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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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January 1989

POLLUTION CONTROL RESEARCH INSTITUTE

DP/IND/83/008/11-06

Republic of India

Expert Report*

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

Based on the work of S.C. Wallin
On Environmental and Impact Analysis Conference for Developing
Countries in New Delhi (28 Nov. 2 Dec. 1988)
And a Mission to the Pollution Control Research Institute, Hardwar
(3 Dec. - 16 Dec. 1988)

Backstopping Officer: R.O. Williams, Chemical Industries Branch
United Nations Industrial Development Organization
Vienna

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CONTENTS

		Page No.
1.	INTRODUCTION	3
2.	ENVIRONMENTAL IMPACT ANALYSIS CONFERENCE, EIA, 28 NOVEMBER-2 DECEMBER 1988	4
	2.1 Presentation of Papers	5
	2.2 Scientific/Technical Content	5
	2.2.1 Inaugural Session I	5
	2.2.2 Scientific Technical Sessions II-XIII	6
3.	EIA CONFERENCE - CONCLUSIONS AND RECOMMENDATIONS	7
4.	MISSION AT THE POLLUTION CONTROL RESEARCH INSTITUTE (PCRI) BHARAT HEAVY ELECTRICALS LTD, HARDWAR	8
	4.1 Diary of Activity and General Comments	8
5.	DISCUSSION	12
	5.1 Functional Organisation of PCRI	13
	5.2 Scientific and Technical Facilities	13
	5.2.1 Stationary and Mobile Source Emissions - Sampling and Measurement	13
	5.2.2.1 Stationary Source Emission Measurement	14
	5.2.2.2 Mobile Source Emission Measurement	14
	5.3 Computer Facilities	15
	5.4 PCRI Project Proposals and Reports	15
6.	SUGGESTED STRATEGY AND PROPOSALS FOR R AND D IN THE SHORT AND MEDIUM-TERM	15
	6.1 Short-Term 'In House' and Field Studies	16
	6.2 Medium-Term 'In House' and Field Studies	16
7.	REQUIREMENTS FOR STAFF, FELLOWSHIPS AND TRAINING	16
	7.1 Proposed Requirement at Senior Level	16
	7.2 Fellowships and Training	17
8.	MISSION AT PCRI - CONCLUSIONS AND RECOMMENDATIONS	17
9.	REFERENCES	19
APPENDIX A:	MAIN SOURCES OF AIR POLLUTION	A1
APPENDIX B:	PCRI STAFF ATTENDANCE AT LECTURES, SEMINARS AND SYNDICATES	B1
APPENDIX C:	VISIT TO IDPL - 11 DECEMBER 1988	C1
APPENDIX D:	CANDIDATE HOST ORGANISATIONS IN THE UK	D1
APPENDIX E:	RECOMMENDED JOURNALS AND BOOKS FOR THE PCRI LIBRARY IN ADDITION TO THOSE ALREADY SUGGESTED BY OTHER EXPERTS	E1

1. INTRODUCTION

The body entrusted by the Government of India for all areas of conservation, including the control of air pollution, is the Department of the Environment. The work of control is carried out by Central and State Boards for the Control of Water and Air Pollution. Unlike the Water Pollution Act of 1974 which made it voluntary for States to set up Water Pollution Control Boards, the Central Air (Pollution and Control of Pollution) Act 1981 is based on the preamble of the Constitution and therefore compulsory.

With regard to environmental monitoring for air pollution this appears to be conducted in a somewhat unco-ordinated manner by bodies such as the National Environmental Engineering Research Institute (NEERI) at Nagpur, Universities, Institutes of Technology and by the Boards themselves. In collaboration with the Indian Meteorological Department and supporting laboratories a network of monitoring stations is being, or has been, set up to provide information on which to base its standards. A brief review of the main sources of air pollution and ambient air quality standards are given in Appendix A together with a list of the major manufacturers of pollution control equipment for India.

As part of an ongoing (for the past three years) UNIDO project giving technical assistance to the Bharat Heavy Electricals Limited Pollution Control Research Institute (PCRI) the following duties were specified for the present mission:

1.1 New Delhi

The expert will participate in the forthcoming EIA conference to be held in New Delhi 28/11 to 2/12, 1988. The expert will participate in discussions on topics relevant to his field of expertise, and should be prepared to chair one of the sessions if requested to do so.

1.2 The expert will spend two weeks at Hardwar at PCRI for discussions with the technical and administrative staff concerning:

- Focus of current PCRI programme and identification of projects of relevance to India and of potential commercial value to PCRI.

- Training programme for PCRI technical staff.

- Optimum use of project equipment

The expert will assist in the preparation of a work plan for PCRI for 1989. This will be undertaken in co-operation with other members of the UNIDO expert team and the National Project Staff. The work plan will constitute an overall scheme of project work for PCRI with commercial potential. This scheme should be co-ordinated with the UNIDO inputs for 1989 in particular:

- Experts (Disciplines/duration and timing of missions)
- Training (Disciplines/duration and timing of Fellowships)

1.3 Prepare a report on the findings of the mission.

The mission was planned with two main duties and therefore the report will be divided into two sections with a separate discussion, conclusions and recommendations for each part. In the case of participation at the 'International Conference on Environmental Impact Analysis (EIA's) for Developing Countries' held in New Delhi I do not propose to deal with the presentations and subject matter in depth firstly because it is not practicable to do so, and secondly the proceedings will be published at a later date. However, it should be noted that the Conference not only gave the opportunity to make contributions on my own areas of research, but provided a useful insight to the environmental issues specific to India.

2. ENVIRONMENTAL IMPACT ANALYSIS CONFERENCE EIA, 28 NOVEMBER-2 DECEMBER 1988

The general organisation of the Conference ran smoothly and efficiently; unfortunately with such a large number of papers programmed for each session presentational difficulties were experienced. The problems were exacerbated by additional papers being included in almost all the sessions - Appendix B indicates the activity for each session. I acted as rapporteur for Session III and Co-chairman for Session VIII and in both instances found it stimulating and rewarding.

In attempting to give an overview of the Conference it should be noted that EIA covers a very wide spectrum of scientific disciplines and makes it virtually impossible to give full justice to the papers. For the sessions I attended - other commitments precluded some - summaries of the proceedings have been classified into; presentation; technical content and discussion.

2.1 Presentation of Papers

The majority of papers were not available to all the delegates, and in some cases no abstract was given in the Conference publication received at registration. With a number of exceptions papers were poorly presented for the following reasons:

(i) too much detail with no clearly defined objectives, relevant information obtained from the study and conclusions;

(ii) overviews (or slides) often gave tables of results with so much data that they became meaningless. Furthermore it was impossible for many delegates to read the overviews except for those very near to the screen;

(iii) in attempting to give as much information as possible in the limited time available the lecturers spoke too quickly, particularly for an international meeting.

