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DRAFT

Restricted

December 1986
English

Development of environmental improvement
expertise within the National Council
for Cement and Building Materials and the
Indian cement industry

DP/IND/84/020/11-21/31.4.B
INDIA

Technical Report (First Mission): The situation regarding environmental control within the Indian cement industry

Prepared for the Government of India by the
United Nations Industrial Development Organisation,
acting as executing agency for the United Nations
Development Programme.

Based on the work of R.M. Hinman, expert in
dust generation, reduction and control

United Nations Industrial Development
Organisation
Vienna

This report has not been cleared with the United Nations Industrial Development Organisation which does not, therefore, necessarily share the views presented.

700

Explanatory Notes

The value of the rupee was approximately 12.60 to 1 dollar during the period of the mission.

N.C.B.M. - National Council for Cement and Building Materials

ABSTRACT

Productivity Improvement through Dust Reduction Techniques

DP/IND/84/020/11-21/31.4.B

Objective: - To evolve measures and implement feasibility studies for the reduction of dust generation.

Duration: - 6 weeks

Conclusions and Recommendations

The principal conclusion is that the supply, operation and maintenance of dust control equipment within the Indian cement industry is of a low level. It is recommended that steps be taken to improve, either by incentives or enforcement, the use of such equipment. The supply and correct design of necessary items, particularly for fabric filters, from local sources should be encouraged.

The National Council for Cement and Building Materials now have an embryo staff capable of developing into a competent and professional team able to give sound advice to the industry on a range of environmental matters.

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INTRODUCTION

Mission Objective

The expert's sphere of work will cover the entire spectrum of activities relating to dust reduction in cement plants. Special emphasis will be placed on:

1/ evolving measures for the reduction of dust generation

2/ feasibility studies for the implementation of techniques to reduce the generation of dust in specific cases.

Background information

The cement industry in India comprises 94 cement plants with a total annual installed capacity of 36.5 million tons. Although most of the cement plants have either already installed or are in the process of installing ESP's and dust collectors in kiln, raw meal and cement mill sections, the operational efficiency of the equipment is low and there is a need to improve their performance.

In view of the fact that pollution control is assuming wider importance, there is an urgent need to investigate ways and means of improving and modifying the design of equipment.

The National Council for Cement and Building Materials (N.C.B.M.), which is attached to the Ministry of Industry, is the national centre devoted to research and technological development and transfer, educational and industrial services. The institute has an ongoing programme of productivity enhancement and modernization from which a number of cement plants have already derived benefits.

The Centre for Environmental Improvement

The Centre for Environmental Improvement, within the N.C.B.M., was set up about 18 months ago (April 1985) in order to try and improve the environment surrounding many of the countries cement plants. The environment is, at present, polluted due to the almost non-existent installation of dust abatement equipment, except at the newer plants. However, the environment is not affected solely by process emissions but also by fugitive emissions generated by a wide variety of materials handling situations e.g. dust from unpaved roads, lorry tipping, bag filling and conveyor transfer points. Indeed, any point in the production cycle which allows air and dust to mix freely without suitable control.

The work reported on covers the period October 16, 1986 to December 7, 1986 and this document is intended as a record of the work carried out and the recommendations and suggestions made. The context in which the document is written is that of a newly formed group requiring enhancement of their existing expertise in environmental control. It also has a limited viewpoint owing to the small number of plants visited.

A number of areas for development have been identified and are spelt out in more detail in the section on Recommendations.

The original objectives of the mission were attained within the limitations mentioned above, with some encroachment on the objectives of the second mission on fabric filtration.

RECOMMENDATIONS

The following two recommendation are for the attention of UNDP or its relevant agency:

1. That efforts be made to encourage the indigenous development of polymeric industrial textiles. Specifically, for this report, in the area of gas cleaning. However, such development could also be utilized in the field of solid-liquid filtration applied, for example, to the chemical industry. Collaboration would be required between textile research, manufacturing, user and user research organisations. Currently the polymeric materials are imported at high cost to the users, who are dependant upon foreign suppliers and their agents. Little or no local expertise exists in these areas of application.

2. That efforts be made to ensure the transfer of gas cleaning technology affectively from the developed countries by suppliers and that this technology be adopted to local conditions.

Some difficulty may be experienced with this recommendation due to the lack of effective enforcement of any copyright legislation. Also the low contract base from which the suppliers are currently operating. The expansion of the requirement for pollution control equipment is largely dependant upon effective enforcement of current and future environmental legislation.

The remaining recommendations are for the attention of the N.C.B.M. Although numbered, there is no specific priority inferred by the numbering system.

3. That a survey be carried out of suitable stack monitoring equipment for both intermittent and continuous sampling. Currently used equipment is heavy and subject

to damage etc during transportation. With lightweight equipment, the monitoring could be carried out quicker, and the possibility exists of establishing a cement industry standard method/procedure. The procedure could then be extended to other industries, eg steel, if proved satisfactory and the need for environmental monitoring increases. Continuous sampling/monitoring, using transducers based on optical principles, are not yet installed/known in the country's cement industry.

4. That advice be given to industrial plants on the possible advantages of the cleaning control of fabric filters by means of pressure drop difference and not by the use of fixed time cycle. The use of time cycles can lead to excessive cleaning, leading to high emissions and high maintenance costs. The pressure difference method is dependant on the dust loading of the exhaust stream. Therefore, if the loadings are low, energy savings may be made, for example, in the use of compressed air in pulse jet cleaning.

5. That the possibility of operating a sampling vehicle be investigated. The vehicle would not only provide good publicity and public relations but would also serve the practical purpose of carrying equipment, spares and repair facilities (including possible accommodation) to test sites. The vehicle will save wastage of travel time etc of operatives who discover, on arrival at the test site, equipment damage currently created by air or rail transportation. The cost penalty of transporting heavy equipment by such means could also be moderated.

6. That consideration be given to the strengthening of the library facilities in the area of environmental improvement and related equipment, including its maintenance,

by the purchase of books etc recorded in Annex II.

The following recommendations apply spedifically to the Centre for Environmental Improvement programme area of the N.C.B.M.

7. That the skill and experience balance of the Centre's staff be broadened to include physicists, chemists and mechanical engineers. Some of these people should have experience of fluid mechanics/aerodynamics and knowledge of powder characterization, materials handling, dust control and design work related to both areas.

Staff should also acquire more experience of a variety of industrial plant with particular reference to the application of dust control equipment.

8. That the Centre consider extending their current survey of stack monitoring to include deposition monitoring. It is interesting to know the current level of emission values but it is more important from an environmental impact viewpoint that it is identified where the dust is being deposited, over what area and whether any damage is being caused.

9. That the Centre consider specific research programmes in the following areas:

a) Deposition modelling and measurement

b) Materials handling design for particulate material e.g. hoppers, silos, transportation methods either mechanical or pneumatic.

c) Examination of the different fabric filtration systems with particular emphasis on the economics and operating advantages of pulse jet filters.

d) The design of dust containment systems specifically related to cement industry unit processes e.g. hood, booth design. The design to emphasise improved efficiency of dust capture at reduced air volume requirements.

e) The overall assessment of gas cleaning systems currently installed in plants to identify redundant components and poor design. Any request for improvement to gas cleaning systems should be accompanied by complete engineering specifications of the component and any associated ductwork. An overall assessment of the system efficiency can then be made instead of piecemeal modifications which can affect the performance of other parts of the system.

10. That a data base/filing system be established to acquire and accumulate relevant data on all aspects of environmental improvement e.g. information on all dust collection and materials handling equipment provided by Indian companies and/or agents for overseas companies.

The response, credibility and expertise of the Centre will be improved when an enquiry from any source (e.g. Government, industry) is received.

11. That in written communications, primarily reports, the correct scientific referencing of data and other sources of information be carried out. Not only will this improve the credibility and professionalism of the papers but will also allow easier subsequent recovery of information from the papers by staff members and external readers alike.

12. That consideration be given to improving the instrumentation and recording of information on the operation of fabric filters and other gas cleaning equipment on plants. Particularily in the case of

electrostatic precipitators and fabric filters, information on voltages, currents,pressure drops etc in chart form will, an analysis, lead to a better understanding of plant operation and lead to the possibility of preventative maintenance.

I. ACTIVITIES AND OUTPUT

Duties and Objectives

The mission objective, stated in the Introduction, mentioned that special emphasis would be placed on:-

1/ evolving measures for the reduction of dust generation

ans 2/ feasibility studies for the implementation of techniques to reduce the generation of dust in specific cases

In the event, because dust generation and control are major problem areas, the advice given also spread into the area of fabric filtration which is the main objective of the second mission. The reason for this encroachment on the second mission is that the problems arising have to be approached as part of a total system i.e. a problem area ,even if correctly diagnosed, may still generate further effects up and downstream once remedied.

The objectives of the activity, as seen by the author, were three fold:-

a/ to improve the expertise of the NCBM in the area of environmental control

b/ to similarity improve the expertise of the industrial plants visited and

c/ to provide constructive feedback to UNIDO on the overall status of the Indian cement industry in the environmental field.

Technical activity

Visits could be arranged to only four plants because of the time available and communication difficulties. [illegible]. All the plants visited were in the private sector. The small number of plants visited compared to the total number, i.e. around 4% of total, means that any recommendations and conclusions drawn are limited.

The approach taken by the author, from which a lot of the activity and solutions evolved, was the simple statement that air and dust material should not mix. The implications of this statement became manifest in a variety of ways during the mission.

