by the Central Pollution Control Board to explore the alternate possibilities for ash transportation and disposal. This study was undertaken by a team from IIT Delhi and Flyash Technology Mission. The findings of the study indicate that Medium and High concentration slurry disposal systems have an added advantage over conventional low concentration slurry transportation and disposal system. The dry ash disposal in mound form is also an environment friendly option for locations where land and water are scarce. The study also points out that increased emphasis need to be given to promote utilization of ash in various activities such as the construction industry, roads, embankments, brick making etc. Utilization of flyash has added another dimension of handling it in dry form.

I would like express my sincere appreciation for the work done by the team of researchers comprising Dr. V. Seshadri, Dr. S.N. Singh, Dr. Manoj Datta, Dr. V. K. Agarwal, Mr. Vimal Kumar. My colleagues Dr. S. K. Paliwal, 'Sc B'; Sh. Lalit Kapur, SEE and Dr. B. Sengupta, Member Secretary coordinated the study.

We hope, the findings of the study will be useful for power generaters, regulatory agencies, academic institutions and others concerned.

(Dilip Biswas)

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CONTENTS

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Millions of tonnes of coal are burnt in thermal power plants across the world. Thermal power constitutes more than half of the world's electric power generation. The quality of the coal used varies widely from one country to another. It can vary with the location of the coal mine, and in some cases the quality of coal can vary between the upper and lower seams in a mine. This variation can be in terms of both the calorific value of the coal and the quantity of unburnt residue produced when it is burnt in a boiler. The quantity of ash generated, and its collection at various locations, is influenced by the ash content of the raw coal, the boiler operating conditions, the excess air used in the combustion process, and the soot blowing operations.

Large quantity of ash are thereby produced and the ash can have a wide range of properties as a consequence, both in terms of chemical composition and particle size. It is important, therefore, that any system built to convey this ash should be reliably designed to take account of the properties of the conveyed material. With most managers having a notion that the flyash has little or no commercial value, the design of such conveying systems is not always given the consideration that it deserves. A poorly designed conveying system can result in repeated plant shut down, with a very significant loss in revenue. With such a high production rate of ash, it is essential that the material is reliably and efficiently removed from the plant.

Handling, Utilisation and safe Disposal of flyash produced across 82 thermal power plants in the country poses a formidable challenge to the engineers associated with the power generation. At present coal is used as a fuel to generate close to 60,000 MW of power. It is estimated that these thermal power plants produce approximately 95 million tones of flyash every year. This is expected to go up to 125 million tones in next four to five years. Most power stations in India dispose off ash using wet slurry system. At present only about 13% of the generated ash is utilised for various applications. The remaining ash is stored either in the ash ponds in case of slurry disposal or in the form of ash mounds, if the ash is disposed off dry. It is estimated that about one to one and half acre of land is required for the ash pond area for every MW of power generated. Large area of land and enormous quantity of water is used at present to dispose off ash in the wet form. Lack of proper maintenance of ash ponds can also cause serious environmental hazard. Moreover, recently due to the thrust on utilisation of ash, the power plants are going in for the pneumatic conveying systems to handle flyash in dry form. As such there are several technological options that are currently used by the power plants to handle and transport the coal ash.

1.2 SCOPE OF THE STUDY

The broad objectives of this study are as follows:

1. Evaluation of existing conventional practices of coal ash disposal based on dilute slurry disposal taking into consideration the water and energy requirements per tonne of flyash disposal. Since the distance of the ash pond from the plant would vary from one location to another, typical cases would in terms of conveying distance would be considered. This would also include the cost of the installation of the systems.
2. Evaluation of alternative ash disposal systems such as: disposal of ash in dry form as mound and disposal of ash into the ash pond in the form of high concentration slurry.
3. Comparison of dilute slurry system with alternate ash disposal system. This would include the cost factors relevant in each case and any other facts that need to be considered.
4. Cost related to operation, maintenance and environmental aspects of ash ponds / ash mounds for various disposal systems would be considered on the basis of the information provided by the thermal power plants.
5. Recommendations about the most desirable combination of slurry disposal alternatives.

During the course of this study extensive discussions were held with the concerned engineers from a number of thermal power plants (TPP). Manufacturers of ash handling systems were also consulted to get their feedback about the various methods of ash disposal and their economics. In addition, latest trends reported in the literature were used as an additional source of reference while analyzing the information collected from other sources. The outcome of this study are discussed and reported in the following sections of this report.

CHAPTER 2

ASH GENERATION, COLLECTION AND REMOVAL IN THERMAL POWER PLANTS

To put the discussion in the following chapters in the right perspective, it is important to briefly discuss how the ash is generated in the power plant, how it is collected and what are the important properties of flyash that would require some consideration in its transportation.

2.1 BOTTOM ASH

The coal in the "As Received" condition is first pulverised in grinding mills to obtain Pulverised Fuel (pf) or Pulverised Coal. During the burning of the coal, glassy droplets of ash are produced. Some of these particles impinge on the furnace wall, and at high temperatures the particles can fuse together to form deposits of slag. Build up of thick layers of ash on a furnace wall increases resistance to the heat transfer process, thus reducing the thermal efficiency of the boiler. In order to minimise the effects of the ash build up, these deposits are periodically blown off by soot blowers. The dislodged lumps fall into the ash hoppers at the bottom and this is generally referred to as Furnace Bottom Ash (FBA) or simply Bottom Ash.

2.2 FLYASH

The finer particles of ash are carried away with the flue gases and get collected at several locations between the boiler and the stack. This ash is commonly referred to as Pulverised Fuel Ash (PFA) or simply Fly Ash. The coarser fraction of this ash is collected in the economiser, air pre-heater and duct hoppers. The finer fraction, and generally the largest percentage, is collected in the electrostatic precipitator (ESP) hoppers.

The FBA constitutes about 10 to 15 % of the total ash and consists of very coarse particles and large lumps. The remaining 85 to 90 % (fly ash) is generally much finer, typically having a mean particle size varying from about 120 micron in the economiser hoppers to about 20 micron in the ESP hoppers. Figure 2.1 shows a typical layout of the ash collection points, and approximate percentages of ash collected at each location. The temperature of the ash also decreases as the point of collection moves away from the furnace.

The quantity of ash produced depends principally upon the quality of the coal used. It is further influenced by the combustion process in the boiler, and other operating variables, as mentioned above. An inefficient combustion process, for example, may result in a high level of unburnt carbon in the ash produced. Carbon in ash gives it a dark colour, and as a result the ash could become unsuitable for certain applications. The ash content in superior grades of coal can be as low as 6 to 8 %, but can be as high as 55 % in poor grades.

2.3 PROPERTIES OF FLY ASH RELEVANT TO ITS TRANSPORTATION

It is important that the properties of any material that has to be conveyed should be taken into account, and that any variations in properties that are likely to occur, from any source, are also allowed for. The chemical composition of coal, and hence of the resulting ash, will vary both globally and locally. This will also influence particle and bulk density. Particle size will vary with respect to the location of the ash hopper on the boiler plant, as well as the air flow settings on the coal grinding mills. Particle shape will be influenced to a certain extent by changes in the combustion process.

2.3.1 Typical Ash Composition

Silicon oxide and aluminium oxide are two major components in the chemical composition of fly ash. The percentage of silica can be as high as 65%, and alumina can vary between about 15 and 30 %. Both alumina and silica are very hard materials, having a hardness value close to 8 on the Mho scale of hardness. It is because of the high concentration of these constituents in fly ash, it is very abrasive, and can cause erosion of ash conveying plant components, and thus require additional measures to control the rate of erosion. The composition of a typical fly ash is given in Table 2.1.

Table 2.1: Chemical Composition of a Typical Fly Ash

Oxides	As Received	As Received
SiO_2	65.1	65.0
Al_2O_3	25.1	17.6
Fe_2O_3	4.2	1.8
CaO	1.4	4.5
MgO	0.4	2.0
TiO_2	1.1	N.A.
Na_2O_3	0.5	N.A
K_2O	1.8	N.A.

In some cases the ash may also contain trace elements. The ultimate safe disposal of such ashes may require additional measures to be taken to prevent contamination of the soil, based on the level of presence of these elements and their leachability.

2.3.2 Size Distribution and Temperature

As the flue gases pass through the boiler ducting before being discharged out of the chimney, ash is collected at several locations along its route. The particle size of the fly ash decreases as the distance of the collection point from the boiler combustion zone increases. The ash is first collected in the economiser hoppers, and the air pre-heater hoppers, before it enters the series of electrostatic precipitator hoppers. ESP's charge the dust particles and use electrostatic attraction to remove approximately 99.8 % of particles from the flue gas. About 85% of the total ash is carried with the flue gas (that means excluding the bottom ash) and is collected in the economiser, air preheater and ESP hoppers.

The average or mean particle size of the ash particles collected in the economiser and air pre-heater hoppers is about 120 and 100 microns respectively. The size of the ash particles collected in the ESP hoppers, however, is much finer. Within the various zones of the electrostatic precipitator, ash collected in the initial rows of hoppers (Field 1 onwards), in the direction of the gas flow, is of a higher average particle size as compared with the ash collected in the last row of hoppers. Although the particle size of the ash collected in the ESP hoppers will vary from plant to plant, typical values of the particle size of the ash collected in the ESP hoppers of a typical 210 MW generating unit are given in Table 2.2. Typical values for the temperature of the ash are also given for reference.

Table 2.2: Particle Size Distribution and Temperature of Ash Collected at Various Locations

Ash Collection Point	Economiser	Air Pre-Heater	Electrostatic Precipitator	Stack
Ash Particle Size	Less than 750 μm Mean Particle Size of 120 μm	Less than 750 μm Mean Particle Size of 100 μm	Larger than 100 μm = 2 to 20% Less than 100 μm = 80 to 98% Less than 80 μm = 75 to 97% Less than 60 μm = 70 to 96% Less than 40 μm = 60 to 90% Less than 20 μm = 40 to 80% Less than 10 μm = 25 to 65% Mean Particle Size of 25 μm	Very Fine
Ash Temperature	300 °C	250 to 300 °C	130 °C	<100 °C

Bottom ash consists of large lumps which are generally crushed to a smaller size before being mixed with water to be disposed off in slurry form.

2.3.3 Particle and Bulk Density

In the case of materials that have to be handled in a large quantity, bulk density can be an important variable to consider. Since bulk density takes into consideration the particle density and voids in bulk storage, it is a useful parameter for the sizing of various system components. Particle density will influence the slip velocity when the material is conveyed pneumatically through pipelines in two phase flow. It is important, therefore, to have an idea of the typical range in which the particle density and bulk density of fly ash can vary. Most fly ashes have a bulk density of about 720 kg/m^3 and a particle density of around 1800 - 2200 kg/m^3.

2.4 ASH COLLECTION HOPPERS

Since close to 75 % of the total ash produced in the combustion process is collected in the ESP zone, it is important to consider the layout of these ash collection hoppers. The electrostatic precipitators have several fields and each field has a number of collection hoppers. A 210 MW generating unit will typically have six fields and eight hoppers in each field, thus making a total of 48 ash collection hoppers. A sketch showing the layout of a typical group of 24 such ESP hoppers, and the direction of the gas stream, is given in Figure 2.2.

The first field hoppers have the highest ash collection rate, which may vary between 70 and 80 % of the total ash entering the ESP zone with the flue gases. The percentage collection of the residual ash in subsequent fields is also of the same order. The ash collected in the hoppers of field 3 and onwards is thus very minimal. If, during a failure, field 1 is not operational, the field 2 hoppers would have the same collection rate as the field 1 hoppers in normal operating conditions. The capacity of the ESP hoppers is generally selected so that they are capable of storing as much ash as is generated in 24 hours of plant operation. The design of the ash handling system has to consider the time cycle for the ash evacuation, keeping in view the differences in ash collection rate in various hoppers.

2.4.1 Off-Loading Arrangements

The removal of ash from the ESP hoppers can either be in a direction parallel to the gas flow, as shown in Figure 2.2, or across the direction of the gas flow. In the first case hoppers of various fields will be connected to each other so that the ash collected in the receiving silo will have a mixture of coarse and fine ash from fields 1 to 6. In the latter option, the hoppers of a particular field will be interconnected thus making it possible to keep the coarse ash of the initial two fields separate from that of the very fine ash of subsequent fields. It is thus possible to collect fly ash from the last few fields for applications requiring finer grade. In the case of the cross direction ash evacuation arrangement, however, the loading on the ash removal system would be non - uniform due to the large differences in the ash collection rate in the hoppers of the various fields. This factor must be taken into consideration when designing the ash removal system for such an arrangement. The choice of system depends largely upon the end utilisation of the ash and the ESP plant layout.

2.5 ASH REMOVAL SYSTEMS IN THE PLANT

The selection of an ash removal system within the plant depends upon the nature of the ash, the quantity of ash to be handled, and if the ash has to be graded for the end utilisation. Possible ash removal systems include mechanical, hydraulic and pneumatic conveying systems. Mechanical systems are used only is very few power plants (like captive power plants) and hence only the hydraulic and pneumatic conveying systems are used more extensively.

2.5.1 Hydraulic Conveying

Conventional hydraulic conveying systems are widely used for the disposal of ash into ash ponds. Ash is discharged from the various ash hoppers, mixed with water and transported through open channels or closed pipes into the ash sump. From the sump, the ash is conveyed in slurry form to the ash ponds, which could be located up to several kilometres from the plant. In India, where ash generation is so enormous, and applications for utilisation not fully explored, handling of ash in the form of slurry is still practised at most power stations. The recent trend worldwide is to go in for high concentration (up to 70 % ash) slurry instead of dilute slurry having only 10 % ash content. Such high concentration slurry should result in considerable savings of water and specific power consumption

Environmental problems associated with ash ponds in many countries, however, are starting to have an impact on the viability of this method of disposal. Legislation is also coming into force in a number of countries, which is setting gradually increasing targets for the practical use of fly ash, with the aim of reducing the quantity of ash that has to be disposed off. For most applications, the ash must remain dry and hence this is necessitating the use of pneumatic conveying systems.

2.5.2 Pneumatic Conveying

Pneumatic conveying systems offer an ideal choice for the handling of fly ash in dry form. Although in some cases for utilization, the mixed ash from ash ponds can be used, for most applications it is desirable to convey dry fly ash. Pneumatic conveying systems broadly fall into two categories: the suction system and the pressure system. Air slides can be considered as an extreme form of pneumatic conveying wherein very high material transfer rates can be achieved by employing the advantage of gravitational flow aided by artificial fluidisation of the material.

An overview of the systems available to convey fly ash has been presented by Harder. Figure 2.3 shows some possible alternatives that can be used for the transportation of ash. Typical values of the conveying parameters associated with these systems are also marked against them. Each system has its own limitations in terms of the conveying air velocity, the maximum achievable pressure drop, distance of conveying, and the concentration, or solids loading ratio, at which the material can be conveyed.

Vacuum or suction type systems generally require a high conveying line inlet air velocity and the maximum permissible pressure drop is typically restricted to about 0.5 bar gauge. These are well suited, however, to situations requiring multiple point pick up of the material, as in case of the evacuation of ash from ESP and other ash hoppers. The distance of conveying, however, is restricted due to the limitation on the pressure drop.

Positive pressure pneumatic conveying systems are now widely accepted for conveying fly ash at power stations. Depending upon the specific application, either dilute phase suspension flow systems or dense phase low velocity systems can be used. Several operating parameters have to be considered in making a judicious choice of the system most appropriate for a given application. The major advantage of positive pressure systems is that since high pressures can be employed for the conveying system, it is possible to convey the material over long distances. A good number of pneumatic conveying systems are in use at power stations where the conveying distance exceeds 1000 m and can go up to a maximum of 2000 m.

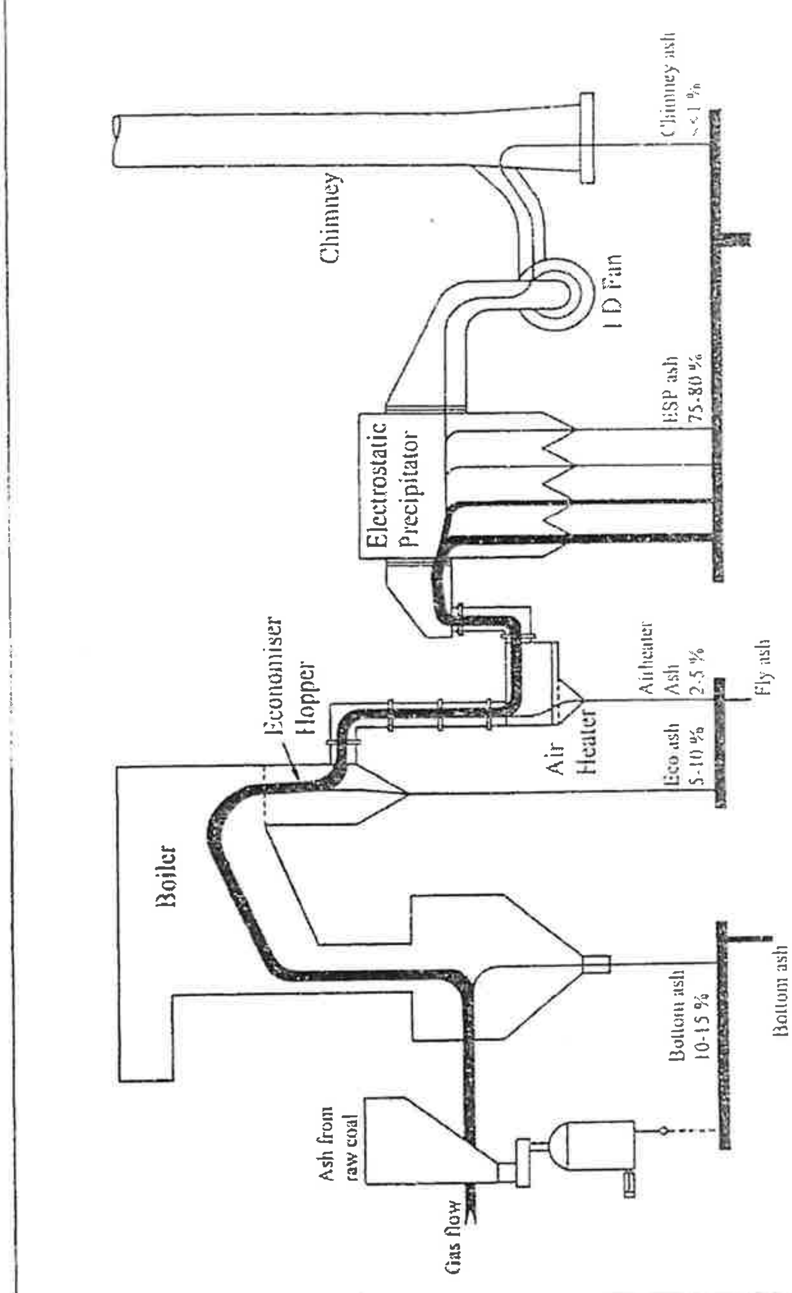
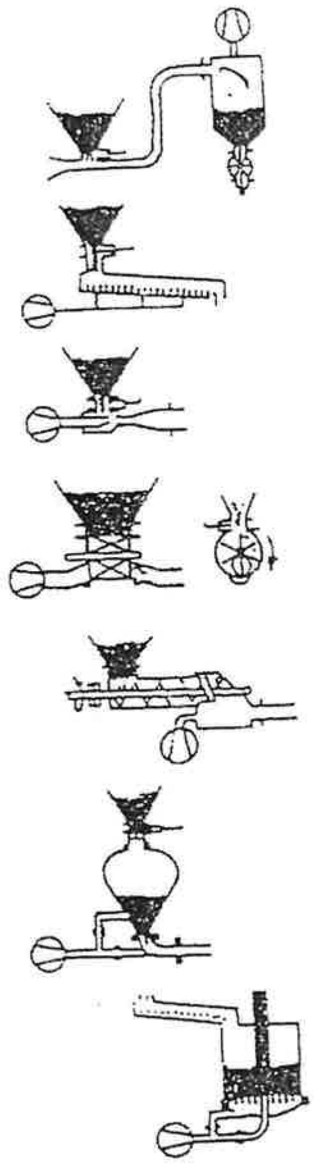


Figure 2.1: Ash Accumulation Points and Typical Ash Distribution of a Dry Bottom Furnace

Pneumatic ash removal systems



Pneumatic ash removal systems	Conveying parameters: ϕ kg/kg	ΔP_{max} bar	L_{max} m	m_{max} t/h
Suction Conveyor	20	0.5	100	100
Airslide	300	0.05	100	400
Jet feeder	5	0.2	75	5
Air-lock feeder	30	0.75	150	40
Screw pump	80	1.5	80	200
Pressure vessel	200	6.0	2000	150
Airlift	25	0.5	100 Vertical	100

Figure 2.2 : Pneumatic Ash Removal Systems with Conveying Parameters Indicated

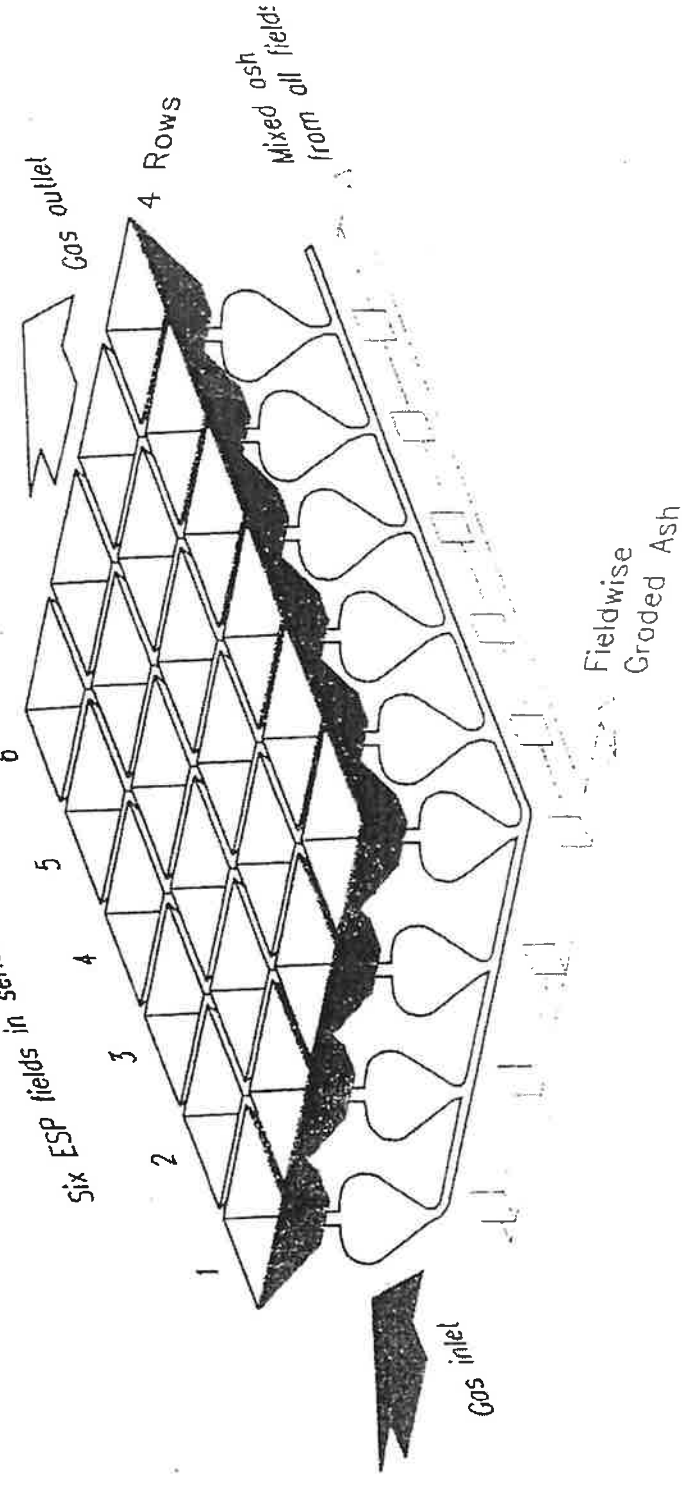


Figure 2.3 : Ash collection of ESP

CHAPTER 3

ASH COLLECTION, REMOVAL AND TRANSPORTATION

3.1 ASH REMOVAL SYSTEMS

It was explained in the last chapter that the coal ash gets collected at various locations within the boiler plant. The quantity of ash collected and its properties also vary from one location to another. The selection of an ash removal system depends upon the nature of the ash, the quantity of ash to be handled, and if the ash has to be graded for the end utilisation. Possible ash removal systems include mechanical, hydraulic and pneumatic conveying systems. Mechanical systems are not so widely used. At present most power plants use slurry conveying for handling different grades of coal ash. Pneumatic conveying systems have been recently introduced for dry flyash collection; primarily for the ash collected in the ESP hoppers. In the following section, present practice of ash evacuation within the power plant will be discussed.

3.2 HANDLING OF BOTTOM ASH

Bottom ash constitutes about 10-15% of the total ash produced in a thermal power station. It mainly consists of large lumps. It is, therefore, first crushed in a crusher into smaller size fractions. Even after crushing, the bottom ash would have coarse particles of size less than 25 mm and hence it is feasible to convey them only hydraulically in the form of a slurry. The crushed bottom ash gets collected in the bottom ash hoppers and they are evacuated from these hoppers using jet pumping technique. In this process, high pressure water is used to convey the bottom ash through a pipe line. This slurry can be delivered either to a sump or directly to the suction of a slurry pump for onward transportation to the disposal site. In some cases where bottom ash is to be disposed in semi dry form the bottom ash slurry is delivered to hydro bins from where water is removed by decantation. The wet bottom ash is then transported to the disposal site by belt conveyors. Not many such systems, however, are in use at the power stations. It is to be noted that bottom ash is usually a very coarse material, which would settle down quickly. It is not a very suitable material to handle it through a pneumatic conveying system. It can also be used as a construction material very effectively.

3.3 HANDLING OF FLY ASH

The flyash is collected in a number of ESP hoppers arranged in several fields. It requires handling in two stages. First the material has to be evacuated from all the hoppers and then further conveyed to a common reception point. The various locations where this fine ash gets collected; decreasing in mean particle size from the first to the last location, are as follows:-

a) Air pre heater
b) Economiser

c) Electro Static Precipitator (ESP) Hoppers
d) Chimney

The fly ash that gets collected in `a' and `b' is usually coarser whereas the fly ash from the last two sources are much finer. For this coarse ash, there are two possible routes for its handling. It can either be conveyed hydraulically to the sump along with the bottom ash or it can be transported in dry form through the same pneumatic conveying system that is handling flyash. Fly ash from the above sources can be evacuated either hydraulically or pneumatically. At present, both these methods are used in the Thermal Power Plants.

