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INDUSTRIAL ENERGY MANAGEMENT CONSULTANCY AND TRAINING

DP/PHI/82/002

PHILIPPINES

Terminal Report

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

Based on the work of P.R. Srinivasan,
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United Nations Industrial Development Organization
Vienna

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SUMMARY OF RECOMMENDATIONS

1. The Energy Management & Consultancy Service of Bureau of Energy Utilization (BEU) should be made an autonomous organisation as early as possible*(5.1.2, 5.1.3).

2. The possibility of transferring EMCS staff along with the assets provided under UNIDO Project to ERDC (Energy Research & Development Centre), a subsidiary of Philippines National Oil Corporation (PNOC) may be explored by the Philippine Government, in case, Office of Energy Affairs, finds it difficult to establish an autonomous body or institution for carrying out consultancy and advisory service in Management and Conservation field. (5.1.6, 5.1.7).

3. ERDC, a subsidiary of PNOC may be entrusted with the responsibility of implementing the second phase of this UNIDO Project, since it has the necessary infrastructure in terms of trained manpower and management know-how. (5.1.7, 5.1.8).

4. The Laboratory Building presently housing the Fuels and Appliances Testing Laboratory should be upgraded to international standards and specifications incorporating safety efficient treatment and other features. (2.6.3, 2.6.4, 2.6.15, 5.1.14).

5. Detailed energy audits of industries of which project engineering and design of retrofit projects are an integral part should be taken up. Effective follow-up of preliminary surveys already conducted in industries should be carried out for this purpose. (2.3.20, 2.3.21).

6. Data bank on Cost and Source of Supply Energy Conservation Equipments manufactured in Philippines and elsewhere shold be established. (1.7.6).

7. More seminars of Energy Management for top management should be conducted. (5.1.10, 4.1.3).

8. More engineers should be trained for consultancy work in BEU so as to augment the strength of existing training specialists to cater for increased work load anticipated in the near future and also to compensate for turn over of trained specialists. (5.1.5, 5.1.12).

9. In-depth specialisation of EMCS engineers in certain generic areas of energy conservation should be taken up with emphasis on Project Engineering and Design aspects in each of these areas. (2.3.20, 2.3.21).

10. As far as possible, orders for instruments/equipments should be placed with manufacturers or their representatives who have a well established after sales services facility in Philippines. (2.6.7).

11. UNIDO should make available the necessary foreign exchange to the project management for supply of fast moving spares for maintenance of critical and costing instruments for two to three years after the project is over. (2.6.8, 2.6.9).

12. A UNIDO study mission may be sent to the Philippines to formulate the project for the second phase, keeping in view the fact that other organisations like USAID, GTZ of Federal Republic of Germany, Australian Government and World Bank are also funding certain projects related to Energy Management and Conservation. (2.2.29, 2.2.30, 3.1.1, 4.1.7).

13. Philippine Government should examine the possibility of setting up a revolving fund of US $ 50 to $ 100 million with the help of Asian Development Bank, for financing Energy Conservation Projects in Philippines industries.

14. Long term plan for Energy Conservation having a time horizon of 10-15 years should be drawn up by Philippine Government for different sectors of the economy. (2.3.23 to 2.3.27, 4.1.10 4.1.11).

15. More extensive dissemination of information about Energy Conservation technologies as also about the services rendered by EMCS, should take place. (4.1.3, 4.1.5).

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* Figures within brackets refer to paragraph numbers in the main body of the report.

ABSTRACT

The Industriai Energy Management Consultancy and Training Project which was funded by UNDP with UNIDO as its executing agency, was implemented by the Bureau of Energy Utilization, Office of Energy Affairs, under the Office of the President, Government of the Philippines. The project commenced on May 15, 1983 with Chief Technical Adviser reporting on that date. The main outputs of the project are establishment of (a) Energy Management Consultancy Service (EMCS) consisting of a group of 15 engineers trained in the field of Energy Management and Conservation, (b) Fuels and Appliance Testing Laboratory to provide service to the EMCS group as well as to the industries in the Philippines, (c) computerized Energy Information Centre equipped with a good library and an HP-1000 computer for storage and retrieval of information pertaining to the energy management field.

The activities of the project included the training of EMCS engineers not only in the Philippines but also abroad by sending them on training fellowships. The allocation of fellowships amounting to 25.5 man-months was utilized in full even before the project was over. Senior project personnel were sent on study tour missions amounting to 16.0 man-months to observe the working of similar institutions abroad. As part of the project, preliminary and detailed energy aduits were carried out in industries, respectively, during the 1983-87. The estimated total savings identified from 1983 to 1986 amounted to 103M as revealed by the industries themselves to BEU authorities who did a follow-up on their activities.

In all the services of 9 international experts were made available both on a long - and short-term basis for the project.

A Fuels and Appliance Laboratory has been set up in a building specially constructed for this purpose in the land adjacent to Energy Research and Development Centre in Quezon City, about 20 kms away from the main BEU office situated in Fort Bonifacio, Makati, Metro Manila, Diagnostic instruments for field energy audits, calibration and fuel testing instruments worth nearly US $600,000 have been received and most of them have been tested already and put into service. Orders for the remaining US$70,000 worth of instruments are being placed. Quality assurance manuals are being prepared. The laboratory will be fully operational for providing calibration service and fuel testing facilities to EMCS staff as well as industries in the Philippines by October 1987. Currently, work is going on establishing procedures for ensuring quality and reliability of test results.

A total of 38 seminars and training programmes have been held from 1983 to June 1987 which was attended by 1,577 mostly engineers working in industries all over the Philippines.

Seventy-five technical journals on topics relevant to energy conservation has been acquired for the Energy Information Centre's library.

The National Engineering Centre (NEC) which was awarded subcontract by UNIDO is currently engaged in the design of Refrigerator Test set up and a setting up procedures for fuels testing and calibration services. In addition, work on the design of computerized national energy data base is going on for storing and retrieval of information related to Energy Management and Conservation.

A substantial portion of what was sought to be achieved at the beginning of the project has been achieved. The entire amount of money allotted for the project namely, US$1,586 million, has been spent and in fact an extra sum of $50,000 has been made available by NEDA to cover the cost of the long-term consultant on Industrial Energy Audit for the project.

1.0 INTRODUCTION

1.0.1 The sudden increase in the price of crude oil to a value of $28 (reaching a peak of $34 for a short period) from $12 a barrel in 1979 sent shock waves throughout the world and bringing about a recession in developed countries in its wake. The effect of this steep price increase on developing countries like the Philippines was even more disastrous. In 1981, for instance, Philippines, had to spend 38% of her export earnings to import crude oil to the extent of 87% of her total commercial energy requirements which amounted to 87.5 million barrels of oil equivalent (MBOE) at that time.

1.0.2 The need for conserving energy therefore in all sectors of the economy was recognized much earlier by the Government of the Philippines which in fact created the Bureau of Energy Utilization, as early as 1979 under the Ministry of Energy by a Presidential Decree No. 1206 as amended by Presidential Decree No. 1573, charged with the responsibility of supervising and monitoring all phases of end uses of energy in industrial, commercial and transport sectors.

1.0.3 The Bureau of Energy Utilization which consists of four divisions, namely, (a) Data and Analysis Division, (b) Conservation Division, (c) Technical Services, and (d) Regulation Division, headed by a Director was initially manned and guided by experienced technocrats and engineers

from Philippine National Oil Company (PNOC). (Refer Annex for Organizational Chart). The Chief of the Conservation Division, who is the project manager of this UNDP/ UNIDO project on Industrial Energy Management Consultancy and Training was charged with the responsibility of developing a National Energy Conservation programme for the Republic of the Philippines. The Conservation Division consists of 4 sections as shown in Annex-1. The very first achievement of the Conservation Division was in drafting and getting an Energy Conservation Law passed by the Batasan Pambansa (Parliament of the Philippines) in 1980 known as Bill No. 73. This bill gave the necessary authority to the Conservation Division in carrying out some of its activities aimed at promoting energy conservation. For example, it was mandatory under this Batasan Pambansa Bill No. 73, for all industries consuming over 1 million kilo litres of oil per annum to appoint a qualified Energy Manager to monitor and supervise and conserve energy in his own industry or establishment.

1.0.4 In order to provide the necessary opportunity for engineers from industries to qualify themselves as Energy Managers under this law, the Conservation Division of BEU started organizing 5-day Basic Energy Management Course at different parts of the country at least 4 to 5 times a year from 1978 onwards. For this purpose, in the initial stages, it sought the help of Productivity Development Centre (PDC), a subsidiary organization of the Development Academy of the Philippines (DAP) and later on

in 1984 this job was entrusted to the National Engineering Centre (NEC), a unit of the University of Philippines (UP). Most of the funds for this training activity was provided by the Philippine Government.

1.0.5 In the year 1982, the Asian Development Bank made available to BEU a small grant for providing the services of International Experts/consultancy organization to carry out Energy Audit in selected industries with a view to identify and quantify the avoidable losses of energy taking place in these industries and to suggest short and medium term measures to prevent such losses and also work out approximately the investment required to achieve those savings. This project was carried out by M/s Arthur D. Little, who have since submitted a report to ADB and Philippines Government on their investigation and findings.

A one-month training programme on Energy Audit procedures and Energy Management as part of this ADB project was also conducted for the engineers in the Conservation Division by the present Chief Technical Adviser of this project in August 1982.

1.1 OFFICIAL MANAGEMENT

1.1.1 Subsequent to this activity, in 1982, the BEU made a request through NEDA for UNDP assistance to set up this project on Industrial Energy Management Consultancy and Training. The project document prepared by BEU in conjunction with Mr. Ivan Pluhar, SIDFA of UNIDO, was approved in 1982 and the project became operational

on 22 May 1983, the day the CTA of the project, Mr. P.R. Srinivasan reported for duty in Manila. The project, which was originally designed to last 2 1/2 years was subsequently extended for a period of 4 1/2 years, i.e. till October 15, 1987 in view of the "Institution Building" type of activity. The cooperating and implementing agency chosen for this project by NEDA was the Conservation Division of the Bureau of Energy Utilization.

1.2 CONTRIBUTIONS

1.2.1 The total contribution of UNDP for this project was US$ 1,586,892 to cover the cost of international experts, training fellowships, study tour, equipment, travels, etc. In all the services of 9 international experts were provided for the project. The details are given in Annex-2. Subsequently, in the year 1986, NEDA at the request of the implementing agency, namely, BEU, agreed to make available an additional sum of $50,000 to cover the 6 man-month cost of one long-term consultant (Post 11-02) in Industrial Energy Audit, Mr. Brian J. Cunningham. The total UNDP contribution comes therefore to US$ 1,636,892 The Philippine Government made available a sum of P5,725,500 in kind of cover the local cost in respect of personnel and other expenses. The revised budget as of March 1987 of UNDP contribution is given in Annex-3 and that of Philippine Government is Annexure -4.

1.3 OBJECTIVES OF THE PROJECT

1.3.1 The immediate objectives of the project as stated in the project document were (i) to assist in establishment and operation of an Energy Management and Consultancy Service (EMCS), (2) to create a core of trained staff in Energy Conservation techniques, (3) set up a Fuels and Appliance Testing Laboratory, and (4) to develop standards for efficiency of energy utilization.

1.3.2 It was decided, after the first tripartite meeting held on 18 May 1984, to revise the project document substantially for which purpose a special committee consisting of SIDFA and CTA from UNIDO side and national Project Managers and a NEDA representative from the Philippine Government side, was set up. However, after some deliberations, the committee felt that since it may not be desirable to effect any changes at that point in time, the original project document was left intact to serve as a guideline for implementation by the project management. The immediate objectives of the project have been achieved to a substantial degree, as evidenced by the increasing interest shown by the Philippine industries, ever since the start of this UNDP/UNIDO project, in the consultancy services offered by the Conservation Division of BEU and also by the fact that all the money allocated for the project would have been utilized in full even before the project formally ends by October 1987.

1.4 TRAINING

1.4.1 The allotted man-months of 41.5 for training and fellowship and study tours for the project have been utilized in full. The engineers of EMCS were trained both in the classroom as well as on the shop-floor in different types of industries and in all subjects related to Energy Management and Conservation techniques. One of the positive result of this training by the international experts attached to this project has been to build up a reasonable level of expertise and confidence among engineers of EMCS which has enabled them to conduct preliminary energy audits on their own in Philippine industries. No negative experience of any kind worth reporting was noticed by international experts during the course of this project. Details of training fellowships and study tours are given in Annexure.

1.5 EQUIPMENT

1.5.1 A sum of US$675,000 was allotted for the purchase of instruments for Fuels and Appliance Testing Laboratory. To date, diagnostic fuel testing and calibration instruments worth $600,000 have been received and all these have been tested and commissioned in the Fuels and Appliance Testing Laboratory for service. A list of all the instruments received so far and instruments for which orders have been placed by UNIDO instruments for which purchase requisition order has been sent to UNIDO recently, is

available in UNIDO Hq., Vienna. UNDP has already approved the transfer of all instruments to BEU and NEDA has been requested for the granting their approval to handover these instruments to BEU. No reply to date has yet been received. However, this matter is being actively pursued.

1.6 SUBCONTRACTING

1.6.1 In view of the difficulty experienced by the project management in getting the right type of International Experts in certain specialized fields at the right time, it was decided to award subcontract to NEC in 1984 and 1985 for the specific purpose of bringing out the following manuals which were urgently required for the project. They are (1) Guides to Quick Estimates of Energy Costs for industrial use, (2) Guides to Retrofitting Oil-Fired Boilers, kilns and other furnaces to use alternative fuels, (3) Guides to Energy conservation in food industries, and (4) Guides to Industrial Preventive Maintenance for Energy Conservation. The total amount given to NEC under this contract was US$26,000 and the work was completed according to the schedule agreed upon between UNIDO and NEC without any delay. The performance of NEC in respect of providing quality service as well as bringing out the documents on the stipulated dates, was indeed commendable. A copy of the contract given to NEC is available in UNIDO Hq., at Vienna.

1.6.2 In view of their track record of having rendered excellent service to the project and also the difficulty experienced by the project in getting the right type of consultants for the design of Appliance Testing facilities, it was decided by BEU to engage the services of NEC once again on a subcontract basis but this time to help them in the entire Design, Operation and Management of Fuels and Appliance Testing Laboratory covering all aspects - both technical and managerial and also in the design of Appliance Testing facilities. In addition, NEC was also requested by BEU to help them in designing a computerized National Energy Information Data Base. For this purpose, UNIDO awarded a subcontract worth $50,000 to NEC for undertaking work and assisting BEU in the above-mentioned areas. This phase of the work is expected to be completed by NEC by January, 1988.

1.7 RECOMMENDATIONS

1.7.1 (a) EMCS should be constituted as an autonomous body with sufficient funding provided by the Government for its operation at least for a period of 5 years or till such time as it is able to be financially self-sufficient.

(b) EMCS should charge a fee for its consultancy services to industries in order to become a financially viable institution in the course of time - say 5 or 7 years.

1.7.2 EMCS engineers should specialize in certain generic areas of Energy Conservation technology such as waste heat recovery, water treatment, instrumentation, boilers, furnaces, electrical energy utilization, energy system analysis, etc.

1.7.3 The Fuels and Appliance Testing Laboratory shouid be expanded with more calibration and diagnostic instruments and international accreditation of the Laboratory should be sought from appropriate international agencies after all quality assurance programme are implemented and the training of Laboratory personnel is complete in all aspects.

1.7.4 The standard and design of the Laboratory building has to be upgraded and improved before getting recognition from international agencies for its facilities.

1.7.5 More and more of detailed energy audits must be undertaken by EMCS engineers in order to acquire the necessary expertise and specialization in depth.

1.7.6 Data about cost and source of supply of products/equipments/technologies commonly needed by industries in the Philippines for implementing energy conservation measures recommended by EMCS Engineers, must be gathered and built up over a period of time and if possible these data may be stored in the HP-1000 computer for instant retrieval when needed later on.

1.7.7 Follow up of energy audit activities by EMCS group in Philippines industries to help them in implementing some

of the recommendations made by them should be on a more extersive scale than hitherto practiced and for this purpose, an institutionalized mechanism should be set up in BEU. If more manpower is needed for this purpose, it should be provided by the Government without any reservation. Project Engineering and Design Work of Retropt Projects on Energy Conservation work should be taken up.

1.7.8 More extensive contacts with the top management personnel of industries than hiterto practiced should be established for creating the necessary energy conservation consciousness among them which would subsequently help BEU engineers in getting full cooperation from engineers in industry in carrying out energy audit in their industries.

2.0 ACTIVITIES AND OUTPUT

2.1 Introduction

It goes to the credit of the Philippine Government that it initiated some actions at national and industry level to tackle the problem of reducing dependency on imported petroleum fuels as early as 1977 by the establishment of Bureau of Energy Utilization (BEU) and by drawing up a 10-year plan for Energy Development. After the second oil shock in 1979, when the international price of crude oil was increased to $28 from $12 a barrel, an accelerated plan of development of indigenous energy base was drawn up and a 10-year plan was compressed to 5 years.

2.1.2 Simultaneously the BEU, which was set up as a nodal point as far as Energy Utilization matters were concerned by a Presidential Degree in 1979, took series of steps at national and unit level to promote efficient use of energy in all sectors of the economy in Philippines. The first step taken was to get an omnibus Energy Law known as Batasan Pambansa No. 73 enacted by which all industrial establishments are required to submit quarterly energy consumption reports tc BEU, which in turn collated all the information thus received and published the data on a quarterly & yearly basis in their official bulletin which is published every quarter and year. Even though it is compulsory for industries to submit to BEU every

every quarter the energy consumption figures, not all industries comply with this mandatory requirement. In fact in 1985, only 215 industrial establishments accounting for 50% of the country's total energy consumption submitted their quarterly reports on Energy consumption in their factories. BEU is also actively pursuing with other industries to submit their quarterly returns. It is mandatory under this law for every industrial enterprise to employ an Energy Manger duly certified by the BEU. The requirement for this certification is attendance in a 5-day Basic Energy Management Programme conducted by BEU in cooperation with some outside agencies such as the Productivity Development Centre (PDC) and the National Engineering Centre (NEC), of University of Philippines (UP).

2.1.3 In fact, it goes to the credit of the Philippines that it is ahead of other ASEAN Group of Nations in having had the forethought and wisdom to adopt an institutionalized approach for tackling the problems of energy management and utilization in industrial and commercial sectors by establishing BEU. The activities in this area started as early as 1977. The BEU was initially set up with the top and middle management level positions filled in by technocrats drawn from the Philippine National Oil Company (PNOC) whose services were lent to the Ministry of Energy for this purpose. A couple of engineers 4 to 5 in number were directly recruited as Ministry of Energy employees to man certain sanctioned positions in the Conservation

Division of BEU, out of which only 2 or 3 had direct line experience of a couple of years in the industrial sector. The initial guidance in the planning and conduct of Conservation Division's activities was provided by PNOC personnel, who were expected to train the Ministry of Energy recruits over a period of time for ultimate take-over of conservation Division's activities.

2.1.4 The BEU, whose organisation chart is given in Annex I was headed initially by Mr. Orlando L. Galang as its Director who has since returned to PNOC (i.e. in October 1986) to head its Logistics Division and Shipping company as Vice-President. Mr. Victor Dimagiba also a PNOC employee acted for a while as acting head of BEU immediately following Mr. Galang's departure. Subsequently, he also had to return to his present organisation, namely, PNOC by April 1987.

2.1.5. Subsequntly, two more Senior Engineers, namely, Mr. Wilfredo Toledo and Mr. Marcial Ocampo, who were in charge of the present UNDP project's laboratory and Computer work, respectively were also sent back in June 1986. Mr. Benjamin P. Lim who was the Chief of Conservation Division from the b[illegible]ing had also to return to PNOC by end of April 1987 as per government's instruction.

2.1.6. The BEU's Conservation Division presently is headed by Mr. Jesus Anunciacion, an Electrical and Mechanical Engineer, and a perm[illegible]nent employee of the Ministry of Energy. All these transfers took place because of the policy of the Government of Philippines to send back such of those personnel from public sector organizations working in the Ministry of Energy back to their respective organizations so as to avoid conflict of interest in their work.

2.1.7. There have been some changes even since the installation of the

new government in the set up of Ministry of Energy. The Ministry of Energy was abolished in March 1987 and in its place Office of Energy Affairs directly under the administrative control of the Office of President was set up. The latest change to take place at the time of writing this report was to transfer all other divisions of Bureau of Energy Utilisation to the Department of National Resources. The Energy Conservation Division, as of today, continues to be directly under the Office of President. In a way, this might auger well for the future of Energy Conservation Division.

2.1.8. The attention bestowed upon all facets of the energy problem by various agencies of Ministry of Energy has paid rich dividend to the Philippines. For instance, the amount of money spent on import of petroleum products has been reduced to a value of $ 1.47 billion in 1984 from a value of $ 2.53 billion in 1981. In energy terms, the petroleum consumption has decreased by 16 million barrels over an 8-year period, having gone down to 55 million barrels in 1985 from a figure of 71 million in 1973.

2.1.9. Part of the reduction in petroleum consumption may be attributed to a lower level of industrial activity because of economic recession during the period 1983-86 resulting in reduced demand for commercial forms of energy. However, there has also been slight improvement in energy efficiency standards at national level as indicated by the energy/GDP Elasticity Ratio. For example, energy/GDP/Ratio computed by BEU from available statistical data and expressed as so many barrels of oil equivalent per P1000 of GNP has gone down to a figure of 1.0 as compared to 1.106 in 1974. This does point out clearly that energy conservation measures have had some effect over the

years, though however small it might have been.

2.1.10. Energy conservation activities in the form seminars and training programmes were stated by BEU in 1977, two years earlier than the second oil shock of 1979. However, since 1979, activities in the area of training and publicity were intensified. The Conservation Division conducted, during the period 1979 to 1985, 52 energy management training programmes attended by nearly 2,500 participants from 989 companies both big, medium and small and spread all over the country. The list of training programmes and seminars held during the project phase is given in Annex. 13.

2.2. **Training and Consultancy**

2.2.1. It was in 1982, that the Asian Development Bank (ADB) provided a grant under its technical assistance of BRU for carrying out energy audits in selected industries in order to assess the potential which exists for saving energy on the shop floor. For this purpose, ADB engaged the services of M/s Arthur D. Little Inc. Consulting Engineers based in Boston, Massachusetts, U.S.A. A.D. Little carried out energy audit studies with the help of some of the BEU engineers, who were assigned to work under the direct supervision of this foreign consultancy company. A summary of the findings of Arthur D. Little Inc. submitted to ADB is available with B.E.U.

2.2.2 In order to prepare the engineers of BEU for carrying out energy audit in industries, along with consultants of A.D. Little Inc., a 4 week training programme was conducted for BEU engineers in certain subjects related to Energy Conservation and Audit work. This training programme was conducted by the present Chief Technical Adviser of this project, whose services were

obtained by ADB for this purpose. The main topic of the training programme was Instrumentation for Energy Audit and Waste Heat Recovery in industries and economic thereof.

2.2.3 The present UNDP/UNIDO project on Industrial Energy Management and Consultancy was the offshoot of the ADB study which highlighted the substantial potential for savings which exists in Philippine industries even by adopting some simple First-Aid measures. As had been mentioned earlier, the UNDP funding for this project amounted to $ 1.578 million and the counterpart funding was P5.7 million. The project started functioning by 22 May 1983, with CTA reporting for duty at Manila on that date.

2.2.4. The four major components of the project are the establishment of (a) An Energy Management Consultancy Centre (b) Fuels and Appliance Testing Laboratory (c) Energy Information Centre (d) Mini Computer for Energy Data Storage. The first requirement of the project was the preparation of a work plan for the originally intended duration of the project of 2 1/2 years taking into account the requirements of the Philippine situation. However, the work plan as finally approved by DEU and also containing the list of instruments to be ordered for the project was submitted to UNIDO HQ Vienna shortly thereafter. A copy of the first work plan is available with UNIDO Hq., Vienna.

2.2.5. Since one of the major outputs of the project, namely, establishment of Energy Management Consultancy Services was an institution building type of activity. It was felt by the project authorities after a year or so that considerably more time than the originally intended duration of 2 1/2 years would be

required and therefore it was decided to extend the project to 4 years and odd and according to this the project is supposed to formally close by October 1987.

2.2.6. The Conservation Division of BEU consists of four sections, namely, (a) Project Engineering and Consultancy, (b) Testing and Standards, (c) Education and Training (d) Computer and Building Energy Analysis.

2.2.7. Engineers mainly from project Engineering and Consultancy Division constituted the main core of the Energy Management Consultancy Service (EMCS) and as required by the project document fifteen engineers were made available for training in Energy Management and Conservation Techniques.

2.2.8. The training programme for EMCS group started off in right earnest from August 1983 and to start with, it was conducted entirely by CTA. However, since CTA of this project had trained the same group of Engineers in certain aspects of Energy Management and Conservation technology earlier under the ADB project (refer para 2.2.2) there was a sense of continuity and new areas were taken up for classroom training. The training session which lasted approximately 6 months was a sandwiched one and consisted of alternate shop floor training and classroom sessions of 3 hours duration once a week - usually every Wednesday of the week.

2.2.9. This type of sandwiched program was found to be quite effective because it gave the engineers an opportunity to relate what was taught in the classroom to a practical situation on the shop floor. It also helped to bridge the communication gap between the lecturer and the participants. Most of what was taught in the classroom was not theoretical staff, but down-to-earth

practical information related to operation and maintenance of various types of equipments/technologies.

2.2.10. In order to provide the necessary shop floor experience, the engineers were taken for one week observation training to Bataan Refinery Plant, a unit of PNOC. There the engineers were given training in operation of boilers and furnaces, calibration of instruments like D.P. Cell, flow transmitters, temperature transmitters, Rotodynamic machinery like centrifugal pumps, distribution of compressed air and steam, steam trap installation, etc. Since Refinery operation and maintenance practices are highly complex and skilled, any experience gained in operation and maintenance even though for short period of time would be highly useful to Engineers.

2.2.11. The feedback that we got from Engineers of BEU was very favourable. In fact, to train engineers effectively in energy conservation technology, the best type of industry sector seem to be the (a) Fertilizer (b) Refineries (c) Petrochemical complexes (d) Thermal Power Station sector. That is because all kinds of problems related to erosion, corrosion, high temperature, high pressures, safety, energy systems design are encountered. If one could learn therefore about the kind of problems being faced by such industries and possibly learn about how to tackle some of the problems related to energy conservation by exchanging ideas with experienced Engineers in these industries, it would benefit everybody immensely. It is then possible to horizontally transfer the tehnology of some of the good energy conservation practices of such industries to lesser efficient industrial units

such as textile mills, food industries, medium scale metallurgical industries, etc.

2.2.12. Much as we would have liked to have this training continued for at least 2 to 3 months at a stretch for the engineers of EMCS, it was not possible for administrative, financial and other reasons to do so and we had to be content with what little opportunity we could get to provide to the Engineers of BEU some training in this regard. The next best thing to do was to take the engineers to a number of industries of diverse type both big and small in the industrial sector for observation cum-study tour.

2.2.13. During the visits to various industries they were taught to observe and identify various forms of energy losses taking place, which normally goes unnoticed unless one is specially trained for such a purpose. In other words, different types of boilers, furnaces, pumps, heat recovery systems, encountered in the industries were shown and subtle operational points and maintenance requirements were explained on the shop floor.

2.2.14. Since some of the engineers of EMCS did not have practical line experience in industries, it was felt that in order to boost their level of confidence and expertise, they should be trained on the spot under the supervision of CTA, for a couple of hours on how to operate boilers, furnaces, etc. This was done after taking permission from the management of different industries by associating the concerned boiler or furnace engineer, so that nothing went wrong during such demonstration and training sessions.

Even this little experience gained by the engineers have helped them to get a feel of the boiler and furnace controls.

2.2.15. This kind of training had stood them in good stead in later assignments, as evidenced by the confidence with which they have trained some of the boiler and furnace operators in correct operation of boilers and furnaces such as correct maintenance of air fuel ratio, etc. during the course of their energy audit work. This kind of approach to training is at best a compromise and the best thing to do in future would be to help these engineers in getting some line experience by sending them to the type of industries already mentioned in paragraph 2.2.1 for a 3 to 4 months period.

2.2.16. BEU engineers were also specially trained on the shop floor is identifying faults or deficiencies in fuel oil handling systems, insulation of steam pipes, furnace walls, etc. They were also told about correct operation and maintenance of waste heat recovery systems, and proper start and shut down procedures of boilers and furnaces. The most important aspect of the training of EMCS engineers was the training given to them on the shop floor in different industries in the correct and proper way of using diagnostic instruments while carrying out energy audit in order to ensure accurate and reliable measurement of various parameters like pressure, temperature and gas analysis for the ultimate purpose of drawing up heat balance and energy analysis. For this purpose, the instruments already in possession of BEU were used.

2.2.17. Since corrosion of cold end of boilers and furnaces like economizer

and air heaters is quite extensive in the Philippines because of the high sulfur content of the fuel oil and wrong operation practices, it was decided to deal with this topic at length and some very practical suggestions aimed at overcoming this problems were made for implementation.

2.2.18. Information about the latest technologies available, to mitigate substantially the problem of acid-corrosion of economizers and air heaters was made available to Engineers of BEU and in fact BEU engineers have been able to advise one or two industries to overcome this problem successfully based on the knowledge and experience they have already gained during this initial training programme.

2.2.19. Another important topic on which some valuable inputs were provided was on Industrial Water Treatment. One of the more experienced BEU Engineers undertook a special study of water treatment of cooling towers of nearly 10 to 15 soft drink bottling companies and made some useful recommendations to the industries concerned in this regard.

2.2.20. The emphasis during the initial training programme was to enable the BEU to learnt some techniques about how to get the best out of the existing equipments/technologies because in a capital scarce economy like those prevailing in developing countries it is difficult if not impossible to replace old and obsolete equipments by new ones. In other words, the philosophy of approach was to help industries in improving their managerial efficiency in the short term by better housekeeping, prevention of obvious

sources of heat leakages, etc. by proper maintenance and operational measures. BEU Engineers were given the opportunity to learn about "First-Aid" measures to save energy on the shop floor.

2.2.21. Further, since in developing countries even some bottom line requirements of good maintenance practices do not exist, which nonetheless which have a profound effect on energy efficiency also, it was thought desirable to impart to BEU engineers some of the preventive maintenance techniques of boilers and furnaces.

2.2.22. Proper procedures for "mothballing" or storing idle boilers and furnaces for long period of time when not in use were also explained. This particular aspect was emphasized because it was found during the course of the visit to industries, that a number of costly boilers and other ancillary equipments had corroded badly due to the neglect and wrong storage practices.

2.2.23. The training programme also included a couple of lectures on how to evolve a long term corporate Energy Plan. It was felt that this approach was needed in order to improve technological efficiency in the long run of the industries in general. The four aspects of technology management, namely: (a) Technology Identification, (b) Technology Assessment, (c) Technology Induction and (d) Technology Innovation were dealt with rather very briefly.

2.2.24 BEU engineers were also trained in making a quick assessment of the potential energy savings possible after a brief preliminary energy audit based on some of the nomograms specially provided to them for this purpose.

Financial analysis techniques based on simple Rate of Return Concept and a little more sophisticated analysis based on Discounted Cash Flow concept were taught to the BEU engineers by one of the PNOC Engineers when was working with BEU at the time of this initial training programme. This enabled them to make a techno-economic evaluation of some of the retrofitting schemes for waste heat recovery, energy systems analysis based on cogeneration etc.

2.2.25 During this initial period of training, periodic discussions and seminars were held once in month in order to get a feedback from the BEU Engineers about what they had learnt during their visits to the industries and also in the classroom. These meetings not only helped them in consolidating what they had already learnt but also to exchange ideas among themselves.

2.2.26. Of the fifteen engineers who constituted the core group of the EMCS and who have undergone this initial training programme, at least five of them turned out to be very good and were capable of carrying on preliminary energy audits all by themselves and in fact later on when preliminary energy audits were undertaken in industries, thse five engineers acted as leaders guided their colleagues on the shop floor.

2.2.27 There was no formal or systematic assessment of the capabilities of all the consultants of BEU who have undergone this training, but what is mentioned above is only a gross impression of CTA based on his observation of the work of these BEU engineers on-the-work spot.

2.2.28. The strength of the EMCS group (which was initially 16) diminished over the years because of the resignation of two of its more

experienced engineers and also the non-return of two engineers from U.S.A., who had gone there on UNIDO training fellowship/ programme. There is therefore need to train some of the freshly inducted engineers in Energy Management and Conservation Techniques.

2.2.29. Further since the start of UNDP/UNIDO project on Industrial Energy Management Consultancy and Training a number of international projects on a bilateral nature have fallen on the lap of the Conservation Division for implementation. They are (a) Technology Transfer in Energy Management supported by USAID, (b) Rational Utilization of Energy supported by GTZ of Federal Republic of Germany, (c) Project on Vehicle Dynamometer Testing under the Australian Government, (d) ASEAN-USAID Programme for Building Energy Standards, and (e) World Bank Project on Energy Conservation Studies in selected industrial sectors.

2.2.30. The existing manpower allotted to take care of all these projects is too inadequate with the result that the undivided attention which UNDP/UNIDO project was getting earlier is no longer there for the past one year or so. To remedy this situation, it would be desirdable to augment the staff of BEU by recruiting engineers from industries with a couple of years of line experience.

2.3. <u>Consultancy Service</u>

2.3.1. The six months of training both in the classroom as well as the shop floor in diverse type of industries of BEU engineers prepared them adequately for carrying out preliminary energy audits in industries, with diagnostic instruments. BEU sets

a target for carrying out certain number of preliminary energy audits every year.