2.2 Scientific/Technical Content

The content and standard of the papers covered a wide range and probably about 30% would, in my view, justify publication in top class scientific journals. As already indicated an attempt will be made to highlight several important features of the sessions.

2.2.1 Inaugural Session I

The need to consider the environmental/ecological problems of both the developed and the developing countries in relation to achievements, improvements, and future trends was pointed out. For the developing countries the tensions that can occur between the driving force of an improved economy and

the requirement of ecological conservation were pointed out thus underlining the importance of cost-effectiveness in the remedial measures that have to be taken.

2.2.2 Scientific Technical Sessions II-XIII

There were approximately 120 scientific/technical papers presented and unfortunately in many cases shortage of time precluded adequate discussion. However, the opportunity to give written questions that could be dealt with by the authors after their presentations was a sensible compromise.

The complexity of EIA's and the requirement by industrially developed and developing countries to establish risk assessment guidelines and to continually update them in the light of experience and new methods became more and more apparent as the Conference progressed. Another issue raised was the question of hazard analysis, but to deal with this in any depth would have added to an already complex and overloaded conference. A plea at the end of all the sessions was made for simple guidelines to be devised in order to arrive at a standard way of EIA development. A number of presenters emphasised the importance of monitoring conditions 'before' and 'after' EIA's which would facilitate sensitivity analyses and provide useful data for model development.

The requirements of funding organisations were dealt with and included feasibility studies, mitigation measures and implementation plans. Papers on technologies for air and water pollution mitigation/abatement were presented; these were generally for new plant and not systems suitable for low-cost retrofitting.

A number of interesting papers on case studies for many industrial activities were given, the processes ranging from small-scale tanneries to thermal power stations. In some cases biological impact assessments were considered for pesticides, heavy metals and pharmaceuticals.

The disposal of waste materials, municipal and/or hazardous were briefly discussed together with the impact on air, water and land.

3. EIA CONFERENCE - CONCLUSIONS AND RECOMMENDATIONS

- The Conference was a success in organising the wide ranging papers on EIA's and supporting scientific information from industrially developed and developing countries. In addition it provided a very useful forum for a large number of delegates to make contact and have dialogue formally and informally on issues of common interest.

- Further to the publication of the Conference proceedings a critical review should be made of the gaps in knowledge and recommendations made for the future way ahead.

- It is recommended that a follow-up Conference be considered in one to two years hence based on the experience and identified priority issues of this first International Conference on EIA for developing countries. The format of a future conference should be arranged to meet the following criteria:

  (a) the submission of papers by invited authors on selected topics to meet the requirements of the referees appointed by the committee. Preprints of the papers should be circulated to all delegates prior to attendance;

  (b) the possibility of including representatives of the relevant universities and professional institutions on the committee would be helpful.

  (c) clear instructions should be given on the preparation of visual aids and the presentation of scientific and technical papers.

- The possibility of organising any future conference on 'workshop' lines and with several running concurrently should be explored. Also a duration of 3-4 days would then be adequate to cover the subject matter.

4. MISSION AT THE POLLUTION CONTROL RESEARCH INSTITUTE (PCRI) BHARAT HEAVY ELECTRICALS LTD, HARDWAR

The visit, activities and timescale are given in Figure 2. A programme of lectures, syndicates and outside visits were prepared and updated taking into account the perceived requirements of the Institute. The times that PCRI staff attended lectures are given in Appendix B; at the end of the mission a short interview was conducted with each attendee. To summarise I found the staff co-operative and without exception of considerable potential which can be realised with good training and career development.

4.1 Diary of Activity and General Comments

Each day's activity will be reported in outline with comments where appropriate.

Monday 5 December 1988

Topic: To provide details on the prevention and control of pollution from coal-fired boilers.

The conventional coal-fired boiler systems were considered for SO_x, NO_x and particulate emissions. Technologies for fuel treatment, combustion control and post combustion abatement were presented[1-4]. Fluid-bed combustion was excluded because an expert (B Locke) dealt with this subject.

A short visit was made to the air pollution measurement laboratory in order to assess the type of equipment and instruments available.

Tuesday 6 December 1988

The previous day's topic was continued followed by a short case study based on a previous investigation/report prepared by PCRI.

In the afternoon the local BHEL industrial complex, where a number of different activities were observed, gave an opportunity to obtain some 'first hand' process information. The producer gas plant (600 m^3/h) used a steam coal with an ash content of about 20%. The final liquid effluent (containing

tars and other organics) from the process is mixed with the coal ash to form a slurry for disposal at a land site. This practice may present a water problem associated with the quality of the leachates from the land disposal site. The Casting Foundry and Forging Plant (CFFP) produces about 2000 tons/y of cast steel mainly for BHEL's power general equipment. An internal pollution problem exists due to metal fume emissions from electric arc melting and pouring, also fume evolved during the thermal cutting of the risers attached to the castings.

Wednesday 7 December 1988

EIA Study for Doon Valley.

Previous work has been carried out by PCRI on monitoring ambient air concentrations of selected pollutants where SO_2, NO_x were above the AQ limits in some cases at the measurement sites. For SPM the majority of the sites indicated concentrations above the AO limits. A further investigation is proposed for this environmentally sensitive valley and seemed appropriate as an EIA case study. The main objective of this seminar was to establish the principles involved in preparing a project proposal.

A PCRI seminar for all the groups was held in the afternoon with the first objective of specifying the important input parameters used for modelling the dispersion of pollutants from thermal power stations. The second objective was to try and develop an expert system taking fuel composition, combustion control and abatement measures into account. This second objective received a note of dissent from myself chiefly because in my view it was not the correct form and could therefore be dealt with only in a simplistic way. I submitted some notes to the modelling group dealing with some of the issues raised - plume buoyancy and the estimation of pollutant emissions.

Thursday 8 December 1988

The power station located within the BHEL complex was visited, where at the present time pulverised coal is combusted in two boilers producing about 7 MW electricity. The volume of flue gas is about 50,000 Nm^3/h and the particulate emission is abated with an electrostatic precipitator before discharge to the atmosphere. Using extractive sampling the concentrations of particulates and SO_2 discharged in the flue gas are measured on a regular basis.

Downstream of the EP arrangements have been made to extract up to 9000 Nm^3/h of the flue gases and direct them into a transportable 'Montair Andersen BV' Model HS-10 Wet Scrubber. A full description and specification of the scrubber is given in a previous Mission Report to PCRI. Possible applications of the HS-10 wet scrubber will be presented in B Locke's mission report.