3.3.1 Hydraulic Method of Evacuation of Fly Ash

In this method, hydro ejectors are used to evacuate fly ash and convey the fly ash slurry to a sump for onward transportation to the disposal site. Normally, a large quantity of water is needed to evacuate fly ash and hence the concentration of fly ash in the slurry will be usually low. Alternately, fly ash is also evacuated by gravity method into an open channel and the ash is transported to the sump by using water jets placed at different points in the channel.

3.3.2 Pneumatic Method of Evacuation of Flyash

In this method, ash is transported in dry form through a pipeline using air as the carrier. Both positive and negative pressure systems are used to evacuate ash from the ESP hoppers. There are two major modes of flow of the material in the pipeline: one is the dilute phase suspension flow and another is the dense phase non suspension flow. The choice of a particular mode of flow is influenced by the material properties and the conveying conditions. It is beyond the scope of this report to discuss these issues in detail.

Normally, the ash is first collected into an intermediate/buffer silo. From this silo, if wet disposal is to be adopted then a slurryfier will make fly ash slurry and transport it to the sump. However, if dry disposal is to be followed, then the ash can be delivered from this silo directly to the users if they are already identified. Ash can be loaded into trucks using bags of different sizes. If the user is a bulk user then the fly ash can be transported to another silo for utilization by the user agency. If ash is not being fully utilized, then the ash from intermediate silo is transported to disposal silo from where it is subsequently transported to disposal site.

In some cases the vacuum needed for evacuation of fly ash pneumatically is created by hydro vectors in which the ash evacuated is automatically mixed with water to form a slurry which is then transported to a sump for further disposal.

Many power plants have modified the existing slurry evacuation systems to dry evacuation of ash from the ESP hoppers into an intermediate silo. Atleast in one of the generating units at a plant, the ash is further transported in dry form to another silo which is located outside the plant boundary. This facilitates availability of dry flyash to the bulk users.

3.4 ALTERNATIVES FOR ASH TRANSPORTATION FROM THE PLANT TO THE DISPOSAL SITE

The need for dry flyash handling for utilization in various applications has been highlighted in some of the earlier sections. The ash, which is not utilized, must be disposed off and stored properly so that it is structurally safe and does not cause any environmental hazard. At present, ash is either stored in ash ponds or in an ash mounds. The various methods that are used to transport ash from the Thermal Power Plants to the disposal site can be classified into following two broad categories:

a) Wet Transportation for disposal in ash ponds and mounds
b) Dry Handling for disposal as Ash Mounds

Except for one power station, the ash is transported from the plant to the pond in slurry form for deposition into the ash ponds. Some experience has been gained in dry deposition of ash in the form of ash mounds but this practice is not widely accepted due to additional handling equipment required to move the ash from one location to another. In case of slurry transportation, the ash discharge location can be easily altered by repositioning the pipeline outlet.

Usually the ash pond is located a few kilometers away from the power plant. In most cases this distance is in the range of 3 to 15 kms. The design of the slurry pipeline must consider all the operational parameters such as the distance of the pond from the plant, the water to ash ratio or the concentration and the ash discharge rate required. This design must also respond to the requirement of safe management of the pond. Various alternatives available for transportation of ash from the power plant to the disposal site would be discussed in the following sections. These would include slurry transportation at varying concentrations and dry handling of ash for storage as ash mounds.

3.4.1 Transportation of Ash in Wet Form

In this method, ash is transported to the disposal site through a pipeline in the slurry form. Depending on the level of concentration of ash in the slurry, this method can be further classified into three categories as follows:

a) Low Concentration Slurry Disposal (LCSD)
b) Medium Concentration Slurry Disposal (MCSD)
c) High Concentration Slurry Disposal (HCSD)

3.4.1.1 Low Concentration Slurry Disposal (LCSD)

In this method, centrifugal type of slurry pumps are used to pump the ash slurry through the pipelines. Depending upon the head requirement, number of pumps can be operated in series to generate the required head. Centrifugal slurry pumps are similar in construction to ordinary centrifugal pumps except they have to be designed specifically to handle solid particles without choking and also wear resistant surface are provided in the wetted portion of the pumps. At present, this method is by far th most widely used method of ash transportation in the existing thermal power plants Since the ash slurry that gets collected in the sump is already having lo concentration, the concentration of ash in the pipelines will also be low. The norm range of ash concentration is approximately 10-15 % by weight (5 to 8 % by volume Some times, the concentration of solids is even lower particularly when the plant i not working to full capacity. In such cases, make up water is added to keep th pumps operating optimally.

In most of the Thermal Power Plants it is usual practice to use the same pumps an pipe lines for disposing both fly ash and bottom ash slurries. Hence, the design ha to be highly conservative and consequently the system will be very inefficient fron the point of view of energy consumption.

3.4.1.2 Medium Concentration Slurry Disposal (MCSD)

Medium concentration slurry has been defined as the slurry which contains ash ir the range 40-50% by weight. This has been dictated by the limiting capacity o conventional centrifugal slurry pumps. This means that apart from the Low concentration slurry, the centrifugal pumps can be used at relatively highe concentrations, termed as the medium concentration slurry. The various investigations in the laboratory and pilot plant level have shown that this method has some major attractions over LCSD. However, at present we do not have sufficien field data on this method of transportation since it is not in use at the power plants.

3.4.1.3 High Concentration Slurry Disposal (HCSD)

In this method, the concentration of ash will be in the range of 60% by weight or above. Thus, the slurry will be in the form of highly viscous and non-Newtonian fluid. Further, at very high concentration it can even be in the form of a paste. Special types of pumps are required to transport this slurry at these concentrations. Some of these pumps are reciprocating pumps, diaphragm type of pumps, progressive cavity pumps etc. Most of these pumps are positive displacement type and can generate high heads required for transporting thick slurries. Although, this method has been used in some cases abroad, experience with the Indian Coal Ash for such disposal systems does not exist at present. However, from the point of view of economy and energy consumption this method is expected to be quite attractive.

3.5 DRY METHOD OF DISPOSAL

In this method, the ash from the disposal silo is transported in the dry form to the disposal site. For this purpose, a chain/belt conveyor, trucks / dumpers could be used and during transportation water is sprinkled over the ash in order to avoid air pollution. The ash is then disposed off to an ash mound where ash is to be stacked and stored properly. A range of mechanical handling equipment are used to move the ash and lift it to make the ash mounds. Movement of large quantity of ash in involved and this must be investigated together with the requirement of stability of the mounds.

3.6 ECONOMICS OF PRESENT DILUTE SLURRY HANDLING PRACTICE

As mentioned earlier most plants evacuate ash from the collection points in the form of slurry and transport it further from the sump to the pond in dilute slurry having a maximum ash concentration of 20 - 25% by weight. The transportation of ash from the boiler and other collection points to the sump is usually within a distance of about 200m at most power plants. The distance of the ash pond from the plant could, however, vary significantly. For new units or if the old units require a new site for the ash pond, the distance of the pond from the plant is usually large. At one of the power stations, ash is conveyed over a distance of around 13 km from the plant to the pond. This plant has two units each of 500 MW.

The capital cost, including mandatory spares, of a slurry handling system; both for evacuation of ash from the collection points and its transportation from the sump to the ash pond comes close to around Rs.70 crores for a generating capacity of approx. 1000 MW. The operation and maintenance cost would take into consideration the following:

- Cost of water consumed
- Cost of power consumed in pumping the slurry and the repumping the overflow.
- Manpower associated with the operation and maintenance.
- Spares and consumables required for the operation of the system.

Water and electricity charge would be most influenced by the type of the slurry handling system adopted. Other costs would not be influenced to similar extent. Generating units having a capacity of 1000 MW at this plant is considered as per the design to generate about 8500 tonnes of flyash and bottom ash per day. To convey around 8500 tonnes of flyash and bottom ash (design capacity taking the case of worst coal) from plant to the pond located at a distance of about 13 km, the rating of the motors installed on the pumps (working as well as standby) is close to 4500 kw. At 25% concentration, for every tonne of ash, three tonnes of water would be required. For 1000 MW generation and 8500 tonnes of flyash and bottom ash generation, the plant would require approx. 1200 cubic meter per hour of water for ash disposal. Pumping of slurry at higher concentration would result in savings of both power and water.

3.7 EVALUATION OF VARIOUS METHODS OF ASH REMOV TRANSPORTATION

In the preceding sections, several methods of ash handling and transportation w discussed. At some stations, the total ash handling viz. evacuation and disposal is wet form while many other plants employ a combination of dry and wet handling. the latter case, the evacuation of economiser, air preheater and ESP ash is dc using either a positive or negative pressure pneumatic conveying system. T bottom ash is invariably handled in wet form. There is, however, one power plant NTPC where complete ash handling and disposal in done in dry form. Only bottom ash is pumped hydraulically upto the hydro bins. The water is drained out the hydro bins and is recirculated into the conveying system.

In case of wet systems, one major issue of interest is the ash concentration of t slurry and hence the requirement of land and water. Apart from some plants, t slurry conveying system at most power stations is done in a highly conservat manner. The concentration of ash in the slurry is in the range between 10% to 15 by weight. Scarcity of land and water coupled with environmental issues forced t plant managers to explore the potential of utilisation of ash and to improve upon t existing technology and practices in ash disposal. Due to limited data available abc the variety of ash handling and disposal systems in use, it would not be possible compare them quantitatively. In the following sections a comparison of vario alternatives will be discussed on the basis of factors affecting the selection process

3.7.1 Slurry vs Dry Handling and Transportation

Handling and transportation and disposal of total coal ash in dry form is a tota different technological option as compared to the conventional wet handling a slurry disposal into the ash lagoons. In case of complete dry handling and dispos system, the ash is conveyed and handled using pneumatic conveying systems anc range of mechanical handling equipments such as the belt conveyors, dumpers a dozers etc. The ash is discharged on the ground in dry form and is prevented frc flying off by employing water sprinklers to keep its top surface wet. The ash is th pushed in the form of hillocks or the ash mounds as they are called. This requir additional heavy machinery which can be used to reach the top of these mounc Some of the major advantages of such a system are as follows:

- The water consumption is significantly reduced except for handling bottc ash upto the point from which it can be mechanically transported with oth grades of the coal ash.
- The land required for making a dry mound would be significantly lower th the area of ash pond required to dispose off the same quantity of ash.

Over the life cycle of the plant these benefits would translate into substant economic savings. There are, however, some negative factors associated with complete dry ash handling system. Some of these are:

- The capital cost of a complete dry ash handling system can be about 50-60% more in comparison to a conventional slurry disposal system
- The operation and maintenance cost of ash transportation and ash mound would increase as the distance of the ash mound from the plant increases. In case of slurry disposal system, the distance has only a marginal influence on this cost.
- Very high skills are required to design conveying systems for various grades of coals ash in dry disposal.
- The behavior of the ash mounds in the post abandonment period is not yet fully understood.

Although a complete dry ash handling system may appear to be a more preferred alternative, most power stations and the equipment suppliers would be more comfortable with a dry evacuation and slurry disposal system. This is largely due to the long experience in dealing with such systems and availability of historical data on operation and maintenance of such systems.

3.8 TECHNOLOGIES FOR ASH REMOVAL WITHIN THE POWER PLANT

The ash is collected at various locations between the boiler and the chimney. The properties of ash collected at every location differ widely and thus it is expected that different technologies would be adopted to evacuate ash from these locations. Bed ash or the bottom ash is invariably handled in wet form and will continue to be handled the same way because of the large sized lumps involved in this type of ash. The bed ash after passing through the grinders is hydraulically conveyed through the channels to the ash sump. It is felt that the design of the hydraulic system to handle bottom ash is very inefficient at many power stations and there is a possibility to further improve it by increasing the concentration of the ash slurry. This would result in lower specific energy consumption.

The ash collected in the economiser and air preheater hoppers is coarse having a mean particle size of about 120 microns. This is suitable to handle both in slurry as well as dry form. In case it is intended to handle it in dry form through the pneumatic conveying system, two options would be available. The first is to have a separate pipeline to convey this ash and another pipeline to convey the ESP ash. This is necessary because the conveying performance of the economiser and ESP ash are totally different. The economiser ash can only be conveyed in dilute phase suspension flow in a conventional pneumatic conveying system. A minimum pick up velocity of about 14 m/s is essential to convey this grade of ash while the ESP ash can be successfully conveyed in dense phase at a pick up velocity of around 4 m/s. The second option is to use a smaller bore pipeline during the initial conveying length and then merge it into the larger bore line suitable for conveying ESP ash.

The disposal of this ash through the slurry system is also practiced at most power stations. It is pumped to the sump, where it gets mixed with other grades of ash before being pumped to the ash pond. Both bottom ash and the economiser ash are very abrasive and thus it may be useful if these two grades of ash are pumped separately from the ESP ash. Apart from the difference in the design of the slur system, the erosion of the pipeline will also be different in the two cases and henc may optimise the period of replacement of the pipeline. Unless this grade of ash required for any specific utilization purpose, it may be easier to handle it along th slurry route.

3.9 ASH TRANSPORTATION FROM THE PLANT TO THE POND

Ash collected within the plant can either be disposed off in dry form to form th mounds as mentioned earlier in this chapter or can be hydraulically pumped to th ash pond. The merits of dry disposal were discussed above. Most power station discharge the ash into the ponds by pumping it in the form of a slurry. There exist an urgent need to improve the methods of design so that saving in energy and wate consumption can be achieved as well at the same time. The environmenta pollution hazard can be minimized. At present the ash concentration in the slurry i very low. In most case it does not go beyond 15% by weight. It is possible to pum the slurry at higher concentrations (upto 25 – 30%) without requiring any change i the existing equipment. Recently at one of the power stations a dense slurry systen has been installed. This unit is designed to handle slurry at concentration of 65% by weight and above. Enough data is yet to be obtained on the associated aspects such as the design modifications necessary in the ash pond area, whether ash dyke is a must or not and if the ash would consolidate on its own or additional measures need to be taken. In the following section, merits and limitations of three differen concentration slurry systems would be discussed to help in identifying the mos suitable option in a given context.

3.9.1 Low Concentration Slurry Disposal (LCSD)

Low concentration slurry would normally contain not more than 10 to 15% ash by weight. This is the most common conveying system adopted by most plants. Some of the major advantages of this method of disposal are:

a) Wide experience is available in designing the systems. The design is highly conservative and hence reliable.
b) The system can also handle emergencies due to the presence of excess capacity.
c) Quality control on the size of the particles need not be very strict since the transportation velocities are usually kept high. This is necessary since in most cases, the same system is used to transport both bottom ash and fly ash slurries.
d) Conventional equipments which are easily available can be used in these systems and hence operation and maintenance will be relatively simple.

There are certain disadvantages of this system. The major drawbacks are:

a) Large quantity of water is required to transport the ash.
b) Arrangement for the reclamation and re-circulation of water from the ash ponds will have to be made.

(27)

c) Possibility of ground water pollution from the ash ponds exists due to the large quantity of water being used. Further, possibility of surface water pollution exists if sufficient care is not taken to ensure that all fly ash particles are deposited in the ash pond before the water is let out of the pond. This problem becomes acute during periods of monsoon.
d) Due to the usage of higher velocity for transportation the extent of wear in the pipeline is much more.
e) This method of disposal is highly inefficient in terms of specific energy consumption (the energy required to transport 1 tonne of fly ash through 1 km.)
f) Since both bottom ash and fly ash are disposed through the same pipe lines, the pond ash will contain both of them and hence this hampers the end utilization of the ash.

3.9.2 Medium Concentration Slurry Disposal (MCSD)

Medium concentration slurry is still not in use at any power station but it holds potential as an optimum choice for slurry handling system. The concentration of ash in the slurry would be in the range 40% to 50%. This means that for one part of ash, one part of water would be required against 6 parts of water used in low concentration slurry. The major advantages of this method of disposal are :

a) Conventional centrifugal slurry pumps with minor modifications can be used for handling such slurries. However, due to reduction in the volume of ash slurry to be handled the number of pumps will be reduced.
b) Quantity of water required decreases considerably resulting in fast drying and settling of ash in the ash pond.
c) Due to reduced water usage, ground water will not be polluted to the same extent. Air pollution will also reduce as ash will not be carried away in the atmosphere by air due to retention of the binding characteristics of Fly ash.
d) The extent of wear of the pipe reduces enhancing the pipe life vis-à-vis the total content of ash transported.
e) Since the transportation velocities will be much lower, the specific power consumption for transportation will reduce.
f) The reclamation and re-circulation of water from the ash ponds can be avoided when transported at higher concentrations due to reduced amount of water present.
g) Bottom-ash when transported separately could be used for road construction and raising the height of ash dykes.

Some of the disadvantages/limitations of this method are :

a) Stricter control on various parameters of the process like solid concentration, particle size distribution etc. is needed to ensure reliable working of the system.
b) Although the system is proven technology in the laboratory/research scale, field experience has to be gained to obtain confidence in this system.

3.9.3 High Concentration Slurry Disposal (HCSD)

This method of disposal is fairly recent in origin and, in our country, we do not have much experience in this technology. The high concentration slurry would contain more than 65% ash by weight. It would require special pumping equipment and its discharge characteristics in the pond is a subject matter requiring some investigation. The major advantages of this method are :

a) Very low water consumption
b) The slurry can be self-setting and also self-limiting so that in the ash pond it is expected that the ash will deposit and dry by itself to form a hard surface.
c) The area of ash pond required at any given time is considerably reduced.
d) The specific energy consumption is much lower.
e) It may be possible to completely eliminate ash retaining dykes in the ash pond area.
f) The pipeline diameters can be much smaller and transportation velocities could also be considerably lower due to the fact that the slurry is non-settling. This could also reduce the wear in the pipeline.
g) Both bottom ash and fly ash can be disposed together if needed.
h) The problem of leaching and surface water pollution in the ash ponds is completely eliminated.
i) Ash from the ash pond area could be utilized since it is also in the dry form.

The major disadvantages of this system are

a) Very strict control on various parameters of the process like solid concentration, particle size distribution etc. is needed to ensure reliable working of the system.
b) Special pumping and handling systems are required. There have to be processed from abroad at present.
c) No experience with Indian coal ash is available.

3.10 THE TYPICAL COST OF WET TRANSPORTATION SYSTEMS

Cost of various types of ash handling and disposal systems is variable and highly dependent on the site conditions. However, in order to obtain a comparative estimate of the cost of the different systems a detailed analysis has been made and these costs have been worked out for a typical case of a thermal power plant having a generating capacity of 1000 MW. Since these are only estimates they are not very accurate and the costs quoted are only indicative. The typical costs of the three slurries disposal system are given in the table below:

Table 3.1 Typical estimated costs of various methods of wet disposal for a generating capacity of 1000 MW

ITEM	LCSD	MCSD	HCSD
CAPITAL COST	50 – 70 Crore	30 – 40 Crore	90 – 100 Crore
ANNUAL MAINTENANCE COSTS	1.5 – 3.5 Crore	1.00 – 2.00 Crore	N/A
ANNUAL RUNNING COST	25 – 50 Lakh	15 – 25 Lakh	N/A

3.11 MEDIUM VS DENSE SLURRY CONVEYING

In the preceding sections, some advantages of the medium concentration slurry were also discussed. Although it has been reported that some power station in other countries are adopting the use of dense or high concentration slurry, we feel that apart from the need to carry out more laboratory trials to establish the behavior of the slurry with Indian flyash, it will also require a detailed techno economic feasibility. Medium concentration slurry on the other hand is technically feasible without much additional work. It can also use standard hardware as is presently available, while the dense slurry would require special equipment especially the pumps. At present there is no plant, which has adopted to dispose of ash in medium slurry concentration but it may be an option worth exploring rather than move on to the dense slurry without establishing all the operational and economic aspects of that system.

It is observed from the above cost estimates that the MCSD has the lowest capital cost as well as maintenance and annual running cost. However, HCSD system has many advantages. Nevertheless, at present we do not have sufficient field data to estimate the maintenance as well as running costs. Evaluation of this system has to await detailed research and development with Indian Coal Ash.

CHAPTER – 4

DISPOSAL / STORAGE OF ASH ON LAND

4.1 DISPOSAL OPTIONS

Ash from a thermal power station is disposed off or stored on land near the the power station at distances ranging from 0.5 to 15 km. The options for disposa governed by the topography of the land on which the ash is disposed and norn one of the following options are adopted:

(a) Disposal in low-lying area (Fig. 4.1(a)).
(b) Disposal on flat ground (Fig. 4.1(b)).
(c) Disposal on sloping area (Fig. 4.1(c)).
(d) Disposal in valley (Fig. 4.1(d)).

The method of ash placement is governed by the mode in which ash is transpor to the disposal area - either as a slurry (low, medium or high concentration pipelines or as a dry/moist mass in trucks/conveyor belts.

At most thermal power stations in India, ash is transported as lean slurry a disposed in ponds (or impoundments) in low lying areas, flat ground, sloping grou or valleys. At one power station, ash is being transported in dry/moist state conveyor belts and disposed on flat ground. Transportation and disposal of h concentration slurry has been recently adopted at one thermal power station.

Ash is disposed/stored in ash ponds or ash mounds. The term 'ash pond' is us for a disposal/storage facility in which ash is deposited in the form of a slurry wit an area surrounded by embankments or upwardly sloping ground (Fig. 4.2). T term 'ash pond' is synonymous with 'ash impoundment' or 'ash lagoon'. The te 'ash mound' is used for disposal/storage facility in which ash in deposited in the fo of dry/moist mass or in the form of paste (high-concentration slurry) to result formation of stable side slopes of ash not surrounded (or enclosed) by a embankments (Fig.4.3). The term 'ash mound' is synonymous with 'ash pile' or 'a dump'.

A combination of peripheral embankments along with sloping ash surface risir above the embankments is also sometimes adopted (Fig. 4.3(e)).

4.2 SEPARATE STORAGE OF BOTTOM ASH AND FLYASH

Disposal of ash on land should be done in a manner that ash can be recovered fro the disposal area for different end-uses. From this perspective it is mos advantageous to look at the 'disposal' of ash as 'storage' of ash for future utilisatio and design facilities which enhance utilisation of ash.

Currently, at most thermal power stations, bottom ash and flyash are mixed and transported as lean slurry to the disposal area. For enhancing the utilisation of ash, it is desirable that bottom ash and flyash are stored in separate chambers/segments in a disposal facility since each component has high utilisation potential when stored individually which is lost on intermixing.

4.3 DESIGN REQUIREMENTS

The disposal of ash on land causes the following impacts at the disposal site:

(a) Several hundred acres of land are covered with ash deposit of 10 to 50 m height above the original ground surface.
(b) The land use pattern is altered.
(c) The drainage paths are altered.
(d) The topography is altered.
(e) The ground water regime and quality is altered.
(f) The visual/aesthetic appearance is altered.
(g) The ecology of the area is altered.
(h) Environmental pollution can occur on account of
  (i) fugitive dust emissions,
  (ii) fine ash particles reaching surface waters of local water bodies,
  (iii) alteration of ground water quality,
  (iv) biotoxicity,
  (v) waterlogging,
  (vi) blockage of natural drainage paths and
  (vii) site wash out.

To overcome the above problems, all ash disposal sites must fulfill the following design requirements.

An ash disposal facility must be designed for three phases, namely:

(a) construction and operation phase – for the period when the ash disposal facility is in use.
(b) Closure (or rehabilitation) phase – for the period when capping and stabilisation by soil cover, vegetation and other means is undertaken.
(c) Post-closure phase – for the long-term period after closure/abandment of the facility.

For each phase, the following requirements are to be met:

(a) Physical stability must be ensured under static conditions, earthquake induced conditions, floods, wind erosion, water erosion and other critical conditions.
(b) Environmental safety must be ensured against excessive dust in local air, excessive suspended sediments in surface water, changes in ground water levels and ground water quality, water logging due to

seepage water, water logging due to blockage of natural drainage paths, site washout by overtopping/breaching.

(c) A surface water management system should be provided to ensure that (i) surface runoff from areas outside the disposal facility is intercepted and diverted around the facility; and that (ii) surface runoff from within the facility is intercepted and taken to sedimentation tank/settling pond/treatment plant.

(d) A water treatment and recirculation system should be provided in wet disposal systems to control suspended solids in decanted water and to maximise re-usage of water for making slurry.

(e) A liner system and/or base drainage should be provided to minimise infiltration of leachate from ash deposit to the subsoil and prevent significant alteration of ground water level and ground water quality.

(f) A plan for placement of ash in stages, should be drawn up in advance for the entire duration of the disposal facility with adequate options for alternate placement of ash in case of malfunctioning during extreme conditions.

(g) A monitoring system should be provided for measurement of geotechnical and environmental parameters at regular intervals.

(h) A plan should be drawn for regular collection, analyses and storage of construction data and environmental data.

(i) A closure and post-closure plan should be drawn up in the beginning which will ensure long-term stability of the ash deposit after abandoment.

4.4 DESCRIPTION OF ALTERNATE SYSTEMS

The feature and components of various alternate systems for disposal of ash on land are described in this section.

4.4.1 Low Concentration Slurry Disposal (LCSD) In Ash Ponds

Low concentration slurry disposal involves discharge of the slurry in a pond (or impoundment), allowing the ash to get deposited as slurry spreads horizontally in the pond and then decanting the clean slurry water (Fig. 4.4). Such a disposal system is used at most thermal power plants in India and its salient features are described below.

(a) ***Peripheral Embankment***: A containment structure (pond) is created by constructing a peripheral embankment around the area in which ash is to be stored. (If the terrain is sloping or valley type, the peripheral embankment may be constructed only on few sides or one side (Fig. 4.5)). Usually the ash pond is made up of 2 to 4 chambers. In the beginning, usually only one chamber (with a decanting system) is constructed having a 5 to 8 m high starter embankment made of local soil. Subsequently, the other segments are completed by using ash as the embankment construction material. As the segments get filled up the embankment height is increased incrementally in stages of 3 to 4 m using one of three methods of construction – the upstream method, centreline method or the downstream method (Fig. 4.6).

(b) ***Slurry Inflow Arrangement*** : The slurry brought to the ash pond segments in pipelines, is discharged into the pond from the top of the embankment. A single inflow point or multiple inflow points can be adopted. The preference is for multiple inflow points all along the periphery of the ash pond (garland system) as such a system helps in uniform filling of the ash pond and is also beneficial for the stability of the incrementally raised embankments.

