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REPORT OF THE EXPERT COMMITTEE ON ATMOSPHERIC ENVIRONMENTAL QUALITY AND PRESERVATION OF TAJ MAHAL AND AGRA MONUMENTS

VOLUME I

Volume I : Report and Annexures

Volume II : Additional Relevant Documents and Bibliography

MINISTRY OF ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA
NEW DELHI
APRIL, 1995

V O L U M E - I

C O N T E N T S

HISTORICAL BACKGROUND

The Government of India announced its decision in 1973 to set up a 6 million tonne per year Petroleum Oil Refinery at Mathura under the Indian Oil Corporation Ltd. (I.O.C), a company wholly owned by the Government of India. Some apprehensions were expressed about the possible adverse effects on the historic monuments in the Agra-Mathura region from the gaseous emissions to be discharged from the Refinery. These monuments include the Taj Mahal, and the palaces and buildings in Agra Fort, Itimad ud- Daula Sikandra and Fatehpur Sikri. An Expert Committee constituted by the Government of India conducted studies on the atmospheric air quality in the region and estimated the extent of release of various components in the gaseous emissions. Based on the recommendations contained in the Report of the Expert Committee on the Environmental Impact of Mathura Refinery published in December 1977, two 10 MW coal based power plants in Agra were dismantled and the Indian Railways replaced coal based locomotion by diesel based locomotion in the marshalling yard in the area. The level of sulphur dioxide (annual average) was reduced from about 15 micro grams/ cubic meter to 8 micrograms/ cubic meter as a result of such action.

2. The WHO-recommended levels of sulphur dioxide at that time was 60 micrograms/cubic meter. The Committee however stipulated that the levels in the Taj Mahal and adjoining monuments area should be maintained below 30 micrograms/cubic meter. The Committee also advised the Refinery that gaseous emissions of sulphur dioxide should not exceed 1000 kg/hr. At such a level, the Expert Committee, based on investigation carried by Tecneco of Italy and the National Environmental Engineering Research Institute (NEERI) of India concluded that the contribution from the Refinery to the long term concentration of Sulphur dioxide would be of the order of 1 to 2 micrograms/cubic metre as compared to the then existing level of 15 to 20 micrograms/cubic meter in Agra. Short term (one hour) peak concentration of the order of 65 micrograms/cubic meter could be expected under the worst metereological conditions in winter in the Taj Mahal area, and the frequency of such occurences are 2.0 to 4.0 per cent for Agra region and 0.0 to 1.0 per cent for Bharatpur bird sanctuary. The Refinery

also adopted oil based power generation instead of using coal, in spite of the concerns arising from the oil crisis of 1973.

3. The composition of the Expert Committee, and the conclusions and recommendations in their Report are attached as Annexure I.

FURTHER DEVELOPMENTS

4. The Refinery was commissioned in 1982. The air quality monitoring stations established at about 10 km intervals in the direction from Mathura to the Taj Mahal (a distance of 43 km) by IOC, Uttar Pradesh Pollution Control Board (UPPCB), Central Pollution Control Board (CPCB), and the Archaeological Survey of India (ASI) have, in the period 1982 to 1995, generally confirmed the estimates made by the Expert Committee in 1977 with regard to the level of sulphur dioxide in different locations between the Refinery and the Taj Mahal. The Expert Committee's recommendation that steps may be taken to ensure that no new industry, including small industries or other units, which can cause pollution are located north-west of the Taj Mahal, has been enforced. However, efforts to relocate existing small industries, particularly the foundries, in an area south-east of Agra beyond the Taj Mahal, have not been successful.

5. The CPCB defined an area named as Taj Trapezium Zone, (see fig. 1), and recommended that industrial activities in the Zone may be regulated. This has been observed strictly. There has however been an increase in non-industrial commercial activities such as construction of buildings and roads, production of bricks from coal burning kilns, shops, restaurants, and various categories of hotels to meet the needs of tourism. In particular, there has been a large increase during the past 7 years in the numbers of two and three wheeler road vehicles, cars, lorries and buses in areas close to the Taj Mahal, Agra Fort and Itimad ud-Daula and increased DG sets in commercial area and Hotels.

REVIEW OF TAJ TRAPEZIUM

6. There had been requests that the restrictions imposed on expansion of existing industries and development of new ones within the Taj Trapezium Zone should be reviewed. NEERI was commissioned by the Ministry of Environment and Forests in January 1993 to carry out studies. A Report entitled "Air Pollution Studies to Redefine Taj Trapezium Coordinates" was submitted in July 1993.

STANDARDS AND GUIDELINES FOR EMISSIONS AND AIR QUALITY

7. The studies carried out by the Expert Committee in 1974-77 on the impact of Mathura Refinery were among the earliest internationally on impacts from proposed new industries. In the ensuing period, world concern for the environment has markedly increased, and new standards and guidelines based on needs of human health, preservation of plant, animal and aquatic life and indeed all others, including micro-organisms, are being evolved. In India the CPCB has also adopted such standards and guidelines for air quality (Annexure II). There are three sets of these applicable to different areas.

8. The standards and guidelines of WHO as well of several developed and developing countries are also given in Annexure III. It may be seen the values in standards in India are quite stringent, especially for sensitive areas which are cultural heritage and wildlife/natural conservancy sites. In any urban environment with a high density of population, housing, commercial establishments, and all forms of hydrocarbon powered vehicular traffic, it would not be possible to attain the standards for sensitive areas.

PUBLIC INTEREST LEGAL ACTION

9. A Writ Petition (C) No. 13381 of 1984 filed by Shri M.C.Mehta in the Supreme Court of India in 1984, in which Union of India and others were named as Respondents, was called for hearing by the Supreme Court on 11 February 1994. The Petitioner had submitted that air pollutants were being allowed to be emitted through chimneys, ducts, flues and other types of outlets, thereby causing destruction to the Taj, endangering the lives of the people living in and around Agra and Mathura, and the wild life in Keolodeo National Park, at Bharatpur. He had consequently prayed that the chimneys and other outlets of the Mathura Refinery may be closed down, or that the most polluting units of the Refinery be shifted to the Etawah region. He had further prayed that the foundries and Thermal Plants be closed or shifted to some other locations. Among the further prayers of the petitioner were that the area in question should be declared as an Air Pollution Control Area, that pollution standards may be identified to check pollution and that a body of independent experts be instituted to ascertain whether necessary safeguards with respect to prevention of air pollution were being implemented and that the findings of the expert body may be circulated from time to time.

10. Additional Solicitor General of India Shri V.R.Reddy had submitted to the Court that NEERI may be asked to examine the possible effects of the use of Propane gas as a safe fuel in industries in place of coal/coke in the Agra Region to reduce atmospheric pollution. On the directions of the Court, NEERI submitted after certain studies a Technical Report on "Issues Associated with Fuel Supply Alternatives for Industries in Agra- Mathura Region" on March 7, 1994. Extracts from the Report are placed in Annexure IV. It recommended shifting of small scale polluting industries outside the Taj Trapezium zone on industrial estate sites to be identified by the Government of Uttar Pradesh, and provision of natural gas for industries in Agra Mathura Region and Mathura Refinery. On March 31, 1994, a list of 852 industries in the Agra-Ferozabad region identified by the Uttar Pradesh Government was submitted to the Supreme Court. On April, 1994 the Court ordered:

"We are of the view the shifting of industries from the Taj Trapezium to be made in a phased manner. NEERI's report indicates that the maximum pollution to the ambient air around Taj Mahal is caused by the industries located in Agra. We, therefore, as a first

phase, take up the industries situated in Agra for the purposes of the proposed shifting outside Taj Trapezium. NEERI in Table IV (A) of its report has given the details of air polluting industries in Agra".

"Before we take a final decision on the question of shifting of these industries from Agra to outside the Taj Trapezium, it is necessary to inter-act with the concerned industries."

11. On April 29, 1994, the Supreme Court made the following observations in their Order,

"We have specifically stated in the above quoted order that no final decision has yet been taken regarding shifting of the industries from Agra to outside the Taj trapezium. Efforts are being made to free the prestigious Taj from pollution, if there is any, because of the industries located in and around Agra. It is further clear from our order that the basis of the action initiated by this Court is the NEERI's report which was submitted to the Government of India in July, 1993. The said report was prepared under the guidance of Dr.P.Khanna and the Project leaders were Dr.A.L.Aggarwal and Dr.Mrs.Thakare. In addition, there was a team of 30 top scientists participating in the Project. NEERI in its report has found as a fact that some of the industries located in the Taj Trapezium are the source of pollution causing damage to Taj Mahal.

We are of the view that it would in the interest of justice to have another investigation/report from a reputed technical/Engineering authority. Ministry of Environment and Forests, Government of India may examine this aspect and appoint an expert authority from (India or abroad) to undertake the survey of the Taj Trapezium Environmental Area and make a report regarding the source of pollution in the Trapezium and the measures to be adopted to control the same. The authority can also identify the polluting industries in the Taj Trapezium. We, therefore, request Mr.Kamal Nath, Minister Incharge, Department of Environment and Forests, to personally look into this matter and identify the authority who is to be entrusted with this job. This must be done within three weeks from the receipt of this order."

APPOINTMENT OF EXPERT COMMITTEE:

12. The Ministry of Environment and Forests, Government of India has, through its office memoranda No.Q-17012/21/93-CPW dated 18 May 1994 and

addendum dated 8 June 1994, (Annexure V & VI) constituted a Committee. The Membership and Terms of Reference are given below:

Membership

Dr.S.Varadarajan, (Formerly Secretary to the Government of India, Department of Science and Technology, Director General, Council of Scientific and Industrial Research, and Chief Consultant, Planning Commission	Chairman
Dr.B.B.Sundaresan, (Formerly Director, NEERI, Vice Chancellor, University of Madras	Member
Shri Jagat Pati Joshi, (Formerly Director General, Archaeological Survey of India)	Member
Director General, India Meteorological Department, Represented by Shri S.C.Sharma, Director	Member
Shri K.K.Baksi, Additional Secretary, Ministry of Environment and Forests	Member
Shri R.Anandakumar, Member-secretary Additional Director, Ministry of Environment and Forests	

Terms of Reference

1.To undertake the survey of the Taj Trapezium environmental area and to make a report regarding the source of pollution in the Trapezium.

2.To identify the polluting industries in the Taj Trapezium.

3. To suggest long-term and short-term measures to be adopted to control such pollution which causes damage to the Taj Mahal.

FACTORS CONCERNING ATMOSPHERIC ENVIRONMENTAL QUALITY AND PRESERVATION OF MONUMENTS:

13. In the appreciation of the Committee, the ambient air quality in the Taj Trapezium, and especially in the area in which the major mouments, namely Taj Mahal, the Agra Fort, Itimad ud-Daula, Sikandra, and Fatehpur Sikri, identified as sensitive areas by the Ministry of Environment and Forests and the CPCB, has to be maintained at a high quality level, and all efforts should be made towards attaining the standards, provided as guidelines for such sensitive areas. The Committee recognised that air quality is strongly influenced by the current and future needs of various forms of energy by all consumers, the availability of different types of energy, the conditions of their utilisation, the reliability of supplies, as well as their cost and alternatives among these supplies. During the past 40 years, and especially during the last 20 years, there is a growing realisation and aspiration the world over to pursue rapid economic growth and simultaneously aim for a cleaner and safer environment, preserving to the utmost the richness of natural heritage of the earth in its living, non living and cultural resources. Fortunately the spectacular advances in Science and Technology are enabling most developed countries to attain a high degree of success in the realisation of such aspirations. It is essential that Indian efforts for development and commitment for economic growth should have high inputs of the most advanced technologies, modified to suit Indian conditions.

14. With this in view, the Committee has striven to gather information from a variety of sources on the following:

* State of monuments and changes in them during the last 50 years.

* Ambient air quality in the Taj Trapezium Zone, and especially in the vicinity of monuments in different seasons over the past 10 to 15 years, including long term averages as well as short time variations.

* Quantitative estimates of all forms of energy available and utilised by different consumers such as households, commercial establishments, transport, hospitals, offices, hotels, restaurants, shops, small, medium and large industries, and infrastructure.

* Technologies adopted or available in many countries to ensure safe and clean operations while meeting social, industrial, and commercial needs in a competitive economic system.

* Plans of major consumers and producers of energy in the short term of 18 months and medium term of five years to contribute to requirements of rapidly attaining and maintaining high ambient air quality in the short term, and effect further improvements.

ASSISTANCE FROM EXPERTS

15. The Committee has also endeavoured to obtain views of recognised experts on the state of monuments, ambient air quality predictions, and newer technologies for quick adoption. In addition the Committee has secured, through discusssions with suppliers, producers and consumers of energy, time bound quantitative commitments, wherever possible, for adoption of technologies for overall improvement in the sensitive area within the Taj Trapezium Zone. The Committee has attempted to consider measures and technologies which, although calling for change, will neverthless be feasible in economic, social and technical terms within a time frame and will also avoid very large capital investments and totally novel or unproven systems.

16. The Committee has taken note of several measures and recommendations which have emerged in the last few months from Government of India and Government of Uttar Pradesh as well certain international agencies. The recent proceedings of the Expert Committee on Environmental Appraisal of Industrial Projects (within the framework of the Environmental Impact Assessment Notification, 1994) with regard to establishment of new petroleum and natural gas related proposal have also been taken note of.

STRUCTURE OF THE REPORT

17. Volume I of the present Report contains an analysis of the information collected and commitments obtained and, of the numerous documents received or examined, only a few are attached as Annexures. A large number of other relevant documents and reports form part of Volume II as these are of intrinsic worth, and will be of interest. A list of these is included in Volume II of the present Report; in addition, a Bibliographical List is attached of reports and publications which have been examined by some Members of

the Committee and the Experts who were invited to provide their views.

18. The Committee has also studied carefully the orders of the Honourable Supreme Court of India in the Writ Petition (c) No.13381 of 1984 dated 10th September 1993 and 11th February 1994, the scientific studies related to the above Writ Petition. A report on "Air Pollution by Industries in Taj Trapezium Zone (T.T.Z)" prepared by a Committee under the Chairmanship of the Commissioner, Agra Division, constituted by the Chief Secretary, Government of Uttar Pradesh, has been made available to the Committee by the Chief Secretary. (Annexure VII).

19. To meet the needs of maintaining high standards of air quality and to further improve upon them, it is necssary that further commercial habitat, transport and industrial developments, including those designed for growth in employment and economic growth of the Region through a variety of steps such as tourism, are so designed as to contribute to the enhancement of the quality of the environment and the invaluable heritage. The Committee has outlined a number of measures to secure these in the short, medium, and long action term, based on the experience in the world over in regard to Heritage Sites. A further set of measures are designed to avoid sources for accidental, sudden and irrevocable damage to the Heritage. Volume I of the Report contains the State of Monument and changes in it during the last fifty years. (Annexure VIII).

STATE OF MONUMENTS AND CHANGES DURING THE LAST 50 YEARS

20. The Committee had opportunities to visit all the five mentioned monuments. Visits to the Taj Mahal were made at night, early morning, late afternoon and evening. Through the courtesy of the Archeological Survey of India, it was possible to go to the top terrace and inspect the Central Dome as well the Four smaller chhatris. The hollow space in the Double Dome was also visited. The Committee also visited Sikandra, Agra Fort, Itimad ud- Daula, and Fatehpur Sikri.

21. The Committee has received responses from Dr.S.K.Mohapatra, Secretary, Department of Culture, who is also currently holding charge as Director General of Archeological Survey of India, endorsing the views of Smt.Achala Moulik, Additional Director General (Admn.) (Annexure IX). The Committee also arranged for three experts namely, Shri B.N.Tandon, former Joint Director General and Director Science, ASI, Shri R.Sen Gupta,

former Director Conservation, ASI, Dr.O.P.Agarwal, currently Director General Indian Conservation Institute, Lucknow of Indian National Trust for Art and Culture Heritage (INTACH) to visit Agra, and their views are appended (Annexure X). A number of Reports by Experts nominated by UNESCO received from Smt.Komal Anand, Joint Secretary, Department of Culture have also been examined by the Committee. A list of these reports is given in Volume II. A detailed note on Conservation of Taj Mahal, giving a history of major structural conservation, studies by special committees dating from 1941, scientific researches during the last 25 years, and on the present status of conservation, prepared by the Expert Member of the present Committee, Shri Jagat Pati Joshi, is placed in Volume II. A few distinguished long term residents of Agra have sent communications on the state of the Taj Mahal to the Committee, and these are given as Annexure (XI).

22. The US National Park Service has initiated studies on the three identified World Heritage Sites (Fatehpur Sikri, Agra Fort, Taj Mahal) and other heritage areas through a Agra Heritage Project. University of Roorkee has carried out extensive investigations on structural stability and materials and has submitted a 8 Volume Report (given in Volume II). It has conducted a Indo-US Workshop on Environmental Assessment during 7 - 10 March 1994. Their Report is not yet available.

23. A Indo-US Blue Ribbon Panel co-chaired by Dr.Abid Hussain and Mme Elizabeth Moynihan with very distinguished Expert Members from India and USA visited Agra during 8 to 13 January 1995, and Notes and Observations arising from Panel Deliberations are included in Volume II.

24. From a study of several reports, and from the impressions gained during the visits, the following observations can be made in summary by the Committee.

Taj Mahal

25. A detailed analysis from all the reports and responses received including historical account of conservation is placed in Annexure VIII. In brief it may be stated that:

i) The Taj Mahal is structurally sound and stable. The main materials of brick and lime mortar of the structure are in good condition and have not been affected by the atmosphere. They will, with continuing

good atmospheric conditions, have the potential to remain for several hundred years.

ii) The marble stone veneer covering walls, floors, upper sides of domes, and chhatris are fixed with iron dowels rivetting adjoining stones. There is some corrosion in these and those affected are replaced by ASI from time to time as and when required. These are also cracks between stones in the lime mortar and these are attended to by using fresh infusions of special mortar. The main outer floor of marble and some marble slabs get affected because of the presence of a large number of visitors as well as the force of water jet falling from the spouts at high height during rainfall. These are also replaced. Due to the enormous self load, some slabs do have cracks, mostly superfical, and some are deeper, extending upto the masonary. In the view of experts, these cracks are not due to atmospheric pollution. They have advised the filling up of wider cracks and replacement of the missing parts to prevent water penetration into the structure and corrosion of iron dowels.

iii) The white marble in the Taj Mahal is of varied types although quarried from the same area, Makrana, with differences in colour, shade and grains. In the inner covered area, electric lamps using generator power were introduced in 1911-12, and line power supply became available in 1924-25. Until then, lighting inside could only be effected through oil lamps and oil torches which necessarily produced soot and smoke materials which deposited on surfaces. Similarly, some suspended particles in the atmosphere and dust also had impinged on the surface of the marble in the upper portions on the outside. At lower wall levels, due to contact on account of touching by several thousand visitors every day, some material deposits on surface.

26. From 1987 onwards, ASI has vigorously adopted a physical absorption technique using activated clay pack. The deposits are transferred in the course of a few hours from the surface of the marble to the surface of the activated solid absorbent. In this way, the original colour and lustre of the marble has been restored in most outer surfaces. The present state of surface seems quite satisfactory, and there is no yellowing. Experts have differed on whether at any time acrylic thin emulsion as a I.V.C. coat protection was attemped, and such coating could have led to discolouring. However, all experts agreed that presently there is no yellowing.

27. The visual impression of the Taj Mahal varies according to the time of the day. Around sunrise and sunset the sunlight and the appearance of the sun itself depends on the angle. As the light passes through a larger layer of atmosphere, it varies between red, orange and yellow; when the sun is at higher levels in the sky, the light is white. The monument reflects light accordingly. Photographic reproductions also vary according to such light or the type of colour film/exposure conditions.

28. The preservation and cleaning process has been extended into the inner marble cladding of walls by erection of scaffolding. However the curved dome's lower side cannot be covered by marble cladding as heavy marble cannot be fastened by mortar or dowels. Therefore the inside top of the upper portion of the cenotaph is covered with white plaster and has deposits, presumably from oil lighting. This can only be removed by slow repeated organic solvent treatments as has been done at Itimad ud-Daula.

29. The red sandstone does not have the strength of marble. It gets chipped off due to weathering, sandstorms and other strains. Floors and some walls show more deterioration. These are replaced regularly in the Taj Mahal as well as in other monuments. While marble jalis have generally been strong and have been unaffected, many red sandstone jalis break or show cracks, and are replaced through very careful replicas made by highly skilled artisans.

30. It is noted that rainfall immediately washes away much dust or particulate matter on surfaces and the monument clearly reflects the highly clear surfaces.

31. The number of visitors to the Taj Mahal is about 7500 per day, and on Fridays, when entry is free, it increases to about 10,000. It may be appropriate to consider closing entry one day in a week or fortnight to allow for cleaning and maintenance. If a mobile crane or a modern easily assembled and dismantled platform can be provided and adequate funds are made available, periodic surface clay pack cleaning can be conducted and the high central inner area curved surface with plaster covering can also be fully cleaned. Visitors need not be allowed into the lower crypt containing the tombs as the stairway is very narrow, the crypt is not ventilated, and is relatively without any daylight. Entry into the replicas area on the upper level would meet the needs of tourists.

ITIMADUDDAULA

32. The monument is in a site across the Jamuna and is just off the main Jawahar bridge with traffic by a variety of transport forms, including diesel lorries and buses as well as three and two wheelers. The monument has attractive highly inlaid marble walls on the outer side, and paintings on the white plaster walls and alcoves in the inner halls. The marble surfaces have been cleaned by the clay pack technique, and exhibit highly varied complex designs with wide ranging coloured stones. Most of complex paintings on the plaster covered walls have deposits and incrustations from soot and oil lamps. ASI have demonstrated that these can be restored by painstaking solvent treatment. Such work has been carried out only on a small portion. It would be desirable to provide funds and facilities to complete the restoration fully.

33. It would be advantageous to divert heavy vehicles traffic away from this location. The monument is not visited by many tourists and can be restored and relatively easily conserved. There does not seem to be any damage by atmospheric gaseous pollution. As in the case of the Taj Mahal, the red sandstone does get damaged and is being replaced.

AGRA FORT

34. There are a large number of buildings where marble has been used. Excellent conservation work has revealed the original spelendour of almost all of these. Currently work is in progress on the Moti Masjid. The marble everywhere is well preserved and is being conserved through clay pack technique. The high SPM, arising from sands and dust storms and other carbonaceous materials in the atmosphere, causes deposition on marble which is removable, and erosion as well as chipping of sandstone are seen. A substantial portion of the Fort area, now with the Ministry of Defence, needs to be transferred to ASI for conservation.

FATEHPUR SIKRI

35. This site is away from Agra city. Industrial activity is almost absent. Most structures are of red sandstone, which show some damage as in the case of other monuments. The marble structure of Shaikh Salim Chishti's shrine, with marble jalis, is in good condition, resulting from good maintenance, repairs and special repairs, appropriate to this World Heritage Monument.

SIKANDARA

36. Sikandara is situated to the north west of the

Taj Mahal on the outskirts of the present day city of Agra. The marble flooring appears to be affected by erosion. The marble surfaces are relatively low. Due to increase in the deer and black buck population and grazing, the maintenance of green cover is proving to be quite demanding. The state of conservation of the monument appears to be good. ASI and IOC are maintaining air monitoring stations at this site. The volume of traffic is increasing here. Green cover and afforestation have to be substantially enhanced to maintain good air quality standards. ASI are replacing damaged red sandstones. There is relatively low adornment of painting on plaster surfaces and inlay in marble in the main structure. Gateway arches have inlay marble in walls and this is in good condition. Damaged marble flooring in the topmost storey of Akbar's Tomb needs urgent repairs.

AMBIENT AIR QUALITY IN THE TRAPEZIUM

General Description of some Climatological Features of Agra Region

37. The climate of Agra region is characterised by a cold winter, a hot summer and general dryness except during the southwest monsoon season.

38. The year may be divided into four seasons:-

i) Cold weather season from December to February. It is also known as the winter season.

ii) Hot season (i.e., summer season) which extends from March to about the end of June.

iii) South-west monsoon season from end of June to September, and

iv) Post-monsoon season, which is the transition period, comprises the months of October and November.

Winter Season

39. After the middle of November, winter season gradually sets in. Both day and night temperatures steadily drop and January is the coldest month. Based on the long-term meteorological data of Agra Observatory, which was established in 1862, the mean daily maximum temperature during January is 22.2°C The lowest minimum temperature recorded was -2.2°C. on 16th January 1935.

40. Skies are generally clear in winter season except when the area is affected by passing western disturbances and cloudiness may increase for a day or two. Nearly 5% of the annual rainfall is accounted for by the winter rains. Occasional fogs also occur during winter season.

41. The atmosphere is stable for a much longer duration during winter season in comparison to other seasons. Due to this meteorological phenomenon, disperson of air pollutants is suppressed to a large extent resulting in localised high concentrations of pollutants emitted from low sources when winds are very light during night time in winter months.

Summer Season:

42. The summer season begins in March when temperatures rise rather rapidly with the advance of the season. May is the hottest month, the mean daily maximum temperature in that month being 41.8°C. On individual days in this month and in June the day temperature may exceed 45°C. The highest maximum temperature ever recorded at Agra was 48.3°C on June 2, 1889.

43. The air during the summer season is generally very dry and relative humidity is often less than 25% in the summer afternoons.

44. The highest incidence of dust storms and thuderstorms occurs in the period March to June. Dust-storms/thunderstorms generally occur in the afternoons/evenings.

45. The atmosphere is moderate to extremely unstable during most of the day-time in summer months.

South-West Monsoon Season:

46. The south-west monsoon sets in by the end of June, resulting in appreciable drop in day temperatures (about 5-6°C) and sudden increase in relative humidity. The mean daily maximum temperature is around 34°C. Although there is no appreciable change in mean daily minimum temperature yet due to high humidity, oppressive conditions often prevail during night time.

47. The average rainfall over the district is 654.5 mm. About 90 percent of the annual rainfall is received during the monsoon season, and August is generally the

month with maximum amount of rainfall. Records of rainfall in the district are available for 8 raingauge stations over a period of 90 years. The statement of rainfall at these stations and for Agra district as a whole is given in Table 1 and Table 2. (Annexure IX).

Post Monsoon Season

48. October and the first half of November form the post- monsoon or transition period. After the withdrawal of the monsoon there is a slight increase in the day temperatures during the month of October but nights become progressively cooler. Skies are generally clear or lightly clouded during this season.

49. Table Nos. 3, 4 and 5 (Annexure X) give the climatological normals of temperature and humidity, mean wind speed, and special weather phenomena, respectively, for Agra.

MAIN METEOROLOGICAL PARAMETERS AFFECTING AIR QUALITY

Wind

50. The wind is the most important meteorological parameter for transport and diffusion of air pollutants in the atmosphere. Thus the data on wind speed and direction form the most important basis for assessment of risk to the Taj Mahal and other monuments from surrounding air pollution sources. The pollutants, while being transported downwind, also diffuse in the cross-wind and vertical directions. This is controlled by the atmospheric stability. Thus, these two parameters viz, wind and the stability combine together in determining the concentration of pollutants at a given place.

51. The India Meteorological Department maintains a meteorological observatory near the Taj Mahal. Data on wind speed and direction are continuously being monitored at this observatory, and the following broad inferences are drawn from the analysis of long-term wind data:-

(i)October to February are the months of light winds. However, it is clearly brought out that the post-monsoon season is characterised by transition from the southerly flow regime of South-west monsoon to a north-westerly flow.

(ii)During post-monsoon season the winds are generally light and there is a large scatter in the direction of wind with a marginally higher frequency of wind from west and north-westerly direction.

(iii)The frequency of winds from directions between west and north-west shows an increase as the season progresses from post-monsoon to winter. The increasing bias towards north-westerly winds in winter is accompanied by a corresponding decrease in winds from south-south westerly direction.

(iv) The frequency of occurrence of winds from southerly direction at Agra is the lowest during winter season.

(v) Practically calm wind (wind speed < 1m/sec) conditions prevail during night time in post-monsoon and winter seasons. The frequencies of wind from north and northeast direction marginally increase in winter season.

(vi) There is general strengthening of wind in summer season, particularly during day time.

(vii)The most predominant winds during summer season are from northwest quadrant. Some increase in frequency of wind from south-west direction is observed towards the latter part of the season. June is the month of moderate to high wind speeds blowing mainly from south-west to north-west directions during daytime.

(viii)The mean wind speed decreases during south-west monsoon season as compared to summer. Winds blow generally from south-east sector to south-west sector during monsoon season. However, wind from directions between northeast and east also is not uncommon.

52. Annexure XIII depicts [redacted] 'wind roses' for Agra for different seasons.

Precipitation

53. Rainfall is an another atmospheric process which may be considered important in determination of time variation of air pollution. Under ordinary circumstances, it can be an efficient scavenger of air pollution. However, the occurence of rainfall is a more discrete phenomenon and is sporadic in nature.

54. Rainfall mainly occurs in the Taj Trapezium Zone during the months of June, July, August and September. Except for these months, the number of rainy days per

month barely exceed 3. This allows a large gap in rainfall events and subsequently a large accumulation of pollutant species in the atmosphere before wash- out. Dry depostion of pollutants is expected to increase during the rainfall gap periods.

AMBIENT AIR QUALITY STATUS IN THE AGRA-MATHURA REGION

A. TAJMAHAL

55. As the Taj Mahal is the focal sensitive receptor, the ambient air quality monitoring (AAQM) was started within Taj Mahal premises in January, 1981 by NEERI, Nagpur. Central Pollution Control Board (CPCB) took over the monitoring activities of Taj Mahal from NEERI during April, 1986. The monitoring at the Taj Mahal was continued by CPCB till August, 1988, and on the 15th September, 1988, the station was handed over to the U.P. Pollution Control Board which is operating the air quality monitoring station till date. Sulphur dioxide ,NO_x and suspended particulate matter (SPM) are the pollution parameters which are being monitored at the AAQM Station at the Taj Mahal, Agra.

56. The trend analysis of various pollutants monitored at the Taj Mahal during 1981-1993 reveals the following:

Sulphur dioxide (Period 1981-1985)

i. The annual mean concentration of Sulphur dioxide was recorded as 15.4 micrograms/ cubic metre in 1981 which came down to 8.2 micrograms/ cubic metre in 1982, probably due to closing down of two coal based thermal power stations in Agra in 1981 and dieselisation of the Agra Fort Marshalling Yard.

ii. The annual average Sulphur dioxide concentrations for 1982-1985 at Taj Mahal work out to less than 13 micrograms/ cubic metre with individual annual mean concentrations ranging between 8.2 micrograms/ cubic metre (Year 1982) and 18.1 micrograms/ cubic metre (Year 1984)

iii. The monthly mean values are generally less than 20 micrograms/ cubic metre with some winter month values crossing 30 micrograms/ cubic metre in 1984 and 1985.

Sulphur dioxide (Period 1987-1993)

iv. The trend analysis shows that ambient Sulphur dioxide concentrations (annual mean) is increasing every year since 1987.

v. The monthly mean values of Sulphur dioxide were however, always found to be within 30 micrograms/ cubic metre except in the winter of 1992.

vi All the peaks in the monthly mean values were observed in the winter months.

The rising trend in Sulphur dioxide concentrations may be due to the fact that inspite of closing down of coal based thermal power plants and stopping of coal based locoshed at Agra Fort Marshalling yard, the increase in vehicular traffic and extensive use of DG sets for domestic, commercial and industrial purposes throughout the city in the absence of reliable electric power supply has resulted in slowly reversing the good air quality observed during 1981-1985.