2.3.2. For this purpose they write letters every quarter to a number of industries offering the services of BEU engineers and UNIDO Consultant to carry out energy audits in their companies. A programme of visit, by BEU staff and UNIDO experts offering their services free of charge to different industries both within and outside Manila is drawn up at the beginning of every calendar year based on the replies received by BEU to their offer of assistance.

2.3.3. Because of the severe economic recession at the time of the starting of the Project in May 1983 (which lasted till 1986) the response by the industries to the BEU offer was rather lukeward in the beginning, but in the latter half of 1984 and early in 1985 the requests for BEU assistance from industries started increasing. Even so, some of the big industries like San Miguel Corporation. Benguet Mining Corporation, etc. who were working at full capacity in spite of economic recession, since the demand for their products were more or less inelastic, availed themselves of the opportunity to obtain the free services offered by BEU. As a result of this, these big industries were able to save substantial amount of energy.

2.3.4. Since these big companies had already a well-trained staff in energy management field, all they needed was a little incremental help from BEU and UNIDO Consultants in identifying the losses taking place with the help of diagnostic instruments and information about latest technologies/products in the energy conservation

field. In fact, some of these big industries, who were energy efficiency conscious, always came back to BEU for more and more assistance. It is indeed a paradox that the relatively more efficient of the industries in the Philippines are the ones who want to be still more efficient, whereas the same sentiment does not prevail among most of the medium and small scale industries.

2.3.5. The preliminary energy audits as envisaged takes any where between 2 to 7 days depending upon the size and nature of industry. This activity is distinct and separate from the "Walk-Thro" type of audits of half-a-day duration, wherein by just visually observing the working conditions of plant and machinery as one walks thro the plant, one is able to identify certain defects and identify certain visible losses taking place (such as spotting bare uninsulated surfaces, smoking chimney, hot effluents going down the drain, leak of water, steam, compressed air and liquids, etc. from pipes, pump glands, etc.) depending on one's experience.

2.3.6. The preliminary energy audits as envisaged and carried out in practice is a little more in-depth study of the plant and is midway between "walk-thro" type audits of half-a-days duration or so on the one hand and Detailed Energy Audits lasting over a month or so at the other end.

2.3.7. In the preliminary energy audits as carried out by BEU, measurements of important parameters like pressure, temperature and Gas Analysis are made on the process side and electrical power in KVA or KW, power factor, as the case may be on the electrical side are measured for a reasonable period of time, depending on the nature of the process (whether, for example it is a batch

or continuous process and how the equipment is loaded over a 24-hr. period) and type of duty to which various equipments are subjected to. Since these parameters have a profound influence on the specific energy consumption of value added processes, their measurement over a reasonable length of time, to get a representative picture is made.

2.3.8. The modus operandi adopted for most of the preliminary energy audits is as follows:

a. Meeting with the top management and/or plant manager as the case may be for discussing energy conservation strategies and examination of the historical record of Energy Conservation data.

b. A quick walk-thro of the plant with the Engineers of the plant.

c. Discussions with Plant Engineers about the kind of assistance required from them for using diagnostic instruments for testing boilers, furnaces, electrical equipments, process equipments, etc.

d. Preliminary preparation for use of diagnostic instruments.

e. Gathering information about the performance of different equipments by measuring various parameters like the ones mentioned above over a reasonable length of time (which may extend from several hours to a couple of days on a continuous 24 hours basis if needed).

f. On-the-spot adjustment of fuel oil temperature and air/fuel ratio of boilers and furnaces to eliminate smoke and also to reduce excess air supply and if need be to train boiler and furnace operators in these aspects.

g. Discussion with plant managers at the conclusion of the survey about the preliminary findings based on the instrumented survey and to make some on-the-spot "Quick-Fix" type of clear and unambiguous recommendations which are capable of being implemented immediately and without delay, and

h. Drawingd up of detailed heat balance of process equipments/ technologies later after all calculations are done and writing a report for submission to the management.

2.3.9. In all, preliminary energy audits were carried out in 193 number of industries for the duration of the project on lines indicated above and reports submitted to the management. Admittedly, there had been some inevitable delays in the submission of reports by BEU engineers to the respective managements resulting in criticisms at times and possibly loss of enthusiasm on the part of the industry concerned. To take the sting out of their criticism and also to sustain their interest, discussions were held about implementation of some quick measures to save energy on the shop floor with plant managers at the plant before the preliminary survey was concluded as indicated in the previous paragraphs. Those were very helpful and this has been made a regular feature of all preliminary surveys.

2.3.10. Since energy efficiency in industries has a strong linkage with preventive maintenance of plant and machinery, which is totally lacking, in most of the industries, this particular aspect was highlighted almost everywhere during discussions. The report on preliminary survey report of Seminara Coal Company in Annex-6.

should give an idea of the kind of problems faced by industries and the kind of experience and expertise gained by BEU Engineers in the energy conservation field.

2.3.11. As a result of a substantial numbers of preliminary surveys carried out among diverse types of industries, it is possible to identify the following deficiencies as the lowest common denominator among all of them:

a. Inadequate attention paid to or benign neglect of fuel storage, handling and preparation prior to burning.

b. Improper air fuel ratio in most of the fuel consuming equipments.

c. Lack of adequately trained manpower to operate boilers and furnaces efficiently in addition to operating it safely.

d. Lack of even basic instruments to monitor fuel efficiency or non-working of some of the critical instruments/controls due to bad maintenance, faulty installation, lack of spare parts etc.

e. Lack of waste heat recovery devices and improper operation of these equipments in a few caseds where they are fitted.

f. Lack of return of condensate to the boiler house because of absence of a good condensate recovery system and lack of the right size and type of steam traps.

g. Lack of adequate insulation of hot exposed surfaces and bad state of repair of the existing insulations.

h. Lack of knowledge about the recent advances in Energy Conservation technology.

i. Lack of production planning and control, resulting in overloading/underloading of equipments.

j. Low load factor, low power factor and low loading of electrical motors and exceeding maximum electrical power demand because of the inability to evenly distribute the electrical load over a 24-hour period. This is tied up with item (i).

k. Leak of water, chemicals compressed air and steam from glands of centrifugal pumps, pipe threads and flange joints.

l. Total absence of preventive maintenance of plant and machinery and poor housekeeping practices.

2.3.12 While what is mentioned above may be true in the majority of cases, there are still a few islands of energy efficient and energy conscious industries in the Philippines where standards of housekeeping and maintenance are also high. In all these cases, invariably, it is because of the top management's keen interest and involvement in the energy conservation and preventive maintenance functions. Top managements of other industries in Philippines also should adopt a similar approach. Unless the involvement of top management is total in these two important functional areas, energy conservation will only remain an empty slogan.

2.3.13. The potential for savings in the industrial sectors is quite substantial. The findings of the preliminary audits in over so many industries indicate that the quantum of energy savings are larger where industrial furnaces are involved like in engineering and metallurgical industries than in boilers. Similarly, quantum of energy savings are much larger on the process side in a chemical, food processing or other steam consuming industries

possible on the furnaces sideand 10 to 30% energy savings are possible in porcess industries.

2.3.14. Half to 60% of the above mentioned energy savings could be affected surprisingly with practically no capital investment but by just good housekeeping measures alone. Obviously, the quantum of savings is dependent upon the initial level of efficiency or inefficiency at which the industries are operating. The remaining half of 50% savings mentioned above are possible by adopting some medium term measures involving retrofitting of economizers, air heaters, redesign of steam distribution lines and condensate recovery systems, etc.

2.3.15. A moderate amount of capital investment is required for this purpose which any company can easily afford. Our experience and analysis shows that for more than 90% of energy conservation technology projects involving retrofitting of the type of items mentioned above, the rate of return on investment has been from 6 months to a year. It therefore makes sense and is profitable for industries even to borrow money at commercial rates of interestfor investment to save energy.

2.3.16. The performance of majority BEU engineers constituting the EMCS group has been quite satisfactory and it can be said that they have now a group of engineers who have acquired the necessary capability after 4 years of training in this UNIDO project, to carry out preliminary energy audit of the type described in paragraph 2.3.8.

2.3.17. As is the case everywhere, the universal law of Caussian distribution of talent, expertise, achievement, etc. applies here also.

Among the 15 engineers, 4 to 5 of them have acquired a high degree of expertise and skills and are in fact capable of carrying out detailed energy audits and also detailed engineering and design of certain specific energy conservation projects all on their own. However, 2 of the four engineers are no longer with the EMCS group, one of them having resigned and left while the other not having returned from the U.S.A. after finishing UNIDO fellowships training. The third person has now become the Officer-in-Charge of BEU's Conservation Division and may not be available anymore for doing direct level consultancy work whih involves detailed engineering and design, in view of his administrative and other responsibilities.

2.3.18 There is therefore urgent need to develop the remaining engineers also in various aspects of detailed engineering and design. This assessment of BEU engineer's performance by CTA is not based on any systematic and scientific assessment technique but is a gross evaluation based on CTA's close interaction with the group.

2.3.19. Since the composition of the group was small, it was possible to make such an evaluation of the consultants as a group and also individually.

2.3.20 This brings us to the question of specialization indepth of the BEU engineers. In addition to the general level experience they have acquired, which is the bottom line requirement for becoming an effective energy conservation consultants they should also acquire specialized knowledge and experience in

any one of the following areas depending on their aptitude and qualifications:

a. Design of waste heat recovery systems in industry.

b. Instrumentation and automatic control techniques for energy conservation.

c. Industrial water treatment.

d. Industrial furnace operation, maintenance and refractories.

e. Insulation practice in industry.

f. Industrial boiler opration and maintenance.

g. Steam engineering, distribution, transmission and utilization of steam for process use.

h. Energy systems design including Cogeneration.

i. Financial management techniques for appraisal of energy conservation projects.

j. Project management techniques for implementing energy conservation technology projects.

2.3.21. The above mentioned fields of specialization are generic in nature and one of two engdineers of BEU should specialize in each of the above fields. The actual fields of specialization chosen would obviously depend upon the requirement of the BEU both current and future and phased programme of training for developing expertise in these areas may be drawn up with the necessary inputs provided by UNDP/UNIDO under the second phase of the project. By developing expertise in these areas, it should be possible for BEU to develop a mosaic of well rounded technical knowhow/expertise in the area of energy conservation technology in the coming years.

2.3.22 The corporate efficiency of the ability of a corporate entity to generate profits is a product of its managerial efficiency and technological efficiency. Most of the measures suggested for recommendation as a result of preliminary energy audits are essentially managerial measures aimed at better housekeeping and "leakplugging" operations.

2.3.23. It must however be realized that there is a limit to what managerial efficiency can achieve. Even if assuming that managerial efficiency is at the maximum level, the specific energy consumption or for that matter cost of production cannot be below what is dictated or set by the technology employed for manufacture or value addition process. Since technologies employed in developing countries are obsolete, naturally one can expect the specific energy consumption levels to be much higher than those prevailing in developed countries.

2.3.24. To cite some examples, average boiler efficiency in developing countries like Philippines is 50 to 70% at best whereas in developed countries it is over 85% to 89% plus. Similarly forging furnace work at an efficiency of 5 to 10% in developing countries whereas in Japan they may work at an efficiency of more than 65 to 70% plus. For industrial drying operation, the specific energy consumption is 2 to 3 times more in developing countries than in Japan. It will not be wrong to say therefore that for practically every energy consuming product/technology the specific energy consumption levels are way above those in countries like Japan and Western Europe.

2.3.25. The industrial sector in developed countries of Western Europe, North America and Japan are consuming almost 30 to 50% less

energy for the same output than what they did in 1973. Relentless progress has taken place and is still taking place in the field of energy conservation technology in developed countries. The only way developing countries can survive and grow in the years to come is to modernise their manufacturing or value added operations in the industrial sector.

2.3.26. This brings us to the concept of technology management which consists of four distrinct phases, namely (a) Technology Identification, (b) Technology Assessment (c) Technology Induction (d) Technology Innovation. The need to develop a corporate energy plan perhaps with a time horizon of 15 to 20 years, as part of Strategic Corporate plan, with technology management as an integral part of it, is obvious.

2.3.27. The present group of EMCS Engineers of BEU have been exposed to this line of thinking rather briefly. But then since this is a specialized subject in its own right, not much headway could be made. Perhaps it would be useful if a group of 2 to 3 engineers preferably doing planning work at present could take up this area of work for getting themselves trained further both within the Philippines as well as abroad.

2.4. International Consultants

2.4.1. The list of international consultants whose services were made available to this project is given in Annex. 2. Three long term experts including CTA and six short-term experts were recruited for the project and their job description is given available with UNIDO HQ, Vienna.
The first long term expert for the project Mr. R. Rajaram trained some if not all of BEU engineers in the detailed engineering and design of certain retrofit energy conservation projects.

2.4.2. In particular, the following topics were dealt with (a) Preparation of Bill of Materials and their cost estimation, (b) Preparation of General Layout Drawings, (c) Specification of Materials, (d) Detailed Working Drawing of a Wood Fired external furnace, (e) Preparation of Tender Document, etc. Mr. Brian Cunningham has been engaged in training BEU engineers in detailed energy audit of some sugar industries, commercial buildings which are centrally airconditioned. The detailed energy audits generally take 15 days to a month and involves detailed analysis of energy usage pattern over a 24 hour period, analysis of the performance of all major energy consuming equipments with sophisticated diagnostic instruments such as the use of Infrared Thermovision equipment, etc. for two dimensional mapping of heat flow, etc. So far, 5 detailed energy audits have been carried out and more are planned in the coming months.

2.4.3. One of the difficulties experienced by BEU has been to get consent from industries for carrying out detailed energy audits. Mr. Brian Cunninghan has also been engaged in assisting BEU engineers in carrying out preliminary energy audit in addition to his primary responsibility of carrying out detailed energy audits.

2.4.4. The short-term expert, Mr. Brian Robninson taught BEU engineers about correct instrumentation techniques for Energy Audit and methodology of energy audit and gave very useful practical tips to BEU Engineers for saving energy on the shop floor when he took them around on his visits to industries for energy audit. Mr. Robert Ericson conducted seminars on Cogeneration under

the auspices of Energy Management Association of the Philippines (ENMAP) and also carried out a survey in a number of industries to assess Cogeneration potential which exists in Philippine industries.

2.4.5. Mr. Waclaw Szulakowaki advised National Power Corporation Management about overcoming erosion problems of superheater tubes of their coal fired thermal power stations. Mr. Geoge Yamamoto studied the set up of the Fuels and Appliance Testing Laboratory and made suggestions about how to organize ourselves for Refrigerator testing and recommended a list of instruments for purchase by the project.

2.4.6. Mr. Norval Jackson, who was [illegible] with the project up to 30th June 1987 on a 3-month assignment was engaged in training BEU engineers attached to the Fuels and Appliance Testing Laboratory in proper testing methods and procedures and supervising the production of Quality Assurance Manual. Mr. Jackson was also assisting BEU in the design of Refrigerator Test Chamber. Mr. Patrick Naghten, who was here for 2 months also assisted BEU in the fuels and appliance testing laboratory. The reports of short-term consultants are available with Factory & Establishment Service Division, UNIDO, Vienna.

2.4.7. Because of the specialized technical nature of the project it has not always been possible to meet the requirements of BEU in respect of the right type of international expert who had the kind of experience which BEU insisted upon in spite of the extraordinary efforts made by UNIDO in locating the right type of specialists. There were therefore at times, inevitable delays

in getting consultants both short and long term for the project. The achievement of some, if not all of the outputs, have as a consequence been delayed slightly but not too much to affect the overall project output as a whole. Even so, the role of the international consultants both short and long term has been crucial in bringing this project upto the present level of maturity.

2.4.8. In order to develop an all round personality of the BEU engineers, trainingd sessions were held for them in which subjects like (a) the art of public speaking, (b) Technical report writing. (c) How to deal with client organizations, etc. by Mr. B. Cunningham. Further a schedule for training the engineering in certain specialized topics which have relevance to detailed energy audit was drawn up and the training sessions were conducted by CTA and Mr. Brian Cunningham. The schedule is attached in Annex. 7. BEU engineers were given several assignments to be completed by Mr. Brian Cunningham. The follow up activity in this regard is being taken up by Mr. Cunningham.

2.5 Education, Training and Information

2.5.1 The bed rock of any successful consultancy organization is the ready access it has to information and knowledge about latest advances in the field of energy conservation technology. A humble beginning in this direction has been made by the establishment of an energy information centre as part of this project consisting of library containing 890 books and 75 number of professional journals related to energy management and allied topics. In addition, trade and commercial literature on a wide

variety of equipment/instruments/technologies related to energy field have been obtained from developed countries like USA, UK, Germany and Japan by writing to the manufacturers of these products.

2.5.2. These pamphlets/literatures are very useful for BEU engineers because itkeeps them abreast of the latest products/technologies in the field of energy conservation. This Information Centre which is presently housed in BEU premises is meant not only to serve the needs of BEU staff but also the needs of industries in the Philippines.

2.5.3. In order to help BEU engineers to conduct training programmes in industries as well as under the auspices of professional associations, both hardware and software facilities have been made available to them. An overhead projector, video camera, television with a wide angle screen and video recorder and player have been provided in addition to a 16 mm film projector. Software support in the form of transparencies on topics related to Energy Management and Computation have been prepared by CTA for use by the Engineers of BEU.

2.5.4. During the phase of the project 29 manual's, pamphlets on various topics related to Energy Conservation & Management were published and there manuals are distributed free of cost to the Engineers from the industries on demand.

2.5.5. An Energy Information Centre consisting of 40 technical periodicals and over 600 books on topics related to Energy Management, Conservation and allied subjects has been set up as part of this project.

2.5.6 At present, the energy information centre is looked after by one of the locally recruited U.N. staff assisted by BEU personnel. The system of classification of books, Journals at present is not scientific. When the project terminates and the liberary is handed over to BEU, a need is foreseen for training one of the BEU staff in the Library Information Science either in the Philippines or abroad. There is an urgent need to classify books and journals and literature on various products/technologies according to internationally accepted system of library documentation.

2.5.7 Since BEU has been equipped with an HP-1000 Mini computer under this project abstract of all articles which appear in professional journals received by the project may be stored in its memory in a wall designed data base for retrieval later on.

2.6 Fuels and Appliance Testing Laboratory

2.6.1 The fuels and appliance testing laboratory was established as part of this project to serve the needs of EMCS engineers as well as the industries. A provision of US$75,000 was made under the UNDP/UNIDO budget fo equipping the laboratory with special type of diagnostic types of instruments for carrying out energy survey and fuels and testing instruments and calibration grade instruments for calibration of electrical instruments. A separate building, located 20 kms away from BEu premises in Quezon City, was built to have this laboratory with funds provided by Philippine Government.

2.6.2 Because of certain administrative and financial matters beyond the control of the project management, there was a delay in the construction of the first phase of the building. However, as soon as the building was completed, the first batch of instruments which had already been received were transferred to the laboratory building. As of now, the second phase of the building intended to house calibration grade instruments has also been completed. Package type of air-conditioners have been provided for the laboratory building and special type of air conditioner for maintaining special temperature and humidity conditions (60° F and 50% R.H) in the primary standards room have been ordered.

2.6.3 It was intended in the beginning that this fuels and appliance testing laboratory should ultimately become a Testing and Calibration Centre for serving the needs of ASEAN Group of Nations and that it should also get recognition from international bodies such as National Physical Laboratory of U.K. and National Bureau of Standards, U.S.A. so that it could become a Centre of Excellence for providing training to laboratory technicians and Standards engineers from developing countries in the Eastern Hemisphere. This particular fuels and appliance testing laboratory has the potential to fulfil this role and all it needs is a little help from UNIDO during the second phase of the project. If this objective is still to be pursued, more sophisticated infrastructural facilities have to built up and a solid laboratory building according to international standards has to be built replacing or modifying the existing one.

2.6.4 At present, for instance, no safety system is installed nor is the electrical wiring system designed for laboratory standards. Effluent disposal have yet to be designed and installed. All these and other problems will be studied by NEC under a subcontract awarded to it and it is hoped its recommendations will be implemented by BEU. In addition to safety of operating personnel, the building has also to be provided with burglar alarm or other similar devices since more than $650,000 worth of instruments but no doubt situated in a well-guarded compound of Energy Research Development Centre. There are also security guards posted on a 24-hour 7-day week basis to guard the property. Once the laboratory equipments and instruments are transferred to Philippine Government. BEU proposes to get all the instruments insured. Even so, there is no harm in taking some additional security measures to be doubly sure of things.

2.6.5 The Laboratory at present is headed by a senior chemical engineer from BEU and is assisted by 10 engineers who are posted in different sections of the laboratory. Except for the temporary laboratory staff who were recruited in January 1987 almost all of the laboratory staff, who are permanent employees of BEU, have undergone training in foreign countries under UNIDO training fellowship programme. All of them have come back after training and are in position (See Anne for details of training).

2.6.6 As of date instruments worth $600,000 have been received and request for placement of orders for instruments worth

$70,000 are under process. The costliest equipments received by the project so far are (a) Perkin-Elmer Elemental Analyzer (b) Fisher Coal Analyzer (c) HP-1000 computer. Since orders for these instruments were placed with the manufacturers or their representatives in Europe, the local sole selling agents of the above-mentioned instruments agreed to install and commission these instruments only on payment of extra money. In view of the sophisticated nature of these instruments, it was decided by the project management that a contract be awarded to the local agents of the above-mentioned instruments for maintenance for one year. For this purpose, a total sum of $5,295.00 was provided. Had the local agents been involved, this extra expenditure could have been avoided.

2.6.7 We were also given to understand on reliable authority that the FOB prices of instruments if ordered through agents in Asian Region like Singapore, Hongkong or even Manila, is lower than if ordered through agents in Europe or America. That is because specifications of instruments for European market are more stringent and therefore more expensive. If at all possible, in future, orders for instruments for future UNDP projects may be placed with their agents in Asia. In a way this will also help the project authorities in getting prompt after-sales-service from local agents.

2.6.8 Particularly in the case of sophisticated instruments like in the present case the old adage that "for want a shoe-nail, a battle was lost" holds especially true. For instance, for want a small fuse of a very special type, which cannot be procured easily in the local market, some instruments in

BEU are not working. Similarly, because the shelf-life of Electrochemical Oxygen Cell has expired the oxygen analyser cannot be used. While the procurement of such small parts off-the-shelf is so easy in developed countries and in fact all that is needed, possibly is just a phone call to the concerned persons, such a situation poses immense problems in developing countries to the project management because of foreign exchange regulations, elaborate paper work involved which is the same irrespective of the amount involved. Further a substantial lead time anywhere for one month to 6 months is quite commonly involved in the ordering of small but vital spares for instruments.

2.6.9 In order to mitigate if not entirely eliminate such problems, it would be desirable on the part of UNIDO if it can authorize purchase or itself place orders for sophisticated instruments through exclusive local agents wherever one exists. This would ensure prompt after-sales-service along with the necessary maintenance of the instruments for a couple of years after installation. Further, when placing orders for instruments, the instrument supplier should be asked wherever practicable, supply along with the instruments, fast moving spares - consumable or otherwise - for at least one or two years of requirement. Wherever certain spare parts have a short shelf-life, instrument manufacturers should be asked to supply the spares (for one or two years after the project is over) direct to the project management but sending the bill to the executing agency responsible for the project. It would mean setting aside a small sum of money by the purchase

department of the executing agency for future purchase of small spare parts and charging that amount to the project under consideration. Such a procedure would ensure that sophisticated instruments are kept working particularly in developing countries even after the project is terminated.

2.6.10 The local agent was unable to commission into service the Perkin-Elmer Elemental Analyzer, and as such we had to get one instrument technician from Singapore to test and commission this instrument. While this technician was successful in doing so, he mentioned that the helium gas supplied by the local manufacturer was not the required purity. Hence, arrangements were made to procure ultra high purity Helium gas from abroad through UNIDO office in Vienna. As soon as this helium gas cylinder is received, the Perkin-Elmer Elemental Analyzer would be fully commissioned. The other relatively expensive instrument, namely, the Fisher Coal Analyzer has been commissioned and put into service.

2.6.11 The most important diagnostic instruments acquired for the project namely, the Infrared Thermovision has been put to use already in several of the preliminary as well as detailed energy audits carried out by EMCS engineers. Two dimensional heat flow patterns were visually observed and with the help of the polaroid camera attached to it, photographs were taken of some of the steam pipes, boiler structures etc. Based on the interpretation of these photographs, it was possible to pinpoint the source of maximum heat loss so that corrective action could be taken.

2.6.12 Most of the fuel testing instruments, water analysis instruments have been tested and put into service. Already in a small way some testing work has been undertaken for outside parties. For instance, hydro fuel oil i.e. a homogenized mixture of fuel oil and water (with 20% water) produced by one of the local entrepreneurs was tested and the result communicated to him. Similarly, calorific value of a biomass fuels like rice busk, fuel oil etc., were determined using the existing Adiabatic calorimeter. The above-mentioned tests have been carried out according to ASTM or API standards as the case may be.

2.6.13 Similarly, most of the calibration instruments on the electrical side have been tested and found to be in order. In fact, some of these instruments were made use of to calibrate a temperature recorder belonging to one of the cold storage companies which was sent to BEU Testing Laboratory for calibration purposes. In order to gain experience as well as to test the accuracy of the instrument, the Kelvin Bridge instrument was used to measure the contact resistance of electrical relays and contractors and household single pole single throw (SPST) electrical switch of different amperages. Very interesting result were obtained.

2.6.14 Even though some minimum number tests have been carried out, the laboratory is not fully operational in the true sense of the word. For instance, the fumehood which is required for carrying out experiments involving hot gases and toxic fumes has just been received and it will be installed within

the next month or so in the alloted place. There are a number of loose ends to be tied up on the management side. Proper procedures for receipt of test samples of either fuel, equipment or instruments received for testing and their storage, despatch etc. have to lay down. Reporting of results, establishment of a Quality Assurance Programme, estimation of confidence level of measurement and steps to be taken to reduce errors in measurement, maintenance of proper environmental conditions for carrrying out tests, etc., are some of the items to be dealt with.

2.6.15 Safety precautions against fire hazard and personnel safety, safe operating procedures and conditions for handling toxic and poisonous chemicals, acids, and their safe disposal ar all important matters which deserve to be attended to immediately. It is only after all these issues have been tackled successfully to be satisfaction of everyone, can the laboratory become truly operational.

2.6.16 The NEC which has been awarded the subcontract by UNIDO is expected to deal with all the above-mentioned issues including training of laboratory personnel. The details of the subcontract are available in UNIDO Hq. It is expected that NEC would complete this portion of the work by October 1987. One could therefore expect the Fuel and Appliance Testing Laboratory by October 1987 i.e., by the time the project formally ends in which case there would have been a delay of 6 to 8 months in the commissioning of the laboratory due to reasons beyond the control of project management authorities.

2.6.17 There will be a great demand for calibration of instruments commonly used in energy audit work for measuring parameters like pressure, temperature, and gas analysis by the industries in Philippines. Facilities for calibration of the above-mentioned type of instruments should be established on a model similar to the one existing in Instrument Association of America's Headquarters office in North Carolina, USA. Since two of the engineers of BEU attached to the laboratory have already been to that institution in USA under UNIDO training fellowship programme, it should be possible for these Engineers to duplicate such facilities in this laboratory.

2.6.18 As and when the laboratory becomes fully operational, it would be desirable to charge a reasonable fee for carrying out any type of test in the laboratory. The quantum of fees to be charged for different types tests is something that should be decided by the BEU management. The income derived from making available the laboratory test facilities to outside parties can be utilized for meeting part if not the total cost of maintenance of laboratory instruments. Wide publicity should be given to the activities of the laboratory once it becomes operational.

2.6.19 A calorimeter room has been set up by BEU without any outside help according to ISO standards, and it is fully operational for the last 3 years. A test programme for testing window type of air conditioners of 1 1/2 HP and below was launched in March 1984, in cooperation with Product Standards Agency (PSA), Association of Home Appliance Manufacturers (AHAM), and 5 appliance manufacturers. It was decided

that a minimum Energy Efficiency Ratio (EER) of 6.8 kilo joules/watt-hour for 1 1/2 HP models and below should be set for voluntary compliance. During the period 1984-85, 16 basic models of airconditioners were tested out of which only 10 models met the suggested minimum EER standards. This is a very useful facility and will help the local manufacturers in improving the EER as well as product quality to meet international standards. The U.S. Navy in Subic Bay, we are given to understand, will buy for its use such of those air conditioners in the Philippines which have been tested by BEU and certified as meeting the minimum EER requirements. It could thus be seen that this test set up for air conditioners has proved it's usefulness to the Philippines. UNIDO has provided an airconditioner for upgrading this test facility.

2.6.20 Similar test facilities for Refrigerators, lamps, ballasts, LPG stoves and water heaters are in the process of being designed by the NEC as part of its subcontract work with UNIDO. Even if the design work is completed by the end of 1987 the actual construction of these test facilities for the above-mentioned items can be taken up only during the second phase of the project. However, there is scope for reordering the priorities for establishing test facilities for the above-mentioned appliances and it is up to the project management to examine this issue afresh and take decisions accordingly.

2.7 HP-1000 Computer

2.7.1 The HP-1000 computer which was obtained for the project after considerable amount of discussion and debate, could be commissioned only in April 1987 because of reasons beyong project management a control. It is presently located in the BEU premises in a separate air conditioned room which is provided with a stabilized power supply. The HP-1000 computer project was being handled by a Senior Computer Specialist who has since left the BEU because being an employee of PNOC, he has to go back. Presently, the HP-1000 computer project is being looked after by 2 engineers of BEU, both of whom have undergone training abroad - one under UNIDO fellowship programme and the other under US-ASEAN project.

2.7.2 There were initial problems about commissioning the Computer because of some defective or mismatched part. After this problem was rectified, the HP-1000 computer has been commissioned. In order to fully exploit the power of this computer, it is essential to either develop custom built software for BEU's use or it has to purchase software already developed by outside agencies. On an average much more money spent should be spent on software to put the computer to its optimum use. NEC is now given the task of training BEU Engineers in the design and development of a National Energy Data Base. This wask, assigned to NEC, as a subcontract by UNIDO is expected to be completed by October 1987.

2.7.3 It is desirable to get all the BEU engineers trained in the use of HP-1000 computer and they should also taught the basic of programming. That way, it would be possible to develop some simple programmes for doing routine Energy Calculations useful in energy audit work and possibly later the same group of Engineers could develop more sophisticated and involved software for Energy Systems Analysis, etc. It is only by having a core group of trained engineers in the field of computer programming is it possible to fully exploit the potential of the HP-1000 computer. Till then it will remain under-utilized.

3.0 Achievement of Immediate Objectives

3.1 Of the four immediate objectives set out to be achieved (refer paragraph 1.3), the first three objectives have been substantially achieved and on a scale of 1 to 10, the achievement rating would be between 7 & 8. However in respect of developing standards for efficiency of energy utilization, much remains to be done. As of date, energy efficiency standards only for locally manufactured room air conditioners of 1 1/2 HP and below have been drawn up. Work in respect of evolving energy efficiency standards is in progress. Admittedly, any progress in this direction is bound to be low, because setting standards is a very complex issue and interests of a number of conflicting groups have to be reconciled while drawing up standards.

3.1.1 It was intended, at the beginning of the project, that BEU engineers should have acquired the necessary skills and expertise in carrying out detailed engineering and design of certain

type of retrofit energy conservation projects. Among 15 engineers of the BEU only 3 or 4 engineers have acquired this capability and the rest of the engineers have to be brought to the same level. This output could be achieved only partially. But the engineers of BEU are well versed in carrying out preliminary energy audits. On the whole, the results achieved compare favourably with the objectives of the project. It would not be wrong to claim in fact that we have progressed far beyond the midway point in our journey to achieve the objectives of the project.

4.0 Utilization Project Results

4.1 As has been mentioned earlier in paragraph 2.3.2 it was some of the big industries, who first started utilizing with great benefit to themselves the services of BEU engineers. This is a clear proof of the level of expertise achieved by BEU engineers as a result of the training they received by UNIDO experts attached to this project. The fact that the very same industries come back to BEU requesting for more help and assistance is a clear rpoof of the benefits that some of the industries have derived as a result of BEU's consultancy services.

4.1.1 Another significant result of project's activities has been the training of about 3400 engineers from all types of industries over a 4 year period. This has created a proper climate which is conducive for further energy conservation work in industries.

4.1.2 The establishment of air-conditioning test facilities by BEU which was upgraded with UNIDO's help, has created awareness among consumers to go in for air conditioners with a high Energy Efficiency Ratio (EER). For example, U.S. Navy at Subic Bay wants only such of those air conditioners which have been certified by BEU as conforming to minimum EER standards prescribed by them.

4.1.3 The same degree of awasreness which exists in big respect of energy utilization does not exist among industries in the medium and small scale sector. A more intensive programme of education of the top management and training of engineers and workers and dissemination of information about latest technologies are factors worthy of attention. In particular, dialogue with the top management personnel periodically would go a long way in utilizing more and more BEU's consultancy services for saving energy on the shop floor.

4.1.4 The modus operandi adopted by BEU at present to get requests for Energy Audits from industries, is to write a routine letter to a number of industries, hoping that at least one or two of them would respond and request for BEU's services which in any case in provided free of charge. A more dynamic approach would be to seek out the industries and prevail upon them to utilize BEU's services. This type of approach, is especially needed to make an inroad into the small and medium scale sectors. It may seem paradoxical but true that if BEU were to charge a reasonable fee for its service, the demand for its service is bound to grow. This has been

the experience of consultancy organizations elsewhere. Therefore BEU should charge a fee for its services in the near future.