(c) ***Placement/Spreading of Ash***: Within each ash pond segment, ash gets hydraulically deposited as the slurry flows under gravity from the inflow point to the outflow point, and the ash pond fills up gradually starting from the peripheral embankment to the outflow point (decanting point). In some cases, inflow pipes may have to be moved from the top of the peripheral embankment towards the inside of the pond, after the deposited ash accumulates on the inside face/slope of the embankment.

(d) ***Outflow/Decantation of Water***: As the ash particles settle from the slurry, clean water is removed from each segment of the ash pond using a decantation system. The decantation system may be in the form of an overflow weir, a decant tower or a barge mounted pump.

(e) ***Sedimentation Chamber, Effluent Treatment Plant and Water Recirculation***: Water coming out from a decanting system can be discharged to open drains/channels/rivers provided it meets the criteria for water quality permissible for direct discharge. Sometimes, due to insufficient settling time, the decanted water has high suspended solids. Also, direct discharge of decanted water to water bodies results in wastage of precious water. It is therefore desirable to collect the decanted water in a sedimentation tank, pass it through an effluent treatment plant for removal of suspended solids and other contaminants (if found necessary) and recirculate it for re-use as slurry making water.

(f) ***Liner/Bottom Drain***: Disposal of ash in the form of slurry in an ash pond results in slurry water/leachate reaching the ground water beneath the base of the ash pond. This may cause the ground water table level to rise. In addition, it may also affect ground water quality depending on the presence of sulphates, chlorides, other salts and leachable trace elements in the ash. Hence, it is desirable to provide an impervious liner and/or bottom drain at the base of an ash pond.

(g) ***Peripheral Drains For Surface Water Management***: Management of surface water around an ash pond is important for prevention of accummulation of surface water around the ash pond and also for prevention of blockage to natural drainage paths. Drains, channels and diversion structures to collect and divert rain water around an ash pond are usually provided.

(h) ***Wind Erosion Control Measures***: To prevent fugitive dust emissions from dry surface of an operative ash pond (especially during summer months), ponding of water is desirable. This ponding requires significant quantity of water and is also detrimental to the stability of embankments. However, full ponding continues to be the most effective method of controlling wind erosion. Other measures such as water sprinkling or temporary vegetative growth in ash ponds which are under operation have met with limited success.

(i) ***Rain Water Erosion Control***: Rain water erosion of ash is not a problem in ash ponds since the ash is contained within a peripheral embankment. However, in high rainfall areas (or in valley-type and slope-type ash ponds) the decanting system should be designed to cater to high discharge rates during monsoon periods. Provision of an emergency spillway in each chamber of ash pond is desirable in such cases.

(j) ***Final Closure and Post Closure Stability***: After filling of an ash pond to its full height, the ash pond should be stabilised by complete dewatering of the pond and by provision of soil cover and/or propogation of self-generative vegetative growth (local species of grasses and shrubs) on the top surfaces. The long-term stability of an abandoned ash pond should be examined, and assured, specially taking into account the possibility of choking of drains and filters in the post-abandonment stage. For high ash ponds which are in close proximity of habitated areas, in-situ densification of ash for stabilisation of the same should be examined.

4.4.2 Medium Concentration Slurry Disposal (MCSD) In Ash Ponds

Transportation of ash in the form of medium concentration slurry has not been adopted at any thermal power station in the country. However, medium concentration slurry can be disposed off in ash ponds having the same features as those described in the previous section for lean concentration slurry with the difference that the ETP for treatment of decanted water as well as the arrangement for recirculation of water will be of much smaller capacities for MCSD in comparison to LCSD. This is so because MCS contains much smaller quantity of water in comparison to that of LCS.

4.4.3 High Concentration Slurry Disposal (HCSD)

It is reported from Australia that high concentration slurry can be disposed on land in the form of conical mounds formed by discharging the thick slurry (or paste) from a central discharge point and allowing the ash to settle naturally at slopes of about five percent (Figs. 4.7(a) and (b)). This central discharge point is raised incrementally as the cone builds up and it can also be moved laterally to increase storage capacity. As reported from Australia the thick slurry is observed to be self-setting and self-limiting (in spreading of ash) which forms a hard surface on drying. The hard surface is reported to be resistant to wind and water erosion. The density of deposition in HCSD is observed to be higher than that in LCSD because segregation of the well-mixed and highly concentrated slurry does not occur as against the same observed in low concentration slurry during deposition.

To increase the quantity of disposal of ash in a given land area, the conical mound can be raised by constructing a low peripheral embankment and incrementally raising the embankment as the central discharge point is raised (Fig. 4.8). Such a HCSD system has been recently adopted at one of the thermal power stations in India.

The following are the features of a HCSD system:

(a) A central embankment (or other arrangement) for discharge of high concentration slurry,
(b) A low-height peripheral embankment or toe to contain the slurry and decant the slurry water,
(c) Incremental raising of the central and peripheral embankment to increase the height of deposited ash,
(d) A peripheral toe drain for collecting the slurry water or rain water passing through the peripheral embankment/toe.
(e) A settling pond / sedimentation tank for settlement of fines, if the same are observed in slurry water reaching the toe drain.
(f) A storm water drainage system for collecting rain water/surface run-off from external areas and diverting it around the ash
(g) A liner/bottom drain to prevent ground water contamination, if required.
(h) Wind erosion control measures against fugitive dust emission.
(i) Rain water erosion control measures against gully formation.
(j) Final closure and post-closure stabilisation by provision of soil cover and/or prorogation of self generative vegetative growth on the exposed ash surface.

4.4.4 Dry Ash Disposal in Ash Mounds

In dry disposal method, ash is mixed with 10 to 20 percent water and transported to the site in belt conveyors or trucks/dumpers. Placement of ash is done using mechanical equipment in predefined stages to sequentially fill the ash to its full height (Fig. 4.9). Such a system has been adopted at one thermal power station. The following are the features of dry disposal systems:

(a) A bottom drainage layer comprising of bottom ash or other granular soil.
(b) A peripheral drain to collect surface water run-off from within the ash disposal area and take it to sedimentation tank / settling pond to prevent contamination of adjacent water bodies.
(c) A storm water drainage system for collecting rain water/surface run-off from external area and diverting it around the ash mound.
(d) Special disposal areas for disposal in monsoons.
(e) Placement of ash by two methods:
    (i) spreading ash with dozers and compacting with rollers as in standard earthwork projects, or

(ii) placing ash by aerial deposition from height of 10 to 20 m using crawler mounted boom spreaders (Fig. 4.10) attached to mobile belt conveyors.

(f) Wind erosion control for fugitive dust emissions by continuous water sprinkling, chemical coating and establishment of vegetative cover.

(g) Rain water erosion control through interceptor drains and vegetative cover.

(h) Final closure and post-closure stabilisation by provision of soil cover and/or propagation of self-generative vegetative growth on exposed ash surface.

4.5 MAXIMISING STORAGE OF ASH

Availability of adequate land for storage of ash is a major constraint faced by most thermal power plants. Hence it is necessary to store/dispose the maximum quantity of ash on a given land area.

The quantity of storage on a given land area can be maximised in three ways namely:

(a) increasing the placement density of deposited ash;
(b) increasing the height of deposited ash; and
(c) Increasing the steepness of the side slopes of deposited ash.

4.5.1 Placement Density

The density of ash depends upon the specific gravity of the solids as well as the method of placement. The specific gravity of solids of Indian ashes usually varies between 1.7 to 2.2. The range of low (minimum) dry densities is of the order of 0.65 to 0.95 t/cu.m and the range of maximum densities is of the order of 1.0 to 1.4 t/cu.m. Hence it is possible to increase the quantity of ash stored in a fixed volume by increasing the placement dry density from low (say 0.8 t/cu.m) to high (say 1.2 t/cu.m), thereby resulting in additional storage of almost 50%. Table 4.1 shows how an increase in density of ash placement can reduce required height of an ash storage/disposal facility (assuming ash production rate of 5T/MW/day)..

It may be noted that the placement density of low and medium concentration slurries in ash ponds is in the 'low' range on account of process of hydraulic deposition which also causes segregation of the deposited ash. In the case of high concentration slurries, the placement density is in the "medium" range on account of non-segregation of the properly mixed ash and the paste-like-conditions during deposition. In dry disposal methods, when ash is deposited by aerial fall from a conveying system or boom spreader, the placement density varies in the range of "low to medium" depending upon the height of fall and moisture content of the ash. The placement density of ash is "dense" when dozers are used for spreading of ash and rollers are used for compaction of ash.

4.5.2 Height of Deposited Ash

The height of an ash deposit is governed by considerations of its stability (under extreme condition such as rains, earthquakes, floods etc.) as well by aesthetic aspects.

For ash ponds, raised incrementally by the upstream method, heights of upto 20-25 metres have been reported. These can be increased to higher levels if the downstream method of incremental raising is adopted. Mounds made by high concentration slurry disposal have been reported to reach heights of upto 35 m whereas mounds made by dry ash disposal have been reported to achieve 50 m height.

High ash deposits, even when properly covered with vegetative growth, have significant negative visual impact in flat undulating areas.

Heights of deposited ash will be low when :

(a) ash is deposited at low density,
(b) ash is saturated/ponded,
(c) peripheral embankments are raised by upstream method,
(d) ash storage is valley-type or slope-type where surface run-off of adjacent areas enters the ash storage site,
(e) seismicity is high,
(f) rainfall/surface water run-off is high,
(g) ash disposal facility is adjacent to habitated areas, national highways, industrial areas etc.
(h) visual impact or aesthetics are imprtant considerations.

Theoretically it is be possible to construct ash deposits up to heights of 50 m or more by using strong peripheral embankments (made primarily of ash by downstream construction method of incremental raising) or by dry disposal of compacted ash at relatively flat slopes. The stability of such deposits is well ensured during the operation phase through proper monitoring and maintenance. However in the long-term (post-abandonment stage), the stability of such structures, under zero-maintenance conditions is often questionable.

Hence it appears desirable to limit the heights of all ash deposits in the 15 to 25 m range and ensure their long-term post-abandonment stability. Higher heights should be undertaken only after careful examination of all stability aspects, specially long-term stability.

4.5.3 Steepness of Side Slopes of Ash Deposit

For a given land area, ash storage is maximised when the peripheral side slopes are the steepest. Normally the range of slopes of ash deposits is observed to be as follows (Fig. 4.1.1) :

(a) Average side slopes in the range of 4:1 to 5:1 (hor : vert.) are common in low concentration slurry deposited ash where peripheral embankments are raised incrementally by the upstream method, using ash as primary construction material.

(b) Average side slopes in the range of 4:1 to 5:1 (hor: vert) are also adopted in dry disposal mounds where the ash is deposited at low-medium density by aerial deposition and where no internal drains are provided.

(c) Average side slopes of the order of 20:1 (hor:vert), i.e. 5 percent, are adopted in mounds where high density slurry is allowed to spread by gravity flow. (For steeper side slopes, peripheral embankments are required).

(d) Average side slopes in the range of 2.0:1 to 3.0:1 (hor:vert) can be achieved when low concentration slurry ash is deposited behind peripheral embankments which are raised incrementally by the downstream method of construction using ash as the primary construction material and adopting elaborated internal/external drainage systems.

The downstream method of incrementally raising peripheral embankments is normally not adopted at most storage/disposal facilities because of its relatively high cost of construction in comparison to the upstream method. However the benefits of additional storage of ash need to be examined vis-à-vis the high cost of construction. In narrow-width ash ponds as well as in high-seismicity areas, the downstream method of construction can be advantageous.

On the other hand, for long-term self-propogation of vegetative growth, relatively less steep slopes appear to be desirable.

The choice of side slopes would have to be decided by the designer on the basis of site specific conditions.

4.6 ENVIRONMENTAL MANAGEMENT OF ASH AT DISPOSAL / STORAGE FACILITIES

4.6.1 Ash Ponds

The predominant polluting pathways of ash from an ash pond are shown in Fig. 4.12. The environmental problems and their management are discussed below:

(a) Effect on Local Air: Fugitive dust emissions from dry part of an ash pond causes an impact on local air quality. The environmental control measures that are required are as follows:

  (i) Location of the ash pond is so chosen that the predominant wind direction is away from habitated areas and towards the ash pond.

(ii) Full ponding of water in an ash pond over the entire ash surface area ensures zero fugitive dust. The embankments have to be designed for long-term stability under full ponding.

(iii) Continuous sprinkling of water over dry surfaces of ash in chambers/segments of ash pond which are not in use but will be used in the future.

(iv) Temporary vegetative growth over dry surface of ash in chambers/segments of ash pond which are not in use but will be used in the future.

(v) Soil cover + vegetative growth over surface of ash wherever full height has been achieved.

(vi) Peripheral green belt all around the ash pond area comprising of local trees and shrubs.

(b) Effect on Local Surface Water: Local water bodies adjacent to ash ponds received the decant water discharged from ash ponds. The decant water may have high suspended solids due to inadequate sedimentation in the ash pond. In addition, if the slurry making water is of poor quality, it can also have negative impact on local surface water quality. The environment control measures that are required are as follows:

(i) Provision of adequate size of ash pond for proper sedimentation of slurry water;

(ii) Provision of treatment plant to treat decant water of ash pond,

(iii) Recirculation of treated water.

(c) Effect on Ground Water: The ground water beneath and around an ash pond may get affected on account of the following reasons: (i) rise in water table level due to continuous ingress of water from the ash pond to the subsoil, which may cause water logging around ash pond and also alter soil moisture/soil salinity due to rise in water table, (ii) presence of leachable anionic components (sulphates, chlorides, flourides) as well as leachable metallic components (Pb, Cr, Ni, Fe, Mn, Cd, As, Hg, Zn, B) which may affect ground water quality and (iii) presence of contaminants in poor quality of water used for making ash slurry which may affect ground water quality.

The environmental control measures that are required are as follows:

(i) Locating the ash pond in area of low subsurface permeability.

(ii) Provision of liner and/or bottom drain, as found necessary to control the above affects.

(d) Biotoxicity: Many species of plants can be grown on surface of ash. Certain studies indicate elevated concentration of ionorganic constitutents in the above ground parts of such plants, raising concerns of cross media transfer of the contamination. Hence it is recommended that only those species of plants be grown which will not caused cross media transfer.

(e) Waterlogging And Surface Water Drainage: Water logging around ash ponds may occur on account of two reasons, namely : (i) seepage of pond water from within and beneath ash pond embankments and (ii) blockage of natural drainage paths due to construction of ash pond in low-lying areas. Provision of drains and diversion channels on the basis of hydrological studies can eliminate this phenomenon.

(f) Site Wash Out: Wash out of ash is reported to occur in ash ponds due to overtopping or breach of embankments. Ash slurry spreads for several hundred metres around the ash pond and though the water drains out with time, ash becomes deposited in acres of land and this is difficult to remove. Proper design of embankments, adequate provision of freeboard and provision of emergency spillways eliminates this problem.

4.6.2 Ash Mounds

The predominant polluting pathways of ash from an ash mound are shown in Fig 4.13. The environmental impacts and their management are discussed below:

(a) Effect on Local Air: Fugitive dust emissions from the exposed and dry ash surface cause an impact on local air quality. Since large areas of sloping ash surfaces are exposed during placement, the following control measures are required:
   (i) Location of ash mound in such a manner that the predominant wind direction is away from habitated areas and towards the ash mound.
   (ii) Continuous sprinkling of water over entire area in which dry ash is exposed.
   (iii) Spraying of special chemicals on ash surface to arrest ash particles from becoming air borne.
   (iv) Providing soil cover + vegetation immediately on reaching the final height of a segment of ash mound. (It is reported that ash deposited as high concentration slurry along gentle slopes becomes hard and resistant to wind erosion on drying. However, the same ash when subjected to rain tends to become loose and dust prone. Hence all the above measures are recommended both for case of dry disposal and HCSD).
   (v) Peripheral green belt all around the ash mound area comprising of local trees and shrubs.

(b) Effect on Local Surface Water: Local water bodies adjacent to ash ponds can become contaminated with fine ash particles which get eroded by rain water from the surface of the ash mound. To control this phenomenon, all rain water which collects as surface run-off at the base of an ash mound should be collected in peripheral drains and taken to a settling pond/sedimentation tank to remove the fine particles before discharge to local water bodies. Surface run-off from the ash surface should not be allowed to become mixed with surface run-off from areas external to the ash mound. It is desirable to have a toe at the base of an ash mound which prevent the ash from flowing outwards during the rainy period.

(c) Effect on Ground Water: In ash mounds constructed by the dry disposal method, infiltration of leachate from ash mound to the sub-soil is likely to be minimal and may occur during monsoon months only. In such cases, provision of a bottom blanket drain at the base of an ash mound with suitable gradient to collect the leachate at the periphery of the ash mound is considered adequate. However, in cases where leachate generation may be significant, as in the case of ash mound constructed by high concentration slurry disposal method or in high rainfall areas, or in ash mounds constructed in low-lying or sloping terrain where surface run-off from adjacent areas may enter the mound area, liners may be provided, if found necessary.

(d) Waterlogging: Water logging around ash mounds may occur if natural drainage paths become blocked by construction of the mound. Drains and diversion channels may be provided for maximum surface run-off from external areas as determined from hydrological studies. The surface run-off from the ash surface should not be mixed with the run-off from external areas.

(e) Storage of Ash During Rainfall Period: During monsoons, it is preferable to place ash by the dry disposal method or the HCSD method during the non-rainfall period only and suspend ash placement when it is raining. However, if heavy rainfall persists for long duration, ash placement may become disrupted for a long period of time. Hence it is desirable to create separate segments with peripheral embankments where ash can be stored temporarily during high rainfall periods in monsoon months.

(f) Biotoxicity: The same measures should be adopted as listed for disposal in ash ponds.

Fig. 4.14 shows the desirable features of an abandoned ash disposal facility.

4.7 COMPARATIVE EVALUATION OF ASH DISPOSAL/STORAGE SYSTEMS

A comparison of various features of different types of ash disposal/storage systems are presented in Table 4.2. One notes from this table that the following are the major differences in various systems:

(a) LCSD in ash ponds requires elaborate arrangements of the following (i) peripheral and internal embankments, (ii) liner system and/or bottom drain, (iii) slurry water inflow (garland) arrangement, (iv) decant water treatment plant and recirculation system and (v) closure after operation. With proper ponding wind erosion of ash can be controlled. Rain water erosion of ash is not a major problem.

(b) MCSD in ash ponds requires the same features as (a) above for LCSD with the exception that decant water treatment plant and recirculation system are smaller.

(c) HCSD in ash mounds requires elaborate arrangements regarding the following (i) bottom drain and/or liner system, (ii) peripheral drains and settling pond, (iii) wind erosion control measures, (iv) water erosion control measures and (v) closure after operation. Water treatment plant and recirculation system can be avoided in arid zones.

Peripheral embankments are required for additional capacity through steep slopes.

(d) Dry disposal in ash mounds requires elaborate arrangements regarding the following (i) mechanical placement of soil, (ii) bottom drain, (iii) peripheral drains and settling pond, (iv) wind erosion control measures, (v) water erosion control measures and (vi) closure after operation.

4.8 COST ESTIMATES

The typical cost estimates of ash disposal in ash ponds and ash mounds are indicated in Table 4.4 for different methods of storage/disposal for a 1000 MW thermal power plant depositing ash on flat terrain as per details in Table 4.3. The estimates are approximate (based on ash production rate of 5T/MW/day) and may vary significantly from one site to another depending on site topography and other factors.

One notes from Table 4.4 that development costs are high in ash ponds whereas operational costs are high for dry ash disposal. Land cost forms a significant component of the overall cost as also does the cost of the liner system.

The disposal cost is observed to be in the range of Rs. 70 to 80 per ton of ash in this present case. These figures are for a specific study and can not be used or extrapolated for any other site. Table 4.5 demonstrates how the cost of disposal of ash may vary significantly when an ash pond is designed under different conditions. The height of an ash disposal facility is a critical parameter which can affect the cost of disposal of ash.

Table 4.1: Height of Ash Deposit

Ash Production = 5 ton per MW per day (*approximate*)

Land Area = 1.0 to 1.5 acres per MW
4.05 to 6.08 × 10^3 sq m per MW

Land Area for Green Belt, Infrastructure etc. = 15%

Land Area for Ash Deposition= 85%

Years of Deposition	Final Height of Deposit (m)		
	Loose Ash γ_d **= 0.65 to 0.95 t/cu.m**	**Medium Ash** γ_d **= 0.85 to 1.15 t/cu.m**	Dense Ash γ_d = 1.0 to 1.4 t/cu.m
Case A: 1.5 acre land area per MW			
15	9	7.2	6
30	18	14.4	12
45	27	21.6	18
Case B: 1.0 acre land area per MW			
15	13.5	10.8	9
30	27.0	21.6	18
45	40.5	32.4	27

Table 4.2: Comparative Evaluation of Different Methods of Ash Disposal/Storage

Feature	Ash Pond		Ash Mound		
	Low Concentration Slurry Disposal (LCSD)	**Medium Concentration Slurry Disposal (MCSD)**	**High Concentration Slurry Disposal (HCSD)**	**Dry Disposal using Boom Spreader**	**Dry Disposal using Dozers and Roller Compactors**
Reported Maximum Height	~25 m (Higher height possible by downstream method)		~35 m	~50 m	
Range of side slopes (hor: vert)	4:1 to 5:1 (upstream method) 2:1 to 3:1 (downstream method)	4:1 to 5:1 (upstream method) 2:1 to 3:1 (downstream method)	20:1 (self spreading) 4:1 to 5:1 (upstream method)	4:1 to 5:1	3:1 to 4:1
Method of Placement	Deposition during spreading of slurry (gravity flow)	Deposition during spreading of slurry (gravity flow)	Deposition during spreading of slurry (gravity flow) – limited distance	Aerial drop from height of 10 to 20 m by boom spreader	Spreading by dozer and compaction by rollers
Segregation during Placement	Yes	Yes	No	No	No
Placement Dry Density	Low	Low	Medium	Low to Medium	High
Peripheral Embankments and Internal Embankments	Extensive	Extensive	Small or Medium	Nil or Toe	Nil or Toe
Liner at Base and/or Bottom Drain	Desirable	Desirable	Desirable	Bottom Drain	Bottom Drain
Water Requirement	High	Low	Low	Negligible	Negligible
Decant Water Treatment Plant and Recirculation Arrangement	Elaborate	Small	No	No	No
Peripheral Drains with Settling Pond for Surface Run-off from Ash Deposited Areas	No	No	Yes	Yes	Yes

Contd

Table 4.2(Contd.): Comparative Evaluation of Different Methods of Ash Disposal/Storage

Feature	Ash Pond		Ash Mound		
	Low Concentration Slurry	Medium Concentration Slurry	High Concentration Slurry	Dry Disposal using Boom Spreader	Dry Disposal using Dozens and Roller Compactors
Peripheral Drains for Surface Run-off from External Areas / Natural Drains	Yes	Yes	Yes	Yes	Yes
Protective Measures for Fugitive Dust	Ponding + Peripherals Green Belt	Ponding + Peripherals Green Belt	Sprinkling/Vegetation + Peripherals Green Belt	Sprinkling/Vegetation + Peripherals Green Belt	Sprinkling/Vegetation + Peripherals Green Belt
Protective Measures for Rain Water Erosion of Ash	Nil	Nil	Vegetation; Peripheral Drain	Vegetation; Peripheral Drain	Vegetation; Peripheral Drain
Main Components of Maintenance of and Repair	Embankments, Treatment Plant , Decanting Structures	Embankments , Treatment Plant , Decanting Structures	Ash Surface, Drains, Settling Pond	Ash Surface, Drains, Settling Pond	Ash Surface, Drains, Settling Pond

Table 4.3: Area and Height Computations for Ash Storage

I. Basic Data

(a) Power Station Capacity	: 1000 MW
(b) Life	: 30 Years
(c) Ash Generation	: 5000 Tons Per Day
(d) Land Allocated (@ 1.0 acre/MW)	: 1000 Acres
(e) Topography	: Flat Ground
(f) Type of storage	: Aboveground
(g) Area for ash storage	: 85% (balance 15% for green belt, infrastructure, side slopes etc.)
(h) Quantity of ash to be stored	: $5000 \times 365 \times 30 = 55 \times 10^6$ Tons
(i) Maximum Height Permitted	: 20 m

II. Ash Pond for LCSD and MCSD

(a) Side slopes	: 4 : 1 (horizontal : vertical) (upstream method of raising)
(b) Placement density	: Low (Dry Density ~0.8 t/cu.m)
(c) Height of ash storage	: $55\times10^6/1000\times4050\times0.85\times0.8 \approx 20$ m

III. Ash Mound for HCSD

Option A :	Gentle side slopes	: 20 : 1 (horizontal : vertical) (self spreading)
	Placement density	: Medium (Dry Density ~1.0 t/cu.m)
	Maximum storage	: 44×10^6 T of Ash (less than required storage)
Option B :	Peripheral embankments upto 7.5 m high	: 3 : 1 (horizontal : vertical)
	Placement density	: Medium (Dry Density ~1.0 t/cu.m)
	Height of ash storage	: 20 m (Gentle slope from peripheral embankment to top of mound 20 : 1 (horizontal : vertical)

IV. Ash Mound for Dry Disposal

(a) Side slopes	: 4 : 1 (horizontal : vertical)
(b) Placement density	
Option A : Boom spreader	: Low-medium (Dry Density~0.9 t/cu.m)
Option B : Dozer + compactors	: Medium-dense (Dry Density~1.1 t/cu.m)
(c) Height of ash storage	
Boom spreader	: ≈18 m
Dozer + compactors	: ≈15 m

Table 4.4: Cost Estimate for Ash Disposal/Storage on Land (Excluding Transportation Cost)

Item	Component	Cost of Disposal (Rs. in Crores)				Remarks
		Ash Pond (LCSD)	Ash Pond (MCSD)	Ash Mound with Small Emb. (HCSD)	Ash Mound (Dry Disposal)	
Initial Land Cost		150	150	150	150	@ Rs. 15 lakh per acre; can vary significantly
Initial Development Cost	(a) Embankment	15	15	5	N	Earthwork @ Rs. 150/- to Rs. 200/- per cu.m
	(b) Liner and/or Drain	30	30	30	10	Liner @ Rs. 300/- per sq m Drain @ Rs. 100/- per sq.m
	(c) Decant, Treatment and Recirculation System	4	3	-	-	
	(d) Plant and Equipment for Ash Placement	N	N	N	10	Boom spreader, dozers, compactors for dry ash
	(e) Toe, Drains and Settling Pond for Eroded Ash; Sprinklers for Dry Ash		-	1.5	1.5	
	(f) Surface Water Management System and Miscellaneous	1	1	1	1	
	Total	50	49	37.5	22.5	
Annual Operational Cost (per year) (30 year life)	(a) Lateral/Vertical Expansion of Embankments	2.5	2.5	0.8	N	
	(b) Lateral Expansion of Liner and/or Drain	3.0	3.0	3.0	1.0	
	(c) Ash Spreading and Compaction	N	N	0.2	4.5	Dry ash spreading and compaction @ Rs 25 per cu.m
	(d) Pollution Control and Maintenance/Repair	0.75	0.25	1.0	1.25	
	Total	6.25	5.75	5.0	6.75	