NO_x (Period 1981-1985)

i. The levels of NO_x concentration were high during the above period. The mean monthly values generally exceeded 20 micrograms/ cubic metre to 50 micrograms/ cubic metre except during monsoon seasons.

ii All the peaks in the monthly mean were found in the winter months.

NO_x (Period 1987-1993)

iii. There is a continuous decreasing trend of monthly mean Nitrogen dioxide levels at the Taj Mahal. Mostly the 90 percentile values are less than 30 micrograms/ cubic metre, except a peak of 55 micrograms/ cubic metre in 1988. Apart from 1987, the monthly mean Nitrogen dioxide levels have always been less than 20 micrograms/ cubic metre.

iv. Over the past few years tree plantations have been made around the Taj and some restrictions about heavy vehicular traffic have been made near the Taj. There may have had some effect on the monthly mean Nitrogen dioxide levels in the area, but a full explanation for reduction of Nitrogen dioxide concentrations at the Taj inspite of increase in consumption of petroleum products in Agra is not

yet available.

S.P.M. (Period 1981- 1993)

i. The level of SPM at Taj Mahal is generally quite high, the monthly mean values being above 200 micrograms/ cubic metre for all the months during 1981-1985 except for the monsoon months.

ii. There is an increasing trend in the monthly mean SPM concentrations from about 380 micrograms/ cubic metre to 620 micrograms/ cubic metre during the period 1987-1991, and the trend reverses thereafter till 1993. There is a decrease in monthly mean SPM levels from 620 micrograms/ cubic metre in 1991 to about 425 micrograms/ cubic metre in 1993.

B. AMBIENT AIR QUALITY MONITORING FOR Sulphur dioxide IN MATHURA-AGRA REGION:

57. Mathura Refinery is maintaining a network of three continuous air quality monitoring stations at Farah, Keetham and Sikandra beteween Mathura Refinery and Agra. The trend analysis of Sulphur dioxide data monitored at these stations by Mathura Refinery during 1990-94 brings out the following salient features:

a. FARAH (7 km from Mathura Refinery)

i. The average monthly concentrations of Sulphur dioxide ranged between 4.0 micrograms/ cubic metre during March, 1994 to 12.6 micrograms/ cubic metre during December, 1993.

ii. The Impact of vehicular emission during the morning and evening hours on the ambient air quality is noticeable. The Farah monitoring statioin is by the side of the highway i.e, NH2.

iii. Higher concentrations are noted in winter months as compared to summer and monsoon months. Night time readings in winter months are the highest.

b. KEETHAM (25 km from the Refinery)

i. Keetham readings are generally low, and 4-hourly and 24- hourly maxima as well as monthly average readings do not show any significant variations to establish a trend. Seasonwise and monthwise variations are not significant.

ii. For the five years considered, the average monthly readings ranged from 3.1 micrograms/ cubic metre in May, 1992 to 6.5 micrograms/ cubic metre in February, 1992.

iii Effect of vehicular pollution is absent at Keetham as the station is 1.5 km away from NH2. Effect of brick kilns in Keetham village is observed during winter months.

C. SIKANDRA (37 km from the Refinery)

i. Sikandra readings have always been higher than Keetham readings.

ii. Normally high readings are observed during 0600 - 0900 hrs and 1800 - 2200 hrs. The monitoring station is located within the boundary limits of the monument and about 400 meters from the NH2.

iii. The readings do not indicate any set pattern of seasonal variations. For the five years considered, the monthly mean concentration ranged from 3.1 micrograms/ cubic metre in August, 1990 to 12.2 micrograms/ cubic metre in October and December, 1993.

58. The trend analysis of ambient air monitoring for Sulphur dioxide at these IOC stations suggests that impact of Mathura Refinery's emissions is felt at Farah station. The impact of refinery Sulphur dioxide emissions at Keetham is not predominant as is the case at Farah. As Sikandra readings have always been higher than Keetham readings, it suggests that local sources may be the cause for high Sulphur dioxide concentrations at Sikandra.

C. RECENT AIR QUALITY SURVEY CONDUCTED IN AGRA-MATHURA REGION

59. An air quality survey was carried out in March/ April, 1995 by M/s. Indian Oil Coporation (IOC) to assess the changes, if any, in the air quality status in comparison to the past air quality data in Agra-Mathura region.

60. IOC carried out continuous monitoring (reported as 1 hourly avg.) of Sulphur dioxide for a few days at a stretch during March/ April, 1995 at Farah, Keetham and Sikandra through their permanent monitoring stations,

and at the Taj Mahal by mobile van as Mathura Refinery does not maintain any fixed monitoring station at the Taj Mahal. During the above period the refinery was shut down for major maintenance w.e.f. 23.3.1995 in a phased manner. The startup of units was done sequntially w.e.f. April, 2, 1995. The period of total unit shutdown was from 26.3.95 to 2.4.95.

61. Perusal of air quality data indicates the following:

(a). Farah Monitoring Station

During March, 1995, the 1- hour maximum reading of 39 micrograms/ cubic metre was recorded prior to refinery shutdown. The 24 hourly average concentration corresponding to that day was 14.0 micrograms/ cubic metre. During refinery shut-down the 1-hour maximum was recorded 11.4 micrograms/ cubic metre and 24 hr. average at 6.4 micrograms/ cubic metre. The effect of vehicular traffic pollution is reflected on certain days during late night/ early morning hours and again towards late evening hours.

b. Keetham Monitoring Station

The 24 hour average concentration of Sulphur dioxide recorded at keetham monitoring station before refinery shutdown in March- April, 1995 was 5-6 micrograms/ cubic metre with 1 hourly maximum at 13 micrograms/ cubic metre. During refinery shutdown the reading came down to 3 micrograms/ cubic metre.

(c) Sikandra Monitoring Station

During March 95, Sikandra station recorded 1-hour maximum at 19 micrograms/ cubic metre, 24 hrly average being 8-9 micrograms/ cubic metre. During refinery shutdown 24-hour average concentration of Sulphur dioxide was observed 6-7 micrograms/ cubic metre with peaks remaining unchanged.

(d) Taj Mahal

The following points emerge from analysis of 1 hourly average concentrations of Sulphur dioxide monitored at Taj mahal by mobile van.

i. The Sulphur dioxide concentrations are higher than those monitored at all the fixed stations maintained by Mathura Refinery viz, Farah, Keetham and sikandra in the Mathura-Agra region.

ii. During evening hours, Sulphur dioxide concentration starts increasing with peaks between 1800 hours to 2000 hours. The high concentration continues till 2100 hrs. on most of the days.

iii. From 2400 hrs. to about 0500 hrs, the concentrations remain the lowest.

iv. From 0600 hrs. to 0800 hrs. the concentrations again rise although the peaks are lower than the evening ones.

v. Average 24 hourly values during March-april, 1995 were in the range of 10 to 21 micrograms/ cubic metre with 1 hourly peaks of over 52 micrograms/ cubic metre (the analyser was operated in 0 to 20 ppb i.e, 0 - 52 micrograms/ cubic metre range) during the evening hours. During March 24, 1995, to April 6, 1995, the 24 hrly average was around 15 micrograms/ cubic metre with individual day average values ranging between 10.1 micrograms/ cubic metre (29.3.95) and 21.5 micrograms/ cubic metre (4.4.1995).

ENERGY FORMS AVAILABILITY AND UTILISATION

Electric Power

62. The cleanest forms of energy, wherever it can be readily utilised, is electrical energy supplied from the Regional Grid. It appears that the supply in Taj Trapezium Area from the UP Electricity Board is grossly inadequate and is not reliable at present. These are frequent unplanned stoppages and fluctuations. Supply to industries in Agra is not made on Wednesdays and therefore many remain closed on Wednesdays. It is learnt that the transformers on the distribution system need to be augumented and some have to be replaced. Without such steps, even when power supply from the grid is available, distribution fails.

63. The Committee has not been able to obtain any information regarding the present supply and future plans. A letter dated 24 April 1995 from the Special Secretary, Ministry of Power, is placed in Annexure XIV.

64. The unreliability of power supply has necessitated the continuous use of diesel generators by the Air Quality Monitoring Unit of the UP Pollution Central Board at the Taj Mahal. The office of the Superintending Archeologist as well as many Government offices and residences invariably have generating sets. The older sets use petrol or kerosene. The newer ones utilise HSD, which has relatively high sulphur of 0.5 to 0.7 per cent. Hotels, shops restaurants, especially those with air conditioning, have large generators.

Petroleum Products

65. Information on the increase in the consumption of total petroleum products in the area is given in Annexure XV. Petrol and HSD consumption has increased by about 200 and 80 percent respectively during the ten year period from 1983-84.

66. These products are from production in Refineries in Mathura, Baroda and Bombay, as well from some imported material. It is not possible to relate Mathura Refinery production to the consumption in Agra.

67. The sulphur content of petrol (motor spirit) and kerosene are relatively low. However presently marketed HSD has sulphur content of 0.7 to 0.8 per cent. HSD consumption in Agra district is approximately 70,000 MT per annum including about 13000 MT by Railways. Most of the diesel in Railways is used outside the main Agra city and Fort area for shunting in the Meter Gauge railway line. HSD is largely used within Agra city in generators and vehicles in the areas close to the Taj Mahal. Thus the incrase in sulphur dioxide annual average levels could be related to the increased use of petroleum products, in particular HSD.

68. Information on categorywise vehicle population has been provided by the UP Government and is shown in Annexure XVI. During the 10 years period from 1983-84, two wheelers increase from about 47,000 to 148,000, and motor cars doubled from 4700 to 9890. Many vehicles, especially lorries, buses and luxury taxis, may be registered outside Agra, although passing into or through Agra. The Commissioner, Agra Division, has estimated that about one lakh vehicles pass through Agra each day.

69. Plans for promotion of tourism will require increase in infrastructure of hotels and vehicles, and larger

employment. These will lead to marked increase in the demand for oil and gas fuels, especially in the absence of assured electrical power supply. Concentration of buildings and activities within a certain area surrounding heritage sites will tend to affect air quality. To meet the standards in guidelines for sensitive areas, further concentration should be avoided.

70. With potential improvements in availability of petroleum products, coal, charcoal, fire wood and biomass materials would be replaced, and there would be further rise in consumption of petroleum oil and gas materials. High quality standards for these are necessary to maintain good air quality.

Coal

71. Information on the quantities of coal and hard coke supplied by coal companies during the last few years in the Agra areas has been provided by the Ministry of Coal (Annexure XVII). Coal consumption is about 500,000 MT and has not shown any increase. Of the total coal/coke, the District Industries Centre has reported that Agra and Ferozabad Industries consume 129 MT and 700 MT per day respectively. On the assumption that these units may function for about 250 days in the year, consumption at Agra and Ferozabad annually would be about 32,000 and 175,000 MT respectively. The balance of about 300,000 MT may be consumed by brick kilns in villages, restaurants, and households in urban and rural areas. These do cause pollution of the atmosphere. Industries in Agra are situated north west, north and north east of the Taj Mahal, several of them being located across the river. These are the major sources of concern as they are not far away, and much of the time winds blow from their location towards Taj Mahal.

72. Almost all foundries use coke, pig iron and scrap ~~steel~~ iron as raw materials. They vary in size and capacity. There are essentially three sizes, determined by the diameter of the cylindrical furnace. Most of them had been following their traditional technologies without any change for a long time. Demand for foundry products increased during 1975-81 from requirements of expansion and industrialisation in West Asia. Since then demand has decreased. There is also competition in India from industry in Punjab and South India. Energy consumption in the form of coke seems high in most units based on the amount of steel produced per tonne of coke. Coal is processed in coke ovens by a process by which most of the volatile materials in coal are removed by distillation.

In the production of foundry steel from pig iron, apart from the high heat energy for melting, certain chemical elements present including carbon sulphur and minor metals in coke are incorporated into the foundry steel. Thus coke has a crucial role in steel making, contributing to the ultimate chemical composition of steel and conferring desirable strength, corrosion resistance and other properties. In addition to 131 ferrous casting foundries there are also 34 pit furnaces for ferro alloys which may depend on coke. Foundries in addition depend on the good quality sand and on trained and skilled labour. Most of the foundries produce diesel pumps for lift irrigation and components for these and for auto industry. One large unit has adopted electrical furnaces with diesel generated power to produce aluminium precision components.

73. Other industries in Agra utilise coal in the main as fuel energy source for heating and steam raising. In such cases, firewood, rice husk, agro-wastes, waste rubber or urban wastes are also burnt as fuel, often inefficiently. These also leave ash and solid residues. Almost all units need some electrical power in their operations as well as in attached offices, and have their own generators. The composition of emissions would depend on the materials burnt as fuel. In all these cases, coal can be substituted by petroleum, oil, or gas fractions, and in most instances by electricity. Most of these units have old equipment. Through modernisation and better design, energy usage can be markedly reduced and air effluent emissions improved in quality.

74. It is learnt that the hotels, restaurant, food articles preparation units and most households in urban areas will be ready to utilise LPG in place of coal, firewood or kerosene if it is available. Brick kilns however will continue to use coal, without chimneys or air pollution control devices. Brick making requires top soil from agricultural lands and is not carried out in the Agra city area or Sikandara.

75. It appears a large number of industry units have installed air pollution control devices (APCD) in Agra to meet the standards for emissions prescribed by CPCB and the norms of UPPCB. NEERI has submitted on 5 April, 1994 a report on 'Inspection of Air Pollution Control Devices in Taj Trapezium'. In Agra only one unit, an Oil Extraction Plant using 3 TPD of rice husk as fuel was inspected by a six member team constituted by the Director, NEERI. Coke and coal using foundries or other industrial units are the ones which release sulphur

dioxide and the performance of APCD in these has to be assessed.

Technologies for clean and safe operations

76. In many developed countries very substantial number of industrial units of varied capacities have been in operation in areas close to residential areas. A large percentage of the population in these countries live in urban areas, which have also high energy usage through heating, air conditioning, transport, home appliances, commercial establishments, medicare, entertainment, sports, education, and leisure activities. In Developed World energy consumption per capita from coal, gas, petroleum is 50 to 100 times compared to India. Yet to meet standards, new energy efficient, environmentally acceptable, and safe, risk free technologies have been developed for industry and services. By selection of such technologies and their modification and adaptation to meet specific conditions in Agra Mathura, the ambient air quality could be improved. These aspects are discussed below:

Foundries

77. New divided cupolas have been introduced by a few units in Agra foundries and these allow heated effluent air to pre heat the intake air. This has resulted in marked improvement in energy efficiency. Coke usage which is normally one tonne for production of four tonnes of steel has been improved so that one tonne of coke is able to produce 8 to 10 tonnes of steel. With further design improvements it is possible to achieve a ratio of 1 to 12. Professor P.Ramachandra Rao, Director and Dr.K.K.Mishra, Deputy Director, National Metallurgical Laboratory, Jamshedpur in discussions with this Committee have confirmed their willingness to evolve demonstration units of three sizes for adoption in Agra foundry industry. A preliminary proposal received is being examined for support by the Ministry of Environment and Forests. One hundred and ten foundry units in Agra have each separately addressed identical communications to this Committee, confirming their decision to instal Divided Blast Cupola. They have sought financial assistance.

78. NML are also willing to develop furnaces which can use gas or petroleum liquid fuels. The main costs are in imported burners of special design available from a limited number of suppliers. NML is eveloping their own designs, and this aspect is also included in the NML project proposal. Natural gas distribution to

industries in existing locations in Agra would need installation of pipelines and meters. This may be expensive and in addition not ensure safety, as accidental leakage in pipeline network may lead to explosions and fires. It may however be possible to use LPG or HSD with suitable precautions, after careful review.

79. Capital costs of modifying existing units to adopt Divided Blast Cupola for reduced coke consumption would depend on capacities. Efficient well designed APCD with cyclone separators, and wet gas scrubbers can provide substantial improvements. The Report on Inspection of Air Pollution Control Devices by NEERI dated April 5, 1994 states that the efficiency is below 20 per cent in two units and below 45 per cent in one, among the four inspected. NEERI Report dated March 7, 1994 on Fuel Supply Alternatives (Annexure) suggests Natural Gas can be considered for use only in new industrial sites.

Other Industries in Agra

80. Almost all these can use LPG or low sulphur liquid fuels in place of coal or firewood through suitable modifications. Here again, it will not be possible to ensure safety for pipeline supply of Natural Gas in the existing locations. Use of LPG or other liquid fuels can be done after meeting requirements for safety in storage, according to regulations.

Ferozabad

81. Ferozabad industries consume 700 MT of coal per day. Many have open pit furnaces. Coal cannot be replaced in such furnaces by petroleum gas or liquid fuels. There are a large number of tank furnaces and it is possible to introduce oil firing. A large number of workers have to be specifically trained. One major unit has totally replaced coal usage and has adopted electrical furnaces, employing power from diesel generators and using oil fired jet flame torches for finishing work on high quality table glassware. Ferozobad has a Technical Assistance Unit rendering very useful service. It has to be strengthened substantially and services of some experts from industry in developed countries could be obtained. Central Glass and Ceramic Research Institute (CGCRI) Calcutta had made some studies earlier. With a suitable sponsored programme of research and demonstration, CGCRI will also be able to provide valuable assistance.

82. Shared common high quality furnaces have been installed in Khurja for pottery producers. This is not feasible in Ferozabad glass industry. It would be desirable to establish a few demonstration units. It would be not be possible to lay natural gas pipelines in the existing industrial area due to safety considerations.

Mathura Refinery

83. Detailed discussions have been held at Mathura Refinery and with the Chairman and Directors of IOCL regarding technological improvements to effect further reductions in emissions in the short term and medium term are the outcome of these are described in the next section on short and medium term plans.

PLANS OF MAJOR PRODUCERS, SUPPLIERS AND CONSUMERS OF ENERGY IN THE SHORT TERM OF 18 MONTHS AND MEDIUM TERM OF 5 YEARS.

Electric Power Supply

84. It is necessary to obtain substantial changes in the availability and consumption of energy in the Taj Trapezium Area so that improvements in ambient air quality can be obtained rapidly and maintained. Electric power supply can be improved if transformers are replaced and augmented. The Ministry of Power has been requested to initiate discussions with the UPSEB, Agra Development Authority (ADA) and Central Electricity Authority (CEA) to find solutions with regard to transformers so that the position can be rectified within 18 months. In addition, Ministry of Power may be requested to examine the possibility of a dedicated power generating project with a capacity of 300 MW to meet the needs of Agra Mathura Region. This could be a combined cycle gas turbine power generation plant based on condensates from associated gas, supplemented by naphtha. Such power generation projects have already been approved in other locations. Such a project can be located south or south east of Taj Trapezium Zone where water for steam generation in combined cycle could be available. Needs of Agra Region should be met and any excess can be fed to the grid. The Project, if approved, could be completed within three to four years. It will help to reduce use of coal and petroleum liqid products now involved in Taj Trapezium Zone and reduce atmospheric sulphur and nitrogen oxide levels.

GREEN APPROACH AND TEN POINT INITIATIVES

85. The Committee has noted the announcement of a Green Approach and Ten Point Initiative by Captain Satish Sharma, Minister of State for Petroleum and Natural Gas, specifically aimed at improving the environment in Agra-Mathura in response to concerns expressed on impact of air pollution on the Taj Mahal. These include;

* Supply of LPG before March 1996 to one lakh applicants in the current waiting list.

* Low lead petrol in Taj Trapezium Zone from September 1995.

* LPG supply to Industrial Units in Taj Trapezium Zone from April 1996.

* Low Sulphur (0.5 per cent) HSD in April 1996.

* Green tree plantations near the Taj Mahal and other monuments.

* Natural Gas (6 lakhs cubic m/day) supply allocation to industries in Agra and Ferozabad.

* Compressed Natural Gas for Vehicles in 1996-97.

* Natural Gas (1.4 mm^3/day) to the Mathura Refinery

* Hydrocracker for Mathura Refinery

* Strategies for environmental management in consultation with the Asian Development Bank.

86. These, when implemented, will be major inputs for the improvement of air quality in Taj Trapezium Zone and particularly in the surroundings of the Taj Mahal.

MATHURA REFINERY

87. The Committee has had several discussions with Shri Narang, Chairman of IOCL and Directors and Officers of the Corporation to examine the possibilities of reduction in the quantum of sulphur dioxide released by Mathura Refinery from the hitherto recommended level of 700 kg/hr. A copy of a letter dated 25 April 1995 from Shri A.K.Arora, Director Refineries and Pipelines, placed as Annexure XVIII gives details of the response from IOCL. From these the quantum of Sulphur dioxide

released is expected to be as follows:

	Kg./hr
May-June 1995	460-520
January 1997	340-380
Hydrocracker (42 Months after approval)	200

88. IOCL have agreed to carry out trials to reduce emissions of Sulphur dioxide from FCC Unit, currently contributing about 160 kg/hr through change of catalyst, and use of additives. There are possibilities of reduction of Sulphur dioxide by about 50 kg./hr by improvement of the Sulphur Recovery Unit (SRU).

SUPPLY OF CLEANER FUELS

89. The Committee has had discussions with Dr.V.L.Kelkar, Secretary, Ministry of Petroleum and Natural Gas, with a view to improving further the plans for supply of cleaner fuels in the Agra-Mathura Region. The response from the Ministry in two recent communications dated 26 April 1995 and 29 April 1995 from Shri Nirmal Singh, Joint Secretary are placed in Annexure XIX and XX. The following measures are designed to make major contributions towards reduction of Sulphur dioxide levels in the Taj Trapezium Zone:

April 1996	HSD with 0.5% Sulphur
September 1996	HSD with 0.25% Sulphur
March 1996	LPG connections on priority to customers enrolled upto January 1995

90. Thus, HSD with 0.25% sulphur will be marketed in Taj Trapezium far ahead of any other location in the country. This is a major step considering that HSD of 0.25 per cent sulphur will be marketed in other parts of India only in the year 2000. The Committee is deeply appreciative of the favourable response from the Ministry of Petroleum and Natural Gas. Thus, in the short term of 18 months, the contributions of Sulphur dioxide in the Taj Trapezium atmosphere, and particularly in the vicinity of the Taj Mahal, from diesel generators and heavy vehicles would be reduced to one third of present levels. Much freer availability of LPG to most consumers and industries from March 1996 will again contribute to reduction of SPM and Sulphur dioxide from coal and firewood. If industries in Agra can be persuaded to use LPG or HSD within this period of 18 months, further improvements in the environment are possible. The expected reduction of Sulphur dioxide

emission quantities from Mathura Refinery in May-June 1995, and possible further reductions before September 1996, will be of some benefit in short term peaks in Sikandra and the Taj Mahal.

91. These measures would help to reverse the trend in the last five years of gradual increase in the long term average levels of oxides of sulphur and nitrogen in Taj Mahal and contribute to reducing frequency of occurrence of high short term concentrations of pollutants. The objective would be to reach the atmospheric quality obtained in 1982-85.

INDUSTRIES IN AGRA

92. Industries in Agra and Ferozabad have been asked to instal APCD to reduce essentially SPM level in air emissions. UPPCB has the authority to monitor their performance to meet standards outlined for different industries by CPCB, noting their capacities. These regulations should be fully enforced. NEERI has suggested suitable sites in Agra and Ferozabad could be identified and developed as industrial estates with facilities, separated from residential areas. If such sites are developed, natural gas supply in the industrial estate would be possible with safety, and the industrial units could be shifted.

93. Natural gas by pipeline supply to households was introduced in Baroda on a small scale in 1970, with a nominal fixed charge per month, without meters. Bombay Gas Co. had distributed producer gas from coal by pipelines in the city to households and for street lighting but this has been suspended. There are proposals to examine the safety and feasibility of using these old lines for distribution of Natural Gas. While Natural Gas is supplied in India in North East and through HBJ pipeline is supplied to major industrial units such as fertilisers, refineries, power plants, gas fractionation units, there does not seem to be any instance of supply to industrial estates in which a large number of small and medium units are located, presumably due to a combination of factors such as safety, capital costs, reliability of supplies, measures for metering, sale and realisation of charges. There are also costs of insurance for obligations in case of accidents. Consuming units have to be trained on safety standards and precautions. There is considerable turn over of labour employed in small industry and these may pose some limitations. There is need for a single authority in such estates to coordinate all maintenance and repair work on electrical supply, telecommunications, water, sewage,

drains, roads and construction. Any industrial estate in Agra with natural gas will have to be located at a substantial distance from monuments to ensure full safety.

94. Natural gas can be supplied for such purposes by GAIL to a local company or authority at a specified terminal. The local bulk purchaser will then have to create suitable distribution system incurring capital outlay. Contracts on pricing and escalations will have to be entered into. These will take some time to establish.

95. When industrial units are relocated, it would be appropriate to modernise technology equipment and buildings. Most of the units will need very substantial financial assistance. The value of the present sites and their future use have to be determined. It would not be desirable to promote residential colonies and commercial establishments in such vacated areas as they may inturn add to the problems of water supply and atmospheric quality by excessive use of energy. Major changes of this nature would need a clear development planning strategy and resources, and will also take several years for implementation.

96. There is urgent need for quicker measures which could lead to better environment, especially in the Taj Mahal. For this purpose, it is necessary to effect overall reduction in coal / coke consumption by industries and others in Agra and in Taj Trapezium Zone generally. The present level of consumption of 129 metric tonne per day by industry can be substantially reduced by new technology and by use of LPG and HSD of low sulphur. Stricter standards for emissions may be evolved when such technological and fuel changes are effected. Support for development of modifications in design and operation and demonstration should be provided. Some assistance to industries for adoption of these may be considered after careful examination of the costs and benefits to the industry and to society. All those industries not responding for action for feasible changes and contributing disproportionately to atmospheric pollution have to face action.

OTHERS: Brick Kilns

97. There are 350 brick kilns in Agra District and they consume 185,000 tonnes of coal in 5 months during November to March at the rate of 1,200 tonnes of coal per day. It is necessary to restrict this activity to areas beyond 10 km. north and north-west of Agra city. Kilns are not listed as industry and do not require approvals

for operation. Some legal instrument and system has to be deveoped to regulate activities which may have effects on the atmosphere in sensitive areas.

Commercial establishments(Petha Industry)

98. All these in Agra city have to be encouraged to desist from use of coal or fire wood or cowdung cake as fuel. Here again, with proposed freer availability of LPG, certain compulsions can be brought about to eliminate solid fuels contributing to pollution.

Industries at Ferozabad

99. Information on the extent of emissions in the atmosphere and their contribution at different locations in the direction of Agra is lacking. It is necessary to establish three monitoring stations in Ferozabad itself, and three more on the route to Agra. Continuous monitoring, as has been done in Farah, Keetham, Sikandra and the Taj Mahal, is necessary to have a reliable appreciation of the extent of pollution contribution from Ferozabad industries in Agra sensitive areas. Such steps were not considered earlier, as it was assumed that due to low percentage of winds from east to west during the greater part of the year will lead to a low contribution. Pending establishment of permanent monitoring stations, it would be desirable to carry out studies of three months duration before and after the monsoon from temporary facilities. Such a survey could be completed by June, 1996 and would enable assessments to be made.

100. Ferozabad industry consumes 700 metric tonne of coal per day. A large number of workers and residents are exposed to high levels of pollution. Human health considerations should prevail here, and efforts should be made to enforce occupations health requirements. Such considerations would neccessitate changes in design, technology, fuel, and would lead to improvement of atmosphere. Some suggestions for improved technology and energy conservation have been outlined earlier in this Report. If studies are sponsored, better information will be available by June, 1996, as well as alternative technologies and designs.

101. In the meanwhile, suitable designs have to be evolved for APCD for each type of furnace, especially in very small industry. This is a challenging task.

GENERAL CONSIDERATIONS:

102. The report of the committee of U.P. Government under the Chairmanship of Commissioner of Agra Division provides a number of suggestions on diversion of traffic, highway linkages etc., to improve the total atmosphere, and need to be carefully examined. In addtion, the following need consideration.

i. Establishment of a new railway station outside of Agra city to handle goods traffic;

ii. A urban railway system for commuters so that use of buses and two and three wheelers in central areas can be reduced;

iii. Development of new habitat south/ south-east of the Taj Mahal with incentives for movement of offices/ residences, industry.

iv. Restrictions on high rise buildings within 10 km. of the Taj Mahal so that decongestion could be effected;

v. General sensitisation of tourists and promoters of tourism to the need for restraint in energy usage in the vicinity of the Taj Mahal and other monuments;

vi. Establishment of a greater Agra Development Authority to cover wider area and to effect several long term measures;

vii. Establishment of air monitoring stations in Agra industrial areas and public display by electronic boards giving information on air quality;

viii. Removal of all HSD usage in locomotives in Agra area within 24 months. Possible conversion of diesel locomotives to electrical power ones;

ix. Provision of increased funds, facilities, and special staff in Archaeological Survey of India to ensure complete conservation in Agra monuments;

x. Gradual decongestion of Taj Ganj and restrictions on use of solid fuels, solid waste.

xi. Consider shifting of cremation ground at a further distance away from the Taj Mahal.

xii. Restriction on opening of new petrol pumps or LPG distribution in the vicinity of monuments to avoid fire or explosion;

xiii. Publication of Annual Report on atmospheric quality and on the state of monuments (with suitable suggestions for improvements) by a duly constituted high level authority;

xiv. Increase in green cover, especially tree plantations, gardens, orchards in and around all monuments to act as filter and protection;

xv. Provision of electrically powered automobiles in an area around Taj Mahal and compulsory replacement of petroleum oil based vehicles. Use of CNG based vehicles in the area. Such area should be extended from time to time so that clean energy is maximised.

xvi. Observance of abundant precautions with regard to increasing any possible loads on monuments through lighting, illumination, abnormal increase in visitors, especially into unventilated spaces;

xvii. Erection of minimum clear unoccupied open spaces around those declared as sensitive areas and heritage sites;

xviii. Establishment of meteorological observatories and air quality monitoring stations in Agra-Mathura-Ferozabad to compile meteorological and air quality data within India Meteorological Department. Strengthening of the scientific divisions for survey and analysis. Acquisition of software and augmentation of personnel for modelling to meet increasing demands for environmental impact assessment;

xix. Establishment and support of Departments and Divisions in Universities, Technological institutes, National Laboratories, for expertise development of human resources and facilities in environmental observations analysis, techique and predictions by autonomous, independent peer group. Support may be provided through Ministry of Environment & Forests and Ministry of Science & Technology;

xx. Review of current legal framework and additional measures and powers to effectively protect and preserve cultural heritage while promoting economic growth.

ACKNOWLEDGEMENTS

103. The Committee records its deep appreciation to many organisations, specialists, Ministries and Departments of Government of India and of Uttar Pradesh, National Laboratories, Experts and Distinguished Persons in Public Life for all information and assistance provided in response to its requests.

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ANNEXURE I

REPORT OF THE EXPERT COMMITTEE ON THE ENVIRONMENTAL IMPACT OF MATHURA REFINERY

MINISTRY OF PETROLEUM CHEMICALS AND FERTILIZERS
DEPARTMENT OF PETROLEUM
GOVERNMENT OF INDIA, NEW DELHI—1978

39

REPORT OF THE EXPERT COMMITTEE ON THE ENVIRONMENTAL IMPACT OF MATHURA REFINERY

DECEMBER- 1977

EXPERT COMMITTEE ON ENVIRONMENTAL IMPACT OF MATHURA REFINERY

MEMBERS

CHAIRMAN :

Dr. S. Varadarajan,
Chairman & MD, Indian Petrochemicals Corporation Ltd.