4.1.5 Dissemination of information about energy conservation technologies and good energy management practices should be on a much wider scale than hitherto done, particularly among small and medium scale industries. Instead of giving away pamphlets and literature free of cost to the industry if token fee might be charged to recover cost of printing at least.

4.1.6 Another factor which might affect the pact of energy conservation work in the future is the availability of capital in Pesos as well as in Dollars for buying some equipments like economizers, air heaters, instruments and automatic control systems, for monitoring and control of energy utilization etc., for saving energy. In fact, even when adequate finance is available at reasonable rates of interest, very often, top management in industries are unwilling to invest in energy conservation projects, because at all points of time they can find alternative projects on the manufacturing side which are more attractive from their point of view. Therefore, education of top management as mentioned in paragraph 4.1.3 seems to be the only answer. They should be that told energy conservation improves not only product quality buy also reduces atmospheric pollution and results in overall productivity improvement and that energy conservation and good preventive maintenance practices are the bottom line for industry's progress towards prosperity.

4.1.7 A project on "technology transfer on Energy Management" of $5 million has been financed by USA AID for implementation by office of Energy Affairs. The objective of this project is to identify certain industries where latest energy conservation technologies could be applied to be financed out of the funds provided by USAID to the Philippine Government. A committee has been established by office of OEA involving an interested parties for implementing this project.

4.1.8 It would be advisable for OEA Philippine Government to approach ADB to make available to them a revolving fund of any where between $50 to $100 million for financing energy conservation projects in the industries. ADB, which had earlier financed a study "Potential of Energy Conser-ion in Philippine industries ould be willing, according to some informal sources to fund, if such a request were to be forthcoming from the Philippine Government.

4.1.9 It is indeed a matter of satisfaction that some if not all of the companies where energy audits were carried out, have been able to save energy in their units to the extent of 5 to 15%(Though in some cases the quantum of savings are larger) by implementing some of the energy conservation measures recommended by BEU engineers. This has been

brought out in a follow up survey carried out by BEU. According to the findings identified by BEU, the amount of energy saved in monetary term is equal to P167 million ($8.4 million) from a total of 40 companies with an investment of 101 million ($5.0 million).

The analysis of energy consumption figures by BEU as reported by the industries, shows that 88 companies have reported energy savings through reduction in specific energy consumption in 1986 over 1985 levels. This list of 88 companies is given in Annex-11.. Some of the measures adopted to save energy on the shop floor is given in Annex-12. .The specific energy consumption of different industries is given in Annexure -13.

4.1.10 A policy framework for promoting energy conservation already exists but the full implications and details of it are not known to many of the industries. For example, many of the industries are not aware of the fact that Board of Investments will allow industries to import any equipment or technology for saving energy free of import duties on certification and endorsement by BEU. Therefore there exists a case for wider dissemination of information such policy issues by BEU to industries in Philippines. No doubt, likewise many more incentives could be thought of to accelerate the pace of energy conservation. For example, provision of low interest loans for purchase of equipments, allowing accelerated depreciation of equipments used for energy conservation etc., are some of the measures which could be considered by the Government.

4.1.11 A lot more ground needs to be covered in the area of policy and decision making. OEA, in view of the recent administrative changes brought about, is having enough clout to push through many more policy level changes aimed at giving a further fillip to energy conservation programme in the Philippines. As such work in this area should be intensified.

5.0 Conclusions & Recommendations

5.1.1 This project on Industrial Energy Management Consultancy and Training which has been in operation for the last four years, has clearly demonstrated that if an institutionalized approach to the problem of Energy Management and Conservation is adopted, it is possible to make a dent in its armour. A good beginning has been made and lot of ground has yet to be covered. But then, "A Thousand Mile Journey Begins with The First Step Forward". It is to the credit of Philippines that it is ahead of other Asean Group of Nations in this regard.

5.1.2 The desirability of making EMCS as an independent entity financially and otherwise has been emphasised by UNDP representative in all the tripartite meetings held so far. It was suggested that to start with, a small fee should be charged by BEU for the services it renders to the industries. Mr. Orlando Galang, Acting Director of BEU, had promised to take a step in that direction from January 1987. But then because of his sudden departure from the scene (having been transferred back to his parent department, namely PNOC) no further action was taken in this direction.

5.1.3 It is strongly recommended that this important suggestion of UNDP making EMCS an independent and autonomous body working outside the rigid framework of Government rules and procedures shcuid be pursued vigorously by the Philippine government, as only then it is possible to provide quality service to the industries. Further, it will also be possible then to compensate the already well trained staff of EMCS at rates close to if not equal to those existing in private sector or public sector autonomous corporations like Philippine National Oil Company (PNOC) or National Power Corporation (NAPOCOR).

5.1.4 It is only when a reasonable fee is charged for the services rendered by specialists of EMCS, that there is a commitment on both sides. The revenue generated by the EMCS consultancy services is bound to grow in the years to come and if experience of other countries be any guide, a time frame of 5 years is foreseen for the services to become financially viable or self sufficient.

5.1.5 If this suggestion to make EMCS an autonomous body is not acted upon expeditiously, there is a distinct possibility of the existing and well trained staff of EMCS leaving the organisation in the coming months and years to seek greener pastures elsewhere either within or outside the country for which ample scope is emerging in view of the recent upsurge in the Philippine economy.

5.1.6 Since, during informal discussions with the officers of OEA during the last stages of the project, it was indicated that

is headed now by the former Project Manager of this UNDP/UNIDO project, who has acquired valuable experience and expertise in this area over the years.

(d) The Fuels & Appliances laboratory is located within the ERDC compound and as such logistically, it would be most convenient for ERDC to manage the affairs of the laboratory.

5.1.8 This aspect of identifying ERDC as implementing agency for the second phase of this project may be kept in mind. If for some reasons, this suggestion does not find favour with Philippine Government, then the scope, nature and objective of the project to be implemented by OEA have to be worked out de novo, because OEA, is now being assisted by GTZ under a bilateral technical assistance programme between Philippines and Federal Republic of Germany in the field of Energy Conservation. Similarly USAID and World Bank and Australian Government are funding programmes on Energy Management and Conservation to be implemented by OEA.

5.1.9 Under these circumstances it would be prudent for UNIDO/ UNDP to redefine its projects so as to not to overlap with the activities in OEA being funded by other governments/ agencies. Expansion and augmentation of the existing Fuels and Appliance Testing Laboratory under the second phase of the programme, so as to make it a Regional Accredited Laboratory for Asean Group of Nations as far measurement,

calibration and standardisation of process parameters used in the production, transmission and utilisation of energy are concerned, may be considered by UNIDO/UNDP for implementation.

5.1.10 For the success of the energy conservation programme, the education of top management at one end of the spectrum and the workers directly in charge of fuel consuming equipments on the other is very crucial. An optimum combination of "CARROT AND STICK" policy should be adopted in developing countries to save energy. It is easier to educate and train middle management people but the bottlenect is at the top.

5.1.11 Much of avoidable energy wastage taking place in the industrial commercial and transport sector in developing countries like the Philippines may be attributed to the following factors; (a) obsolete Equipments/Technology, (b) Untrained or unskilled manpower, (c) Lack of information about latest technology, (d) Lack of managerial Know-how, (e) Lack of availability of capital, and (f) Lack of incentives and motivation for workers. Each one of the above issues must be addressed either separately or together in order to achieve the goal of energy efficient operations.

5.1.12 Since trained manpower is the very foundation on which any efficient economic activity rests, massive training programmes on a scale far greater than what is currently being done for industry personnel at all levels must be undertaken. More funding should be provided for this purpose

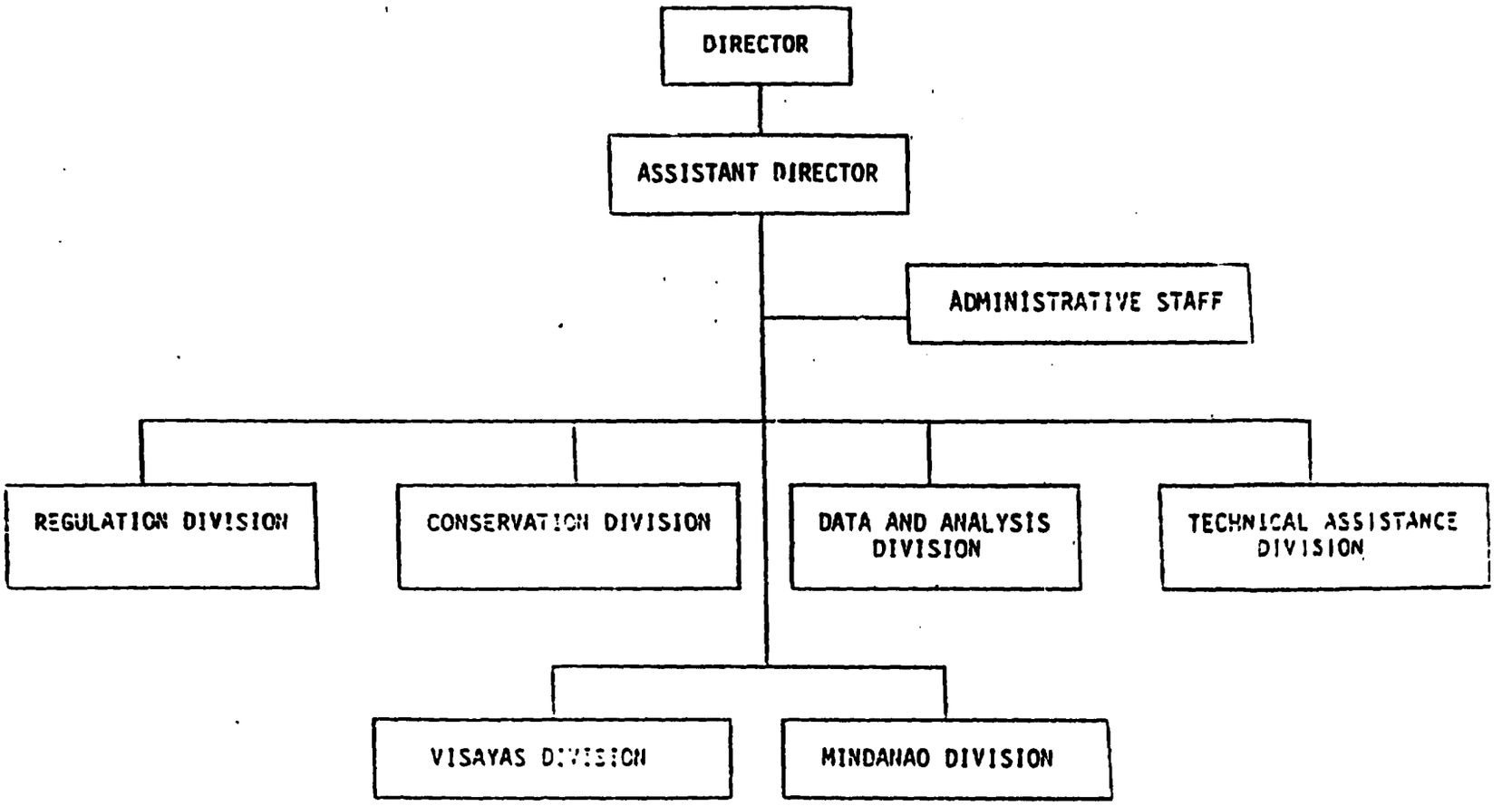
which can be channelled through BEU. The attitude of the engineers in industries general to energy conservation measures has been a very positive one. BEU should also train more Engineers in the field of energy management and conservation by the existing senior staff not only to take care of the increased tempo of activities in the years to come but also to compensate for the turnover of trained staff.

5.1.13 There is a need to develop a holistic or system approach to the problem of energy conservation because of its strong interface with process technology, preventive maintenance and capacity utilization of plant and machinery. There is also a need to develop a strategic long-term plan - having a time horizon of 15 to 25 years - for saving energy in all sectors of the economy. Any tactical short or medium term plan drawn up should dovetail without any contradiction on to this long term plan. This concept needs to be introduced at all levels - both at the Government and Corporate levels.

5.1.14 This project needs to be extended by providing more quality inputs by UNDP/UNIDO to develop BEU engineers to take up detailed engineering and design work in industries and to develop the Fuels and Appliance Testing laboratory as a regional laboratory for serving the ASEAN Group of Nations. The Philippines is well equipped in terms of trained manpower to absorb effectively any high quality input that UNDP/UNIDO may provide in the coming years during the second phase of the project.

ORGANIZATIONAL CHART
BUREAU OF ENERGY UTILIZATION

Annex.I



Annex 2

LIST OF INTERNATIONAL EXPERTS

List of International Experts/Consultants
Recruited by the UNDP/UNIDO Project

Post	Name	EOD	EID
11-01	CHIEF TECHNICAL ADVISER (P.R. Srinivasan)	May 1983	June 1987
11-04	ELECTRICAL & MECHANICAL ENERGY PROCESS SPECIALIST (R. Rajaram)	June 1984	June 1985
11-57	ENERGY AUDIT SPECIALIST (B. Robinson)	August 1985	September 1985
11-54	COAL COMBUSTION EXPERT (W. Szulakowski)	January 1986	March 1986
11-51	FUELS & APPLIANCE TESTING SPECIALIST (P. Najjar ?)	February 1986	April 1986
11-55	COGENERATION CONSULTANT (R. Ericson)	June 1986	August 1 6
11-56	FUELS AND APPLIANCE CONSULTANT (G. Yammoto)	August 1986	August 1986
11-05	APPLIANCE TESTING SPECIALIST (N. Jackson)	April 1987	June 1987
11-02	ENERGY AUDIT SPECIALIST (B. Cunningham)	October 1986	October 1987

Annex 3

REVISED BUDGET

(MARCH 1987)

UNITED NATIONS DEVELOPMENT PROGRAMME

MANDATORY PROJECT REVISION 1987

COUNTRY: PHILIPPINES

TITLE: INDUSTRIAL ENERGY MANAGEMENT CONSULTANCY AND TRAINING

PROJECT NO: PHI/82/002/M/01/37

The attached budget of the above project is hereby revised for the following purposes:

(1) To formalize advance authorization "K" issued on 12 January 1987 and also advance authorization "L" issued on 29 April 1987 which reflected the following budgetary changes:

- the increase in BL (11-02) and (11-50) by 6 m/m and 0.3 m/m respectively,
- the decrease in BL (11-05) by 3 m/m,
- the increase in BL (13-00) of $ 7,350 ; BL (15-00) of $ 1,494 ; BL (16-00) of $ 3,500 and BL (39-00) of $ 10,900.

(2) To reflect actual 1986 expenditures as reported by the executing agency.

The change to the project budget - UNDP input is as follows:

Previous UNDP input - project budget code (J)	$ 1,586,892
Revised UNDP input - project budget code (K) (AA)	$ 1,586,892
UNDP input - increase (decrease)	-
Previous UNDP input - project budget code (K) (AA)	$ 1,586,892
Revised UNDP input - project budget code (L) (AA)	$ 1,635,607
UNDP input - increase (decrease)	$ 48,715
Previous UNDP input - project budget code (L) (AA)	$ 1,635,607
Revised UNDP input - project budget code (M)	$ 1,635,607
UNDP input - increase (decrease)	-

Agreed on behalf of the Government — Date

Letter from Mr. A. Vassiliev, Deputy Director-General, DIO, UNIDO/Vienna — 14 April 1987

Agreed on behalf of the Executing Agency — Date

Turhan K. Mangun, Resident Representative

Approved on behalf of the United Nations Development Programme — Date

SUMMARY OF BUDGET CHANGES

PHI/82/002 : Industrial Energy Management
Consultancy and Training.

Dsk0125-1bd

	BUDGET "L" (AA)		BUDGET "M"		DIFFERENCE	
	m/m	$	m/m	$	m/m	$
10 PROJECT PERSONNEL						
11 Int'l. Professionals						
11-01 Chief Technical Adviser	48.2	315,473	48.2	315,473	0.0	0
11-02 Indus. Energy Con.	12.0	75,854	12.0	75,854	0.0	0
11-03 Cancelled						
11-04 Elect./Mechanical	12.0	78,772	12.0	78,772	0.0	0
11-05 Fuel & Applic. Testing	3.0	19,350	3.0	19,350	0.0	0
11-50 Short-Term Experts	8.0	71,833	8.0	71,833	0.0	0
11-99 Sub-Total	83.2	561,282	83.2	561,282	0.0	0
13-00 Administrative Support		87,255		87,255		0
15-00 Official Travel		12,548		12,548		0
16-00 Mission Costs		29,280		29,280		0
19-00 Component Total		690,365		690,365		0
20 SUBCONTRACTS						
21-01 Sub-Contracts		74,906		74,906		0
30 TRAINING						
31-00 Fellowships		101,293		101,293		0
32-00 Group Training		124,237		124,237		0
38-00 Prior Year's Savings		(9,922)		(9,922)		0
39-00 Component Total		215,608		215,608		0
49-00 EQUIPMENT		622,512		622,512		0
59-00 MISCELLANEOUS		32,216		32,216		0
99-00 PROJECT TOTAL		1,635,607		1,635,607		0

	BUDGET "L" (AA)		BUDGET "M"		DIFFERENCE	
	m/m	$	m/m	$	m/m	$
1982-1985		977,757		977,757		0
1986		281,437		281,437		0
1987		376,413		376,413		0
		1,635,607		1,635,607		0

SUMMARY OF BUDGET CHANGES

PHI/82/002 : Industrial Energy Management
Consultancy and Training.

	BUDGET "E" (AA)		Budget "I." (AK)		DIFFERENCE	
	m/m	$	m/m	$	m/m	$
10 PROJECT PERSONNEL						
11 Int'l. Professionals						
11-01 Chief Technical Adviser	48.4	309,882	48.2	315,473	(0.2)	5,591
11-02 Indus. Energy Cons.	6.0	39,900	12.0	75,854	6.0	35,954
11-03 Cancelled						
11-04 Elect./Mechan .al	12.0	78,772	12.0	78,772	-	
11-05 Fuel & Applic. Testing	6.0	39,900	3.0	19,350	(3.0)	(20,550)
11-50 Short-Term Experts	7.7	61,586	8.0	71,833	0.3	10,247
11-99 Sub-Total	80.1	530,040	83.2	561,282	3.1	31,242
13-00 Administrative Support		79,905		87,255		7,350
15-00 Official Travel		11,054		12,548		1,494
16-00 Mission Costs		25,780		29,280		3,500
19-00 Component Total		646,779		690,365	-	43,586
20 SUBCONTRACTS						
21-01 Sub-Contracts		74,906		74,906	-	
30 TRAINING						
31-00 Fellowships		96,546		101,293		4,747
32-00 Group Training		118,084		124,237		6,153
38-00 Prior Year's Savings		(9,922)		(9,922)	-	
39-00 Component Total		204,708		215,608		10,900
49-00 EQUIPMENT		622,512		622,512	-	
59-00 MISCELLANEOUS		37,587		32,216		(5,771)
99-00 PROJECT TOTAL		1,586,892		1,635,607		48,715

SUMMARY OF BUDGET CHANGES

PHI/82/002 : Industrial Energy Management Consultancy and Training.

Dat011181bd

	BUDGET "J"		BUDGET "K" (AA)		DIFFERENCE	
	m/m	$	m/m	$	m/m	$
:10 PROJECT PERSONNEL						
:11 Int'l. Professionals						
11-01 Chief Technical Adviser	48.4	309,882	48.4	309,882	0.0	0
11-02 Indus. Energy Con.	6.0	39,900	6.0	39,900	0.0	0
11-03 Cancelled						
11-04 Elect./Mechanical	12.0	78,772	12.0	78,772	0.0	0
11-05 Fuel & Applic. Testing	6.0	39,900	6.0	39,900	0.0	0
11-50 Short-Term Experts	7.7	61,586	7.7	61,586	0.0	0
11-99 Sub-Total	80.1	530,040	80.1	530,040	0.0	0
13-00 Administrative Support		79,905		79,905		0
15-00 Official Trave		11,054		11,054		0
16-00 Mission Costs		25,780		25,780		0
19-00 Component Total		646,779		646,779		0
:20 SUBCONTRACTS						
29-00 Sub-Contracts		74,906		74,906		0
:30 TRAINING						
31-00 Fellowships		96,546		96,546		0
32-00 Group Training		118,084		118,084		0
38-00 Prior Year's Savings		(9,922)		(9,922)		0
39-00 Component Total		204,708		204,708		0
49-00 EQUIPMENT		622,512		622,512		0
59-00 MISCELLANEOUS		37,987		37,987		0
99-00 PROJECT TOTAL		1,586,892		1,586,892		0

PROJECT BUDGET COVERING UNDP CONTRIBUTION
(In U.S. Dollars)

Country : PHILIPPINES
Project No. : PHI/82/002/A/01/37
Project title : Industrial Energy Management Consultancy and Training.

Date Prepared: 15 May 1987
Disk0125-1bd

	TOTAL		1982-84		1985		1986		1987	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
10 PROJECT PERSONNEL										
11 Int'l. Professionals										
11-01 Chief Technical Adviser	48.2	315,473	19.1	121,688	11.3	75,702	11.8	78,977	6.0	39,114
11-02 Indus. Energy Con.	12.0	75,854					2.5	14,579	9.5	61,275
11-03 Cancelled										
11-04 Elect./Mechanical	12.0	78,772	6.9	44,015	5.1	34,757				
11-05 Fuel & Applic. Testing	3.0	19,350							3.0	19,350
11-50 Short-Term Experts										
11-51 Fuels & Applic. Testing	2.4	17,562					2.4	17,562		
11-52 Bldg. Energy Eval.(Cancelled)										
11-53 Cement Expert(Subcont.)										
11-54 Coal Combustion	2.0	15,659					2.0	15,659		
11-55 Cogeneration	2.0	19,621					2.0	19,621		
11-56 Fuels & Applic.Testing	0.4	6,155					0.4	6,155		
11-57 Ind. Energy Audit Spec.	1.2	12,836			1.2	12,836				
11-58										
11-99 Sub-Total	83.2	561,282	26.0	165,695	17.6	123,295	21.1	152,553	18.5	119,739
13-00 Administrative Support		87,255		21,835		21,427		23,993		20,000
15-00 Official Travel		12,548		4,550		2,277		1,721		4,000
16-00 Mission Costs		29,280		6,280						23,000
19-00 Component Total		690,365		198,360		146,999		178,267		166,739
20 SUBCONTRACTS										
21-01 Sub-Contracts		74,906		11,020		13,378		15		50,485
29-00 Component Total		74,906		11,020		13,378		15		50,485
30 TRAINING										
31-00 Fellowships										
31-01 Home Appliance (HDA)		5,250		4,978		272				
31-02 Bldg.Energy Stand.(HTO)		2,432		2,432						
31-03 " " (JHA)		2,432		2,432						
31-09 Eng'g. Design (MLS)		10,797		10,747		50				
31-09 Eng'g. Design (LHH)		10,797		10,747		50				
31-10 Petrol. Mgmt (HDA)		18,083		17,789		294				
31-11 Home Applic. & Equipment Testing (RA)		12,004						12,004		
31-13 " " (ID)		12,004						12,004		

FRI/82/009/A/01/37

	TOTAL		1982-84		1985		1986		1987	
	m/m	$	m/m	$	m/m	$	m/m	$	m/m	$
31-14 Energy System Plan & modelling (LB)		8,953						8,953		
31-15 " " (AP)		8,953						8,953		
31-15 Industrial & Utility Energy Consultant (VT)		3,196						3,196		
31-17 " " (CC)		3,196						3,196		
31-18 " " (DP)		3,196						3,196		
31-99 Sub Total		101,293		49,125		666		51,502		
32-00 Group Training										
32-01 Study Tour (OLG/BPL)		11,629		11,629						
32-03 Study Tour (HARC/RLS)		13,447		13,447						
32-04 Study Tour (WST/JCA)		11,321		11,321						
32-05 Study Tour (RDA)		2,777				2,777				
32-06 Study Tour(JC/AH/GS/TC)		13,493				13,493				
32-07 Study Tour (OLG)		13,498				13,498				
32-08 Study Tour (BPL)		11,796				11,387		409		
32-09 Study Tour (ZYH)		2,772				2,772				
32-10 Study Tour (LHH)		1,777						1,777		
32-11 Fuels & Applic. Testing (AH)		6,012						6,012		
32-12 Study Tour (JTT/HAA)		4,260								4,260
32-13 Fuels & Applic. Testing (HARC/HA)		18,000								18,000
32-14 Study Tour (CU)		2,500								2,500
32-15 Study Tour		10,955								10,955
32-99 Sub-Total		124,237		36,397		43,927		8,198		35,715
38-00 Prior Year's Savings		(9,922)				(9,922)				
39-00 Component Total		215,609		85,522		34,671		59,700		35,715
40 EQUIPMENT										
41-00 Expendable Equipment		121,717		83,843		25,542		6,332		6,000
42-00 Non-Expendable Eqt.		507,759		277,112		88,322		33,857		107,468
48-00 Prior Year's Savings		(6,964)		(1,369)		(2,786)		(2,809)		
49-00 Component Total		622,512		360,586		111,078		37,380		113,468
50 MISCELLANEOUS										
59-00 Component Total		32,216		11,187		4,948		6,075		10,006
99-00 PROJECT TOTAL		1,635,607		666,683		311,074		281,437		376,413

Annex 4

BUDGET OF GOP

BUDGET OF DOE

		Current Operating Expenditures			
		Personal Services	Maintenance and Other Operating Expenses	Capital Outlays	Total
A.	Functions				
1.	General Administration and Support Services	₱ 358,000	₱ 250,000	₱	₱ 608,000
2.	Energy Conservation and Management Services	596,000	1,180,000		1,776,000
3.	Data Collection and Analysis	228,000	250,000		478,000
4.	Technical Services and Evaluation of Crude Oil and Petroleum Product Supply of the Country	118,000	109,000		227,000
5.	Regulation, Inspection, Adjudication and Licensing Services	2,025,000	1,139,000		3,164,000
	Total, Functions	3,325,000	2,928,000		6,253,000
B.	Projects				
1.	For the Operational Requirements of the Technical Assistance Component of the Structural Adjustment Loan (SAL II) (IBRD Loan No.2266-PH)		2,675,000	3,880,000	6,555,000
	Loan Proceeds		2,675,000	3,880,000	6,555,000
2.	For the Establishment and Operation of an Energy Management Consultancy Center under the Industrial Energy Management Consultancy and Training Project (UNDP Grant PHI/82/002/A/01/37)	375,000	540,000		915,000
	Peso Counterpart	375,000	540,000		915,000

Annex 5

LIST OF TRAININGS/SEMINARS HELD DURING THE PROJECT PHASE

LIST OF TRAINING/SEMINARS UNDERTAKEN BY BEU

	COURSE	DATE	NO. OF PARTICIPANTS	COORDINATING AGENCY
1.	20th Basic Energy Management Training Course	Aug. 1-5, 1983	34	BEU/DAP
2.	National Workshop on Energy Conservation	Sept. 7-9, 1983	28	BEU, ENMAP, UNESCO
3.	Seminar on Energy Conservation Technology	Oct. 11-12, 1983	109	BEU, ENMAP/JETRO
4.	Seminar/Workshop for the Engineering Academe	Oct. 17-19, 1983	30	BEU, DAP
5.	21st Basic Energy Management Training Course	Jan. 30-Feb. 3, 1984	55	BEU, UPERDFI/NEC
6.	Seminar on Total System Approach to Energy Management	Feb. 22-24, 1984	38	BEU, DAP
7.	Seminar/Workshop on Energy Management for Medium Scale Industries	March 27-29, 1984	18	BEU, DAP
8.	1st Energy Management Training Course for the Least Developed Countries	May 3-20, 1984	19	BEU/DAP/TAC/UNDP/UNIDO
9.	2nd Energy Management Training Course for the Least Developed Countries	June 18-July 17, 1985	29	BEU/UPERDFI/NEC/TAC/UNDP/UNIDO
10.	22nd Basic Energy Management Training Course	June 25-29, 1984	46	BEU, UPERDFI
11.	Seminar on Preventive Maintenance	Aug. 8-10, 1984	76	BEU, UPERDFI

12.	Seminar on Computer Application in Energy Management	Aug. 22-24, 1984	35	BEU, ENMAP, UNESCO/BEU ROSTSEA, Phil. Computer Society
13.	Trainors' Seminar/ Workshop on Energy Management for the Engineering Academe	Oct. 15-13, 1984	21	BEU,UPERDFI/NEC
14.	First National Textile Industry Workshop on Energy Conservation	Oct. 24-25, 1984	38	BEU, ENMAP, JETRO, TMAT
15.	First National Cement Industry Workshop on Energy Conservation	Nov. 8-9, 1984	46	BEU, ENMAP, JETRO, Philcemcor
16.	Energy Management Training Course For Graduating Engineering Students	Nov. 19,1983-March 26, 1984	38	BEU,UPERDFI/NEC
17.	23rd Basic Energy Management Training Course	Dec. 10-14, 1984	57	BEU, UPERDFI/NEC
19.	Seminar on Energon for Mining Industry	March 11-15, 1985	64	BEU, UPERDFI/NEC
20.	1st National Mining Industry Workshop on Energy Conservation	Sept. 2-3, 1985	45	jetro, ENMAP, BEU
21.	Seminar on Energy Management Systems in Buildings	Oct. 2-4, 1985	105	UNESCO/BEU/ENMAP, BEU
22.	25th Basic Energy Management Training Course	Nov. 11-15, 1985	37	BEU/UPERDFI/NEC
23.	Seminar/Workshop on Optimization Techniques for Industrial Energy Conservation	Nov. 28-29, 1985	52	ASEAN-Australia Energy Coop. Program, NSTA/PCIERD ACI/PLDT/ RN Ferrer Asso./BEU/DAP/TAC, UNDP/UNIDO

24.	Seminar on Efficient Conservation and Utilization of Steam	Nov. 6-29, 1985	53	BEU/UPERDFI/NEC
25.	26th Basic Energy Management Training Course	June 23-27, 1986	33	BEU,UPERDFI/NEC
26.	Seminar/Workshop on Cogeneration	July 16-18, 1986	33	BEU, UPERDFI/NEC
27.	Adv. Course on Preventive Maintenance for Energy Conservation	Aug. 25-29, 1986	50	BEU, UPERDFI/NEC
28.	Seminar/Workshop on Building Energy Analysis	Sept. 23-25, 1986	18	UPERDFI/NEC, PCIERD-ASEAN US Project on Energy Conservation in Bldgs., BEU
29.	Energy Management and Preventive Maintenance for Small and Medium Scale Industries	Nov. 27-29, 1986	50	BEU, UPERDFI/NEC
30.	Advance Energy Management Course	Dec. 11-13, 1986	12	BEU, UPERDFI/NEC
31.	Financial Evaluation of Energy Investment Projects	Feb. 24-Mar.7, 1986	23	GTZ, UPERDFI/NEC, BEU
32.	Seminar on Guides to Preventive Maintenance for Energy Conservation	Apr. 25, 1986	95	UNIDO/UNDP, UPERDFI/NEC BEU
33.	Seminar on Guides to Energy Conservation in the Food Processing Industry	June 6, 1986	22	UNIDO/UNDP, EPERDFI/NEC, BEU
34.	IAC/UNIDO Sponsored EMTC for Least Developed Countries	Oct. 29-Nov.28, 1986	22	UNIDO/UNDP, EPERDFI/NEC BEU
35.	Cogeneration Technology	Nov. 3-24, 1986	24	USAID, UP College of Eng'g/BEU

30.	Energy Management Technology in the Transport Sector	Dec. 18, 1986	22	ASEAN-Australia Energy Cooperation Program, NSTA, UPERDFI/NEC, BEU
31.	5th Basic Energy Management Training Course	Nov 5-9, 1988	50	Beu/UPERDFI/NEC
32.	Energy Conservation and Renewable Maintenance for Small-Medium Scale Industries	June 8-10, 1987	48	BEU/UPERDFI/NEC

Annex 6.

ENERGY AUDIT REPORT ON SEMIRARA COAL COMPANY

ENERGY SURVEY REPORT

FOR

SEMIRARA COAL CORPORATION
CAPTIVE POWER PLANT
SEMIRARA, CALUYA, ANTIQUE

BY

CONSULTANCY & PROJECT ENGINEERING GROUP
CONSERVATION DIVISION
BUREAU OF ENERGY UTILIZATION

ENERGY SURVEY TEAM : JESUS C. ANUNCIACION
WAYNE D. ABAYAN
CHARLIE A. QUIRANTE

CONSULTANT : P. R. SRINIVASAN, UNDP/UNIDO

CONTACT PERSONS : J. LEE, JR., TSD MANAGER
: G. BACALSO, COST REDUCTION COMMITTEE CHAIRMAN
: A. MAPUTI, CPP SUPERINTENDENT
: J. MIRANDA, CPP ASST. SUPERINTENDENT
: F. ROSALES, ENERCON OFFICER

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(cont....)

FIGURES

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APPENDICES

EXECUTIVE SUMMARY

Introduction

This report describes the findings of the energy survey at Semirara's Captive Power Plant (CPP). The plantwide study of CPP was conducted by experts from the BEU's Consultancy and Project Engineering composed of Messrs. J.C. Anunciacion, W.D. Abayan, and C.A. Quirante, BEU consultant Mr. P.R. Srinivasan of UNDP/UNIDO. The 5-day visit of the thermal plant was carried out from 19 to 23 May 1986.

The energy survey of CPP was undertaken to identify and assess potential areas, provide recommended improvements for energy conservation in the plant. The report outlines the current operational problems of CPP and the necessary actions the company have to undertake to mitigate such problems and consequently improve overall efficiency, life, safety, reliability of the central power plant.