Contd

N = Negligible

Table 4.4(Contd.): Cost Estimate for Ash Disposal/Storage on Land (Excluding Transportation Cost)

Item	Component	Cost of Disposal (Rs. in Crores)				Remarks
		Ash Pond (LCSD)	Ash Pond (MCSD)	Ash Mound with Small Emb. (HCSD)	Ash Mound (Dry Disposal)	
Final Closure Cost	Soil Cover + Vegetative Growth	40	40	45	45	(i) @ Rs. 100/- per sq.m; exposed area higher for mounds (ii) Closure can also begin during operation
Total Cost		427.5	411.5	382.5	420.0	Additional storage height available in dry ash disposal
Total Cost Per Ton of Ash (Rs./T)		78	75	70	77	

Table 4.5: Variation in Cost of Ash Disposal in Ash Pond (LCSD)

S.No.	Alternatives	Cost of Disposal Per Ton of Ash (Rs. Per Ton)
1	Base Example (as per Tables 3 and 4)	78
2	Base Example But Cost of Land Neglected (e.g. very low cost of land)	51
3	Base Example But No Provision of Liner (e.g. natural impervious base)	56
4	Base Example But with Only 50% Cost of Embankment (e.g. valley or side hill impoundment)	69
5	Base Example But Maximum Height Limited to 10 m (e.g. close to habitation in highly seismic area; quantity of ash reduced to 50%)	135

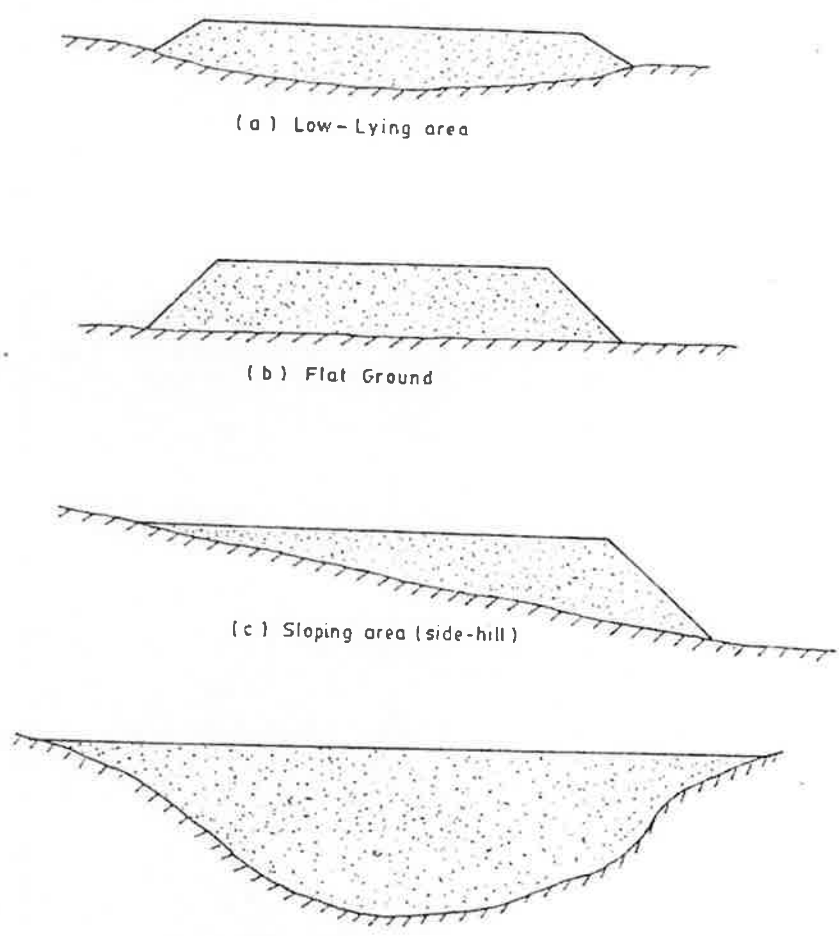


Fig. 4.1 Land Disposal on Land-Variable Topography

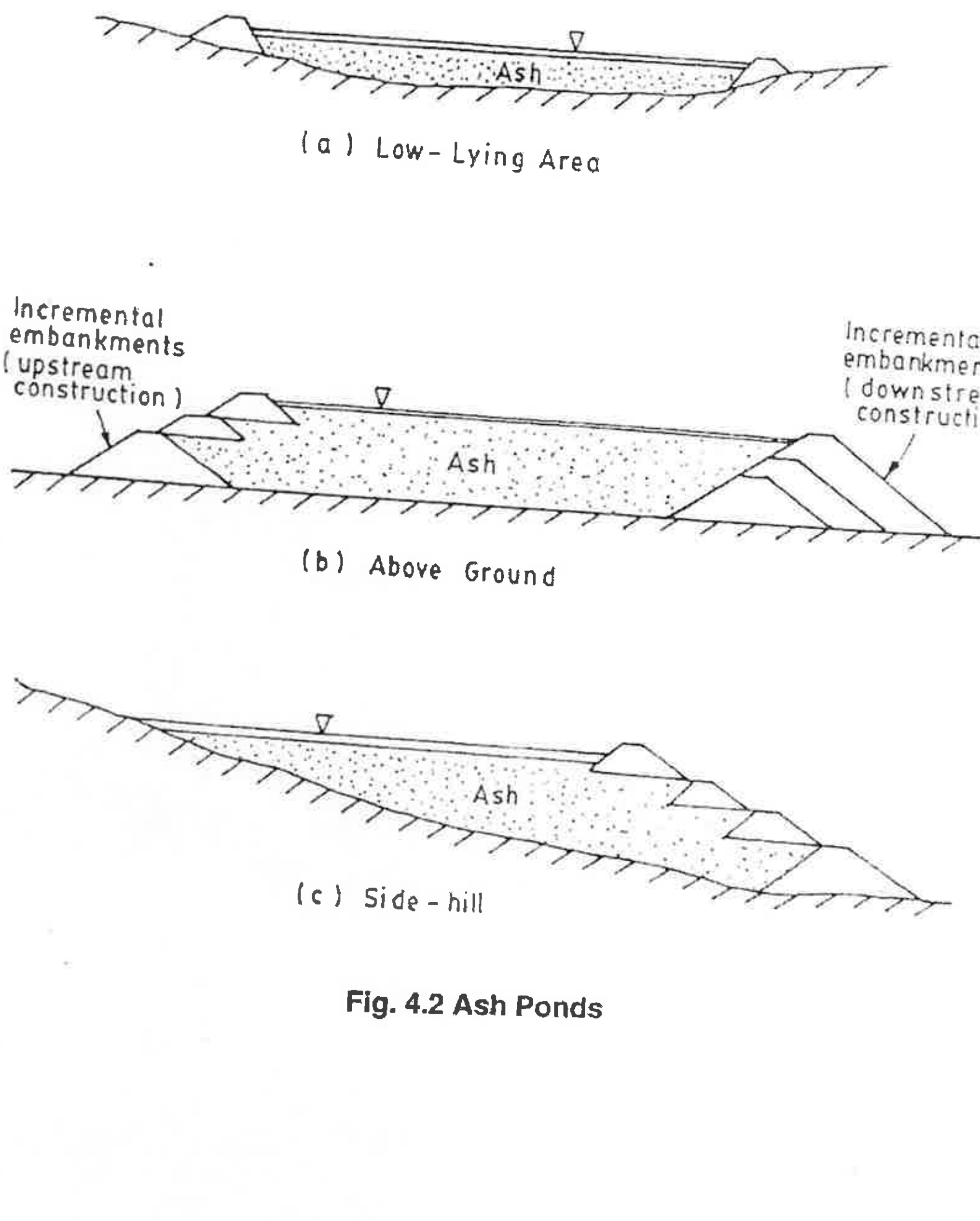


Fig. 4.2 Ash Ponds

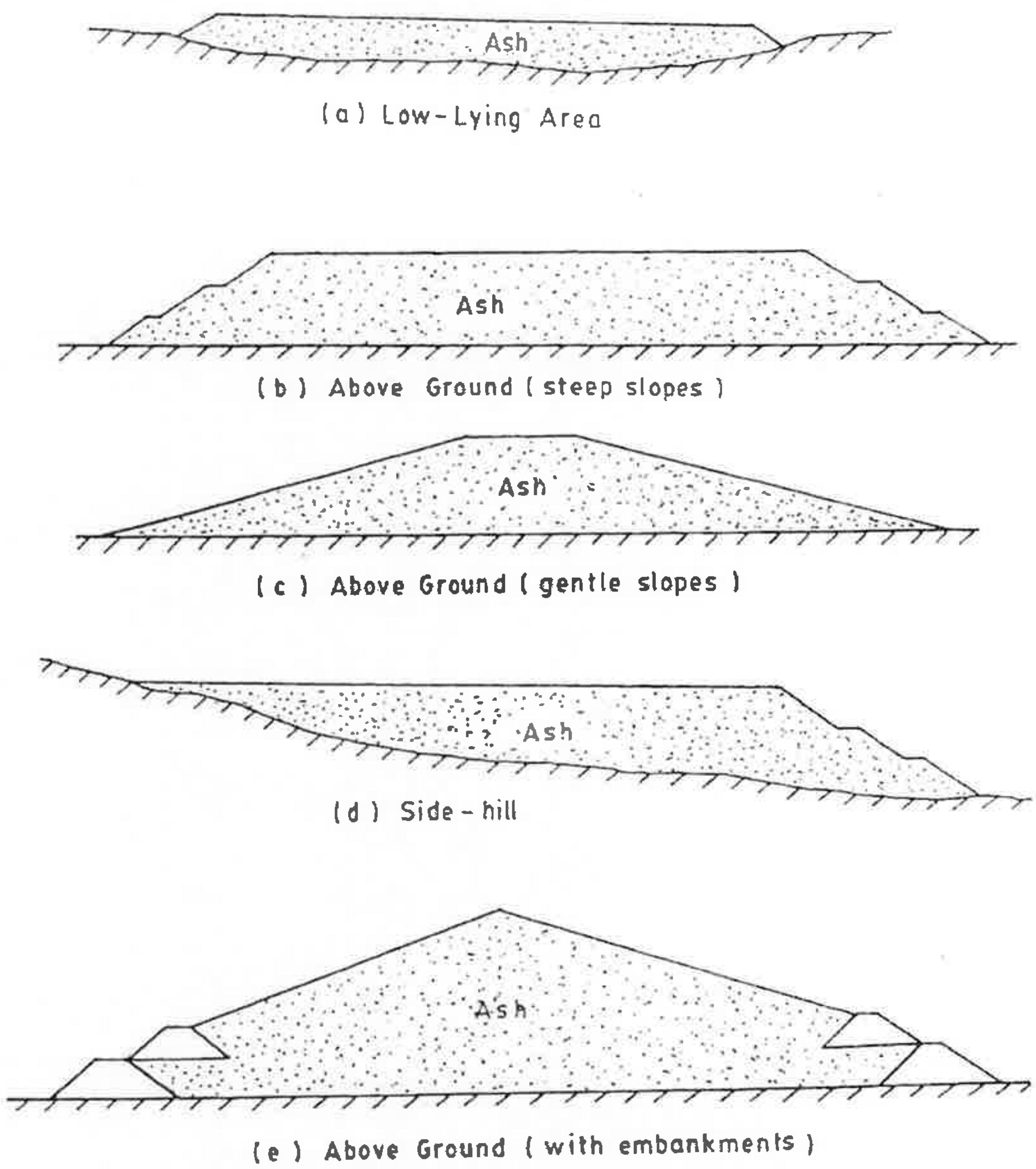


Fig. 4.3 Ash Mounds

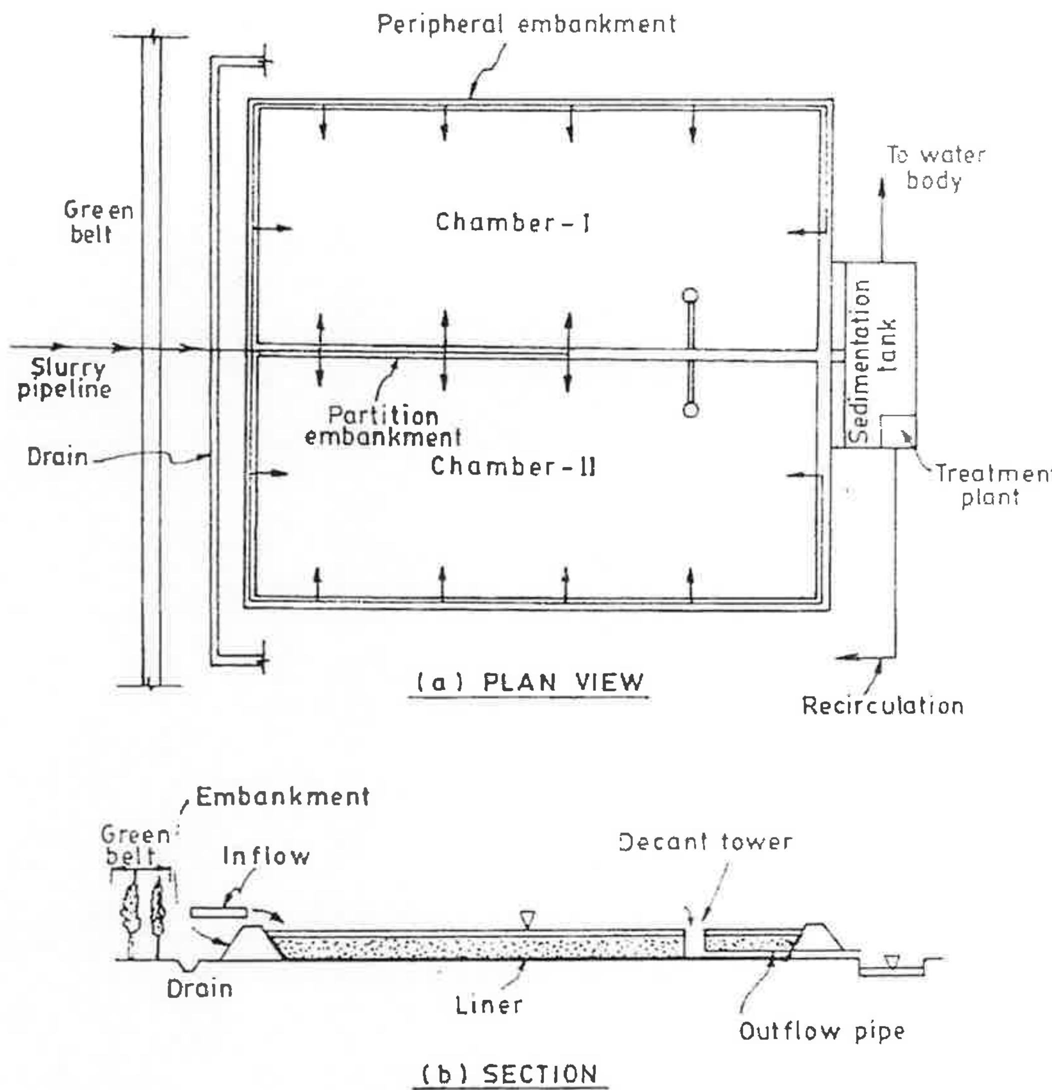


Fig. 4.4 Slurry Disposal in Ash Pond

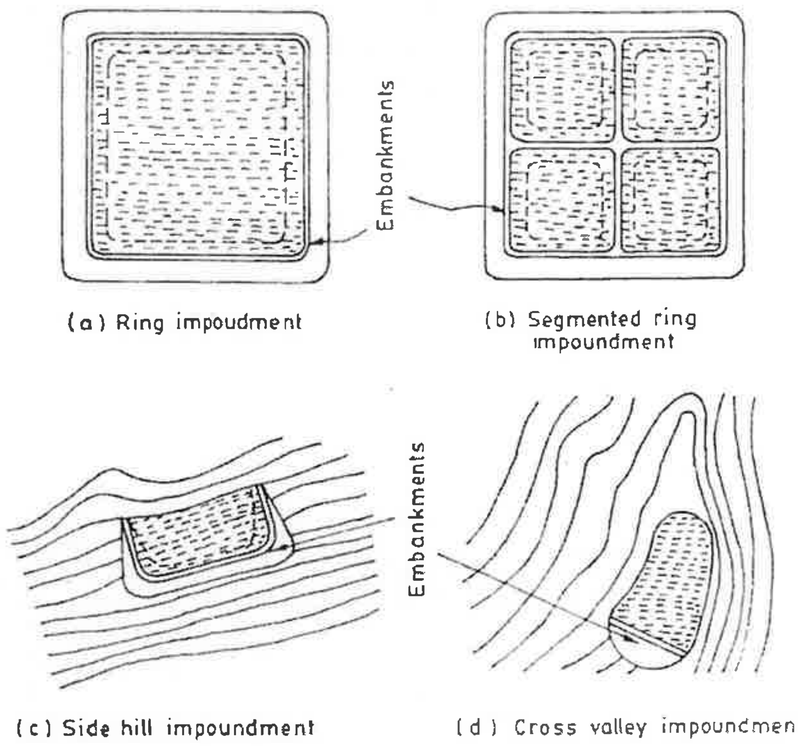


Fig. 4.5 Ash Pond Layout in Plan

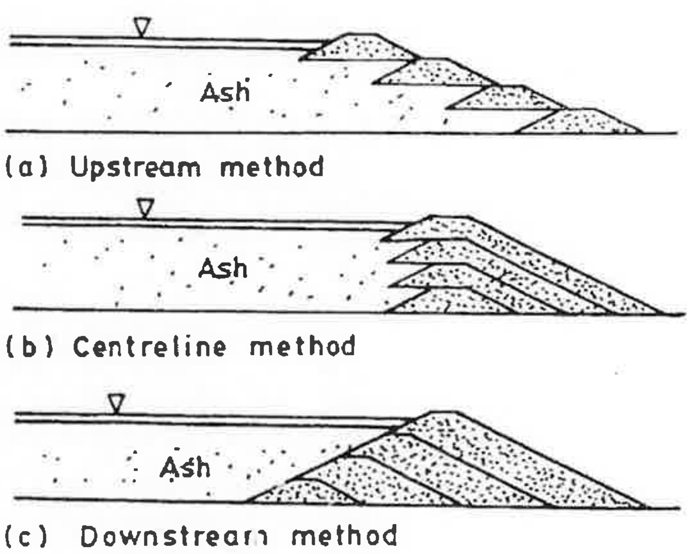


Fig. 4.6 Incremental Raising of Embankments

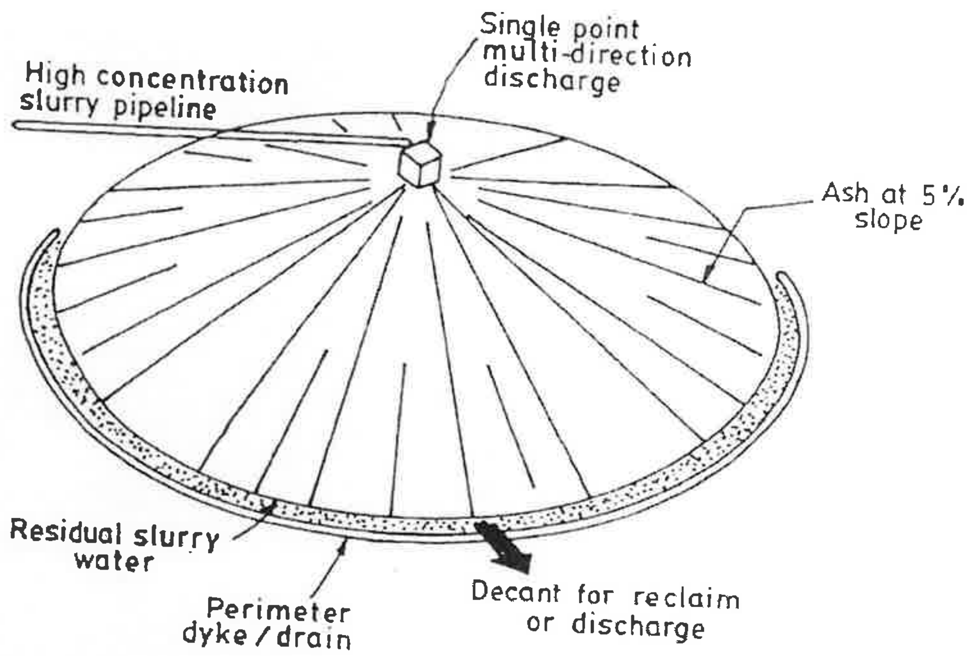


Fig. 4.7(a) HCSD Conical Mound (from single point discharge)

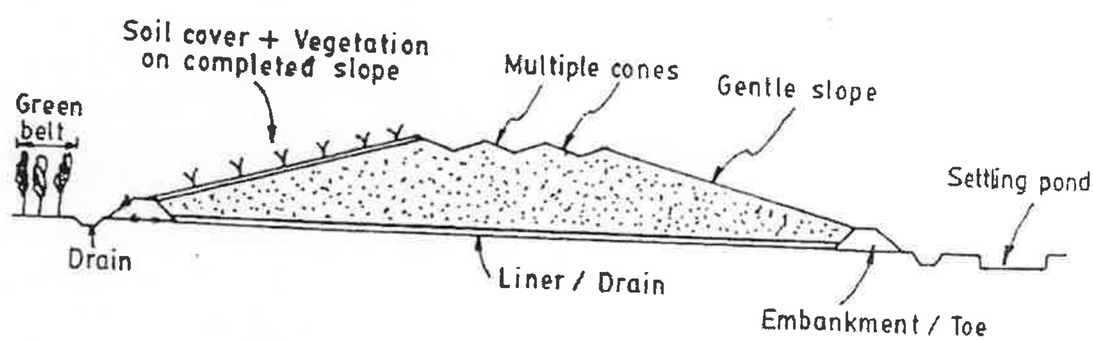


Fig. 4.7(b) HCSD Ash Mound (from multiple point discharge)

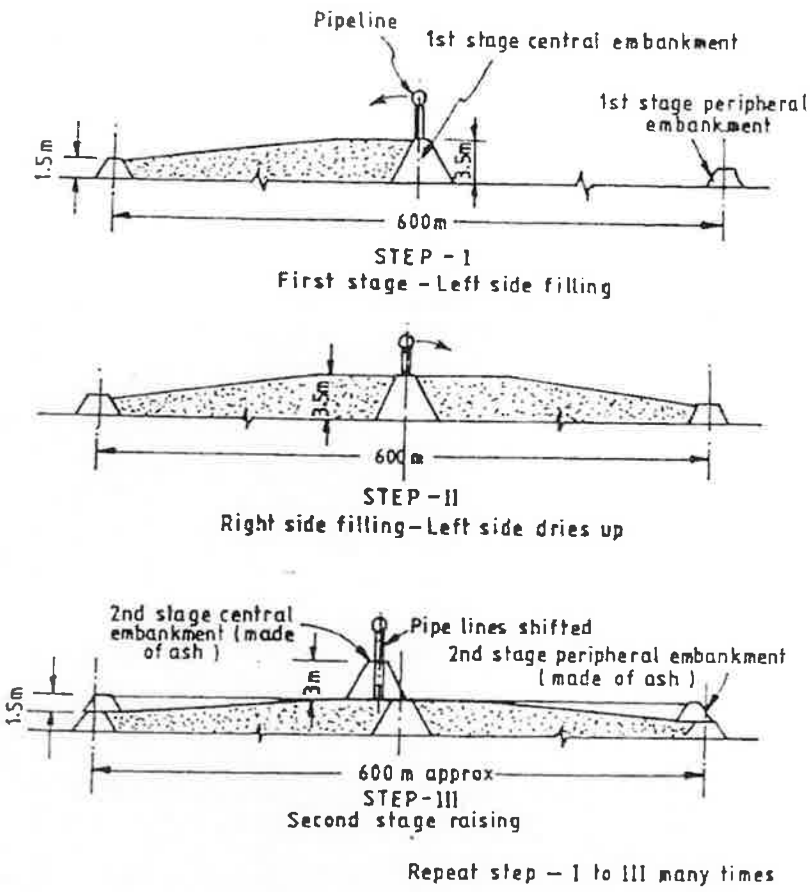


Fig. 4.8 HCSD Mound with Incremental Raising of Embankments

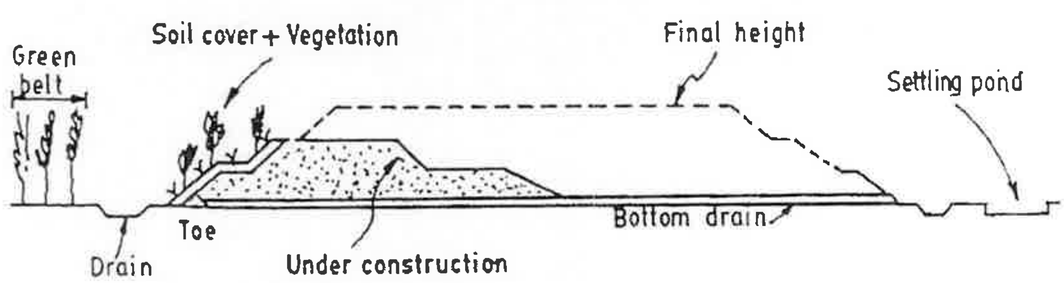


Fig. 4.9 Components of Ash Mound (Dry Ash)