The technical activity consisted of two main parts-work at NCBM and work at the plant.

In the case of NCBM, the activity took the form of lectures on a wide range of subjects from dust generation, design of control systems for dust capture, ductwork design, abatement equipment fan characteristics, emission and deposition measurement. In addition, discussions were held with the programme leader on new proposals for research topic areas and ways of improving the balance and expertise of the project team.

As part of the improvement of the team expertise, the author was accompanied on plant visits by members of the team. The presence of team members enabled points to be illustrated at first hand, to emphasise the approach to be taken, and also greatly smoothed the administrative arrangements necessary.

For the plant visits, the entire process from the quarrying operations, though crushing, storage, blending, the kilns, the cement mills and the packing plant was examined. Emphasis was placed on the major dust generation points e.g. crushers, conveyor transfer, storage areas, mills and packing. Discussions were held with plant management on their various problem areas. In some cases, a brief talk was given on dust generation and control in order to elicit further problem areas from a wider range of personnel and to inform them, by illustrations on their own plant, of the approached to take.

The detailed findings during the individual plant visits are given in Annex I.

2. RESULTS OF THE ACTIVITY

The results of the activity will be split into two parts. The findings and results relating to NCBM forming the first part whilst a similar part will describe the plants.

N.C.B.M.

It is only recently that major emphasis has been put on the environment, although work has been going on at a low level in the subject for a number of years. However, given a further period of eighteen months to two years, with the present strong emphasis, the team should providing competent and professional advice to the industry.

The balance of the team requires strengthening in two areas - in the understanding of the behaviour of airflows and in practical knowledge of materials handling and dust control equipment and design. These weaknesses may possibly be rectified by suitable transfer or allocation of staff from other sections within NCBM.

Additional strengthening was required in the areaof relevant literature i.e. reference books and was also needed in expanding the current files held on instrumentation and equipment to cover broader areas.

Steps have already been taken to rectify the situation regarding the literature and files. The question of team balance will take longer to implement. Staff accompanying the author experienced the problems and assisted with the solutions given to plants. Now that they possess some of the techniques of examining a problem and evaluating the solutions, it is mainly a requirement to built up a catalogue of case histories and examples from the industry with which to illustrate practical and cost effective solutions.

The emphasis of the research programme has also been adjusted and a number of additional new project proposals have been put forward on relevant topics. Each of the new projects combines well with others so that a large amount of information should be obtained. The emphasis of the projects is on:-

a/ reduction of dust generation by modification of materials handling systems.

b/ improved capture efficiency and design of capture devices for dust generated.

c/ the investigation of suitable design and methods for the suppression of dust if (a) and (b) cannot be employed.

d/ the measurement of dust deposition around plants.

Plants

The type of problems being experienced in the plants are common throughout the world. Problems are created by the design of the materials handling systems. From a production/mechanical engineering viewpoint the handling systems are based on standard knowledge and this knowledge is applied to maintain the desired throughputs. However, if an additional viewpoint is used, i.e. is this procedure likely to generate dust, then the designs may need some reassessment and modification e.g. minimising conveyor transfer drop heights.

The main problem experienced by the plants was that equipment bought to control dust emissions was not reliable or satisfactory. The plants do not have in-house expertise and rely on the suppliers for information and support. It is here that everything appears to enter into a vicious circle because of the lack of enforcement of copyright regulations and a tendency, created partially by lack of availability, to copy items of equipment. Consequently companies supplying dust control equipment are reluctant to provide full details of the specifications because they fear that, having supplied one unit, no further sales will flow particularly if it is highly efficient. It is also the case that high proportion of units of advanced design contain items made outside India and therefore the price is high to pay for import charges/taxes. For example, no fabric supplied for use in pulse jet filters appear to be made in India nor do the sophisticated control valves used on the high pressure compressed air providing the cleaning action. There is, therefore, a natural reluctance on the part of purchasers to pay high prices and suffer long replacement delays for equipment even if it is highly efficient. Replacement times for imported items were quoted in months and years rather than days or weeks.

One suggestion put forward when discussing this problem was that tax relief should be given on equipment providing the company could show an improved environment resulting from its installation.

The question as to whether or not the detailed advice given to plants in Annex I on specific areas needing improvement is implemented can only be judged by subsequent visits from NCBM staff. Most suggestions made were inexpensive enough for the companies to carry out without capital cost.

3. CONCLUSIONS

The conclusions are drawn from a limited number of site visits to privately operated plants only and work at the NCBM.

There is no doubt that excessive emissions are taking place from fugitive dust sources and some process dust sources. Some of the dust, namely raw cement meal, is the same as the final product and therefore makes a most expensive and direct loss in output and money to the plant.

The main difficulty being experienced appears to be the design, acquisition, operation and maintenance of suitable dust control equipment. In particular, the use of fabric filters, which are commonly used on low temperature and fugitive dust emission sources create problems. Until the supply of suitable fabrics and good designs are readily available from local sources, it is hard to see any major improvements taking place. Only encouragement by the use of incentives or the strict enforcement of the legal requirements will hasten the process.

Education is needed at plant level in the design and operation of equipment to minimise dust generation and improve control. This may be achieved by suitable seminars from NCBM.

The introduction of the new concept of avoiding the mixing of dust and air, which although simple in idea has wide implications, should enable the staff of the Centre for Environmental Improvement to develop the expertise necessary providing they have frequent exposure to actual plant problems.

[redacted]

4. ACKNOWLEDGEMENTS

Acknowledgement should be given to Mr S N Mehrotra (Project Leader for the Centre for Environmental Improvement) and the following members of his staff:

Mr B S Roy - (Mining Engineer)
Mr B Kumar - (Chem Engineer)
Mr R A Ramanujjam (Chem Engineer)
and Mrs S George - (Chem Engineer)

for their willing assistance to the author in the various aspects of his mission.

ANNEX - I

Visit reports on cement plants in:

Satna	Madhya Pradesh
Maihar	Madhya Pradesh
Gagal	Himachal Pradesh
Bhupendra	Haryana

Visit to Satna Cement Works, PO Sagamania, Satna-485114 (MP) on 7.11.86 and 8.11.86

Persons contacted

Mr J N Prasad	- Vice-President
Mr Pillai	- Asst Vice-President
Mr C V Singh	- Mines Manager
Mr M Singh	- Quality Control

NCB-8 Team

Mr S N Mehrotra
Mr B Kumar
Mr R W Higman (UNDP)

Description of Plant

Old plant - 2 wet and 1 semi-dry kilns with a total rated capacity of 2000 tpd and built between 1955 and 1964.

New plant - 1 dry kiln with a total rated capacity of 2500 tpd fitted with a pre-calcinator and built in 1983.

The Quarry

The road from the quarry offices to the quarry face is concreted and provides a good surface. The drilling machine, at the time of visit, appeared not to have its dust control system working. The loading of the 35 tonne dumper trucks creates the usual dust generation problem due to the way the front end bucket loader is operated for safety reasons. The trucks then travel a kilometer or so back to the mines office area where the primary crusher is situated. A water spray was fitted in a horizontal fashion around the three sides not touched by the truck. Tipping was done in the open. The company were advised to fit a corrugated or sheet metal enclosure to cover all three sides and the top, arranging the water spray in a vertical position so that it covered the sides and top of the lorry. The spray which has to be manually operated, and which was not done with the first load seen, will then become more effective having to cover a smaller open area. The spray across the box opening will also contain any dust generated within the box. Access for breaking or removal of large blocks trapped on the grid is not adversely affected.

The dust control at various belt sections was not functioning well and the duct work leading to twin parallel high volume cyclones required redesign. Various reject piles had discharge points high in the air which caused excessive dust generation. The use of telescopic trunking was suggested with a tilt switch controlling the operation of the telescoping motor.

Several motor drives to the secondary crushers were stirring up dust because they were fitted with only mesh safety guards. The use of the mesh allows the V-belts and pulleys to act as fans. Solid thin metal covers were suggested which will cut down the fan-like action of the pulleys. Closer attention was required to the maintenance of ductwork.

The material, having passed the secondary crusher, was fed to a 4.5 kilometre ropeway to the cement works. The loading of the ropeway containers generated dust which could be controlled but would involve some cost. The design of the enclosure would also have to be carefully considered so as not to interfere for operational reasons e.g. the containers sometimes stick requiring immediate human intervention which may be more difficult in an enclosed system.

The Plant

The works had three major emission sources all related to the clinker store and the removal from the store by conveyor to the storage silos. Equipment based on fabric filtration has been ordered to control the emissions at both ends of the conveyor which was severe.

The worst point was at the top of the silos because dust could be spread over the entire plant.

The clinker store operation, where material is discharged from a moving tipper conveyor system, is a classic example of free falling material streams over a distance of 15-20 metres. Because of the A-frame construction of the store, the possible choices for control of the dust generated were small. After group discussions, the possibility of fitting water sprays to the outside of the discharge hopper seemed the best option. Spraying from the stockpile base would be ineffective as it would only control the pile surface and not the falling streams from which trails of dust are blown.

Another source, which was related to house keeping, occured at the drive end of a conveyor which was sitting in a dust pile and the pile was being stirred generating dust clouds. Apparently a vacuum dust control system is due to be fitted soon which should improve the situation. A vacuum lorry is also being purchased for cleaning plant roadways.