Semirara Coal Corporation is the biggest coal mining firm in the Philippines with a coal minefield operation rated at 1.0 million metric tons per annum. The Bureau provided the company on February 17, 1986 a coal expert from UNDP, Dr. W. Szulakowski to help them improve quality control of the coal used in the plant and mitigate current coal-related problems in the power plant. On February 19, 1986, BEU experts and Mr. P.R. Srinivasan of UNDP/UNIDO conducted an in-house seminar on energy conservation and preventive maintenance and this was attended by about 30 minesite personnel. These consultancy services are part of the BEU's UNDP/UNIDO-assisted Energy Management and Consultancy Service (EMCS) Project.

Preliminary findings of the survey were reported to Messrs. J. Lee, Jr., TSD Manager, G. Bacalso, Cost Reduction Committee Chairman, and A. Maputi, the CPP Superintendent during the management meeting held at the site. Messrs. F. Rosales, Enercon officer and J. Miranda, Assistant CPP Superintendent assisted the BEU team in the plant tour.

Summary of Findings

The question of drawing up a detailed energy balance as suggested by the management for the Captive Power Plant was considered carefully by BEU experts and after a detailed examination of the records of working of the power plant, it was concluded that it is neither desirable nor feasible at this point of time to carry out such an exercise in view of the unpredictable and rapid fluctuations of demand for electricity from the minesite, which prevented the steady load conditions essential for evaluation of boiler and turbine efficiencies.

Meanwhile, BEU would be willing to help Semirara Coal Corporation in the training of boiler operators in efficient operation of chain grate stoker-fired boilers once arrangements are made to supply the correct size of coal according to specifications to the Captive Power Plant. Detailed energy balance of CPP can also be drawn up at that point of time. Likewise, BEU would be happy to train the engineers of the marketing and sales division from the company on "Coal Utilization Technology", so that they would be in a position after the training provide the necessary technical help and guidance to their customers on matters related to choice of equipment, operational problems, and improvement of combustion efficiency in boilers, etc.

Chain grate stoker-fired boilers cannot burn coal efficiently if the calorific value of coal falls below 4721 Kcal/kg (8500 BTU/lb). Coal as supplied to the power plant is likely to contain lot of fines even in the foreseeable future, and the disposal of fines to outside parties may pose special problems. Further, the possibility of CPP being supplied with progressively lower quality coal in the years to come cannot be ruled out because of the policy of management to sell higher grades of coal to outside parties in order to generate substantial corporate revenues. One of the ways to tackle this problem would be to retrofit the existing boilers with fluidized bed combustion equipment, since in that event it would be possible to burn efficiently very low grade fuels containing high percentage of fines. In fact, fluidized bed boilers can operate with 100% of -3mm size coals having calorific value as low as 3333 Kcal/kg (6000 BTU/lb) with boiler efficiencies approaching 85% plus. A number of companies in U.K., U.S.A., Sweden and Finland are capable of designing and supplying retrofit fluidized combustion equipment for burning low grade coal. BEU would be very happy to assist the management of such a retrofit scheme or project.

In the energy survey, an examination of the conditions under which the power plant was working revealed some obvious but major deficiencies and it was the considered opinion of BEU experts that it would be prudent and worthwhile on the part of the management to concentrate in the first instance on the following items as the benefits to the company by implementing them would be enormous. The problem areas are divided into two (2) areas and are narrated as follows:

MANAGERIAL

Wide Fluctuations in Load Demand

The station overall efficiency levels are low and the life of power plant equipment particularly the steam turbine is reduced due to thermal cycling. The management priority should be to formulate better production planning and control, i.e. to run the mine continuously for two or three months at a stretch followed by

maintenance of mine equipment, if possible. Better coordination between marketing and production, stockpiling of coal during lean seasons must be given consideration. An urgent attention to proper production planning and control would result in a uniform load demand and higher load factor compared to the current factor of Captive power plant of 0.49 to 0.74%. Coupling this with the supply of the right size of coal to the boilers in CPP will bring about dramatic improvements in the efficiency of the plant, while at the same time having a salutory effect onthe life of boilers and turbines in the power plant.

At this point, we would like to emphasize to the company the need for improvement in the supervision of the interlocking controls of the boiler plant. Control room operators must be trained on how to make the best-known selection of control settings during variation of boiler load. If controls are manually operated, CPP should establish the correct settings of grate opening (mm) and speed (%) that correspond to the anticipated load change. This will prevent any overshooting of the correct control setting (a current perennial problem of the plant as shown in Appendix A) and eliminate unnecessary wastage of coal which is estimated to be about 0.02 MT of coal per MW generation.

TECHNICAL

Inadequate Coal Preparation Prior to Firing in Boilers

The plant consumed as much as 20 to 35 percent more coal than necessary because of the completely wrong size of coal being fed to the boiler. In view of this, the plant is beset with the following current operational problems:

1. Unnecessary electric power is consumed in coal crusher. A screening process should be provided before the coal crusher so that coal fines of -4mm size as well as coal between -3mm and +4mm sizes are made to by-pass the crusher and only coals of sizes of +35mm above are made to pass through the crusher.

2. Dust nuisance presents a problem to the power station. A "Sonic Foggers" is necessary to eliminate the housekeeping problem which is caused by the presence of coal dust everywhere in the power plant.

3. High carbon content and unburned coal in the ash is beyond the tolerable level. The coal as fired contained fines of about 50 to 70 percent with the right size of not being more than 20 percent. Addition of moisture by as much as 10 to 20 percent to the coal before firing will reduce sifting and blowholes in the fire, patchy fire bed which produces "[illegible]" and thereby reduce [illegible], improve ignition, and decrease carbon loss of about 4 to 5 percent.

4. High excess air. Correct size of coal is a very essential prerequisite for the efficient operation of chain grate stoker. Presently, the company is wasting coal due to high excess air of about 192%, This amountsto 15% of the total daily coal consumption. The plant is currently operating its boilers at 70% efficiency. However, the high level of oxygen present in the flue gas can be dealt with only after proper size of coal supply is ensured to the boiler.

Insufficient Design Features of the Boiler

Improvement or modification of certain operational systems or redesign of certain subsystems to accomodate possible energy savings and/or improvement in the life and reliability of components, safety of boiler operation.

1. Slagging problem in furnace refractory walls. Clinkers at refractory walls interfere with the free movement of the coal bed along the furnace length to the ash pit. The problem can be eliminated by lining both sides of the refractory walls to a height of 23 cm. from the bottom with Silicon Carbide Bricks as shown in drawing (A).

2. Acid-corrosion of air heater and economizer tubes and passages. In order to protect economizers and air heaters against the possibility of acid-corrosion, a by-pass duct should be provided as shown in drawing (B).

3. Replacement of gauge glass plates every six (6) months. Such life of the gauge glass is too short and the present suppliers may be asked to supply better quality gauge glass. Also, provide absolute gauge glass reading of the boiler drum from the operating floor by installing a bi-colour gauge glass and bringing the reading of the water level onto the boiler operating floors through a system of mirrors.

4. Damage to boiler tubes caused by accidental opening of drain valves. Provide a fool-proof locking arrangements for there drain valves. Also, installation of necessary non-return valves on both the boilers immediately after main stop valves is important for boilers that are connected to a common header.

5. Erosion of boiler tubes due to impingement of water particles at supersonic velocities from soot blowers. The drain point for removal of moisture from the sootblower lines should be as close to the point of the sootblowing as practicable so as to reduce to an absolute minimum the length of sootblower steam pipeline which cannot be drained effectively of moisture.

Ineffective Water Treatment System

1. Barnacles are still present in the condenser tubes even after treating seawater with chlorine. The plant should not only inject chlorine into the intake sump and into the circulating water pump exit pipe, but also into the sump in which the suction pipes of the circulating water pumps are located.

2. There is an unreliable supply of chlorine. Chlorine for seawater treatment is worth ₱120,000 per year. If for some reason, chlorine cylinders from Manila do not reach the island in time, cooling water treatment would be affected. It is suggested that the company go for an on-site sodium hypochlorite generator to be self-sufficient in chlorine.

3. Expensive gravels for the demineralizer plant are imported from Austria. For future requirements of gravel for the two gravel filters, local sources in the Philippines may be explored.

Unsatisfactory and Unreliable D.C. Power Supply System

1. Unsatisfactory D.C. supply system for the turbine l.. ic module, circuit breaker operation, annunciators and alarms. In view of the criticality of this D.C. supply for vital functioning of the electrical system of the power plant, a spare set of industrial lead-acid batteries must be provided, so that while one set is being charged the other set is in service.

Table 1

PLANT LOAD FACTOR	STATION HEAT RATE	TURBINE STEAM RATE	BOILER HEAT RATE	BOILER EFFICIENCY
0.[illegible].74%	17,000 - 19,000 BTU/Kwh	11.5 lb.steam/kwh	1363 BTU /lb	79%

Major Areas	Steam Conditions	Description of Energon Opportunity	Average Savings
Managerial	. Wide fluctuations in load demand.	1. Formulation of better production planning and control, better coordination between marketing and production.	0.04 MT Coal/MW by improving S.H.R.
		2. Improvement in the supervision of interlocking controls of the boiler plant.	0.02 MT Coal/MW
Technical	.. Inadequate coal preparation prior to firing in boilers and too much "fines in coal" as fired.	1. Provision of screening process before the crusher.	N.A.
		2. Addition of moisture to the coal before firing.	0.04 MT Coal/MW
		3. Control of excess air level from 192% to 20%.	0.35 MT Coal/MW
		4. Installation of "Sonic Foggers".	Indirect
	.. Insufficient design features of the boiler.	1. Lining of both sides of refractory walls with Silicon Carbide Bricks.	N.A.
		2. Provision of a by-pass duct to protect economizers and air heaters.	Indirect
		3. Replacement of gauge glass with better quality bi-colour gauge glass and transference of water level reading onto the boiler operating floor through a system of mirrors.	Indirect
		4. Provision of a fool-proof locking arrangements for drain valves.	Indirect
		5. Provision of drain as close to the point of the soot blowing.	Indirect
	.. Ineffective water treatment system.	1. Installation of an on-site Sodium Hyprochlorite Generator.	N.A.
		2. Exploration of the use of local gravel for the gravel filters.	N.A.
		3. Injection of chlorine into both the intake and suction pipes of the C.W. pump.	Indirect
	.. Unsatisfactory and unreliable D.C. power supply system.	1. Provision of a spare set of industrial lead-acid batteries.	Indirect

PLANT BACKGROUND

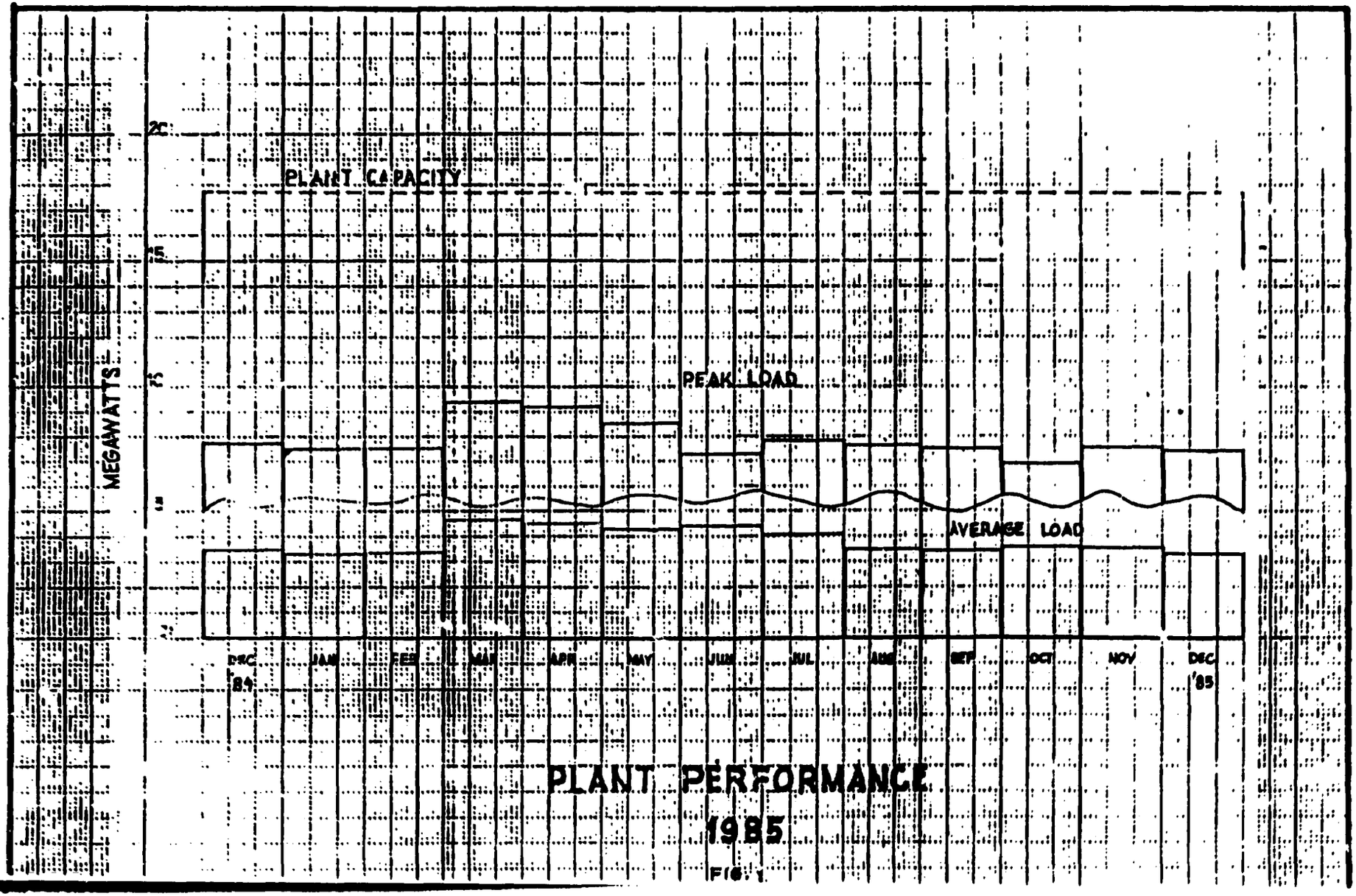
Semirara Coal-Mine is considered as the biggest coal mine in the Philippines. The three minefield (Unong, Himalian and Panian) are in the island of Semirara in Caluya, Antique. Open pit mining operation is presently done at the Unong field which has a rated capacity of 1 million MT per annum. Also, there are a number of smaller-scale open pit mines in the island using conventional earthmoving equipment for overburden removals and coal extraction. The coal mine produces sub-bituminous coal with calorific value ranging from 4610-5170 kcal/kg (8300-9300 BTU/lb).

The coal-fired thermal plant rated at 15 MW supplies power to minefield to run the four (4) SR400 Voest-Alpine Ah. Bucket Wheel Excavators (BWE's), about 4 km.-long overland conveyors, sump pumps, etc. BWE's are used in cutting 30-meter high benches and its total daily output is about 20,000 bank m^3 of coal and overburden. Belt conveyors are utilized in transporting run-of-mine coal to coal stockpiles and overburden to dumpsite. The plant maintains two (2) stockpiles of run-of-mine coal in the stockyard. Good quality coal (selected coal) is sold to National Power Corporation (NPC) and Atlas Mining Corporation while contaminated coal or low grade coal is consumed in the thermal plant.

PLANT DEMAND

The typical conditions of power service of CPP are reflected in the load diagrams of Fig. 1 and Fig. 2. Shown in Fig. 1 are the average monthly variation of the peak and average demand in 1985. Fig. 2 exhibited the typical hourly variationof the load during five consecutive days in May 1986. Most of the time, the demand to be met does not follow a consistent pattern, thus, generating plant capacity and output required to meet them cannot be forecasted.

Load factor of the plant is somewhat low especially in 1985. The performance ranges from as low as 0.49 to a highest of 0.74 indicating an unsteady 24-hour-per-day operation with peak demand periods above average load. Undoubtedly, the company operates the thermal plant with high generating cost per unit of energy. CPP's cost per kwh ranges from P0.73 to P0.79 compared to other thermal plants in the country with about P0.30 to P0.36 per kwh.


MEGAWATTS
PLANT CAPACITY
PEAK LOAD
AVERAGE LOAD
DEC '84
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC '85
PLANT PERFORMANCE
1985
FIG. 1

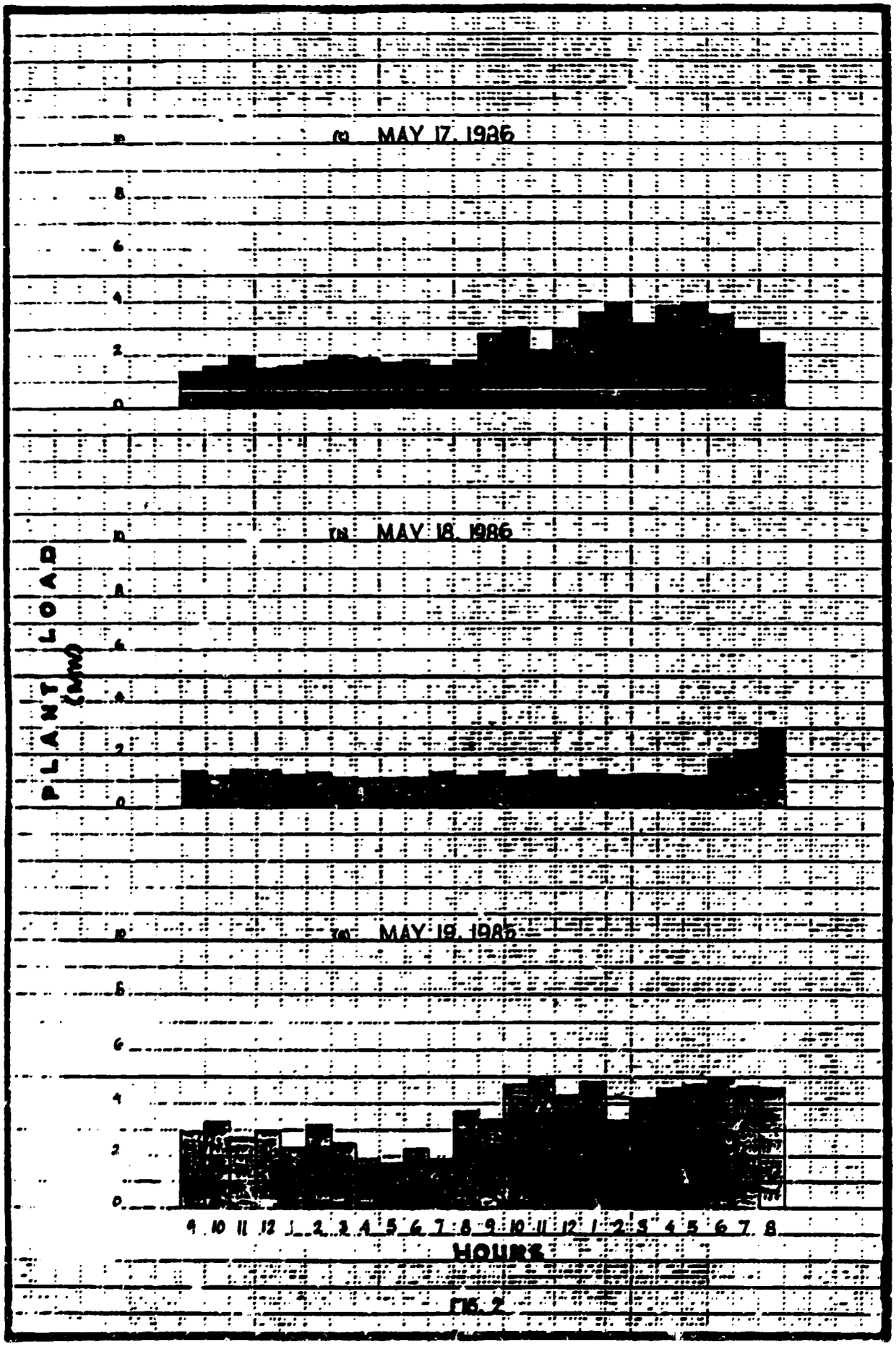
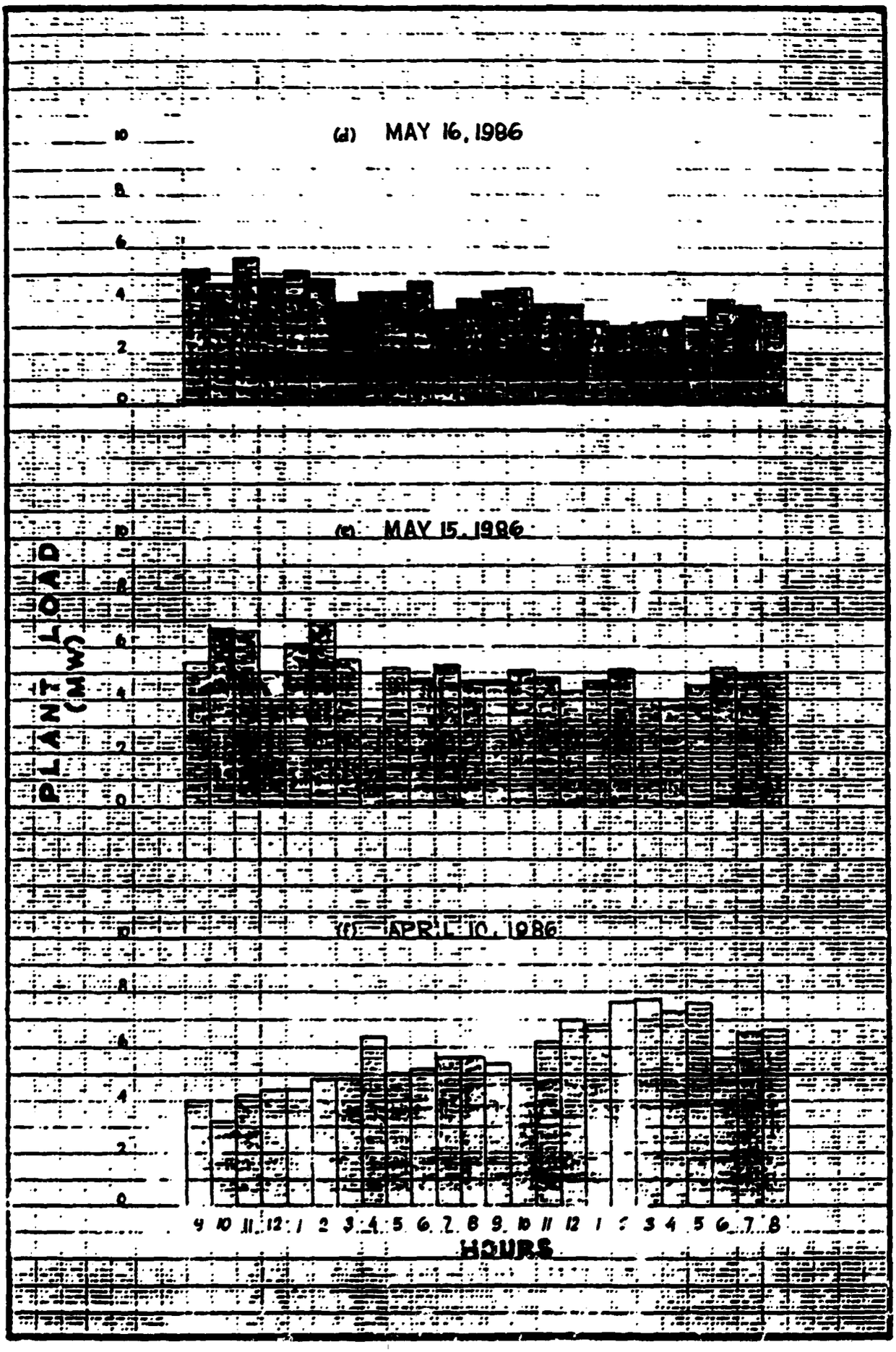

(a) MAY 17, 1926
(b) MAY 18, 1926
(c) MAY 19, 1926
PLANT LOAD (MW)
0
2
4
6
8
10
9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8
HOURS

FIG. 2


(d) MAY 16, 1986
(e) MAY 15, 1986
(f) APRIL 10, 1986
PLANT LOAD (MW)
0
2
4
6
8
10
4 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8
HOURS

FUEL CONSUMPTION

Table 1 shows the plant performance in 1985 exhibiting the variation of the monthly fuel consumption of the thermal plant and the Unong Diesel Plant. A typical hourly consumption of CPP are shown in Appendix A. Figures from which the daily boiler trend curves were established are taken from the logsheets of CPP.

Noted in the trend curves are the erratic control settings of the grate opening and speed of the grate in anticipation of a load change. From the visits of the control room, it is our view that the operators by virtue of their skills and experience manage to make random selection of control settings, thus, manually overriding the automatic control. without very much knowing what is going on in the system. In order to avoid any wastage of coal due to incorrect adjustment of settings, such practice of managing the interlocking controls of the plant manually should be improved. Operators must be trained on how to make the best-known selection of control settings to avoid different operators or even the same operator making different selections of control settings when faced with the same conditions of fuel quality, boiler load, and boiler conditions.

From the boiler trend curves shown in Appendix A, our analysis reveals the following:

1. Indiscriminate selection of control settings during sudden change in boiler load.

2. In operating the unit below 30% of its M.C.R., a lot of heat available in the steam is wasted and if converted to coal consumption would amount to a loss of about 18.5 tonnes of coal per day. This is about 34% of the unit's average coal consumption per day.

3. An average coal of about 7.9 tonnes per day which is approximately 13% of daily coal consumption is put into waste due to fluctuating steam demand. With fluctuating steam demand, it also becomes very difficult to secure good combustion and steady steam pressure.

Table 2 and Table 3 show the chemical analyses (proximate analysis) of Semirara coal and ash in boiler . sipit, respectively. The representative sample of coal and ash were collected by BEU during the period of observation of working of the boilers. Coal experts found the Semirara coal with high ash fouling properties because of its high content of alkalis: Na_2O and K_2O. Table 3 indicates the presence of high carbon content and unburnt coal in ash.

Table 1

MONTHLY FUEL CONSUMPTION
(1985)

	Captive Power Plant MT Coal	Unong Diesel Plant Liters, ADO	Power Generation MWH
January	2,893	71,550	2,604.2
February	2,333	12,577	2,059.7
March	4,098	10,793	3,477.1
April	4,074	63,302	3,254.7
May	3,541	69,977	3,182.8
Jun	3,699	21,605	3,027.6
July	3,031	5,994	3,067.7
August	2,822	1,882	2,623.0
September	2,518	52,696	2,489.8
October	3,023	21,843	2,672.4
November	3,156	26,003	2,536.9
December	2,234	66,114	2,281.0

Table 2

CHEMICAL ANALYSES OF SEMIRARA COAL
(Proximate Analysis)

	"Air-Dried" Basis	"As-Received" Basis
Moisture @ 105°C, %	18.37	25.90
VCM, %	37.56	34.10
Ash, %	9.41	8.54
FC, %	34.66	31.46
ADL, %	9.22	-
HV, Kcal/kg	4,956.5	4,499.4
Sulphur*, %	0.78	-
Na_2O in coal*, %	0.56	-
K_2O in coal*, %	0.16	-

(*Coal analysis from the previous report of Dr. W. Szulakowski.)

Table 3

CHEMICAL ANALYSES OF ASH
(Proximate Analysis)

	"Air-Dried" Basis	"As-Received" Basis
Moisture, %	4.74	28.70
VCM, %	7.64	5.72
Ash, %	66.16	49.52
FC, %	21.46	16.06
ADL, %	25.15	-
HV, Kcal/kg	2,117.2	1,584.6

THE CAPTIVE POWER PLANT

The 15 MW thermal plant consists of 2 x 7.5 MW Austrian-made boiler-turbogenerator units. The two chain grate stoker-fired boilers have a combined steam output of 72 tonnes and consumption of about 50,000 MT of low grade coal per annum. Maximum boiler working pressure is 56 bar and steam temperature of 453°C. Each boiler has a superheaters, economizer, air heater and desuperheating system.

CPP's boilers are tube-wall-radiation type boilers and are equipped with travelling chain grate stoker driven by a shaft at the front of the grate. The coal is conveyed through the inlet of the travelling grate to the grate bed and thickness of bed is set by the guilotine door. The necessary residence time for the coal, in order to ensure an efficient combustion, is achieved through a suitable combination of the coal layer thickness and the grate speed. Combustion air is led through the grate layer from the various air zones of the grate. The combustion is terminated before the clinker dam sections and the slag goes to the slag hopper. For each air zone, the air flow can be set separately by means of manually operated dampers called "air troughs", immediately under the grate bed. The primary air flow is set automatically during operation so that ideal combustion conditions are achieved. The secondary air flow is normally kept constant, independent of the boiler load. This is introduced into the furnace by a forced fan in the right side of the boiler.

A mechanical dust separator is installed after the air-heater. The dust collected is withdrawn from the separator's hopper by a screw conveyor at the bottom and transported the dust and ashes to the ash disposal system by a steeply inclined belt conveyor.

The two boilers are connected in parallel and a common steam header provides steam to both or to any one of the two steam turbines. The two steam turbines have an individual surface condenser of divided box-type for condensing the exhaust steam. CPP uses seawater for their cooling systems. Make-up water for the two boilers istreated at the demineralizer plant which has two units of gravel filters each supplying one cation and one anion.

OBSERVATION AND RECOMMENDATIONS

1.0 General

1.1 Plant Load

The Captive Power Plant which has now an installed capacity of 15 MW consisting of 2 x 7.5 MW turbo-generator sets is severely underloaded. It was ascertained that even at a production level of 1 million tonnes of coal per annum, the maximum electrical load would not be more than 8 MW. Such being the case, at the present average production level of 450,000 tonnes per annum, the average loading hardly exceed 4.5 MW or so, though momentary peak loads might reach a figure of 7.5 MW. This was corroborated by previous performance of the plant that are shown in the load diagrams in Appendix A. Undoubtedly, the plant has a low load factor which indicates an unsteady 24-hour-per-day operation with peak demand periods above average load. It is opined that in view of the unpredictable load on the system and load swings of 2 to 4 MW, sometimes over a 10-minute period, the generating plant capacity and output required to meet them cannot be forecasted. This makes CPP experience operational problems such as high generating cost per unit of energy due, partly, to inaccurate adjustment of control settings of boiler plant.

The sudden variations of load imposes heavy thermal stresses on the boiler and more particularly on the turbine rotor. In fact, the steam turbine is more susceptible to get damaged in the long run because it is generally designed to work under steady load conditions. Further, there is a limitation imposed by the manufacturer on the number of startings and stoppings of the steam turbines in a year, which in the present case, we gathered from the power plant staff, was around 10 or 12 per year. This figure, however, seems to have been exceeded in the first quarter of the year itself.

Repeated shutdowns and start ups, however, carefully regulated impose certain thermal stresses on the massive steam turbine rotor which in the long run might be detrimental and cause distortion of the turbine rotor resulting in heavy vibrations leading to early breakdown. Further, running of the steam turbine under very low load conditions (at 30% and below) for sustained periods will result in low pressure end of the steam turbine blades churning steam, at 3600 r.p.m., of much higher density and temperature than what they were originally designed for because of the reduced vacuum conditions (of the order of 6 in. Hg. against 26 in. Hg. at full load conditions)

prevailing in the condenser shell. This causes a rise in the exhaust hood temperature and possibly the L.P. end bearing temperature and might also result in distortion and/or breakage of L.P. blades.

It is therefore not desirable to run steam turbines under very low load conditions for any length of time, i.e., CPP's operation last May 18, 1986, if the steam turbines presently installed are therfore to serve their full design life, it is very essential that these steam turbines should be loaded as uniformly as possible over a 24-hour period and as near full load conditions as possible. Obviously, under the present circumstances, this seems to be a difficult condition to be achieved. However, it should be the priority of the management to find ways and means of optimally and uniformly loading the CPP not only to increase the efficiency of the power plant but also the life of major items of equipments like boilers and steam turbines.

1.2 Coal Size

Consideringthe type and nature of the load imposed on the boiler as well as the size of coal made available to it, it is felt that a spreader stoker equipped boiler house would better suited the purpose because they are capable of meeting sudden changes in load demand without too much loss of efficiency while burning coals with a much higher percentage of fines. However, even chain grate stoker-fired are capable, though to a much lesser degree, of taking care of variable load demands, provided the right size of coal is supplied to it according to specifications prescribed by the boiler manufacturer.

At present, however, the size of coal as supplied is rather way out of the specifications as was revealed by the sieve analysis of a representative sample of coal as fired into the boiler, carried out everyday by BIT during the period of observation of working of the boilers. While it may be possible to burn a little lower grade coals than what the chain grate stoker is originally designed for with some minor modifications if the necessity so arises, it may be mentioned here rather emphatically, that if size of coal as supplied to the chain grate stoker deviates too much from the specifications (as in the case at present), it is well not impossible to burn coal efficiently. At present a very heavy penalty is being paid by the management by way unduly heavy loss of carbon in ash. It is our estimate that

as much as 20 to 30 percent more coal than necessary is being presently consumed because of the completely wrong size of coal being supplied to the boiler (as much as 70 percent fines in coal as applied as against the stipulated requirement of not more than 10 percent fines in a coal of -30mm and +4mm size). Refer Table 4 for sieve analysis of coal burned at CPP boilers.

It is our recommendation therefore that screened coal of the right specifications to the boiler house be supplied as a first essential step in improving the efficiency of boiler. It is our estimate, based on our experience elsewhere, that supply of correct size of coal would result in a saving of a minimum of 20 to 25 percent of the coal currently being consumed on conservative estimate. To start with, double screened coals of -30mm and +4mm size of approximately 2500 tonnes may be made available to the power plant on a trial basis.