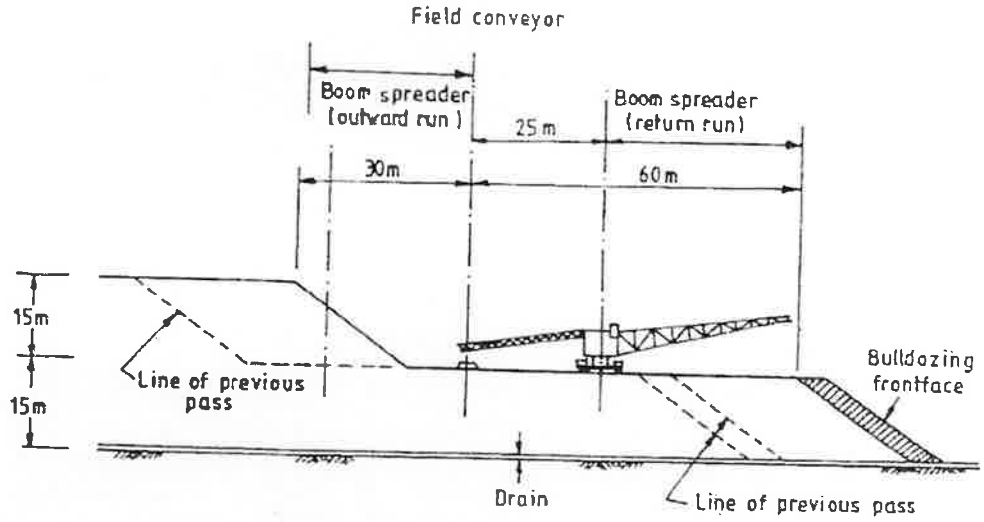


Fig. 4.10 Placement of Dry Ash by Boom Spreader

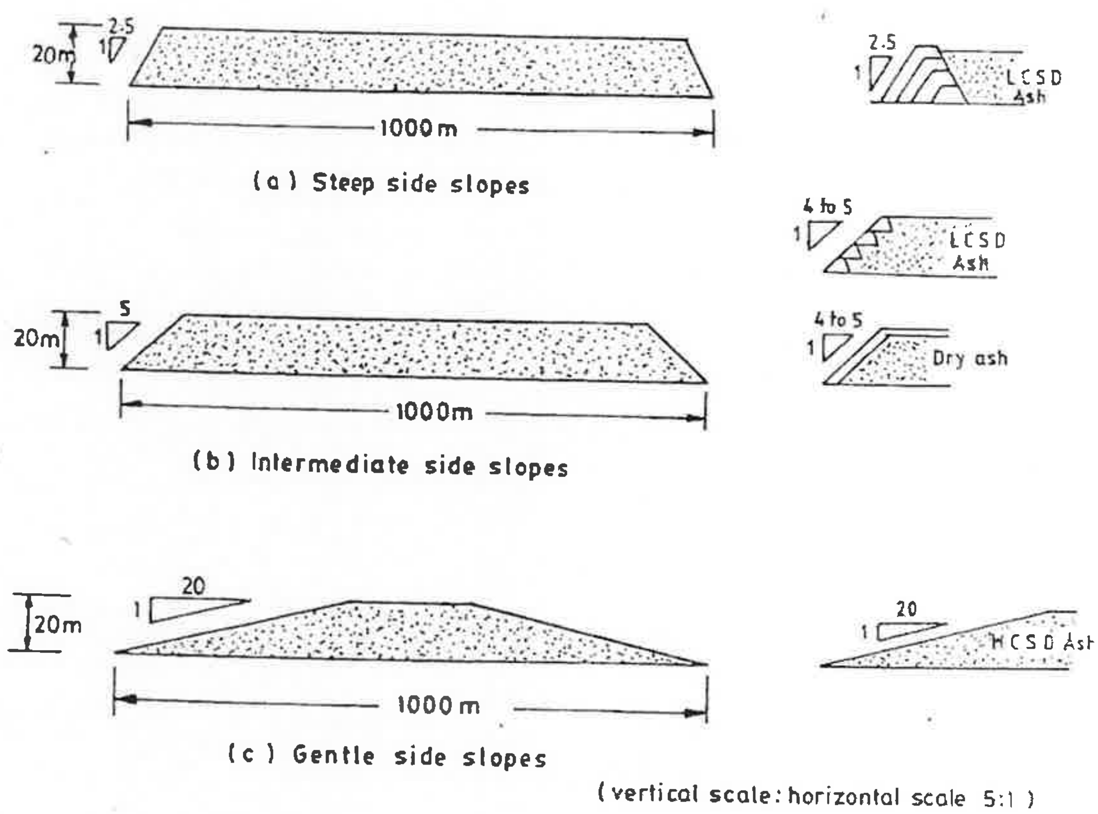


Fig. 4.11 Typical Side Slopes of Ash Storage/Disposal Facilities

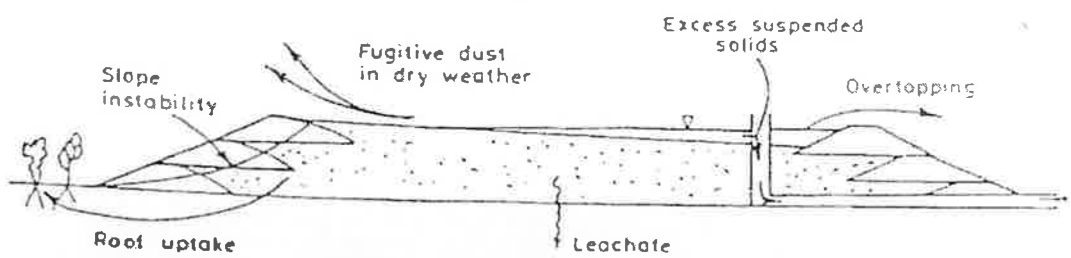


FIG.4.12 POLLUTING PATHWAYS IN AN ASH POND

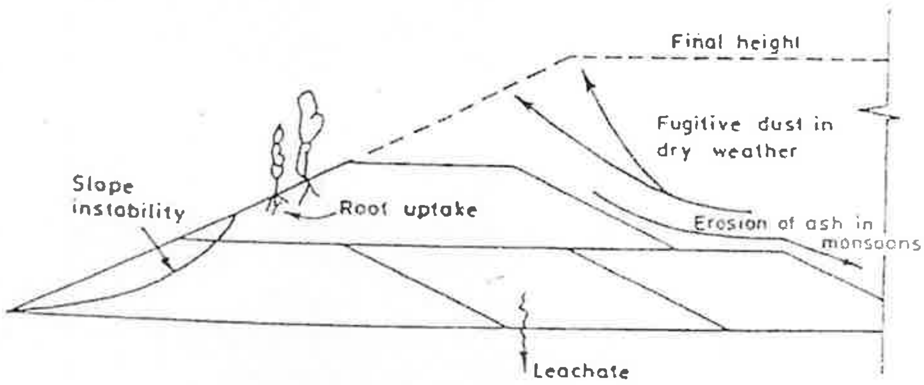


FIG.4.13 POLLUTING PATHWAYS IN AN ASH MOUND

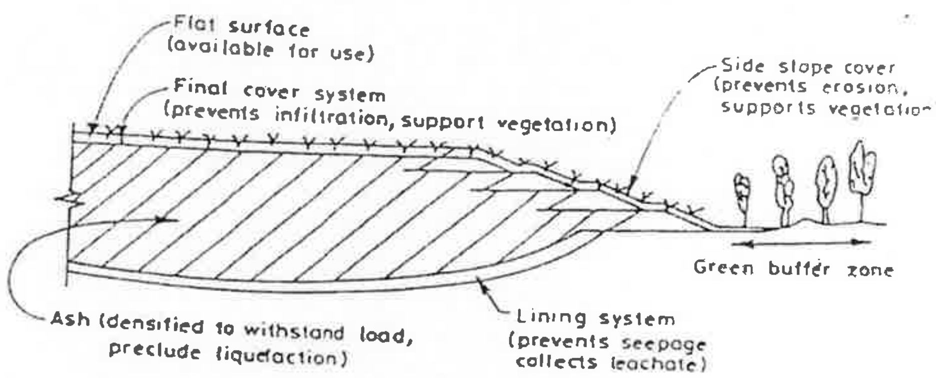


FIG.4.14 ENGINEERED CLOSURE OF AN ASH POND

CHAPTER – 5

RECOMMENDATIONS AND CONCLUSIONS

The coal ash consists of several fractions such as the bottom ash, economiser and air pre heater ash and the flyash. Apart from the quantity of ash of a particular type as a percentage of the total ash generated, these types of ash also differ in their bulk properties and hence the technology used to transport them. These details have been discussed in chapter 1. For example, due to the large sized lumps (even after the grinding at the furnace bottom), the bed ash or the bottom ash can only be handled in slurry form. The economiser, air preheater and ESP ash can be handled either in wet form using slurry systems or in dry form through a pneumatic conveying system. Depending upon the bulk properties, several design options are available both in slurry as well as pneumatic conveying systems. These aspects have been discussed in detail in earlier chapters. The distance of conveying and the ash conveying rate are two important operational parameters which further influence the choice of a particular system. Pneumatic conveying systems to transport dry flyash, for example, have a limitation of about 2 km in terms of conveying distance. The disposal silo for dry flyash will thus have to be located within this distance to enable dry flyash transportation and collection using a pneumatic conveying system.

Apart from the technological options available to handle different grades of coal ash, several locational factors would also influence the choice of a suitable technology for its transportation. The potential to use dry flyash either for the construction activity or in cement production, availability of land for the ash pond and the management commitment for safe transportation and deposition are some of the factors that will need to be considered during the decision making. It is, therefore, important that realistic estimates are prepared to take into account the influence of such factors on the choice of a technology.

In addition to the above, the capital, operation and maintenance costs would be important considerations in adopting a technology for transportation of coal ash. Although exact estimates are not available about the cost of safe maintenance of the ash ponds or the ash mounds, these would definitely be influenced by the technology selected for transportation of ash. In view of the unpredictable levels of utilisation of ash at any power plant, it would be desirable to have provision to make dry flyash available to the prospective users and also to pump it to the ash pond in situations when utilisation levels reduce or completely stop. Addition of such flexibility may add to the capital cost of the ash handling system, but in the long run it may be offset by the savings on the reduced quantity of ash to be pumped into the ash ponds.

The conclusions drawn which would apply to any plant, are presented below.

On the basis of the present study and analysis, the following recommendations can be made for ash handling, transportation and disposal at the thermal power plants.

1. To facilitate availability of dry flyash to the potential users, flyash from the ESP hoppers must be evacuated in dry form using a pneumatic conveying system. The ash can be evacuated using either a positive or negative pressure pneumatic conveying system and collected into a buffer silo. Negative pressure conveying systems are ideally suited for multiple pick up (since these do not require an expensive feeder under each hopper and the discharge from all the hoppers in a particular field can be connected to a common pipeline) provided this is correctly designed. Vacuum conveying systems also require less hardware as compared to the positive pressure conveying system and thus the capital cost of these systems is likely to be lower.

2. In case of dedicated bulk user of flyash, such as the cement grinding unit, the ash from the buffer silo can be transported to another silo some distance away from the ESP operational area. This can be achieved using a positive pressure pneumatic conveying system. Negative pressure or vacuum conveying systems are not suitable for long distance conveying application.

   For users who may require relatively smaller quantity of ash, a bagging unit can be installed under the buffer silo. This system could be capable of filling bags of varying quantity ranging from conventional 40/50 kg bags to jumbo bags of about 1000 kg capacity. It is also possible to make provision for filling bulk tankers directly under the buffer silo.

3. In case dry flyash is not required for any utilisation application, the ash from the buffer silo can be pumped to the ash sump via a collector tank. A vacuum system can be used to draw ash from the buffer silo into the collector tank. It can then be pumped into the sump. For the new power plants, it is recommended that the sump may be so designed that the flyash and the bottom ash could be handled separately. Bottom ash being a coarser material can be very useful for filling applications since it has no settling problems like the flyash.

4. The evacuation of bottom ash can continue in slurry form as is the practice currently followed in all the thermal power plants. After grinding the bottom ash is pumped to the ash sump. The concentration of the ash in the slurry can, however, be increased by improved design. The economiser and air pre heater ash can also be pumped to the ash sump along with the bottom ash unless it is specifically required for utilisation at any plant. This is primarily due to the fact that the conveying performance of economiser ash in a pneumatic conveying system is very much different from the performance of the ESP ash. Thus a pneumatic conveying system design would be more complex if it has to handle both grades of the coal ash.

5. Ash collected in the sump can be pumped to the ash pond using a wet disposal method. It is worth mentioning again that the concentration of ash in the slurry is a major factor to be considered. The present dilute slurry design is not an efficient one and needs to be improved upon. After considering the merits of various alternatives available, it is recommended that ash from the sump to the pond may be pumped in the form of a medium concentration slurry. The concentration of ash in this system can be in the range of 40- 50% (by weight). This would enable the existing centrifugal pumps to be used. This would also result in lower specific power consumption for pumping the slurry.

6. Ash disposal in the form of low concentration slurry, in ash ponds, may be gradually phased out and replaced by medium concentration slurry.

7. Bottom ash and flyash should preferably be stored in separate chambers of ash ponds and mounds to help in enhancing the future utilization of ash for different end uses.

8. For those plants where it is intended to handle the coal ash in completely dry form, dry ash may be collected in large disposal silos using pneumatic conveying systems. From the disposal silo, several options are available to transport the ash to the ash mound such as conveying systems and trucks/dumpers.

9. Dry disposal of ash in mounds may, however, be adopted only at those locations where availability of land is a major constraint.

10. Disposal of ash in the form of high concentration slurry may be adopted only after sufficient data has been generated on the viability of this method through the laboratory and field studies for the Indian coal ash.

11. All ash disposal facilities, ponds or mounds, must be designed to meet the requirements of physical stability and environmental safety for all the three phases of the life of the facilities, namely (a) the construction and operation phase; (b) closure phase and (c) post – closure phase.

The above recommendations have been made keeping in view the need to promote ash utilisation but also to ensure safe disposal using an appropriate technology at the same time. A summary of the above recommendations is presented in Fig. 5.1

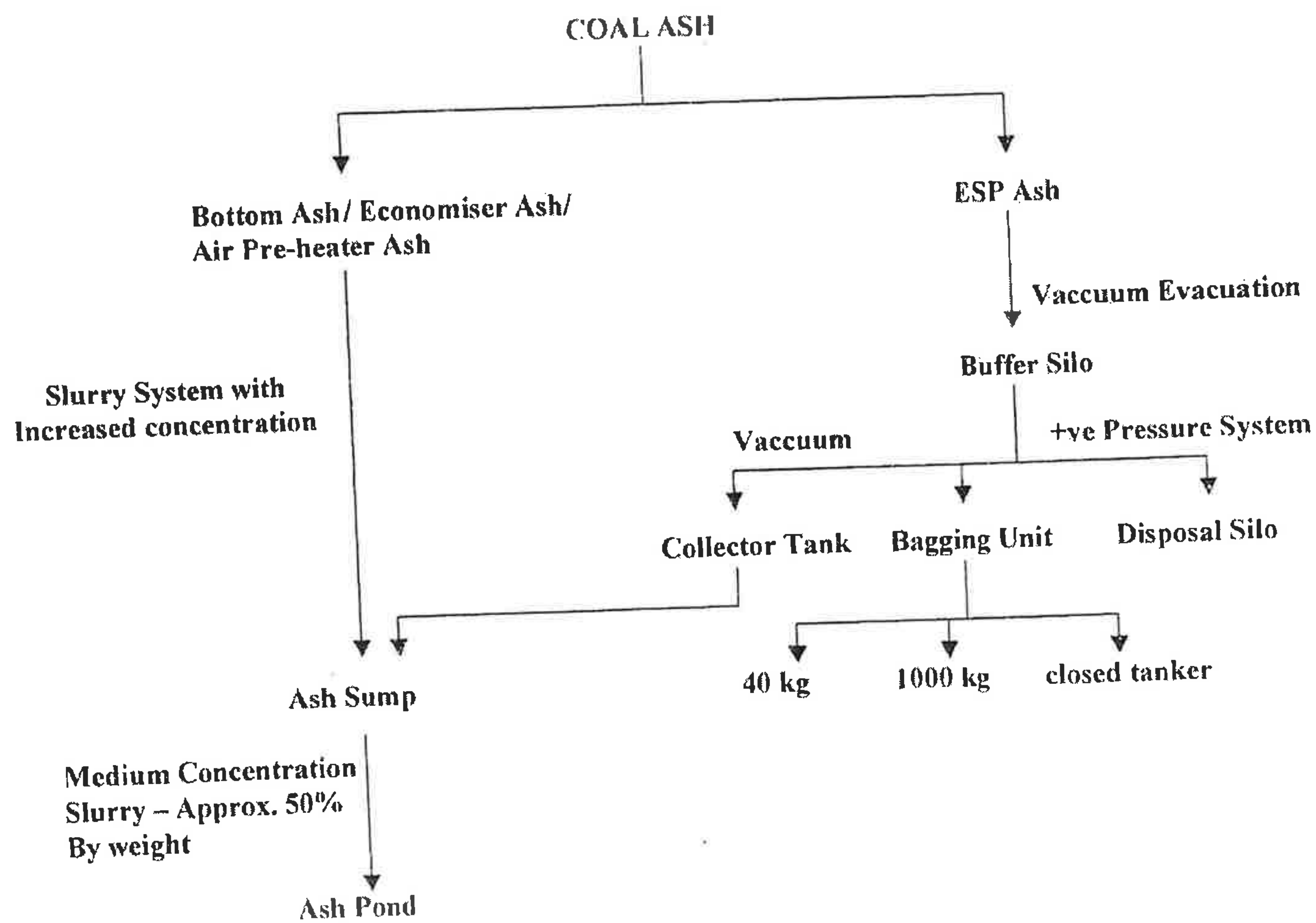


Figure 5.1 : RECOMMENDED OPTIONS FOR COAL ASH HANDLING AND SAFE DISPOSAL

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ANNEXURE - II

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Guidelines for disposal/utilisation of Fly Ash for reclamation of Low Lying Areas and in stowing of Abandoned mines/Quarries

cpcb

Central Pollution Control Board
March, 2019

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2. Guidelines for Low Lying area development using Ash, ash Policy 2015, NTPC Ltd.

3. Permission of DGMS to M/s JSPL & JPL for disposing ash in coal mines

Guidelines for disposal/utilisation of flyash for reclamation of Low Lying Areas and in stowing of Abandoned mines/Quarries

1.0 Introduction:

Management of huge quantity of ash (fly ash, bottom ash and pond ash) generated from coal fired Thermal Power Plants (TPPs) is a serious environmental challenge. Ash generation from coal or lignite based thermal power plants, has increased from 40 Million tonne per year in 1993-94, to more than 200 Million tonne per year in 2017-18 and is projected to increase to 275 Million Tons / year by 2032.

The ash generation in coal and lignite based thermal power plants in various forms such as dry ash, bottom ash, pond ash and mound ash that are required to be managed in such a manner that it does not affect the environment. Utilisation of ash for reclamation of low lying areas and abandoned quarries is recognised as an alternate option and therefore, MoEF&CC has issued a notification to address utilisation off ash for various purposes including these two options

The Ministry of Environment, Forest and Climate Change (MoEF&CC) issued the Fly Ash notification on 14th September, 1999, which has subsequently been amended in 2003, 2009 and 2016. The Fly Ash notification (1999) mandates the use of fly ash for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels or any other material and for construction of roads, embankments, dams or for any other construction activity within a radius of 300 km from thermal power stations (TPPs). Besides, it also mandates use of fly ash in mines backfilling or stowing of mines within a distance of 50 km.

2.0 Status of fly ash utilisation:

Since 1999 when flyash utilisation was made mandatory, the utilization of fly ash has increased from 6.64 million-ton in 1996-97 to 147.7 million-ton in 2017-18. Fly ash generation and utilization in 2017-18 from 182 coal/lignite based TPPs of various power utilities in the country was 220.7 and 147.7 million-ton, respectively. The percentage of fly ash utilization during 2017-18 has been 66.9%. During 2017-18, out of total fly ash generation, 35.6 % of total fly ash was used in the cement sector, followed by 14.28 % in making bricks & tiles, 11.57 % stored in ash dyke raising, 7.99% in mine filling, 16.85 % in reclamation of low lying area, 5.43 % in roads & embankments, 1.34% in concrete making, 0.21 % in agriculture, 6.73 % in others and 33.1% remained as unutilized fly ash.

Mine reclamation represents a potential beneficial use of flyash that has been receiving increased attention in recent years. Coal mining operations have produced both open pits and deep underground mine voids that can be filled by flyash. Placement of flyash into deep mines can provide structural support to abate subsidence, and placement of flyash in surface mines or other open pits can aid in restoring mined land to beneficial use. The use of flyash as mine backfill may provide the additional benefit of limiting impacts of acid mine drainage (AMD). Mostly flyashe is alkaline material that can neutralize acidic water and/or inhibit production of acid. Placement of fly ash may also reduce the permeability of mine strata and divert water away from acid-generating materials. Although flyash possess these beneficial physical and chemical properties, there are concerns regarding potential for release of toxic chemicals in the leachates from the fly ash. Therefore, scientifically sound fly ash management is needed so that environmental concerns can be adequately and reliably identified and addressed.

3.0 Need of Guidelines:

Ministry of Environment and Forests and Climate Change (MoEF&CC) vide Notification No. S.O. 763 (E) dated 14th September 1999, last amended on 25th January, 2016 issued following directions for reclamation low lying area and stowing of mines;

i. No agency, person or organization shall within a radius of three hundred Kilometres of a coal or lignite based thermal power plant undertake or approve or allow reclamation and compaction of low-lying areas with soil; only ash shall be used for compaction and reclamation.

ii. Soil required for top or side covers of embankments of roads or flyovers shall be excavated from the embankment site and if it is not possible to do so, only the minimum quantity of soil required for the purpose shall be excavated from soil borrow area. In either case, the topsoil should be kept or stored separately. Voids created at soil borrow area shall be filled up with fly ash with proper compaction and covered with topsoil kept separately as above and this would be done as an integral part of embankment project.

iii. No person or agency shall within fifty kilometers (by road) from coal or lignite based Thermal Power Plants, undertake or approve stowing of mine without using at least 25 % of fly ash on weight to weight basis, of the total stowing materials used and this shall be done under the guidance of the Director General of Mines Safety (DGMS).

iv. No person or agency shall within fifty kilometers (by road) from coal or lignite based Thermal Power Plants, undertake or approve external dump of mining Over Burden (OB) without using at least 25 % of ash on volume to volume basis of the total materials used for external dump of overburden and same percentage in upper benches of back filling of opencast mines and this shall be done under the guidance of the Director General of Mines Safety (DGMS);

v. All agencies undertaking construction of roads of flyover bridges and reclamation and compaction of low lying areas, including Department of Road Transport and Highways (DORTH), National Highways Authority of India (NHAI), Central Public Works Department (CPWD), State Public Works Department and other State Government Agencies, shall within a period of four months from the publication of this Notification " make provisions in their tender documents, schedules of approved materials and rates as well as technical documents for implementation of this Notification, including those relating to soil borrow area or pit".

vi. The pond ash should be made available free of any charge as is as where basis to manufacturers of bricks, blocks, tiles including clay flyash bricks production manufacturer's units, farmers, central and the state road construction agencies, Public Works Department and to agencies engaged in backfilling or stowing of mines.

Though, flyash utilisation has gained momentum progressively over the years, further efforts are required to explore new areas of ash utilisation. With suitable safeguards, mine backfilling including disposal of flyash in abandoned quarries and road construction specially in the construction of National Highways and Expressways could be the major mode of flyash utilisation in the near future as these areas have vast potential. It would perhaps be desirable that the concerned Ministries should take steps in sorting out the bottlenecks such as declaring a list of abandoned mines, making adequate provisions in respective schedules for flyash utilisation by the Indian Road Congress & construction agencies etc.

MoEF & CC vide letter dated 01.03.2019 asked CPCB to come out with guidelines based on Odisha Pollution Control Board experience for reclamation of low lying areas and abandoned quarries with ash as recommended by the Expert Committee that was constituted by Niti Aayog vide O.M. No. 25 (11)/2014-Minerals dated 12.06.2018 for developing a focus strategy for best utilisation of fly ash to manufacture end products recommended.

The scope of guidelines covers transportation and disposal of flaysh in low lying areas and abandoned quarries in an environmentally friendly manner.

4.0 Loading/unloading and transportation of flyash

4.1 Current Practice for Handling & Disposal of Flyash & Bottom ash (within the power plant)

Flyash is collected in dry form from ESP hopper and disposed either in dry form or through wet slurry form. While, bottom ash collected at the bottom of boiler and is disposed in wet slurry form into the ash ponds.

Following technologies are conventionally used for handling & disposal of flyash and bottom ash collected from ESPs hoppers and boiler bottom respectively within the plant or upto the ash pond area:

I. Dry Pneumatic conveying
II. Dry (moist) Conveying system through belt conveyor/tube belt conveyor
III. High concentration slurry disposal system
IV. Medium concentration slurry disposal system
V. Lean concentration slurry disposal system

Amongst the above technologies, Dry Pneumatic conveying, Medium concentration slurry disposal system, High concentration slurry disposal system, and Dry (moist) Conveying system through belt conveyor/tube belt conveyor are preferable as compared to Lean concentration slurry disposal system.
The dry ash is typically conveyed pneumatically from the ESP or filter fabric hoppers to storage silos where it is kept dry, pending utilization or further processing, or to a system where the dry ash is mixed with water and conveyed (sluiced) to an on-site storage pond. Fly ash is stored in silos, domes and other bulk storage facilities. Fly ash can be transferred using air

slides, bucket conveyors and screw conveyors, or it can be pneumatically conveyed through pipelines under positive or negative pressure conditions.

Dry fly ash collected is also be suitably moistened with water and wetting agents, as applicable, using specialized equipment (conditioned) and hauled in covered dump trucks for special applications such as structural fills. Water conditioned fly ash can also be suitably stockpiled at jobsites. Exposed stockpiled material must be kept moist or suitably covered to prevent fugitive emission.

The dry bottom ash removal and its transportation is certainly more environment friendly, compared to that of wet ash removal and transport system.