MEMBER-SECRETARY :

— Indian Oil Corporation Ltd. (R & P Division)
Shri RN Bhatnagar, Managing Director (Up to April 1977)
Shri SK Nayak, General Manager (From May 1977)

MEMBERS :

— Ministry of Petroleum, Government of India
Shri M Kurien, Adviser (R) (Up to January 1977)
Shri TS Nayar, Adviser (R) (From February 1977)

— National Environmental Engineering Research Institute
Shri JM Dave, Scientist (Up to September 1977)
Dr. BB Sunderesan, Director (From October 1977)

— National Committee on Environmental Planning & Co-ordination, (Deptt. of Science & Technology)
Dr. Ashok Khosla, Sr. Specialist (Up to April 1976)
Shri Thomas Mathew, Sr. Environmental Specialist (From May 1976)

— Indian Institute of Petroleum
Shri HK Mulchandani, Head, Projects Division

— India Meteorological Department, Ministry of Tourism & Civil Aviation
Dr. AK Mukherjee, Director, Regional Met Centre, Bombay (Up to March 1977)
Dr. B. Padmanabha Murthy, Meteorologist (From April 1977)

— Government of Uttar Pradesh
Dr. SD Shukla, Director, Harcourt Butler Technological Institute, Kanpur
Shri AB Malik, Resident Commissioner, New Delhi
Shri Desh Raj Singh, Additional Resident Commissioner, New Delhi.

— Archaeological Survey of India, Govt. of India
Shri R. Sengupta, Director (Conservation) (From December 1975)

CHAPTER 4

CONCLUSIONS

Based on the data made available to the Committee as well as the results of the studies and investigations undertaken, the following conclusions are made.

4.1 There is substantial level of pollution of sulphur dioxide and particulate matter in the Agra region. The possible sources are all coal users consisting of two Power Plants, a number of small industries mainly foundries (approximately 500) and a Railway Shunting Yard. As far as suspended particulate matters are concerned, because of use of coal, contribution will be substantial. Even though the total amount of emission of sulphur dioxide from these sources may be small, on account of their proximity to the monuments, their contribution to the air quality of the zone will be considerably high.

4.2 IOC have estimated that total emission of sulphur dioxide from the refinery would be limited to one tonne per hour and these estimates have been confirmed by the representative of the Ministry of Petroleum. Since basically low sulphur fuel will be used in the furnaces and modern instruments are available for proper measurement of emissions, it would be possible to ensure that the actual emission is limited to one tonne per hour. IOC have also assured that modern technology will be used for electro-static precipitators of the power plant so that particulate emission from the stack is effectively controlled.

4.3. Based on the dispersal studies made by IMD and their investigations conducted by Tecmo and NEERI it has been estimated that the contribution from the refinery to the long term concentration of sulphur dioxide at Agra would be of the order of one to two micrograms per cubic metre compared to the existing level of 15 to 70 micrograms per cubic metre. Short term (one hour) peak concentration of the order of 65 micrograms per cubic metre could be expected under worst meteorological conditions in winter and the frequency for such occurrences are 2.0—4.0 per cent for Agra region and 0—1.0 per cent for Bharatpur region.

4.4 Adequate facilities are being provided for treatment of water effluents to meet the required specifications laid down by the Indian Standard Institution and the U.P. Government. Arrangement will be made for ensuring proper dilution of the treated effluents on occasions when enough water is not available in the river for dilution. Adequate expertise and proven technology is available indigenously for such treatment plants. IOC are operating similar plants in their existing refineries satisfactorily.

4.5 So far as the effect on the Bharatpur Bird Sanctuary is concerned, it has been established that there is no likelihood of any adverse effect either on the birds or the plant life at Bharatpur on account of the refinery.

4.6 Effective steps need to be taken quickly to reduce the existing level of pollution in Agra.

4.7 It will be necessary to ensure that the actual long term contribution to the sulphur dioxide levels at Agra as a result of the refinery is not more than two micrograms per cubic metre.

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*Winter refers to the 90 day period from the beginning of December to end of February. When the temperature profile in the atmosphere is such that it prevents a parcel of air to rise above a certain height, the atmosphere is said to be stable. Usually, stable condition mean that a rising parcel of air can rise upto a height of 100 to 500 metres, but its further ascent is prevented by an adverse temperature profile. The adverse temperature gradient is referred to as an "inversion" in meteorological literature. Meteorological data indicate that the frequency of wind direction towards Agra during the winter months varies from 14 to 28 per cent during the winter. Out of this percentage, the frequency of conditions which prevent the dispersal of pollutants due to stable conditions is approximately 2.0 to 4.0 per cent for Agra. This implies that the probability of joint conditions of favourable northwesterly winds towards Agra, and stable atmospheric conditions in winter, is likely to be small.

CHAPTER 5

RECOMMENDATIONS

Although primarily the Committee has been formed to advise the project authorities on the measures to be taken for keeping the pollution effect to the absolute minimum, conscious of the great responsibility entrusted to the Committee and its deep concern for the preservation of the priceless monuments at Agra and particularly the Taj Mahal, the Committee considers it of utmost importance that the following recommendations be considered by the Government for urgent and expeditious implementation in order to reduce substantially the existing pollution levels at Agra and to forestall creation of any future sources of pollution.

5.1 Efforts should be made immediately to minimise the existing pollution from sources close to the monuments in the Agra zone. The U.P. State Electricity Board has given indications that the old thermal power station (nominal 10 MW capacity) near the Agra Fort would be dismantled as soon as the grid for power supply to Agra is ready and the other power station (110 MW capacity) at Itmad-Ud-Daulah which is in good condition will be shut down and used only as a stand by in emergencies. Closing down of these two power plants is expected to make a significant reduction in the existing levels of sulphur dioxide and particulate matter at Agra. It is recommended that early steps are taken to close down these two power plants.

5.2 Railways may be advised to replace the present coal-based locomotives with diesel-based locomotives at the marshalling yard at Agra. Since the marshalling yard is very close to the Agra Fort, this measure is expected to reduce the sulphur dioxide and particulate matter levels considerably.

5.3 Steps may be taken to ensure that no new industry including small industries or other units which can cause pollution are located north west of the Taj Mahal.

5.4 Efforts may be made to relocate the existing small industries, particularly the foundries, in an area south east of Agra beyond the Taj Mahal so that emissions from these industries will not be in the direction of the monuments.

5.5 Similar considerations may apply to large industries such as Fertilizer & Petrochemicals. Such industries which are likely to cause environmental pollution may not be located in the neighbourhood of the refinery. The Committee further recommends that no large industry in the Agra region and its neighbourhood be established without conducting appropriate detailed studies to assess the environmental effect of such industries on the monuments. Location should be so chosen as to exclude any increase in environmental pollution in the area.

5.6 The Committee wishes to record its deep concern regarding the existing level of pollution in Agra. It recommends that an appropriate authority be created which could monitor emissions by industries as well as the air quality at Agra on a continuous basis. This authority should be vested with powers to direct industries causing pollution to limit the level of emission and specify such measures as are necessary to reduce the emission whenever the pollutant level at the monuments exceeds acceptable limits. The Committee particularly desires that the recommendations made in regard to reduction of existing pollution levels at Agra should be converted to a time-bound programme and should be implemented with utmost speed.

5.7 The Committee recognises that there is urgent need for continuous study and investigations to ensure that the monuments at Agra are not exposed to further threats from the pollutants or from any cause. Therefore, it recommends that such studies should be periodically conducted with a view to determine whether any deterioration has occurred and if so scientifically analyse the cause/s for the same to enable taking suitable measures for prevention of such deterioration. Since the Archaeological Survey of India are in charge of preservation of the monuments it is logical that they should be entrusted with the responsibility for getting such continuous studies made. For this purpose, ASI may have adequately staffed cell which can carry out studies and additionally utilise the services of other organisations such as National Environmental Engineering Research Institute, India Meteorological Department, National Physical Laboratory, Bhabha Atomic Research Centre, National Aeronautical Laboratory etc., for determining the fabric of the monuments and also the effects of pollutants thereon. Adequate funds should be made available to ASI for these investigations.

5.8 The Committee also recommends that studies should be undertaken by competent agencies to explore the possibility of protecting the monuments by measures such as provision of a green belt around Agra in the region between Mathura and Agra.

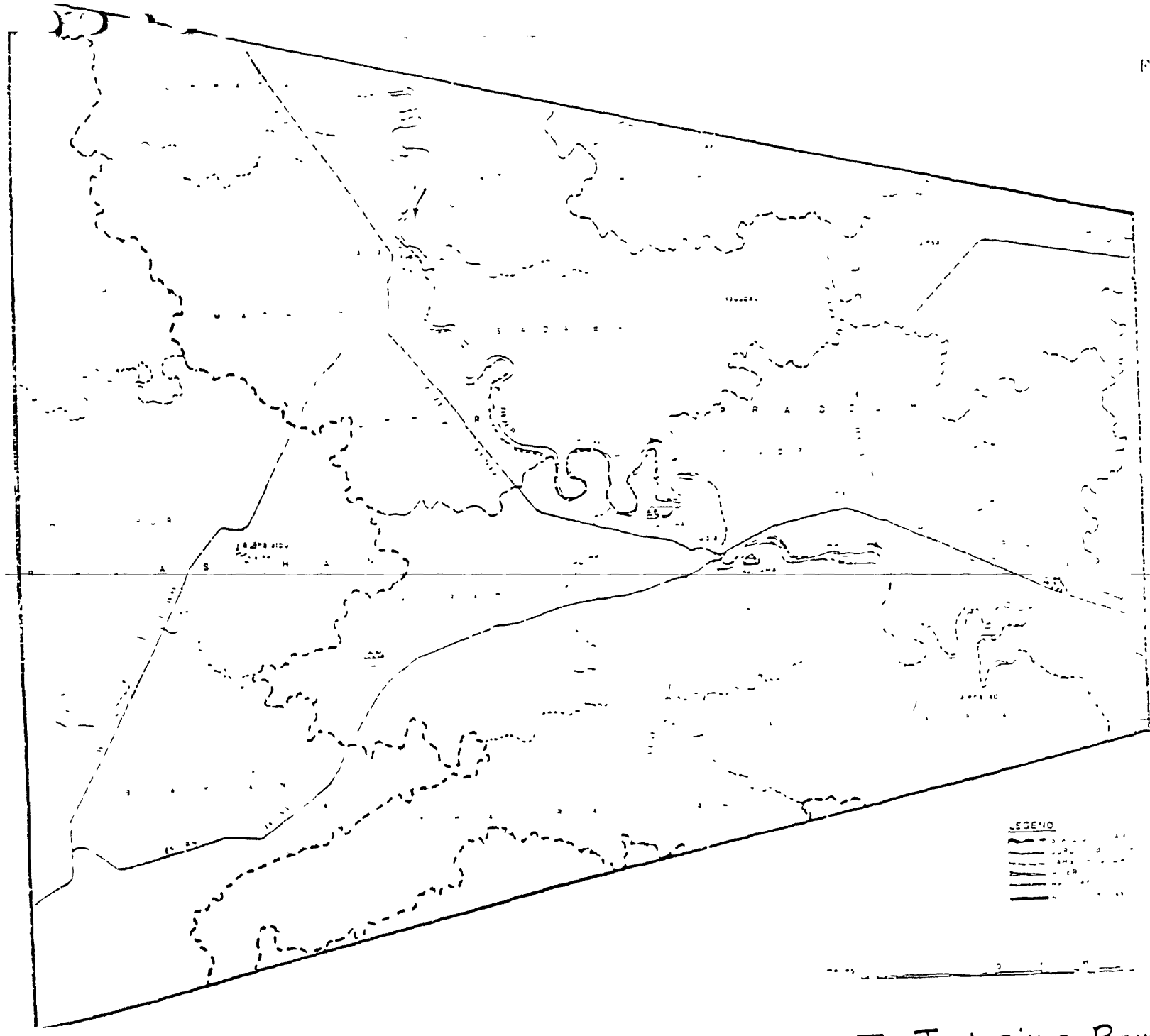
5.9 Even though assurances have been obtained from IOC that adequate precautions would be taken to contain the pollution on account of using coal in the power plant, the Committee is of the opinion that till such time this problem is studied in depth and suitable technologies have been found to be satisfactorily in use elsewhere, the use of coal in refinery power plant should be deferred.

5.10 In order to ensure that the emissions from the refinery and their dispersion towards Agra are in accordance with estimates made and assurances given

a minimum of 3 monitoring stations beyond 10 KM from the refinery in the direction of Agra at suitable intervals may be established. These should be operated well before the commissioning of the refinery and operated continuously thereafter. The agency proposed earlier under para 5.7 shall audit these measurements.

5.11 The Committee recommends that the Government should establish facilities and expertise in organisations such as India Meteorological Department, National Environmental Engineering Research Institute, Bhabha Atomic Research Centre, Environmental Division of Dept. of Science & Technology, National Aeronautical Laboratory, Physical Research Laboratory and Raman Research Institute for developing dispersion models suitable for conditions as are actually obtainable in different parts of the country. This is essential for studies as the one entrusted to this Committee.

FIGURE I



Taj Trapezium Boundary

ANNEXURE II

CENTRAL POLLUTION CONTROL BOARD

National Ambient Air Quality Standards

NOTIFICATION

Delhi, the 11th April,1994

S.O.384(E)-The Central Pollution Control Board in exercise of its powers conferred under Section 16(2) (h) of the Air (Prevention and Control of Pollution) Act, 1981(14 of 1981) hereby notify the National Ambient Air Quality Standards with immediate effect.

SCHEDULE-I

Pollutant	Time weighted average	Concentration in ambient air			
		Indl. Area	Residential, Rural & Other areas	Sensitive Area	Method of measurement
(1)	(2)	(3)	(4)	(5)	(6
Sulphur Dioxide (SO_2)	Annual Average*	80ug/m^3	60 ug/m^3	15 ug/m^3	1.Improved West and Gaeke method
	24 hours**	120 ug/m^3	80 ug/m^3	30 ug/m^3	2.Ultraviolet Fluorescence.
Oxides of Nitrogen as NO_2	Annual Average*	80 ug/m^3	60 ug/m^3	15 ug/m^3	1.Jacob & Hochheiser Modified (Na-Arsenite Method
	24 hours**	120 ug/m^3	80 ug/m^3	30 ug/m^3	2.-Gas Phase Chemiluminescence
Suspended Particulate Matter(SPM)	Annual Average*	360 ug/m^3	140 ug/m^3	70 ug/m^3	-High Volume Sampling, (Average flow rate not less than 1.1 m^3/minute
	24 hours**	500 ug/m^3	200 ug/m^3	100ug/m^3	

Respirable Particulate matter (size less than 10 um)(RPM)	Annual Average*	120 ug/m^3	60 ug/m^3	50 ug/m^3	Respirable particulate matter sampler
	24 hours**	150 ug/m^3	100 ug/m^3	75ug/m^3	
Lead(Pb)	Annual Average*	1.0 ug/m^3	0.75 ug/m^3	0.50 ug/m^3	-AAS Method after sampling using EPM 2000 o equivalent filter pape
	24 hours**	1.5 ug/m^3	1.00 ug/m^3	0.75 ug/m^3	
Carbon Monoxide(CO)	8 hours**	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3	Non dispersive infrared spectroscopy
	1 hour	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3	

*Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

**24 hourly/8 hourly values should be met 98% of the time in a year However, 2% of the time, it may exceed but not on two consecutive days.

NOTE :

1. National Ambient Air Quality Standard: The levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property.

2. Whenever and wherever two consecutive values exceed the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.

3. The State Government/State Board shall notify the sensitive and other areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

(F.N.B-33014/4/90)
D.K.BISWAS, Chairman

ANNEXURE III

Sulphur dioxide

Standard	Time weighted average (μg m^{-3}) 1 hour	8 hours	24 hours	1 year	Guidelines and standards with other averaging times (μg m^{-3})	Source(s)
WHO	350		125[a]	50[a]	500 (10 minutes)	1
			100–150	40–60		2
Argentina					70 (30 days)	3
Alert	(1)[b]	(0.3)[b]				
Alarm	(5)[b]					
Emergency	(10)[b]					
Brazil						
Primary			365	80		4
Secondary			100	40		
São Paulo						
Attention			800			
Alert			1,600			
Emergency			2,100			
China						
Class I[c]			50		150 (not once)	5
Class II[d]			150		500 (not once)	
Class III[e]			250		700 (not once)	
European Community (UK)						
98 percentile			350[f]		6	
98 percentile			250[g]			
50 percentile			120[h]			
50 percentile			80[i]			
50 percentile			180 (Winter)[j]			
50 percentile			130 (Winter)[k]			
Guide value			100–150	40–60		
India						
Sensitive area		30	15			7
Residential area		80	60			
Industrial area		120	80			
Indonesia	286 (0.1)					8
Japan	286 (0.1)					9
Korea	429 (0.15)			143 (0.05)		10
Mexico			350			11
Philippines	850		369			12
Russia			150			13
Thailand			300	100[l]		14
USA						
Federal			365	80	1,300 (3 hours)	15
California	715 (0.25)		143 (0.05)[m]			16

Numbers in parenthesis are original standard concentrations in ppm Conversion factor: 1 ppm = 2,860 μg m^{-3}

Technical Report

Issues Associated with Fuel Supply Alternatives for Industries in Agra-Mathura Region

The Hon'ble Supreme Court
New Delhi

National Environmental Engineering Research Institute
Nagpur 440 020

March 7, 1994

2.4 Safety Requirements

2.4.1 NG : The use of NG involves the defining of No Gas Zone for safe distribution. The new sites in Agra and Firozabad industries being identified by the Government of Uttar Pradesh shall minimise this hazard as the industrial estates shall be suitably designed for NG distribution.

The new industrial sites should preferably be out of the Taj Trapezium. The incentives for industries to shift to new industrial estates need to be established to ensure speedy implementation.

2.4.2 LPG : The supply of LPG would primarily be from MR. Safe handling and proper distribution system is essential for its supply, requiring open industrial areas to avoid hazards to nearby residential zones.

2.4.3 Propane : The use of propane involves special storage facility, and suitable distribution and handling systems. New open industrial estates are desirable to minimise safety hazards.

The safety requirements bring out that all the three fuel alternatives require open spaces highlighting the need for new industrial estates outside the Taj Trapezium where the existing industries in Agra-Mathura region could shift.

3.0 Summary

The various issues raised in this report pertaining to the fuel supply alternatives to the industries in Agra-Firozabad region and the Mathura Refinery, can be summarized as:

- Need for relocation of industries
- Availability of cleaner fuel (present and future)
- Environmental benefits from alternate fuels
- Safety considerations

The recom...endations are summarized hereunder:

- Shifting of small-scale polluting industries outside the Taj Trapezium on industrial estate sites to be identified by the Government of Uttar Pradesh;

- Provision of natural gas to the industries in Agra-Mathura region and Mathura Refinery

Table 3

Consumption - Cost of Industrial Fuels in Agra-Mathura Region

Town/city	Industries		Coal/Coke		NG			LPG			Propane		
	Type	Number	Consumption (MTPD)	Cost (Rs/day)	Consumption (S cum/day)	Cost (Rs/day)	Savings over coal/coke (Rs/day)	Consumption (MTPD)	Cost (Rs/day)	Savings over coal/coke (Rs/day)	Consumption (MTPD)	Cost (Rs/day)	Savings over coal/coke (Rs/day)
Agra	Foundry	131	1,048	26,20,000	3,45,930	25,59,877	60,123	414.4	46,32,992	-20,12,992	410.7	41,24,600	-15,04,600
	Pit Furnaces	34	34	85,000	11,223	83,050	1,950	13.4	1,49,812	-64,812	13.3	1,33,798	-48,798
	Rubber Sole	30	6	15,000	1,980	14,652	348	2.7	30,186	-15,186	2.4	24,144	-9,144
	Chemical	34	52	1,30,000	17,165	1,27,018	2,982	20.6	2,30,308	-1,00,308	20.4	2,05,224	-75,224
	Refractory Brick	16	32	80,000	10,562	78,161	1,839	12.7	1,41,986	-61,986	12.5	1,25,750	-45,750
	Engineering	20	17	42,500	5,612	41,531	969	6.7	74,906	-32,406	6.7	67,402	-24,902
	Lime Processing	18	58	1,45,000	19,145	1,41,671	3,329	22.9	2,56,022	-1,11,022	22.7	2,28,362	-83,362
Firozabad	Glass	267	1,284	32,10,000	4,23,833	31,36,367	73,633	507.7	50,76,086	-24,66,086	503.2	50,62,192	-18,52,192
	Muffle Furnace	1132	374	9,35,000	1,23,453	9,13,552	21,448	147.9	16,53,522	-7,18,522	146 6	14,74,796	-13,81,296
	Pottery	33	215	5,37,500	70,970	5,25,180	12,320	85.0	9,50,300	-4,12,800	84.3	8,48,058	-3,10,558
Mathura	Foundry	8	64	1,60,000	21,128	1,56,350	3,650	25.3	2,82,854	-1,22,854	25.1	2,52,506	-92,506
Total			3,184	79,60,000	10,51,001	77,77,409	1,82,591	1,259.3	1,40,78,974	-61,18,974	1,247.9	1,25,46,832	-54,28,332

* Source : - Air Pollution Studies to Redefine Taj Trapezium Coordinates, NEERI; July 1993

- Latest Technical Note of GAIL submitted to the Hon'ble Supreme Court

* Present cost of NG= Rs. 7400/1000 m^3 of gas
* Present cost of LPG= Rs. 11180/tonne (ex-refinery)
* Present cost of Propane = Rs. 10060/tonne (ex Bijapur)

Table 4 (A)

Projected Emissions from Combustion of different Fuels in Agra-Mathura Region

Town/city	Industries		Coal/Coke						Natural Gas					
	Type	Number	Consumption (MTPD)	Estimated Emissions, MT/day					Consumption (SCMD)	Estimated Emissions, MT/day				
				SPM	SO_2	NO_x	CO	HC		SPM	SO_2	NO_x	CO	HC
Agra	Foundry	131	1,048	273.0	9.9	7.9	1.05	0.52	3,45,930	27.72	0.003	0.67	0.09	0.02
	Pit Furnaces	34	34	8.8	0.3	0.25	0.03	0.02	11,223	0.9	-	0.31	-	-
	Rubber Sole	30	6	1.6	0.06	0.05	-	-	1,980	0.162	-	-	-	-
	Chemical	34	52	13.5	0.5	0.39	0.05	0.03	17,165	1.37	0.0002	0.04	-	-
	Refractory Brick	16	32	8.3	0.3	0.24	0.03	0.02	10,562	0.85	-	0.02	-	-
	Engineering	20	17	4.4	0.2	0.13	0.02	0.01	5,612	0.45	-	-	-	-
	Lime Processing	18	58	15.1	0.5	0.44	0.06	0.03	19,145	1.53	0.0002	0 04	-	-
Firozabad	Glass	267	1,284	333.8	12.2	9.63	1.28	0.6	4,23,833	33.84	0.0040	0.81	0.11	0.02
	Muffle Furnace	1,132	374	97.2	3.6	2.8	0.37	0.2	1,23,453	9.90	0.0013	0.23	0.04	-
	Pottery	33	215	55.9	2.1	1.61	0.21	0.1	70,970	5.67	0.0007	0.14	0.02	-
Mathura	Foundry	8	64	16.6	0.6	0.48	0.06	0.03	21,128	1.69	0.0002	0.04	-	-
	Total	1,723	3,184	828.2	30.26	23.92	3.16	1.56	10,51,001	84.08	0.0097	2.2	0.25	0.04

Contd...

Table 4 (A) (Continued)

Projected Emissions from Combustion of different Fuels in Agra-Mathura Region

Town/city	Industries		LPG						Propane					
	Type	Number	Consumption (MTPD)	Estimated Emissions MT/day					Consumption (MTPD)	Estimated Emissions MT/day				
				SPM	SO_2	NO_x	CO	HC		SPM	SO_2	NO_x	CO	HC
Agra	Foundry	131	414.4	43.5	-	290.1	38.3	7.45	460	61.3	-	414.0	55.2	11.0
	Pit Furnaces	34	13.4	1.4	-	9.4	1.25	0.24	14	1.9	-	12.6	1.7	0 33
	Rubber Sole	30	2.7	0.28	-	1.9	0.25	0.05	3	0.4	-	2.7	0.4	0.07
	Chemical	34	20.6	2.16	-	14.4	1.9	0.37	23	3.1	-	20.7	2.8	0.55
	Refractory Brick	16	12.7	1.34	-	8.9	1.2	0.23	14	1.9	-	12.6	1.7	0 33
	Engineering	20	6.7	0.7	-	4.7	0.6	0.12	7.4	1.0	-	6.7	0.9	0.18
	Lime Processing	18	22.9	2.4	-	16.0	2.2	0.41	25.4	3.4	-	22.9	3.0	0.6
Firozabad	Glass	267	507.7	53.3	-	355.4	46.9	9.1	564	75.2	-	507.6	67.7	13 5
	Muffle Furnace	1,132	147.9	15.5	-	103.5	13.7	2.7	164	21.9	-	147.6	19.7	3 9
	Pottery	33	85.0	8.9	-	59.5	7.9	1.5	94.4	10.6	-	85.0	11.3	2.3
Mathura	Foundry	8	25.3	2.66	-	17.7	2.3	0.5	28.1	3.8	-	25.3	3.4	0 67
	Total	1,723	1,259.3	132.14	-	881.5	116.5	22.67	1397.3	184.5		1257.7	167.8	33.43

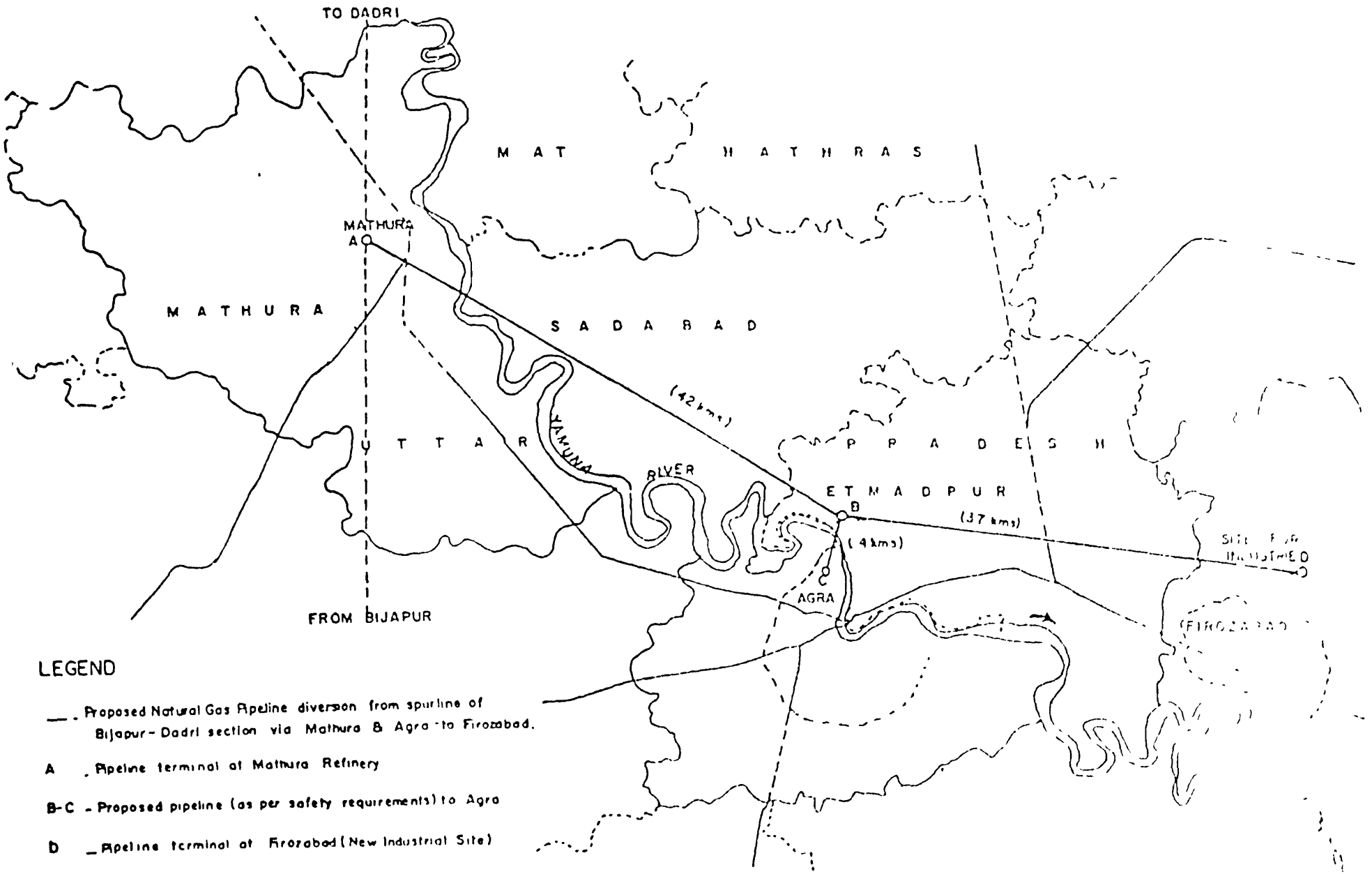


FIG 2 : TENTATIVE ROUTE PLAN FOR PROPOSED NATURAL GAS TRANSMISSION SYSTEM : NFRI

ANNEXURE V

No. Q-17012/21/93-CPW
Government of India
Ministry of Environment and Forests

Parvavaran Bhavan,
CGO Complex, Lodhi Road
New Delhi-110003.

Dated: 18.5.1994.

OFFICE MEMORANDUM

Subject: Writ Petition (C) No. 13381 of 1984- M.C. Mehta Vs. Union of India and others in the Supreme Court- Orders of the Hon'ble Court dated 29.4.1994- appointment of an Expert Committee-regarding.

*****

The Hon'ble Supreme Court of India in writ petition (C) NO.13381 of 1984- M.C. Mehta Vs. Union of India and others passed the following order on 29.4.1994:

"It is further clear from our order that the basis of the action initiated by this Court is the NEERI's report which was submitted to the Government of India in July, 1993. The said report was prepared under the guidance of Dr. P.Khanna and the Project leaders were Dr. A.L. Aggarwal and Dr.Mrs. Thakare. In addition, there was a team of 30 top Scientists participating in the Project. NEERI in its report has found as a fact that some of the industries located in the Taj Trapezium are the source of pollution causing damage to Taj Mahal.

We are of the view that it would be in the interest of justice to have another investigation/report from a reputed technical/Engineering authority. Ministry of Environment and Forests, Government of India may examine this aspect and appoint an expert authority (from India or abroad) to undertake the survey of the Taj Trapezium Environmental Area and make a report regarding the source of pollution in the Trapezium and the measures to be adopted to control the same. The authority can also identify the polluting industries in the Taj Trapezium. We, therefore, request Mr. Kamal Nath, Minister Incharge, Department of Environment and Forests, to personally look into this matter and identify the authority who is to be entrusted with this job. This must be done within three weeks from the receipt of this order. A responsible Officer of the Ministry shall file an affidavit in this Court within two week indicating the progress made by the Ministry in this respect. Registry to send copy of the above quoted order to the Secretary, Ministry of Environment and Forests and also to Mr. Kamal Nath, personally, within three days from today."

As per the orders of the Hon'ble Supreme Court, the Ministry of Environment & Forests is required to appoint an expert authority to undertake the survey of the Taj Trapezium environmental area and make a report regarding the source of pollution in the Trapezium and the measures to be adopted to control the same. The authority is also to identify the polluting industries in the Taj Trapezium.