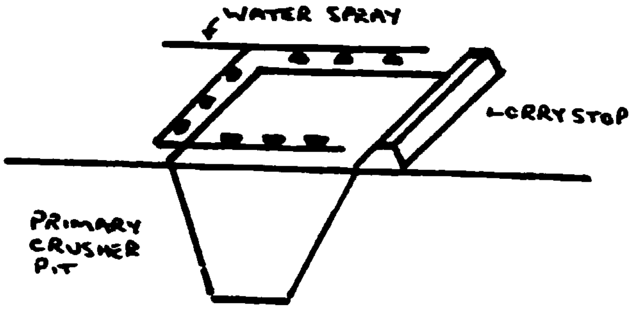
The final suggestions were made on the bag filling plants where it was explained that simple extension of the service doors would improve the situation dramatically. The dust control over the exit conveyor should be extended to include the first conveyor transfer point. The first belts from the filler are also going to be converted to a mesh type allowing excess material to be more easily returned to the collection hopper.

Some discussion took place over the silo venting filters and also the packing system filters. The packing filters are of two types, Flakt India and Andrews. The Flakt India run with a face velocity of 1.4m/min and

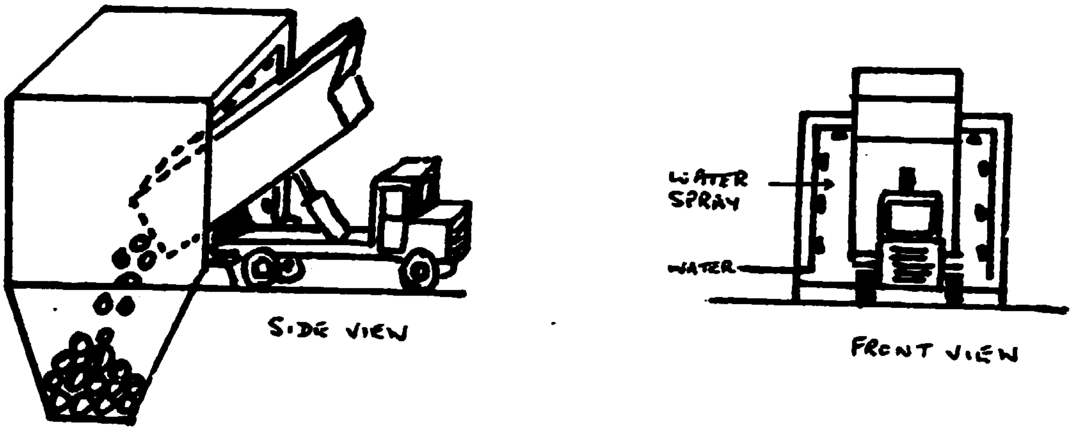
2.5 kg/cm^2 pulse cleaning pressure whilst the Andrews systems run at 2.4 m/min$^?$ and 5-6 kg/cm^2 cleaning pressure. The Andrews system is more usual for pulse jet systems and energy/money could be saved by reconsidering the Flakt India operation.

A further energy saving suggestion was the use of the pressure drop difference as the initiating signal for the cleaning sequence as against the fixed time cycle. Dependant on the variations in the dust loadings experienced by the filters, it is possible that the pulse action will be less frequent thereby saving on compressed air costs. In any case, it will control excessive cleaning leading to lower emissions immediately after cleaning.

ILLUSTRATIVE SKETCHES



EXISTING ARRANGEMENT

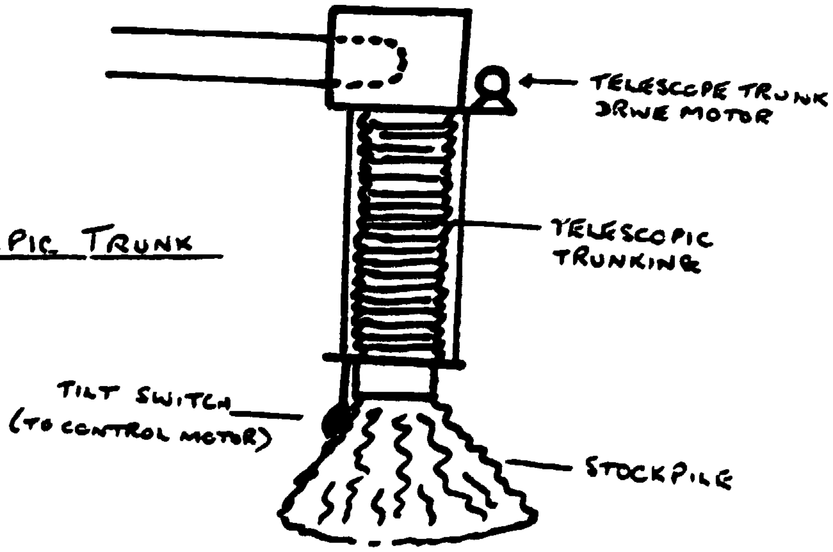


SIDE VIEW

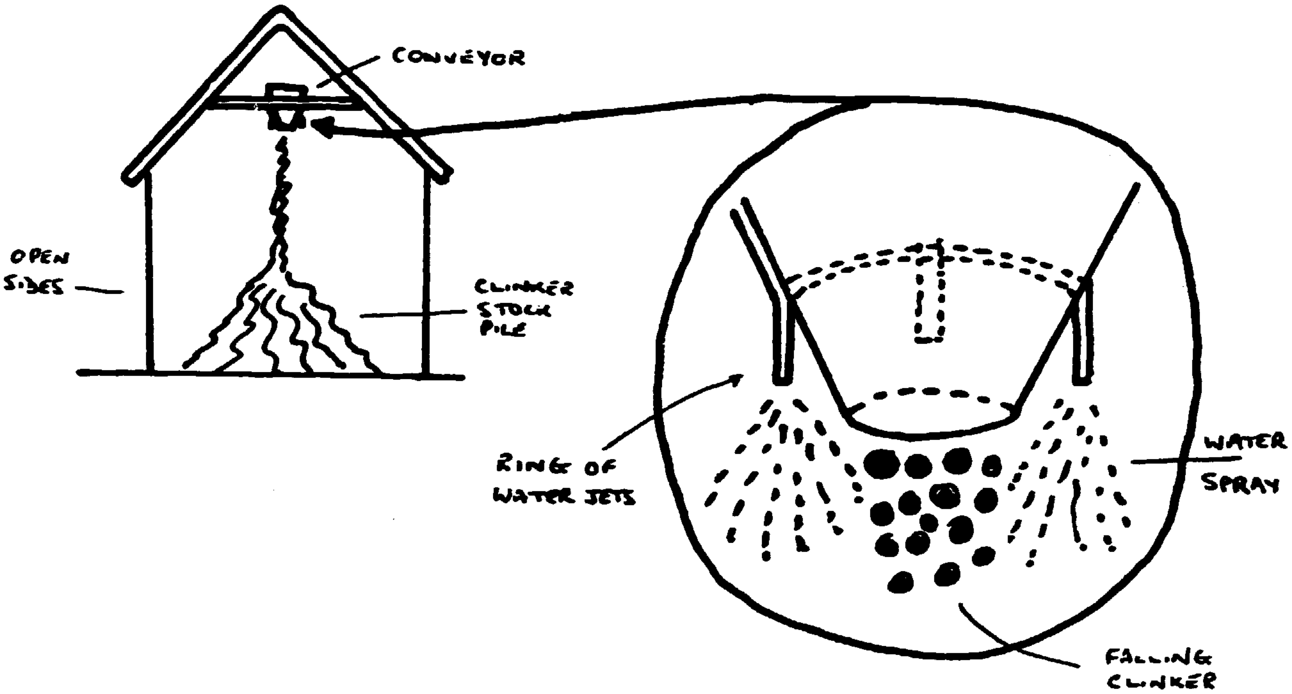
FRONT VIEW

SUGGESTED ARRANGEMENT

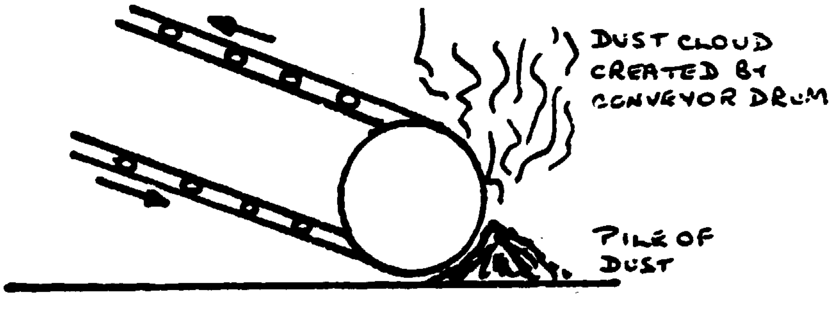
TELESCOPIC TRUNK



SKETCHES (cont)