4.2 Guidelines for loading, unloading, storage, transportation of flyash

The power plants need to maximise dry collection of fly ash & bottom ash and also adopt adequate measures to prevent fugitive dust emission during loading, unloading, storage, transportation and various uses of dry as well as ash bottom ash and pond ash. Following guidelines are, therefore, suggested for prevention of pollution and augmentation of flyash utilisation

4.2.1 Maximise dry collection of fly ash and bottom ash

a. Coarse fly ash from first field of ESP hoppers need to be collected and stored separately.

b. Fine fly ash from second field onwards of ESP Hoppers should be collected separately. For some specific usage, fine fly ash may be passed through Classifier for further separation of fine fly ash and stored in separate silo.

c. Bottom ash which is not utilised presently could also be collected in dry form and converted into a valuable resource if processed to match the end use specification. Wet collection & disposal of bottom ash should be minimised as far as possible

4.2.2 Loading, Unloading and Storage

Installation of Bag Filters with dry flyash collection and storage in Silos at loading and unloading points are standard practices at both locations i.e loading at power plant site as well as at the unloading point at user's site. Suggestions for further improvement in existing practices are as under:

a. Current practice of loading of fly ash in Bulkers/Tankers requires improvement at the stage of loading of fly ash in Tankers. The opening of telescopic chutes at the loading end should be air tight and confined to avoid fugitive dust emission.

b. The Pollution Control Equipment / Cascade Filters, attached with fly ash loading chute should be periodically cleaned along with regular scheduled maintenance of bag filter to avoid choking and malfunctioning of Bag Filter. It would mitigate the dust emission during loading of fly ash.

c. Malfunctioning of level sensors can be avoided, with regular maintenance, to prevent over filling of fly ash in Tankers .

d. The Weigh Bridge to be installed under fly ash loading chute to fill just the required quantity of fly ash in tankers so that overflow/spillage of fly ash in open areas is avoided which otherwise results in heavy fugitive emission all around.

e. Opening of tankers need to be properly locked during transportation of fly ash. Automatic opening / closing system need to be installed without fail.

f. Current practice of unloading of fly ash from tanker to storage hopper through pneumatic system is fairly good. Otherwise, the leakage of fly ash will occur at bends and joints of transportation pipe line. The fly ash being abrasive in nature causes damage at bends and joint locations. Fly ash should, therefore be transported through PVC coated pipes to avoid abrasion otherwise it may lead to leakage of flyash. The mechanical unloading system should be envisaged to avoid high pressure and dust leakage from unloading pipe lines. As far as possible, number of bends should be minimised.

g. The fly ash storage silo should be of or coated with anti-abrasive or anti-corrosive material. It is better to provide concrete silo/hopper to avoid leakages.

h. Proper functioning of all the level sensor of Storage Hopper to be ensured to avoid any possible spillage from Hopper opening.

i. The Bag Filter made of anti-abrasive material/cloth be provided with telescopic chute.

j. Dumping of ash in Ash pond should be done mechanically in moist condition so that ash does not get air borne and pose fugitive dust problem.

k. The bottom ash discharged from boiler bed, may be transported pneumatically in dry form / in slurry form to the ash pond

4.2.3 Transportation

Fly ash transportation has many challenges like distance to be transported, form of ash i.e. dry or wet ash, user's requirement, economic feasibility, requirement of surrounding vicinity and many other site specific issues. In any case, control of dust emission during transportation is prime concern and more challenging being a non-point source of pollution and larger area coverage due to movement from one place to other passing through various receptors. As flyash is used by different users for different purposes such as cement manufacturing, brick manufacturing, mine back filling, road construction and filling of low lying area, the handling and transportation have to accordingly decided. Following modes of transportation and precautions are suggested for mine back filling and development of low lying areas by disposal of flyash or bottom ash to avoid fugitive dust emission:

a. Transportation for abandoned mine back filling

I. Pipe conveyors, wherever feasible, based on the topography of the area should be used.
II. Tankers/ railway wagons/ bulkers or mechanically designed covered trucks need to be used
III. Thermal Power Plants using wet ash disposal, if permitted can transport ash slurry directly to abandoned mine through ash slurry pipe line.

b. Transportation for filling of low lying area

I. Tankers/ bulkers or mechanically designed covered Trucks need to be used.

In no case, flyash or bottom ash shall be transported by open trucks / trollies irrespective of distance or end use. Thermal power plants and fly ash user agency shall collectively ensure that fly ash or bottom ash is transported in environmentally sound manner by following the guidelines mentioned in para 4.2.3 & 4.2.4.

4.2.4 General Code of Practices for Maintenance of roads, vehicles and conditioning of flyash

a. Roads inside power plant and that of flyash user agency should be paved and plantation of adequate width should be done at both sides. Mechanised road sweepers should be deployed. In addition, adequate arrangements for water sprinkling should be made to suppress fugitive dust emission, if any.

b. Thermal power plants and user agencies should make arrangements (two stages) for washing of wheels of the vehicles (bulkers/trucks) before deployed for fly ash ransportation.

c. Pond ash to be transported should be conditioned with water to maintain minimum of 15% moisture at the disposal point so that ash does not get air borne and cause fugitive emission.

d. Adequate free board in trucks should be kept to avoid overflow/spillage during transportation.

e. In case of any spillage enroute during transportation of fly ash, the agency shall ensure that spilled ash is collected and transported to the disposal/usage site immediately.

f. All the bulkers and trucks responsible for carrying fly ash should be with valid Pollution Under Control certificates.

g. Provision should be preferably made for weighing of fly ash loaded into tankers/ railway wagons/bulkers etc under the silo.

h. The speed limit of vehicles carrying flyash should be strictly enforced and it should not exceed 40 km per hour.

i. State Pollution Control Boards shall clearly indicate mode of transportation and method of loading and unloading while granting the consent.

j. Transportation of flyash through thickly populated areas should be avoided as far as possible.

k. General awareness/ training programmes be organised regularly for tanker operating staff like drivers and cleaners on the impact of hazards of fly ash.

5.0 Reclamation of Low Lying area using Ash

Filling of Low lying areas inside the plant premises and outside within 300 km. of power plant may be taken up using ash. Low lying area reclamation with ash should be taken up adopting standard practices as per 2015 technical specification mentioned in NTPC Policy. Following steps should be taken up prior to initiate low lying area developmental activities.

5.1 Preconditions:

5.1.1 **Consent from land owner:** Consent/ permission should be obtained in writing from the land owner before start of work.

5.1.2 **Permission from Regulatory authority:** Power plant/ land owner/ agency shall obtain statutory permission from regulatory authorities such as SPCB as per the requirement.

5.1.3 **Prevention of pollution:** Suitable methods should be adopted and necessary arrangement should be made to prevent pollution during excavation of pond ash at ash pond, filling area and during transportation of ash.

5.1.4 **Soil Cover on the top of ash fill:** As per the MOEF&CC gazette notification of ash utilization dated 14-09-1999 and as amendment on dated 27-08-2003 and 03-11-2009, the soil required for soil cover shall be excavated from land fill site itself and kept separately before taking for ash filling. If it is not possible to do so, only the minimum quantity of soil required for the purpose of cover shall be excavated from the soil borrow area. The voids so created due to removal of soil shall be filled up with ash with proper compaction and covered at top with soil cover. About 300-500 mm thick soil layer shall be placed over the ash fill area. This should be done as an integral part of low lying area development work.

5.1.6 **Restrictions :**

Reclamation of area by ash shall not be permitted in the following areas :

i. Flood plain area/Ecologically Sensitive Areas.
ii. Agriculture land / area.
iii. Reclamation of Forest land / area is permissible only if clearance from MoEF&CC as per Forest Conservation Act, 1980 is available.
iv. Gochar Kisan Land.

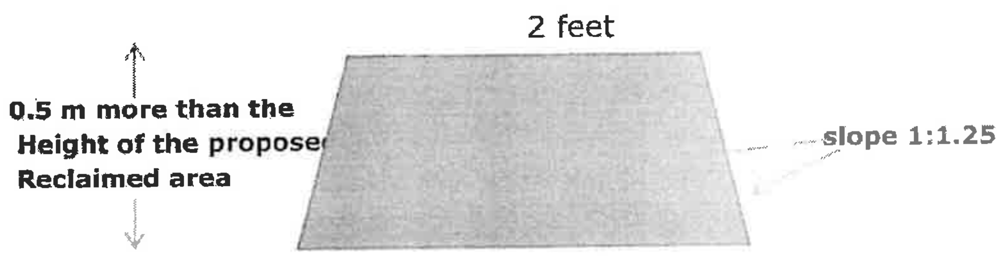
5.2 Preparation of filling area

5.2.1 The entire area meant to receive the ash and earth filling shall be stripped by minimum 150 mm. The exact depth of stripping shall be decided by the Engineer-in-Charge depending upon nature of top soil and the vegetation present. All organic matter, vegetation, roots, stumps, bushes, rubbish, swamp materials, etc. shall be removed from the site. The stripping material and other unsuitable materials as referred above shall be kept away from the area to be filled up so that these do not get mixed up with filling material and disposed off to a place as decided by the Engineer-in-Charge.

5.2.2 Levelling

All existing undulations, holes, cavities and excavations made for plate load rests and other soil investigations, etc. shall be filled with pond ash having requisite moisture content. The ash thus filled shall be compacted with the help of vibratory rollers so as to achieve dry density of not less 95% as per I.S-2720 (Part-VII). This would result in a levelled surface upon which layer wise filling of compacted ash can be done.

5.2.3 Protection of pond or water body adjoining or within the working site: If any pond or water body exists within or adjoining the low lying area /quarry then an earthen embankment of the cross-section as given in the Figure below be constructed around the pond or water body to protect it from
spilling of ash or ingress of surface runoff into it.



Cross- section of water body protection embankment

The soil used for the embankment should neither be granular nor black cotton soil. It should be of good quality for geo-technical application. Soil should be compacted to 95% proctor by Vibratory Roller of 15 T minimum capacity, in the layers of 25-30 cm and the optimum moisture content determined before execution of work. After attaining the desired height, the disposal area should be thoroughly compacted, graded followed by soil cover at least 15 cm thickness for proper reclamation of the land by grass turfing or appropriate plantation.

5.3 Excavation of pond ash from borrow area

5.3.1 Borrow Area-location

The location and permissible depth of excavation of the Borrow areas for pond ash shall be got specifically approved from concerned Thermal Power Station. The boundaries and permissible depth of excavation so approved shall be strictly followed and no deviation shall be allowed. Similarly, routes for movement of all ash transportation vehicles, water tankers, equipment, etc. shall be got approved from Thermal Power Station. These shall be strictly followed and no deviation shall be allowed.

The excavation surfaces and surface of waste materials shall be left in a reasonably smooth and even condition. All the excavations within the ash pond shall be at a minimum slope of 4 (Horizontal): 1(Vertical)

5.3.2 Site Clearance

All areas required for borrowing shall be cleared of all trees and stumps, roots, bushes, rubbish and other objectionable material. Particular care shall be taken to exclude all organic matter from the ash to be placed in the fill. The cleared areas shall be maintained free of vegetation growth during the progress of the work.

5.3.3 Stripping

Borrow area shall be stripped of top layer by a depth of minimum 150 mm. The exact depth of stripping shall be decided by the Engineer-in-charge depending upon nature of top layer and the vegetation present.

5.3.4 Borrow area watering & dewatering

The natural moisture content of material in the borrow areas as well as the optimum moisture corresponding to the Proctor's maximum dry density for the material in the particular borrow area shall be obtained from laboratory tests. Additional moisture, if required, shall be introduced into the borrow area by watering well in advance of excavation to ensure uniformity of moisture content. If in any borrow area before or during excavation there is excess moisture, steps shall be taken to reduce the moisture by the selective excavation to secure the materials of required moisture content by excavating drainage ditches, by all owing adequate time for drying or by other means. To avoid formation of pools in the borrow areas during excavation operations, drainage ditches from borrow areas to the nearest outlets shall be excavated so as to obtain homogeneous mix. In general, all materials from a particular borrow area shall be mixture of materials obtained for the full depth of cut.

5.3.5 Earth cover in Borrow Area

It shall be the responsibility of Thermal Power plant to arrange sweet soil from approved external borrows areas. The earth cover material shall consist of sandy loam free of admixture of stiff clay, refuse, stumps, roots, rock, bushes, weeds or any other material which would be detrimental to the proper development of vegetation growth. It shall not contain stone of size 25 mm and over . The loamy top soil shall be of healthy crops, grass or other plant growth, that is of good quality and reasonably free draining. Other specifications for Borrow area e.g. site clearance, stripping, Borrow area watering/De-watering etc. shall be as per relevant clauses of Borrow area for ash as outlined above i.e clause nos. 5.3.1 to 5.3.4.

5.4 Filling with pond ash

5.4.1 Placement

After the area has been prepared and levelled, pond ash excavated from Borrow areas having required moisture content shall be placed in layers not exceeding 300 mm in compacts thickness. The placing operations shall be such that in strips of 10-15 m of the material when compacted in the fill will be blended sufficiently to produce specified degree of compaction and stability. No stones, cobbles or rock fragments, having maximum dimensions more than 100 mm shall be placed in the fill. Stones and cobbles shall be removed either at the borrow pit site before it is used as soil cover.

5.4.2 Procedure

The material shall be placed in the fill in continuous horizontal layers, stretching right across the whole section, not more than 300 mm in compacted thickness and rolled as herein specified. The length of one layer shall not exceed 150 meters at one stretch. The layers shall be compacted in strips overlapping not less than 600 mm, if the rolled surface of any fill is found to be too wet for proper compaction, it shall be raked up, allowed to dry, or shall be worked with a harrow or any other approved equipment to reduce the moisture content to the required amount and then it shall be re-compacted before the next layer of ash is placed. Ash surfaces are likely to become dry in short intervals especially during hot and dry weather and hence enough moisture shall be added between difference passes to ensure proper compaction

5.4.3 Compaction

The compaction of each layer shall be carried out so as to achieve maximum in-situ dry density 95% of maximum dry density (MDD) of the material found out as per I.S 2720 (Part VII). To achieve maximum compaction level use of vibratory rollers shall be made. Required number of passes shall be made so as to achieve desired compaction. Number of passes required shall be verified through trials tests before actual execution of work. The broad specifications of vibratory rollers required for the purpose is as follows:

a)Static Weight = 6 to 10 t
b)Static Linear Load = 20 – 35 kg/cm
c)Frequency = 18 – 30 Hz (1100 to 1800 vibrations/ minute)
d)Amplitude of vibrations = 0.5 mm to 1.5 mm

5.4.4 Moisture control

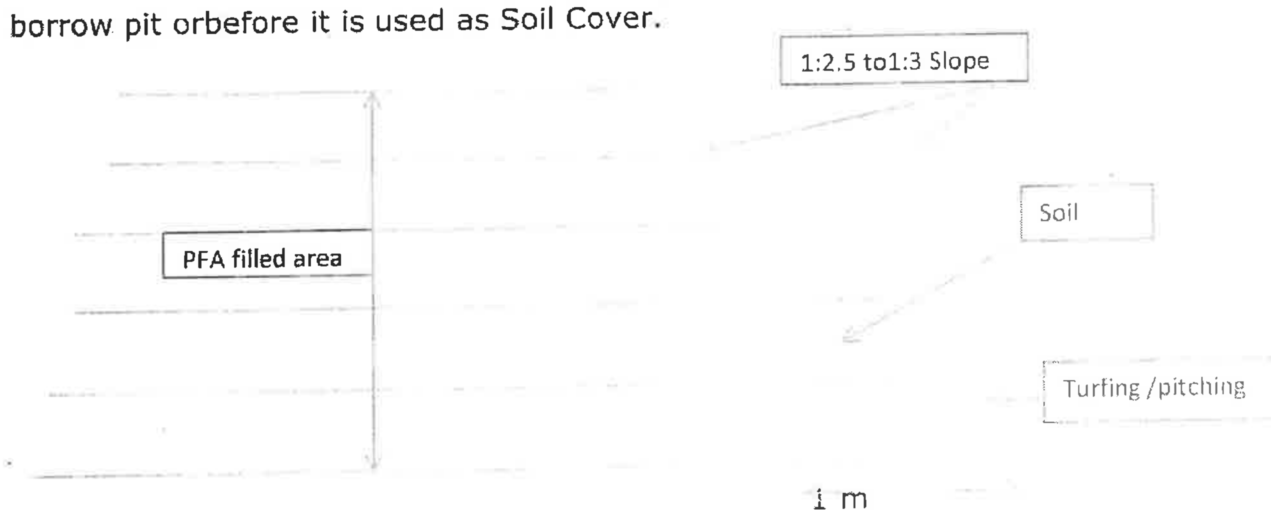
So far as practicable, the materials shall be brought to the proper moisture content in the borrow area before excavation. If additional moisture is required, it shall be added at the fill site by sprinkling water before rolling the layer. Thermal Power Plant shall make arrangements for supply of water to the borrow areas as well as to the fill area. If the moisture content is more than requirement, the material shall be spread and allowed to dry before rolling. The moisture content shall be at most uniform throughout the layer of material and ploughing or other methods of mixing to obtain uniform distribution. If the moisture content is more or less than the range of the required moisture content, or if it is not uniformly distributed throughout the layer, rolling shall be stopped, and shall be started again only when the above conditions are met with.

Fill materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the materials.

5.4.5 **Placement of earth cover in filing area**

Earth cover shall be laid simultaneously with the laying of compacted ash layers and on side slopes. As in the case of ash layers, compacted thickness of earth layers shall not be exceeding 300 mm. As far as top cover of earth is concerned, after the area has been covered with compacted ash up to 500 mm below the required finished level of the area, a compacted layer of 500 mm thickness of suitable earth shall be placed over ash surface. This cover shall be placed in layers, each layer shall be of 250 mm in compacted thickness.

The combined excavation and placing operations shall be such that the materials when compacted in the fill will be blended sufficiently to produce specified degree of compaction on stability. No stones, cobbles or rock fragments, having maximum dimensions more than 25 mm shall be placed in the earth cover. Such stones or cobbles shall be removed either at the borrow pit orbefore it is used as Soil Cover.



Exposed boundary configuration

Other requirements of earth cover laying shall be similar to those of ash laying i.e. as outlined in 5.4.1 to 5.4.4 above.

5.5 Prevention of Pollution

It shall be responsibility of thermal power plant or his contractor that no air borne and water borne pollution shall occur during all stages of operations such as in Borrow areas, during transportation of ash/ earth, during placement of fill material etc. All measures such as water sprinkling covering moist ash/ earth with tarpaulins in open trucks, etc., shall be taken to done care of above.

6.0 Disposal of flyash in voids of abandoned mines

As per notifications 1999 and 2009, power plant shall undertake or approve stowing of mines without using at least 25% of fly ash on weight to weight basis, of the total stowing materials used. Mine void filling on pilot basis is being carried out at the power plants of NTPC Ltd., Bhushan Steel and NALCO in Odisha with prior permission from MoEF & CC and OSPCB. Based on their experience and study conducted by CMPDIL, Ranchi for NTPC Talcher, following methodology is suggested for filling of mine voids with flyash.

6.1 The power plant authority shall carry out following study prior to taking up ash disposal activities in mine void to ensure no change/damage/deterioration in water quality and hydrology in and around the proposed area:

- Ash Characterisation and Leachate Study (Table 1.1)
- Techno-Economic Feasibility Study for disposal of ash into the Quarry
- Topographical Survey of Pipeline Corridor & Mine Void area
- Feasibility of transportation of ash to mine void
- Geotechnical study of the Pipeline Corridor & Mine Void area
- Pre and post filling mine water quality including leachability of metals (Table 1.1)

6.2 Mode of ash transportation to mine void area

One of flowing mode of transport actions of flyash shall be used depending upon the topography of the area:

1. Pipeline using pneumatic conveying system

2. Dumpers/ Trucks
3. Merry Go Round (MGR) System
4. Belt Conveyors in case of dry ash disposal
5. Wet ash (lean slurry or high concentration slurry) through pipeline

6.3 Monitoring:

6.3.1 Regular environmental monitoring to be undertaken during the period of disposal of ash into mine void as well as after the reclamation of mine void. The detailed monitoring programme is given in Tables below:

Table 1.1 : Proposed Monitoring Programme during Disposal of Ash

Samples	Parameters to be Analysed	Frequency
Ash Samples	Chemical Parameters (%): SiO_2, Al_2O_3, Fe_2O_3, K_2O, TiO_2, CaO, MgO, Na_2O, P_2O_5, SO_3 Trace Elements (mg/kg, using TCLP Test): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn Radio-activity (Bq/kg): ^{238}U, ^{235}Ra, ^{232}Th, ^{228}Ra, ^{230}Pb, ^{40}K, ^{137}Cs	Once before initiation of filling
Ash Leachate Analysis	Trace Elements (mg/kg, using TCLP Test): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Once a year
Piezometer Water Samples	Chemical Parameters (mg/l, except, pH and EC): pH, EC, TDS, Total Alkalinity, Ca, Mg, Na, K, Cl, SO_4, NO_3, PO_4, Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Monthly
Mine Water Sample	Same as above	Monthly
Ground Water	Same as above	Twice a year - Pre-monsoon and Post-monsoon
Surface Water Samples	Same as above	Twice a year - Pre-monsoon and Post-monsoon
Soil Samples	Texture, type, pH & cation exchange capacity. Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Once a year

Survey of Flora and Fauna	• Listing of Flora (herbs, shrubs and trees) and Fauna (soil invertebrates and other animals) based on field observations and review of information available • Analysis of trace elements in plants (herbs, shrubs and trees), the invertebrates • Analysis of trace elements in aquatic fauna from the mine void filled with fly ash • Bio-accumulation and Bio-magnification tests	Once in two years

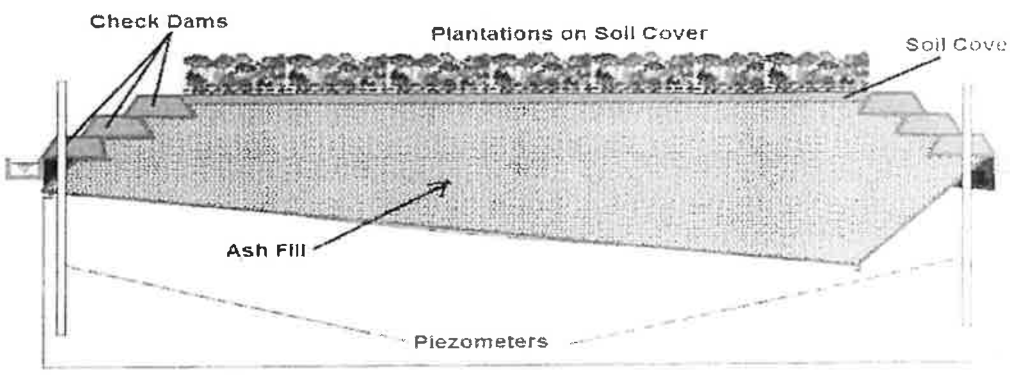
Table 1.2: Proposed Monitoring Programme After Reclamation of Mine void

Samples	Parameters to be Analysed	Frequency
Piezometer Water Samples	Chemical Parameters (mg/l, except, pH and EC): pH, EC, TDS, Total Alkalinity, Ca, Mg, Na, K, Cl, SO_4, NO_3, PO_4, Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Twice a year - Pre-monsoon and Post-monsoon
Ground Water Samples	Same as above	Once a year - Pre-monsoon
Surface Water Samples	Same as above	Once a year - Pre-monsoon
Survey of Flora and Fauna	• Listing of Flora (herbs, shrubs and trees) and Fauna (soil invertebrates and other animals) based on field observations and review of information available • Analysis of trace elements in plants (herbs, shrubs and trees), the invertebrates • Analysis of trace elements in aquatic fauna from the mine void filled with fly ash • Bio-accumulation and Bio-magnification tests	Once in five years

In the event of deterioration of environmental quality, the same will be reported to concerned SPCB immediately and suitable preventive/ corrective action will be undertaken.

6.4 Reclamation of Land filled site

After the quarry is filled to the permitted height as per DGMS, the same shall be provided with a soil cover and plantation shall be done with local fast growing species (preferably trees), to make it a part of the overall post-mining land use pattern envisaged in the mine closure plan The design of surface contours and land profile will be in consonance with the surrounding features. A three tier plantation approach (consisting of large trees, smaller trees and shrubs) will be followed for overall eco-restoration of the area. This will also help in checking the surface run-off, preventing the water from percolation and maintaining the aesthetics beauty of the surrounding in general. A conceptual diagram of the reclaimed mine void is presented below.



Conceptual Plan for Reclamation of Mine Void
(Drawing not to Scale)

During the mine void reclamation, the following measures are to be undertaken:

i. Storm water drains shall be constructed for channelizing the run-off water away from the disposal site.

ii. A 30 cm thick soil cover shall be provided to promote vegetation growth.

iii. For plantation purpose, preference shall be given to both native species and mixed culture. The species will be selected carefully from the following groups for quick reclamation under the guidance of a taxonomist:

- Tree species for fuel wood and timber
- Forestry type tree species.
- Tree species with dense foliage for shade.
- Native species.

iv. However, fruit bearing species shall be avoided.

7.0 Precaution

The following precautionary measures are required for safe working during the reclamation activity:

(i) Appropriate measures should be taken to prevent entry of cattle/livestock inside the disposal area during execution period.
(ii) Care shall be taken to avoid any kind of nuisance / inconvenience to the public due to such dumping / filling activities.
(iii) Water sprinkling for dust suppression during handling of Ash shall be ensured from being air borne.
(iv) After complete reclamation of the site, sign board shall be kept indicating the low lying land / abandoned quarry has been reclaimed with ash. This will help to propagate the message of mine void using ash.

8.0 Regulatory Procedure for Processing the Application for consideration of grant of permission for Reclamation of Low Lying Areas / Abandoned Quarries :

8.1 The activity of reclamation of Low Lying Areas / Abandoned Quarries will be regulated under the provisions of Water (Prevention and Control of Pollution) Act, 1974 and Air Water (Prevention and Control of Pollution) Act, 1981. The stipulations specified in this guideline is consistent with the provisions of Fly Ash Notification, 1999 and amended thereafter which should be a special condition mentioned in consent order issued under the Water (Water (Prevention and Control of Pollution) Act,1974 and the Air Water (Prevention and Control of Pollution) Act, 1981. Thereafter any deviations from the guidelines shall be treated as violation of both Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 and action as deemed proper shall be taken under Consent Administration by the Board.

8.2 Necessary clearances shall be obtained from the concerned agencies such as DGMS, SPCB, IBM, MoC, etc .

Appendix

Guidelines for disposal of flyash in open cast mines along with Over Burden (OB)

As per notifications 1999 and 2009, "No person or agency shall within fifty kilometres (by road) from coal or lignite based Thermal Power Plants, undertake or approve without using at least 25 % of ash on volume to volume basis of the total materials used for external dump of overburden (OB) and same percentage in upper benches of back filling of opencast mines and this ***shall be done under the guidance of the Director General of Mines Safety (DGMS).***

The methodology as approved by Directorate General of Mine Safety (DGMS) in case of M/s JSPL & JPL (RGR/JPL/P-98(1) &(3)/Flyash/18/2014/1518 dated 31.07.2014) may be referred for filling ash in coal mines. **However, for each case separate approval of methodology from DGMS shall be sought.** Following methodology for disposal of flyash in open cast mines along with Over Burden in case of JSPL was approved by DGMS.