In my view consideration should be given to incorporating the HS-10 scrubber as part of a pilot-scale test facility for the development and evaluation of other abatement systems. The test facility could also be used to evaluate on-line measurement systems and instruments for gases and particles.

With the objective of using the CFFP's pollution problems within the working environment as a case study where a minimum cost solution is required a syndicate exercise was set up. Four main areas of involvement were identified, two PCRI staff were allocated to each task so that a specimen project proposal could be the end result. In the event the proposal will probably develop into a viable project for the CFFP at BHEL.

Friday 9 December 1988

The syndicate exercise for the CFFP with what were considered to be the least cost technical options was completed.

A candidate low cost system was described for the abatement of particulate emissions from a foundry cupola and the relevant design principles referenced[6] The problems associated with the measurement of emissions from cupolas were briefly discussed.

Saturday 10 December 1988

It was considered necessary to emphasise the importance of the structure of a project proposal from the point of view of customer and the contractor. To this end the morning session was scheduled.

A lecture was given on recent advances in abatement technologies, with special reference to electrostatic precipitators.

Sunday 11 December 1988

A visit was made to the Indian Drugs and Pharmaceuticals Ltd (IDPL) Antibiotics Plant at Virbhodra near Rishikesh. The plant is situated on the banks of the river Ganges and a biological treatment system for industrial and domestic wastes is in place before discharging the treated liquid effluent into the river. Mr P N Thakral, Senior Executive, nicely described the biological treatment plant and conducted a tour of the site. The plant is well operated and maintained.

During the visit three problem areas were mentioned and advice requested to overcome or ameliorate them. The possible solutions to problems posed are given in Appendix C.

Monday 12 December 1988

The three problem areas identified at the IDPL Plant were used as a syndicate approach, and the data used in Appendix C resulted from PCRI's staff.

As part of R and D at the PCRI sampling procedures for ambient and stack sampling with special reference to particles were considered in a group seminar. Information on the sampling and measurement of particles suspended in gases together with special equipment and commercial equipment has been forwarded to PCRI (21-12-88).

Tuesday 13 December 1988

Methods of on-line sampling for gases and particulates from boiler plant[7] were presented in a seminar.

A case study on the options for the abatement of SO_x and particulate matter from small boilers was carried out.

At the request of Mr R Prakash (Deputy General Manager BHEL, Hardwar) a meeting in the afternoon explored the practicability and options for PCRI to carry out a study at the CFFP.

Wednesday 14 December 1988

Disposal and Utilization of Coal-Fired Power Plants Fly-ash and Slag.

A lecture was given on the site selection, transportation of the waste, physical and chemical characteristics of the waste and the environmental considerations at the disposal site. The possibilities for the utilization of flyash and slag were briefly discussed.

A short presentation was made on the proposed 'in house' study of Bentonite for water treatment. To facilitate the study a bench-scale test facility has been designed. The lack of a feasibility study before embarking on the project was surprising and information has been submit ed to PCRI (21-12-88) which may be helpful in making such a study.

Thursday 15 December 1988

The EIA for the Feroze Gandhi Thermal Power Plant, Unchahar is being undertaken jointly by U P Rajya Vidyut Utpadam Nigam Ltd (UPRVUN) and PCRI. The assessment is in two phases to take account of the phased construction and introduction of the thermal power stations. In my view the project proposal prepared by members of the seminar group is comprehensive and if implemented should meet the stated objectives. To complete my mission at PCRI I wrote an outline of suggested actions; and projects for 'in house' and 'field' investigation. Copies were given to Mr Agarwala and for Dr Biswas when he returns to PCRI.

Brief interviews were held with all the attendees at my lectures and seminars.

5. DISCUSSION

During my short mission to the PCRI it was difficult to understand the general policy of the Institute with regard to the way it wished to operate. I presume it has a twofold function, firstly to act as a research arm to BHEL and secondly to function as a contract research institute on environmentally related topics. If this is the case and PCRI operates as a 'cost centre' I think it is imperative to have in place a forward programme with planned staff and resource

accountability. Also a suggested functional organisation is given in Figure 1.

The following topics in the discussion are biased towards research on air pollution and emission abatement, but in many cases the comments apply equally well to the whole spectrum of the environmental work at the Institute.

5.1 Functional Organisation of PCRI

The total number of staff at present is very small and even with the projected complement (100?) will create management difficulties in relation to the many aspects of pollution control. It would appear that on the scientific and technical side a matrix type of management is necessary and I gained the impression that this is the way it is developing. However, it is obvious that at a deputy director level a scientist/engineer with the ability to deal with multi-disciplinary activities is urgently required.

5.2 Scientific and Technical Facilities

With respect to the sections set up to deal with the various R and D activities these are adequate, but in some cases the means to meet the requirements is not. This is particularly evident in the library where books and journals essential for the day to day work of the scientific staff are not available. Other visiting experts[5] have made recommendations regarding this matter.

Although there is always pressure to enhance the analytical equipment at an Institute generally these are satisfactory. With regard to the indirectly coupled plasma analyser already in place, some expansion in routine environmental survey work is required to justify its use.

5.2.1 Stationary and Mobile Source Emissions - Sampling and Measurement

There is often a need to determine the emissions into the environment from a number of activities for the purpose of regulatory conformity, emission inventories (input to EIA's) and the development of abatement equipment. A mobile, well equipped laboratory is available and operational to continuously measure a range of gaseous concentrations in the ambient atmosphere and it would be possible to convert this facility for dual operation viz the measurement of

gaseous concentrations in the ambient atmosphere or in process gases emitted to the atmosphere. In my view the capability of dual operation of the mobile laboratory would be a cost effective asset for PCRI.

5.2.2.1 Stationary Source Emission Measurement. The measurement of gaseous emissions from processes e.g. combustion relies mainly on discontinuous wet chemical methods. Clearly this is unsatisfactory and portable instruments for gases such as: O_2, CO_2, CO, SO_2, THC and NO_x are required.

For the measurement of particulate emissions the Institute is quite well equipped for determining the physical and chemical characteristics of particles and their rate of emission. However, the use of equipment for this work (US EPA method V and Andersen 'in stack' impactor) is not always convenient or practicable because of its size and the 'in house' manufacture of a simplified system should be considered[8]. A further requirement is the need to continuously measure the particle concentration in some processes and a transmissometer could be suitable for this function.