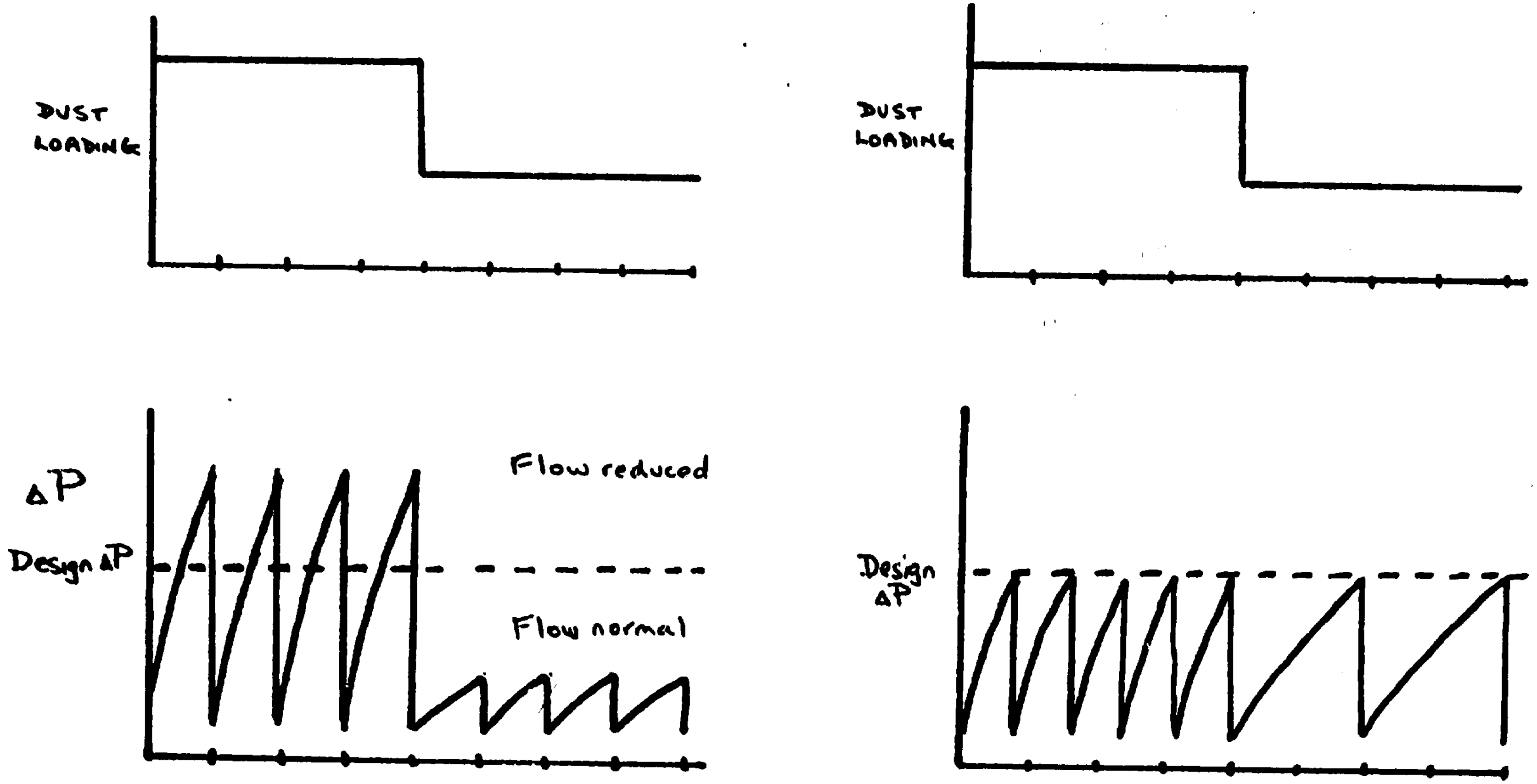


SUGGESTED MODIFICATION TO CLINKER STORE TIPPER CONVEYOR.



EXAMPLE OF POOR HOUSEKEEPING

SKETCHES (cont)



TIME CONTROL

ΔP CONTROL

EFFECT OF DIFFERENT CLEANING CONTROL SYSTEMS

Notes: 1) Flow is reduced during period above dashed line creating inadequate suction at hoods etc.

2) When the dust loading is reduced, bags are overcleaned and full design range of filter not used.

1) Flow is unaffected by dust load.

2) When the dust loading is reduced, energy for bag cleaning is reduced and full design range used.

Visit to Maihar Cement Works, Sarlanagar 485 772 Maihar, Satna (MP) on 10.11.86 to 11.11.86

Persons contacted

Mr Kamal Kishore	General Manager
Mr V Y Wyawahare	Sr Mgr-(P&QC)
Mr B P Jain	Sr Mgr-Engineering
Mr M K Sethi	Mgr-Mines
Mr Lokre	Chief Technical Manager

NCB-B Team

Mr B Kumar
Mr R W Higman (UNDP)

Description of Plant

2 dry kilns with a total rated capacity of 2400 tpd and built in 1980.

The Quarry

The roads from the mines offices to the quarry pit have been recently concreted and tarmac coated at a cost of 2 lakh Rs. The payback period is estimated at 10 years by savings on tyre wear, suspensions and maintenance of the dumper trucks. The quarry pit is well maintained and the company have one advantage from a dust generation view point. The quarry limestone material has a high moisture content of around 8-10%. Although this does cause some processing difficulties of building up material at the primary crusher, the saving on dust control is large. Apparently, the dust control is used only when processing sweetner material.

The primary crusher receiver pit was enclosed but, as no vehicles were seen tipping, dust generation is not known. The material after secondary crushing is carried by covered belt conveyor a distance of 8 kms to the plant. Dust control is not fitted to any transfer points.

The Plant

At the plant the material either goes straight into use or drops down a high tower to be fed to a circular stacker/reclaimer system. Initially the system was not seen in operation but subsequently it was noted that the operator failed to control the pile building conveyor correctly by adjusting its height as it was rotated i.e. material free-fell heights of 5-10 m. Although the material appeared damp to feel, this procedure still generated a lot of dust. It is possible that the dusty material was created when the conveyors were stopped allowing the thinly spread material to dry out. Possible enclosure of a complete or partial nature should be considered particularly on the side nearest to the housing colony to reduce dust emission reaching them.

Around the plant there appeared to be excessive quantities of spilt material which was capable of becoming airborne at any time. Apparently a vacuum system is on order and is due to be installed soon. The system will improve the overall cleanliness of the plant which is currently cleaned only every week to 15 days over the roadway areas.

The dust filters used in various parts of the plant were supplied by Flakt India. Comments were made to the effect that the company was not prepared to act as "guinea pigs" at the expense of the equipment suppliers. General dissatisfaction with the information, service and expertise of the equipment suppliers was expressed. The suppliers were expected to provide the correct equipment as the cement companies had no knowledge of suitable equipment for pollution control in a detailed sense. (It does seem that even with Indian companies having overseas collaboration that the expertise existing overseas is not being transferred or adapted to Indian conditions).

The clinker store again provided the major dust source and loss of product. In this case the building construction should allow the fitting of telescopic chutes at intervals down the store. The number to be used is dependant on the materials angle of repose. The reclaimer also generated dust with a free-fall of about 2m. The alternatives of raising the extraction conveyor or fitting a chute were discussed.

One other major dust source arose from a horizontal exhaust duct situated virtually at ground level. The pollution from this source flowed around between the buildings creating high concentration levels in low lying dust clouds.

Visit to ACC Gagal Cement Works, PO Barmana Dt Bilaspur 174 013 (HP) on 18.11.86 and 19.11.86

Persons contacted

Mr S B Agarwal	General Manager
Mr M S Gilotra	Dy General Manager
Mr Nanda Kumar	Mgr-Engineering
Mr N Mishra	Mgr-Mining
Mr Nangia	Mgr-Q&PC
Mr Prem Sagar	Master Burner

NCB-B Team:

Mr B S Roy
Mrs Salila George
Mr R W Higman (UNDP)

Description of Plant

1 dry kiln with pre-calcinator with a total rated capacity of 1700 tpd and built in 1983.

The Quarry

The limestone quarries for this plant are, in fact, hill tops which are slowly being truncated. There are large reserve in two mining areas. The major area is slowly being developed as there was a land dispute which is reaching a conclusion.

Some advice was given on the re-siting of the spray bars and enclosure of the primary crusher hopper. The need for enclosure was due to the exposed position of the site. The site is also unusual in that there are two dropping towers(~15-20 m)on the belt conveyor system to enable the material to be efficiently transported down the steep hillside. The use of sprays, containing water and compressed air, surrounding the periphery of towers spraying inwards; was discussed. The effect would be to minimise the dust generation on impact.

The remainder of the belt conveying system was protected on one side and with a roof. No problems are likely as the exposed side is sheltered by the hillside. All roadways were concreted and/or tarmac covered thereby minimising vehicle dust generation.

The mining area did not generate much dust overall and no persons need work in any of the generation areas.

The Plant

The raw material, limestone, was received at the plant in a standard A frame building. Normally a telescopic chute is used to minimise dust generation during fall of material from the conveyor. However the chute was not working due to a faulty tilt switch consequently material was being dispersed.

Pulse jet dust filters supplied by Andrew Yule were fitted to the grinding circuits for the raw materials. These units were not examined but subsequent doubts as to their overall efficiency have been raised (see minute of visit to ACC Bhupendra). However they were claimed to be operating effectively.

A problem of mal-distribution of air and dust flow into the multicyclones from the clinker cooler was created by the duct work design. The design threw the dust stream to one side of the collector creating excessive wear etc. The only remedy in the space available is to try and fit suitable distribution baffles which would need to be very close to the cooler in the initial junction of the Y-shaped ductwork.