Table 4

SIEVE ANALYSIS OF CPT COAL

Trial	+35mm	30mm	+4mm	Fines	Total Sample
1	1.294	3.585	1.585	5.787	12.251
2	1.151	1.798	1.491	3.772	8.212
3	0.429	0.780	0.730	4.650	6.589
4	0.713	2.612	2.703	3.922	9.950
5	0.700	3.333	1.785	3.635	9.453
6	0.820	2.282	1.654	4.734	9.490
7	1.489	2.018	1.411	8.404	13.322
8	1.261	1.539	1.399	7.790	11.989
9	0.710	2.317	2.266	4.636	9.929
10	1.400	3.310	2.249	3.698	10.657
11	0.929	2.642	1.808	5.511	10.890
12	0.509	1.325	1.529	6.651	10.014
13	0.490	1.345	1.248	6.457	9.740
14	0.501	1.354	1.300	9.425	12.580
15	0.256	2.160	2.518	7.973	12.907
16	0.465	3.963	3.702	5.486	13.616
Total	3.140	36.563	29.378	92.531	161.622
%	1.95	22.62	18.18	57.25	100.00

2.0 Coal Handling

2.1 Stockpiling

As was pointed out in the earlier report of BEU, the method of stacking coal leaves much to be desired. As far as practicable, coal should be stacked on a hard drainable ground floor, in the form of trapezium of not more than 15 feet high, particularly when coal as is presently the case, contains too much of fines. If coal is stacked for more than 6 months at a stretch, then it is preferable to compact the top portion of coal heap with a bulldozer so as to prevent upward movement of hot air up to the coal pile. Covering the sides of the coal heap by plastic sheets to prevent ingress of atmospheric air which is responsible for supporting combustion in the coal heap, is also recommended to minimize if not totally eliminate coal fines in coal yard.

2.2 Crushing

Since coal as stored in the coal yard already contains a substantial percentage of fines because of the mechanical nature of the mining operation, further generation of fines while passing through the coal crusher, which is installed for this purpose of supplying crushed coal to the central power plant, should be avoided. For this purpose, it is suggested that a screen provided before the coal crusher so that coal fines of -4mm size as well as coal between -30mm and +4mm sizes are made to by-pass the crusher and only coals of sizes of +35mm above are made to pass through the crusher. This will also result in less wear and tear of the impact hammers of the crushers and also result in lesser power consumption of the crusher.

Coal fines, i.e. coal particles having -4mm size and below should be separated and these may be sold and shipped to utility power plants like NPC's Calaca unit which in any case would require fines because their boilers are designed for pulverized fuel firing. Since Semirara Coal Corporation is already supplying coal to NPC's power plant at Calaca, disposal of fines to them should not pose a problem to the management.

2.3 Coal Dust Collection

At present good housekeeping is a problem because of the presence of coal dust everywhere in the power station. This is because while handling carryover dry coal through

the belt conveyor to the coal bunker in the boiler house and while transferring the same coal from the bunker to the hopper a substantial amount of fines are generated. These fines are carried away by the wind all over the power plant. This problem can be mitigated if not totally eliminated by the addition of water in the form of a fine spray over the conveyor belt. Incidentally, addition of water (salt water should not be added at any cost or at any stage to coal because chlorides present in salt water will give rise to trouble-some deposits in the boiler passes) will improve combustion efficiency because of more uniform aeration of the fuel bed which again is as a result of the fines in coal sticking to bigger particles of coal in a thin film of water surrounding it. Sometimes water mixed with certain chemical additives is also sprayed on at strategic points to prevent dust nuisance.

Micron-size particles of coal dust in the atmosphere, however, can be taken care off by installing what is known as "Sonic Foggers" in which water particles are broken into a fine mist (of 10 to 15 micron sizes) which also get electrically charged and this attract and absorb fine coal dust in the atmosphere. The address of the manufacturer of this type of equipment is given in Appendix B.

3.0 Boiler House

3.1 Combustion Efficiency

3.1.1 Chain Grate Stoker-Fired Boilers

Chain grate stoker-fired boilers are capable of burning a wide variety of fuels like anthracite, bituminous coals, lignite, peat, wood, etc. However, chain grate stokers are very sensitive to coal sizes and hence the recommendations in earlier paragraphs to the management to be uncompromising as far as the supply of correct size to the boiler (according to specs) is concerned. It should, however, be remembered that chain grate stokers are unsuitable for burning coal with strongly caking characteristics, i.e. coals having a tendency to swell while undergoing combustion. Such types of coals can be burnt successfully only on an underfeed stoker. The swelling characteristics of coal from different seams in Semirara Coal mines should be determined in the near future according to British or American standards in the coal analysis laboratory for which purpose necessary equipment should be procured.

Chain grate stoker-fired boilers respond to changes in load much slower than spreader stoker-fired boilers. Therefore, it is always a good practice to inform the boiler house people about sudden load changes at least 1 hour in advance. That way it will give enough time for boiler house people to take care of load changes in load demand without sacrificing the efficiency of boilers in operation. It is to be noted that in the case of chain stoker-fired boilers first degree response to load changes is obtained by variation in air flow quantity and second degree response by change in grate speed and third degree response by change in coal bed thickness.

3.1.2 "Fines in Coal" as Fired

Representative samples of coal from the hopper just as it enters the furnace on the chain grate stoker were collected at periodic intervals and accumulated over a 12-hour period for sieve analysis in the coal laboratory. The results of the sieve analysis are given in Table 4. It could be seen from it that the coal as fired contained fines anywhere from 45 to 70 percent with the right size of coal of -30mm and +4mm not being more than 20 percent or so at anytime on all days. Even though travelling type of chute is provided on top of the coal hopper at the entrance to the boiler furnace, primarily for the purpose of distributing coal as uniformly as possible across the full width of the chain grate stoker, this purpose is not being achieved because at present no moisture is added. In fact, it was observed that as the chute travel from one end of the hopper to the other, there was a tendency for heavier particles of coal to settle on one side while lighter particles of coal settled on the opposite side. Such a tendency for segregation of coal could be minimized to a large extent if not totally prevented by addition of moisture to coal in the travelling chute above the hopper to the extent of 10 to 12 percent even when current size according to specifications of coal is supplied. The rule is that for every 1% increase coal fines over and above 10%, moisture to the extent of 1% is to be made. For coals containing 20% fines, therefore, moisture addition should be to the extent of 10 to 12%. Any addition of moisture to the coal before firing will reduce airflow and blockage in the fine, and thereby reduce excess air and improve ignition. This extra moisture however reduces overall boiler efficiency by about a few tenths of 1%.

Again, a very essential prerequisite for the efficient and trouble-free operation of chain grate stoker-equipped boilers is the correct size of coal which should be between -30mm and +4mm with not more than 10 to 15 percent fines (i.e. -3mm size particles). Because of too much fines in coal as fired (as much as 50 to 70 percent) and also the segregation of different sizes of coal across the width of the furnace, the resistance of the fuel bed to the flow of primary air from beneath the grate is not the same as air tends to follow the path of least resistance. Segregation, therefore, results in a patchy fire bed resulting in very intense combustion in certain preferred spots is leading to clinker formation. Once the clinker formation takes place, air flow will shift to another place of least resistance - repeating the same process of clinker formation all over again. Progressively, therefore after sometime, clinker formation takes place all over the grate as in fact has been observed in the boiler under observation. Since clinker is a fused mass of ash, with lot of coal and unburned carbon trapped in it, it becomes impervious to the flow, thus, causing increased carbon loss.

The analysis of ash in the laboratory discharged by the boiler on the days boilers was under observation, revealed its calorific value to be 2500-3000 BTU. This is almost one-third the value of coal as fired. Normally, ash discharge from a chain grate stoker-equipped boiler should not contain more than 10 to 20 percent of fixed carbon. The intolerably high carbon content and even unburned coal in the ash at present can be attributed to excessive fines in coal as fired and no moisture addition to coal, in other words, due to segregation of different coal sizes in the furnace across the full width of the chain grate stoker.

3.1.2 Slagging at Furnace Refractory Walls

Both sides of the chain grate stoker in the furnace of the boiler are lined with refractories right to the bottom. This may not be a very desirable arrangement, because during operations, there is a tendency for the clinkers in the furnace particularly those in contact with the refractories on both the sides to get fused with them, thus, interferring with the free movement of the coal bed along the furnace length to the ash pit. When this problem becomes severe, the clinker has to be dislodge

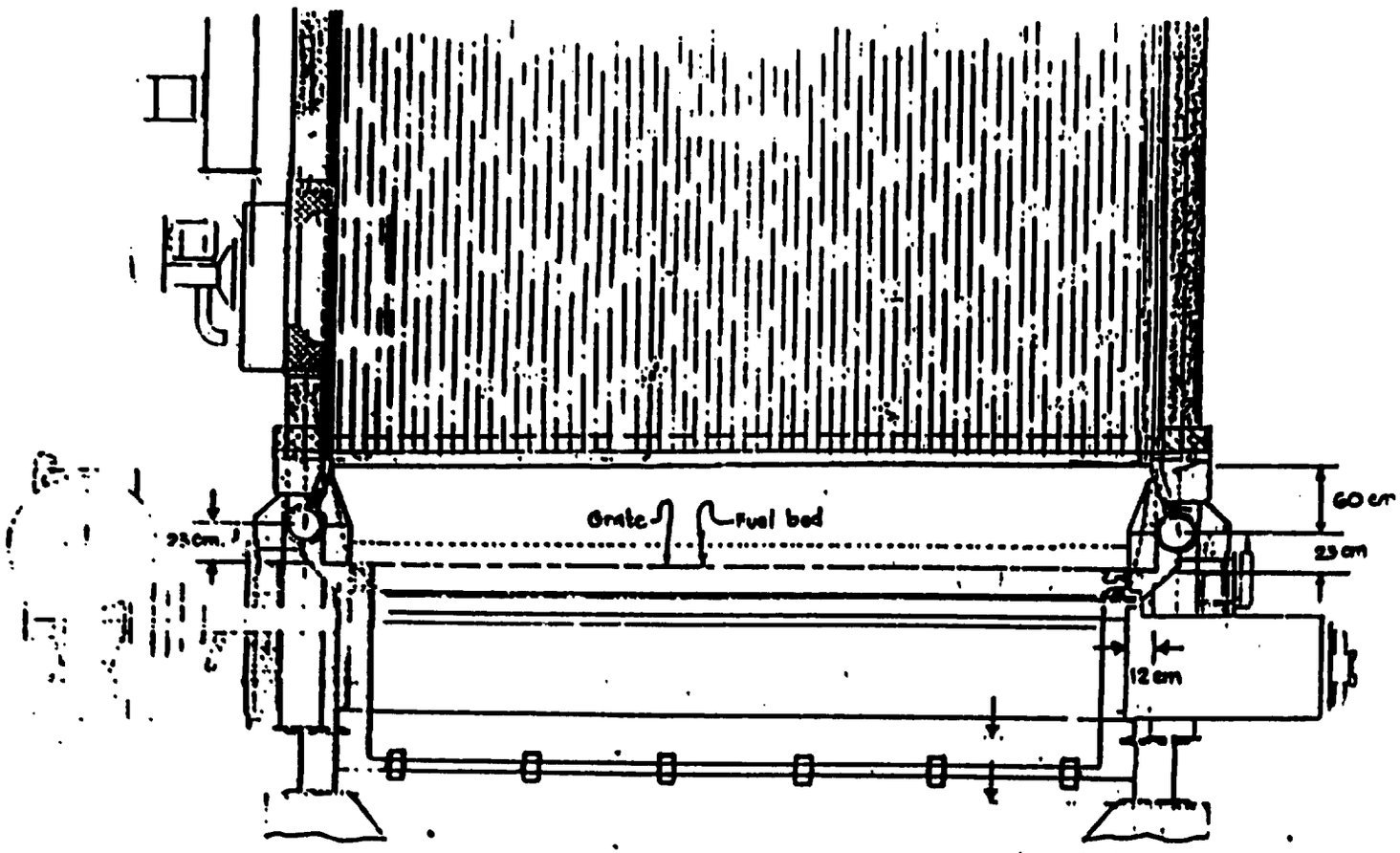
with the help of a long poker bar introduced from the feeding and by raising the guillotine door. Such a procedure is time consuming and during that process, a lot of cold air will infiltrate into the furnace, cooling the boiler considerably and reducing the output of the boiler. This kind of a problem is presently being experienced by the boiler house staff.

In order to overcome this problem, there are two (2) approaches. One is to line both sides of the refractory walls to a height of 23 cm. from the bottom with Silicon Carbide Bricks. Since Silicon Carbide bricks have a much higher thermal conductivity than refractory bricks, they have the ability to conduct heat rapidly through them to the outside from incandescent coal in contact with it. The resultant temperature of coal in contact will be much lower than in the case of refractory bricks thereby preventing fusion of ash with the Silicon Carbide bricks. Alternative, a square header (of 15 cm. x 15 cm. size) may be provided on both sides of the chain grate stoker to which down comers from the boiler drum carrying water at saturation temperature from the boiler drum are co ected. This is explained in the attached drawing (A) showing cross-sectional elevation of the boiler.

3.1.3 High Level of Oxygen in Stack Gas

BEU experts conducted a series of tests of stack gas.: O_2 and CO_2 concentration before and after economizer, air heater, mechanical dust collector. The air supply to the boiler was excessive as evidenced by the level of oxygen present in the flue gas at the exit of boiler. The present level of excess air in the boiler represents a loss of about 31% of available heat in fuel input. It is therefore the priority of the boiler operator to ensure a minimum amount of air necessary for completely burning the fuel is supplied to the boiler furnace.

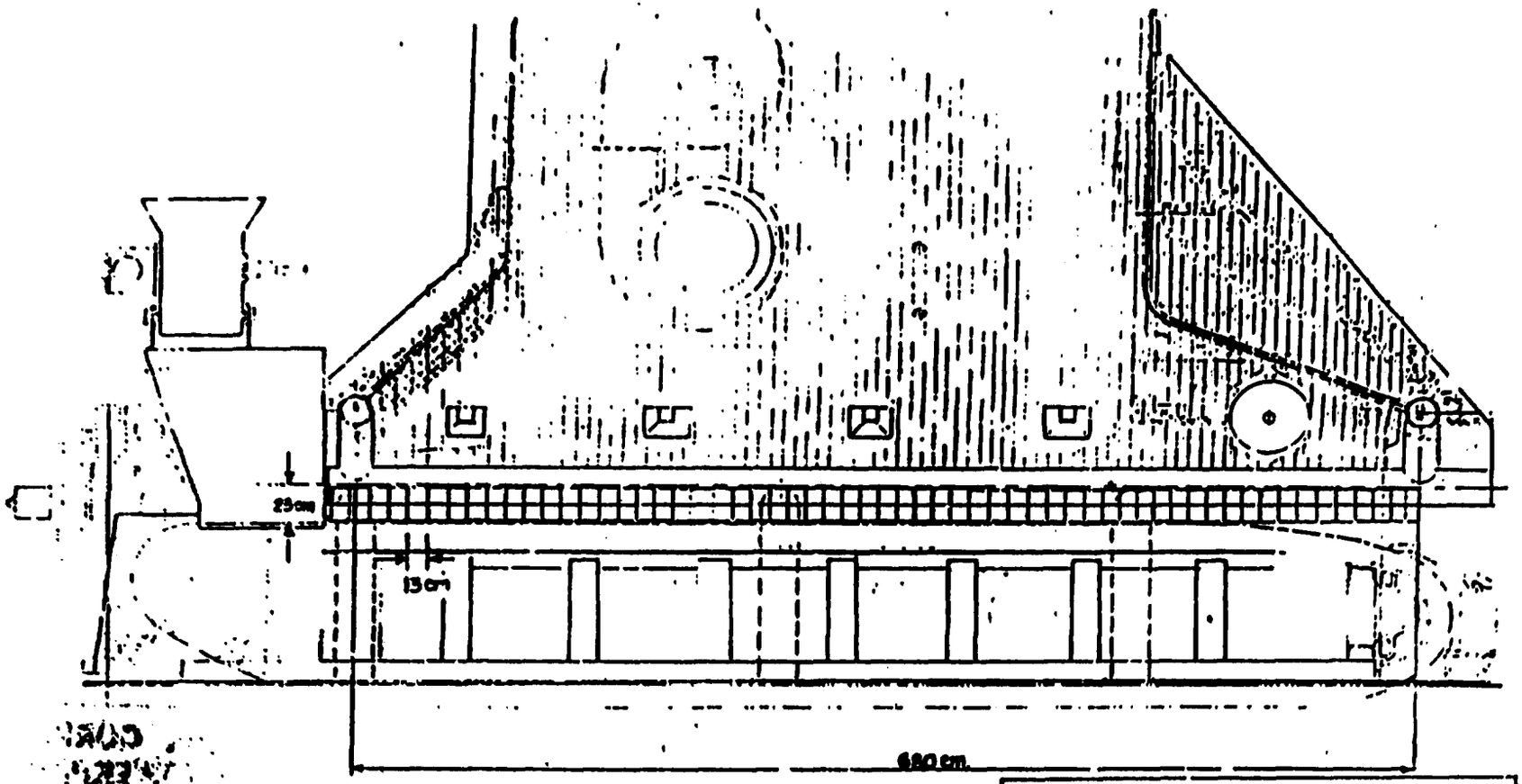
A correct control of excess air is essentially important in the operation of boilers.. Any depart from its correct control setting, will increase sensible heat lost to the stack gas when high excess air exist while low excess air levels may cause incomplete combustion, increase particulate emissions, create explosive conditions, and promote



Note: Provide both sides of the refractory wall with lining of Silicon Carbide Bricks as shown.

SEMIRARA COAL
CAPTIVE PO
FRONT VIEW
BOILER FU
Drawn by:
BUREAU OF ENERGY U

DRAWING 'A'



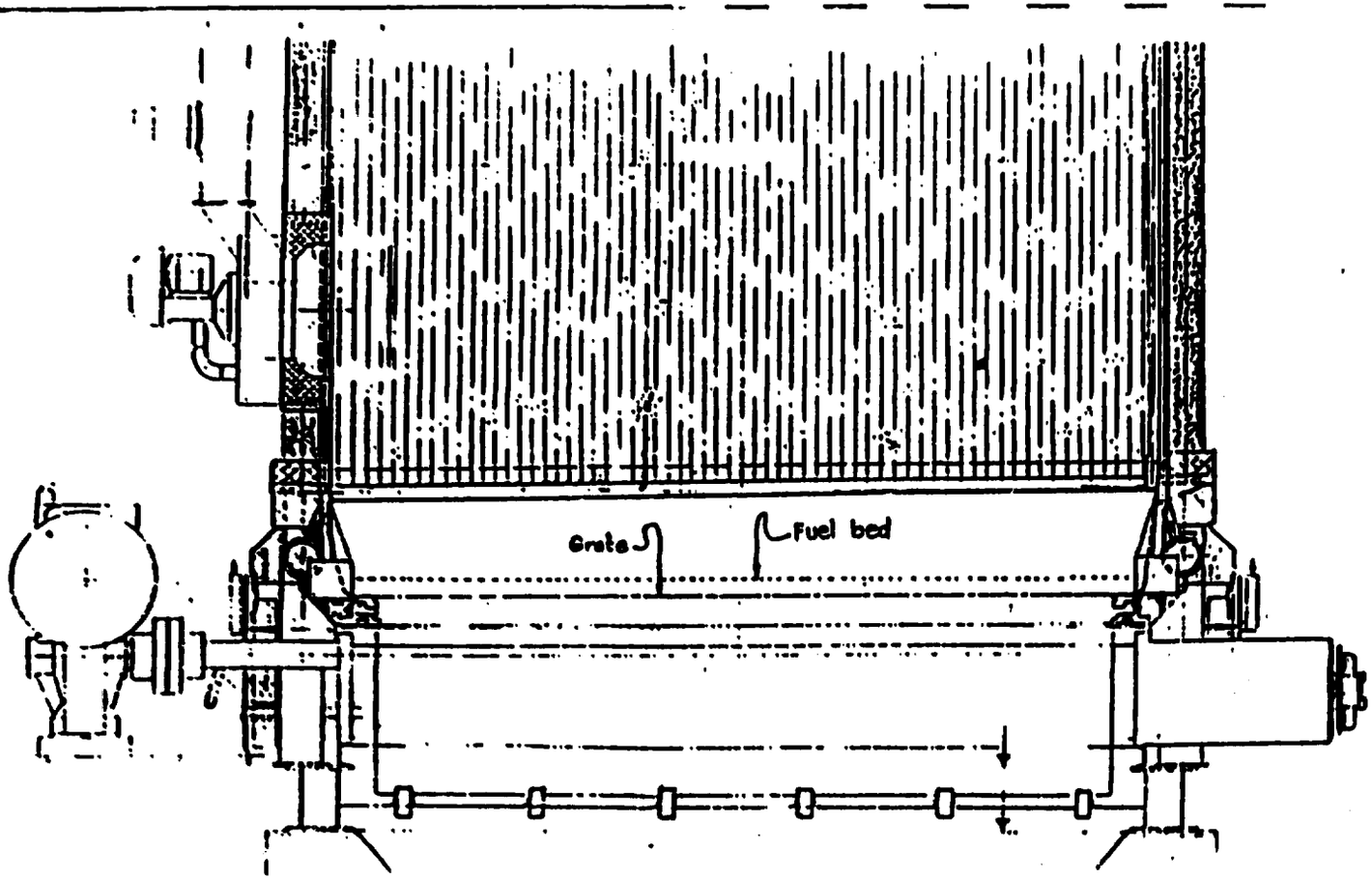
Notes: Silicon Carbide (SiC) Bricks
size: 23cm x 13cm x 12cm
maximum use temp. 1760°C

DRAWING 'A2'

SEMIRARA COAL CORPORATION
CAPTIVE POWER PLANT

RIGHT SIDE VIEW OF BOILER FURNACE

DRAWN BY:
BUREAU OF ENERGY UTILIZATION



SEMIRARA COAL CORPORATION
CAPTIVE POWER PLANT

FRONT VIEW OF BOILER FURNACE

Drawn by:
BUREAU OF ENERGY UTILIZATION

DRAWING 'A3'

corrosion and fouling in the superheater. Low excess air levels is more dangerous in the boiler operation because this promote slag build up, tube wastage, and high rates of plugging and corrosion in the air heater. Therefore, it is necessary and is recommended to have about 20% excess air during normal operation. Table 5 shows the result of the flue gas analysis of CPP boilers. If the present excess air is reduced from 192% to 20%, a boiler efficiency improvement of 13.1% can be realized. Also, this will result to a fuel savings of about 15.1% or 0.5 MT coal per hour. Refer Table 6 for boiler efficiency calculation.

However, this aspect of combustion control can be dealt with only after proper size of coal supply is ensured to the boiler. In a chain grate stoker-fired boiler not only is it important to supply the right quantity of air, but it should be supplied at the right place and the right time. For instance, 60 to 80% of the total quantity of air is supplied as primary air, while the remainder is supplied as secondary air above the grate.

In this type of boiler, the secondary air is blown in at a high pressure in the right side of the grate at about 2 m. above the grate. The air is supplied not only to burn the volatiles evolved from the burning coal mass on the grate but also to create the necessary turbulence in the furnace. For this reason, the pressure of secondary air should not be less than 30 to 40 cm. w.g. The supply of primary air beneath the chain grate stoker is zoned into several air sealed compartments each of which is provided with its own dampers. The objective of such an arrangement is to adjust the amount of air pressure in each of these compartments in accordance with combustion requirements. The pressure of primary air supplied beneath the grate should be not less than 7.5 to 10 cm. w.g. It is also necessary to adjust the under grate air pressures in different zones along the length of stoker (from furnace and to the ash pit end) depending on the fuel bed thickness and also the type of fuel used. Since the fuel bed progressively reduces in thickness as it progresses from hopper end to ash discharge end. it is obvious that the dampers at the near end should be closed to a larger extent than dampers in the proceeding zones.

Table 5

FLUE GAS ANALYSIS OF CPP BOILERS

	9:50 AM			3:40 PM		
	Temp., °C	% O_2	% CO_2	Temp., °C	% O_2	% CO_2
Before Economizer						
1	335	8	8	324	10	9
2	335	7.5	8.5	324	11	9
3	335	10.5	7.5	324	12	10.5
4	335	10	9	324	10	9.5
After Air Heater						
1	208	9	7	234	8	10
2	208	5.5	10.5	234	10	9.5
3	208	6	9	234	10	7
4	-	-	-	234	11	7
After Dust Separator						
1	200	12	9	220	12	6.5
2	200	7	10	220	10	9
3	200	8	10	220	12	7
4	-	-	-	220	10.5	7.5
Boiler Load	4.4 MW			3.0 MW		
Coal Consumption	3.6 th			3.2 th		

Table 6

BOILER EFFICIENCY CALCULATION

Mass Balance, Kg./Kg.	Current Level of Excess Air (192%)	Normal Level of Excess Air (20%)
Stoichiometric Air	6.12	6.12
Actual Air	17.86	7.34
Flue Gas, CO_2	1.71	1.71
H_2O	1.13	0.94
SO_2	0.02	0.02
O_2	2.72	0.28
N_2	13.74	5.65
Total Flue Gas	19.32	8.60
Energy Balance, Kcal/Kg.		
Calorific Value	4,956.46	4,956.46
Total Heat Input	5,014.57	4,980.33
Flue Gas Loss, Sensible	833.70	385.91
Latent	660.05	549.56
Radiation Loss	49.56	49.56
Total Losses	1,543.31	985:03
BOILER EFFICIENCY, %	70.0	80.6

The adjustments to air supply beneath the grate have to carried out manually after an on-the-spot inspection of the combustion conditions in the furnace and the automatic controllers installed cannot take care of this optimizing function. Even though, boilers may be automatically controlled to take care variations in load demand, it is obvious that a lot of work to optimize combustion conditions have to carried out manually on the shop floor. If this is the case, boiler operators have to be specially trained in properly distributing the primary air beneath the chain grate stoker.

3.2 Boiler Auxiliaries

3.2.1 Economizer and Air Heater

At present, there is no by-pass passages provided for by passing economizer and air heater. Such a by-pass from the exit of superheater to the inlet mechanical cyclone is deemed to be essential because during starting and stopping and low load operation of the boiler, the flue gas temperature to the inlet of the economizer is likely to fall below 427°C. In such an event, there is a possibility of acid-corrosion of air heater and economizer tubes and passages taking place because flue gas temperature might reach dew point levels. Since Semirara coal contains about 0.78 percent sulphur such an acid-corrosion of economizer and air heater surfaces is a distinct possibility.

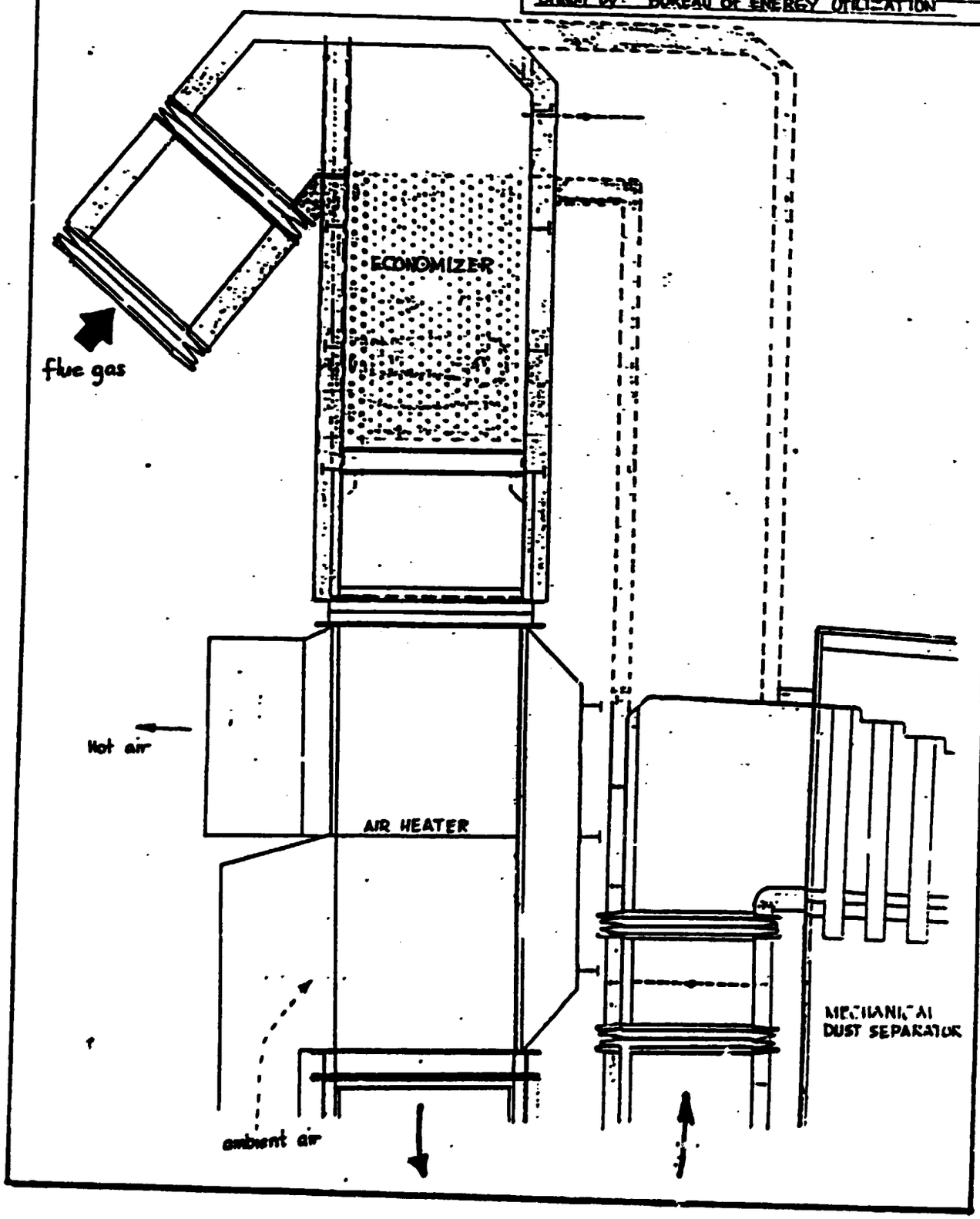
In order to protect economizers and air heaters against the possibility of acid-corrosion, it is recommended that a by-pass duct be provided as shown in the accompanying drawing (B), with a damper provided in the by-pass duct as well as the existing inlet duct to the economizer. As a rule, economizer and air heater should be put into service only when inlet temperature of the flue gas to the economizer is above 427°C. If the flue gas temperature falls below 427°C, then the flue gas should be by-passed directly to the chimney through the mechanical cyclones. The operation of the dampers in the by-pass passage and main flue gas passage at inlet to the economizer may be either automatic or manually controlled. In the event of manual control, a careful watch on the inlet temperature of the flue gas to the economizer should be kept, so that dampers could be operated at the appropriate time as indicated above.

..../

Note: Provide a by-pass duct for economizer and air heater, as shown, to prevent heat exchanger equipments against acid-corrosion.

SEMIRARA COAL CORPORATION
CAPTIVE POWER PLANT
BY-PASS DUCT

DRAWN BY: BUREAU OF ENERGY UTILIZATION



Mechanical Dust Separator

A dust separator is installed after the air heater. The dust collected in the hopper is withdrawn by a screw conveyor at the bottom of the hopper and transported to the ash disposal system by belt conveyor.

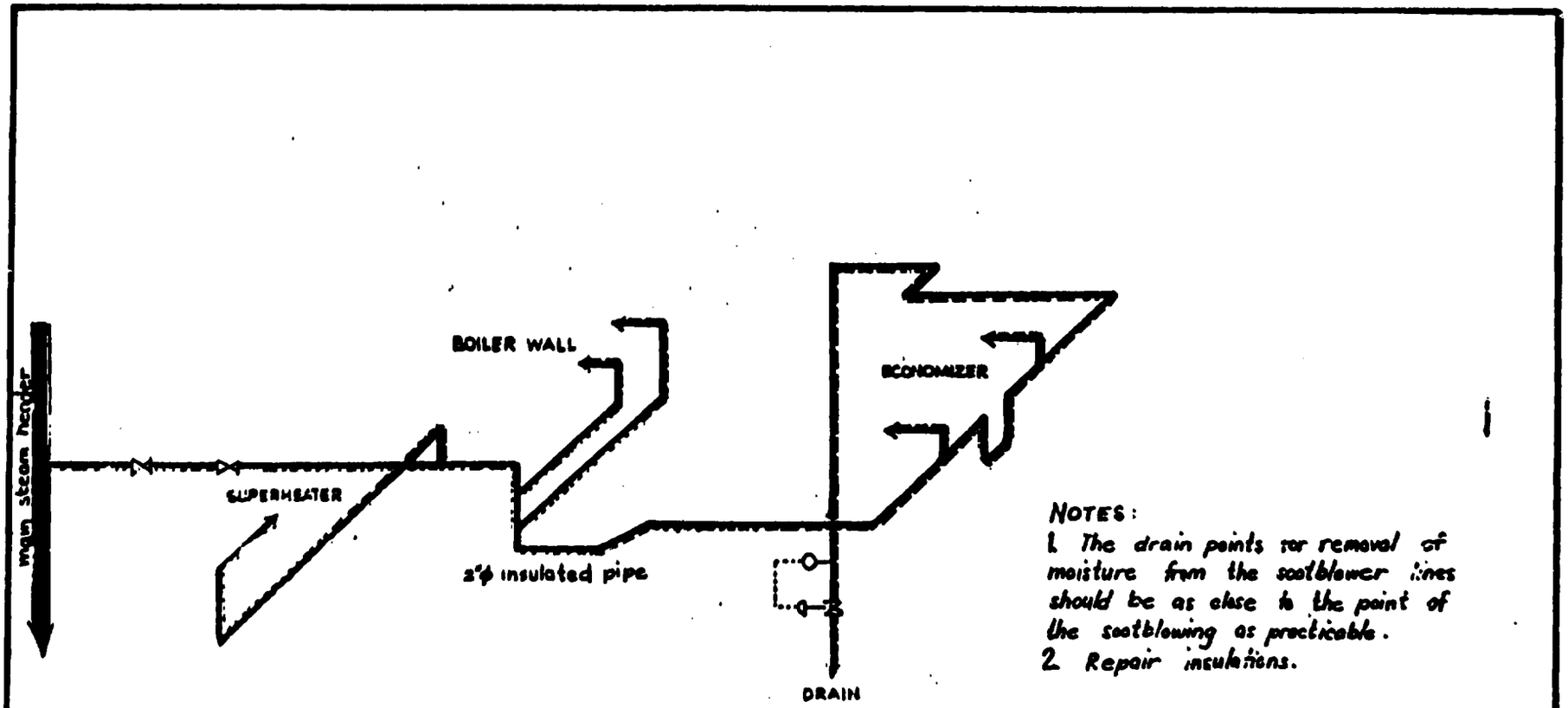
Flue gas analysis before and after the mechanical dust separator reveals an increase in oxygen level in separator. Air in-leakage is estimated to be about 2.8 kg. per second and is possibly coming in from dust hoppers or dust removal valves. Refer to Table 3 for the flue gas analysis of CPP boilers.