5.2.2.2 Mobile Source Emission Measurement. The attribution of emissions from mobile sources - diesel and petrol-engined vehicles - is often needed as an input for an EIA. It is possible to use published data e.g. US emission factors, but it may be preferable to obtain those relevant for India. One method to determine the emission factors is to measure the gaseous and particulate concentrations for a specified driving cycle on a roller dynamometer using a constant volume sampling system (CVS). This facility is beyond the scope of PCRI, but an alternative is to sample on the vehicle[9,10] under relevant driving conditions the gaseous and particulate emissions and analyse them at the Institute. PCRI is already capable of making these analyses.

Although Indian legislation gives a limit for concentrations from diesel-engined vehicles in Hartridge units the only way that this can be validly tested is by using a roller dynamometer at maximum load down to 40% of the governed speed[11]. Furthermore Hartridge smoke units (HSU's) measure opacity and therefore calibration is necessary[11] to express HSU's in terms of particle concentration[12].

5.3 Computer Facilities

At the present time these are totally inadequate for serious environmental work and I understand that measures are 'in hand' to enhance this facility.

In addition to routine documentation to be presented in spread sheets I see the need for models capable of determining wet and dry deposition[13-15] as well as dispersion in complex topographical situations. For the later case and the presentation of EIA data in good statistical and graphical presentation a more powerful computer is required as well as additional PC's.

5.4 PCRI Project Proposals and Reports

It is important to PCRI that the standard of its reports both in presentation and content establish a good reputation for the Institute. Also bearing in mind the need for sponsored work I think it would be helpful to specify a 'house' style in addition to being in a better position for publication of the investigations (where applicable) in technical and scientific journals.

With regard to project proposals these should have the essential elements and be in such a form that the proposed investigations will lead to a report meeting clearly defined objectives.

6. SUGGESTED STRATEGY AND PROPOSALS FOR R AND D IN THE SHORT AND MEDIUM-TERM

For the next 12 months it seems advisable to build on the resources and expertise that are already available, at the same time moving towards the goal of being a centre of excellence in pollution contro.. In 1989/90, and onwards, a number of projects is identified for both 'in house' and 'field' activities relevant to EIA, Air and Land Pollution and Abatement Technology - Figure 3. The speed at which some of the projects progress is related to circumstances outside the Institute's control, but as a general rule the 'forward look'/activity chart, Fig. 3, should ensure coherence of activity.

6.1 Short-Term 'In House' and 'Field' Studies

Experience and expertise should be gained in the operation of portable and/or simplified source measuring equipment. To provide a pilot-scale test plant for this purpose, and the evaluation of 'end-of-pipe' abatement systems, the special sampling section at the BHEL Power Plant would meet this requirement.

An emission index/inventory should be started, the data base to include a wide range of sources 'with' and 'without' abatement equipment. This should be a continuing project so that data are available as an input to EIA studies.

Project proposals have been prepared for 'field' studies to provide an input for two EIA studies; also an investigation at the CFFP is likely to become active in 1989. In addition unsolicited requests for investigations should increase in number for both source and ambient air pollution topics.

6.2 Medium-Term 'In House' and 'Field' Studies

On-line monitoring of gaseous and particulate concentrations in process effluents, e.g. power station flue gases, should be studied at bench and pilot-scale. The BHEL Power Station facilities at Hardwar can provide a good site for pilot-scale work as well as the means of evaluating abatement systems. Figure 4 shows a suggested activity chart.

7. REQUIREMENTS FOR STAFF, FELLOWSHIPS AND TRAINING

The development of PCRI as a centre of excellence and an effective research arm for its parent organisation, BHEL, highlights the need for staff with research experience together with appropriate fellowships and training for some of the scientists who are already in post.

7.1 Proposed Requirement at Senior Level

The post of scientific controller and co-ordinator (Fig. 1) is in my view urgently required. The appointment should be as one of two Deputy Directors to the PCRI Director (Head). A job description should include a proven research record with business accumen and capable of developing the commercial interests

of the Institute. If there is a problem with recruitment on a permanent basis the possibility of secondment to the post for a period of about two years should be explored.

7.2 Fellowships and Training

I understand that a number of visits have already been made to host organisations and this practice will no doubt continue. During the Mission to PCRI I suggested a number of possible host organisations for selected candidates and these are given in Appendix D.

For the 'on-going' work it would be helpful to obtain consultancy on a short-term (say several days) basis from Indian Universities with expertise relevant to the project. A specific requirement that became obvious as I read some of the Institute's reports, is for statistical advice on data reduction and analysis which could be obtained from a local university.

A suggested list of journals and books that should be available in the library is given in Appendix E. Further relevant publications were presented to the library or are in transit.

8. MISSION AT PCRI - CONCLUSIONS AND RECOMMENDATIONS

- PCRI requires a 'forward' plan with clearly defined objectives for the next 12 months and in outline up to 5 years hence. The plan should include the resources necessary to meet the objectives.

- It is essential to appoint, be it on a secondment basis, a Deputy Director with responsibility for the scientific/technical aspects of the Institute. The wide spectrum of environmental research requires more staff with specialist knowledge to be appointed so that the investigations undertaken establish a credible reputation for PCRI. If it is not possible to appoint additional staff consideration should be given to narrowing the area of interest.

- At the project planning stage the possible involvement of university departments with relevant specialist knowledge should be considered.

- Improvement and enhancement of the library facilities is essential so that projects can be implemented in a competent way. The recommendations made by experts on previous visits do not appear to have been carried out.

- Proposals for the purchase of additional portable sampling and measurement equipment are considered necessary, particularly for small investigations.

- The further development of a pilot-scale test bed at the BHEL Power Station should enhance the measurement and pollution abatement capability of the Institute. The proposed short-term and longer-term investigations in some cases are linked to this pilot-scale test facility.

- On-line continuous measurement techniques for gases and particles are proposed with the possibility of converting the existing well equipped mobile laboratory for source and ambient measurement.

- Reports on methods and equipment suitable for the measurement of emissions from mobile sources have been submitted.

- The computer facilities should be enhanced and the possibility of allocating a PC to each group considered.

- For regulatory decision making and probablistic risk assessment the acquisition of improved meteorological data should be explored. Also the applicability a of new method for describing the meteorological state of the boundary layer with greater certainty than by the present Pasquill (A-G) methods based solely on surface measurements.