The major problem arose from the retrieval of material from the clinker silos. The two silos have, between them, four conveyor belts feeding to two central points. Material is fed to the conveyors by a moving trolley system which sweeps the material off a ledge into a small hopper. The original concept was acceptable except that the rotating arm could have been enclosed more. However the problems were caused by lack of maintenance and understanding of the device by the operators. For example, inspection flaps were left open, rubber seals not replaced and, in one case, fitted upside down over a conveyor opening. Similar faults were found on all four trolleys.

There are two possibilities:- (1) fit a small dust collector unit on the trolley which would drop fine dust onto the moving material surface. The dust would then be blown off. (2) Modify the discharge arrangements. By removing the ledge onto which the material currently falls and extending the hopper section to the belt, the flow rate could be controlled by a slide valve. The material would not fall through the air and could be uniformly discharged onto the belt with little dust generation.

It is believed that (2) will be tried on one of the feed points and, if successful, adopted for the remaining discharge points.

Problems were also created at the two central feed points where material dropped approximately 3.5m. Although well sealed underneath, the dust extractor fitted to the hood over the discharge points was not functioning allowing dust to escape. No curtains were fitted over the hood inlets which further aggravated the situation. The dust collector is believed to be of "home-made" manufacture and design but was not examined.

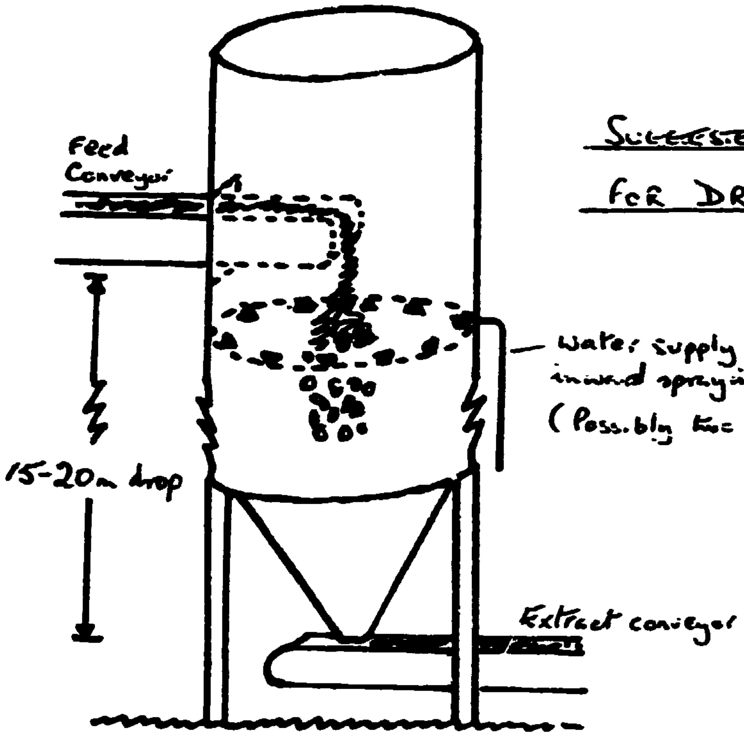
The other main problem area was the packing plant where some commissioning of dust extractors was taking place. There are three lines, of which the latest looked extremely well designed, including the extendable conveyors to the insides of the lorries. Lorries are the only method of transport for this plant. Once this line is running, the other two lines will be modified and brought up to the same standard. The general environment of the packing house could have been improved with better house keeping as loose material on the floor creates further possibilities for dust generation. Some material will be loaded into HPDE sacks (polythene) which cannot be handled using the hook spikes currently used on jute sacks when the sacks jam on conveyor or slides.

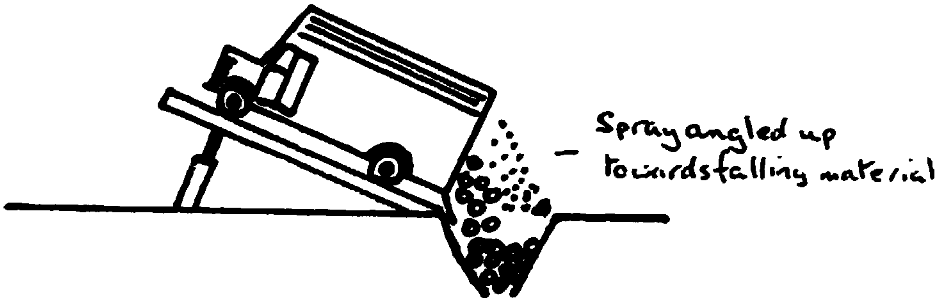
The lorry tipping area for unloading bricks etc was stated to create problems in the dry reason. The complete lorry is tilted by means of an hydraulic ram to empty into one of two hoppers. A water spray could be fitted as moisture will create no problems here. The important point is that the spray should cover from ground level upwards for an angle of around 45°. The spray will then coat the material as it falls, before the material impacts on the material already deposited. Otherwise the application of the spray will be too late to be effective. Venturi or air pump type sprays using compressed air and water should provide better spray atomisation and, if the water is turned off first, maintain clear nozzles.

During a discussion session with plant management and engineers, the question of silo venting was raised. An alternative was suggested to having a fixed ductwork to the exhaust filter, which entails the suction of extra dust onto the filter. The alternative is a stub pipe with a coolie-hat type hood over it which does not create suction on the silo. Should the silo pressurise, then any emission is contained by the hood. The amount of dust collected is thereby reduced.