The President is pleased to appoint an Expert Committee comprising of the following members to look into the matters mentioned above and submit a report to the Ministry of Environment & Forests within a period of six months from the issue of this order :-

1. Dr. S. Varadarajan — Chairman
   Former D.G., CSIR
   4-A, Girdhar Appts.,
   28, Ferozshah Road,
   New Delhi-110001.

   Director General, IMD. — Member
   Mausam Bhavan, New Delhi-3.

3. An Expert who has good experience in the maintenance of archaeological monuments (to be nominated) — --Member

4. An Expert who has experience in Environmental Engineering. (to be nominated) — --Member

5. Shri Kalyan Kumar Baksi, Additional Secretary, Ministry of Environment & Forests, New Delhi. — - Member

6. Dr. R.Anandakumar, Additional Director (Scientific) Ministry of Environment & Forests, New Delhi. — -- Member Secretary

The terms of reference for the Committee will be as follows:-

1. To undertake the survey of the Taj Trapezium environmental area and to make a report regarding the source of pollution in the Trapezium.

2. To identify the polluting industries in the Taj Trapezium.

3. To suggest long-term and short-term measures to be adopted to control such pollution which causes damage to the Taj Mahal.

The committee will guide the compilation, monitoring and an sis of the data, surveys and studies to be undertaken for the purpose of the objectives mentioned in the court order. The specific activities will be executed by M/s Engineers India Limited, who will, wherever necessary, take the assistance of specialised agencies or organisations working under the control of the Director General, CSIR, as per the requirements of such activities.

Since there were a number of studies before NEERI undertook the project referred to in the Supreme Court order of 29.4.1994 (supra), the Committee headed by Dr. S. Varadarajan will examine all the reports of the preceding Committees which looked into the impact of atmospheric pollution on the Taj Mahal and make a comprehensive report covering all relevant aspects, including those which may not have been considered in the earlier studies.

The Committee under the chairmanship of Dr. S. Varadarajan will also suggest an ongoing institutional mechanism to permanently monitor changes of pollutants in the Taj Trapezium atmosphere and advise on corrective action thereon. For the smooth functioning of the Committee's work, a financial grant of Rs.25.00 lakhs is hereby sanctioned. Since the work involved in all the operations as envisaged above is not immediately quantifiable, as and when the work progresses the Committee may make demands for further grant if it feels the necessity for additional resources.

The expenditure involved in the functioning of the Committee is debitable to Major Head "3435", Sub-Head, C.5(1)(2)-Assistance for abatement of pollution under Demand No.23 of the Ministry of Environment & Forests during the year 1994-95(Plan).

This issues after consultation with DG, CSIR and with the approval of Hon'ble Minister for Environment & Forests.

(T. GEORGE JOSEPH)
Joint Secretary to the Govt. of India.

1. Chairman and all Members of the expert Committee.
2. PS to MEF/PPS to Secretary(E&F).
3. Chairman, Central Pollution Control Board, Delhi.
4. Commissioner, Agra, Uttar Pradesh.
5. Secretary, Ministry of Petroleum & Natural Gas, Shastri Bhavan, New Delhi.
6. Director General, C.S.I.R., Rafi Marg, New Delhi.
7. M/s Engineers India Limited, Bhikhaji kama Place, New Delhi.
8. The Director General, Archological Survey of India, New Delhi.

No. [illegible]/93-CFW
Government of India
Ministry of Environment and Forests

Paryavaran Bhavan,
CGO Complex, Lodhi Road
New Delhi-110003.

Dated: June 8, 1994

ADDENDUM

Subject: Writ Petition (C) No. 13381 of 1984- M.C. Mehta Vs. Union of India and others in the Supreme Court- Orders of the Hon'ble Court dated 29.4.1994- appointment of an Expert Committee-regarding.

* * *

In continuation of this Ministry's Office Memorandum of even number dated 18.5.1994 constituting an Expert Committee under the chairmanship of Dr. S. Varadarajan, former DG, CSIR, in compliance of the orders of Hon'ble Supreme Court to that effect, the following persons are appointed as members of the Committee against the slots of the two experts mentioned in the earlier Office Memorandum:

1. Dr. Jagatpathi Joshi, Member
Retired Director General,
Archeological Survey of India,
134, Venus Apartments,
Inder Enclave, Rohtak Road,
DELHI-110041.
(Expert having experience in maintenance of archeological monuments)

2. Dr. B.B. Sundaresan, Member
Former Director, NEERI, and
Former V.C., University of Madras,
76, First Avenue,
Indira Nagar,
MADRAS - 600 020.
(Expert having experience in Environmental Engineering)

(T. GEORGE JOSEPH)
JOINT SECRETARY TO THE GOVT. OF INDIA

1. Chairman and all members of the Expert Committee.
2. PS to MEF/PPS to Secretary(E&F).

4. Chairman, Central Pollution Control Board, Delhi.

5. Commissioner, Agra, Uttar Pradesh.

6. Secretary, Ministry of Petroleum & Natural Gas, Shastri Bhavan, New Delhi.

7. Director General, C.S.I.R., Rafi Marg, New Delhi.

8. M/s Engineers India Limited, Bhikhaji Kama Place, New Delhi.

9. The Director General, Archeological Survey of India, New Delhi.

ANNEXURE VII

AIR POLLUTION BY INDUSTRIES IN TAJ TRAPEZIUM ZONE (TTZ)

STATUS * PROBLEMS * SOLUTIONS

Report of the Committee formed by U P Govt. vide order No 970/18-13-51/Bha/94 dated 30-5-94 under the Chairmanship of Commissioner Agra Division

PREAMBLE

Increasing ambient air pollutants in Taj Trapezium Zone endanger monuments in Agra specially Taj Mahal. The Supreme Court is hearing a writ petition against Govt. of India (GOI), U.P.Govt., Central Pollution Control Board (CPCB) and Mathura Refinery (MR) for protecting Taj Mahal from effects of "Air Pollution"

During the course of hearing a proposal for shifting small scale industries particulary foundries came before The Hon'ble Supreme Court for its consideration. This agitated the involved enterprenuers and workers who approached U.P.Govt.to make an indepth study of the problem as they felt that pollution from these small industry was minor and has very little effect on the total ambient air quality

U.P.Govt. vide its order No. 970/1B 13 51/Bha/94 dated 30 5 94 appointed a committee under chairmanship of the Commissioner of Agra Division and representatives of Dept.of Industries U.P UPPCB,PPDC,UPSIDC,UPFC ,local authorities, CII, PHDCCI IIA and local industries as its members

The first meeting of this committee was held on 27-6-94. based on the disussion of first meeting a draft report was prepared which was discussed in the next meeting held on 26-7-94.

This report is based on the views expressed by the committee members and various reports prepared earlier by different agencies on this subject particulary NEERI, university of Roorkee, CPCB, PPDC, and others

The industries in TTZ are located mainly in Agra or Firozabad cities. The meteorological conditions for 10 months in a year are such that smoke from Firozabad not likely travel towards Taj Mahal during 2 months of rainy season the wind is easterly but due to rains it is scrubbed and impact on Taj Mahal would be minimal. This report mainly relates to industries in Agra

TABLE OF CONTENTS

ABBREVIATIONS

AAQ	-	Ambient Air Quality
AAQM	-	Ambient Air Quality Monitoring
AEMP	-	Air Environment Management Plan
APCS	-	Air Pollution Control System
AQSP	-	Air Quality Surveillance Programme
ASI		Archeological Survey of India
CNG		Compressed Natural Gas
CPCB	-	Central Pollution Control Board
EG	-	Expert Group
GAIL	-	Gas Authority of India Ltd
GOI	-	Govt. of India
HPC	-	High Power Committee
LPG	-	Liquid Petroleum Gas
MEF	-	Ministry of Environment & Forests
MR	-	Mathura Refinery
mg	-	Milligram (1mg = 1000 ug)
NEERI	-	National Environment Engineering Research Institute
PPDC	-	Process and Product Development Centre,
SPM	-	Suspended Particulate Matter
TOR	-	Terms of reference
TTZ	-	Taj Trapezium Zone
ug		Micro gram
UPPCB		U.P Pollution Control Board
UPFC	-	U.P Financial Corporation
UPSIDC	-	U.P State Industrial Development Corporation

INTRODUCTION

Ever since Government of India(GOI) decided to setup a Petroleum Refinery at Mathura in 1973. questions regarding safety of Taj Mahal from pollution caused by Mathura Refinery (MR) agitated the minds of environmentalists/conservationists in the country.

Questions were raised in the parliament. To allay the fears GOI appointed an expert committee under chairmanship of Dr. S.Vardrajan in 1974. This committee concluded that there was no danger to Taj from proposed MR and recommended the following in 1978

1. Closure of Two thermal power plants in Agra.

2. Diesalisation of shunting yards to stop use of steam locomotives.

3. Shifting of foundries from Agra city to an area south east of Taj Mahal.

Work on MR was subsequently started and controversy about threat to Taj from MR surfaced again. A joint committee of parliament under chairmanship of Dr. Karan Singh considered the threat from MR for TAJ MAHAL as very real and suggested in 1979 that most polluting units of MR be shifted to Etawah region.

Subsequently GOI constituted a High Power Committee (HPC) and Expert Group (EG) to assist the HPC. The HPC and EG was to make a detailed and in depth study of the whole problem and make suitable recommendations. The chairman of CPCB was appointed chairman of the EG.

2. TAJ TRAPEZIUM ZONE

CPCB (report CUPS/7/1981-82) defined an area covering sensitive receptors i.e. Taj Mahal, Bird Sanctuary (Bahratpur) etc. and industrial activity area i.e. Mathura, Agra, Firozabad as a sensitive zone.The geographical limits were defined in the form of a regular trapezoidal shape as per figure I

The basis of delineation of this zone was the weighted mean wind speed in twelve directions from Agra to Mathura and Bharatpur The boundries of the zone were made keeping in mind the effect of any pollution source in this zone on critical receptor TAJ MAHAL..

This area was declared as "Air Pollution Protection Area". In this area new units of "High Polluting Nature" or expansion of existing units was not to be permitted.

In 1993 Ministry of Environment & Forest (MEF) recognising the need to preserve precious monuments like Taj Mahal from Air Pollution threat initiated another study by National Envirnomental Engineering Research Institute - Nagpur (NEERI) They have made an exhaustive report. The boundries of TTZ have been suggested for slight modification. But interestingly the TTZ has not been notified under any Environmental Act..

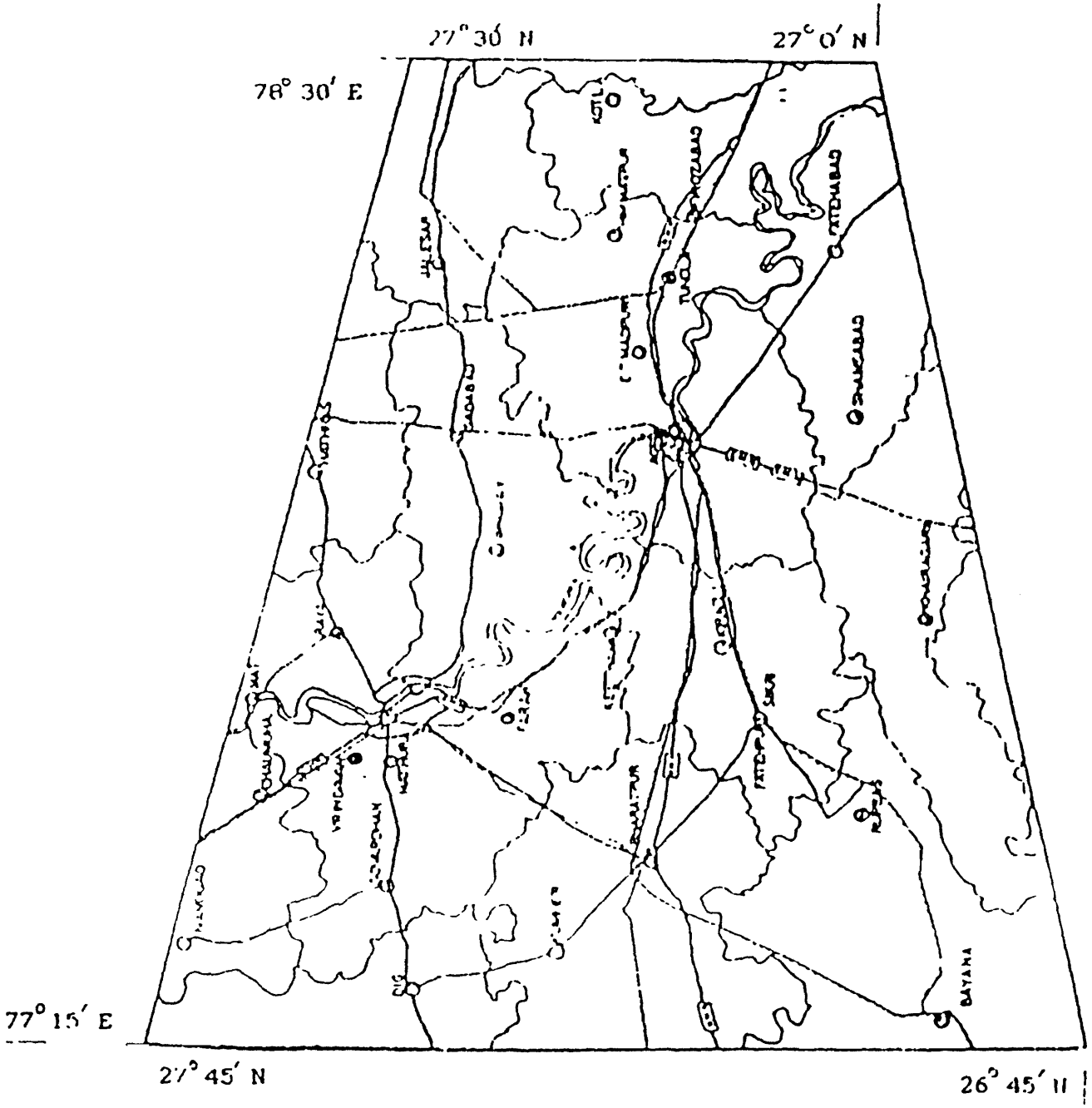


Fig 1 - TTZ BOUNDRIES
AAQM SAMPLING LOCATIONS

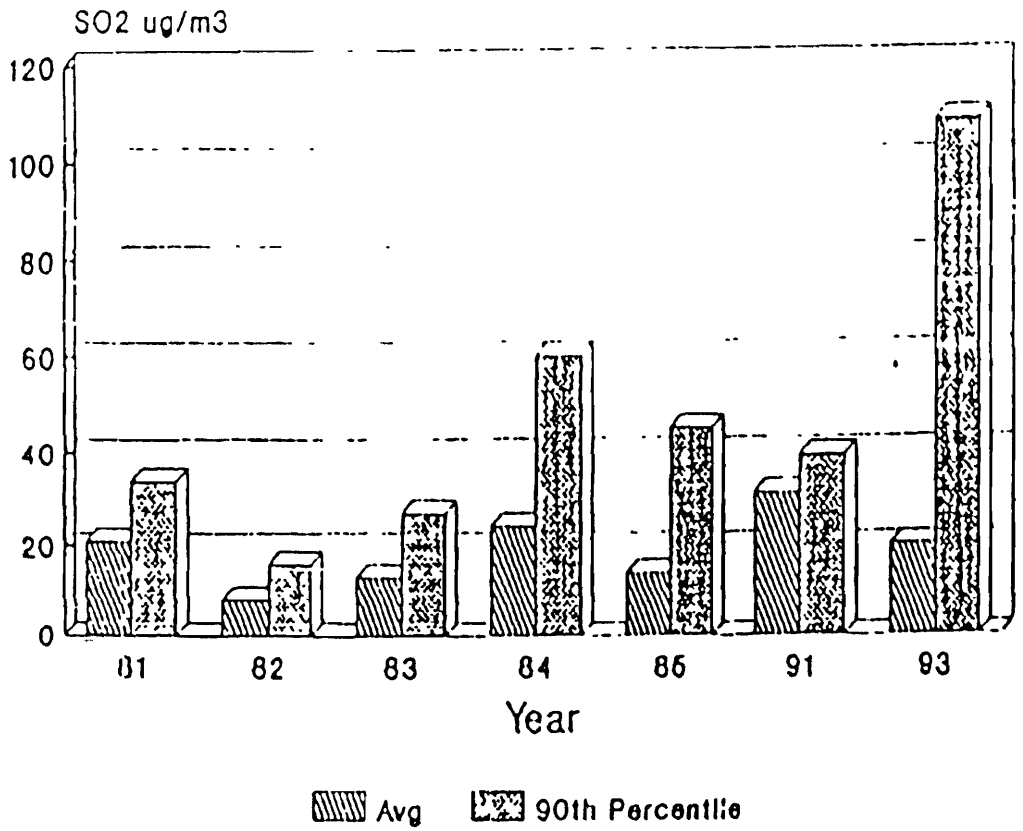


Fig. 3. SO2 TRENDS : TAJ MAHAL 1981-93

(Source - NEERI - July 93 report)

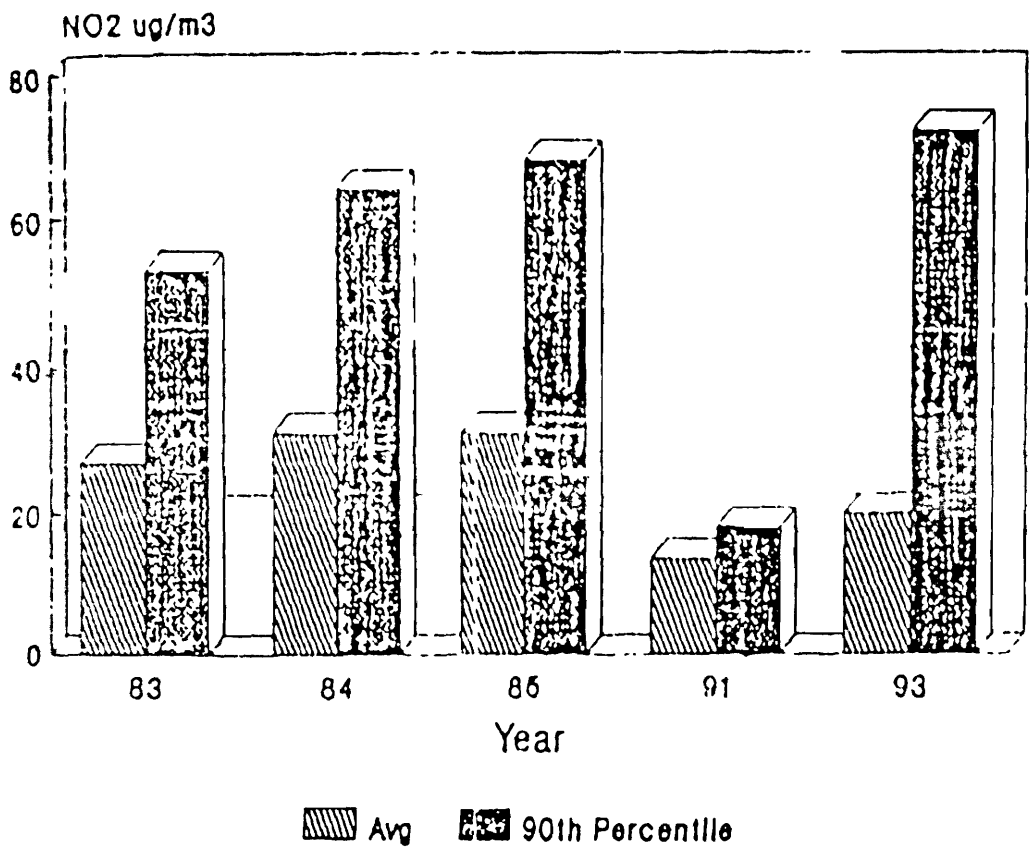


FIG. 4 - NO2 TRENDS : TAJ MAHAL 1981-93

(Source - NEERI - July 93 report)

Detailed studies relating to Air Quality Monitoring were undertaken by "University of Roorkee" who were commissioned for study by National Park Service, USA under a Indo-US Technical cooperation Programme during winter of 1990-91 which concludes as follows.

1. Data collected by them during short period agreed with data generated by NEERI and CPCB on annual basis.

2. SO2 values were within specified limits in most of the observations.

3. NOx levels were within CPCB limits during November but higher during Dec Jan 91 period (low temperature, over cast skies and calm air)

4. SPM values are higher than those specified by CPCB but in most observations these were below ISI specifications of 500 ug/m3. Agra is semi-arid and there is a very high background dust.

5. The ambient air quality (AAQ) of Agra could be categorised as fairly clean/moderately polluted.

6. For trace metals vehicular Traffic/transportation and to a very less extent industrial activities have been recognised as contributing sources.

7. The increase and decrease of SPM are directly related to vehicular movement during the afternoon and night period

4. CONSERVATION OF TAJ MAHAL

4.1 The study undertaken by university of Roorkee on "Building Materials" of Taj Mahal has the following conclusion (Page 17-18 Agra Heritage Project -Report - annexure - 1)

Based on the laboratory and site studies on "fresh" "contemporary" and "monument" materials obtained from the Taj Mahal complex and other contemporary structures, it may be concluded that the "useful" life of the brick lime mortar composite in the Taj Mahal which is shielded by cladding material i.e. marble or sand stone will be in excess of 910 years as predicted by the curves fitted through the laboratory data. This has been done by defining the useful life of the materials as the life at which the compressive strength of the materials is reduced to 50 % of the strength of the "fresh" materials. This estimate is based on the premise that the materials are constantly subjected to the maximum levels of pollution which may not actually happen, and that there is no protective marble cladding.

The laboratory studies also indicate that staining and pitting of the marble cladding surface may occur under the effects of NOx and chlorides in the environment. This would lead to a reduction in the lusture of the marble surface A physical examination of the present marble cladding in the

4.2 The ASI has to say following in an affidavit submitted to the Hon'ble Supreme Court

"Marble of Taj is not a pure variety of marble (statutory).... but a dolomite one containing carbonates of calcium and magnesium as well as silica (less amount) while iron, arsenic, tellurium, etc. in traces as revealed through auto-scan. Chemical analysis of many samples reveal the presence of calcium as oxide in the range of 47 - 56 % and magnesium oxides as 0.75 - 3.5 %. R203 (iron and aluminium oxides) - 0.6 to 5.4% . the pattern found in marble at Taj is a result of impurirty and other various natural processes taking place under the conditions of climate, mainly temperature and humidity The yellowishness of the marble is the cumulative effect of moisture deposition, aerosoles particularly in sulphate, particulate carbonacious matter and gaseous pollutants present in the ambient air. The coating they form in most of the cases in superficial in nature and is being removed by suitable physical and chemical methods from time to time.In general,this is the result of natural weathering and they do not form a penetrating type of magnificience form of sulphuric acid or any such deteriorating agents but is only on the surface . . . Cracks have nothing to do with air pollution and have been produced as a result of uneven stresses produced on the surface .... It is also surmised at the moment that once the cracks are produced, they may increase in width as a result of pollution crossing critical limits, which has not been noticed so far... cracks existed at the time of Emperor Shahjahan . .In the where more of water accumulated black deposits of microbiological growth has been noticed but poses no problem Archaeological Surey of India established its anti-air pollution laboratory to study the impact of gaseous particulate cationic concentration on the marble and sand stone. It is proceeded with the identification of sources of irritants and in order to have a comprehensive picture, did the analysis, SEM examination, BSEI-examination in order to understand if there are mineral alterations to sulphates At a few places SO4 was detected but then to pin point the sources was difficult and that the deterioration is done due to natural weathering more than chemical one. The clear picture that emerges is that the monument is quite well preserved and the measures adopted are satisfactory.

4.3 The NEERI report of July 1993 gives a general description of danger to marble, sand stone of Taj mostly citing literature and does not throw light on specific pollutant and its effect on Taj Mahal The report mentions about damage from SPM and SO2 in vague terms only

The study undertaken by Roorkee University did carry out laboratory tests on "fresh", "contemprary" and "monument" Building Materials and concludes as follows:-

(a). Even under impact of maximum pollution level the useful life of brick lime mortar will be in excess of 930 yrs

(b). Laboratories study indicate that staining and pitting of marble may occur under the effects of NOx and chlorides in the environments.

This study does not mention any damage from SPM or SO2 to Taj Mahal

4.4 The US National Park Service has following to report

Damage to three World Heritage Sites and other adverse effects of this kind of air pollution depends primarily on the chemical composition of the particles and their size. chemically reactive particles e.g.NH4,SO4, are generally of greater concern than neutral particles (e.g. silica,dust). While all particles contribute to soiling and stone discoloration, neutral particles are relatively simply cleaned, but removal of reacted particles entails some damage to the stone substrate. Fine particles are more mobile and travel longer distances than large particles before deposition. Fine particles are more of a health hazard because they are easier to inhale than large particles. Unfortunately, size-selected particle chemistry data are not readily available for the Agra region.

Perhaps of greatest concern are the unmeasured pollutants, i.e. hydrocarbons and other effluents from combustion of alternative biogenic fuels, i e. dung, tires and other refuse The suite of standard air quality measurements does not capture the early morning aroma and haze, which derive from residential areas. As the sensitive heritage resources are surrounded by densely populated areas such as the Taj Ganj, the possible impact of these emmissions should not be ignored. An assay of the chemical composition of these emmissions over several seasons or years would be very helpful to assay the risk potential.

4 5 "Taj Mahal" so far is well preserved but a detailed scientific study by renowed experts is called for to evaluate long term effect of various pollutants in the air so that suitable steps may be taken to mitigate those effects and Taj is very well preserved for several thousand years.

5. POLLUTION FROM INDUSTRIES

In 1981 Govt. took following steps:

1. Closed two Thermal Power Plants at Agra.
2. Diesalised shunting yards at Agra and stopped use of steam locomotives.
3. Declared TTZ as sensitive area and banned any New or Expansion of any fossil fuel using industry.

Level of SO2 in ambient air at Taj Mahal came down dramatically from 23 to 5.6.(ug/M3) THERE HAS BEEN NO REPORT OF INCREASE IN USE OF FUEL BY INDUSTRY SINCE 1981 BUT SO2 LEVEL IN 1993 HAS GONE ABOVE 30 WHICH MAKES IT VERY CLEAR THAT THERE HAS BEEN A LARGE INCREASE IN POLLUTION FROM OTHER SOURCES, PERHAPS EVEN MR.

The study/reports made by Vardrajan/Dr.Karan Singh/High Powered committees and CPCB did not make a detailed emmission inventory of different polluting sources. The NEERI study of 1993 did make a detailed inventory of pollution from all Point, Line, Area sources and Mathura Refinery

However it appears that NEERI did not interact with the industries in TTZ and prepared the emmission inventory from hypothetical data which is 3-6 times the actual consumption of hard coke and steam coal specially in Agra.NEERI even prepared a scenario where all the foundries are supposed to work at the same time at full capacity in this case the consumption of fuel shown is almost 14 times of actual figure

The position of Firozabad industries is also similar As regards Mathura Refinery the NEERI report of 1993 says that it emitts 501 Kg/hr SO2 (Page iv-10) where as their report of Feb 94 say 705 kg/hr(16.92 MT SO2 per day - Table 4B page 14). It is very surprising that in Table 4.9 page iv-30 (NEERI report 1993) fuel consumption from 2353 industries is given but for Mathura Refinery it says NA (annexure-2). details of how they arrived at the figure of 501 kg/hr or 705 kg/hr are not given in the report.

6. STACK EMMISSION STANDARDS

A comparision of standards for SPM applicable to industries in Agra (TTZ) and outside this zone is given below:

		SPM		Chimney/Stack Height
		TTZ	OUTSIDE TTZ	Same all over U.P
1. Foundry	- Cupola - below 3 MT/hr melting rate	450 mg/NM3	Same	
	Cupola - 3MT or above melting rate	150 mg/NM3	Same	
	Induction Furnace	150 mg/NM3	Same	
2. Small Boiler	(a) COAL FIRED Less than 2 MT/hr Steam.Less than 8.5 MT/day Coal	500 mg/NM3	1600mg/NM3	9m
	(b) OIL FIRED	-	-	9 m
3. Lime Kiln	upto 5 Ton/day	-		30 m
	5-10 Ton/day	500 mg/NM3	Same	30 m
4. Engineering unit Where D.G.sets are used	Capacity of D.G.Sets			Height of Building
	0-50 KVA			+ 1.5m
	50-100 KVA			+ 2.0m
	100-150 KVA			+ 2.5m
	150-200 KVA			+ 3.0m
	200-300 KVA			+ 3.5m

A comparison of standards for SPM for cupola of some countries is given below

Australia	-	250 mg/NM3	All Sizes
Italy	-	250 mg/NM3	Melting rate upto 4 Ton/hr
Japan	-	200-400 mg/NM3	All Sizes
GDR	-	1000 mg/NM3 400 mg/NM3	Industrial Area Residental Low population
Yugoslavia	-	800-600 mg/NM3 600-400 mg/NM3 500-150 mg/NM3	upto 20000 NM3/hr Exhaust Gas 20000-60000NM3/hr " Over 60000 NM3/hr "
Great Britain	-	9.0 Kg/hr 7.1-9.8 Kg/hr	Melting rate upto 3 Ton/hr " 3-10 Ton/hr
India		450 mg/NM3 150 mg/NM3	Melting rate below 3 Ton/hr " 3 Ton or more

From perusal of the above it will be noticed that even a highly developed and industrialised country like Japan permits SPM level of 400.GDR is permitting 1000 in industrial areas and a country like Yugoslavia has a relaxed limit of upto 800.

The level of 450 itself is quite stringent for India and dropping it to a level of 150 as soon as melting rate reaches 3 Ton/hr can not have any scientific or justifiable reason. A level of 450 for cupolas of upto 5 Ton/hr capicity appears more reasonable

The case of "Rubber" units in Agra is very typical most of these units have "Baby Boilers". these are so small that they do not fall under the perview of "Boiler Act" even on these boilers the UPPCB has applied standards of Boilers using 8500Kg coal per day. How can a boiler using about 200 Kg coal per day be clubbed together with boiler of 8500Kg capacity The standards prescribed for SPM were 1600 mg/Nm3 as per norms of CPCB but these have been dropped to 500mg/NM3 after Supreme Court closed 212 units in TTZ. The norms prescribed should be applied to boilers falling under perview of "Boiler Act" only. small boilers may continue to have the old norms.

7 NEERI REPORTS: (July 1993 and Feb. 94)

7.1 The objective of the NEERI'S July 1993 report was-:

1. Redefining the Taj Trapezium.

2. Delineating an Air Environment Management Plan(AEMP)

This is a lengthy report of some 310 pages. The trapezium has been redifined but the changes are marginal. As far as AEMP is concerned it has reiterated the fundamentals of any air quality management plan. These are

1. Mitigation at source through technology upgradation.

2. Pollution attenuation through Green Belts.

Following basic issues which should have been tackled by NEERI remain unanswered.

1. Are the Taj and other monuments in the area being damaged at a rate faster than those in non-polluted areas?

   The NEERI report does not address this issue. The Archeological Survey of India thinks not.

2. If the Taj is really in danger, what are the specific pollutants responsible?

   The NEERI report provides a general description, mostly citing literature.

3. Once the specific pollutants are identified, which specific sources are contributing and in what proporation?

   NEERI has not made any attempt in this direction and has not recommended the most cost-effective solution to reduce ambient air pollutants concentration within acceptable limits.