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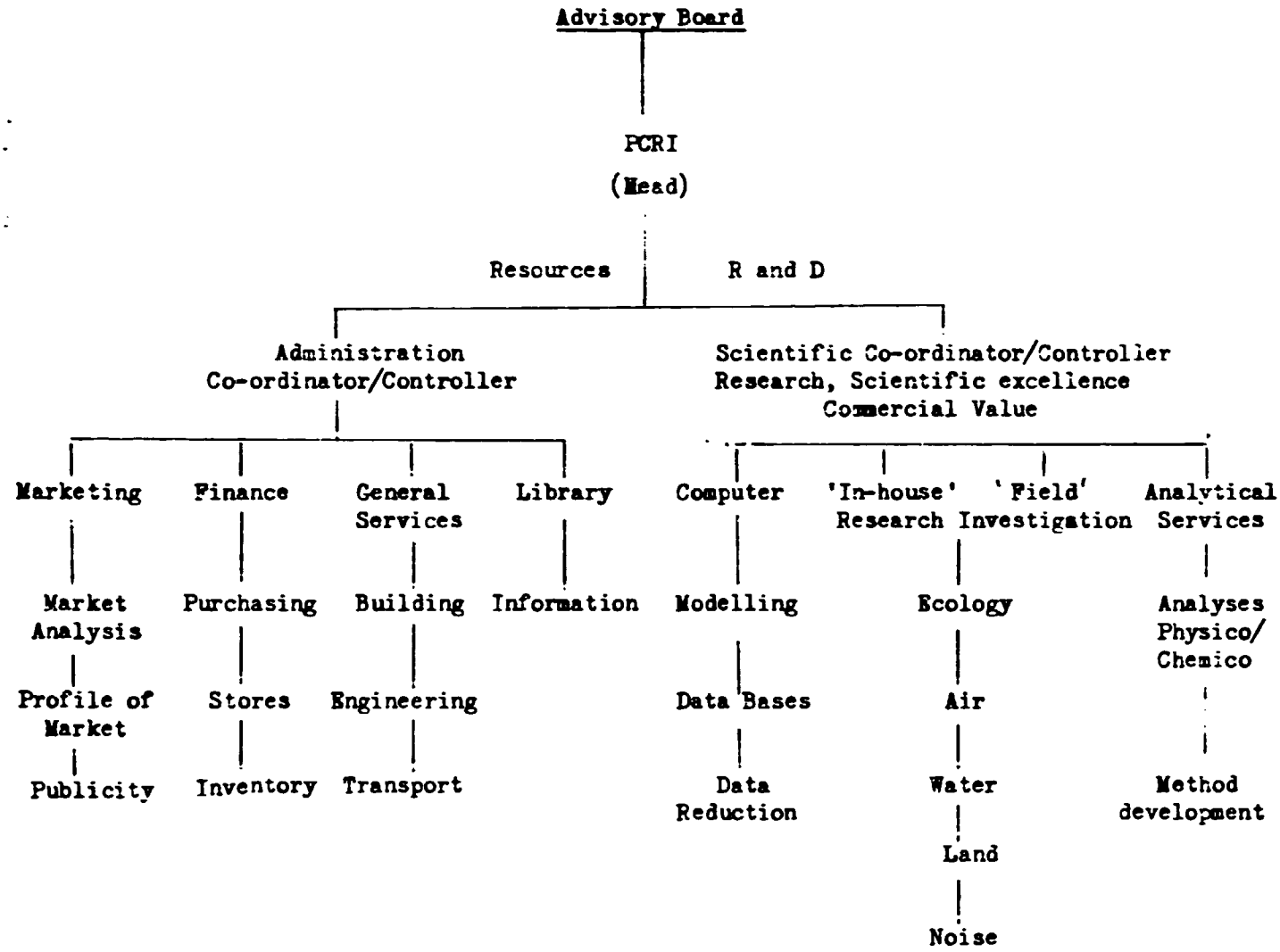
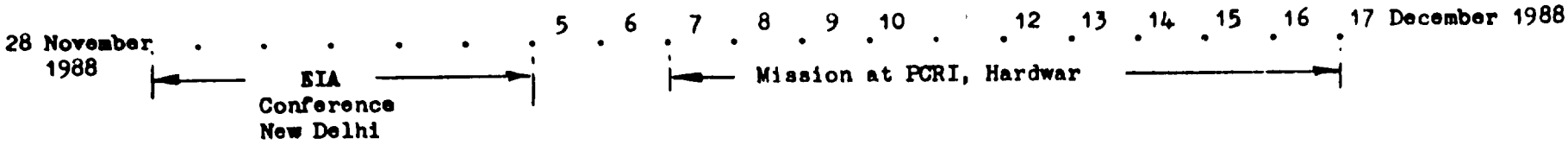
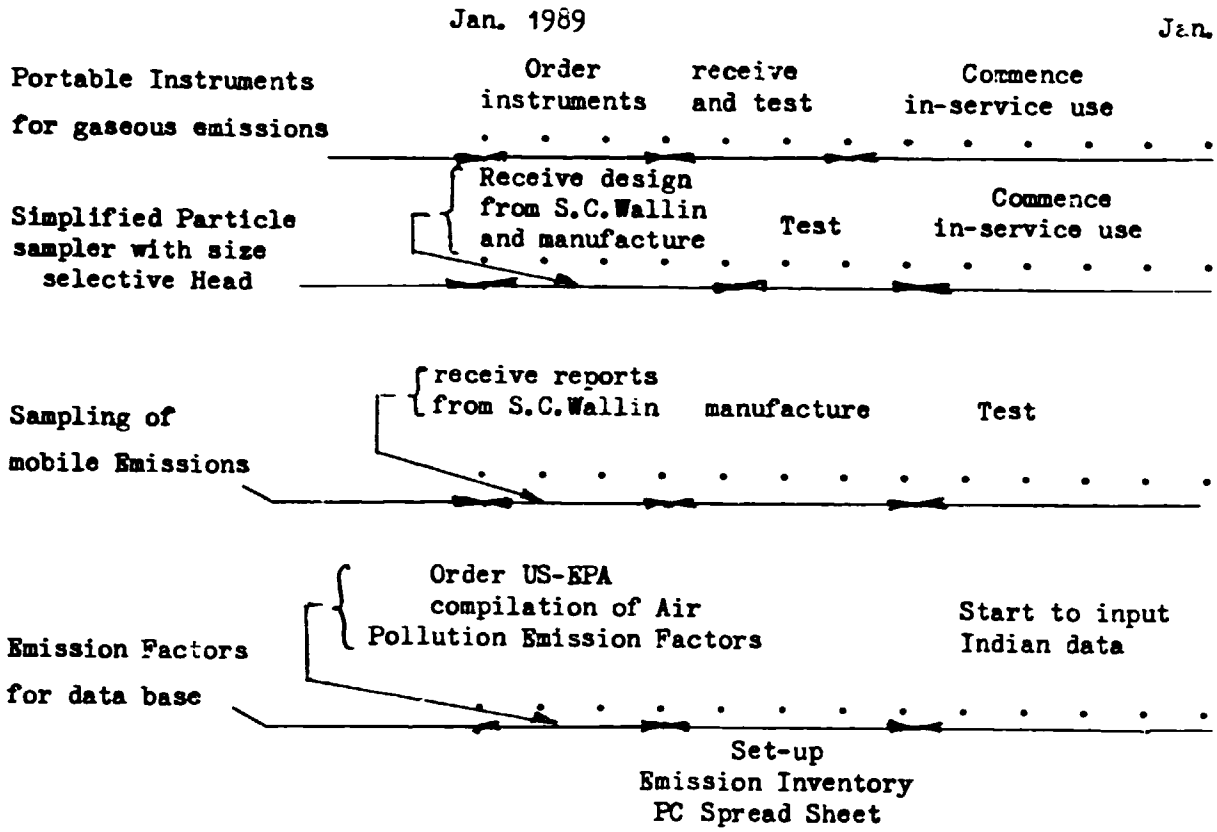