1.1 Distance of the internal/overbuden dump area from the working faces of mine shall not be less than 100 m.

1.2 The area of filling ash shall be specifically earmarked and the same shall be marked on the plan and dumping fly ash shall be carried out accordingly.

1.3 Height of each deck shall not be more than 30 m and the total height of the dump shall not exceed 90 m.

1.4 The road leading to the dump site for transportation of fly ash shall be independent from the main haul road for transporting OB to the dump site from the mine.

1.5 Method of dumping fly ash

1.5.1 The fly ash shall be dumped in alternate layers/stages, of height not exceeding 5.0 m in each layer/stage.

1.5.2 Initially a row of OB dumps not less than 15.0 m width shall be dumped having height of 5.0 m all around the area proposed for ash dump over a deck (of 30.0 m height) of only overburden dump adequately compacted. A number of such areas shall be formed in a layer/stage wherein the fly ash shall be dumped so that one dump of fly ash is separated by another with 15 m wide over burden dump.

1.5.3 Thereafter, fly ash (25%) and overburden shall be dumped within the area surrounded by such OB dumps. In this manner, the dumping shall be laid in the section/layer of 5.0 m height containing both over burden as well as fly ash so as to form a deck of height not more than 30.0 m , distance between two consecutive decks shall not be less than 30.0 m.

1.5.4 In the next section i.e. immediately above bottom section/stage, only OB dumping shall be made to ensure that the Ash is totally covered and protected from the OB dumps all around.

1.5.5 In the same manner as explained above the alternate layer/section of the over burden and over burden with fly ash shall be dumped. Each layer/stage shall be adequately compacted by dozing.

1.5.6 At the top of the dump i.e. at the final stage, the dump shall be covered with 2.0 m thick soil and adequately compacted by dozing. Adequate precaution against rain fall shall be taken by way of plantation, geo-synthetic, or jute/coir reinforcement and formation of gully drains along the slope of the dump and formation of toe walls and peripheral drains as suggested by the scientific agency conducing geo-technical study. The precaution measures shall periodically be checked for its efficacy.

1.5.7 Plan and section in suitable scale (1:2000) shall be maintained showing the details of the dump both external and interval, height of each deck and dump, distance between the dumps containing fly ash and also the distance from the active working faces, plantation done, gully drains, peripheral drains, toe walls, etc. Such plan shall be signed by the Surveyor and countersigned by the Manager as prescribed in the statute.

1.5.8 Code of practices for transportation, dumping compaction of fly ash as mentioned in para 5(4.2.3 & 5.4.3 of main guidelines), shall be implemented.

1.5.9 **1.6 Dump slope management**

1.6.1 The sides of the OB dumps shall be kept benched and height thereof shall not exceed 30.0 m at an angle of slope not exceeding the angle of repose of the dumped material or 28° whichever is less.

1.6.2 Width of the OB dump shall not be less than 40.0 m which shall also be compacted. The benches shall be laid in such a manner that the overall slope of the dump shall not exceed 21° from horizontal.

1.6.3 The toe of the OB dumps shall be protected or armored in such a manner that the sludge does not flow down into the working faces.

1.6.4 A geotechnical study shall be conducted to assess the stability of the dump and the monitoring of various parameters during the course of dumping and also thereafter till the mine is closed permanently.

1.7**Dust control measures**: The fly ash dumping including the OB dumps shall be kept moist all the time to prevent ash getting airborne. The quality of the Ash shall be chemically and physically tested at least once in every quarter.

1.8 **Surface and ground water quality monitoring**

1.8.1The surface and ground water measurement (Chemical Parameters (mg/l): pH, EC, TDS, Total Alkalinity, Ca, Mg, Na, K, Cl, SO_4, NO_3, PO_4, Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn,Ni, Pb, Zn) shall be carried out once in a year (post monsoon) in consultation with the State Pollution Control Board in order to ensure that no harmful heavy metals or any other chemicals pollute the surface or ground water sources or any other water sources present in the area.

1.9 **Provision of check drains** Proper Check Drains/garland drains having width of adequate size and section shall be made around the OB dumps to ensure that the sludge or waste materials along with the ash does not go into any river, nullah, water streams or any other surface water bodies.

1.10 Impact assessment of flora, fauna, aquatic lives and habitat, water & air quality:

1.10.1 A scientific study shall be carried out by an independent scientific organization to study the impact of Ash filling on Flora, Fauna, Aquatic Life and Habitation (once during the filing and at the end of filling).

1.10.2The Monitoring of all the aforementioned parameters shall be carried out through any accredited institute/organization/Labs and monitoring report shall be submitted to SPCB and DGMS.

1.10.3 A dedicated team of qualified persons headed by senior officer at the level of General Manager shall be established in the mine level, who shall be responsible for the entire ash filling operation, conducing different studies and shall maintain all records as prescribed.

1.10.4Record of every analysis and study shall be maintained in a bound page register kept for the purpose and the same shall be signed by the person in-charge of the operation and countersigned by the manager of the mine. Records shall also be maintained showing the details about the slope of each dump, quantity of ash filled, quantity of overburden removed, etc.

1.10.5Risk Analysis about the risk arising out of ash filling operation shall specifically be conducted at regular intervals and Safety Management Plan including the control mechanism shall be prepared as per the guideline contained in DGMS(Tech)(S&T) Circular No.13 of 2002 dated 31.12.2002 and implemented and the same shall be reviewed time to time

1.10.6In case, any adverse impact is observed, it should be brought to the notice of the DGMS and also to the State Pollution Control Board including the Environment and Forest Ministries of the State and Central Government. No further use of fly ash shall be done in the mine till permitted in writing afresh from DGMS.

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F. No. 22-13/2019-IA.III
Government of India
Ministry of Environment, Forest and Climate Change
(Impact Assessment Division)
*****

Indira Paryavaran Bhawan
Aliganj, Jorbagh Road
New Delhi-110 003

Dated: 28th August, 2019

Office Memorandum

Sub: Change in conditions stipulated in the Environmental Clearances of Thermal Power Plants and Coal Mines in line with the Fly Ash Notification and subsequent amendments - reg.

The Environment Impact Assessment (EIA) Notification, 2006 under the Environment (Protection) Act, 1986 mandates the requirement of prior environmental clearance to the projects/activities listed in the schedule to the said Notification. These projects/activities have been categorized under category A or B and require appraisal/and approval by the respective regulatory authorities (MoEF&CC/SEIAAs) at the Central/State level.

2. As per the provisions of the EIA Notification, 2006, read with subsequent amendments, mining of minerals is covered under Category A/B of the Schedule to the EIA Notification, 2006 based on their areal extent, and thus requiring prior environmental clearance from the concerned regulatory authority.

3. Based on the proposals submitted by the project proponent and recommendations of the sectoral Expert Appraisal Committee, mining projects and thermal power plants were granted Environmental Clearance by the Ministry/State Environment Impact Assessment Authorities (SEIAAs) from time to time, subject to compliance of certain terms and conditions as environmental safeguards necessitated at that stage, which also included the condition for backfilling of mines voids, use/disposal of fly ash in low lying areas, etc.

4. In order to address the environmental concerns of fly ash and to improve its utilization, MoEF&CC has issued a Notification on 14th September, 1999 and subsequent amendments issued vide Notifications dated 27th August, 2003, 3rd November, 2009 and 25th January, 2016 from time to time.

The Fly Ash Notification issued vide S.O.2804 (E) dated 3rd November, 2009 provides for mandatory use of fly ash in the external overburden dump, backfilling or stowing of mines. The main concern is poor fly ash utilization by the pithead power plants mainly because of limited potential in cement industries/road projects and non-utilization of fly ash in stowing and overburden in coal mines.

5. An Expert Committee was constituted for developing a focussed strategy for best utilization of flyash to manufacture end products. The Committee has made recommendations for enhanced utilization of flyash in various sectors viz. mines, roads, bricks manufacturing, cement manufacturing, etc. During an Inter-ministerial consultation held on 21st January, 2019 under the Chairmanship of Secretary (EF&CC), recommendations of the Expert Committee were accepted, which *inter-alia* included the following:-

a) MoEF&CC should revisit the conditions stipulated in the existing environmental clearances of Thermal Power Plants for flyash utilization and modify them in consonance with the flyash notification.
b) Appropriate conditions need to be incorporated in the environmental clearances for utilization of flyash in mines backfilling/stowing.

6. The matter has been examined in the Ministry. Further, the matter has been also been referred to the EAC (Thermal Power Projects) in its meeting held on 28.5.2019 and 12.7.2019. The EAC mentioned that though the Flyash Notification, 1999 and subsequent amendments allow the unrestricted use of flyash in abandoned mines, low lying areas, soil conditioner in agriculture, there are no specific guidelines/methodology available for safe disposal of flyash so as to minimize the damage to the environment. In absence of methodology, EAC has been examining the proposals on case to case basis and recommending for disposal of flyash in abandoned mines. Further, the EAC has also expressed the concerns over the long term impacts of flyash disposal on groundwater, soil quality and impact on associated flora and fauna. Now, the guidelines for disposal of fly ash utilisation in low lying areas and mine voids have been prepared by the Central Pollution Control Board and placed before the EAC (Thermal Power and Coal Mining) in its meeting held on 12.7.2019.

7. In view of the recommendations of the EAC (Thermal Power) in its meeting held on 12.7.2019, after careful examination of the matter and to meet the objectives of the Fly Ash Notification, 1999 & its amendments, the Ministry hereby stipulates the following conditions in the existing Environmental Clearances of Thermal Power Plants and Coal mines which have valid Environmental Clearance accorded by the Ministry/SEIAA, that will replace the existing conditions (Specific & General) which prohibited the use of fly ash in abandoned mines/low lying areas/soil conditioner in agriculture:

i. The guidelines prepared by CPCB for disposal of flyash for reclamation of low lying areas and in stowing/backfilling of abandoned mines/quarries shall be followed during disposal of ash in abandoned or working mines, as annexed.

ii. There should at least be clearance of 500 m of safe distance be maintained from River and water body in case of ash disposal in abandoned mines to prevent embankment failures and flyash flowing into the nearby water body.

iii. The top layer of the flyash disposal area in the abandoned mines shall be kept moist during disposal.

iv. Top layer of the disposed area should have 70 cm overburden or gravels/stones and then 30 cm sweet soil cover. Subsequently, the vegetation shall be raised on the soil cover.

v. Bioaccumulation and bio-magnification tests shall be conducted on surrounding flora and fauna (tree leaves, vegetation, crop yields and cattle population) during pre-monsoon and post monsoon to find out any trace metals escaped through groundwater or runoff.

vi. Surface runoff and supernatant water, in any case shall not be let into the surrounding areas. It shall be collected by providing adequate drains around the mine. The supernatant water along with surface runoff shall be treated and re-used for mixing ash and plant operations.

vii. To the extent possible, only decanted water from mine, make up water from treated effluents such as cooling tower blow down and treated sewage water shall be used for making ash slurry.

viii. Flyash to be used as soil conditioner in agriculture needs and to be applied in controlled manner to limit excessive application so as to prevent soil degradation. The optimize proportion of ash to be applied which is to be certified by the State Agricultural Universities/Colleges based on the soil testing.

ix. Approval from DGMS shall be obtained before disposing the ash in the mine voids.

x. Technology for conversion of fly ash into coarse granules for stowing in the underground mines to be explored.

xi. All the power plants should install different silos for dry collection of flyash.

xii. Records pertaining to details of month-wise quantity of flyash disposed and water consumption along with nature/source of water shall be maintained and submitted to Ministry/Regional Office annually.

xiii. Before starting the disposal of ash into mine voids, the NOC/Permission from the mine owner is to be obtained incase the mine closure activities are not completed or State Government incase the mine has been handed over to the State Govt. after its closure. A copy of such NOC/Permission is to be submitted to the Ministry and its Regional Offices.

8. This issues with the approval of the Competent Authority.

(Dr. S. Kerketta)
Director, IA Division

To

1. The Chairman, Central Pollution Control Board (CPCB)
2. The Chairman/Member Secretaries all the Expert Appraisal Committees
3. The Chairman /Member Secretaries of all the SEIAAs/SEACs
4. The Chairman/Member Secretaries of all SPCBs/UTPCCs
5. All the Power Plant Operators/ Coal Mining Operators who were accorded Environmental Clearance.
6. All the ROs of MoEF&CC.
7. All the Officers of I.A. Division

Copy for information to:

1. PS to Hon'ble Minister for Environment, Forest and Climate Change
2. PS to Hon'ble MoS (EF&CC)
3. PPS to Secretary(EF&CC)
4. PPS to SS(AKJ) / AS (RSP)
5. Sr.PPS to JS (GM)/ JS(NK)
6. Website of MoEF&CC.
7. Guard file.

Ash Disposal in Ash Pond in wet form (in MMT) (on Dry weight basis)												
Year	Singrauli			Anpara			Vindhyachal			Rihand		
Capacity	2000			2630			4760			3000		
	Ash	A:W	Ash water	Ash	A:W	Ash water	Ash	A:W	Ash water	Ash	A:W	Ash water
2-83	0.117	1 & 9	1055946	0			0			0		
83-84	0.319	1 & 9	2866824	0			0			0		
1984-85	0.549	1 & 9	4939809	0			0			0		
1985-86	0.756	1 & 9	6806949	0			0			0		
1986-87	0.768	1 & 9	6911627	0.017	1 & 9	153000	0			0		
1987-88	1.249	1 & 9	11245317	0.040	1 & 7	280000	0			0		
1988-89	1.765	1 & 9	15886732	0.594	1 & 7	4158000	0			0		
1989-90	1.692	1 & 9	15226695	0.884	1 & 7	6188000	0.458		4121909	0.279	1 & 8	2232000
1990-91	1.413	1 & 9	12719062	0.980	1 & 7	6860000	0.821		7385747	0.597	1 & 8	4776000
1991-92	1.694	1 & 9	15250320	1.051	1 & 7	7357000	1.178		10602106	1.035	1 & 8	8280000
1992-93	1.777	1 & 9	15990650	1.060	1 & 7	7420000	1.185		10664104	1.131	1 & 8	9048000
1993-94	2.119	1 & 9	19071986	1.057	1 & 7	7399000	1.451		13055310	1.257	1 & 8	10056000
1994-95	2.509	1 & 9	22582741	2.045	1 & 7	14315000	1.230		11070540	1.233	1 & 8	9864000
1995-96	2.382	1 & 9	21440350	2.569	1 & 7	17983000	1.703		15322800	1.542	1 & 8	12336000
1996-97	2.516	1 & 9	22646979	2.770	1 & 7	19390000	1.795		16154591	1.317	1 & 8	10536000
1997-98	2.399	1 & 9	21588759	2.807	1 & 7	19649000	1.621		14591896	1.473	1 & 8	11784000
1998-99	2.477	1 & 9	22296717	2.689	1 & 7	18823000	1.807		16261854	1.227	1 & 8	9816000
1999-20	2.414	1 & 9	21725901	2.722	1 & 7	19054000	1.763		15870287	1.488	1 & 8	11904000
2000-01	2.709	1 & 9	24383664	2.787	1 & 7	19509000	2.527		22741889	1.473	1 & 8	11784000
2001-02	2.451	1 & 9	22063446	2.905	1 & 7	20335000	2.259	1 & 9	20334600	1.438	1 & 8	11504000
2002-03	2.809	1 & 9	25280118	2.826	1 & 7	19782000	2.165	1 & 9	19488186	1.278	1 & 8	10224000
2003-04	2.562	1 & 9	23058921	2.938	1 & 7	20566000	1.685	1 & 9	15164307	1.271	1 & 8	10168000
2004-05	2.509	1 & 9	22577753	2.919	1 & 7	20433000	2.569	1 & 9	23121630	1.158	1 & 8	9264000
2005-06	2.745	1 & 9	24700793	2.974	1 & 7	20818000	2.693	1 & 9	24234714	1.383	1 & 8	11064000
06-07	2.691	1 & 9	24215960	3.065	1 & 7	21455000	3.112	1 & 9	28008000	2.978	1 & 8	23824000
007-08	3.302	1 & 9	29715706	2.832	1 & 7	19824000	4.235	1 & 9	38114736	2.681	1 & 8	21448000
2008-09	3.396	1 & 9	30562976	2.943	1 & 7	20601000	4.545	1 & 9	40904937	2.420	1 & 8	19368000
2009-10	3.217	1 & 9	28949824	2.980	1 & 7	20860000	4.037	1 & 9	36330849	2.565	1 & 8	20520000
2010-11	3.677	1 & 9	33091337	2.983	1 & 7	20881000	4.023	1 & 9	36209409	2.847	1 & 8	22776000
2011-12	3.483	1 & 9	31314728	2.934	1 & 7	20538000	5.618	1 & 9	50565202	3.036	1 & 8	24288000

2012-13	3.448	1 & 9	31031310	2.647	1 & 7	18529000	6.205	1 & 9	55840961	3.381	1 & 8	27048000
2013-14	3.243	1 & 9	29190341	2.987	1 & 7	20909000	6.383	1 & 9	57451359	4.373	1 & 8	34984000
2014-15	3.616	1 & 9	32541613	3.148	1 & 7	22036000	6.996	1 & 9	62966285	4.720	1 & 8	37760000
2015-16	4.538	1 & 9	40838852	3.855	1 & 7	26985000	7.488	1 & 9	67387822	4.286	1 & 8	34288000
2016-17	3.657	1 & 9	32910219	3.999	1 & 7	27993000	7.473	1 & 9.2	68755982	4.717	1 & 8	37736000
2017-18	3.450	1 & 9	31053604	4.140	1 & 7	28980000	7.790	1 & 9.6	74782944	4.212	1 & 8	33696000
2018-19	2.876	1 & 9	25886944	4.166	1 & 7	29162000	8.122	1 & 9.4	76349958	3.340	1 & 8	26720000
Total	89.295		803654474	**81.313**		569225000	**104.937**		953854915	66.136		529088000
.1.03.2019	69.800			52.193			68.730			34.530		

Ash Disposal in Ash Pond in wet form (in MMT) (on Dry weight basis)															
Year	Lanco Anpara			Essar			Sasan			Mahan Al.			Renusagar		
Capacity	1200			1200			3960			900			820		
	Ash	A:W	Ash water	Ash	A:W	Ash water	Ash	A:W	Ash water	Ash	A:W	Ash water	Ash	A:W	Ash water
2012-13	0.970	1:4.1	3977000	0			0			0			0		
2013-14	1.640	1:4.1	6724000	0.017	35 & 65	31599	0.355	44 & 56	451866	0.050	1 & 3	150000	0		
2014-15	1.990	1:4.0	7960000	0.014	35 & 65	25088	1.600	44 & 56	2036989	0.162	1 & 3	486000	0		
2015-16	1.810	1:4.4	7964000	0.000	35 & 65	0	3.298	44 & 56	4197880	0.321	1 & 3	963000	0.75	23 & 77	2510870
2016-17	1.790	1:4.0	7160000	0.241	35 & 65	446710	4.566	44 & 56	5811055	0.553	1 & 3	1659000	0.662	23 & 77	2216261
2017-18	1.480	1:4.5	6660000	0.431	35 & 65	800323	3.929	44 & 56	5000752	0.623	1 & 3	1869000	0.685	23 & 77	2293261
2018-19	1.190	1:5.0	5950000	0.280	35 & 65	520827	3.536	44 & 56	4500412	0.330	1 & 3	990000	0.467	23 & 77	1563135
Total	**10.870**		**46395000**	**0.982**		**1824547**	**17.285**		**21998954**	**2.039**		6117000	2.564		8583826
31.03.2019	10.906			0.440			16.849			0.339			0.466		

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Annexure IV

Site visits and information collection

i) CPCB officers carried out a rapid survey of ash pond sites of all thermal power plants on periphery of Rihand reservoir, namely Anpara TPS & Anpara-C (Lanco Power), Renusagar Power (Hindalco), Singrauli TPS (NTPC Shaktinagar), NTPC Vindhyanagar, NTPC Rihand on 22.12.2019. It is understood that all these plants till some point of time had discharged ash pond overflow water to Rihand reservoir. Overflow of the common ash pond of Anpara TPS and Anpara-C (Lanco Power) is still discharged into reservoir although some portion is re-circulated back and reused, whereas, other plants have adopted re-circulate system for reuse it entirely.

ii) CPCB requested U.P. Jal Vidyut Nigam Limited to inform if any study for estimation of silting in Rihand Reservoir due to release of ash from individual power plants in the area has been carried out vide letter dated 17.12.2019, and simultaneously requested UPPCB to inform if any action taken on Committees recommendation about preparation of DPR for de-silting. Further, during the site visit CPCB officers contacted Assistant Engineer, U.P. Irrigation Department, Pipri-Sonbhadra on 23.12.2019 to know if any study for estimation of silting in Rihand reservoir has been carried out.

iii) CPCB requested CWPRS vide letter dated 17.01.2020 to prepare a modified proposal for assessment of reservoir silting and its apportionment and views/comments on possibilities of de-silting such a large reservoir based on any global experience. CWPRS replied to CPCB vide email dated 21.01.2020 that in order to work out technical feasibility and budgetary cost, a field visit is essential and also expressed that CPCB officials may visit CWPRS for a discussion. Accordingly, an officer from CPCB HO visited CWPRS, Pune on 06.02.2020 to discuss the proposed study. The revised proposal for assessment of reservoir silting is awaited from CWPRS

iv) CPCB collected year wise information on annual power generation and coal consumption, average ash content, and annual ash generation as well as annual ash slurry generation based on ash to water ratio power plants located in the area surrounding Rihand reservoir in order to estimate total ash quantity and ash slurry volume generated over the years by individual thermal power plants located on the periphery of Rihand reservoir.

v) CPCB asked all thermal power plants on periphery of Rihand reservoir, namely Anpara TPS & Anpara-C (Lanco Power), Renusagar Power (Hindalco), Singrauli TPS (NTPC Shaktinagar), NTPC Vindhyanagar, NTPC Rihand and other plants which are near to Rihand reservoir, namely Sasan UMPP, Essar Power, Mahan Aluminium Essar and also Obra TPS which in downstream of the dam to provide ash pond details. The details of ash pond received are summarised below:

Details of Ash Ponds

TPP	Capacity, MW	Annual ash generation 2018-19, MMT	Ash in pond as on 31.03.2019, MMT	Ash storage capacity, m3	Storage capacity used, m3
Anpara &	2630	4.399	52.193	88150000	45650000
Lanco	1200	1.531	10.906		
Renusagar	820	???	0.466	15390000	14450000
Singrauli	2000	2.89	69.8	363800000	
Vindhyachal	4760	8.324	68.73	19100000	15200000
				9800000	7400000
				13700000	5800000
				26000000	26000000
				34400000	31300000
				11200000	5200000
Sasan	3960	5.028	16.849	13000000	13000000
				7000000	2800000
Essar	1200	0.563	0.44	100000	100000
				540000	540000
				270000	270000
				2630000	50000
Mahan Al.	900	???	0.339	1300000	97%
				1462000	40%
Rihand	3000	3.516	34.53	30955000	13436000
				22671000	9841000
				10545000	7112000
				9050000	5581000

TPP	Area			Depth/ Height, m	Side slope, V:H	Type of raising	Ash storage capacity, m3	
Anpara & Lanco	3383500	at base	Initial	12.5	1H:2.5V	N.A.	45650000	Filled
	4107375	at 4 m	R1	5	1H:2V	Upstream	19850000	Filled
	4803937	at 9 m	R2	5	1H:3V	Upstream	23070000	In use
Renusagar	304253		Initial	30	1H:2.5V	N.A.	2400000	Filled
			R1	8	1H:2.5V	Upstream	6400000	Filled
			R2	7	1H:2.5V	Upstream	560000	Filled
			R3	5	1H:2.5V	Upstream	500000	In use
	485964		Initial	25	1H:2.5V	N.A.	2000000	Filled
			R1	10	1H:2.5V	**Downstream**	800000	Filled
			R2	8.5	1H:2.5V	**Downstream**	680000	Filled
			R3	8.5	1H:2.5V	**Downstream**	850000	Filled
			R4	8	1H:2.5V	Upstream	1200000	In use
Singrauli	1618744		Initial	14	1H:2.5V	N.A.	3000000	
	1537807		R1	4.7	1H:3V	Upstream	7228000	
	1396167		R2	4.3	1H:3V	Upstream	6004000	
	1254527		R3	3	1H:3V	Upstream	3764000	
	1436635		Initial	14	1H:2.5V	N.A.	12500000	
	1294995		R1	3	1H:3V	Upstream	3885000	
Vindhyachal	1274805	at base	Initial & R1	9+12	1H:2.5V & 1H:3V	Upstream	19100000	In use
	696084	at base	Initial & R1	9+12	1H:2.5V & 1H:3V	Upstream	9800000	In use
	744648	at base	Initial & R1	9+6	1H:2.5V & 1H:3V	Upstream	13700000	In use
	1918278	at base	Initial & R1	9+12	1H:2.5V & 1H:3V	Upstream	26000000	Filled
	2428200	at base	Initial & R1	9+12	1H:2.5V & 1H:3V	Upstream	34400000	Future
	667755	at base	Initial & R1	9+6	1H:2.5V & 1H:3V	Upstream	11200000	Future
san	3250000 (two lagoons)		Initial	11	1H:2V	N.A.	13000000	Filled
			Initial	7	1H:2V	N.A.	7000000	In use
Essar	1790000		Initial & R1	3.5+5	1H:2V	Upstream	100000	Filled
	5650000		Initial & R1	3.5+10	1H:2V	Upstream	540000	Filled
	3340000		Initial & R1	3.5+10	1H:2V	Upstream	270000	Filled
	23970000		Initial & R1	3.5+10	1H:2V	Upstream	2630000	In use
Mahan Al.	78000		Initial	13	1H:2V	N.A.	1300000	Filled
	104000		Initial	13	1H:2V	N.A.	1462000	In use
Rihand	1436000		Initial & R1	12+3	1H:3V	Upstream	30955000	In use
	1052000		Initial & R1	12+3	1H:3V	Upstream	22671000	Future
	627000		Initial & R1	11+3	1H:3V	Upstream	10545000	In use
	538000		Initial & R1	11+3	1H:3V	Upstream	9050000	Future

ANNEXURE-V
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Item No. 01 & 02 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 164/2018
(Earlier O.A.No.276/2013)
WITH
Execution Application No. 22/2018
IN
O. A. No. 276/2013

(With report dated 29.10.2019)

Ashwani Kumar Dubey Applicant(s)

Versus

Union of India & Ors. Respondent(s)

Date of hearing: 05.11.2019

CORAM: **HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON**
HON'BLE MR. JUSTICE S.P WANGDI, JUDICIAL MEMBER
HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER
HON'BLE MR. SAIBAL DASGUPTA, EXPERT MEMBER

For Applicant (s): Mr. Pankaj Sharma, Advocate

For Respondent(s): Ms. Vidushi Garg, Advocate for R-10 to 12
Dr. Ashwani Bhardwaj with Kavita Rawat, Advocates for R-33&35
Mr. Anip Sachthey, Senior Advocate with Ria Sachthey, Advocate for R-36
Mr. Rajkumar, Advocate for CPCB
Mr. Daleep Dhyani, Advocate for UPPCB
Mr. Pradeep Misra, Advocate for R-19&20
Mr. Rajat Jariwal, Advocate for Grasim Industries.
Mr. Gaurav Dudeja, Advocate for Lanco Anpara
Ms. Deep Shikha Bharati, Advocate for State of UP

ORDER

1. Issue for consideration is remedial action against pollution and violation of environmental norms by Thermal Power Stations operating in Singrauli and Sonebhadra Districts of Madhya Pradesh

and Uttar Pradesh resulting *inter-alia* in air pollution, water contamination and large scale of damage to public health.