To have an efficient collection of dust in the mechanical separator, prevention of internal fouling by emptying regularly and never allowing an overfill of dust hoppers is necessary. It is important that no in-leakage of air is permitted especially at the hoppers or removal valves. Any air in-leakage would result to the increase of fan power of FDF and IDF. In practice, water washing or hot caustic soaking is often employed during overhauls of the dust separator to ensure complete cleanliness of all parts.

Soot Blower

For trouble-free and efficient soot blowing of boiler heat transfer surfaces, it is very essential to remove all the moisture which may have accumulated in soot blower steam lines, so as to prevent erosion of boiler tubes due to impingement of water particles at supersonic velocities. Therefore, the drain point for removal of moisture from the soot blower lines should be as close to the point of the soot blowing as practicable so as to reduce to an absolute minimum the length of soot blower steam pipeline which cannot be drained effectively of moisture. Since the soot blower drain valve is located far away (Fig. 3), there is a distinct possibility of some horizontal sections of soot blower steam lines not being drained effectively just before soot blowing, thus, allowing some water particles to be propelled at high speeds on heat transfer surfaces.

It is further possible the service life of the soot blower valve seats will be shortened. The thermal shock brought about by the presence of moisture droplets in the steam may damage the seats of the soot blower valve seats and its sealing gland. Therefore, provision of additional drain



NOTES:
1. The drain points for removal of moisture from the sootblower lines should be as close to the point of the sootblowing as practicable.
2. Repair insulations.

Fig. 3
SOOTBLOWER PIPEWORK SYSTEM
SCALE 1 200 inches

SEMIRARA COAL CORPORATION
CAPTIVE POWER PLANT
SOOTBLOWER PIPEWORK SYSTEM
Drawn By
BUREAU OF ENERGY UTILIZATION

points nearest to the point of soot blowing may be [illegible] the manufacturers of the boilers.

3.2.4 Ash Disposal System

The present method of discharge of ash from the boiler under water seal and its subsequent transport to the ash silo through a steeply inclined belt conveyor is quite satisfactory. However, for the belt conveyor, in view of the steep incline provided in the original design to conserve space, a very special type of belt conveyor with projections in the middle and also on the sides (to prevent ash slipping back) is provided and every 1½ to 2 years, this belt has to be discarded and a new imported belt costing ₱400,000 or so has to be installed in its place. In order to overcome this problem, the power plant engineers have come up with an alterrative scheme of handling and disposal of ash whereby a less expensive belt conveyor with an incline of 10° to 16° would be provided. This scheme seems to be quite satisfactory and we recommend to the management that they go ahead implementing this scheme.

3.3 Boiler Accessories

3.3.1 Water Level Gauge Glass

Each boiler is provided with two (2) gauge glasses and are mounted at each end of the drum. In addition to this, a remote type of water-level indicator is installed and mounted on the instrument control panel. At present, considerable difficulty is experienced in the maintenance of gauge glass of the boiler drum. This is because of the special design of attachment of the flat gauge glass plate to the boiler drum. It is suggested that the design of gauge glass connection to the boiler drum employed in Combustion Engineering (CE) or Babcock and Wilcox boilers maybe adopted replacing the present design as in our opinion, they are more robust and poses less maintenance problems may be adopted in the near future. At present, the tendency for steam space in the flat gauge glass becomes translucent due to alkali reaction is quite pronounced making it difficult for the operating staff to read the water level in absolute gauge glass. It is further our view that the cause of this is the existence of temperature shock during periodic blowing to clear the gauge for any foreign materials. The temperature shock can cause

erosion of the mica and possible breakage of the glass. The replacement of gauge glass plates every six (6) months seems to be too short. The present suppliers of this may be asked to supply better quality of glass.

At present, apart from the drum level indicator in the boiler-turbine-generator control room, which is an indirect method of measuring water level in the boiler drum, there is no way of having access to the absolute gauge glass reading of the boiler drum from the operating floor. In some countries, it is mandatory for transmitting the boiler water level in the absolute gauge glass mounted on the boiler drum to the operating floor through a system of mirrors known as "Periscope". From the point of view of safety of boiler operation, similar arrangement should be made in the plant also. It should be possible to install a bi-colour gauge glass and bring the reading of the boiler drum water level on to the boiler operating floor through a system of mirrors. This would of course necessitate rotating the existing absolute gauge glass assembly by 90° and making a direct hole in the cat-walk adjacent to the boiler walls so that direct line of sight for transmission of drum level image through a system of mirrors right up to the operating floor, becomes possible.

3.3.2 Drain Valves

The boiler blowdown valves and drain valves are operated to drain off water which accumulates on cooling down the boiler. The drain valves of water walls are to be operated only during stopping and starting of the boilers and it is a dangerous practice to open them during or while boiler is in service as it will adversely affect the safety of water walls and riser tubes in the furnace. Since, as was reported to us, there were some instances in the past when some of these drain valves were opened by mistake by the boiler operators causing considerable damage to boiler tubes, it is recommended that these drain valves should be provided with fool-proof locking arrangements. For instance, a simple steel strip can be lock welded to the valve handle and valve body making it impossible to operate the valve, taking care to see that this steel strip is removed during starting and stopping of boiler.

3.3.3 Non-Return Valves

Since the two boilers are connected to a common header so that either of the boilers could supply steam

to any one of the two steam turbines installed, it would be necessary to provide non-return valves on both the boilers immediately after main stop valves.

4.0 Water Treatment

4.1 Make-Up Water

The make-up water requirements at present amount to about seven (7) percent. This figure is rather on the high side and may be partly, if not wholly, due to the periodic blowing of the safety-valve through which steam escapes to the atmosphere without being condensed whenever the boiler pressure rises as a result of sudden drop in load on the boiler. It is our view, therefore, that the plant has to keep a close watch of increases in boiler water loss because of the high cost of providing make-up water. Indiscriminate operation of drains, blow-down, soot blowing, and especially pump leaks should be eliminated and a leakage test of the plant has to be undertaken to identify unnecessary wastage of treated water.

The problem of safety-valve blowing can be mitigated to a large extent, if not totally eliminated, by anticipating the load changes as much in advance as one possibly can and making corresponding adjustments to air supply, grate speed and fuel bed thickness, manually overriding the automatic control. In other words, alertness of the control room operators and certain anticipatory action on their part will prevent waste of steam through safety valves. Such an overriding supervision over the existing automatic control becomes necessary because of the relatively slow response of chain grate stoker-fired boiler to changes in load demand.

Installed in the plant are two (2) units of gravel filters each supplying 1 cation and 1 anion. The filters operate downflow and the bed is supported by several courses of graded gravel. The upper portion of the bed consist of 1.5-2 mm. grain size gravels, while the lower layer is composed of gravels with grain size of 3-5 mm. Maximum setting for head loss of the filter is 0.6 bar (20 ft. w.c.) Backwash water generally amounts to about 1-5 percent of the total flow.

In the demineralized plant, the gravel bed in the two gravel filters installed had become hard and shrunk in size allowing channelling in the filters. Because of this, even the differential pressure [illegible] installed on these filters to indicate the pressure drop across filter

The introduction of chlorine into the intake pump preceeding the band filter is through a pipe whose discharge is at only one point in the middle and because of the relatively quiscent nature of seawater in this intake sump, chlorine is not getting mixed thoroughly throughout the tank. This is evidenced by the fact that, of the two band filters installed to remove extraneous matter from seawater before it enters the circulating water sump, the one nearest to the chlorine discharge pipe is relatively free of barnacle deposit while the band filter farthest away from the same pipe is experiencing barnacle growth. It is therfore recommended that the injection of chlorine be uniform across the width of the intake sump, possibly by providing a perforated pipe.

Presently, chlorine worth ₱120,000 per year is used and it is brought from Manila in 1-ton cylinders and separate chlorine injection system is installed. If for some reason, chlorine cylinders do not reach the island in time, cooling water treatment would be affected. In order to be therefore self-sufficient in chlorine, we suggest on-site generation of sodium hyprochlorite in an electrolytic cell with seawater and electricity as the only inputs both of which are locally available anytime. Besides this system is inherently safe also. We suggest that the company may send one of their officers to PASAR in Leyte to study the working of the on-site Sodium hyprochlorite generator installed there for an identical purpose. Appendix C gives the addresses of some of the manufacturers of on-site sodium hyprochlorite generators from whom quotations may be called for and a techno-economic evaluation made. If the rate of return on the investment is attractive, the company might consider going in for an on-site sodium hyprochlorite generator.

In addition to shock treatment of chlorine, we also suggest injection of chlorine at more frequent intervals to completely suppress the growth of barnacles. While doing so, however, care must be taken to see that the total amount of chlorine content over a 24-hour period does not result in average value higher than that imposed by the pollution control authorities. Once barnacle growth is suppressed, it should be possible once again to put into operation the "TAPPROGE" on-line condenser tube cleaning system.

It was reported that so far necessity has not arisen to replenish both Cation and Anion resins which is indeed good. However, there may arise a possibility in future where during the time of backwashing and regeneration of resins, some of the lighter sizes of resins might be washed away. Since these resins are expensive and are imported, it would be preferable to provide a resin-trap in the backwash or regeneration line. The name of the manufacturer of resin-trap is given in Appendix D.

was indicating a low value even after considerable number of operating hours. This condition was revealed only when the filters were opened for inspection by the power plant staff. In order to replace the gravel, a fresh supply of gravel was imported all the way from Austria at considerable cost to the company. It is our considered opinion that for future requirements of gravel, local sources in the Philippines may be explored. Gravels/stones found in the riverbeds in the Philippines could be crushed to the required size and could be used as filter bed materials for filtering the raw make-up water in the demineralizer plant.

4.2 Boiler Blowdown

Presently, the CPP has an intermittent system of blowdown system. In this connection, it would also be desirable to provide a continuous blowdown system instead of the intermittent system once boilers are subjected to a more uniform loading pattern at present.

4.3 Condenser Cooling Water

The intake system of the cooling water for the condenser which is in fact the seawater was examined (see Fig. 4). The seawater settles down initially into an intake sump, after which it passes through an endless belt-type of band filter made of stainless steel (two are installed - one standby and one in operation) into the cooling water intake sump. There are three (3) vertical type circulating water pumps installed (one in operation and two standby) to pump seawater through the condenser in an open circuit or once-through fashion, sending the discharge from the condenser back to the sea through a separate channel.

At present, a one shot dosage of chlorine is resorted to, to treat the seawater used for condenser cooling purposes. For instance, in the first and second shifts chlorine is injected at the rate of 8 kg/hr for 10 minutes and in the third shift chlorine is injected at the rate of 14 kg/hr for 45 minutes. Inspite of this, barnacles are found in the condenser tubes. This is because while chlorine is injected into the sump in which the suction pipes of the circulating water pumps are located, and it is in this area that barnacle growth is noticed. Since this sump is located after the band filter, these barnacles find their way through the pump and get themselves deposited on the condenser tubes. We therefore strongly recommend that this circulating water sump also should be injected to the same shock chlorine treatment as the intake settling tank.

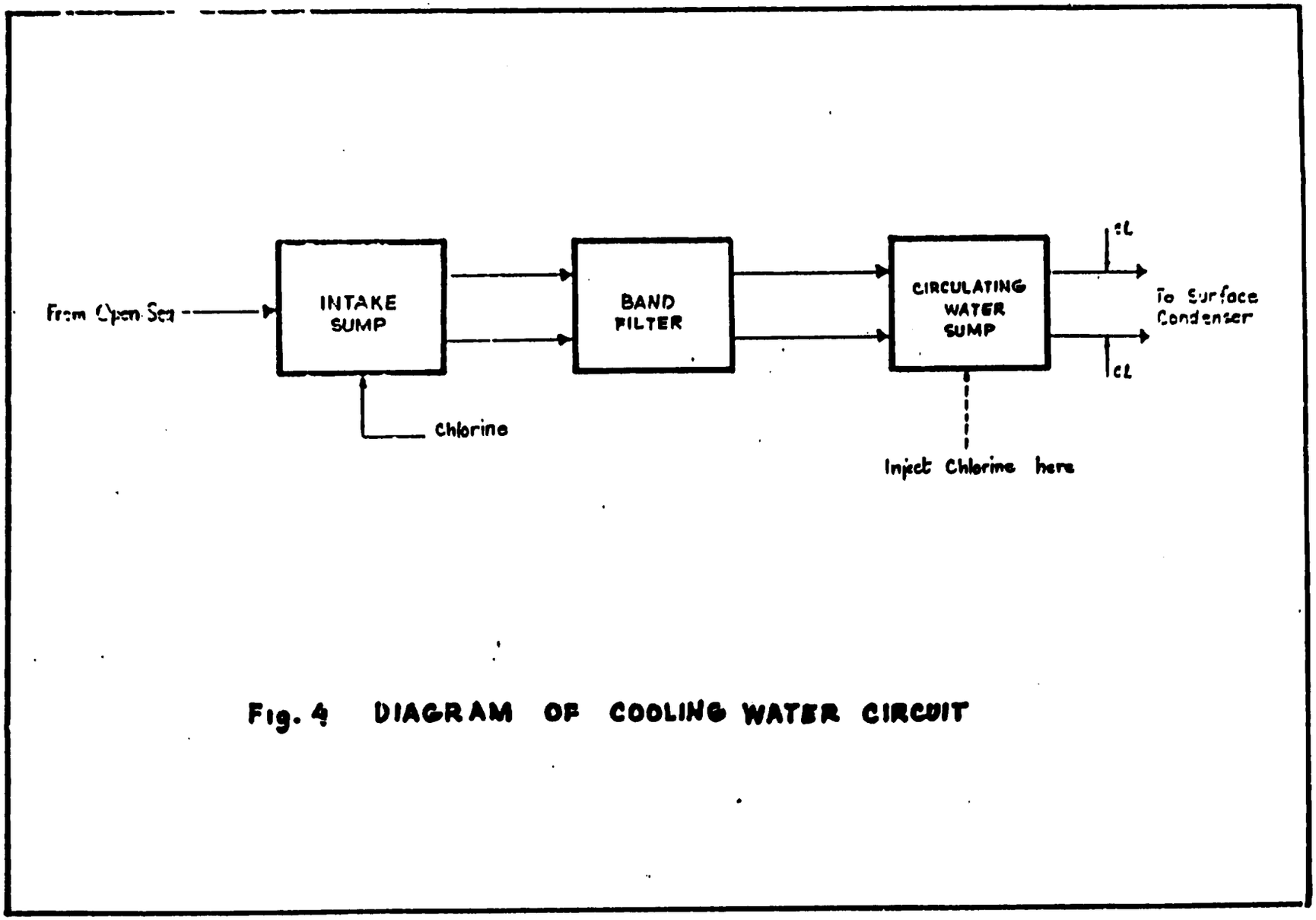


Fig. 4 DIAGRAM OF COOLING WATER CIRCUIT

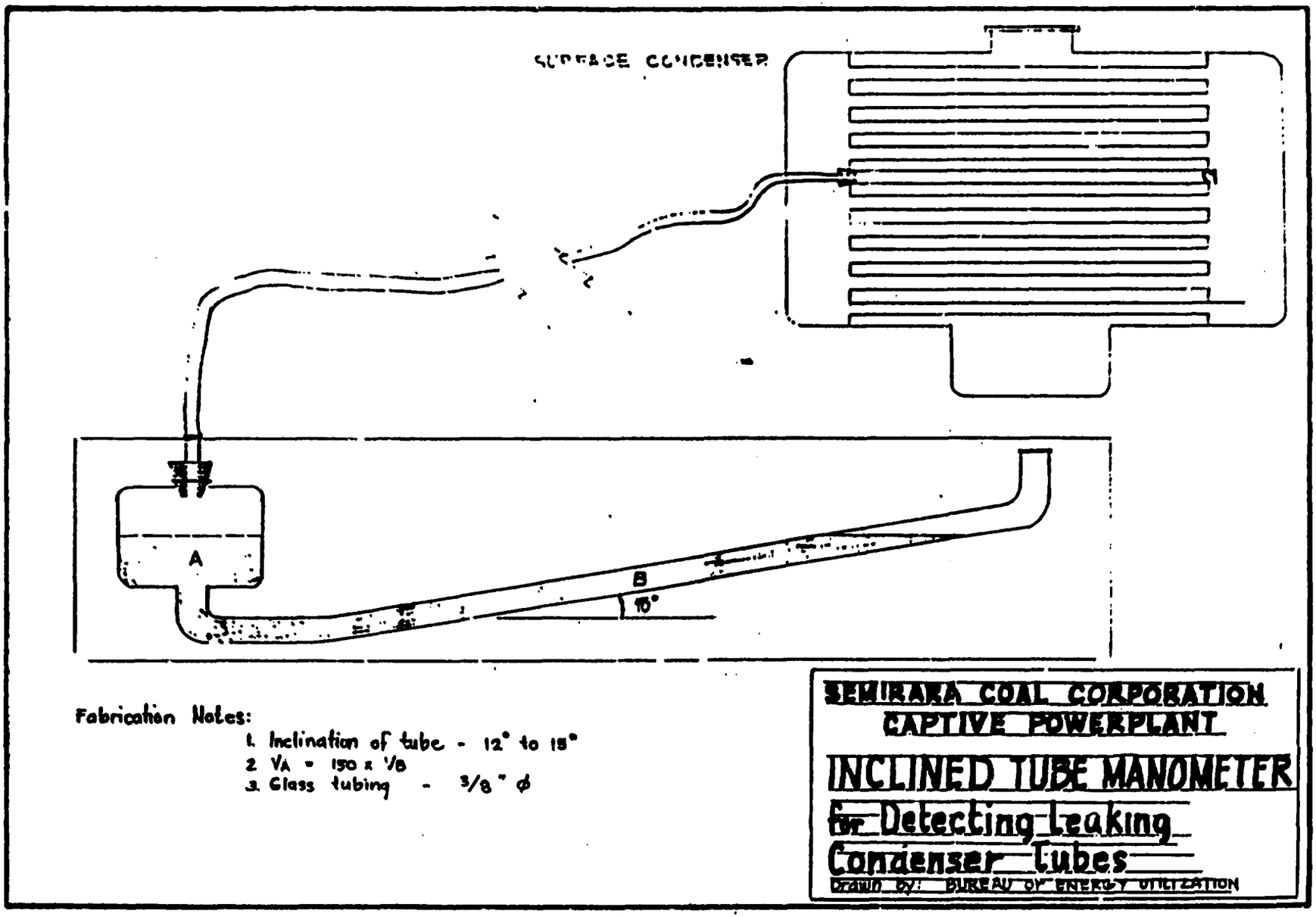
5.0 Surface Condenser

The two individual surface condensers of divided box-type for condensing the exhaust steam from each of the two turbines in the central power plant are at present provided with "TAPPROGE" rubber ball cleaning system, whereby about 100 to 150 numbers of spongy rubber balls coated with abrasives and having more or less the same diameter as condenser tubes are introduced into the inlet pipe of condenser circulating water system. These rubber balls pass through one of the condeser tubes at a time at random and in the process remove any slime or dirt which may have accumulated on them. This type of on-load cleaning of condenser tubes has gained acceptance in recent years the worldover, and in fact have proved to be quite effective. Maintenance of steady condenser vacuum over long periods of time have been reported elsewhere in the world because of installing such a system. In this power station, however, this cleaning system is not in operation presently because according to the power plant staff, a large number of condenser tubes get choked with barnacles and other marine growth very quickly, making it difficult for the spongy rubber balls to pass through.

The Cathodic System of protection for the condenser shell and water box is not in operation at present because the electrodes have been consumed and the spare electrodes are yet to arrive. It is recommended that the cathodic protection system should be revived as soon as the electrodes are received from Austria.

At present, considerable time and effort is spent in trying to exactly pinpoint the location of a leaky condenser tube from amongst hundreds of tubes in the tube bundle. In order to quickly identify the leaky condenser tube, a simple cheap but effective method could be used which is as follows.

An inclined tube manometer filled with water with a 12 to 15 degrees inclination of the tube may be fabricated as shown in Fig. 5 and this manometer tube may be connected to each of the condenser tubes during condenser shutdown for maintenance or repair, in rapid succession with the ejector is in operation, a vacuum of 5 to 6 inches of Mercury on the shellside of the condenser is usually developed as a result. If there is a hairline crack or leak in anyone of the tubes, then vacuum on the shellside will suck air through these leaky tube and this will be detected at once by the inclined manometer. Therefore, if there is a "kick" in the manometer water level when connected to one of the condenser tubes, it means that that particular tube is leaking.



Fabrication Notes:

1. Inclination of tube - 12° to 15°
2. V$_A$ = 150 x 1/8
3. Glass tubing - 3/8" ϕ

SEMIRARA COAL CORPORATION
CAPTIVE POWERPLANT

INCLINED TUBE MANOMETER for Detecting Leaking Condenser Tubes

DRAWN BY: BUREAU OF ENERGY UTILIZATION

6.0 Turbine and Instrumentation

5.1 Maintenance of Turbine

As mentioned in earlier paragraphs, the two turbines installed in central power plant are not meant for variable load operation. As such attempts should be made to run them at as constant a load as possible. If turbines are shut for long periods of time, then steam lines which are connected to the steam turbines are also idle and may rust in the process, and it is possible that these rust particles may lodge themselves in the turbine stop valve, and subsequently when for some unforeseen and unavoidable reasons full-load on the turbine is thrown off, the stop valve may not "snap-shut" causing overspeeding of the turbine leading to rotor damage. A stainless steel strainer before the turbine stop valve may therefore be provided in addition to the steam-tight stop valves and sealing system to guard against such eventualities. There have been a number of instances around the world where the turbine stop valve has not closed immediately after the full load on the turbine is thrown off when it ought to, for some reason or the other, thereby admitting steam at full bore to the turbine, and thus over-speeding the steam turbine rotor and shattering the turbine casing and the rotor blades. In the Philippines, the 20-MW turbine generator installed in M/S Atlas Mining Company is supposed to have been damaged under such circumstances.

6.2 Turbine Logic Module

The turbine logic module which exercises the necessary supervisory control over the steam turbines installed in the power plant, requires for its successful operation a steady D.C. supply at all times. At present, the source of D.C. supply is an automobile battery, which, to say the least, is very unsatisfactory and unreliable.

We were told that sometime in the recent past, one of turbines would trip of loaded beyond 1 or 2 MW. This trouble was traced to the unsatisfactory D.C. supply system. The entire power station's output literally hangs on a slender thread at present, namely on this 12V automobile battery. There is of course a spare battery kept nearby, even-though it is not clear as to how on-load change to the standby battery is possible without creating any disturbance to the turbine logic module.

industrial batteries connected in series is used. However, there is no spare set of batteries. In view of the criticality of this D.C. supply for vital functioning of the electrical system of the power plant, a spare set of industrial lead-acid batteries must be provided, so that while one set is being charged the other set is in service. Even though it might involve an investment of over P400,000, it is a necessary and worthwhile investment. A similar back-up arrangement is also recommended for the D.C. supply system presently provided for the annunciators and alarms.

6.4 Instrumentation

It is apparent that the plant has a lot of energy saving potentials which need thorough examination. However, to fully assess these potentials, firstly an accurate coal consumption monitoring system is required, and calibration of utility flowmeters and pressure, temperature indicators have to be undertaken to ensure reliable results. Calibration of instruments begins as a one-time effort, but an improved, ongoing uniform preventive maintenance program for these instruments is necessary. The maintenance program should include not only frequent calibration checks, but also the servicing necessary to maintain or upgrade the instruments and controls.

From the maintenance group, a dedicated instrument maintenance individual should be designated. This individual(s) should maintain an inventory of all instrumentation, its location and function. Appropriate spares for critical instruments should be stocked. All control loops should be evaluated, and non-functioning loops should be prioritized for rehabilitation or replacement.

In the inspection of control room instruments, the steam flow totalizer/integrator was reading higher than the feedwater meter. It was found that part of this inaccurate display of total flow of the steam may result if the meter has not been calibrated for the lower superheated steam temperature and pressure of 453°C and 44 bar, respectively, currently being achieved (the flow recorder/integrator are calibrated for 453°C, 55 bar steam). Part of this resulting error are tabulated in Table 7.

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Table 7

READINGS OF INTEGRATOR FOR STEAM X FEEDWATER FLOW

3:11 PM	Feedwater Flow T/HR	Steam Flow T/HR	Pressure Bar	Temperature °C	Percentage Error
17	17.4758	18.9475	43.3	450	1.949
22	18.9475	19.1491	43.5	452	1.850
27	17.8218	20.2248	43.1	449	2.113
32	17.8218	18.7499	44.4	456	1.168
37	17.6472	18.1818	43.7	441	0.715
42	18.5566	19.7802	42.5	451	2.997
47	20.7504	20.4545	43.6	461	2.282
52	18.9475	19.5653	44.6	452	0.624
57	18.0000	20.0002	42.4	433	1.662
4:02 PM	18.7500	18.9475	43.6	460	2.119
07	18.0000	18.3672	44.1	449	0.921
12	17.3077	19.1491	43.6	443	1.011
17	18.7500	20.4545	44.6	458	1.111
22	17.6472	19.7802	44.1	441	0.260
27	16.5139	19.7802	44.0	449	1.033
32	14.6344	13.9536	44.2	450	0.898
37	16.666	17.4758	43.7	446	1.128
42	18.9475	19.3550	43.6	459	2.303

7.0 Laboratory for Coal Analysis

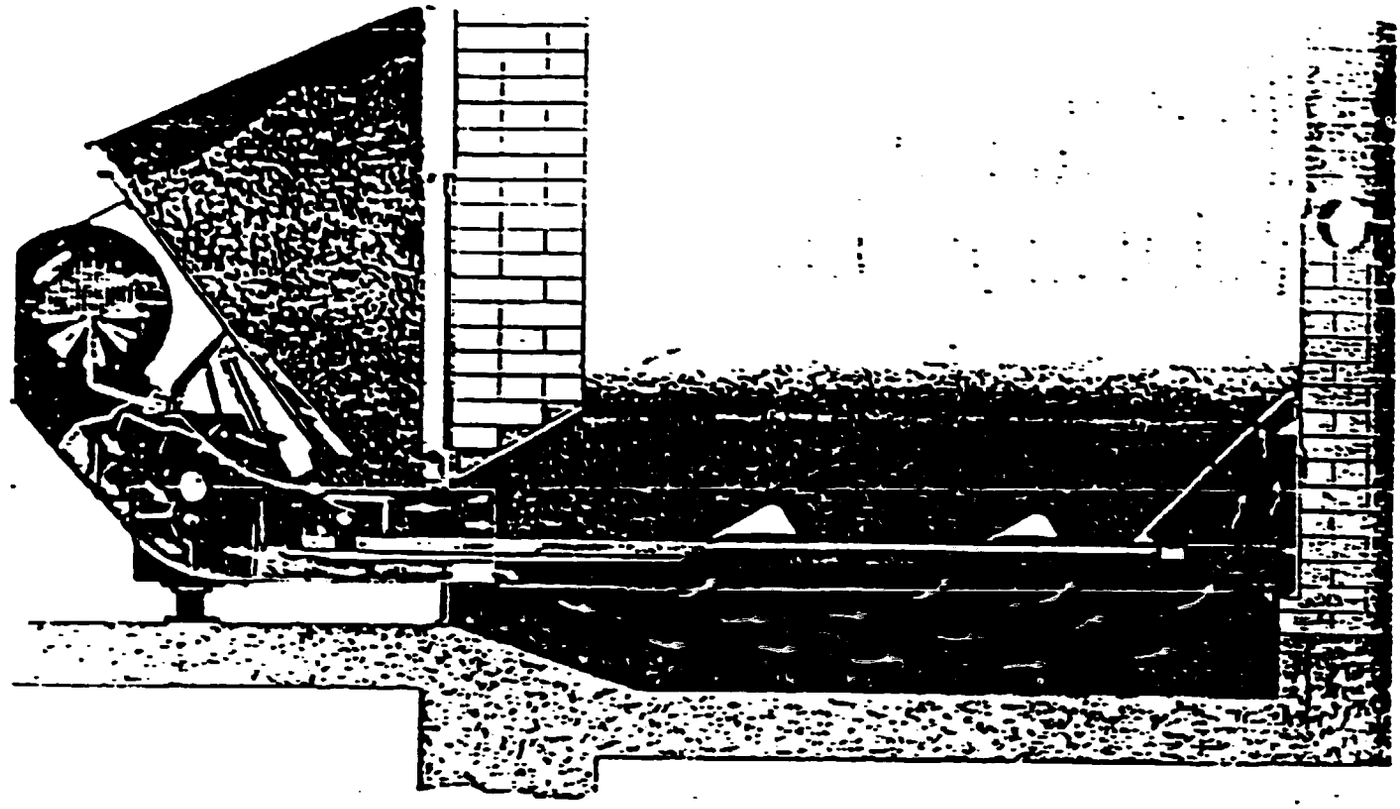
Since Semirara Coal Company is primarily engaged in mining and selling coal to power stations and industries in the Philippines and hopefully to export coal also in the years to come, it is but proper that the management should be aware of all the physical and chemical properties of coal mined and marketed by them. Only then will the Semirara coal be in a position to render the necessary advise to its clients about the type of combustion equipment they should purchase which is best suited to burn the type of coal supplied by them. If advise on how to cope with some operational problems like erosion of boiler-tubes, build-up of slags on boiler tubes, erosion of ash-slurry pipelines, etc., is offered by Semirara Coal Company as a kind of after-sales-service, it will inspire confidence among customers of Semirara coal and will result in increased sales for the company.

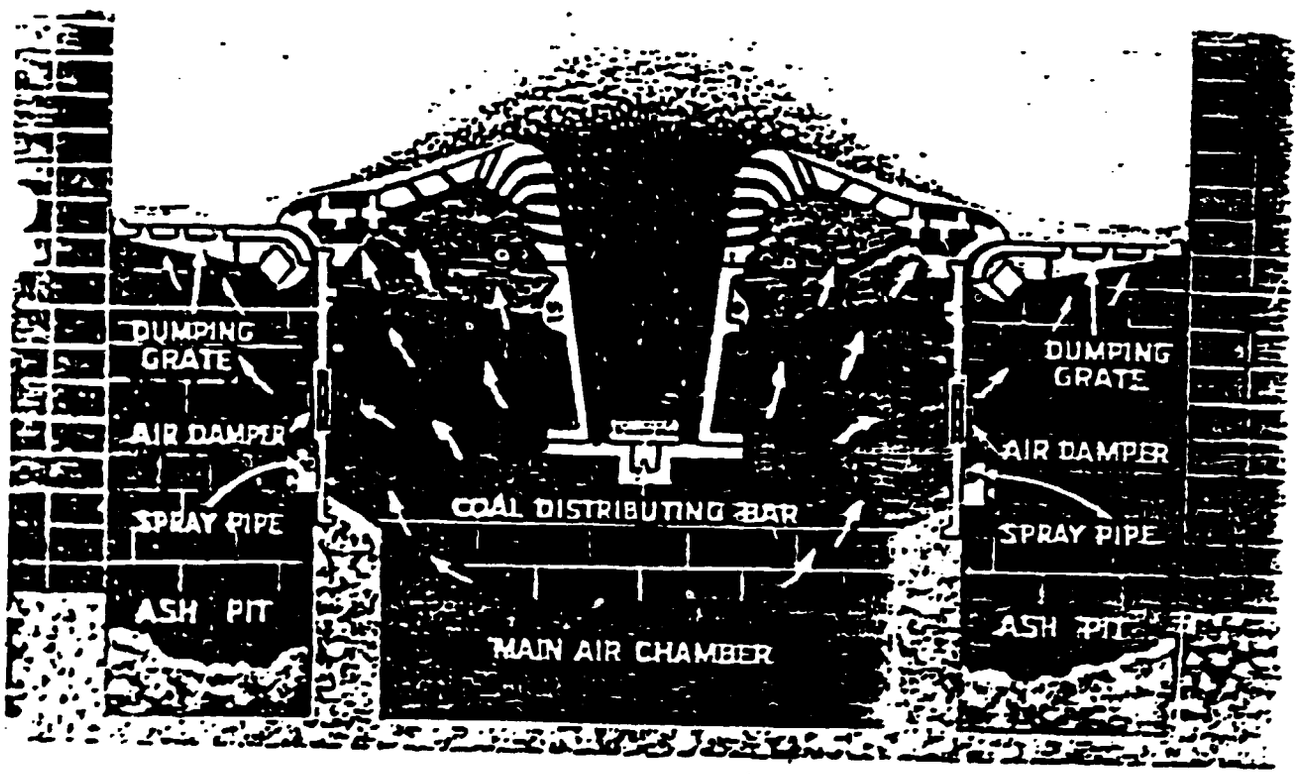
For this purpose, the facilities available in the Coal Analysis Laboratory should be augmented so as to evaluate the following additional properties of coal, to start with:

(a) swelling characteristic of coal;
(b) ash fusion temperature of coal ash;
(c) viscosity of molten ash and its dependence on temperature;
(d) evaluation of erosive properties of ash;
(e) analysis of ash for its mineral constituents.