Fig. 1. Functional Organization Chart

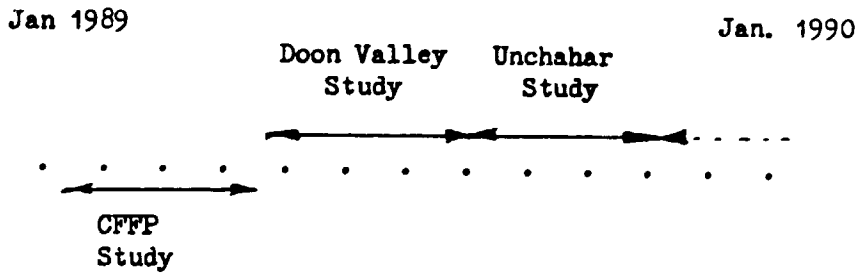


Note: December 5 - 16 see Diary of Activity in the report text.

Fig. 2. Visit, Activity and Timescale for Mission.

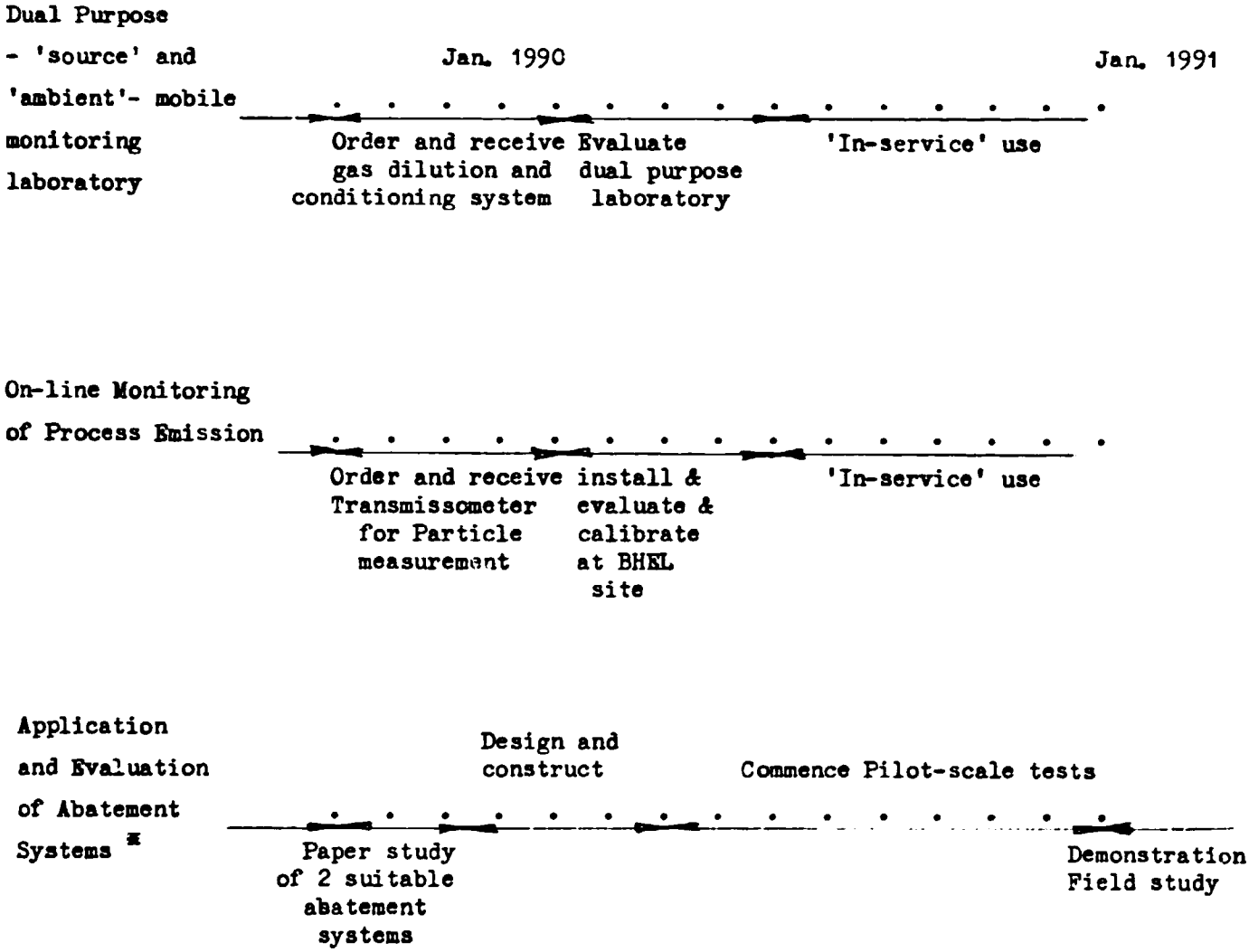


'In-house' Activity



'Field' Activity

Fig. 3. Forward Look - Suggested Activity for Short-term 'In-house' and 'Field' Studies



* Probably a low-cost, easy to operate and maintain abatement system for process plant eg cold-blast cupola.
- The two selected systems could include one 'dry' and one 'wet' design.

Fig. 4 Forward Look - Suggested Activity for Medium-term R and D

APPENDIX A

MAIN SOURCES OF AIR POLLLUTION

Domestic

Alternative fuels such as cow-dung, wood, husks etc are used for cooking and heating in many situations and result in emissions of particles, aldehydes and other organics.