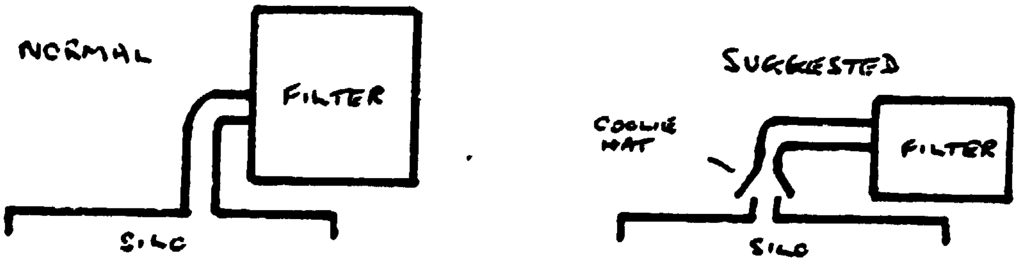
ILLUSTRATIVE SKETCHES

SUGGESTED ARRANGEMENT FOR DROPPING TOWERS



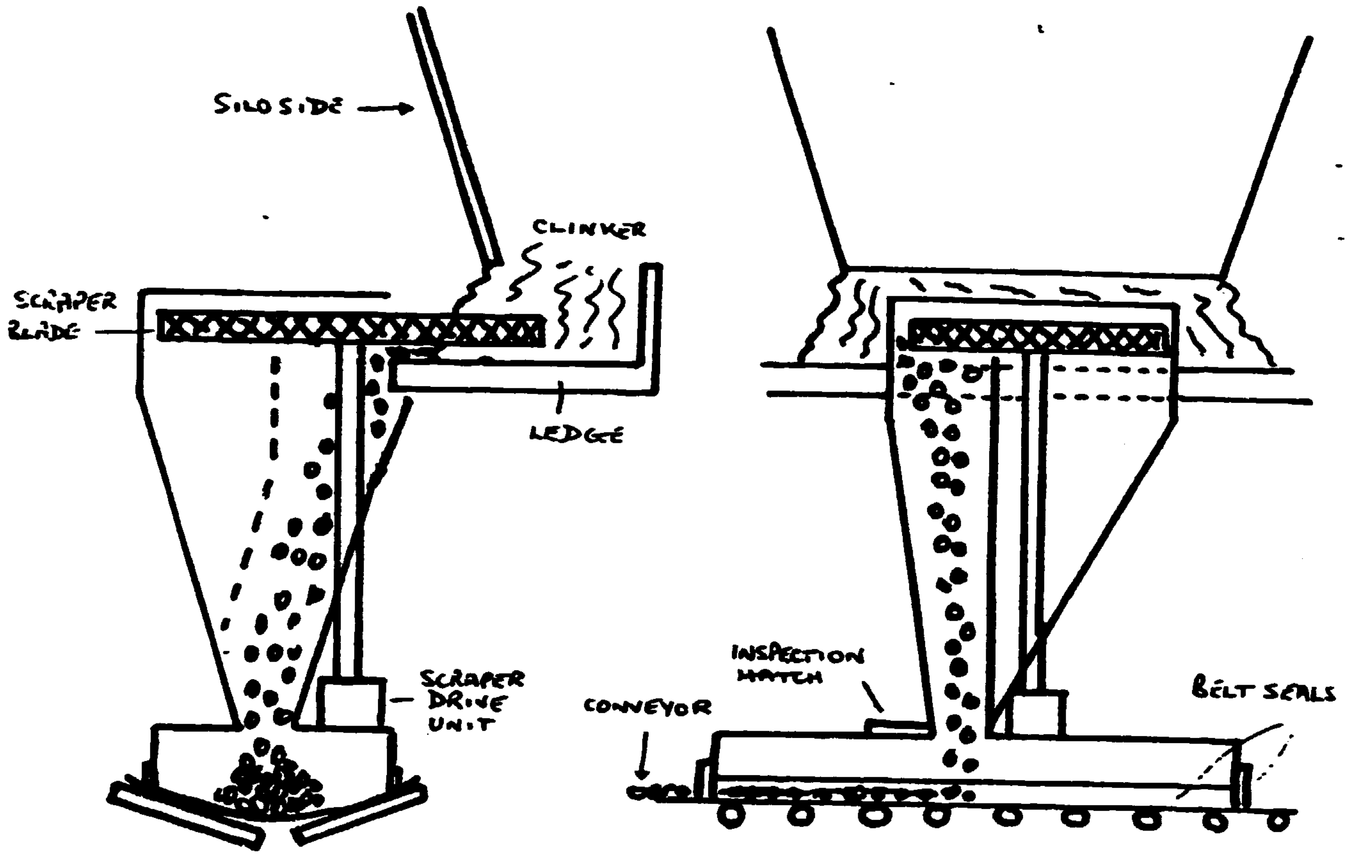


SPRAY AT LORRY TIPPING POINT



SILO VENTING

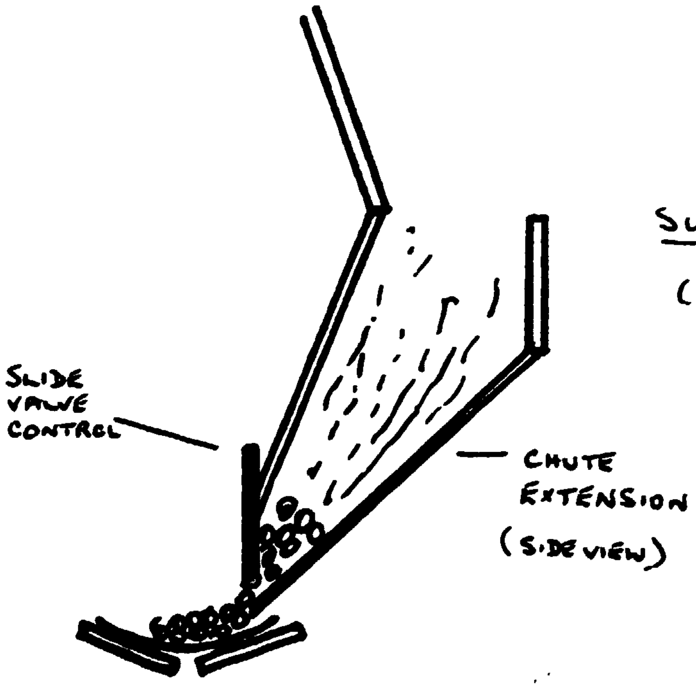
SKETCHES (cont)



SIDE VIEW

FRONT VIEW

EXISTING ARRANGEMENT FOR CLINKER REMOVAL



SUGGESTED ALTERNATIVE

(No moving parts to generate dust)

Visit to ACC Bhupendra Cement Works, Surajpur 133301 (Haryana) on 21.11.86 and 22.11.86

Persons contacted

Mr K Jayaraman - General Manager
Mr J C Khurana - Dy General Manager
Mr M K Srivasthava - Mgr - Engineering
Mr N K Sharma - Mgr-Mining

NCB-B Team

Mr B S Roy
Mrs Salila George
Mr R W Higman (UNDP)

Description of Plant

3 wet kilns with a total rated capacity of 1200 tpd and built between 1939 and 1956.

The Quarry

The quarries are some 15 km from the plant and are connected by an aerial ropeway system. The quarry area has been developed in three sections and work is currently being done in the second and third sections. The first section is being landscaped and planted in cooperation with the Forestry Commission. The second section has an overburden of some 60m which makes the economics of working marginal. The third section is a hill which is being truncated but the available working area is small.

To reach the quarry several river wadi's have to be crossed which means that the area is liable to be isolated in the rainy season. Although the actual quarry roads were not made up by concrete or tarmac, a similar surface had been achieved by spraying. A solution of 100 kg of salt in 10,000 litres of water sprayed twice daily was found to combine well with the crushed road material. The salt, being hydroscopic, drew moisture into the roadway surface retaining the spraying efficiency for longer periods. However in the rainy periods the entire surface tends to be destroyed by washing away of the top layer but little dust would be generated under these circumstances.

Not all the mining equipment was seen in operation but material fed to the primary crusher appeared to be moist and created no problems. Water sprays were fitted at various points.

The primary emission area appeared to be the secondary crusher hammer mill which, when operated without material, created dust clouds from the fan-like action of the hammers and the dried out material loosened by the vibrations. A water spray was fitted to the entrance, which had a chain curtain fitted, but it was only hand operated when the material flowed.

In discussion it was mentioned that dust masks and ear defenders (muffs) were provided but not used because of unsuitability. The opportunity was taken to examine both protective devices.

It was immediately clear why no worker would wear the dust mask as there was a basic design fault. The fault was created by the filter pad being allowed to deform and seal over the air inlet valve. This not only restricted the area over which air could be drawn but also, if the air was dirty, created a high resistance over the small area thereby making breathing difficult. The life of the filter pad was effectively reduced by a factor determined by the ratio of the total filter area divided by the air inlet area.

The solution suggested was to support the filter pad over its entire area with a backing of wide spaced mesh, sufficiently strong not to deform under breathing pressures. The use of the mesh would ensure the utilization of the entire filter area and reduce the resistance to air flow by making effective use of the chamber already provided behind the filter pad. Currently the chamber contains the deformed filter pad.

The ear muffs consisted of two hemi-spherical cups with a small amount of padding around the open circumference joined by a metal headband. Apart from providing a slight attenuation of the sound, due to the approx 2mm thickness of the plastic, no effective sound diminution was achieved. On the contrary, the hollow spheres could act as effective resonator boxes.

The solution suggested was to fill the spheres either with cotton wool or preferably foam sponge material. Either would provide better sound reduction and were cheap enough to try and evaluate until better designed muffs could be obtained.

The Plant

The plant could be seen from a couple of kilometres distance to be producing far greater dust emissions from other sources then from the kiln stacks fitted with electrostatic precipitators. These other principal sources were later identified as being a bucket elevator/belt conveyor transfer point handling clinker from the clinker cooler to the store and the ineffective dust control on the cement grinding mills. It was stated that at least 15 tonnes/day of cement were being emitted. By simple calculation, the cost of retrofitting the dust collectors with a more effective system could probably be recovered in two months as the cost of such a retrofit was already known for ACC Mancherial. Other sources were sieving tables,two spout-sack fillers (which were fitted with similar dust collectors to the cement mills) and a newly installed rotary packer fitted with an Andrew Yule "pulse jet" unit still under commissioning.

The cement mill emissions were being generated at both ends of the process. As the dust collectors were not functioning correctly, excessive emissions were taking place. The draft was reduced to some 20mm water.gauge for the same reason and dust clouds were being generated where the materials were being fed into the mill. Both sources could be eliminated by the installation of correctly sized and functioning bag filters.

The circular dust collectors currently in use combine reverse air with a form of mechanical shaking where the bag support frame in each quadrant is lifted and dropped 5 times by a rotating sawtooth attachment. Only three quadrants function as cleaners whilst the fourth allows ambient air, drawn in by fan suction, to reverse air clean the bags during the shaking operation. The tensioning and securing of the bags did not seem to be correct and the radial fan sizing/specification may also have been in error.

The bucket elevator/belt conveyor transfer point emissions can be reduced by carrying out a number of simple tasks:

(1) the open door at the base of the elevator should be closed as they provide air access for the pumping action of the buckets.

(2) the opening at the top of the elevator should also be closed for similar reasons. In this case it is more important because the action of the material falling from the buckets will induce extra air which will enter by the shortest, most convenient route.

(3) the grid at the base of the elevator, used for returning spilt material to the elevator, should be sealed by moveable flaps. Again the reason is to reduce access of air into the elevator system.

(4) the elevator discharge chute should be completely enclosed until the right-angled bend feeding to the belt conveyor.

(5) at the right angled bend, across the mouth of the enclosed chute, an atomised water spray should be fitted. The water rate to be adjusted so that no residual moisture remains once the clinker hits the stockpile.

(6) the small chute from the bend to the conveyor should be narrowed to improve location of material in the belt centre and reduce the chance of spillage occuring.

Any air which is pumped out of the elevator should go down the enclosed chute and dust will be trapped by the water spray at the exit. The temperature of the clinker, around 300°C,at this point excludes the use of a fabric filter for this application if it is to be placed close to the point of emission.

The rotary packer unit was not itself generating dust but because of a misplaced air washer, for cleaning the bag surfaces, material was being allowed to be carried on the bag surface. On hitting a roller, placed to assist the sack down a curved right angle chute, the sack tumbled giving greater impact on the dust laden area of the bag surface. Dust was therefore being generated by every sack and no dust control was fitted. By repositioning the air washer lower and further inside the conveyor hood, the bags and belt should be cleaned more thoroughly avoiding the need for any additional control.

The Andrew Yule unit is claimed to be a pulse jet cleaning system but is unlike anything the author has experienced under this heading. A better description would be a low pressure reverse air system as the high intensity pulse, which should be applied to the bag, is rapidly lowered in intensity by the time it reaches the top of the bag opening. The design of the unit also ensures that the bags collecting the most dust, i.e. those nearest inlet, are those least likely to be cleaned effectively.

The fit of the bags to the metal support cages also raised some doubts as at least 5 cms of slack was found on the bag diameter. The fit of a new bag to a cage could not be evaluated as no spares had been provided. There is the possibility that the fabric has stretched in use in which case another fabric should be sought. If this is not the case, then the bag diameter should only be a few millimetres greater than the cage diameter i.e. a sliding fit.