On the different kinds of properties of coal to be evaluated as mentioned in the previous paragraph, priority may be given to items (a) and (b). This is because swelling characteristics determine how coal behaves while it is undergoing combustion. For instance, if a coal having a strong swelling or caking tendency is used in a pulverized fuel boiler, the carry-over of flyash is increased, because the cenospheres (burning particles of pulverized fuel) expand during combustion, become lighter and are carried away along with the flue gases, thus, increasing the tendency for fouling of the heat transfer surfaces. One way of overcoming this problem is to reduce the fineness of grinding so that the coal particles become heavier and therfore have a less tendency to be carried away under the same furnace draft conditions. Similarly, if strongly caking coals are to be used in industrial boilers, an underfeed grate of the type shown in Fig. 6 is necessary. Chain grate stokers are generally preferred for free burning coals.

Free burning property of coal, i.e. the ability of coal to burn without swelling, increases as the volatile matter



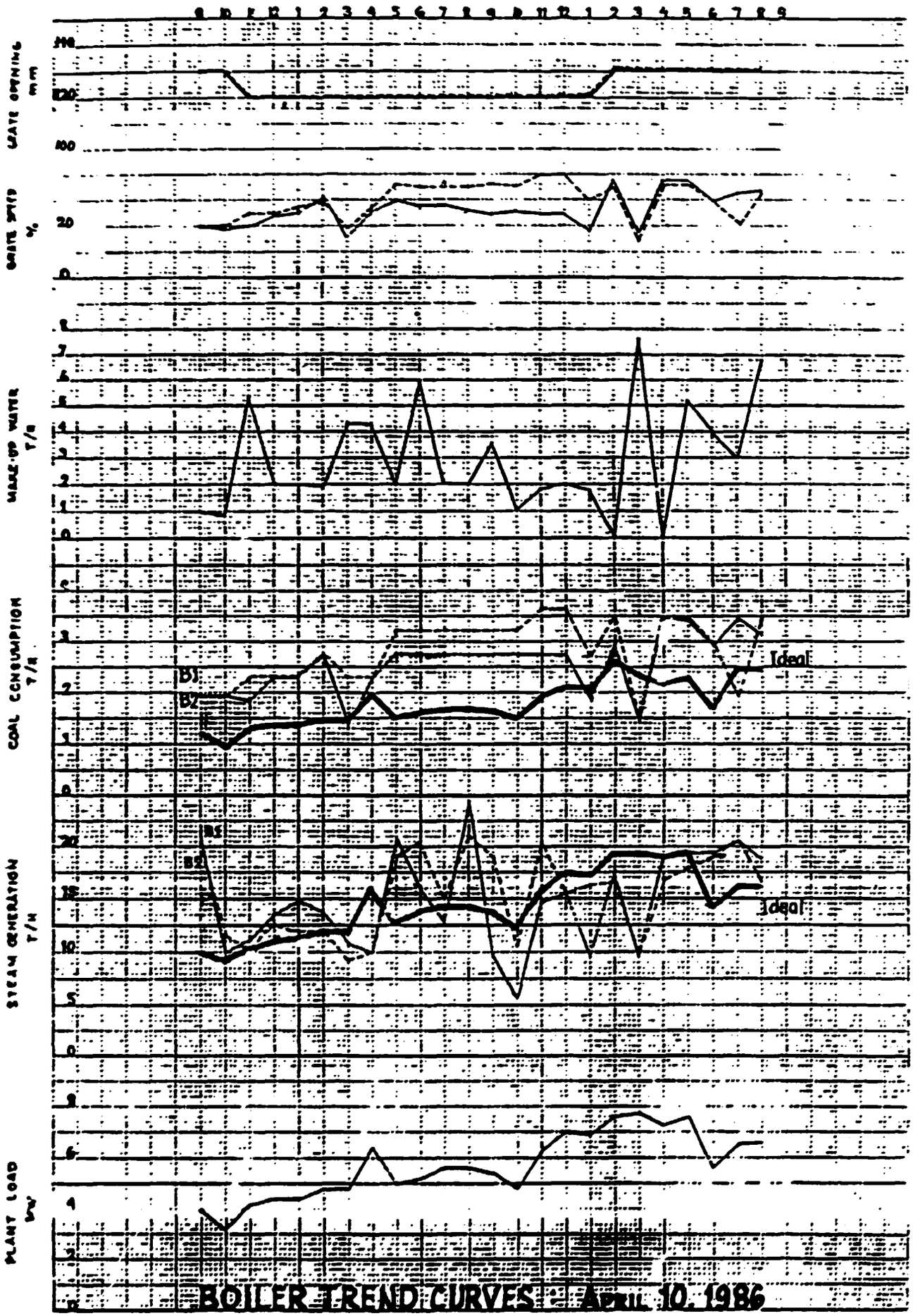


UNDERFEED STOKER

in coal increases from 5% or so for anthracite to about 25% for Bituminous/semi-bituminous coals. However, coals having V.M. between 25 to 30% exhibit widely varying burning characteristics. For example, it is possible for a 28% V.M. coal to exhibit either free burning or strongly caking properties depending upon the geographic location of the coal seam and other chemical properties of its hydrocarbon contents. It is therefore worthwhile evaluating the caking or swelling properties of bituminous coals having V.M. between 25 to 30% for aforesaid reasons. It may be noted that coals having V.M. beyond 30% once again exhibit free burning properties.

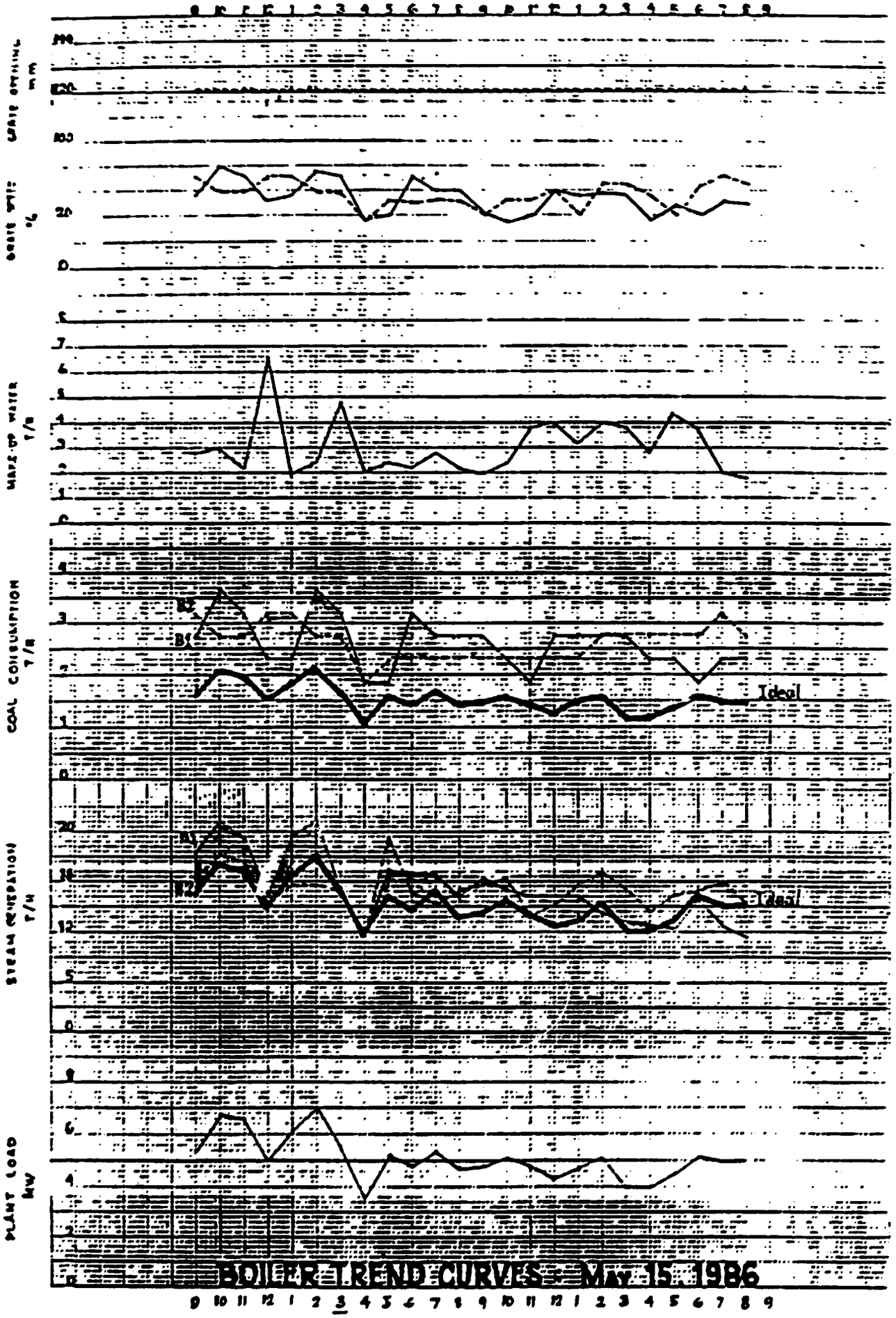
The ash fusion temperature of coal ash also is a very useful piece of information which will help in the choice of a certain type of fuel burning equipments for boilers. Also for boilers which are already using coal containing ash of a certain specified ash fusion temperature and mineral contents, based on the analysis additives could be added to overcome certain operational problems connected with fouling of superheater tubes, electro-static precipitator operation, etc.

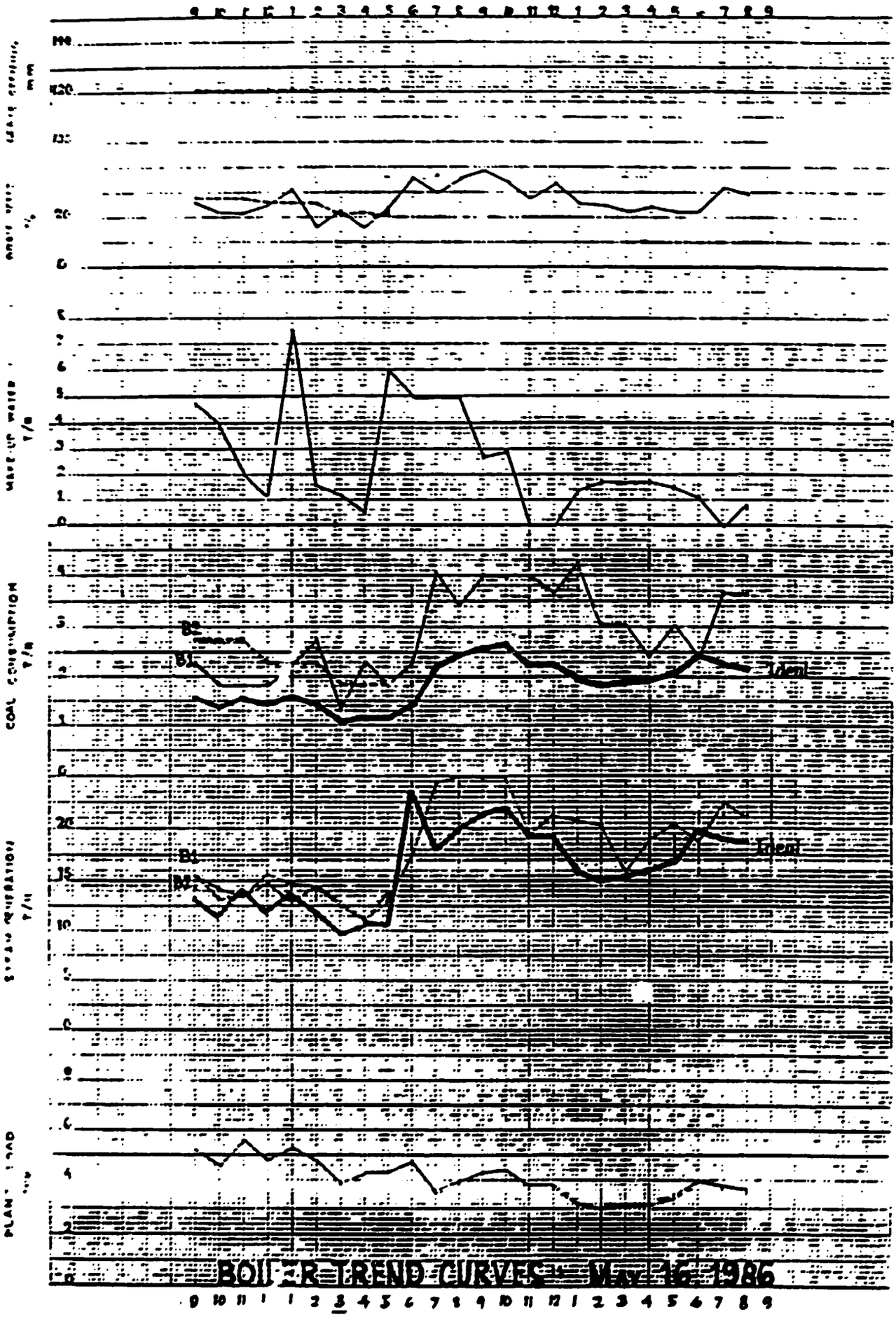
If all the relevant properties of coal mentioned above from different seams in the mine are evaluated, then it should be possible, in principle and practice, to blend different types of coal to get a coal of a uniform but predictable properties. In developed countries like West Germany, etc., power stations blend different types of coal so that their boilers all the time receive coal having consistent properties. That way it will be possible for power stations to optimize their automatic control settings and predict maintenance schedules, life of certain equipments based on their operating experience.

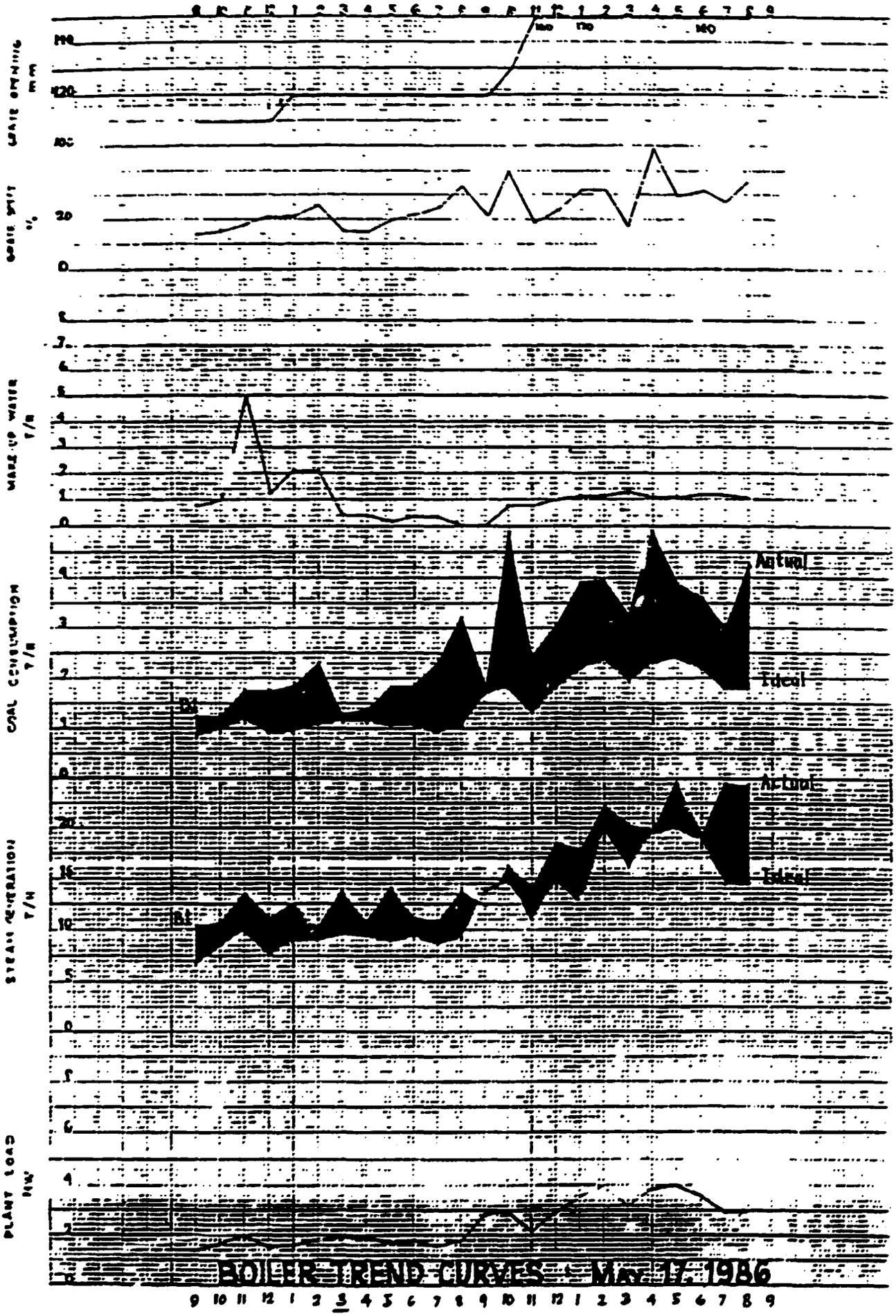


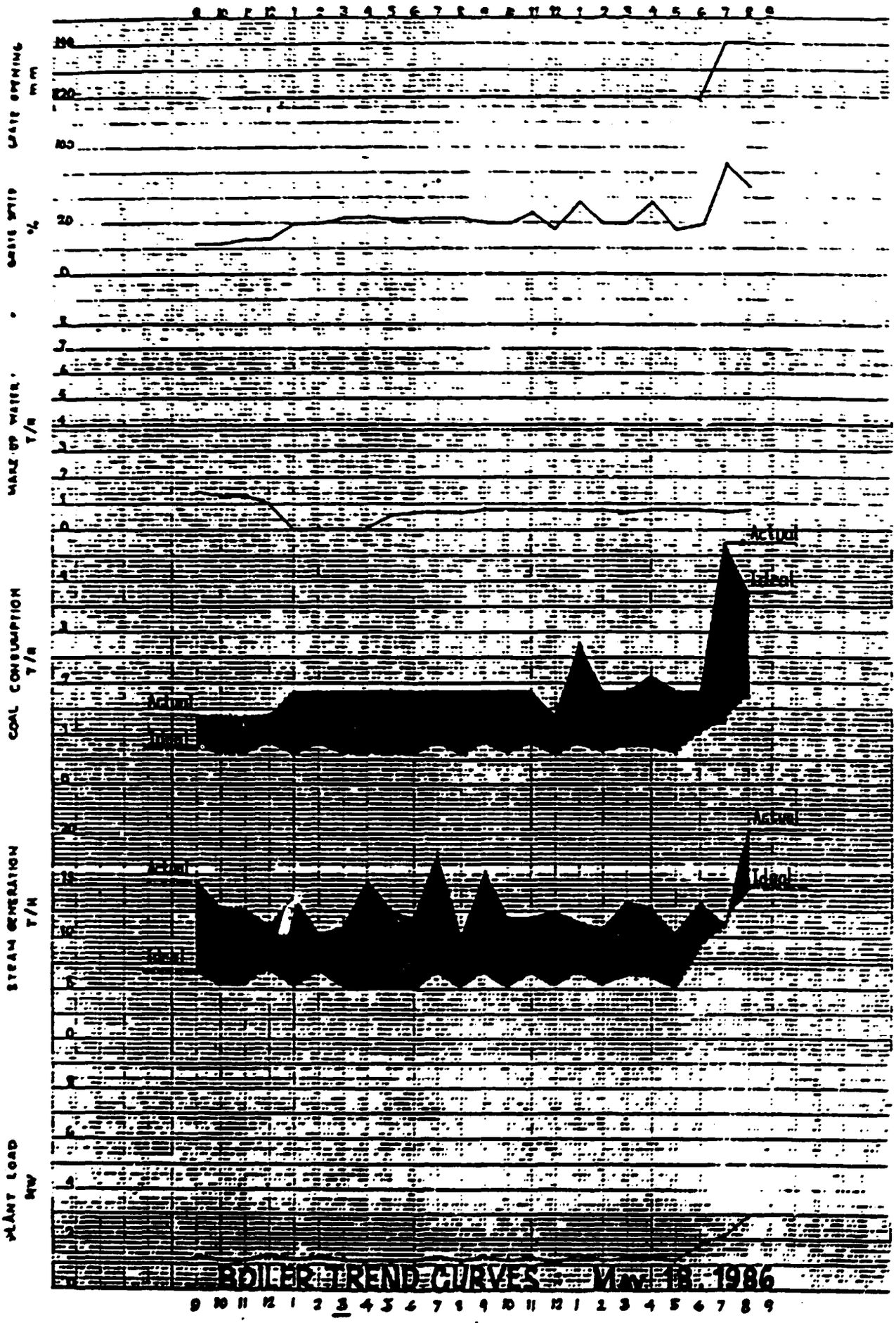
BOILER TREND CURVES - APRIL 10, 1986

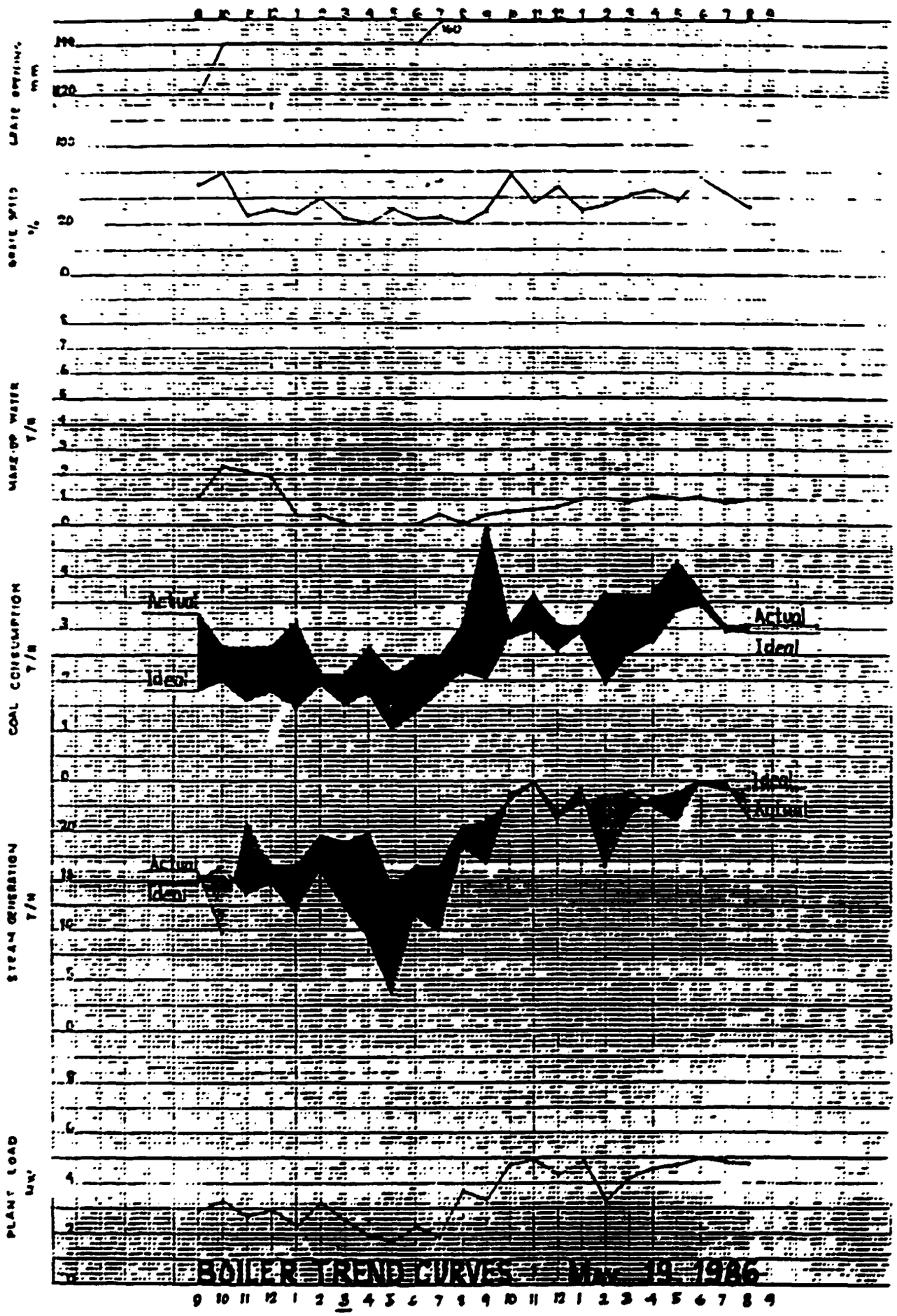
APPENDIX A


BASIS OPENING mm
BASIS WTR %
MAKE-UP WATER T/H
COAL CONSUMPTION T/H
STEAM GENERATION T/H
PLANT LOAD MW
B2
B1
Ideal
Ideal
BOILER TREND CURVES - May 15, 1986


B2
B1
Ideal
B1
B2
Ideal
BOILER TREND CURVES - May 16 1986


Actual
Ideal
Actual
Ideal
BOILER TREND CURVES - MAY 17, 1986


PLANT LOAD MW
STEAM GENERATION T/H
COAL CONSUMPTION T/H
MAKE-UP WATER T/H
BASIS SPRING %
GATE OPENING mm
Actual
Ideal
Actual
Ideal
Actual
Ideal
BOILER TREND CURVES — May 18, 1986


PLANT LOAD MW
STEAM GENERATION T/H
COAL CONSUMPTION T/H
MAKE-UP WATER T/H
DRUM LEVEL %
GRATE OPENING mm
Actual
Ideal
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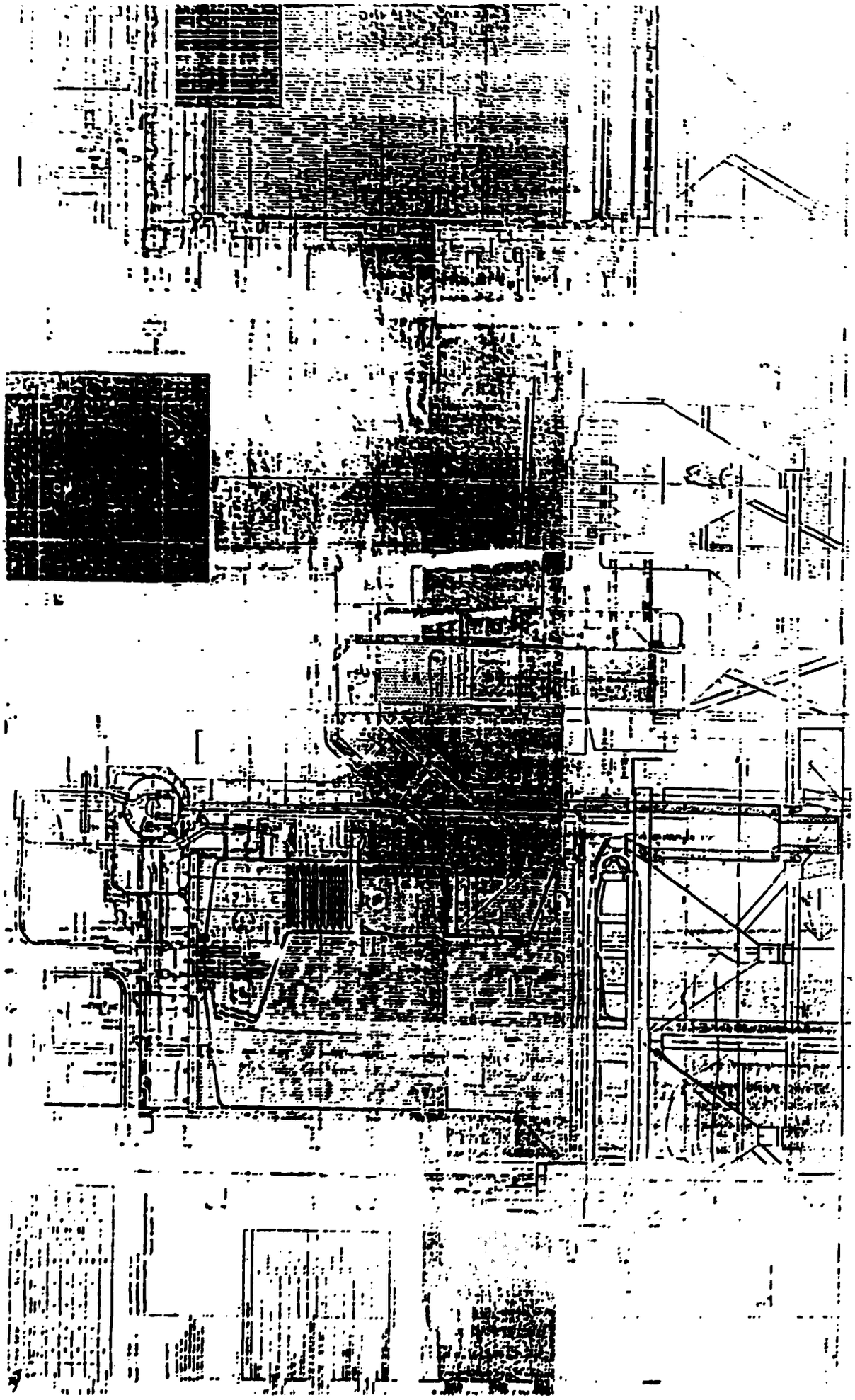
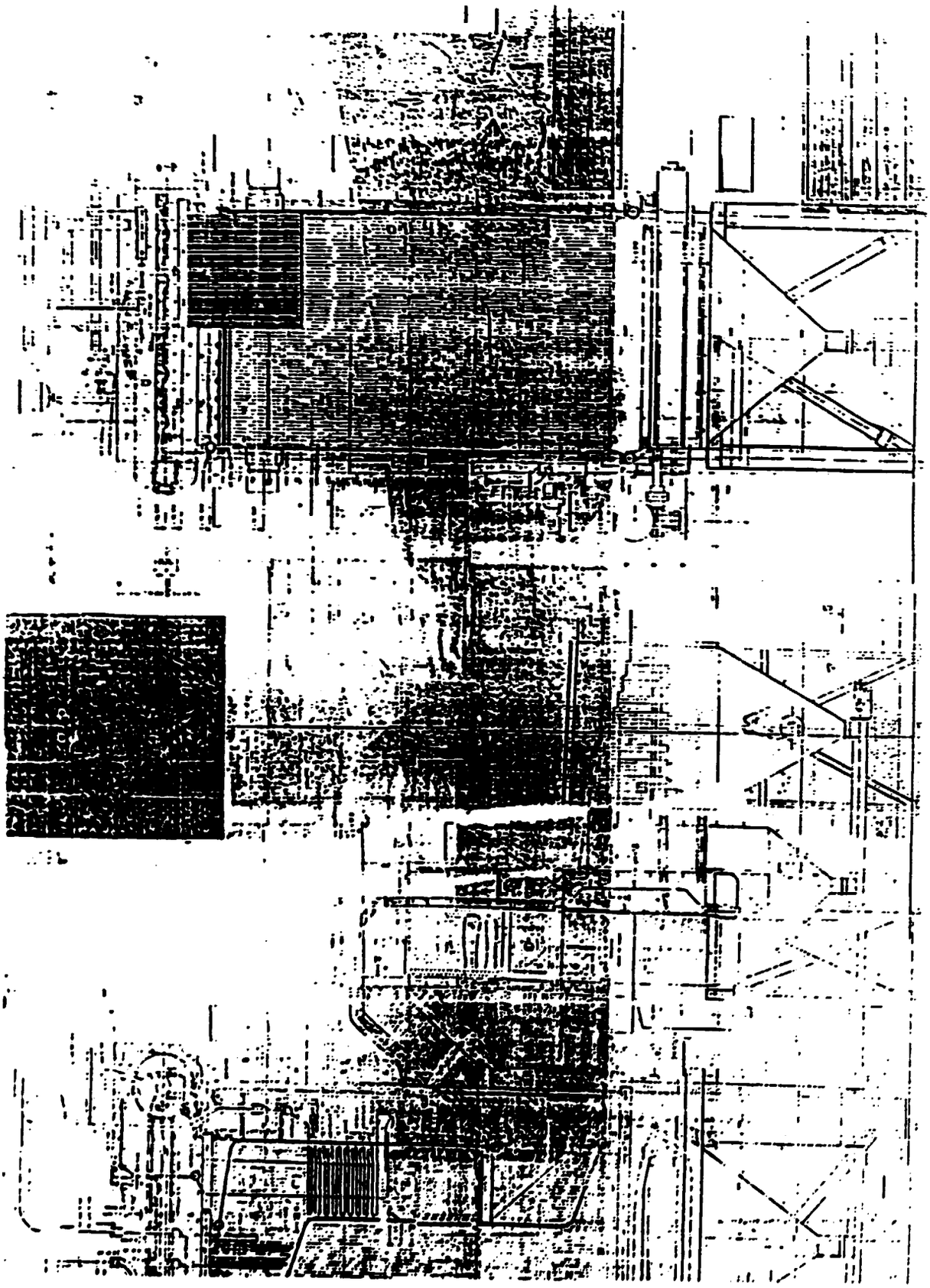
BOILER TREND CURVES - May 19 1986





Annex 7

SCHEDULE OF TRAINING FOR BEU ENGINEERS PREPARED
PREPARED BY B.J. CUNNINGHAM
WITH CTA

SCHEDULE OF CLASSROOM SESSIONS FOR THE DEU ENERGY AUDIT TEAM

Date (1987)	Topic	Lecturer
14 Jan. (Wed)	Audit Procedure	BJC/PRS
4 Feb. (Wed)	Field Use of Energy Audit Instruments	BJC
9 Feb. (Mon)	Design of Water/Steam Piping and Air Ducts	BJC/PRS
11 Feb. (Wed)	Specification of Heat Recovery Systems	PRS/BJC
16 Feb. (Mon)	Choice & Specifications of Pumps, Compressors, Refrigeration, Air Conditioning	PRS/BJC
18 Feb. (Wed)	Design & Specification of Instrumentation Control Systems for Boilers, Furnaces, and Simple Chemical Processes	PRS/BJC
23 Feb. (Mon)	PUBLIC SPEAKING	BJC
25 Feb. (Wed)	Choice & Specification of Mechanical Drive Systems/Speed Control	PRS/BJC
2 Mar. (Mon)	Cost Engineering Fundamentals	BJC
4 Mar. (Wed)	Preparation & Layout of Drawings	TPC/BJC
9 Mar. (Mon)	Design of Electrical Distribution Systems, Layouts, Protection	CAQ/BJC
11 Mar. (Wed)	Financial Appraisal of Retrofit Projects	BJC
16 Mar. (Mon)	Materials Engineering and Specification	(To be decided)

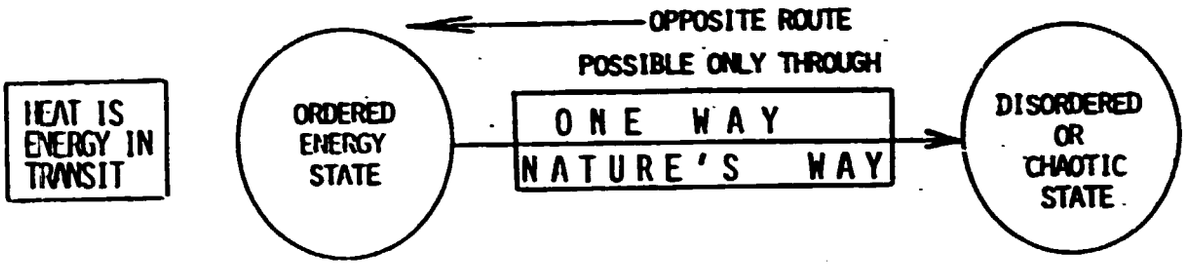
Annex 8.