Industrial

Probably about 50% of electricity is generated in thermal coal-fired power stations and the older units tend to emit relatively high concentrations of particulates. Indian coal has typically about 30% ash although the sulphur content is fairly low (about 1%). The large number of small industries also contribute significantly to particulate emissions because many installations burn cane bagasse, rice husks and other alternative fuels. Chemical, fertilizer and refinery plants are fairly major emitters of pollution.

Mobile Sources

There are probably of the order of 6 million vehicles (not including scooters/motor cycles) and in many cases the engine technology is outdated and the standard of maintenance poor. The contribution of spark-ignition engines to CO and HC emissions must be appreciable and in the case of compression ignition engines particulate emissions are high. Although for diesel-engined (CI) vehicles a limit of 65 Hartridge units is specified this would not appear to be kept within.

Principal Abatement Equipment Manufacturers

ACC Vickers-Babcock, Andrew Yule and Co, BHEL, Indabrators Ltd, SF India Ltd, Voltas, Instrumentation Ltd, Patel Filters Ltd, Wanson India Pvt Ltd, Batliboi, Flakt.

Ambient Air Quality Standards

Area	Category	Concentration (ug/Nm^3)+			
		Suspended Particulate Matte - (SPM)	Sulphur Dioxide	Carbon Monoxide	Nitrogen Oxides
A	Industrial and mixed use	500	120	5000	120
B	Residential and rural	200	80	2000	80
C	Sensitive*	100	30	1000	30

+ I am not certain of the averaging time - it may be 8 h.

* Sensitive areas such as hill stations, bird and animal sanctuaries and national monuments.

APPENDIX B

PCRI STAFF ATTENDANCE AT LECTURES, SEMINARS AND SYNDICATES

Name	Date - December 1988								
	6	7	8	9	10	12	13	14	15
A Goel	✓	✓	✓	✓	✓	✓	✓	✓	✓
K V Ramani	✓	✓	✓						
V K Gupta	✓	✓	✓	✓	✓	✓	✓	✓	✓
P K Behra				✓	✓	✓	✓	✓	✓
A K Manuwal				✓	✓				✓
C P S Khosla	✓	✓	✓	✓					✓
K S Gusain	✓	✓		✓	✓		✓		✓
P K Parwa	✓		✓	✓		✓	✓	✓	✓
R L Singhal	✓			✓					
A Jain				✓	✓	✓	✓		
K Keshav				✓	✓	✓	✓	✓	
A Gupta				✓	✓	✓	✓	✓	
R Maheshwari				✓	✓	✓	✓		
P K Jain				✓	✓	✓	✓	✓	✓
V Kumari				✓	✓	✓	✓	✓	✓
S K Shama								✓	✓

APPENDIX C

VISIT TO THE IDPL - 11 DECEMBER 1988

Dear Sir

Thank you for the opportunity to see the Biological Treatment Plant at IDPL, Virbhodra yesterday, we all appreciated your helpfulness and guided tour.

During the visit three problem areas were mentioned and given as:

1. the porosity of the digested roof due to 'hair line' cracks caused by ambient temperature variations;

2. the need to optimise the digested sludge temperatures in order to maximise the CH_4 evolved during the process;

3. a requirement to ensure that the gaseous effluent from the oil-fired boilers producing process steam was less than an emission limit of 100 ppm sulphur dioxide concentration.

Having reflected on the questions posed during our discussion I now make a few possible options to try and overcome the problems.

Item 1. The preferred solution to this problem is to treat the roof of the storage vessel with a mastic coating capable of maintaining its properties under fluctuations in temperature (0-45°C) ambient air and high UV input. Preferably it should be light (white) in colour to minimise solar heating. An alternative solution is to attach an impermeable membrane sheet to the roof and then cover with bituminous coating and roofing felt. To ensure good attachment to the external roof and ensure no leakage could present difficulty; also to ensure no lifting of the cover during high wind conditions may be difficult.

Item 2. This is linked to the previous requirement of ensuring no leakage of CH_4 from the digester tank. Assuming this to be the case a short feasibility calculation indicates that an option to meet the requirement is as follows:

Conditions for calculation - sludge temperature 30°C.

Evolution of CH_4 18 m^3/h. Calorific value of CH_4 32 MJ/m^3. Sludge volume per day 30 m^3.

It is proposed to install a diesel electric generator near the storage tanks (I think a suitable location is adjacent to the RH House?). The advantage of providing the heat from the diesel engine exhaust is twofold, firstly, the engine operates in a combined heat and power mode and secondly the exhaust gas is inert. A schematic flow diagram, Fig. C1, shows the proposed arrangement at the site. A further reason for choosing a diesel engine is the fact that it is possible to operate as a dual fuel engine - up to 15% of the energy input can be introduced through the inlet air manifold. Although at this stage it is not necessary to go into a detailed consideration of the heat transfer to the sludge and the heat losses in the system it is encouraging to know that the heat in the exhaust gases is at least four times the maximum requirement (excluding heat losses).

The following table is a rough estimate of the heat balance for the system proposed:

Fuel consumption 9 kg/h (diesel)
Electricity generated 30.0 kW - 40 HP
Total heat output in exhaust gas 2000 Mj/h
Heat required to sludge from 0°C = 4200 Mj/d = 176 Mj/h
Temperature drop in exhaust gas t = 150°C
Actual available heat input to the sludge = 700 Mj/h.

If 40% of the CH_4 produced is introduced into the inlet manifold of the diesel engine a saving of 7% of the diesel fuel (gas oil) can be achieved. Depending on the CH_4 demand by the IDPL it is possible to introduce up to 80% of the CH_4 produced which will reduce the diesel fuel by approximately 14%. It should be noted that the introduction of gaseous fuel can improve diesel engine performance within certain limits of CH_4 injection.