2. Vide order dated 24.05.2016, this Tribunal sought a factual and action taken report from a joint Committee comprising of the Ministry of Environment, Forest and Climate Change (MoEF&CC), the Central Pollution Control Board (CPCB), the Uttar Pradesh Pollution Control Board (UPPCB) and the Madhya Pradesh Pollution Control Board (MPPCB) with reference to the allegation that Thermal Power Stations operating in the Districts of Singrauli and Sonebhadra in the States of Madhya Pradesh and Uttar Pradesh being Northern Coalfields Limited Singrauli, Northern Coalfields Limited Kakri Project, Post Kakri, District-Sonebhadra, Uttar Pradesh, Northern Coalfields Limited Bina Project Post Bina District Sonebhadra, Northern Coalfields Limited Krishna Shila Project, Northern Coalfields Limited Kadia Project, Post Khadia District Sonebhadra, Northern Coalfields Limited, Dudhichuwa Project, Post Khadia District-Sonebhadra, UP were causing damage to the environment. The violation of environmental norms was resulting in damage to water bodies, including Rihand Reservoir. Surface and underground water was polluted affecting rivers like Son, Renu, Bijul, Kanhar, Gopad, Pankagan, Kathauta Kachan, etc. and streams/nalas like Ballia Nala, Chatka Nala, Kahuwa Nala, Tippa Jharia, Dongia Nala, etc. Water had been contaminated by toxic effluents discharged, chemicals and fly ash and was not fit for consumption.

3. The Tribunal after considering the report vide order dated 28.08.2018, constituted a Committee headed by Justice Rajesh Kumar a former Judge of the Allahabad High Court to prepare a time

bound action plan to deal with the problem and to monitor its implementation and send reports of the action taken by it to this Tribunal.

4. The Tribunal dealt with the report of Justice Rajesh Kumar Committee dated 14.12.2018 vide order dated 03.01.2019. The report, *inter-alia*, mentioned lack of proper management of ash ponds, disposal of red mud and steps necessary for control of air and water pollution. The Tribunal directed the concerned State Pollution Control Boards (SPCBs) and the Central Pollution Control Board (CPCB) to take remedial measures and furnish a status report about the ambient air quality, water quality of the reservoir and other water bodies to the Oversight Committee. The States were also to give their reports about the health status of the citizens in the affected areas and to prepare plan for providing potable water through pipelines in a time bound manner.

5. Second report of Justice Rajesh Kumar dated 28.06.2019 was considered on 19.07.2019. The report suggested ban on manufacture of red bricks by use of clay/soil and burning coal so that more fly ash could be utilized. This aspect was directed to be looked into by the MoEF&CC and the CPCB. The Committee was to give further report setting out recommendations cumulatively at one place. The Tribunal also directed compliance of observations of the CPCB with regard to operation of STP, establishment of piezometers and remote calibration as well as other deficiencies forthwith which was to be overseen by the CPCB. CPCB was to assess compensation for the damage to the environment.

6. Reports dated 21.08.2019 and 23.08.2019 were filed by the MPPCB and UPPCB. In *O.A. No. 453/2019*, a direction was sought for implementation of the said reports on the issue of environmental compensation in respect of 11 units in the State of Madhya Pradesh and 10 units in the State of Uttar Pradesh. The Tribunal directed the SPCBs to proceed in accordance with law to recover the compensation assessed.

7. The matter has been put up today mainly for consideration of the report filed on 29.10.2019 by Justice Rajesh Kumar dealing with the issue of management of fly ash by thermal power stations and the damage caused to Rihand reservoir which is a source of water for operation of thermal power plants and other industries and also for drinking purposes by the inhabitants. The Committee observed that the capacity of the reservoir was reduced due to draining of effluents and fly ash which required desilting. Fly ash dykes of Essar Power was breached on 07.08.2019 and of NTPC on 06.10.2019. Slurry was flowing on the ground causing damage to the crops. Slurry also travelled upto Rihand reservoir. This gave rise to emergent situation. The Committee held a meeting. The Committee prepared its agenda on the subject as follows:

> *"Generation and storage of Fly-ash in Thermal Power Plants is becoming a great cause of concern affecting the environment. Due to the regular storage of Fly-ash in Fly-ash Dykes since long, affecting air pollution, has led the Ministry of Environment, Forest and Climate Change, Government of India to declare the Sonbhadra and Singrauli area as a most critically polluted area. No proper roadmap has been presented for its proper disposal by the Thermal Power Plants.*
>
> *It has been noticed that in recent times there had been breach of Ash Dykes of two Thermal Power Plants in Singrauli district of Madhya Pradesh, which has resulted in discharge of Ash slurry to the river as well as to Rihand*

Reservoir adversely affecting their water quality. These Ash Dyke pertains to Thermal Power Plants (TPPs) namely M/s Essar Power Ltd and NTPC,Vindhya Nagar. These incidence are of serious concern and indicates improper and non scientific design of Ash Dykes. The Oversight Committee constituted by Hon'ble NGT has taken this matter very seriously and also discussed in the previous meeting. In this regard a meeting of the Committee is convened on October 22, 2019 at 11:00 AM in Circuit House at Prayagraj to discuss various issues related to handling of Ash and their disposal. The agenda of the meeting is as below: -

All Thermal Power Plants have to talk about the structural design of their Ash Dykes to prove that their Ash Dykes are proper and scientifically designed.

1. *To discuss with all the Thermal Power Plants about structural details of their Ash Dykes and their adequacy for handling of Fly Ash generated. Whether submitted the details of ash dykes to SPCBs and taken permissions from SPCBs .*
2. *All Thermal Power Plants have to talk about the structural design of their Ash Dykes to prove that their Ash Dykes are proper and scientifically designed.*
   Submission of affidavit by TPPs in compliance of decisions taken in the last meeting of Committee regarding adequacy of Fly Ash Dyke. The status will also be shared about the action taken by TPPs for third party assessment of Ash Dyke of their plants through expert institutions like NEERVIITs.

4. *Thermal Power Plants may submit their roadmap for the future disposal of the stored Fly-Ash as well as the currently generated Fly-Ash.*
5. *What effort has been made to fill up the Fly-Ash in the abandoned Coal Mines and Stone Mines? Whether any letter has been written to the Mine-owners or to the concerned Authority in this regard, seeking permission in light of the discussion in the earlier meeting(s)?*
6. *To provide opinion about option of developing mounts of Ash Dyke as done by NTPC Thermal Power Plant, Dadri, where green cover has been developed by covering it with the top soil.*
7. *Submission of status by NTPC Vindhya Nagar about necessary clearance from Madhya Pradesh Pollution Control Board about Gorbi mines and disposal of Fly Ash.*
8. *Preparation of DPR for project of desilting the Rihand Reservoir and bearing of such expenditure by Thermal Power Plants of the area on polluter pay principle.*

All the Thermal Power Plants situated in the State of U.P. and M.P., Members of the Committee, District Magistrate of concerned districts may be informed to attend the meeting with relevant information as per Agenda."

8. The deliberations of the Committee have been summed up as under:

"Thermal Power Plants — Ash Utilization:

NTPC-Vindhyanagar: *Shri V.K. Maurya, Deputy General Manager (Civil_Design) NTPC, New Delhi along with Shri Debashis Sen, Executive Director (Vindhyanagar) states that they could not comply the direction given by the Committee in the earlier meeting and could not submit the affidavit till today. They could not file any reply to the points raised in the Agenda of notice. However, Shri V.K. Maurya tried to explain that their Fly Ash Dyke was constructed in accordance to the norms and time to time, when the height of the Dyke was raised, the technical advices were also taken from the experts. However, no evidence in this regard has been produced before us. Despite asking from us that whether they have brought any reply to the points detailed in the agenda, Mr. Jain another officer states that they have everything. The periodical inspection has been made by the various internal department officers but he admitted that no assessment or report by third party agency has been obtained with regard to Fly Ash Dyke. Prima facie, the Committee is off the view that the officers of the NTPC are still not serious. They have not complied with the direction given by the Committee in the earlier meeting. The affidavit has not been filed. Recently, we came to know that there was a breach of Fly Ash Dyke on 06.10.2019 due to which huge quantity of fly ash slurry travelled alongwith the ground causing damage to crops and the fly ash travelled up to the Rihand Reservoir. If as per the version of Mr. Jain and Mr. Maurya everything was perfectly all right and time to time dykes have been checked why this incident happened. The incident itself shows that there was some deficiency in the construction of Fly Ash Dyke. The whole purpose for asking the affidavit in the earlier meeting was to get their dykes checked properly from the third party experts inasmuch as these dykes were originally constructed much earlier, in the present case in the year 1981. Plant is not able to produce any roadmap for the disposal of the stocked Fly Ash and the currently generated Fly Ash. A continuous process of stocking the Fly Ash is going on, which is causing environmental effect every day. In this view of the matter, the Committee is of the view that the Plant is liable for the compensation/penalty for causing environmental damage every day.*

Later on, at the end, they have provided an affidavit. The averments made in the affidavit are vague and casual. The paragraphs are sworn on the 'personal knowledge' and not on the basis of documents. We are not satisfied with the averments made in the affidavit. Sri Jain submitted that some time may be allowed to get the Fly Ash Dyke inspected by the third party agencies. He prays and is allowed one month time to get the Fly Ash Dyke inspected by the third party agencies like IIT or any other agencies, who are experts on the subject. He further submitted that he may be allowed a week's time *thereafter to give the reply of each and every point of the agenda of the meeting.*

NTPC Shaktinagar: *Shri Debashish Chattopadhyay, Chief General Manager submitted an affidavit in respect of the Fly Ash Dyke. From perusal of the affidavit it appears that the averments are vague and general in nature. The averments are sworn on the basis of personal knowledge and not on the basis of the documents. The Committee is not satisfied with the affidavit. Let the Plant may file a fresh affidavit after getting the report from the third party technical agency. He further submitted that due to the breach of the Fly Ash Dyke of NTPC Vindhyanagar and on account of the heavy pressure, their recycled water pipeline has been damaged resulting overflow of the water from the Dyke. He fairly admitted that some quantity of the over-flown water is going to Rihand Reservoir. He, however, assured that within a week the recycled water pipeline will be repaired and they may also get the technical structural stability report about their Fly Ash Dyke from third party agencies namely IIT etc. He submitted that he will submit the Affidavit within a period of one month giving reply of each and every point raised in the agenda.*

NTPC Rihand: *Shri Ranjan Kumar, G.M. NTPC Rihand submitted an affidavit. The averments made in the affidavit are vague and casual. The paragraphs are sworn on the 'personal knowledge' and not on the basis of documents. We are not satisfied with the averments made in the affidavit. He states that their Plant has already engaged IIT, Kanpur for the inspection and report in respect of the Fly Ash Dykes. The report may likely be obtained within one month. The Committee is of the view that let one opportunity may be given to the Plant to file a better affidavit along with the documents to demonstrate the action taken by the Plant in this regard and also the report of the third party agency in regard to the structural stability of the Fly Ash Dykes.*

Lanco Anpara & U.P. State Power Corporation Ltd.: *An affidavit has been submitted by the Anpara Thermal Project, a Unit of U.P. State Power Corporation Ltd. The affidavit is vague and general in nature. In support of the averments in the affidavit, no document has been annexed. There is no report of the third party technical agency. They are directed to give a better and detailed affidavit. It is stated that they have only one Fly Ash Dyke in which their fly ash as well as the fly ash of Lanco are being drained. The maintenance of the said Fly Ash Dyke is the responsibility of the Anpara Thermal Project, U.P. State Power Corporation Ltd. In this way, so far as the construction, stability and maintenance of the Fly Ash Dyke is concerned, Lanco is not responsible. The entire responsibility is upon U.P. State Power Corporation Ltd. The officer of U.P. State Power Corporation Ltd. submitted a report of 2018 wherein the structural stability of the Fly Ash Dyke has been examined. In the said report, it is approved that their Fly Ash Dyke is suitable for further raising of height up to 5 meters. The copy of the said report has been submitted before us. The Committee is of the* *view that after raising the height, the Plant may get a further report in respect of structural stability in order to overrule any possibility of technical flaw. Shri A.K. Rai, Executive Engineer states that in the Fly Ash Dyke the rainy water of the catchment area also flows and in such a situation during the rainy season when the Fly Ash Dyke is full of water due to heavy rainfall etc. Sometimes the fly ash along with the water also flows to Rihand Reservoir. The Management of the Plant is very serious about this issue and has asked the District Administration to divert the Nala of the catchment area to somewhere to avoid any flow of fly ash in the Rihand Reservoir. The District Magistrate, Sonbhadra states that the Administration is very serious and taking all possible steps to get the Nala diverted. The work is likely to be completed within two months. Both Lanco and U.P. State Power Corporation Ltd. are directed to furnish their reply by filing a fresh affidavit in regard to each and every point of the agenda of the meeting.*

Essar Power: *The officers of the Company submitted the affidavit regarding their Fly Ash Dykes. They submitted that 80% of the fly ash which had flown due to the breach of the Fly Ash Dyke have been removed and 20% fly ash lying on the earth shall be removed within a period of one month. They submitted that for the assessment of the environmental damage they have engaged NEERI, Nagpur. The document relating to their engagement has been produced before the Committee. They stated that NEERI has asked for six months time to assess the environmental damage. They further submitted that for the structural stability of the Dyke and making it technically sound they have taken the advices from two professors of the IIT Roorkee, namely, Prof. K.S. Hariprasad and Prof. Narendra K. Samadhia. They have visited the spot. They are likely to give their report within a period of fifteen days. On the basis of their report, they may proceed to reconstruct their Fly Ash Dyke. It has also been informed to the Committee that there was a joint inspection done by the officers of the Central Pollution Control Board and the officers of the M.P. Pollution Control Board and on the inspection the report has been submitted wherein they found that the Plant has removed 80% fly ash and they are in the process of removing the remaining 20% of the fly ash. The Committee directs the Plant to submit the report of the IIT within fifteen days and thereafter also submit the progress report, of the steps being taken to reconstruct the Dyke. On the report being received from NEERI, the environmental compensation shall be assessed. Let the Company may give detailed reply of each and every point of the agenda of the meeting by filing an affidavit within one month.*

Shasan Power Ltd.: *The representative of the Plant submitted the affidavit. However, the report of the third party agency certifying the structural stability of the Fly Ash Dykes has not been submitted. They have also not submitted the reply of each and every point raised in the agenda. The representative states that they will get the report about the structural stability of the Fly Ash Dykes and give the reply of each and every point raised in the agenda within one month.*

***Hindalco Industries — Mahan Aluminium Project**: The Company is engaged in the manufacturing of Aluminium from Alumina and has a Power Plant of 900 MW capacity. It is submitted that they have 02 Fly Ash Dykes, one dyke has been completely filled to the capacity and the other is being used now. For the purposes of raising height of the Fly Ash Dykes they have engaged the BHU for technical advice and on the basis of the advice they will proceed further in the matter. The Committee is of the view that they may also get the report from the third party agency about the initial structural stability of the two Fly Ash Dykes. The Company has submitted an affidavit. The averments in the affidavit are general in nature. They are also directed to file a fresh affidavit giving reply of each and every point raised in the agenda within one month.*

***Bajaj Energy:** The representative of the Plant stated that they have received copy of the agenda very late. Therefore, they could not collect the necessary documents. They sought time to furnish the details. Let the Plant may submit an affidavit relating to the structural stability of the Fly Ash Dykes and also give the reply of each and every point raised in the agenda, supported by the certificate from third party agency in this regard. They are directed to give the reply of each and every point of the agenda within a period of one month.*

***M.P. Power Generating Co. Ltd.:** There are 04 (four) Units of this Company, namely:-*

(1) ATPS, Chachai, District Anuppur, established in 2007.
(2) SGTPS, Birsinghpur, District Umariya, established in 2015.
(3) STPS, Sarni, District Betul — two Plants established in 2013 and 2017.
(4) SSTPP, Dongalia, District Khandwa, established in 2018.

A consolidated Paper Book has been submitted in respect of all the Units. However, they have not submitted any Affidavit with regard to the Fly Ash Dykes and also the Certificate of the third party agency who are the Technical expert. The officers of the Company pray for one month time to submit the affidavit and the certificate. They have also submitted a roadmap for the disposal of the Fly Ash. A perusal of the roadmap reveals that in comparison to the other Power Plants, their Unit-wise disposal are quite satisfactory.

However, they admit that even after more than 90% disposal, the stock of Fly Ash still remains and they are making efforts to dispose it by negotiating with the Cement Plants and approaching the Government for permission to fill the Fly Ash in the abandoned Mines. It is submitted that they are hopeful to achieve the target shortly. Let the Company may file the affidavit and the certificate in respect of the structural stability of the Fly Ash Dykes within one month.

MB Power (Madhya Pradesh) Ltd.: *The Company has submitted a presentation in the form of small paper book. However, they have not submitted any Affidavit with regard to the Fly Ash Dykes and also the Certificate of the third party agency who are Technical expert. The officers of the Company pray for one month time to submit the affidavit and the certificate. The representative of the Company states that their disposal of Fly Ash is at present more than 100% and there is very little stock of Fly Ash lying in the Plant. For the further disposal of Fly Ash, they have approached the Southern Coalfields Ltd., Bilaspur to provide abandoned Mines for the purposes of filling of the Fly Ash. He stated that they are continuously approaching the Southern Coalfields Ltd., Bilaspur but they are not giving any reply. A copy of the letter has also been given to the Ministry of Coal, Govt. of India and also to the Madhya Pradesh Pollution Control Board. Sri Hemant Sharma, Director, MPPCL states that he will look into the matter and do the needful The Committee further directs the Southern Coalfields Ltd., Bilaspur to look into the request of the Plant and if it is feasible and there is no impediment, they may allow the filling of their Fly Ash in the abandoned Mines. Let the Company may file the affidavit and the certificate in respect of the structural stability of the Fly Ash Dykes within one month.*

Obra Thermal Power Plant, Obra: *The representative of the Plant submitted an affidavit in pursuance of the direction given by the Committee in the earlier meeting. We have perused the affidavit. The manner in which the affidavit has been submitted is not acceptable. It is, in fact, not an affidavit and nothing has been stated properly, supported by any document, as required by the Committee. Let the Company may file a fresh affidavit stating that their Fly Ash Dykes are structurally stable and there is no possibility of any breach, and also annexing the certificate in respect of the structural stability of the Fly Ash Dykes from a third party technical agency. The representative submitted that the Plant is raising the height of the Fly Ash Dykes after taking the advice from the IIT Roorkee. Committee directs that after the completion of the work, they will further get their Dykes inspected by the third party technical agency, namely, NEERI to get the certificate that the Dyke is fully structurally stable and there is no possibility of any breach. He submitted that although, at present, the Fly Ash Dykes is not operational but the Plant has negotiated with the NHAI and also got allotment of abandoned mines from the concerned Authorities. After getting the N.O.C. from the Department, they will fill the Fly Ash in the abandoned mines. In this way, they will be able to dispose off sufficient quantity of the Fly Ash. Let the Company may file a fresh affidavit, supported by documents, stating their Fly Ash Dykes are structurally stable and technically sound and also submit reply of the issues raised in the agenda within one month.*

Prayagraj Thermal Power Plant: *The representative states that although they have two Fly Ash Dykes but since their disposal of Fly Ash is at present 100%, there is no occasion to store the Fly Ash. The Plant is not facing any problem with* *regard to the Fly Ash Dyke. The Plant is, however, not operating in full capacity due to lack of coal in adequate quantity. Since their disposal of Fly Ash is to the nearby Industries, there may not be much problem of storage of fly ash in the Dykes.*

***Jaypee Bina Thermal Power Plant**: The representative of the Company filed an affidavit. We have perused the affidavit. Let the Company may file a fresh affidavit within one month enclosing the certificate from the third party technical agency that their Fly Ash Dykes are structurally stable and there is no possibility of any breach. They may also submit the reply to each and every point of the agenda in the said affidavit.*

***Jaypee Nigrie Thermal Power Plant**: The representative of the Company states that there is 100% disposal of the Fly Ash. There is no stock of Fly ash in the Dykes. Only bottom ash is filled in the Fly Ash Dykes. At present, there may be about 3.9 Lac MT bottom ash in the dykes. He stated that they have sought permission from the concerned Authority to fill up the old lying Ash for filling up in 04 abandoned Stone mines, which are also leased out to them for the quarry of stone. The total capacity of the mines is about 15 lac MT. On the permission being granted, they will be able to consume the entire stock of the bottom fly ash stored in the Fly Ash Dykes. Let the Company may file a fresh affidavit within one month enclosing the certificate from the third party technical agency that their Fly Ash Dykes are structurally stable and there is no possibility of any breach. They may also submit the reply to each and every point of the agenda in the said affidavit.*

***NTPC Meja** : The representative of the Plant stated that their Plant has been commissioned in the year 2019. After commissioning of the Plant, the production of the Plant has not been properly carried on initially, for the shortage of the coal and at present due to technical fault. The production may likely to start very soon. Therefore, they are not facing any problem relating to the Fly Ash.*

***NTPC Dadri** : The representative of the Plant states that there is no Fly Ash Dyke in their Plant. In the Plant premises, they have developed a huge Fly Ash Mount wherein they are directly sending dried fly ash from the Plant to the Fly Ash Mount through the pipeline. The permissible height of the Fly Ash Mount is 55 Meters. The Fly Ash Mount is full of trees which works as a binding of fly ash and avoids any damage during the rainy season. The creation of the Fly Ash Mount is a continuous process. There is no effect of Fly Ash effluents and affecting any air pollution and environment. On the contrary, due to heavy growth of plantation, which is about 2,00,000, over the Fly Ash Mount, the entire area is full of greenery and creates a better environment."*

9. In view of above, the Committee observed that the fly ash could be managed by developing a fly ash mount. The Committee has made following recommendations:

"(1) *All the Thermal Power Plants are directed to get their Fly Ash Dykes inspected by the third party agencies who are Technical expert to certify that their Fly Ash Dykes are technically sound and structurally sustainable and file an affidavit in this regard along with the certificate of the third party agencies.*
(2) *All the Thermal Power Plants may make a serious effort for 100% disposal of the currently generated Fly Ash and also for the disposal of the stocked Fly Ash.*
(3) *All the Thermal Power Plants may approach the District Administration with the request to allot abandoned mines (stone and coal) to them for the permission to fill the Flay Ash.*
(4) *Generation of Fly ash is a continuous process in all the Thermal Power Plants which is causing pollution of every day - Why the environment compensation on per day basis or month-to-month basis may not be imposed and recovered for the continuous pollution of air and water?*
(5) *There are number of Acts relating to air pollution and water pollution. The concerned authorities are directed to initiate the civil and criminal proceedings against these Thermal Power Plants who are causing air pollution and water pollution every day.*
(6) *U.P. Pollution Control Board under whose jurisdiction the Rihand Reservoir comes is directed to prepare a D.P.R. for de-silting of Rihand Reservoir for its restoration to its original form.*
(7) *All the Thermal Power Plants are being cautioned to take the necessary steps, as directed above, failing which they will be subject to the penalty/ environment compensation."*

10. We are of the view that the recommendations on the subject of development of fly ash mounts and filling up of abandoned mines are issues which need to be examined by experts with regard to the safeguards necessary in the process, after studying the impact of environment. It is only after such a study that the development of mounts and filling up of abandoned mines can be undertaken. If there are pre-existing guidelines of MoEF&CC/CPCB on the subject, the same may be followed.

11. As regards desilting of Rihand reservoir, the same needs to be undertaken on scientific basis and cost recovered in the manner apportioned by CPCB. Apart from desilting, structural improvement of the dykes needs to be simultaneously taken up. CPCB may ensure that an action plan is prepared by the power plants whose dykes have breached. The issue of developing fly ash mounts and filling up of abandoned mines may also be got examined by the CPCB from its Expert Committee.

12. The CPCB has given report dated 26.09.2019 in response to order dated 19.07.2019. The CPCB has recommended payment of compensation of Rs. 155,42,85,300/- (One hundred fifty five crore forty two lac eighty five thousand three hundred). Since it is pointed out that vide order dated 04.11.2019 the Hon'ble Supreme Court has directed deferment of the proceedings, we defer the proceedings till the matter is decided by the Hon'ble Supreme Court.

13. We have also perused the report filed by the CPCB on 21.08.2019 with regard to compensation to be paid by the Essar Power in pursuance of order dated 19.07.2019. The assessed compensation may be recovered after following the due process of law.

14. We also find a letter from Justice Rajesh Kumar seeking extension of time. The report may be furnished as early as possible preferably by 31.12.2019. The structural steps for restoration of dykes may commence expeditiously, preferably by 31.12.2019 by Essar Power as well as NTPC.

15. The CPCB may give its reports on the subject of development of fly ash mounts and back filling of the abandoned mines and also cost

apportionment for desilting and restoration of Rihand reservoir preferably by 31.12.2019. CPCB will be at liberty to consult/associate any expert/institution for the purpose.

List for further consideration on 18.02.2020.

Adarsh Kumar Goel, CP

S.P Wangdi, JM

K. Ramakrishnan, JM

Dr. Nagin Nanda, EM

Saibal Dasgupta, EM

November 05, 2019
Original Application No. 164/2018
(Earlier O.A.No.276/2013)
WITH
Execution Application No. 22/2018
IN O. A. No. 276/2013
DV