On the other hand some vital inacuracies have crept in like highly inflated coal/ coke consumption figures particulary in the case of Agra

7.2 NEERI'S February 1994 report:-

This report is submitted by NEERI to Supreme Court in response to their directive of 15th Feb. 94 and in this report it has given highly inflated figures of coke/coal consumption(10-12 times - annexure-3) and recommended shifting of small industry from TTZ (annexure - 4).

However Hon'ble Supreme Court has disregarded these reports and directed that another study be undertaken to study pollution in TTZ.

8. WRIT PETITION IN SUPREME COURT.

In 1984 Mr.M.C Mehta filed a writ petition before Supreme Court against GOI,MR , U.P Govt. and other govt. agencies,departments with a prayer that they be directed to take suitable measures including shifting of MR to save TAJ from threat of air pollution caused by MR hearing started in 1993.

The Supreme Court directed UPPCB to file status of pollution in TTZ. UPPCB asked 511 units in TTZ thru Newspaper advertisement to submit their fuel consumption etc.A total of 212 units did not reply, the Hon'ble Supreme Court ordered closure of these units. As of now only 30 units in Agra & 67 units in Firozabad remain closed others have installed APCS and Hon'ble Supreme Court has ordered their reopening

The Hon'ble Supreme Court on 15-2-94 directed NEERI(National Environmental Engineering Research Institute - Nagpur) to examine use of SAFE FUELS like propane etc.as alternative to currently used fuels (Coke,Coal etc.) by foundries and other industries in TTZ.The report by NEERI to Supreme Court was devastating as it went beyond what Hon'ble Supreme Court had asked and concluded shifting of small scale industries from TTZ. The conclusions drawn were seemingly based on wrong and inflated data relating to use of COKE/COAL specially in Agra as given below

CITY	NO OF INDUSTRIES		COKE/COAL USED-PER DAY		
	As per NEERI	As per DIC	As per NEERI report of Feb.94	ACTUAL reported by	
				DIC	UNITS
Agra	292	305	1247 MT	129MT	92 MT
Firozabad	1432	1787	1873 MT	700MT	N A

The Hon'ble Supreme Court guided by this report asked industries in Agra to give information relating to shifting vide their order of 11-4-94.

Sensing that such step would kill the small industries and will play havoc with the life of 305 enterprenuers,57800 workers and their families peacefull demonstrations were held at TAJ on 27 & 28 April by enterprenuers and workers respectively Thoughtfully Hon'ble Supreme Court took cognizance thru "Newn Paper" reports and directed GOI - ministry of environment to undertake a new study on "Air Pollution" in TTZ by any agency from India/Aborad.

Page 15

Excerpt from Hon'ble Supreme Court's order is given below

"We are of the view that it would be in the interst of justice to have another investgation/report from a reputed technical/ Engineering authority. Ministry of of Environment and Forests, Government of India may examine this aspect and appoint an expert authority (From India or abroad) to undertake the survey of the Taj Trapezium Environmental Area and make a report regarding the source of pollution in the Trapezium and the measures to be adopted to control the same."

GOI (MEF) has appointed a committee under Dr. S.Vardrajan (who had also chaired another study in 1974) which is to give its report in 6 months.

The Hon'ble Supreme Court during hearing of the petition has mentioned that the basis of their order of April 8,1994 was NEERI'S report. The Hon'ble Supreme Court mentioned in their above order as follows.

"NEERI'S reports indicates that the maximum pollution to ambient air around Taj Mahal is caused by the industries located in Agra'

9. DR. S.VARDRA.'AN COMMITTEE

The terms of reference (TOR) of this committee appointed by GOI vide notification of May 18, 1994 are given below.

1. To undertake survey of Taj Trapezium and source of pollution.

2. Identify polluting industries.

3. Suggest measures to control pollution which causes danger to Taj.

4. Specific activities of monitoring, analysis & data, etc by Engineers India Ltd. who will take assistance of specialised agencies of CSIR

5. The committee will examine all reports of preceding committees.

   Will also suggest an ongoing institutional mechanism to permanantly monitor changes of pollutants in the Taj Trapezium and advice on corrective action.

The recommendation of this committee is going to be crucial not only for existing industries of this area but also future development. U.P Govt should approach GOI for inclusion in this committee scientists with experience and impeccable credentials as its members. Industries and local authorities of TTZ must also have their representation on the committee

10 OTHER AIR POLLUTING SOURCES

a. BRICK KLINS

There are more than 600 brick kilns (613 as per NEERI) in TTZ out of which about 350 are in Agra district Each kiln uses about 500 MT of coal in one season (year) which lasts 5 months (Nov.- March). The total coal consumption is 3,00,000 MT over a period of 150 days i.e. 2000 MT/day

Firing in the kilns is carried out during winter season which is the worst period of the year from air pollution angle as the smoke does not go up in the atmosphere but tends to settle near the ground level.

A detailed study can throw more light on the impact of the pollution from brick kilns on sensitive receptors specially Taj Mahal.

b. VECHICULAR TRAFFIC

There are about 20,000 heavy vehicles and another 10,000 -15,000 LCV's & Motor Cars plying every day in the city mainly on the National Highway portions. Beside the four wheelers there are about 50,000- 60,000 two and three wheelers like Motor Cycles, Scooters, Mopeds, Auto Rickshaws, Tempos,etc, which contribute heavily to the pollution in Agra

The heavy duty diesal powered vechicles contribute more of NOx and SPM while two stroke vechicles (Two & Three Wheelers) contribute more of CO and HC.

The air pollutant concentration in the atmosphere is not only a simple function of the emmissions, but it depends on the height of emmissions,meteorology, topography and several other factors The impact of vechicular pollutants is comparatively more due to the fact that these are ground level emmissions.

c. DOMESTIC FUEL

Due to poor economic condition of a large portion of population in Agra specially in bastis jhuggi jhopries and the fact that there is a 10 year waiting list for LPG connection ,a large number of house holds are forced to use wood, cowdung, soft coke and other solid fuels which cause lot of smoke in the urban areas. The domestic smoke emanating from Taj Ganj basti has immediate impact on Taj Mahal as this basti is located just next to the southern gate of Taj Mahal

The Ministry of Petroleum (GOI) should take special measures to liquidate waiting list and ensure LPG connection on DEMAND

The weaker section of society in the urban areas be given monetary grant to buy LPG chullahs and cylinders.

d. SMOKE FROM COMMERICAL ACTIVITY

Agra is famous for its petha and there are more than 250 manufacturers of this delicious sweet, besides there are more than 2000 halwais ,500 kumhars and bharbujas who all use solid fuels because these are cheaper than cleaner fuel like LPG.

Use of LPG should be made compulsory for all commerical activity and to encourage people it should be supplied at domestic (LPG) price.

Kumhars have to use cowdung because of the technique of firing, they should be encouraged to carry out their activity outside the city limit.

e. DIESEL GENERATING SETS

The electricity supply in Agra city is very poor and erratic with the result that about 20,000 D.G.Sets operate each day particualrly in the evening hours when meteorological conditions are most conducive for smoke to remain near ground level.

Some of the hotels use generators of 1000-1500 KW capicity and all these hotels are located within 1-2 Kms of Taj Mahal with the result that its impact is high.

THERE IS A VERY URGENT NEED TO ENSURE UNINTERRUPTED ELECTRIC SUPPLY TO AGRA.

f. DIESEL ENGINE PUMP SETS

Most of the pump sets used in the rural areas are powered by diesel engines as electric supply is either not available,erratic or unreliable. The number of such pump sets in TTZ would be more than 50,000. These pump sets should be converted to electricty to avoid use of diesel.

g. CITY GARBAGE (SOLID WASTE)

The solid waste generated in the city which at present is piled on and along the main roads and is thrown into air when speeding vehicles pass over it can be utilised to produce electricty if it is properly collected and suitably disposed off in a sanitary landfill (12-30 meters deep). Very suitable sites are located near Jharna Nala on Agra-Kanpur road.

This will greatly reduce high level of SPM along the roads.

h. SAND from dry Jamuna River bed and smoke from samshan ghat located adjacent to Taj Mahal also contribute to air pollution.

11 PROBLEMS OF INDUSTRY IN ACHIEVING POLLUTION STANDARDS

The details of various industries in TTZ and air pollution control systems installed by them in Agra and Firozabad are given below:-

UNITS REGESTERED WITH INDUSTRIES DEPT.

A. AGRA

(i) No. of units- 305 (Foundries -167, Chemical, Plastic, Rubber Tannery, Engineering and others -138)

(ii) Coal Consumption - 28500 tpa Hard Coke (mainly Foundries) 21600 tpa Steam Coal

B. FIROZABAD

(i) No. of units - 393 (Glass-334, Ceramic-31, Chemical-28)

(ii) Coal Consumption - About 210000 tpa mainly Steam Coal (annual capacity 700000 MT)

(iii) Unorganised sector units - 1394 (mainly pakai bhatta of Glass)

APCS INSTALLATION STATUS

S.NO.	DETAILS	AGRA	FIROZABAD
1	No. of Industries (As per records of UPPCB)	293	217
2	No of whom closure ordered issued by Supreme Court	88	152
3	No. which are open	205	62
4	No of units where APCS installed	260	146
5	No. where monitring completed and standards achieved	186	107
6	No. where APCS installed but standards not achieved	4	3
7	No. where monitring is to be done	4	21
8	No. of units closed and no progress in APCS installation	30	67

The industry in ITC is mostly in small and tiny sector who have very limited technical and financial resources.

The technology of pollution control is new for India and foolproof solutions are not readily available. The problems of various groups of industries is as follows:

FOUNDRY - CUPOLA FURNACE

In Agra, units which have not been able to achieve standards are mostly CUPOLA foundries. NEERI wanted Rs. 25 lacs and a period of 6 months to provide a design of pollution control equipment Such financial resource was out of reach of Agra foundries.

UPPCB lacks experience and expertise to guide these small units to install and achieve pollution norms. Most of the units who are unable to achieve standards have installed APCS as per designs given by consultants on the panel of UPPCB.

These units now require Technical as well as Financial aid to improve/change their APCS/Cupolas. UPPCB and UPFC should come forward to help and state Govt should give atleast 50% subsidy to these units or provide for soft loan at about 6% rate of interst.

From the experience gained in the last 6 months during which extensive work has been done by Agra foundries to improve thermal efficiency of their CUPOLAS and to control the SPM in flue gases the following has come out very clearly

1. It is possible to reduce consumption of coke atleast by 30 %. some units have reported even better results

2. Achieving SPM standards of 150 in flue gas involves installation of very costly equippment which makes the unit economically unviable even if the funds are made available

3. It is much better to change to a divided blast CUPOLA with I.D of about 33"-36" or below so that thermal efficiency is increased. COKE consumption is reduced and higher molten metal temparature is achieved which helps in reduction of floor rejection.

The following steps are suggested:-

a. PPDC should immediatly install a pilot plant and all the foundries in Agra be given incentives to change to this system. This step alone will reduce Hard Coke consumption by atleast 8000-10000 Tons/year which in turn means reduction of pollution level in Agra.

b. U.P. Hard Coke should be made freely available in Agra

c. Foundries who wish to convert to Electric Furnace should be provided all financial assistance. Electricty at subsidised rates may be given to make them economically viable.

GLASS INDUSTRIES

Following improvements are suggested for Firozabad Glass Industries:

(i) Installation of cyclone or multiclone on basis of capicity and process of industry

(ii) Installation of chemical scrubber on the basis of capicity and process of the industry

LIME KILNS

(i) Installation of continuous system instead of batch system

(ii) Installation of mechanical separators, cyclones and wet scrubbers

It is therefore recommended that Glass technology institute may take number of pilot projects/consultancy on above lines. However the entire scenario would undergo a major change if gas could become available through gas pipe line from Auraiya. The furnaces could then change to gas fired and pollution would disappear to a large extent.

12. ACTION PLAN FOR COMBATING POLLUTION AROUND TAJ MAHAL

There is almost unanimity in recommendations of different agencies like CPCB, Roorkee University, Committees appointed by GOI, U.S.National park Service and others as far as steps to combat pollution is concerned.

a. ELECTRICITY

The power Grid Corporation should take over the grid power transmission system and supply electricty directly to the substations of UPSEB in TTZ. The supply to TTZ should be independent of the grid for rest of U.P. and should be accorded highest priority by Power Grid Corporation in the event of any shortage in its system

Additional capacity of 150 MW should be created at Sikandara substation of UPSEB so that it is able to cater to full demand of Agra city. UPSEB should also upgrade and strengthen its distribution system in Agra so that power failures due to local faults is completely avoided. An amount of about 25-30 crores be allocated for this purpose.

Once uninterrupted electricity is ensured use of atleast 20,000 Gen. Sets which is one of the major source of pollution will stop and result in reduction of avoidable pollution.

b. FUEL FOR VEHICLES - LPG & CNG (COMPRESSED NATURAL GAS)

Vehicular traffic is one of the major source of air pollution in Agra. all possible steps should be taken to reduce it

The pollution can be greatly reduced if cleaner fuel like LPG or CNG are used by vehicles specially public transport. In Delhi a large number of local buses are running on CNG, in Sydney - Australia all taxis are run on LPG and all new local buses are allowed only if they run on CNG

In Agra buses and three wheelers are the main public transport vehicles. arrangement for conversion to CNG by buses and LPG by three wheelers should be made on urgent basis Ministry of Petroleum (GOI) should take the lead in this matter

Individual vehicle owners should also encourged to be change to LPG by providing adequate supply of LPG for this purpose.

c. LPG - DOMESTIC GAS CONNECTIONS

There is a 10 year waiting list for LPG connections in Agra this should be liquidated immediately and connection should be made available on DEMAND.

d. ELECTRICITY FOR FOUNDRIES

Electricity connection should be given on immediate basis to those foundries who wish to install electric melting system.

e. GAS PIPE LINE

UPSIDC has carried out a demand survey cum feasibility study for natural gas distribution system at Agra - Firozabad Shikohabad.

Danish International Development Agency (DANIDA) had offered grant of Rs. 5.9 Crores for this purpose. This proposal of UPSIDC is pending with GOI/GAIL. UP Govt. may persue this proposal vigorously with Govt. of India.

f. BYE PASS & RING ROAD

For any plan to reduce pollution levels near Taj Mahal it is essential that vehicular traffic on National Highways should pass Agra at maximum possible distance from Taj.

A Bye Pass and Ring Road should be constructed at earliest so that thru traffic on NH2,NH3, & NH11 does not enter Agra city. The benefit will be doubletold as it will reduce congestion on city roads facilitating faster movement of city traffic thus reducing total fuel consumption.

g. TRAFFIC WITHIN AGRA CITY

1. Checking of vehicles for pollution must be much more stringent. Accredited work shops with modern equipment not only for checking of pollution but for setting it right (tuning etc) should be spread all over the city so that all vehicle owner's can get their vehicles tested with ease

   The test certificate should be prominently displayed on vehicles including 2 & 3 wheelers and severe penalty be imposed on defaulting vehicles.

2. Pollution by vehicles is dependent not only on the condition of vehicle but the speed at which city traffic moves, slow traffic means more idling time i.e. more smoke, to avoid this following steps should be taken by Nagar Mahpalika, PWD, ADA and other agencies.

i. All roads be broadened and any hinderance to free flow of traffic removed.

ii. All crossings should be enlarged.

iii. Flyovers should be constructed on busy intersection. Such a flyover has been planned for Bhagwan Talkies crossing on NH2.

Similar flyovers should be made on either side of Jawahar Bridge, construction of these flyovers would be easier because of the higher elevation of the bridge and cost of these flyovers would be much lower.

iv. There are service roads on either side of bye pass road between Bhagwan Talkies and Water Works crossings but these are not in use because of encrochments and disrepair

These roads should be cleared and repaired so that slower and local traffic can use these roads. Traffic Police should also enforce use of these service roads by cycles, rickshaws, bullack carts and other slow moving traffic so that the main road is used by thru and fast traffic.

v. More people will use bicycle for personal transport if safe and exclusive pathways are provided as is being done in European cities, Copenhagen in Denmark is a good example where thousands of people use cycles inspite of their effluence

However such pathways should be constructed immediately along all the national and state highways leading to the city where thousnads of people come to work in the city in the morning and go back in the evening from nearby villages, during this period the whole highway is occupied by these cyclists which not only hinders fast traffic but is also an accident hazard for these poor people

vi Only non polluting vehicles like cycles,rickshaws, animal drawn vehicles and CNG/Battery operated vehicles be permitted to ply in a 1 5/2 Km zone around Taj Mahal so that vehicular pollution is avoided in such close proximity of Taj

3. Recommendations made by Roorkee university on this subject in their study should be implemented.

h. BARRAGE & WIER

For any pollution control plan to be effective greening of atleast an area of 20 Km around Taj Mahal is a must. Requirement of water is a prerequisite for such a plan. Construction of a Barrage upstream and Wier down stream is essential for the following reasons

1. Supply of water for people in the city, its neighbouring areas and horticulture activities.
2. Improvement in water table of Agra.
3. Elimination of dry Jamuna bed to avoid dust storms next to Taj Mahal during summers.
4. Much more appealing view for visitors to Taj.

i. GREEN BELT

Massive plantation in an area of about 20 Kms of Taj Mahal will change the scene completely as such parks,city forests,orchards are essential in this zone.

Village folk should be vigourously encouraged to change to orchards from farming.

This step alone will have far reaching beneficial effect on the environment and climate of Agra.

j. LOCAL RAILWAY TRANSPORT

It is a boon to the city of Agra that an extensive railway track exists within the city from the time of the BRITISHERS. these tracks have now been electrified.

A local railway system can operate in a circular loop connecting Agra Cantt.,Idgah,Agra Fort,Jamuna Bridge,Agra City, Raja Ki Mandi,& Agra Cantt stations which can greatly reduce traffic on the roads

Local train service at quick intervals can run between Tundla and Runkuta/Kitham in East West direction and Raja Ki Mandi to Bhandai in North South direction. This will not only reduce traffic on NH2 and NH3 but will facilitate movement of people from villages to the city

A local train service from Agra Fort to Fatehpur Sikri is also essential as this will make the journey of the tourists from Agra to fatehpur Sikri much more comfortable. The time on the train can also be used for service of lunch and tea etc. this will give the tourists more time to enjoy the monuments.

Roorkee university has also made a proposal in their study on this subject

13. CONCLUSIONS SUMMARY & RECOMMENDATIONS

1 The increase in pollution level at Taj from 1981 to 1993 is not prima facie due to industries because there has been a ban for any new or expansion of fossil fuel using industry in TTZ since 1981

The impact predictions as generated by NEERI and after applying correction for fuel usage also confirm this view.

2. The impact of pollution from industries in TTZ except Mathura Refinery is minimal on Taj Mahal

A scientific and detailed study by a very reputed institution should be carried out to find out the pollutant/pollutants from which Taj Mahal is really threatened

A detailed emmission inventory of all sources in TTZ and their impact on Taj Mahal should be established.

For any Air Environment Management Plan (AEMP) to be realistic above studies are crucial therefore U.P.Govt. should commission such a study by University of Roorkee or I.I.T.

3. UPPCB need not follow CPCB blindly while fixing emmission standards and should revise the permissible level of SPM in view of high back ground dust in this area as follows:

Cupolas upto 5 Ton/hr capicity - 450 mg/NM3
Small Boilers -1600 mg/NM3

The standard for down draft Kiln (600 mg/NM3) should also be revised

4. Most industries in TTZ have installed APCS and a majority is able to achieve standards.

The units which have not achieved the norms are all SSI units and do not have adequate technical and financial resources UPPCB should give the technical assistance and a grant of 50 % or soft loan at 6% interest be given to these units so that proper APCS are installed by these units

SHIFTING of units is not required as it will render all these units financially unviable. If closed it will render a very large number of people unemployed. This step is not desirable.

Impact of pollution from industries other than MR on Taj Mahal is insignificant as such threat if any to Taj will remain even after SHIFTING of industries

5 The pollution from industry can be controlled by following steps

(a) Better design of equipment such as divided blast cupola
(b) Better process control such as metal fuel ratio, use of soda ash etc.
(c) Installation of proper APCS.
(d) Use of better and cleaner fuels like natural and petroleum gas from Auraiya through pipeline

6. There is need to constantly improve technology/ systems for most efficient working of industry which results in reduction of pollution PPDC at Agra and Glass Technology Institute at Firozabad should be upgraded to international level so that they prove equal to this challenge

7. Use of Generators should be permitted in existing and new non polluting industrial units with immediate effect.

8. There has been a great set back to the development of industries in TTZ because of informal ban on any fossil fuel using industry right from 1974.

   After imposition of formal ban from 1981 there has been very little growth of industries which has not kept pace with population increase. The industries in this area are lagging much behind industries in Faridabad, Delhi, Noida & Ghaziabad and the economy of whole area is stunted.

   The existing industry is also unable to modernise in view of the uncertain situation, it is high time that the stranglehold on industry is removed and any industries other than "Major Pollution" industry be permitted with due APCS installed in TTZ so that people of TTZ also enjoy the benefits of economic prosperity and are not deprived of the oppurtunities available elsewhere in the country

9. The area of trapezium need be reduced in view of the evidence and scientific data available If a large unit like MR can function at a distance of about 45 Kms from Taj Mahal, there is no logic in preventing even pollution free industries from setting up or expanding at a distance beyond 45 Kms from Taj Mahal

10. Action Plan for control of pollution as given in S No 12. Page-20 should be initiated at the earliest

11. TTZ area has been in the past very rich in handicrafts but they have languished during recent times Intensive handicraft development and training in stone inlay, Zari, durry and carpet weaving, ornate metal work, glass toys, luminaires and leather goods etc should be taken up to provide large scale employment in absence of development of organised industries.

12. The recommendations of the Dr Vardrajan Committee appointed by GOI is going to be very crucial not only for the existing industries but future growth of the industries in the entire TTZ as such it is important that -

   (a) There should be a representative of U P Govt on this Committee preferably Commissioner of Agra

   (b) There should also be a representative of the industries from Agra

If for some reason it is not possible to have representatives from U.P. then a panel of reputed scientists should present the case before "Vardrajan" Committee.

A list of scientists for the pannel is given below:

1. Dr. Jaweed Ashraf - J.N.U. - Delhi
2. Dr. D.N.Trikha - University of Roorkee
3. Dr. R.P.Mathur - University of Roorkee
4. Dr. M.K Khare - I.I.T. - Delhi
5. Dr. C.Venkovachari - I.I.T. - Kanpur

The city of Agra in TTZ has the distinction of having 3-world heritage sites including Taj Mahal with two others likely to come on the list soon. However it also has a population of about 15 lacs and was once the largest centre of small scale industry in U.P.

To conclude it is recommended that a holistic approach for the entire "Agra Mathura Heritage Area" should be taken so that Taj Mahal and other heritage sites are well preserved and economic growth/job oppurtunities which is possible only if industrialisation keeps pace with time and the people of this area are not left behind. That alone can prepare the basis for sustained development and environmental protection in this region.

31.8.94

(O.P.Srivastava)
Joint Director of Industries
Agra Division, Agra

31/8/94

(S C Tripathi)
Commissioner
Agra Division, Agra

Date : 31-08-94

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Annexure - 1

Photocopy of Page 17 & 18 of Report of Roorkee university executive summary - AGRA HERITAGE PROJECT

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18. The ultimate compressive strength, the modulus of elasticity and the poisson's ratio for "contemporary" brick-lime mortar composite were found to be 5.69 Mpa, 160.0 Gpa and 0.12 respectively. These values may be used to analyse the monument and the base walls and to determine the possible zones of distress induced under loads.

19. Based on the laboratory and site studies on " fresh", "contemporary" and " monument" materials obtained from the Taj Mahal complex and other contemporary structures, it may be concluded that the "useful life of the brick lime mortar composite in the Taj Mahal which is shielded by cladding material i.e. marble or sand stone will be in excess of 900 years as predicted by the curves fitted through the laboratory data. This has been done by defining the useful life of the materials as the life at which the compressive strength of the materials is reduced to 50% of the strength of the "fresh" materials. This estimate is based on the premise that the materials are constantly subjected to the maximum levels of pollution which may not actually happen, and that there is no protective marble cladding.

The laboratory studies also indicate that staining and pitting of the marble cladding surface may occur under the effects of RO and chlorides in the environment. This would lead to a reduction in the lustre of the marble surface. A physical examination of the present marble cladding in the Taj

Annexure 1 contd. from Page - 27

Mahal also validates this conclusion

3.0 Conclusions from the Studies Related to Geotechnical Engineering

In order to obtain the desired data as regards the nature of the soil strata below Taj Mahal and the physical and engineering properties of these strata, both in-situ and laboratory soil investigations have been carried out. The field investigations consisted mainly of advancing six bore holes, each upto a depth of 40m below the ground level, sampling for both representative and undisturbed samples, carrying out standard penetration tests and observing ground water elevations in the borehole. In-situ unit weights were also determined at the site. Representative and undisturbed soil samples taken from the bore holes at 1.5 to 2.5 m intervals were tested in the laboratory. The laboratory tests consisted of natural water content determination, classification tests, shear tests, compressibility and consoldiation tests and permeability tests. On the basis of the results of these investigations, the following conclusions are drawn

On the basis of borehole logs and plots of subsoil profiles along typical sections, the following sequential order of soil strata is projected for the substrata beneath the structure

Reduced level (m)		Nature of soil stratum
From	To	
149.0	133.0	Clay of low to intermediate compressibility (CI & CL) (Stratum I)
133.0	123.0	Sand to silty sand (SP-

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Annexure - 2

Photocopy of page iv-30 of NEERI'S July 93 report.

TABLE 4.9

INDUSTRIAL FUEL CONSOUMPTION : TTZ

Town/ Dist.	Industries		Fuel Consumption (MTPD)
	Type	Number	
Agra	Foundry	131	1048
	Pit Furnaces	34	34
	Rubber Sole	30	6
	Chemical	34	52
	Refractory Bricks	16	32
	Engineering	20	17
	Lime Processing	18	58
Firozabad	Glass	267	1284
	Muffle Furnaces	1132	374
	Pottery	33	215
Mathura	Foundry	8	64
	Oil Refinery	1	NA
Bharatpur	Oil Boilers	29	16
	Rolling Mill	4	4
	Pottery	1	37
	Dairy	1	46
Faran	Foundry	4	32
Vrindavan	Foundry	3	24
Kumher	Oil Boiler	1	1
Rupbas	Lime kilns	2	10
Bayana	Lime kilns	2	10
	Oil Boiler	1	1
Hathras	Cotton Mill	1	8
	Oil Boiler	1	1
Mursar	Glass	50	22
Jalesar	Brass	530	17

Annexure - 3

Photocopy of page 12, table 4(A) showing fuel consumption of TTZ submitted by NEERI to hon'ble supreme court in its report of Feb.94

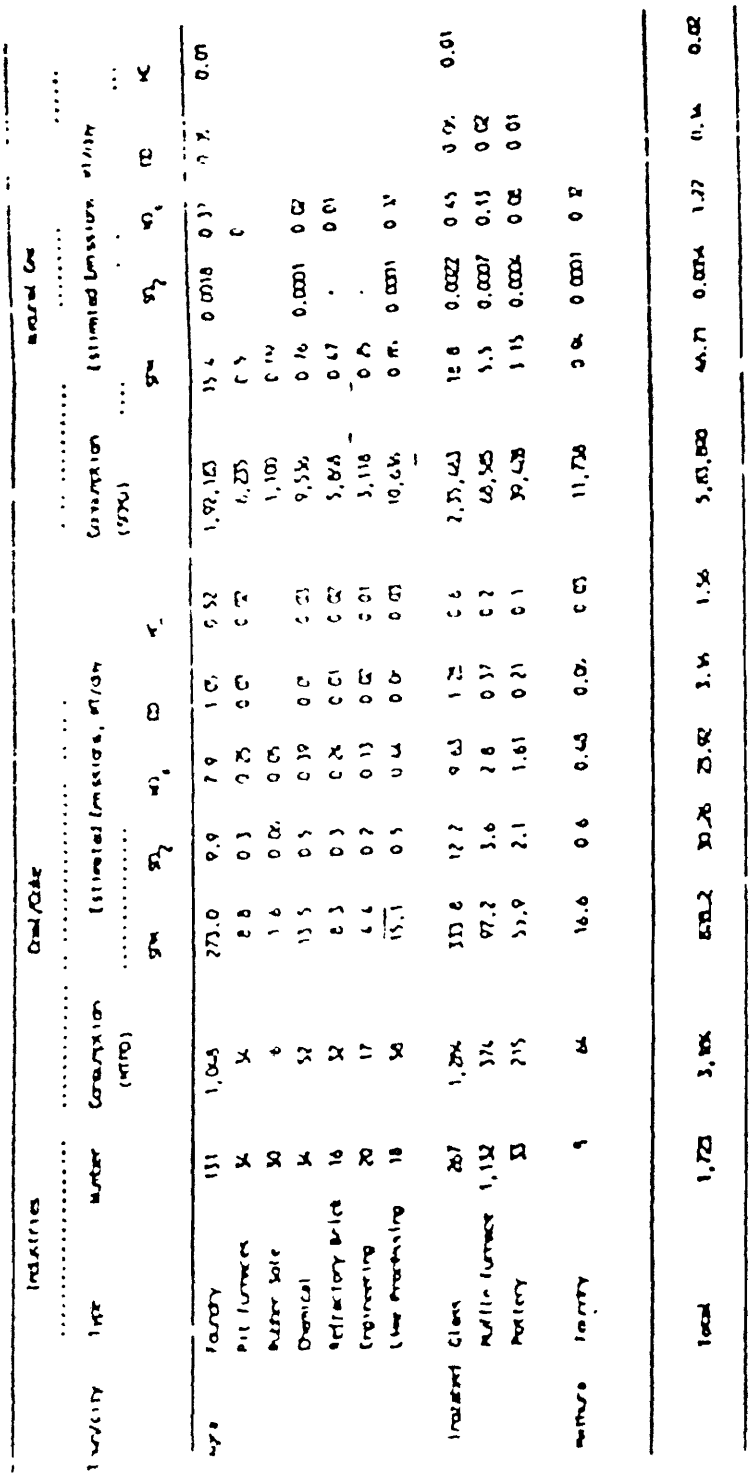

Table 4 (A)

Projected Emissions from Combustion of different fuels in Agra within Region

Industries			Coal/Coke						Natural Gas					
Industry Type	Type	Number	Consumption (MTPD)	Estimated Emissions, MT/DY					Consumption (SCMD)	Estimated Emissions, MT/DY				
				SPM	SO_2	NO_x	CO	HC		SPM	SO_2	NO_x	CO	HC
Big	Foundry	111	1,065	270.0	9.9	7.9	1.07	0.52	1,92,183	15.4	0.0018	0.37	0.07	0.01
	Pit Furnace	34	34	8.8	0.3	0.25	0.03	0.02	6,235	0.5	0.0001	0.02	0.01	0.00
	Rubber Sole	30	6	1.6	0.06	0.05			1,100	0.10	0.0000	0.00		
	Chemical	34	52	13.5	0.5	0.39	0.07	0.03	9,534	0.76	0.0001	0.02		
	Refractory Brick	16	32	8.3	0.3	0.24	0.03	0.02	5,854	0.47	0.0000	0.01		
	Engineering	28	17	4.4	0.2	0.13	0.02	0.01	3,118	0.25	0.0000	0.00		
	Lime Processing	18	30	15.1	0.5	0.4	0.06	0.03	10,646	0.85	0.0001	0.02		
Medium	Glass	267	1,354	350.6	12.7	9.63	1.72	0.8	2,35,443	18.8	0.0022	0.43	0.09	0.01
	Rolling Furnace	1,132	324	97.2	3.6	2.8	0.37	0.2	68,305	5.5	0.0007	0.13	0.02	
	Pottery	33	215	53.9	2.1	1.61	0.21	0.1	39,438	3.15	0.0004	0.08	0.01	
Others	Foundry	9	34	16.6	0.6	0.45	0.06	0.03	11,778	0.94	0.0001	0.02		
Total		1,723	3,356	858.2	30.26	23.02	3.34	1.56	5,63,800	45.11	0.0054	1.27	0.14	0.02

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Annexure 4

Photocopy of page 5, giving recommendations to hon'ble supreme court by NEERI in its report of Feb. 94.