Suggestions were made on how to convert the unit to a more effective pulse jet arrangement which included:-

(1) extension of high pressure pulse tubes across the top of the bag.

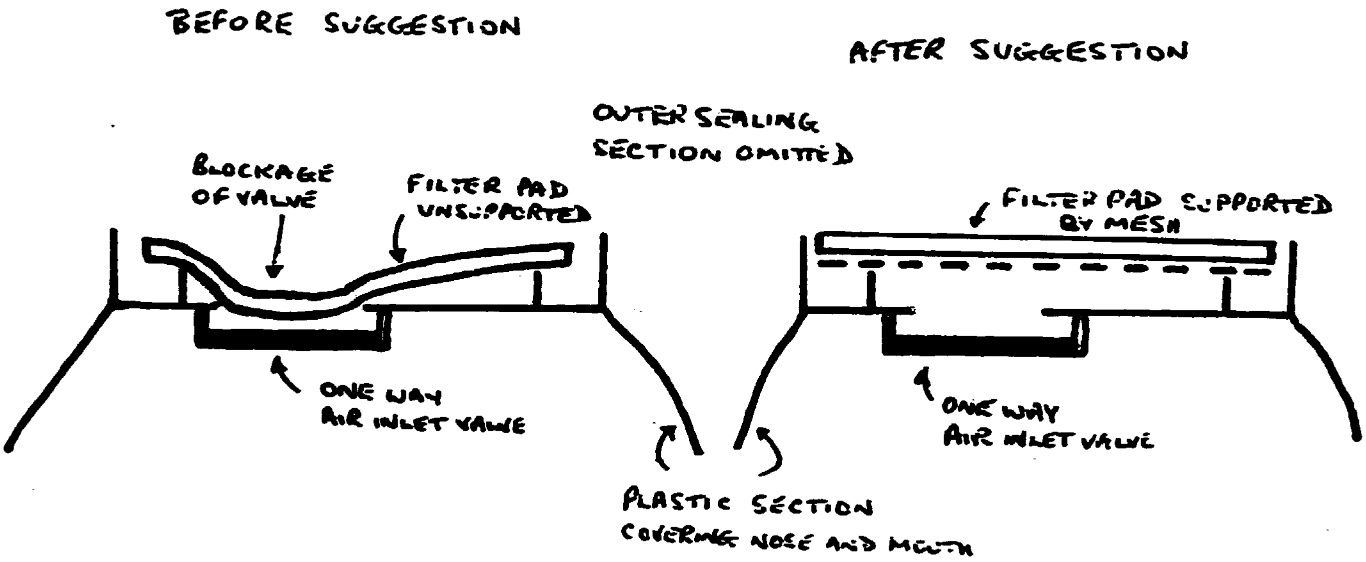
(2) removal of dividing panel between each bag set in the area above the bags and

(3) increasing the height of the unit above the bags to make a more effective plenum and allow correct induction of additional air by the high pressure pulse.

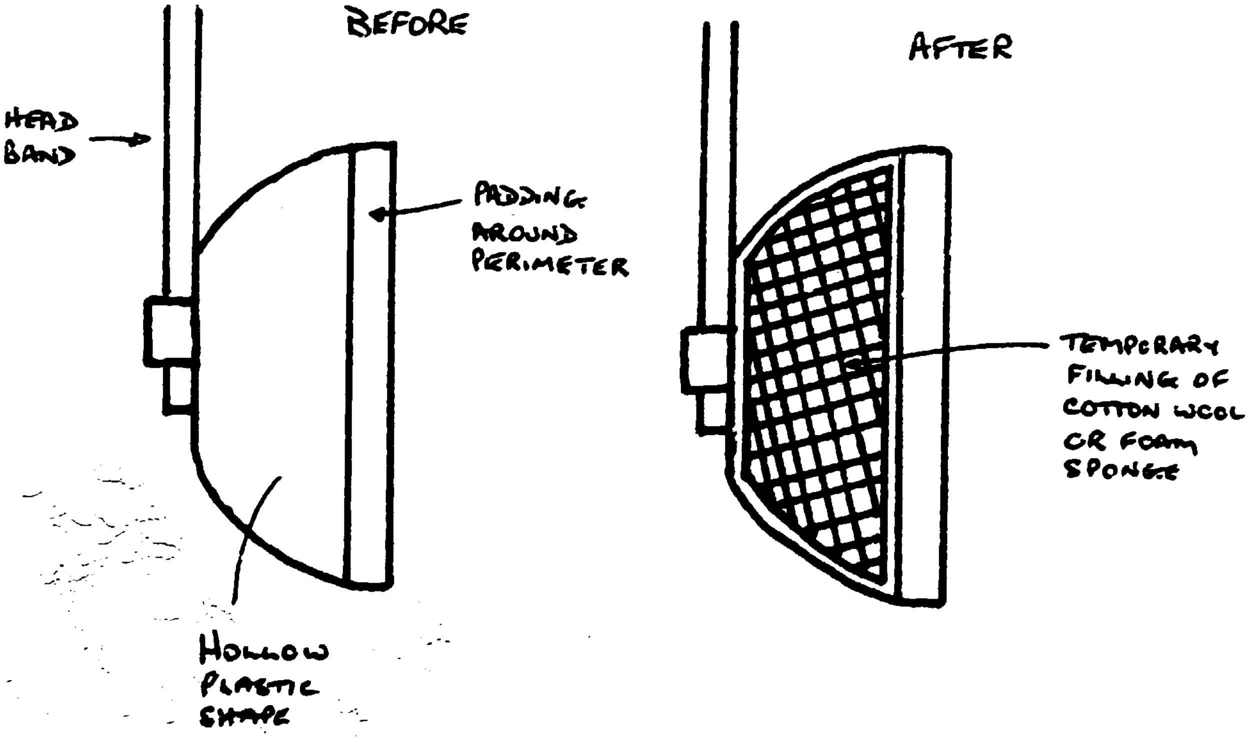
Yet again a radial fan was provided, which for dust control purposes are around 10% less efficient than backward inclined fans, and which have a poorer pressure drop/flow rate fan characteristic. Ideally, the requirement is for a fan to maintain the flow rate volume irrespective of pressure drop variations and this is most closely achieved by a backward inclined fan used on the clean air side of the filter.

The sieving operations connected with the feeding of cement to the two 4-spout sack filters were not fitted to dust collectors. The sack fillers themselves could have been better enclosed to improve the extraction at any open point but this would have been negated by the inefficient dust filters fitted. Until better filters are fitted little improvement can be expected.