Item 3. To reduce the SO_2 emission concentrations to the atmosphere from the fuel oil combustion I propose two alternative solutions:

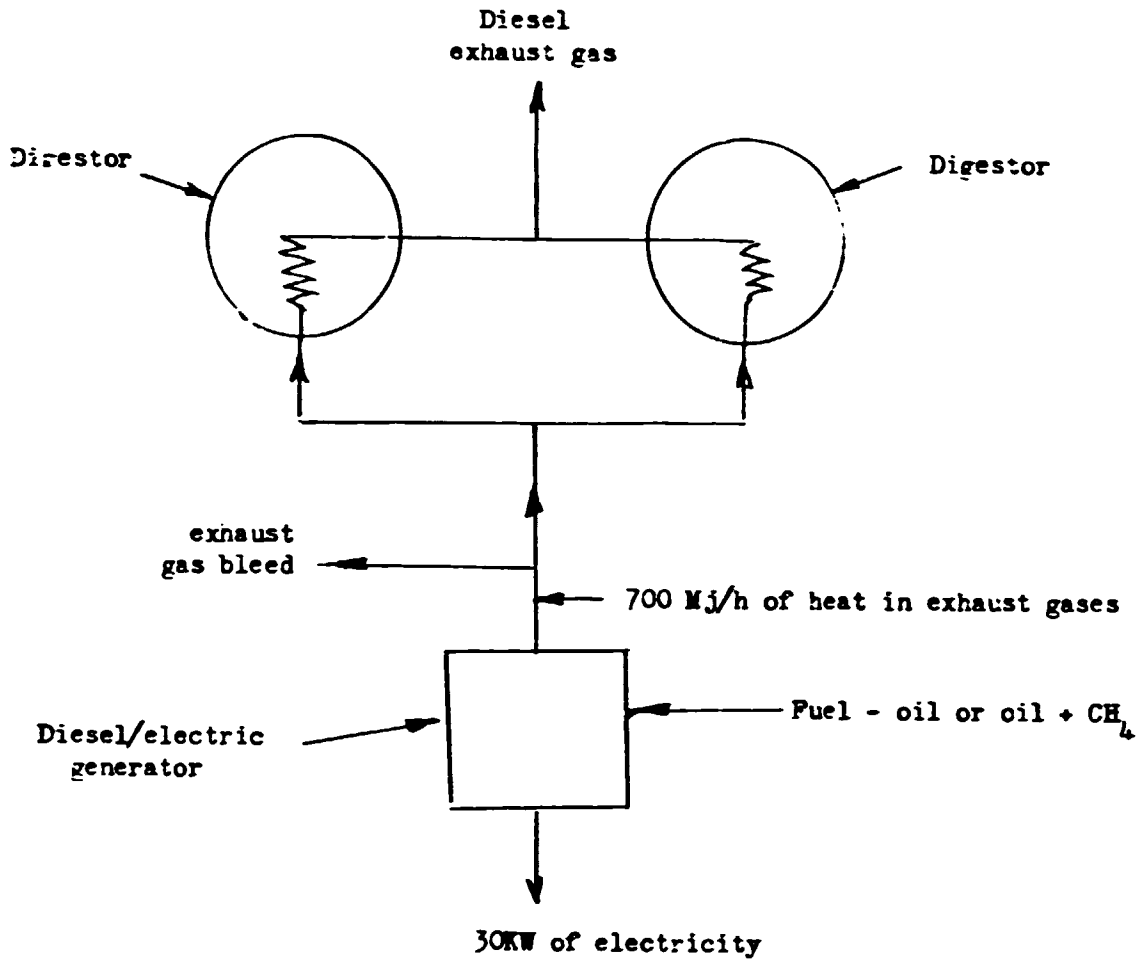
(a) Bearing in mind that the reduction in SO_2 concentration appears to be small (about 10%) blending of the oil should be considered. Depending on the sulphur content of the fuel oil and the relative sulphur content of a distillate fuel (gas oil) it is possible to achieve the required SO_2 concentration in the flue gases. If this results in a maximum gas oil input of 20% it may be the most cost effective way of meeting the limit. Obviously the option requires an additional storage tank and the purchase of a mixing pump. On the credit side the combustion efficiency in the furnace will be improved slightly. In my country (UK) in some circumstances we use blending pumps to burn waste engine oil with fuel oil to reduce SO_2 emissions. Again up to 20% only is suggested not in this case because of costs, but depending on the composition of the oil (e.g. Pb contamination) and other undesirable emissions. Also engine oil has no lighter fractions and therefore combustion will deteriorate when higher percentages are introduced.

(b) An alternative solution is to introduce finely divided alkaline material (calcium) into the combustion zone. For a 2% sulphur fuel and a stoichiometry of 2 to 1 for adsorption it is estimated that about 27 kg/h of lime is required. The lime can be introduced in the secondary air combustion stream and could be achieved by using a steam assisted ejector. By introducing steam the combustion of the oil is likely to improve slightly and the heat losses are minimised (obviously lime/water slurries result in a higher heat loss). Using such a remedial/abatement method for SO_2 is estimated to increase 8 hourly concentrations of $CaSO_2$ by about 15 ug/m^3.

To sum up, should you find any of the proposals of interest please contact Mr Agawala, PCRI for further information. Perhaps I should add that the proposals and any shortcomings are attributable to me and not PCRI.

S C WALLIN

12.12.88



Note: A diesel engine can operate with a relatively high exhaust back pressure, therefore no fan is required.

Fig. C1 Schematic for Item 2.

APPENDIX D

CANDIDATE HOST ORGANISATIONS IN THE UK

Air Pollution Control	Warren Spring Laboratory Stevenage, Herts
Water Pollution Control	Dr R Allen, SPS UKEA, Harwell, Oxon
	Prof R Perry, Imperial College, Exhibition Road, Dept of Public Health Engineering, South Kensington, London
Design and Control of Emissions from Power Stations Air, Water, Flyash and Clinker	Central Electricity Research Laboratory (CERL), Leatherhead, Surrey
Environmental Impact Assessment	Dr C Wood, EIA Dept, Manchester University or Aberdeen University
Measurement and Analysis of Toxic Pollutants	Health and Safety Executive Occupation Medicine and Hygiene Labs 403 Edgware Road, Crickelwood London NW2 6LN
	Laboratory of the Government Chemist Teddington, Middlesex

APPENDIX E

RECOMMENDED JOURNALS AND BOOKS FOR THE PCRI LIBRARY IN ADDITION TO THOSE ALREADY SUGGESTED BY OTHER EXPERTS

Journals to be provided:

- The International Journal of Air Pollution Control and Waste Management - Address: PO Box 2861 Pittsburgh PA 15230, USA.

- Industrial and Engineering Chemistry Research - published by American Chemical Society, 1155 16th Street NW, Washington DC 20036.

- Environmental Science and Technology: published by American Chemical Society.

- Atmospheric Environment. Pergamon Press Ltd, Headington Hill Hall, Oxford, OX3 OBW, UK.

Books to be purchased:

- CRC Handbook of Chemistry and Physics, Editor-in-Chief, CRC Press Inc, Boca Raton, Florida, USA.

- Handbook of Environmental Engineering, Volume 1, Air and Noise Pollution Control, edited by Lawrence K Wang and Norman C Pereira, The Huma Press, Clifton, New Jersey.

- Atmospheric Chemistry and Physics of Air Pollution, John H Seinfeld, 1986, John Wiley and Sons, ISBN 0-471 82857-2.