The recommendations are summarized hereunder:

Shifting of small-scale polluting industries outside the Taj Trapezium on industrial estate sites to be identified by the Government of Uttar Pradesh;

Provision of natural gas to the industries in Agra-Mathura region, and Mathura Refinery.

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Annexure - 5

COMMITTEE MEMBERS

1 Shri S C Tripathi - Commissioner - Agra Div.- Chairman

2 Shri O P Srivastava - Jt.Director of Industrries-Agra Div.- Secretary

3 Shri Ved Prakash - Special Secretary - Industries deptt. - Lucknow

4 Shri Yogesh Kumar - District Magistrate - Agra

5 Shri P.K.Mohanty - District Magistrate - Firozabad

6 Shri C.M.Bhatt - Member Secretary - UPPCB

7 Shri C.P.S.Sengar Jt. Director - Directerate of Industries U.P.-Kanpur

8 Shri A K Trivedi - Manager Project - UPSIDC - Kanpur

9 Shri R K Maheshwari - Regional Manager - UPFC - Agra

10 Shri Vijay Prakash - Vice Chairman - Agra Dev. Authority

11 Shri A Rama Rao - PPDC - Agra

12 Shri Virendra Agarwal - Confederation of Indian Industries (CII)

13 Shri Raj Kumar Pa.iwal- PHD Chamber of Commerce & Industries (PHDCCI)

14 Shri Sashi Jain - Indian Industries Association (IIA)

15 Shri K.K.Paliwal - Local Industries - Agra

16 Shri Vishwadeep Singh - Local Industries - Firozabad

17 Shri . Kamar - Local Industries - Agra

18 Shri S M Khandelwal - Local Industries - Agra

ANNEXURE VIII

PRESENT STATUS OF TAJ

JAGAT PATI JOSHI

The Taj Mahal was built between 1631-1643 AD by Emperor Shahjahan to enshrine the mortal remains of his queen Mumtaj Mahal. Immediately after its construction in dome and galleries. The repairs were carried out but details are not available. Except a few examples of vandalism by Jats of Bharatpur and by the soldiers of Lord Lake 1803 and between 1828 - 1833 Lord William Bentinks desired to demolish Taj and auction its marble which could not be materialised, Taj has received attention during British period. But after 1942 structural repairs were given a scientific footing and 1972 onwards in-depth studies both for material and environmental aspects were made. The awareness for the structural and environmental conservation of Taj has been tremendous which could be even gleaned from the tri-media. Presently Taj is in the World Heritage List and receives constant attention and care by the Archaeological Survey of India (ASI). The large number of scientific committees appointed by the Government of India and their voluminous work on one hand shows the anxiety of Government of India and on the other gradual development of a 'Holistic' and 'Inter Disciplinary' approach for the preservation of Taj.

On Taj scientific researches are going on and whatever data is available it is quite useful.

2. STRUCTURAL STABILITY OF TAJ

The studies carried out by the electro-resistivity method by NGRI, Hyderabad and the study of soil profile by CBRI, Roorkee indicated that the foundations are in a fairly good conditions in respect of stability subsidence and material deterioration. NGRI has further brought to light:

1. "Magnetic, seismic and resistivity logging in bore holes on Taj Mahal side seems to indicate the foundation depth is around 12m / 13 m (138/139 R.L.).
2. Seismic amplitude studies indicate that the North boundary wall thickness is not more than 3.0 m.

3. Geo-radar and seismic experiments were conducted in and around the Taj Mahal structures to study the applicability of these methods in identifying the hollow structure below jasmine and marble floors if any an no definite conclusions could be drawn from the obtained data.

4. Seismic reflection studies indicate that the basement (sandstone) depth is about 90m in Taj Mahal region."

The Agra Heritage Project Report clearly states,

" the settlement analysis based on consolidation test data reveals that possibly, 99.4 percent of the anticipated ultimate settlement may have already taken place. The future settlement, if at all, is likely to be insignificant and it will present no problem to the stability of Taj Mahal vis-a-vis the settlement of the foundation."

Observations of levels on over 100 points marked on the floor of the Taj Mahal by the Survey of India and the tilt observations on the four minarets and the central dome are being recorded periodically since 1941 to 1994. These levels were also observed by the Central Building Research Institute, Roorkee and Survey of India that there was no marked change in the values from the earlier values.

The CBRI in its report of September, 1991, has further stated that the "survey level did not show any significant settlement of terraces. Also no tilting of the minarets has been noticed during the period of observations, i.e, June, 1986 to July, 1987".

In regard to cracks, breakages have been identified due to load stresses, and due to thermal expansion of iron dowels in relation to marble.

Archaeological Survey of India spends on an average Rs. 15-20 lakhs per year on structural conservation, chemical preservation and environmental development of Taj since 1990-91.

3. **UNESCO EXPERTS' ADVICE**

i. Taj Mahal being a monument on the World Heritage List, the Government of India sought the expert advice of experts of ICCROM through UNESCO on the structural and chemical preservation aspects of the monument. Accordingly, two experts viz., Dr. Mentrizio Marbeilli and Dr.M.Larze Tabasso visited the Taj Mahal between January, 17-30,1987 for a detailed study of the problems pertaining to the conservation of marble and sandstones in Taj Mahal and recommended remedial measures. It is opined on the basis of the data made available by the various investigating agencies in India to the UNESCO experts that the yellowishness of the marble is due to :-

a. Suspended Particulate Matter; and

b. Dustfall impinging on the surface.

ii. The experts, after visiting the air pollution monitoring stations of the Archaeological Survey of India and Central Pollution Control Board were of the opinion that the concentration of pollution like SO_2 is lower than the permissible value recommended by the World Health Organisation and is considered safe from the conservation point of view.

iii. On the basis of investigation carried out so far, Archaeological Survey of India has developed its own technique of cleaning the marble which consists of use of clay pack process called 'attapulgite' which is an inert as well as harmless clay. It works by a physical process instead of a chemical one. By suitable adjusting the proportion of other chemicals along with non-ionic surface detergent, excellent results have been obtained.

iv. The UNESCO experts have examined the methods adopted by the Survey and the results obtained and have expressed their full satisfaction with the method used.

2. **FORMATION OF CRACKS**

i. Cracks of various nature and magnitude have been observed

on the Taj marble veneer. Though most of them are superficial, some are deep and in limited cases extend beyond the veneer slab.

ii. The UNESCO experts , Dr. Mentrizio Marbeilli and Dr.M.Larze Tabasso felt that the cracks can be due to various reasons e.g, corroded iron dowels, structural behaviour of the masonry, excess of load, anisotrophy of marble, etc., but certainly not due to atmospheric pollution. In their view, what is urgently needed is to fill the wider cracks and to replace the missing parts in order to prevent water penetration and further oxidation of iron dowels.

iii. Mr. Beckmann and Sir Fieldon, the UNESCO experts, have visited Taj and carefully examined the monument from the structural point of view and have observed that the Taj is stable and sound.

iv. The remedial measures and restoration work suggested by the experts are being carried out as indicated below:

a. The worn out and cracked red sand stone veneer on the eastern side enclosure wall have already been replaced. The work on western side enclosure has been completed.

b. The cracked and worn out white marble veneer strong on the North-East , North-West and South-West minarets (upto 1st Floor level) and the bracket of the 1st floor balcony have been changed . The red sandstone veneering inside the South West minaret has been replaced. Cracked/ decayed white marble of the minarets have already been attended to.

c. In the mausoleum a marble pillar and cracked floral panel and a portion of the calligraphy inlay work has been restored.

d. Minor cracks in white marble and red sandstone of parapet and the lower part of the drum have been

attended by filling with special lime mortar.

4. THE PROBLEM OF MARBLE

In order to understand and interpret correct position regarding the marble used in Taj, it can be said that there is conclusive proof that it is only the calcitic marble and to a lesser degree the dolmetic one having a very low poracity and water absorption have been used in Taj. The marble is not of the purest variety at all the places at Taj as the chemical composition has revealed. After his long studies on the marble of Taj, Dr. B.B. Lal sums up the position, 'chemical and petrographic studies have shown that the marble has not undergone mineralogical alteration, nor is there any evidence for chemical weathering.... The impact of acidic gases in the air has not been noticed, as there is hardly any perceptible sulphation of the marble.

Studies have also been carried out by GSI and Hertz etc., whose finding are similar on the petrographic studies on Taj marble.

Shri B.N. Tandon carried out accelerated tests on marble at differentiation concentration levels of SO_2 ranging from 10 mg-m^3 to 80 mg -m^3 (International standard for human health). He also carried out surface enrichment studies (SEM). His findings on accelerated laboratory test is as below:

> "Weathering test was conducted with the sole purpose of determining the impact of SO_2 on the marble- surface and coated with different preservative to test the physio-chemical behaviour of marble. (blank) in a perspex chamber with arrangement for introducing steam and U.V. light as well as the system to produce SO_2 by the action of an acid on an alkali-sulfite. The marble samples were kept at 45°C to have the maximum surface exposure. The samples were polished after cleaning in Toluene and Acetone and dried at 40°C. The samples were exposed to various concentrations 10,20,25.... 70 mg/m^3. to detect any physical and chemical change. The details of these tests in general indicated that (duration was 30 days intermittent) reflectance and glossiness was noted to be coming down only slightly as a

concentration increased at the RH '85-90'. Further the growth of coloured patches indicating micro biological growth was clearly seen at several concentrations. The quantification of relation of concentration versus damage, which has the aim of these testing, eluded any consensus. However, at 60 mg/m^3 - black green patches at 2 to 3 points were seen along with the dirty white spots.

However it was noted that with so many variables, it was difficult to assess damage caused by one factor alone. Macarthy Rae and Haynie in their paper on 'benefit model for pollution effects in materials' has pointed out that:

1. The type of damage associated with air borne pollutants also tend to occur in unpolluted atmosphere producing the damage which cannot be unequivocally-distinguished from that caused by other factors, CO_2, moisture, natural particulates, sunlight.

2. Laboratory studies introducing single pollutant are exposed to materials- independent of other influences are generally conducted at unrealistically high concentrations and are therefore, not representative of the actual exposure conditions.

These are only cause/ effect relationship.

3. Reduction in SO_2 levels will reduce the damage. Surface erosion is initially a prime function of time of wetness. It is a surface damage function. In a carbonate/S-compound system-many chemical reaction have been pointed and including dry deposition reaction thus making it quite complex in so far mechanism of delay is concerned.

The mechanism of delivery system of SO_2 rate of deposition concentration, time of wetness and how it actually reacts to produce mechanical stresses and breaking down the matrix by dynamic forces and removal by rainfall is still not properly understood. However, this is very slow process. Haynie, Spence, Upham at north Carolina while writing on the effects of SO_2 on marble and cement further mentioned (" Effects of gaseous pollutants on materials - a chamber study) "That RH and levels of SO_2,O_3 appear to accelerate

the erosion of white chirokee marble. The empirical formula predicts that this marble will erode only 1mm in about 300 years. When exposed to somewhat humid environment (80% RH) containing 80 ug/m^3.... A scrutiny of above details, indicate that the marble of Taj is still in a satisfactory condition and its conversion to sulfates etc, is still very rare as SEM analysis revealed a number of formations at the surface which have been enriched as a result of depositions, a number of inclusions like elemental sulphur (at a few places only) silicon, chlorine while sand stone is having advanced stage of deterioration."

5. YELLOWISHNESS OF MARBLE

The yellowishness of the marble has been attributed to the main causative factor which is settleable particulate getting deposited on the surface containing carbonaceous matter. Since no chemical reaction is involved between the carbonate of the marble and the deposited aerosols it may be termed as a superficial deposit and poses no major problems for its removal.

The marbles at Acropolic Athens, Field Museum Chicago and Taj Mahal are similar. While the sulphates that form due to SO_2 attack on the marble are altogether absent at the Taj. At Acropolis and the Field Museum they form a black crus and have penetrated into integranular space of marble. This is based on observations of K.L. Gowri.

M. Lorezi Tabasso and M. Marabelli of Instituto Centradel Restauro, Rome, UNESCO Experts also opined (1987) "The results of cleaning and observations carried out on different parts of the Taj Mahal including four minarets, and also on the other marble monuments visited allow to conclude that the yellow shadow of the marble is mainly due to suspended particulates matter and also to dust fall impinging on the surface. This is in agreement with the report by O.P. Agarwal et el (NRLC, Lucknow, Nov.1986) and the report by B.N. Tandon (ASI Dehradun, 5th Report, 1985)

Tirkha et el in Agra Heritage Project Report of Investigations of related research studies, Vol.II records." "

Based on the laboratory and site studies on "fresh", "contemporary" and "monument" materials obtained from the Taj Mahal complex and other structure, it may be concluded that the "useful" life of the brick line mortar composite in the Taj Mahal which is shielded by cladding material (i.e,) marble or sand stone will be in excess of 930 years as predicted by the curves fitted through the laboratory data. This has been done by defining the useful life of the materials as the life at which the compressive strength of the material is reduced to 50% of the strength of the "fresh" materials. This estimate is based on the premise that the materials are constantly subjected to the maximum levels of pollution which may not actually happen.

The laboratory studies also indicate that staining and pitting of the marble cladding surface may occur under the effects of NO_x and Chlorides i the environments. This would lead to a reductions in the lustre of the marble surface. A physical examination of the present marble cladding in the Taj Mahal also validates this conclusion."

6. ASI's NEW TECHNIQUES OF CLEANING MARBLE:

'The ASI developed a technique for the removal of yellowishness and other settled particulates on the surface. This yellowish has been removed by the use of chemico-physical absorption technique along with the particulates. The steps are as following:-

1. About 3% ammonical liquor with a surface non-ionic detergent like teepol - 300 and hydrogen peroxide in 3:2:1 for a general clean up in distilled water in methanol.

2. Followed by the use of triethanol-amine in suitable proportions (1:2) for the removal of soot tarry deposits.

3. Cleaning with distilled water.

4. Absorption by Mg tri-silicate and Al-silicate in 1:4 ratio again in distilled water with few drops of glycerol'.

8. OPINIONS OF ASI, SCIENTISTS AND OTHERS ON THE PRESENT STATUS OF TAJ

With a view to have a correct assessment of the status of the monument, the Committee invited the views of the Deptt. of Culture (Archaeological Survey of India) and some eminent scientists in the field of Archaeological conservation and environment. These include Padmashri R. Sen Gupta, Former Director of Conservation, ASI, Shri B.N. Tandon, Former Director, Science and Joint Director General ASI and Dr. O.P. Aggarwal, Director General, Indian Conservation Institute, INTACH. These scientists made it convenient to visit Taj and have given their considered views. Besides, these, the committee also invited Dr. Jaweed Ashraf of School of Life Sciences, Jawaharlal Nehru University, New Delhi, Prof. Ashraf is also mentioned as an expert in the panel suggested in the Agra Commissioner's report. It was thought to have his opinion also. Prof. S>C> Pandeya, FNA, Emeritus Professor, Agra volunteered and his opinion was recorded.

The Chairman has been also receiving from time to time the views of some senior citizens of Agra on the status of Taj.

COMMENTS OF A.S.I.

The following comments of ASI on Taj were duly endorsed by Dr.S.K.Mahapatra, Secretary, Deptt. of Culture under his letter No.34/Secretary(C)/91 dated March, 13, 1995.

" On the structural side, the Taj Mahal is in a sound state of preservation and the studies conducted so far also confirm the same. The only threat to the Taj Mahal is from the environmental pollution.

The Science wing of the ASI is continuously monitoring the level of suspended particulate matter, sulphur dioxide concentration and sulphation rate. The studies made in this regard shows that suspended particulate matter level has been found to be higher than the maximum permissible level 100 kg/m^3 . This has imparted a yellowish appearance on the surface of the Taj Mahal.

The monthly average concentration of sulphur dioxide has certainly been observed to be less than 30 g/m^3.

Though the structure is more than three and a half centuries old and is exposed to atmospheric pollution, the resilient quality of the marble has enabled it to withstand the wear and tear of time. The chemical treatment of the marble has removed accretions and deposits, thereby restoring lustre to the surface of the building. This has been measured by glass reflectance procedures.

The yellowish appearance on the surface as already stated is due to the deposition of suspended particulate matter, smoke, grease, etc., although this phenomena has been long manifested but there has been increase in the level of suspended particulate matter and other air pollutants. However, ASI is taking care of this problem by attending to the cleaning of the marble surface in phased manner. This effect has been noticed in the marble surface of the monuments in Delhi like Red Fort and Humayun's Tomb, whereas in Bibi-ka-maqbara it is not affected as less amount of marble is used. The soot deposition has been reported in the monuments in Venice, Italy.

Regular periodic cleaning of the surface is being done, depending upon the conditions of the area of the monuments.

The deposition has been found more in the lower areas where the palm grease gets deposited due to constant touching of the visitors. Also it is found in the arches where lashes of rain is insufficient. It is all around and no perceptible difference in particular side is noticed. The areas which are subjected to rain lashes are less affected".

2. Dr.B.N. Tandon who visited Taj on 20th April found the monument was looking yellow in appearance due to SPM deposits and at 2.30 it rained heavily and exposed surface was washed out,

leaving the original white marble surface exposed.... In Agra which is close to Rajasthan desert the value of SPM is quite high (reaching some times toi 300-500 ug/m^3 thus this accumulation produces soiling effect on marble as well as red stone which is primarily a function of uncontrollable variable (SPM) on the surface....with regard to gaseous pollutants it is to be noted that no visual effect is seen on the surface of the marble.... I have no hesitation to state that the marble of the Taj is quite satisfactory while sand stone due to its sedimentary origin and composition has weathered."

3. Dr. O.P. Aggarwal who visited Taj on 21st April, 1995 reported one thing I can stated categorically that the cause of yellowing is definitely not pollution; the fault lies somewhere else".

4. Padmashri R. Sengupta writes " After visiting the Taj mahal and discussing relevant issues with the local officers of the Archaeological Survey of India (ASI) , I felt that structurally the present status of the monument is not in any way different from what it was in the early sixties when I was looking after the monument as Assistant Superintending Archaeological Engineer (Sep.1961- April, 1963) with the Agra (Northern) Circle of the ASI. In my opinion, therefore, there is no cause for alarm or apprehension about its being ruined in the near future. My views resupported by the report of the ASI's Superintending Archaeologist that the Survey of India's recent check-up of levels (bench marks) on the plinth and verticality of the minars showed no movement or change in the stability of the structure....

Some areas on the outer face of the Taj Mahal show light yellowing which could be attributed to deposition of suspended particulate matters, but no corrosion, to speak of could be seen. Areas of yellowing could be cleaned effectively by chemical treatment and the original colour of the stone restored. I do not think burning of oil lamps had produced yellowing as discolouration of stones is also seen on monuments inside the

Agra Fort and the tomb of Itimaduddaula. The superintending Archaeologist of Agra Circle has informed that electric lamps were introduced in 1911 and a generator was used to light them and probably after 1924 regular electricity was made available".

5. Prof.Jaweed Ashraf writes: " In so far as the Taj is concerned it is a fact that there is no sign of decay or neglect of the monument as a whole and of its stones in particular. Only the sand stone part of the balcony on the river side is sand-damaged, in all probability recently. There are some minor aspects that need periodic attention and repairs and that has been provided to them for last more than a hundred years. Otherwise, the monument would not have survived so far. Repairs were required since the times of Shahjahan when first repairs were necessitated as a consequence of quality of stone and some other construction defects. Nothing extraordinary has happened since last three decades in so far as maintenance and repair of the Taj is concerned. Taj has certainly not been neglected by ASI so far. Now it is being seriously compromised under pressure from Ministry of Tourism and local politician-land-hotel lobby.

It is the red sandstone surfacing in the Taj complex, and the surface mortar layers on the boundary wall, that are vulnerable to climatic as well as biotic damage and degradation. However, significance of this aspect is marginal in comparison with the main building and its important structural components.

Hence, one can conclude that climatic and other damage to Taj complex as a whole in fact has been only superficial and marginal nor deserving so much noise.

In places like Sikandra and Aitmad-up-Daula there is serious problem with fungus and leachen colonies on red sandstone slabs. Other damage is due to human factors; It is not climatic or due to pollution.

Taj as well as other heritage monuments, have retained their architectural and visual impact since at least the times these were taken over by the British, i.e, since the establishment of

the ASI.

6. Prof. S.C. Pandeya has remarked: " The white lustre of Taj Mahal is very much present as on today. The quality of marble used at all the places in Taj is not uniform. The good quality white marble has been used for graves, Jali around cenotaph and the lower floral designs. All these areas can be brought to original by simple bentonite and water cleaning. On rest of the areas marble used has bands of inherent impurities and hence have different shades. The corridor and interior portions of Taj have remained neglected for centuries and so it has turned yellowish due to deposition of dust, dirt and entrapped smoke emitted by burning of candles, incense sticks and the smoke emitted by different modes around Taj in the past, prior to stopping coal engines at Agra Fort, Railway year and the Thermal Power House etc, The exterior parts of cenotaph of Taj has the same white luster as before. Apart from rains, cleaning of Taj has been mostly from outside in the past.

There is evidence right from early days soon after completion of Taj upto as late as now that rain water is seeping through domes and arches. During the seeping of water, it has entered the main structure built of Lahheri bricks and lime plaster, which in turn has dissolved the soluble parts of the material used. This has resulted in some permanent staining and weakening of marble from inside wherever it has remained stagnated behind the inlaid marble slabs and also on where it flowed over through the joints and on the floor (Plates 3 & 4). It has caused some permanent damage like resulting of dowels, joint pins and disintegration of marble surface near joints. All this has already happened in the past and now complete water tightening of roof and walls is urgently required.

Biological weathering is occurring fast at Taj Mahal. Right at the base of cenotaph, algal blooms (Myxophycease) are coming up On the outer walls and domes both on sandstone and marble structures, algal blooms and even angiospermic plants have started invasion All this directly proves that SO_2 in the atmosphere is not in effective lethal dose".

7. PEOPLES' VIEW:

The Committee received quite a few letters from some senior citizens of Agra who were borne and brought up at Agra and seen Taj since their childhood. One of the Senior Citizens have recorded " I can say with certainty and with all the assertion at my command that Taj is as it was sixty years back" (Letter from Dr. P.N. Gupta dated 23.4.95 to Dr.S. Varadarajan) some have even strongly resented the misinformation on yellowingness of Taj in press.

9. ACTION TAKEN FOR ENVIRONMENTAL PROTECTION OF TAJ:

The short term and long term measures taken for environmental protection of the monument from pollution include:

i. Two thermal power plants in Agra were closed down in 1981;

ii. Agra railway marshalling yard has been dieselised.

iii. The Archaeological Survey of India and the State Government are monitoring the ambient air around the Taj Mahal to assess the level of sulphur-dioxide suspended particulate matter and other pollutants as well as meterological data in order to take such remedial measures as may be required. Besides, periodical chemical treatment and preservation is being carried out.

iv. Uttar Pradesh Pollution Control Board has initiated action to control emission from small scale industrial units including foundries located in Agra.

v. Air pollution levels are being monitored by the Uttar Pradesh State Pollution Control Board at 5 locations in Agra around the Taj Mahal.

vi. A trapezium area surrounding the Taj Mahal has been constituted. No new polluting industry is allowed to be set up in this area of 10,400 sq.kms.

vii. There is a ban on the use of furnace oil and diesel generators in industries in Agra. The foundries are not

permitted to operate during winter nights.

viii Emission standards for vehicles have been prescribed under the Environment (Protection) Act, 1986.

ix Gross and mass emission standards for all vehicles have been notified under the Motor Vehicles Rules, 1989.

x. Public awareness campaigns have been launched.

xi. Movement of heavy vehicles around the Taj Mahal has been stopped and the parking has been shifted to Shilpgram.

xii Burning of rubbish near Taj has been stopped.

xiii The Forest Department of the Government of Uttar Pradesh has created a green belt around Taj Mahal by plantation of trees on available Government land.

ivx The Ministry of Environment & Forests, Government of India is evolving guidelines to determine measures for abatement of pollution.

xv The Social Forestry Division has taken steps to plant trees in an area of 50 hectares around the Taj Mahal, Agra.

xvi A special cell has been set up in the Ministry of Environment & Forests to ensure a green belt around Taj.

xvii The State Government has also taken steps for planting of trees in an area of 10 hectares around Foundry Nagar and Industrial area, 12 Hectares in UPSIDC area and 5 Hectares in the Cantonment area.

xviii The Mathura refinery has implemented Vardharajan Committees' recommendations, besides de-sulphurisation of fuel gas, establishment of recovery units, development of green belt, effluent treatment plant, regular monitoring of pollutants and planting of trees.

Annexure IX

डा० एस० के० महापात्र
Dr. S. K. MAHAPATRA

सचिव, भारत सरकार
मानव संसाधन विकास मंत्रालय
संस्कृति विभाग
शास्त्री भवन
नई दिल्ली-११० ००१

Phone: 386995

SECRETARY TO GOVERNMENT OF INDIA
MINISTRY OF HUMAN RESOURCE DEVELOPMENT
DEPARTMENT OF CULTURE
SHASTRI BHAVAN
NEW DELHI - 110001

March 13, 1995

Dear Shri Krishnan,

Thank you for your letter dated 3rd March, 1995

The Department of Culture endorses the comments already sent by Additional Director General, Archaeological Survey of India regarding the state of preservation of Taj Mahal.

Yours sincerely,

(S.K.MAHAPATRA)

Shri N.R.Krishnan
Secretary
Ministry of Environment and Forests,
CGO Complex, Lodi Road,
New Delhi 110003

Annexure IX A

सत्यमेव जयते

Achala Moulik, IAS

मुख्य कार्यकारी अधिकारी एवं अपर महानिदेशक (प्रशासन)
Chief Executive Officer & Addl. Director General (Admn.)

प. स. पत्र सं०.....
D. O. No. 23/1/94-C
भारतीय पुरातत्व सर्वेक्षण
ARCHAEOLOGICAL SURVEY OF INDIA
नई दिल्ली-110011, तारीख.....19
New Delhi - 110 011, the.....19
26 DEC 1994

December 26, 1994.

Dear Shri Krishnan,

Kindly refer to D.O.letter No.Q-17012/21/93-CPW dated 9th December, 1994 regarding Expert Committee to survey the Taj Trapezium Environmental area, identifying the polluting industries such as long terminal/short terminal measures.

On the structural side, the Taj Mahal is in a sound state of preservation and the studies conducted so far also confirm the same. The only threat to the Taj Mahal is from the environmental pollution.

The Science wing of the ASI is continuously monitoring the level of suspended particulate matter, sulphur dioxide concentration and sulphation rate. The studies made in this regard shows that suspended particulate matter level has been found to be higher than the maximum permissible level 100kg/m^3. This has imparted a yellowish appearance on the surface of the Taj Mahal.

The monthly average concentration of sulphur dioxide has generally been observed to be less than 30g/m^3.

Though the structure is more than three and a half centuries old and is exposed to atmospheric pollution, the resilient quality of the marble has enabled it to withstand the wear and tear of time. The chemical treatment of the marble has removed accretions and deposits, thereby restoring lustre to the surface of the building. This has been measured by glass reflectance procedures.

The copy of the Status report and affidavit as desired are also enclosed for necessary action.

With regards,

Yours sincerely,

(Achala Moulik)

Shri N.R.Krishnan,
Secretary,
Ministry of Environment & Forests,
New Delhi.

ANNEXURE A

(Padma Shri) R. Sengupta

ARCHITECTURAL CONSERVATION CONSULTANT

- Member, Executive Committee, ICOMOS (International Council On Monuments and Sites), Paris, (1984 -87).
- Indian Representative in ICCROM (International Centre for the Study of Preservation and Restoration of Cultural Property), Rome (1979-1984)
- Retired Director of Conservation, Archaeological Survey of India (1984)
- Leader, Indian Archaeological Mission in Afganistan (1969-1977)

Dr. R. Anandakumar
Additional Director (S),
Ministry of Environment & Forests,
Paryavaran Bhawan,
C.G.O. Complex, Lodhi Road,
NEW DELHI - 110003.

40/78, Chittaranjan Park,
New Delhi-110019.
PH: 6440739

April 25, 1995

Sub: EXPERT COMMITTEE CONSTITUTED ON THE DIRECTIONS OF THE SUPREME COURT ON THE CONSERVATION AND PRESERVATION OF TAJ MAHAL.

Dear Dr. Anandkumar,

Please refer to your letter no. O-17012/21/93-CPW dated 17 April, 1995 on the subject mentioned above.

As desired by the Expert Committe and communicated through your letter under reference, I am enclosing a report after visiting the Taj Mahal and other monuments at Agra.

Yours sincerely,

(R. Sengupta)

Encl: as above.

A REPORT ON THE TAJ MAHAL AND OTHER MONUMENTS AT AGRA

- R. Sengupta

On the recommendation of the Expert Committee constituted by the Ministry of Environment and Forests on the directions of the Supreme Court on the conservation and preservation of the Taj Mahal and other monuments at Agra,it asked me in its letter no.Q-17012/21/93-CPW dated 17th April,1995 to visit the Taj Mahal,Agra Fort,Akbar's tomb at Sikandra and the tomb of Itimaduddaula and report my independent views on their present status,yellowing and its remedy,the time of introduction of electric lights inside the Taj Mahal and suggestions for conservation measures.Accordingly I visited the monuments at Agra on 19th,20th and 21st April,1995.

After visiting the Taj Mahal and discussing relevant issues with the local officers of the Archaeological Survey of India (ASI),I felt that Structurally the present status of the monument is not in any way different from what it was in the early sixties when I was looking after the monument as Assistant Superintending Archaeological Engineer (Sept. 1961 - April 1963) with the Agra (Northern) Circle of the ASI.In my opinion,therefore,there is no cause for alarm or apprehension about its being ruined in the near future.My views are supported by the report of the ASI's Superintending Archaeologist that the Survey of India's recent check-up of levels (bench marks) on the plinth and verticality of the minars showed no movement or change in the stability of the structure.

It may be emphasized that the marble stones used on the Taj Mahal are neither "Pure white" or "Pearl white" as given out in press reports from time to time.The stones are a mixed lot,most of them with greyish bands and some with brownish veins showing presence of minerals.These minerals in contact with water in course of time cause damage to the stones.The main causes of damages to stones have already been identified and mentioned in the report of the Expanded Advisory Committee on the Restoration and Conservation of the Taj Mahal at Agra 1943 and require no repeatation.However the cracks in the vaulting on the second floor,mentioned in the report are not "alive" i.e. do not show any movement of the structure. These cracks I feel might have developed due to the devastating earthquake shocks of mid-thirties in Bihar when cracks in buildings at Allahabad also had appeared.A survey of old buildings and churches at Allahabad by me (while restoring the Muir College of the

University) showed cracks in the upper regions reportedly appeared in the thirties.