ILLUSTRATIVE SKETCHES

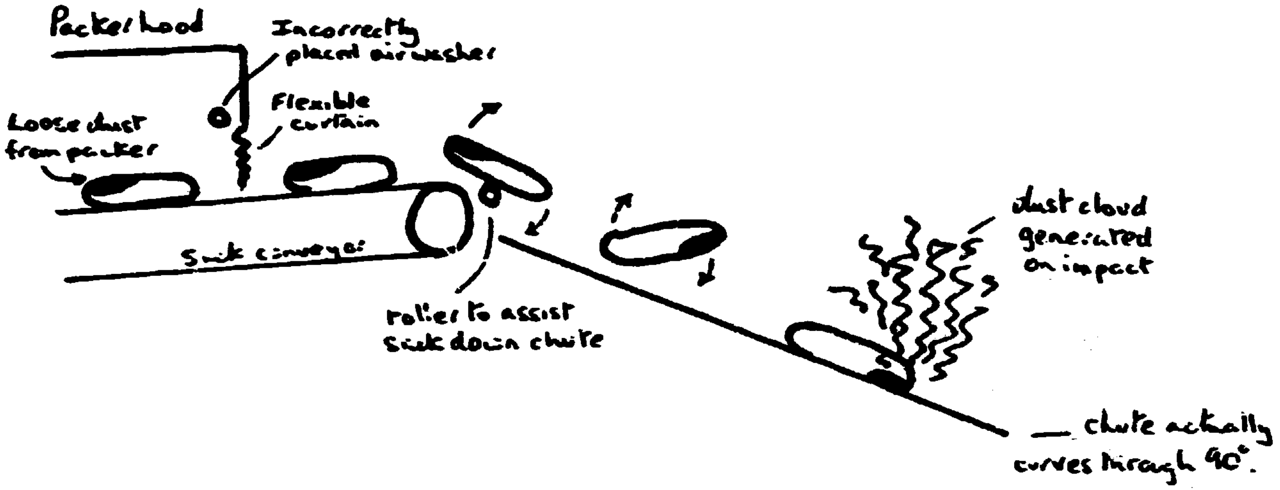


SECTION THROUGH DUST MASK

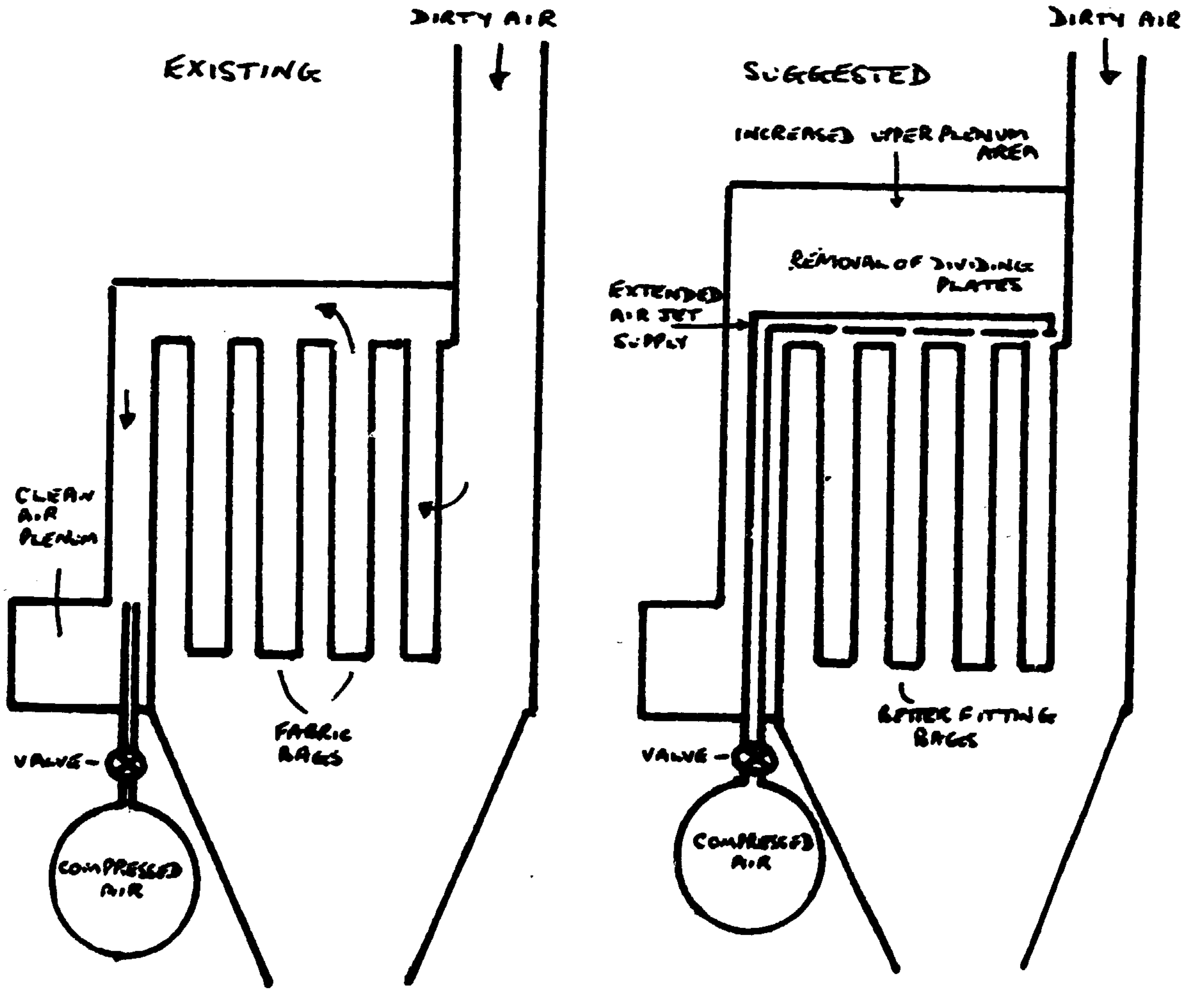


SECTION THROUGH EAR MUFFS

SKETCHES (cont)

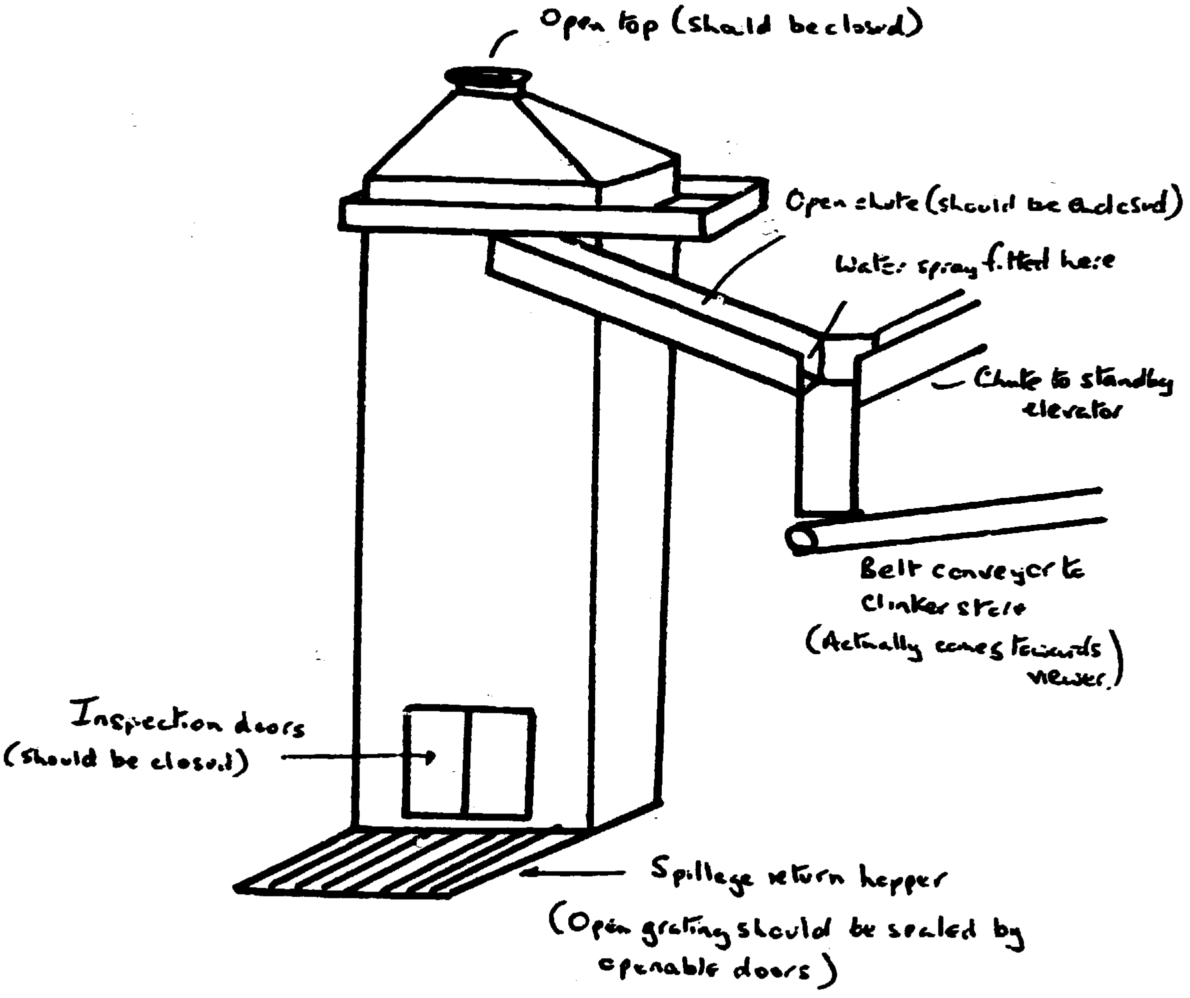


GENERATION BY INCORRECT SACK CLEANING



SUGGESTED ALTERATION OF ANDREW YULE "PULSE JET"

SKETCHES (cont)



SUGGESTIONS FOR BUCKET ELEVATOR

ANNEX - II

Suggested acquisitions for NCBM Library

ANNEX II

The following books have been recommended for purchase-by the library of N.C.B.M. - in order to strengthen the available literature in the areas of abatement equipment design and maintenance, ductwork design and fan selection/operation, and the control of dust explosions as well as the capture and control of fugitive emissions.

Air Pollution Control Equipment. 1982. Theodore L and Buonicore A J. Prentice Hall.

The Art of Electrostatic Precipitators. 1980. Katz J. Precipitator Technology Inc. Munhall. P.A. USA

Handbook of Environmental Engineering. 1979. Wang L K and Pereira N.C. Vol 2 Air and Noise Pollution Control. The Humana Press USA.

Air Pollution Control Technology. 1978. Bethea R.M. Van Nostrand Reinhold

Fans. 1977. Osborne W.C. Pergamon

Advanced Design of Ventilation System for Contaminant Control. 1985. Goodfellow H. Elsevier

Fans and Systems. Publication 201 Air Movement Control Association. Arlington Heights, Illinois USA.

Woods Practical Guide to Fan Engineering. 1978. 3rd Edition Daly BB. Woods of Colchester UK.

Industrial Ventilation - a manual of recommended practice. Latest edition. American Conference of Governmental Industrial Hygienists

Explosions. 1981. Bartknecht W 2nd Edition. Springer-Verlag W Germary

Guide to dust explosion venting. 1984. C Schofield Institution of Chemical Engineers. Rugby. UK.

(another guide on suppression and inerting techniques is due for publication Dec 86/Jan 87)

Fundamentals of Industrial Ventilation. 1972. Baturin V.W. Pergamon Press.

Plant and Process Ventilation. 1963. Hemeon WCL 2nd Edition Industrial Press. New York

APCA - Speciality Conference. Dispersion modelling from complex sources. Proceedings. St Louis. Missouri. April 1981.

APCA - Speciality Conference. Operation and maintenance of gas cleaning equipment. Proceedings. Pittsburgh. PA. 1980

Air Pollution Measurement Techniques. Parts I and II. (Special Environmental Report No. 10) Unipub

Predicting and measuring fugitive dust. 1985 Hesketh H.E. and El-Shobokshy M.S. Technomatic Publishing Co. Inc.