The causes for appearence of cracks enlisted by the Expanded Advisory Committee are still valid.Subsequent to the Committee's findings, large scale replacements of damaged marble stones,including those on the dome,were carried out in 1949.Earlier such major restorations were executed in 1810 and 1874,as per records.So replacement of damaged stones with new ones and corroded iron dowels with ones of non-corrosive metal is done occassionally as per requirements.

Some areas on the outer face of the Taj Mahal show light yellowing which could be attributed to deposition of suspended particulate matters,but no corrosion,to speak of could be seen.Areas of yellowing could be cleaned effectively by chemical tratment and the original colour of the stone restored.I do not think burning of oil lamps had produced yellowing as discolouration of stones is also seen on monuments inside the Agra Fort and the tomb of Itimaduddaula.The Superintending Archaeologist of Agra Circle has informed that electric lamps were introduced in 1911 and a generator was used to light them and probably after 1924 regular electricity was made available.

Incidentally it may be pointed out that awareness about pollution was created by officers of the ASI who kept vigil on important monuments and obtained results of latest researches on preservation matters from internationally famous scientists with whom contacts were maintained.Dr.Torracca of ICCROM was consulted by me at that time when permissible/tolerable limits of pollution effect on marble was being talked about.The foundries,thermal power station near Agra Fort and the shunting Railway engines burning coal were identified as sources causing pollution only in 1972,earlier nobody spoke about marbles yellowing.Neither the Expanded Advisory Committee of 1943 nor the Committee of CPWD engineers detected the discoloration in July,1956.But from the nature of discolouration seen at untreated portions of Agra Fort,it appears the phenomenon is older than 23 years i.e. of pre-1972 time.People became conscious of yellowing of stones of the Taj Mahal only after the debate on Mathura Refinery gathered momentum.

For better preservation and maintenance of the monument it is suggested for consideration that the vehicular traffic between the river-side road on the east of Agra Fort and the Taj Mahal be diverted to keep the area free from vehicular traffic and gaseous emissions from vehicles.An area on the east of the Taj Mahal,near Silpgram,be developed for parking of tourist vehicles.The burning ghat (for cremation of dead bodies)close to the spurs behind the monument may be shifted to avoid smoke affecting the monument.

In February last shooting of a Tamil film with casts caused damages to the garden inside.Earlier in the sixties when the Hindi film "Leader" was being shot,the garden had suffered considerable damages and thereafter shooting of film inside with casts was discontinued; shooting of films inside should be totally stopped.

Aforestation on the river-side land,behind the Taj Mahal,seems to be an incongruity and should be discouraged.

As entry of large number of visitors at a time inside the crypt and the tomb chamber above is hazardous for the safety of the monument and life (though in a different situation inside the Qutb Minar,many children died in a stampede),the crypt may be closed to visitors and entry to the tomb chamber above it restricted to 20 at a time, as practised at Ajanta Caves.

It appears there are proposals to construct barrages across the river to impound waters for boating to promote tourism,After the spurs were constructed the river course has undergone changes.Before any further construction is planned the behaviour of the river should be studied to avoid any adverse effect on the river-side monuments.

Inside the Agra Fort,the damaged marble flooring of the courtyard of the Moti Masjid was replaced with new stones over two decades ago. Though the condition of the stones is generally good,some pieces of poor quality show pitting,scaling etc.On the outer face of the dalans and inside the Masjid there are areas blackened by smoke.Similarly, the jalis of the Muthamman Burj (where Shahjahan was kept imprisoned by his son Aurangzeb) and the ceiling are also covered with black patina.Obviously these places have not been chemically treated for cleaning.In this respect the cleaned walls of the Diwani Khas demonstrate that the discolouring is superficial and can very well be cleaned without disturbing the fabric of stones.The cleaned walls

with the original colour of marbles stand in full glory.

The tomb of Itimaduddaula also shows the effect of smoke viz.blackening,especially more on the south and west walls.The monument is said to have been cleaned in early sixties.Many coloured stones in the inlay-work on outer walls are missing.These areas need urgent repairs.

Marble flooring of the topmost storey of Akbar's tomb at Sikandra shows much damages as it was at Moti Masjid and needs urgent repairs.

STATUS REPORT OF MARBLE MONUMENTS AT AGRA

B.N. JOSHI

Taj, a world heritage monument built by Mughal Emperor Shahjahan in 1637-48 is a brick in lime mortar-structure with marble veneering and is known the world over for its exquisite beauty and architecture. Apprehensions arose in the minds of the people when the GOI decided to erect a refinery at Mathura situated at about 40 kms from Agra to process the crude oil obtained from Bombay high, about the possible adverse effects of gaseous/ particulate pollutants to be emitted from the refinery. Several expert groups were constituted to assess the impact on marble and red sandstone of which most of the monuments at Agra are built. Since this type of pollution study was new- Tecneco of Italy which had some expertise in such matters - in view of their experience at Venice was also associated with these studies on Taj, Itmad-ud-daula-Agra Fort and Sikandra. The studies encompass the status of foundation, subsidence sub-structure, verticality measurements, chemical composition of materials, air and soild profiles the background pollution levels micro-biological petrological and seismic studies. These studies helped in revealing the status of various elements of the structure before an attempt at the conservation is made.

Taj is made of marble ($CaCO_3$) and at places presence of dolomitic stone have also been noted, other minerals in the marble are mica (phlogopite), talc, clay and iron hydroxide (brown) derived from weathering of pyrite (iron sulfide). It has occasional blocks of Schist as well as graphite (black). Along veins and cracks a bleached white material is found only at a few places which is probably $CaSO_4 . 2H_2O$ - but is not apparently widespread. Gypsum formation is indicative of the effect of the SO_2. A lot of biological and micro biological growth is found where there is stagnation of water or ingress of moisture. This is generally black in colour. The marbles used in Taj, Sikandra, Itmad-ud-daula and Fort have been analysed.

The general trend arrived after this analytical procedure is that good quality marble has been used which is of three varieties

and has a low porosity and water-absorption with appreciable compressive strength. It is extremely resistive to alteration and is of durable variety. The polishing make it stronger against deterioration.

In Agra which is close to Rajasthan desert, the value of SPM is quite high (reaching sometime to 3000-5000 $\mu g/m^3$) thus this accumulation produces soiling effect on marble as well as red sand stone which is primarily a function of incontrollable variable (SPM) on the surface.

I visited Taj on 20.4.1988 at about 12.30 pm and it looked quite dirty yellow in appearance due to these SPM deposits, at about 2.30 pm it rained heavily and the exposed surface was washed out, leaving the original white marble surface exposed. This is conclusive evidence as to what is happening to Taj.

"With regard to gaseous pollutants, it is to be noted that no visual effect is seen on the surface of the marble at Taj.

I have no hesitation to state that the condition of marble of Taj is quite satisfactory- while sandstone, due to sedimentary origin and composition has weathered".

(S) I: The Conservation is a continuous process and the results obtained by the use of clay pack technique is extremely satisfactory since we have been able to remove most of the soil/dust particulates which have deposited with time from the surface thus exposing the original whiteness. Many areas outside, like arches, big arches, verandah and inside the mausoleum up to a certain height had been already cleaned. The top of the upper portion of the cenotaph will have to be taken up in a phased manner in due course.

(S) II: Similar treatment will have to be given to marble at Sikandra and other monuments at Agra.

Annexure X-B

REPORT ON THE STATUS OF TAJ MAHAL

- Dr. O.P. AGRAWAL

The scientific studies on materials of the Taj Mahal being pursued by NRLC aimed at first identifying the types of deterioration of the Taj Mahal materials and their causes, and, then trying to minimize the effect of various deteriorating factors. Thus, we wanted to find answers to some of the problems of major concern, namely:

1. Nature of various types of discolouration on the marble.
2. Causes of discolouration.
3. Development of techniques for cleaning of marble surface without the use of hard brushes which are commonly employed for this purpose.
4. Causes of cracks formation and chipping of marble.
5. Effect of pollutants on the Taj Mahal.

The salient features of our observations and the results of scientific studies done so far are as follows:-

1. DISCOULARATION

1.1 Yellowing of marble protected from rain has been caused by the acrylic resins which might have been applied in the past as a protective coating.

1.2 The blackish accretion on the brackets of the first floor S-W minaret was found to be due to hydrated calcium oxalate and dirt.

1.3 Blackish accretions on the walls of the inside gallery and on the cenotaph curtain was found to be palm-grease and dirt.

1.4 Blackish spots of algai growth were seen in areas which remain wet for longer periods e.g. base of the walls and near the spouts.

2. CLEANING METHODS

Yellowed acrylic resin can easily be removed with a pack of acetone + toluene _ cyclohexane. For the removal of other accretions, a formulation of weak

bases, a complexing agent, a thixotropic agent and a wetting agent, recommended for marble cleaning was used. The standardisation of the method was done in the laboratory and then tested on the monument. The results were very satisfactory.

3. CHIPPING AND BREAKING OF MARBLE SLAB EDGES

3.1 Lower portions of the marble slabs resting on the platform and on the terrace have chipped off extensively due to prolonged action of accumulated water. At such points the joints should be sealed.

3.2 Chipping off at the horizontal joints of marble veneer has occurred extensively. This appears to be due to the pressure exerted by the load of the slabs at these sensitive points.

4. FORMATION OF CRACKS

4.1 Vertical cracks on marble veneer have developed extensively. Such cracks are particularly present on the base of the arches in the cenotaph area and on the drum of the dome. Formation of these cracks could be attributed to the downward pressure exerted by the load of the slabs.

4.2 Cracks along the mineral impurity veins due to preferential leaching of these mineral impurities by water. Such cracks should be sealed with epoxy resins injected with a hypodermic syringe.

4.3 Cracks near the replaced portions of the marble slabs have also developed because the replaced portions are made to fit too tightly.

5. BULGING OF MARBLE SLABS

Some marble slabs have bulged out due to plastic deformation of marble, a natural phenomenon.

6. PITTING

Marble slabs have developed small pits at some points under the water spouts due to preferential leaching of minerals present as patches. These pits should be sealed with epoxy resin. Ways and methods have to be thought of to divert the rain water somehow so that it does not fall through the spouts.

7. RUSTING OF IRON DOWELS AND CLAMPS

Rusting of iron dowels and clamps has caused cracking, breaking and bulging of marble slabs because of the swelling of rusted iron, due to formation of magnemite. At some places brown rust spots have also developed on marble.

ANNEXURE XI

LIONS CLUBS OF INTERNATIONAL

We Serve

DISTRICT - 321 C-2

Lion N. N. BANSAL
Advocate
Region Chairman
Region - 2

B-501, KAMLA NAGAR
AGRA - 282 005
Phone : 380053

Dt 22-6-95

Dr. S. Vardrajan
c/o Ministry of Environment & Forests.
C.G.O Complex
Lodi Road.
New Delhi-110003.

Dear Dr. Vardrajan ji

I was born in Agra and watching Taj for last 45 years. even today I find Taj to have same beauty as I had seen in my childhood.

There is/are [illegible] Taj is getting yellow but in my opinion the marble of Taj does not appear to have any change.

Thanking you

Yours faithfully

N N Bansal

Annexure A1-A

LIONS CLUBS OF INTERNATIONAL

We Serve

DISTRICT - 321 C-2

Lion B. N. SINGHAL
Zone Chairman
Zone - 5

C-30, KAMLA NAGAR
AGRA - 282 005
✆ : (O) 344441, 344501
(R) 381123, 381125, 381126

22.4.95

श्रीमान डा बदराजन जी

सप्रेम नमस्कार

मैं एक आगरा का नागरिक हूँ, पिछले 40 वर्षों से बराबर ताजमहल आता रहता हूँ। मैंने पिछले वर्षों में और अब में ताज महल के रंग के अंदर कोई बदलाव नहीं देखा। मेरे अपने विचार से जैसा ताज पिछले 30-35 साल पहिले था, उसी रूप में आज है। सब देश के अखबार लिखते हैं कि ताज महल पीला पड़ गया है परन्तु मैं अपने विचार से यह मानता हूँ कि ताज के रंग में कुछ भी बदलाव नहीं हुआ है।

धन्यवाद

आपका

सचिव

जोन चेयरमैन

वाटर्स पोलो इन्टरनेशनल

G. P. Seth

Annexure XI-B

AGRA LEATHER BOARD (P) LTD.
5, Industrial Estate, AGRA-282006
Phone : 344112, 344143
Telex : 565-314 ALB IN
Fax : 0562 - 344073

23rd April'95

To,

Respected Dr. S. Vartharajan
Scientist, NEW DELHI.

I wish to express my considered openion on the status of TAJ MAHAL relating to the facts of much exagerrated talk of its decaing and loss of its beauty.

I had the privelge of being a student of history of St. Johns College, Agra during the year 1948-49 and since then I have been closely admiring the glory and beauty of TAJ. As a businessman and a Senior citizen of Agra, I have had many opportunities to visit TAJ MAHAL along-with eminent Foreign and Indian guests. I also had opportunities at number of occasions to officiate for protocal as a first citizen of Agra (in the absence of a Elected Mayor) and accompany the dignatories like Smt. Indira Gandhi, Prince Charlse, World Bank Chief - Machnamara, Chief of the U.S. Arm Forces etc. Besides number of business and Trade delegations from abroad.

From the visual appearances, I have not noticed any significant change in the colour and look of the stone of TAJ, except in summers the blowing of river sand from dry bed of Yamuna river, accumulating its dust and haze. The gardens, plants are also not being maintained to the high standard be-fitting to the status of the TAJ.

I, sincerely feel that better water management, greenery and care can lengthen the lifespan of the great monument of TAJ.

Contd... 2

RESI. : GAUR HOUSE, NEHRU NAGAR, AGRA. PHONE : 350627, 351311, 50078
1, KHAN MARKET, NEW DELHI. PHONE : 4632424
MADRAS PHONE : RES. : 4910195, OFFI. : 458534

AGRA LEATHER BOARD (P) LTD.
5, Industrial Estate, AGRA-282006
Phone : 344112, 344143
Telex : 565-314 ALB IN
Fax : 0562 - 344073

" THE CREATER OF UNIVERSE HAS ONLY CREATED THE SUN AND MOON IMMORTAL. EVERYTHING ELSE HAS LIMITATION OF LIFE".

G.P. SETH

- Chairman, Agra Leather Board, Agra.
- President, Agra Exim Federation, Agra.
- Past President, Agra Club Ltd. Agra.
- Past President, Factory Owners Association, Agra.
- Past President, Chamber of Commerce & Industries, Agra.
- Past President, Nehru Nagar Society & Trust, Agra.
- Past President, Tuberclosis Association, U.P.
- Past President, All India Dhyanchand Hockey Tournament-
- Past Vice President, Agra Gliding Club. -Committee.
- Past Director, National Industrial Corporation Ltd.
- Life Honorery Member of Air Force Station Mess, Agra.
- Had also served on Advisory Committees of Indian Railways, - LIC, Central Excise & Customs.
- Had been member of the Small Scale Industries Advisory - Board, appointed by the State Government.
- Member of the PHDI Committee of U.P. affairs.
- Chairman, Seth Ramji Dass & Sons (P)LTD/MA Exports (P)LTD.

RESI. GAUR HOUSE, NEHRU NAGAR, AGRA. PHONE : 350627, 351311, 50078
1, KHAN MARKET NEW DELHI. PHONE : 4632424
MADRAS PHONE. RES. : 4910195. OFFI. : 458534

Dr. Prakash Narayan Gupta
Bsc. M. B. B. S
Ex Minister of State U. P.
Election Obsurver for Dist. GAYA

Annexure XI-C

Date 23-4-95

Dear Dr. Varadarajan,

Every other day we find that there is some hue and cry regarding the deteriorating condition of the Taj. The media of this country and abroad join in this cry. It is the cry of those people who have not watched the Taj regularly even for some time. It is said that the color of the Taj is fading or that it is getting pale. How can a casual visitor make these statements.

I am an old citizen of Agra and since my child hood I have passed my time in the Taj premises. I was fond of it then and I am fond of it to-day. I visit the Taj often as I did in my childhood when the Taj was open to all with out any restriction day and night with out any ticket. I am now 73 yrs of age and still I visit the Taj quite often. I can say with certainty and with all the assertion at my command that the Taj is as it was sixty years back.

Yours Sincerely

(Dr P N Gupta).

सतीशचन्द गुप्ता
पूर्व विधायक

☎ : 367415, 54588, 53568
164, नेहरू नगर,
आगरा-282 005

23.4.1995

Dr S. Varadharajan,
Ministry of Environment & Forests,
New Delhi

Dear Sir,

I am quite concerned with the safety of the Tajmahal, which is our precious cultural heritage. I have been living in the city since birth and have been frequently visiting the Tajmahal. In my opinion, the building is no doubt ageing but to say, that its marble stone are getting yellower & loosing its whiteness is away from reality.

I would also like to say that lately road transport is causing anxiety in the city in the matter of pollution and needs immediate measures.

Thanking you,

Satish Chandra

(SATISH CHANDRA GUPTA)
Ex M.L.A.

Annexure XI-E

✆ : (0562) 363579
(0562) 363738

AGRA CLUB LIMITED

191, THE MALL, AGRA-282 001 (INDIA)

21st April '95

Dr. S. Varadarajan,
C/o Ministry of Environment & Forests,
C.G.O. Complex, Lodhi Road,
NEW DELHI-110003

Dear Dr. Varadarajan,

Our club established more than a century ago is affiliated to a large number of clubs all over India. The current membership is around one thousand (1000)

Our members are much concerned about misleading reports in the media that marble of Taj Mahal is yellowing.

A large number of our members are born & brought up in Agra & have occasion to see the Taj at regular intervels. This matter was discussed by the members & we have unanimous in our opinion that there is no yellowing. of Taj Mahal.

We may mention that a lot of people come from outside Agra & stay in the accomodation provided by the club and we never find any one saying that Taj is yellowing.

We feel strongly about this misinformation in News Papers & wish to state our views before you so that you may make suitable reference in your report to Hon'ble Supreme Court.

Thanking you,

Yours faithfully,

Dayal Saran

HONY. SECRETARY

TABLE - 1

Normals and Extremes of Rainfall

Station	No. of years of data		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Highest annual rainfall as % of normal& year**	Lowest annual rainfall as % of normal& year**	Heaviest rainfall in 24 hours* Amount (cm)	Heaviest rainfall in 24 hours* Date
Agra (obsy)	50	a	13.2	13.5	8.4	6.6	9.1	51.8	193.6	318.2	133.9	19.6	3.3	5.8	679.0	169 (1917)	41 (1913)	286.0	1959 Sep 16
		b	1.2	1.2	0.8	0.7	1.0	3.1	10.4	11.0	6.1	0.8	0.3	0.6	37.2				
Fatehpur-Sikri	50	a	12.3	11.4	5.8	4.3	6.3	47.2	179.6	193.5	130.6	15.3	3.6	5.3	618.4	175 (1926)	27 (1918)	217.2	1919 Aug 10
		b	1.3	1.1	0.6	0.5	0.8	3.0	9.8	10.1	6.0	0.8	0.3	0.6	34.9				
Kheirgarh	50	a	11.4	11.2	6.3	4.6	4.6	43.0	193.0	207.5	126.5	19.1	3.6	6.1	638.9	175 (1933)	35 (1918)	320.0	1873 Aug 12
		b	1.2	1.0	0.5	0.5	0.6	3.0	10.0	10.1	5.8	0.8	0.2	0.6	34.3				
Fatehabad	50	a	13.5	11.4	7.9	5.1	5.1	46.0	183.1	209.8	125.4	19.1	3.6	5.8	633.8	163 (1916)	31 (1913)	207.0	1912 Sep 07
		b	1.4	1.1	0.8	0.6	0.7	3.2	10.1	10.7	6.0	0.9	0.3	0.7	36.5				
Dab	50	a	13.7	10.7	8.6	6.6	8.9	60.7	230.2	225.3	151.6	20.6	4.3	6.6	755.8	191 (1936)	39 (1913)	229.1	1905 Jul 15
		b	1.4	1.0	0.9	0.8	0.8	3.5	11.2	11.2	6.8	1.0	0.3	0.7	39.6				
Firozabad	50	a	14.7	11.7	6.9	4.3	6.9	58.4	205.7	204.2	124.7	21.1	2.8	6.1	665.5	184 (1936)	34 (1918)	274.6	1939 Jul 22
		b	1.3	0.9	0.7	0.5	0.7	3.1	9.9	10.4	5.9	0.9	0.2	0.6	35.1				
Etmadpur	50	a	13.7	13.2	7.4	4.6	9.9	53.3	191.8	204.2	125.0	19.1	3.3	5.6	651.1	180 (1949)	44 (1905)	236.2	1921 Sep 21
		b	1.3	1.1	0.7	0.5	0.9	3.1	9.9	10.9	5.9	0.9	0.2	0.7	36.1				
Bhikapur	50	a	9.4	7.4	6.1	3.8	3.3	44.2	180.9	208.8	127.5	14.5	3.3	4.6	615.8	178 (1919)	28 (1918)	233.7	1912 Sep 07
		b	0.8	0.7	0.6	0.5	0.4	2.5	8.3	9.6	5.2	0.6	0.2	0.5	30.4				
Agra(Dist)		a	12.8	11.3	7.4	5.0	6.8	50.8	195.5	208.9	127.9	16.9	3.5	5.7	654.5	158 (1919)	34 (1918)		
		b	1.2	1.0	0.7	0.6	0.7	3.1	10.0	10.3	6.0	0.8	0.3	0.6	35.5				

(a) Normal rainfall in mm (b) Average number of rainy days (days with rain of 2.5 mm or more).

*Based on all available data upto 1980. **Years given in brackets.

Source: India Meteorological Department.

TABLE - 2

Frequency of Annual Rainfall in the District

(Data 1901-1950)

Range in mm	No. of years	Range in mm	No. of years
201 - 300	3	701 - 800	10
301 - 400	3	801 - 900	7
401 - 500	3	901 - 1000	3
501 - 600	8	1001 -- 1100	1
601 - 700	12		

TABLE - 3

Normals of Temperature and Relative Humidity

(AGRA)

Month	Mean Daily Maximum Temperature °C	Mean Daily Minimum Temperature °C	Highest Maximum ever recorded °C	Date	Lowest Minimum ever recorded °C	Date	Relative Humidity 0830 %	Relative Humidity 1730* %
January	22.2	7.4	31.1	1946 Jan 24	-2.2	1935 Jan 16	73	45
February	25.7	10.3	35.6	1897 Feb 25	-1.7	1929 Feb 01	64	32
March	31.9	15.7	42.8	1892 Mar 27	5.6	1945 Mar 07	47	24
April	37.7	21.6	46.5	1979 Apr 28	10.2	1981 Apr 02	32	18
May	41.8	27.2	48.0	1985 May 28	16.7	1926 May 12	30	21
June	40.5	29.5	48.3	1889 Jun 02	14.0	1983 Jun 06	48	34
July	34.8	27.0	46.5	1985 Jul 26	17.0	1962 Jul 23	75	66
August	32.8	25.8	42.2	1918 Aug 14	20.8	1957 Aug 13	81	75
September	33.2	24.6	41.4	1979 Sep 02	17.2	1935 Sep 30	77	62
October	33.3	19.1	41.1	1920 Oct 01	9.4	1939 Oct 31	59	40
November	29.2	12.0	36.1	1909 Nov 01	2.8	1926 Nov 19	61	33
December	24.1	8.2	30.5	1977 Dec 02	-0.6	1926 Dec 28	68	40
Annual	32.3	19.0					60	41

*Hours I.S.T

Source : India Meteorological Department.

TABLE - 4

Mean Wind Speed in Km/hr.

(AGRA)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3.6	4.2	4.9	5.1	5.9	6.9	5.8	4.9	4.5	3.2	2.6	2.9	4.9

TABLE - 5

Special Weather Phenomena

(AGRA)

Mean No. of days with*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Thunder	0.3	0.8	1.9	1.3	3.0	3.0	2.0	1.5	1.3	0.4	0.1	0.6	16.0
Hail	0.1	0	0.1	0.0	0.1	0.1	0.1	0	0	0	0	0	0.5
Dust-storm	0.0	0	0.5	0.7	1.5	1.7	0.1	0.1	0.1	0	0.1	0.1	5.0
Squall	0.0	0.1	0.2	0.5	1.1	1.0	0.3	0.2	0.3	0	0	0.1	4.0
Fog	1.1	0.3	0.1	0	0	0.2	0.8	0.5	0.6	0.1	0.1	0.8	5.0

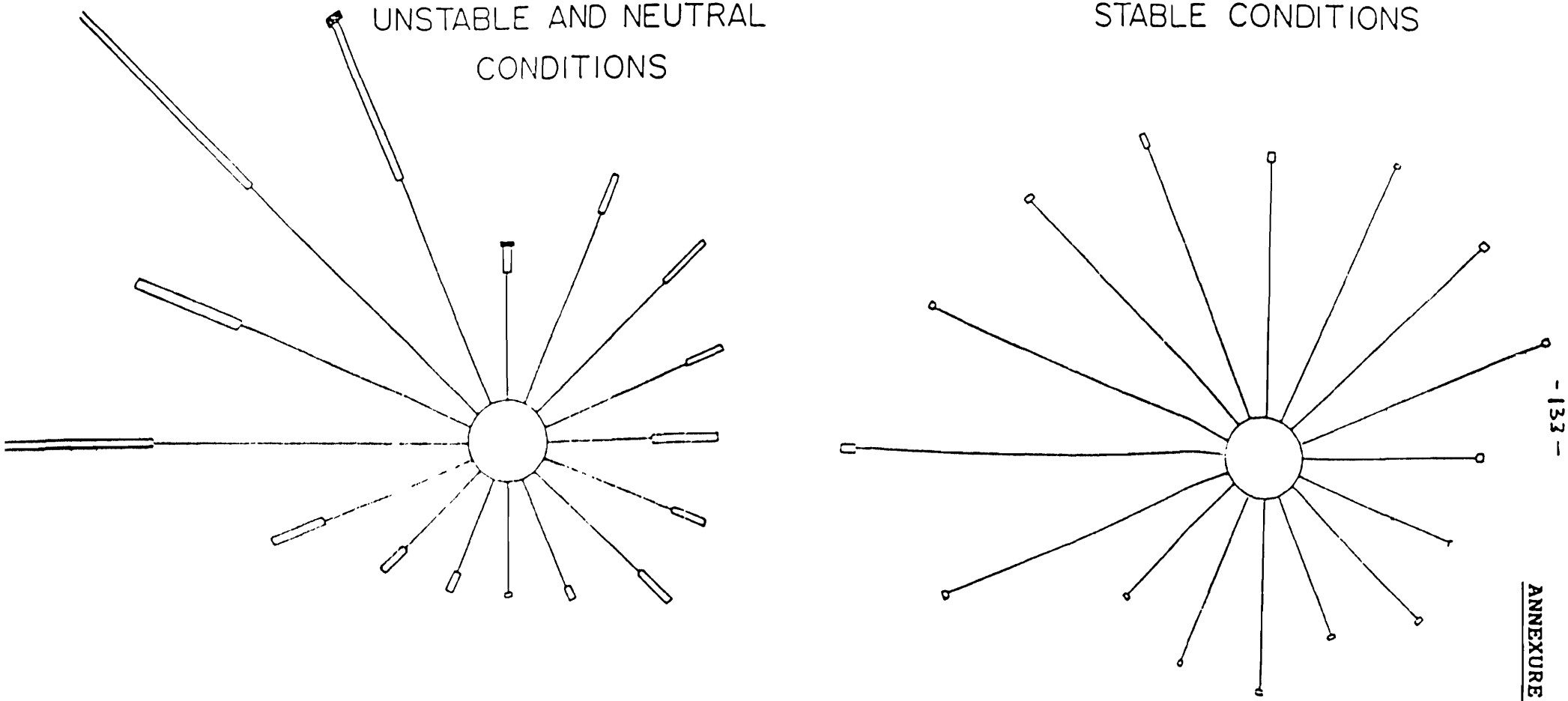
*No. of days two and above are given in whole numbers.

Source : India Meteorological Department.

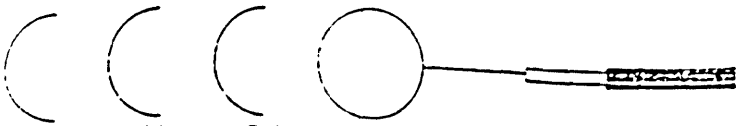
WIND ROSES FOR AGRA (SEASON: WINTER)

UNSTABLE AND NEUTRAL CONDITIONS

STABLE CONDITIONS



Source: India Meteorological Department.



LEGEND

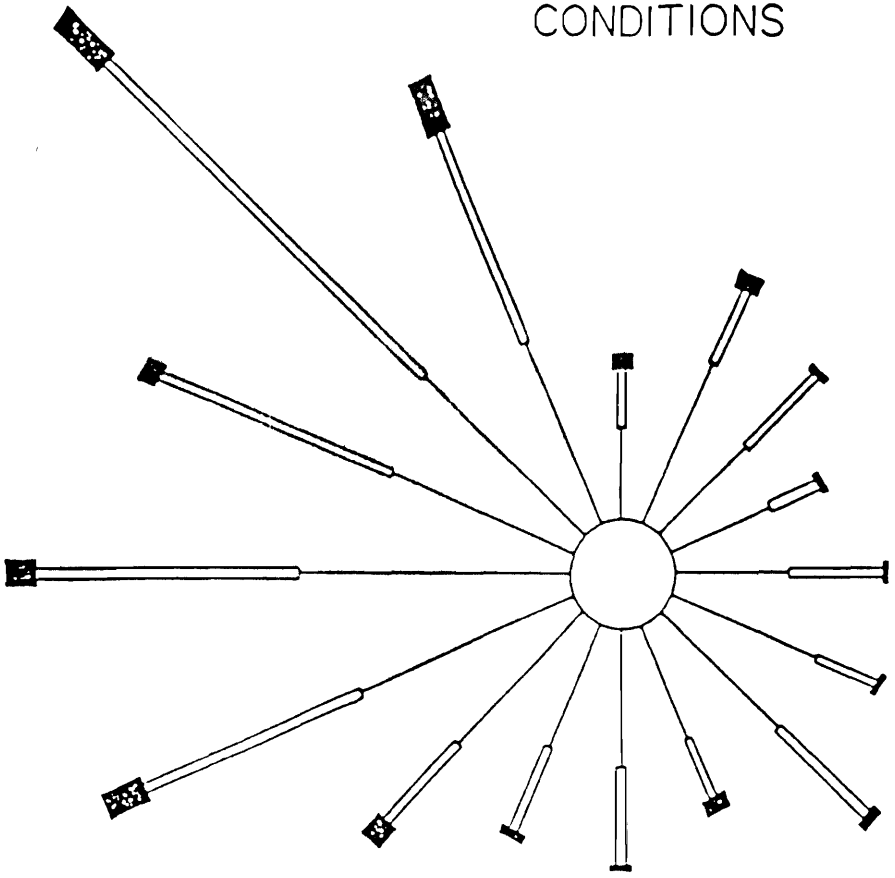
PERIOD --- 1983 TO 1992

ANNEXURE XIIIA

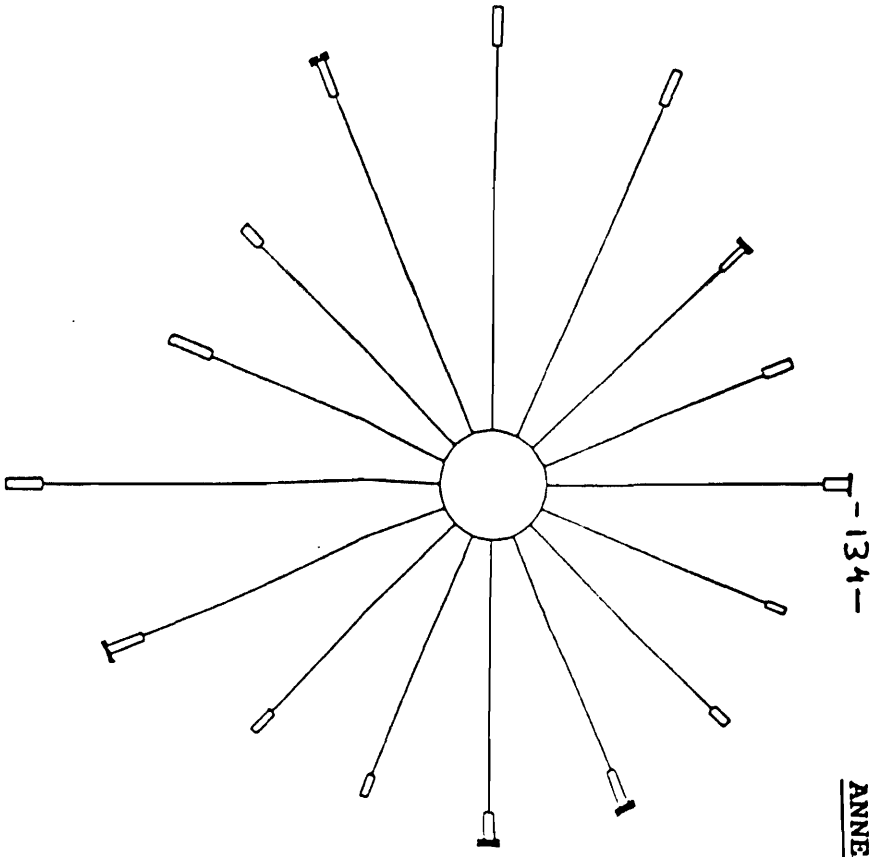
WIND ROSES FOR AGRA (SEASON SUMMER)

Annexure

UNSTABLE AND NEUTRAL CONDITIONS

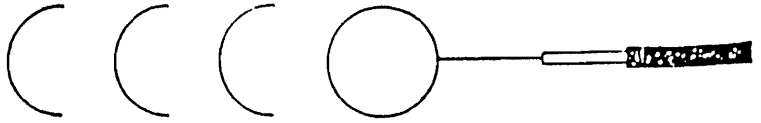


STABLE CONDITIONS



ANNEXURE XLIIB

Source: India Meteorological Department.



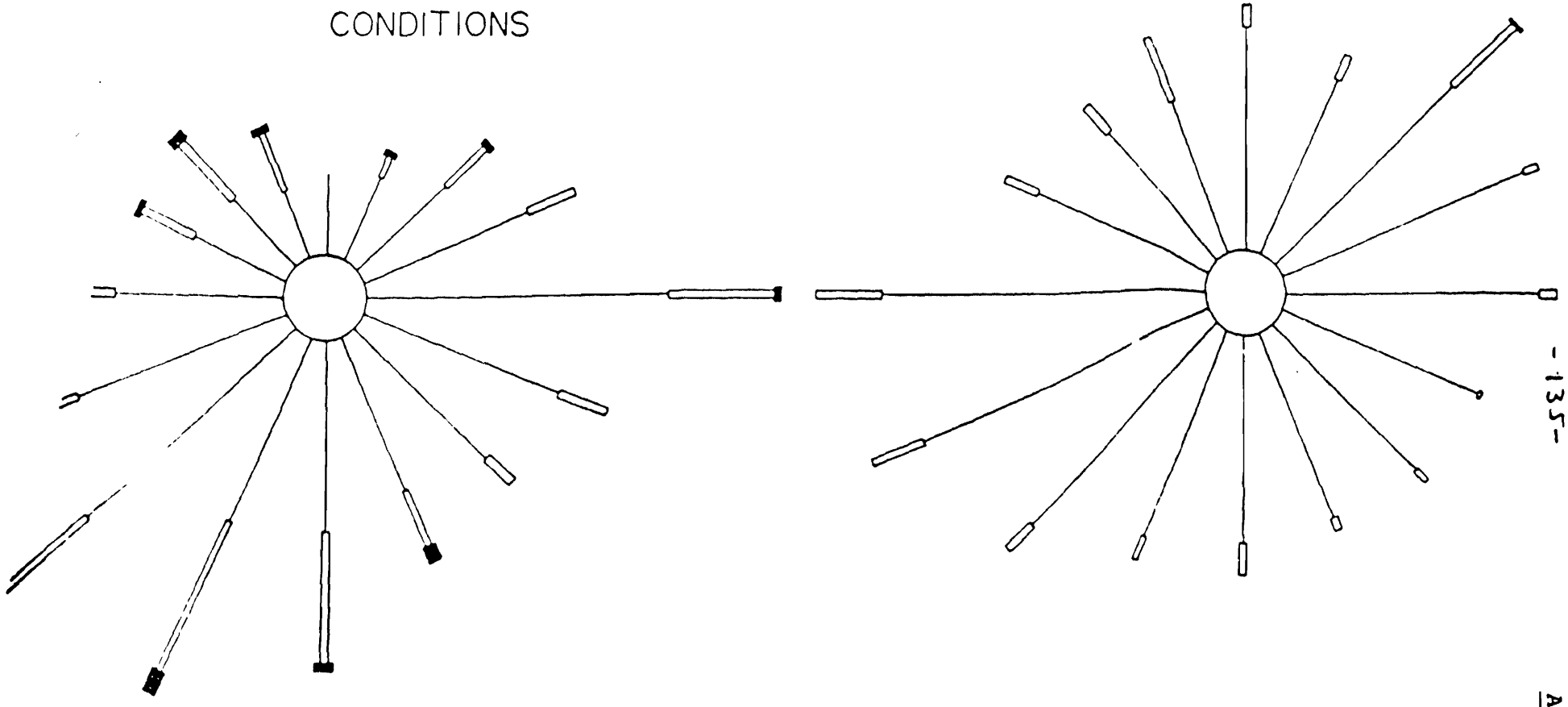
LEGEND

PERIOD ---1983 TO1992

WIND ROSES FOR AGRA (SEASON MONSOON)

UNSTABLE AND NEUTRAL CONDITIONS

STABLE CONDITIONS



Source: India Meteorological Department.

LEGEND

6% 4% 2% ≤3 4-6 7-10 KNOTS

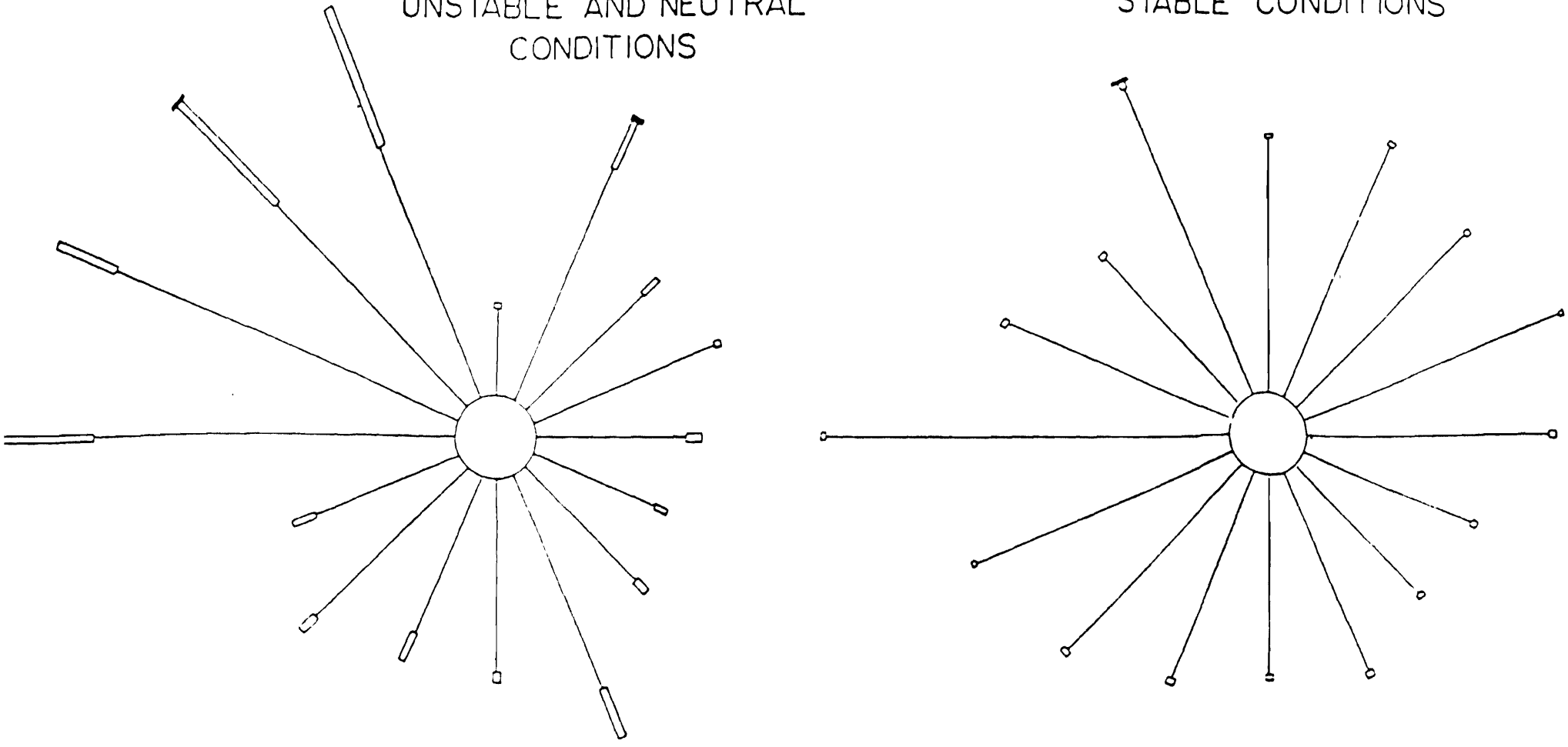
PERIOD---- 1983 TO 1992

ANNEXURE XIIIC

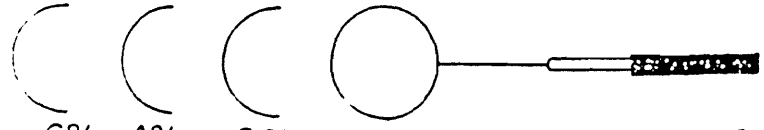
WIND ROSES FOR AGRA (SEASON: POST - MONSOON)

UNSTABLE AND NEUTRAL CONDITIONS

STABLE CONDITIONS



Source: India Meteorological Department.



LEGEND

PERIOD ---- 1983 TO 1992

Annexure XIV

P. ABRAHAM

विशेष सचिव
SPECIAL SECRETARY

भारत सरकार
GOVERNMENT OF INDIA
विद्युत मंत्रालय
MINISTRY OF POWER
श्रम शक्ति भवन, रफी मार्ग,
SHRAM SHAKTI BHAWAN, RAFI MARG,
नई दिल्ली - 110001
New Delhi - 110001

D.O.No. 13/12/93-OM

24th April, 1995.

Dear Shri Bakshi,

Please refer to your D.O. letter No. O-17012/21/93-CPW dated the 6th April, 1995 regarding power supply demand-deficit gap in the Agra Area.

2. The matter has been examined in consultation with Central Electricity Authority. CEA, have expressed that the actual power supply in Agra and other Districts of the State is not monitored by them. Any study of the future demands of Power in Agra City/Region would be done by the UPSEB and may be available with them. Regarding uninterrupted power supply to Industries and Commercial establishments in Agra, it is mentioned that the Agra Sub-Station of UPSEB has an installed capacity of 3x100 MVA, 220/132 KV transformers. This capacity is not adequate to meet the full power requirements of Agra, and UPSEB propose to augment this capacity by installing a additional (4th) transformer.

3. As regards the present demand - supply gap and the future estimated requirements in Agra City/Region, it is to be mentioned that the matter has been taken up with UPSEB several times at all levels and inspite of D.O. letters to the Chairman, UPSEB we have not received any information in this regard.

With best wishes,

Yours sincerely,

(P. ABRAHAM)

Shri K.K. Bakshi,
Additional Secretary,
Ministry of Environment & Forests,
Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi.

ANNEXURE - 2 A

SALE OF POL PRODUCTS OF AGRA DISTRICT YEAR 1982-83 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	254	194	183	147	137	155	185	233	220	184	174	230	2296
HSD	3196	2973	2872	2879	2407	2704	3342	3117	3236	3277	3141	3841	37085
SKO	854	1062	991	953	876	990	887	1023	1124	1287	1051	1002	12100
LDO	78	126	130	33	77	51	94	77	85	102	176	317	1355
FO	150	252	186	159	103	121	185	196	168	149	138	9	1835
LSHS	--	--	--	--	--	--	--	--	--	--	--	---	---

SALE OF POL PRODUCTS OF AGRA DISTRICT YEAR 1983-84 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	213	211	220	241	191	237	266	223	240	289	247	317	2895
HSD	3206	3469	3471	2764	2477	2894	3089	3825	3071	3459	3373	3724	38822
SKO	1136	911	1079	1058	935	1230	965	1010	1012	1037	1082	985	12440
LDO	216	226	198	179	128	206	189	222	276	283	311	312	2746
FO	48	50	220	289	172	--	100	73	97	78	83	--	1210
LSHS	--	--	--	--	--	--	--	--	--	--	--	--	---

SALE OF POL PRODUCTS OF AGRA DISTRICT YEAR 1984-85 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	275	298	240	237	295	259	283	301	276	294	276	352	3446
HSD	3452	3608	3262	3040	2562	3339	3253	3464	4580	3583	3249	3830	41322
SKO	1042	1107	1080	999	1075	1163	1202	1205	1237	1149	1164	1319	13742
LDO	183	242	183	166	178	130	239	353	249	309	270	239	2741
FO	21	--	--	62	--	45	65	29	105	--	95	41	463
LSHS	10	--	--	--	--	--	--	--	--	--	--	--	10

SALE OF POL PRODUCTS [illegible] GRA DISTRICT

YEAR 1985-[illegible] (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOT''
MS	271	271	256	277	279	276	286	307	321	349	317	354	3564
HSD	3954	3013	3497	3696	3282	3290	3807	4827	4112	3952	3973	4151	45554
SKO	1228	1271	1174	1219	1190	1268	1272	1247	1298	1339	1303	1311	15121
LDO	173	193	164	174	121	141	181	104	182	175	152	190	1950
FO	-	-	-	-	-	-	-	-	-	-	-	-	-
LSHS	-	-	-	-	-	-	-	-	-	-	-	-	-

SALE OF [illegible] PRODUCTS OF AGRA DISTRICT

YEAR 1986-87 (MT

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT.	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	332	342	322	399	407	361	416	433	453	459	446	482	4843
HSD	4187	3835	3916	4011	3015	3760	4385	4934	4959	4843	4419	4497 (482)	50787
SKO	1161	1080	1065	1102	1060	1146	1276 (1276)	1149	1133	1208	1175	1233	13787
LDO	189	225	154	218	183	230	191	155	239	234	227	206	2452
FO	13	-	41	-	-	-	-	21	-	-	-	-	75
LSHS	-	-	-	-	-	-	-	-	-	-	-	-	-

1-47-1

SALE OF POL PRODUCTS OF AGRA DISTRICT

YEAR 1987-88 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	451	460	493	451	422	461	466	498	493	483	509	586	5773
HSD	4397	3865	3259	3343	2976	3875	3853	5415	4504	3773	3921	3536	46736
SKO	1222	1178	1163	1203	1197	1247	1306	1223	1240	1209	1230	1291	14709
LDO	261	210	299	150	145	206	212	270	263	283	315	200	2814
FO	13	102	-	-	-	-	-	-	11	730	760	1607	3223
LSHS	-	-	-	-	-	-	-	-	-	-	-	-	-

SALE OF POL PRODUCTS OF AGRA DISTRICT YEAR 1988-89 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	619	498	533	621	563	634	659	628	613	626	661	622	6877
HSD	3665	3205	3394	2800	2773	3239	3482	4506	4028	3538	4234	4313	43189
SKO	1327	1264	1267	1217	1273	1345	1267	1214	1237	1245	1242	1170	15069
LDO	259	256	206	179	191	247	241	359	1743	242	280	386	4590
FO	-	-	-	-	-	-	-	-	-	-	-	-	-
LSHS	-	-	-	-	-	-	-	-	-	-	13	-	13

SALE OF POL PRODUCTS OF AGRA DISTRICT

YEAR 1989-90 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	EEB	MARCH	TOTAL
MS	655	708	660	681	644	658	655	716	691	684	731	777	8260
HSD	4379	3811	4065	3603	4128	3988	4294	5911	5401	4796	4623	4782	53781
SKO	1226	1214	1181	1301	1306	1352	1393	1760	1421	1384	1416	1351	16305
LDO	381	360	261	329	347	295	570	360	449	650	585	575	5162
FO	-	11	13	-	64	-	116	41	41	41	13	32	372
LSHS	-	13.5	-	-	-	2552.4	-	-	-	-	-	13.2	2579 1

SALE OF POL PRODUCTS OF AGRA DISTRICT

YEAR 1990-91

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	754	740	677	677	809	671	675 725	659	585	742	739	721	8499
HSD	4788	4769	4072	3627	5027	4611	5599	5225	4847	4992	3940	3689	55186
SKO	1321	1322	1188	1259	1198	1336	1353	1330	1376	1353	1318	1443	15797
LDO	738	628	430	479	410	152	405	189	116	293	241	384	4465
FO	-	-	13	-	-	-	-	-	-	34	-	161	208
LSHS	-	-	-	-	-	-	-	114.1	48	-	9.6	159.6	331.5

YEAR 1991-92

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	667	746	697	833	647	628	670	764 764	735	824	872	619	8702
HSD	3748	3796	3954 3454	4018	3908	4338	5260	5354	4914	4862	4942	4957	53551
SKO	1435	1415	1399	1335	1308	1324	1342	1369	1413	1377	1570	1353	16640
LDO	476	391	558	529	418	454	582	497	628	398	365	512	5808
FO	161 161	175	146	190	116	157	157	168	112	190	232	123	1927
LSHS	-	109.1	220.9	26.5	-	13.3	-	-	11.9	-	-	13.3	395.1

SALE OF POL PRODUCTS OF AGRA DISTRICT

YEAR 1992-93 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	851	797	712	877	810	773	746	882	595	680	758	711	9192
HSD	5510	4397	4659	5388	4475	4499	5347	5609	4749	5659	5578	5059	60929
SKO	1659	1355	1292	1339	1198	1230	1296	1286	1502	1295	1367	1273	16092
LDO	387	456	427	437	278	85	259	235	188	317	345	357	3771
FO	56	34	318	45	111	241	327	94	260	142	78	11	1717
LSHS	40.1	93	81.2	49.7	25.3	14.3	41.7	14.2	28.1	105.7	213.9	125.8	833.5

SALE OF POL PRODUCTS OF AGRA DISTRICT

YEAR 1993-94 (TT

ODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	775	738	844	703	789	706	597	647	675	617	796	681	8568
HSD	6132	5054	5862	5547	5332	4771	5526	6415	7058	5798	5928	5752	69175
SKO	1343	1267	1258	1180	1178	1127	1142	1217	1367	1306	1373	1324	15082
LDO	254	261	171	229	173	323	270	333	433	457	384	276	3564
FO	-	-	-	82	100	447	11	26	11	1348	1546	69	3640
LSHS	184.3	174.3	233.3	255.7	253.5	293.7	344.3	321.8	630.7	544.7	459.9	445.9	4141.9

SALE OF POL PRODUCTS OF AGRA DISTRICT YEAR 1984-85 (MTS)

PRODUCT	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	TOTAL
MS	613	668	650	625	628	653							
HSD	5510	4830	5016	4681	4518	6266							
SKO	1029	1040	1040	1002	1023	1008							
LDO	114	135	78	67	67	67							
FO	--	--	11	11	23	23							
LSHS	--	--	--	--	--	--							

Annexure XVI

Yearwise and categorywise vehicle population in Agra Region for the period 1982 to 1993

Year	Motor Car	Motor Cycle including moped	Bus mini Bus	Taxi three wheeler Taxi	Goods carrier Vehicle of Six tyre e more	Goods carrier vehicle of four tyre	Goods carrier vehicle of three tyre	Tractor	Tax free vehicle	Other Vehicle	Total
1982-83	4507	39469	392	2416	3705	532	337	11103	922	1072	64455
1983-84	4702	47364	399	2510	3827	626	345	11401	951	1095	73220
1984-85	4908	69428	409	2603	3925	720	354	11679	982	1127	96135
1985-86	5115	87912	422	2724	4032	815	362	12092	1011	1151	115636
1986-87	5606	98504	439	2841	4140	928	387	13399	1046	1175	128465
1987-88	5963	112211	455	2963	4225	1034	402	13753	1074	1198	143278
1988-89	6158	121815	493	3002	4311	1192	433	14002	1105	1223	153734
1989-90	6534	132215	522	3101	4403	1102	452	14592	1245	1245	165411
1990-91	7368	115214	577	2936	4502	1222	398	15594	1337	1322	150470
1991-92	9918	128377	642	3532	4102	1116	452	16397	1393	1669	167598
1992-93	9050	138566	851	4439	4048	1218	1027	17028	1314	2835	180476
1993-94	9890	148210	973	3674	3338	974	1154	17586	1708	1223	188780

Annexure XVII

सचिव
SECRETARY

सं० d
No. 23021/51/94-CPD

भारत सरकार
कोयला मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF COAL

नई दिल्ली, दिनांक
New Delhi, February 14, 1995

Dear Shri Krishnan,

Please refer to your D.O. letter No.Q-17012/21/93-CPW dated 9.2.95.

2. The information has since been received from Coal India Limited a copy of which is herewith enclosed.

With regards,

Yours sincerely,

(S.K. LALL)

Sh. N.R. Krishnan,
Secretary,
Ministry of Environment & Forests,
Paryavaran Bhawan,
CGO Complex,
NEW DELHI.

Encl: As above.

इण्डिया लिमिटेड
(मार्केटिंग डीवीजन)
ब्लोक-बी 6, तला
कलकत्ता-700 016
: 29-3421, 29-3425, 29-3427, 29-2569
फैक्स : 21-7180 सीआइएल इन
टेलेक्स : 29-3428
ग्राम : कोलइण्डिया

Coal India Limited
(MARKETING DIVISION)
BLOCK-B (6th FLOOR)
15, PARK STREET, CALCUTTA-700 016
Phone : 29-3421, 29-3425, 29-3427, 29-2569
Telex : 21-7180 CIL IN
Fax : 29-3428
Gram : COALINDIA

पत्र संख्या. Ref. No. CIL:CMD:SO:147223/ 470 दिनांक Date 8th Feb'95. 19

Kindly refer to your reminder vide No. 23021/51/94-CPD dated 30.1.95 in connection with the information sought by Shri KK Misra, Joint Secretary vide Fax message of even number dated 9.12.94 regarding supply of Coal to the Consumers in and around Agra.

2. As desired, the position, year-wise and Company-wise for Coal and Hard Coke is indicated below :-

(Figs. in '000 Ts.)

Year	ECL		CCL		BCCL	
	Coal	Hard Coke	Coal	Hard Coke	Coal	Hard Coke
1982-83	NA	-	0	-	NA	30
1983-84	NA	-	2	-	NA	29
1984-85	341	-	22	-	NA	24
1985-86	371	-	25	-	NA	23
1986-87	430	-	31	-	-	32
1987-88	479	-	5	-	12	34
1988-89	525	-	19	-	49	21
1989-90	490	-	25	-	82	21
1990-91	356	-	29	-	232	12
1991-92	276	-	35	-	223	7
1992-93	384	-	38	-	98	5
1993-94	354	-	23	-	111	10

3. The Coal supplied to nearby Thermal Power Stations like Panki, Faridabad and Hardgani in the above years is also indicated in the enclosed Statement (Annexure-I).

4. The figures for supply of Coal from ECL during 1982-83 and 1983-84 are not readily available and therefore are not being submitted. Similarly, the figures for BCCL for Coal for 1982-83 to 1985-86 are not available and hence not been submitted.

5. The Coal supplied from the respective Coal Companies had been Non-coking Coal having Sulphur content generally below 0.5 % . The Sulphur content in Hard Coke of BCCL is generally within 0.7 % (approx) .

Yours faithfully,

(B. AKALA)
Chief of Marketing

Encl: As above (PTO)

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(रिफाइनरी व पाइपलाइन प्रभाग), स्कोप कॉम्प्लेक्स, कोर - 2
7, इंस्टिट्यूशनल एरिया, लोदी रोड, नई दिल्ली-110003

Indian Oil Corporation Limited

(Refineries & Pipelines Division) Scope Complex, Core - 2
7, Institutional Area, Lodhi Road, New Delhi - 110003
Telex : 031 - 00000 Grams : 'OILREFIN'

Annex. XV

No.EP/HPC

April 24,1995 25

Shri R Anandakumar
Additional Director(S),
Ministry of Environment & Forests,
New Delhi.

Dear Sir,

This is with reference to various discussions which Dr. S Varadarajan and other distinguished members of the Expert Committee had with us on the subject of reducing SO2 emissions from Mathura Refinery. We are thankful for the various advices given to us on connected issues which can contribute to the reduction of SO2 emission ex Mathura Refinery. We are grateful for the consideration and appreciation shown by the Committee, during discussions, for our efforts being made in this direction.

It may kindly be recapitulated that the prescribed limits for the SO2 emissions are 1000 kg/hour during summer months and 700 kg/hour during winter months (October to February). Notwithstanding, we had been able to restrict the SO2 emissions well within 700 kg/hour throughout the year(s). We have forwarded to you our data indicating that we have been operating around 570-640 kg/hour SO2 emission. It is needless to say that our efforts to reduce the SO2 emission is a continuing process.

As suggested, we have been exploring the feasibility of further reducing the sulphur content of internal fuel oil (IFO) till natural gas becomes available, which is expected from Jan'97. Prima-facie this seems feasible by downgrading low sulphur heavy vacuum gas oil, which is a valuable feed component of FCC Unit, and blending it into the IFO. This step leads to reduction in production of valuable distillates. As advised, this interim measure of use of IFO having lower sulphur content of 0.3% wt. is being tried out from 2.4.1995 and the SO2 emission level is expected to be in the range of 460-520 kg/hour with the said change effective May/ June'95.

-2-

The use of natural gas, which has already been allocated to Mathura Refinery, in combination with internal fuel oil firing (20%), is expected to bring down the SO2 emissions from 460-520 kg/hour to the range of 340-380 kg/hour.

The above indicated SO2 emissions take into consideration that the Govt. will allow downgradation, as mentioned on pre-page, enabling blending/use of internal fuel oil having 0.3% wt. sulphur at the cost of distillate yields.

In addition, our proposal for setting up Batching Secondary Processing Facilities at Mathura Refinery inclusive of provision of a Hydrocracker is awaiting approval of the Govt. On completion of these facilities expected in 42 months after Govt. approval, the emission level is expected to come down to a level of around 200 kg/hour.

Meanwhile, we are exploring various other options to bring down SO2 emission in a shorter time frame. Feasibility of changing catalyst in the FCC unit and trial use of suitable additive to reduce SO2 emission is being looked into and inplant trials will be taken up during 1995-96.

We are also taking action for improving efficiency of existing Sulphur Recovery Units.

Considering various factors like possible change in crude mix/quality, shut-down of units for maintenance and outage of natural gas supply during maintenance of upstream systems, there can be occasions when SO2 emissions could be higher than those indicated above. These factors deserve due appreciation.

We express our thanks once again to all the Committee members who had series of discussions with us and gave us ample opportunity for fruitful interaction.

Thanking You,

Yours faithfully,

(A K Arora)
Director(R&P)

CC: Joint Secretary(R), MOP&NG

Adviser(R), MOP&NG

This issues with the approval of MOP&NG, as conveyed vide letter no.R-42011/4/95-OR.I dated 25th April'95.

Annexure XIX

NIRMAL SINGH
TEL: 381832

भारत सरकार
पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय
Government of India
Ministry of
Petroleum & Natural Gas
New Delhi - 110001

संयुक्त सचिव
JOINT SECRETARY

DO NO. P-39018/1/95-CC

26TH APRIL,95

Dear Shri Baksi,

Kindly refer to your DO letter no.Q-17012/1/93-CPW dated 25th April, 1995. The matter has been examined in consultation with the oil industry and information is furnished as under:

According to the Plan approved by this Ministry for introduction of 0.25 sulphur containing HSD, same will be available in the country by 2000 AD and not by 1997 as mentioned in your letter as it will not be technically feasible to do so by 1997.

The demand of the petroleum products is at peak during the months of March to June and October to January. During this year due to unexpected shut down of Mathura Refinery and longer turn around in HBJ pipeline the oil industry has to make dip into its inventory and therefore presently managing the demand and supply in a hand to mouth situation. The demand of HSD has also shot up during these months for the agriculture sector and the oil industry has geared fully to meet this demand by importing quantity of HSD as per the existing specifications.

We have reassessed the situation and consider such a situation is likely to continue for a few months or till the Kandla Bhatinda pipeline which would get commissioned by last quarter of 1995-96. In view of this, our considered view is that it is not desirable to change the product movement slate and product specifications as it will adversely affect the supply resulting in hardships to the entire consumers in the northern region. I am to mention here that already consumers in the northern region are suffering due to the shortage of diesel.

In view of these facts and due to suggestions of Dr. Varadarajan, we had discussed the matter in great detail with the oil industry and this Ministry proposes the following action plan for Agra and Taj Trepizium.

i) 0.5 sulphur diesel from April,1996 as announced by the MOS under the Ten Point Programme.

ii) Supply of 0.25 sulphur diesel in the Taj Trapezium from 1st Sep 1996. 6 months additional time is required after introduction of 0.5 sulphur diesel to segregate a separate distribution system for 0.25 sulphur diesel. However, it would mean that from 1st 1996 three different varieties of diesel would be marketed i.e.

a) 1% sulphur diesel for rest of the country
b) 0.5% sulphur for the 4 metropolitan cities
c) 0.25% sulphur for Taj Trapezium Area.

I am also to add here even this would be achieved by the oil industry under very tight schedule and by importing the quantities at the considerable higher cost.

With regards

Yours sincerely,

(Nirmal Singh)

Shri K.K. Baksi,
Additional Secretary,
Ministry of Environment and Forests,
Paryavaran Bhavan,
CGO Complex,
New Delhi.

Annexure XX

सचिव
JOINT SECRETARY

Nirmal Singh
Joint Secretary
Tele : 381932

भारत सरकार
पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय
Government of India
Ministry of
Petroleum & Natural Gas
New Delhi-110 001

D.O. No. P-39018/1/95-CC

April 29, 1995

Dear Shri Baksi,

Kindly refer to your d.o. letter dated 27.4.1995 regarding supply of LPG cylinders in the Taj Trapezium area. The matter has been examined in consultation with the Oil Industry. It is proposed to supply LPG connections on prioirity by March 1996 to customers in the Taj Trapezium area, enrolled upto 1st January 1995.

With regards,

Yours sincerely.

(Nirmal Singh)

Shri K.K. Baksi,
Additional Secretary,
Ministry of Environment & Forests.
CGO Complex, Lodi Road,
New Delhi.