LIST OF TRANSPARENCIES PREPARED BY CTA AND STAFF
FOR USE BY BEU ENGINEERS

SOME FUNDAMENTAL CONCEPTS ABOUT THERMODYNAMICS

1) ALL MATERIALS HAVE THE TENDENCY TO DEGRADE BY DISPERSION, DECAY OR OXIDATION TO A CONDITION IN HARMONY WITH ENVIRONMENTAL DATUM.

2) ALL ENERGY RESOURCES EVENTUALLY DETERIORATE BY OXIDATION OR NUCLEAR RADIATION TO HEAT AT AMBIENT TEMPERATURES AND PRESSURES.



WORK = F.S. EQUILIBRIUM PROCESS

WHERE F - FORCE
S - DISTANCE

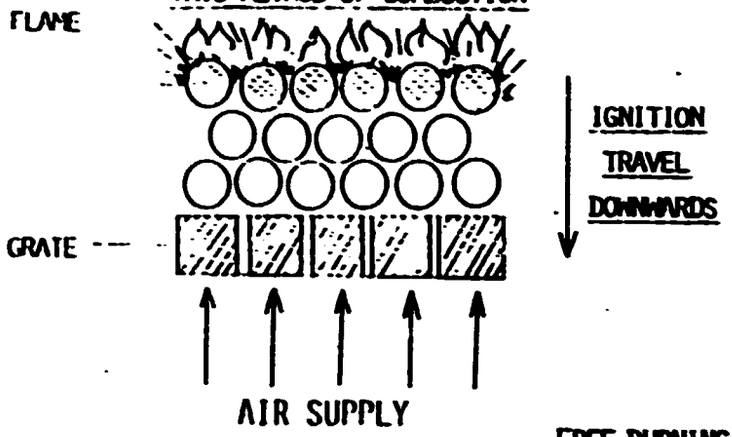
3) UNLIKE MATERIALS, THERMODYNAMIC AVAILABILITY CANNOT BE RECYCLED. THEREFORE, IT SHOULD BE THE OBJECTIVE OF THERMAL PROCESS DESIGN ENGINEERS TO EXTRACT AS MUCH USEFUL WORK AND HEAT AS POSSIBLE FROM A DEGRADING CHAIN BEFORE EQUILIBRIUM CONDITIONS ARE OBTAINED.

4) WHAT SHOULD BE CONSERVED IS THE QUALITY OF ENERGY AND NOT THE AMOUNT OF ENERGY BECAUSE ENERGY CAN NEITHER BE CREATED NOR DESTROYED BUT CAN ONLY BE CONVERTED FROM ONE FORM TO THE OTHER.

TWO METHODS OF COMBUSTION OF COAL IN SOLID FORM ON GRATES

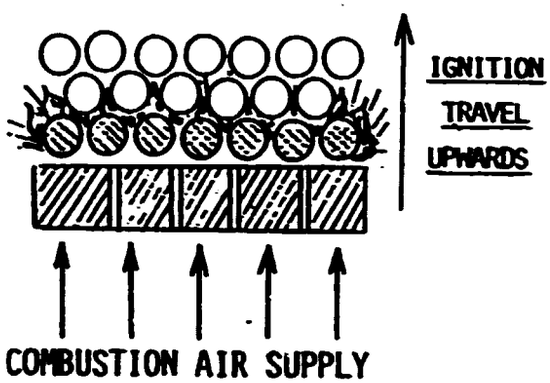
IN (1. CHAIN GRATE STOKER
(2. UNDERGRATE STOKER

THIS METHOD OF COMBUSTION



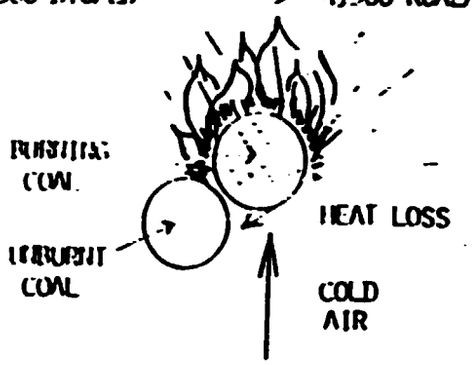
IN (1. HAND FIRING
(2. SPREADER STOKER

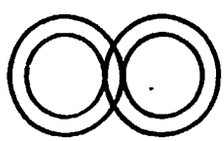
THIS METHOD OF COMBUSTION



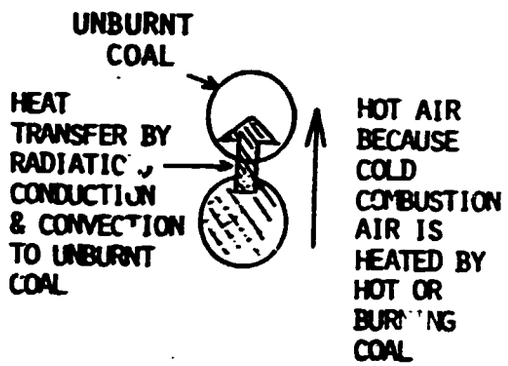
FREE BURNING CHARACTERISTICS

6,500 BTU/LB ⟶ 4,500 KCAL/KG





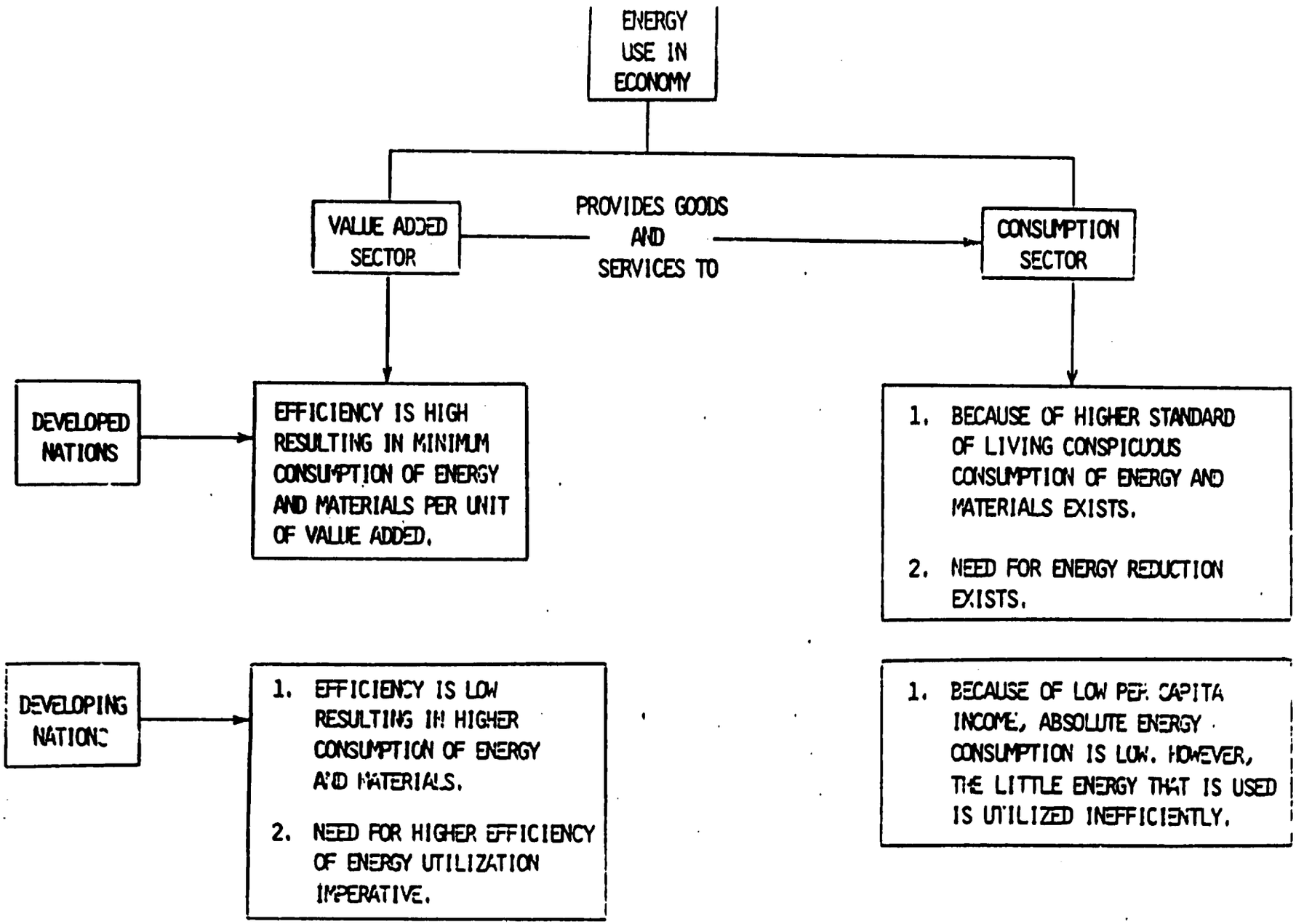
SWELLING INDEX



THE HEAT RELEASED BY COAL SHOULD COMPENSATE (1) HEAT LOSS TO GREEN COAL, AND (2) HEAT CARRIED AWAY BY COLD COMBUSTION AIR.

CONDITION NOT SO FAVOURABLE FOR IGNITION

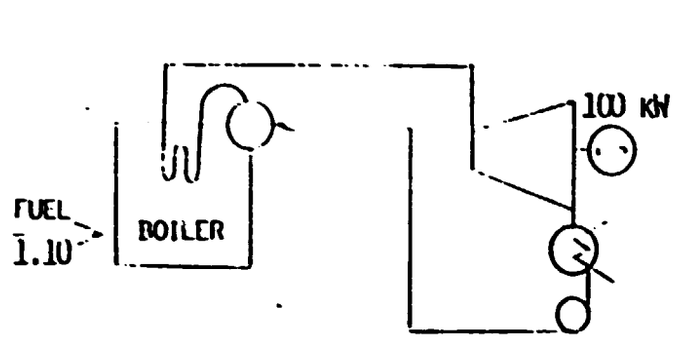
CONDITIONS MORE FAVOURABLE FOR IGNITION OF UNBURNT COAL


ENERGY USE IN ECONOMY
VALUE ADDED SECTOR
PROVIDES GOODS AND SERVICES TO
CONSUMPTION SECTOR
DEVELOPED NATIONS
EFFICIENCY IS HIGH RESULTING IN MINIMUM CONSUMPTION OF ENERGY AND MATERIALS PER UNIT OF VALUE ADDED.
1. BECAUSE OF HIGHER STANDARD OF LIVING CONSPICUOUS CONSUMPTION OF ENERGY AND MATERIALS EXISTS.
2. NEED FOR ENERGY REDUCTION EXISTS.
DEVELOPING NATIONS
1. EFFICIENCY IS LOW RESULTING IN HIGHER CONSUMPTION OF ENERGY AND MATERIALS.
2. NEED FOR HIGHER EFFICIENCY OF ENERGY UTILIZATION IMPERATIVE.
1. BECAUSE OF LOW PER CAPITA INCOME, ABSOLUTE ENERGY CONSUMPTION IS LOW. HOWEVER, THE LITTLE ENERGY THAT IS USED IS UTILIZED INEFFICIENTLY.

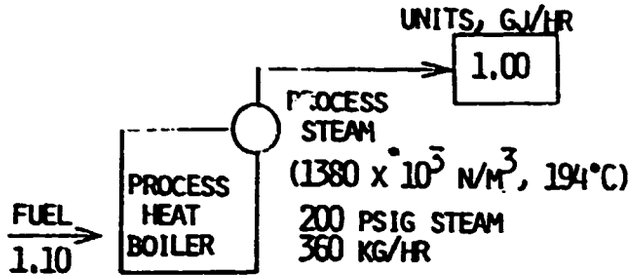
PERCENTAGE INCREASE IN ENERGY FOR SOME OF THE WELL-KNOWN EQUIPMENT/PROCESSES OVER AND ABOVE THOSE IN DEVELOPED COUNTRIES

	PERCENTAGE
1. TRANSPORTATION SECTOR	
(A) FREIGHT	25 TO 35
(B) PERSONAL TRANSPORT	10 TO 25
2. BOILERS (INDUSTRIAL)	25 TO 60
3. FURNACES (INDUSTRIAL)	150 TO 300
4. DRYING OPERATION	60 TO 150
5. HEATING AND COOLING	60 TO 200
6. LIGHTING	25 TO 40
7. EVAPORATION	50 TO 300
8. POWER GENERATION	25 TO 40

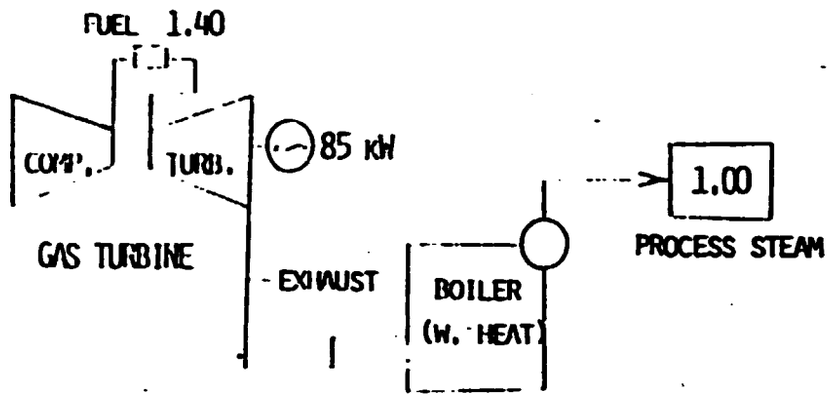
THE ONLY EXCEPTION IS AGRICULTURAL SECTOR.



ELECTRICITY GENERATION ONLY



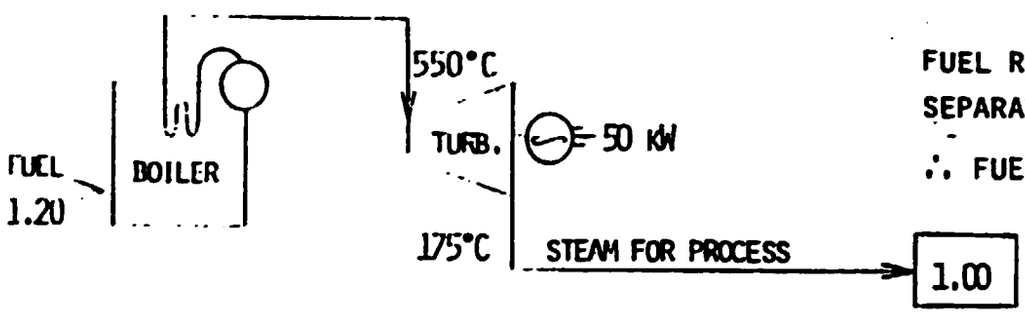
STEAM GENERATION FOR PROCESS HEAT ONLY



FUEL REQUIRED IF GENERATED SEPARATELY IS 2.10.

∴ FUEL SAVINGS = 30%

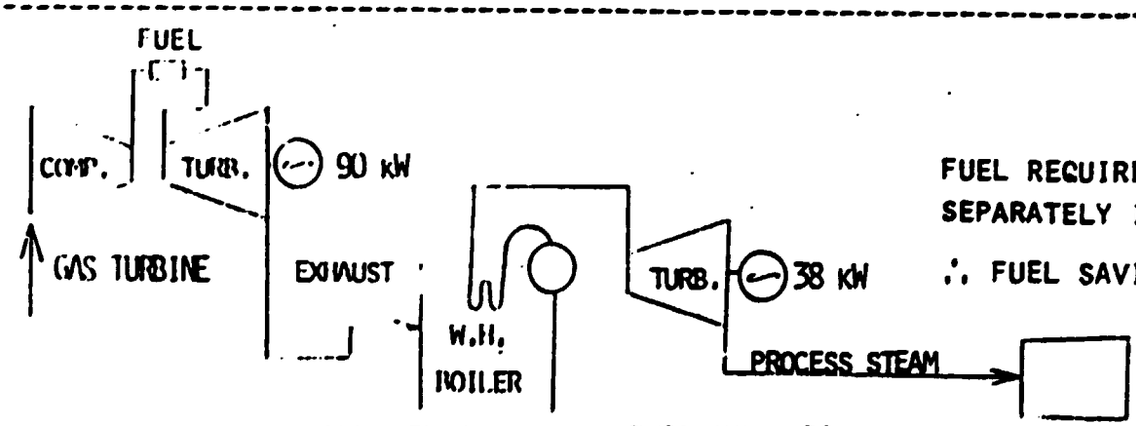
GAS TURBINE - STEAM GENERATION CYCLE



FUEL REQUIRED IF GENERATED SEPARATELY IS 1.7.

∴ FUEL SAVINGS = 30%

COMBINED STEAM TURBINE - STEAM GENERATION

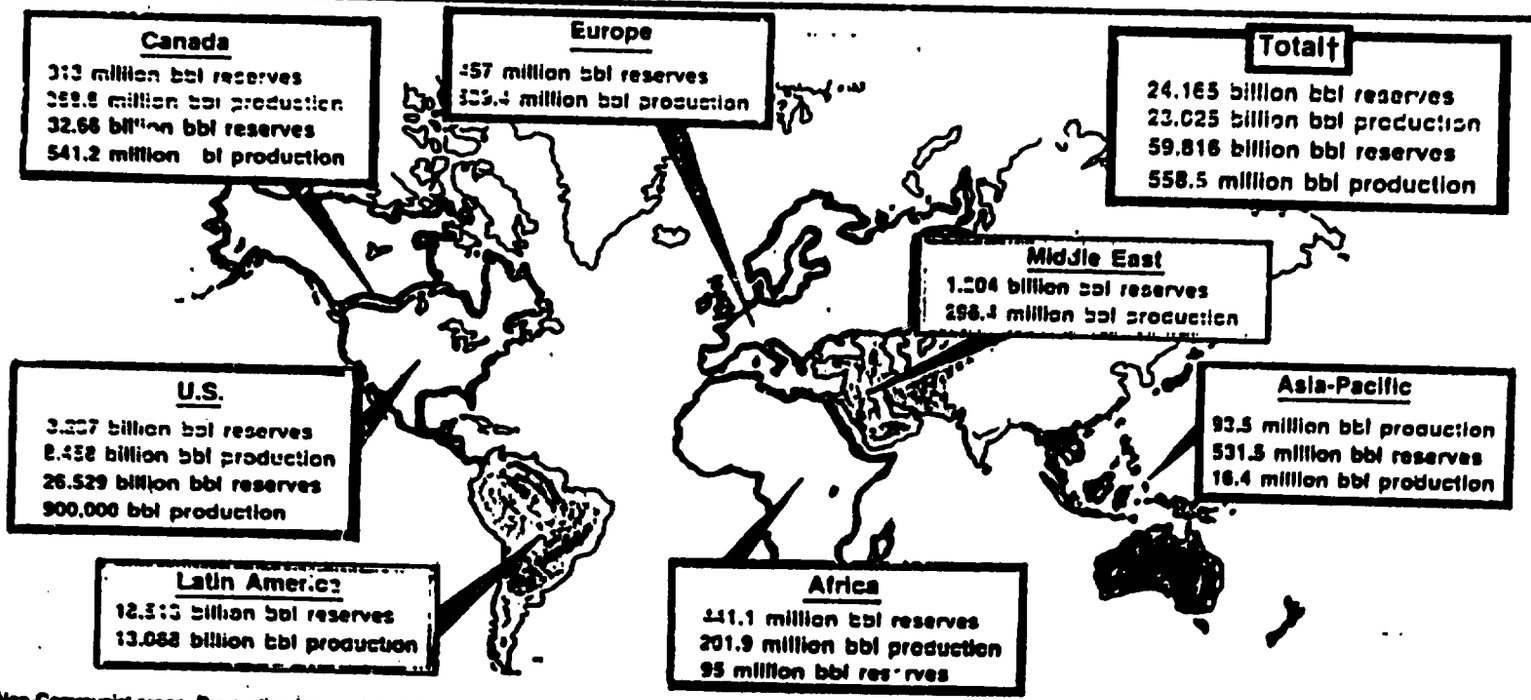


FUEL REQUIRED IF GENERATED SEPARATELY IS 2.5.

∴ FUEL SAVINGS = 40%

COMBINED GAS-STEAM TURBINE STEAM GENERATION

World heavy crude, bitumen reserves, production*



*Non-Communist areas. Production is cumulative. Figures in blue are heavy and extra heavy crude. Figures in [illegible] are bitumen.
†Totals may not add due to rounding.
Source: Unitar/UNDP Information Center for Heavy Crude and Tar Sands

CORPORATE EFFICIENCY = (MANAGEMENT EFFICIENCY) × (TECHNOLOGICAL EFFICIENCY)

OBJECTIVE OF MANAGEMENT: TO MAXIMIZE PROFIT OR SURPLUS.
1. BY HAVING A CLOSE ON EFFECTIVE CONTROL OVER ALL INDECENOUS FACTORS OF PRODUCTION.
2. ELIMINATING ALL FORMS OF WASTE.

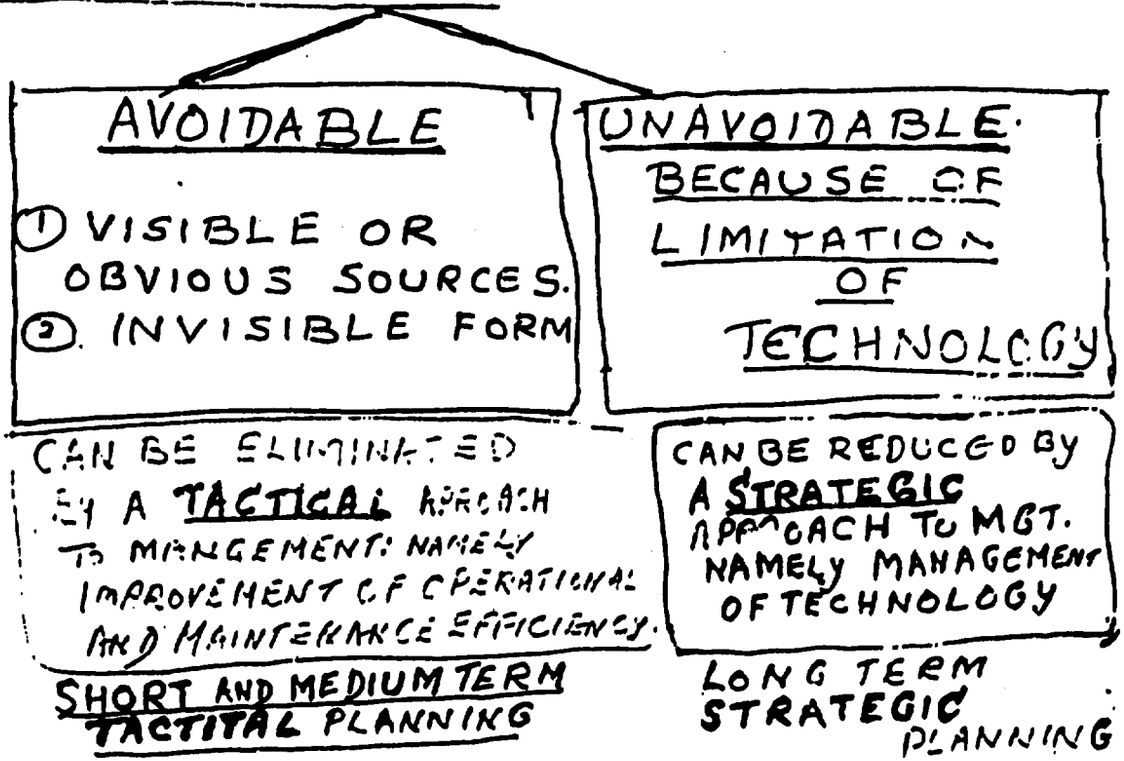
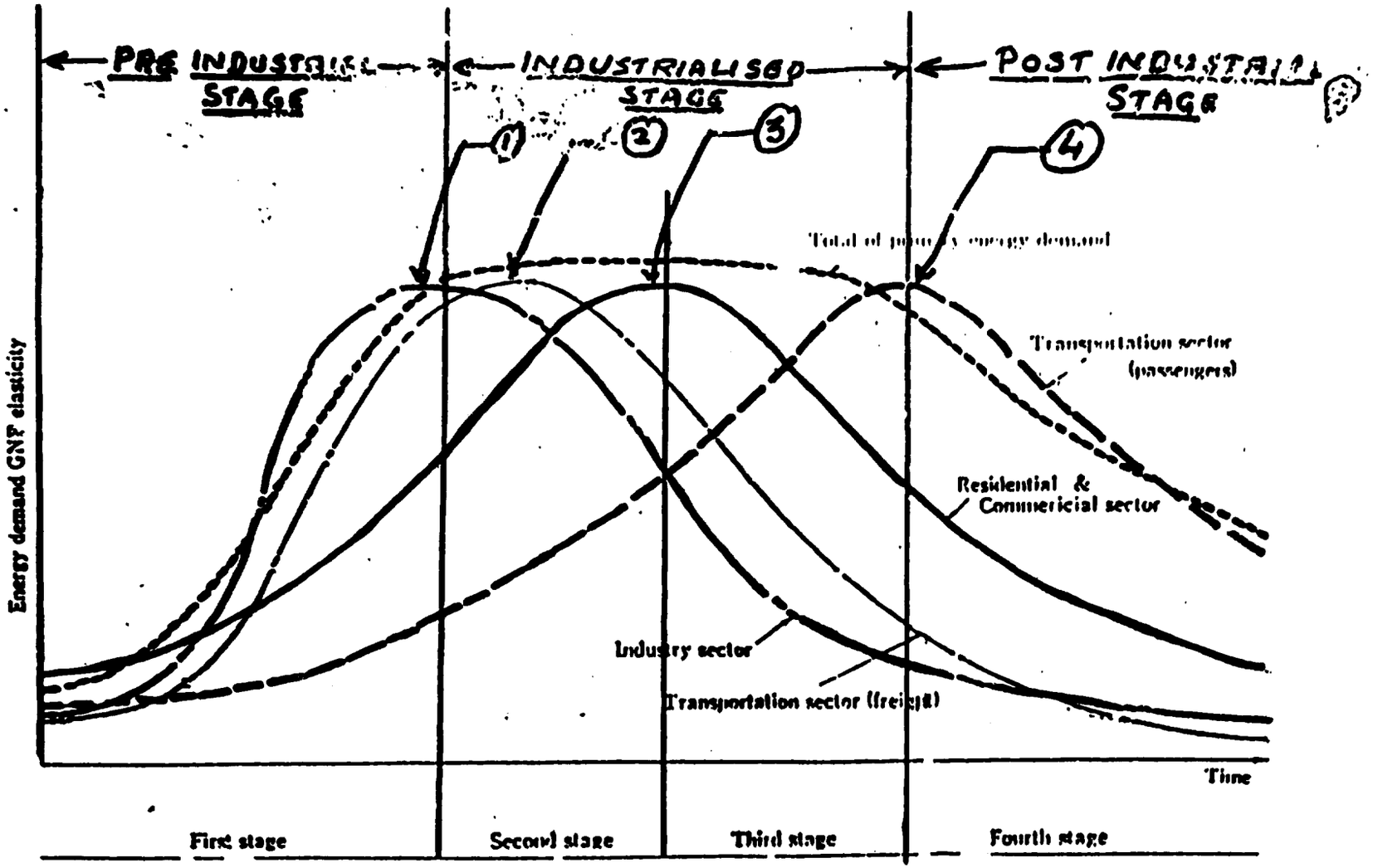


Table 3.1 General Principles of Energy Management

Principle	Relative Cost	Relative Time to Implement	Relative Complexity	Relative Benefit (Typical)
1. Review historical energy use (review of historical data)	Low	1 year	Low	5-10%
2. Energy audits (review of current practices)	Low	1 year	Low	5-10%
3. Housekeeping and maintenance	Low	1 year	Low	5-15%
4. Analysis of energy use (engineering analysis, computer simulation, availability studies)	Low to moderate	1-2 years	Moderate to high	10-20%
5. More efficient equipment	Moderate to high	years	Moderate to high	10-30%
6. More efficient processes	Moderate to high	years	Moderate to high	10-30%
7. Energy containment (heat recovery and waste reduction)	Low to moderate	years	Moderate to high	10-50%
8. Substitute material	Low to moderate	1 year	Low	10-20%
9. Material economy (scrap recovery, salvage, and recycle)	Low	1-2 years	Low to High	10-50%
10. Material quality selection (material purity and properties)	Low	1 year	Low	5-15%
11. Aggregation of energy uses	Moderate to high	years	Moderate to high	20-50%
12. Cascade of energy uses	Moderate to high	years	Moderate to high	20-50%
13. Alternative energy sources (energy form or fuel substitution)	Moderate to high	years	Moderate to high	10-30%
14. Energy conversion	Moderate to high	years	Moderate to high	10-30%
15. Energy storage	Moderate to high	years	Moderate to high	10-30%
16. Economic evaluation (cost benefit, rate of return, life-cycle costing)	Low	1 year	Low	5-15%



Conceptual Pattern of Limping Energy Demand GNP Elasticity by the Sector

ORDER OF RESPONSE TO ENERGY CONSERVATION MEASURES.

FIRST: INDUSTRIAL SECTOR.

SECOND: FREIGHT TRANSPORTATION SECTOR.

THIRD: COMMERCIAL AND RESIDENTIAL SECTOR.

FOURTH: PERSONAL TRANSPORTATION SECTOR.

THE TWO ASPECTS OF ENERGY CONSERVATION

FIRST LAW ANALYSIS

CONCERNED WITH:

(1) MAPPING OR TRACING ENERGY FLOWS IN A SYSTEM. I.E. TO DRAW A HEAT BALANCE.

(2) IDENTIFICATION OF AVOIDABLE SOURCES OF WASTAGE OF ENERGY,

LEADING TO:

A TACTICAL APPROACH
INVOLVING MANAGERIAL AND
TECHNICAL MEASURES
OF
SHORT AND MEDIUM TERM
NATURE (1 TO 3 YEARS)
WITH
MARGINAL CAPITAL INVESTMENT.

SECOND LAW ANALYSIS

CONCERNED WITH:

(1) IDENTIFYING SOURCES WHERE WORK IS DEGRADED INTO HEAT.

(2) EXAMINING THE EXTENT TO WHICH WORK AND HEAT DEMAND COULD BE INTEGRATED,

LEADING TO:

A STRATEGIC APPROACH
INVOLVING MAJOR TECHNOLOGICAL
CHANGES OR INNOVATIONS
OF
LONG TERM NATURE
(5 TO 15 YEARS)
WITH
SUBSTANTIAL CAPITAL INVESTMENT.

THREE REGIMES OF ENERGY CONSERVATION PROGRAM

SHORT TERM MEASURES (1 YR OR LESS)

1. OPERATIONAL MEASURES
2. LITTLE OR NO CAPITAL INVESTMENT

PAYBACK = 1~2 YRS

MEDIUM TERM MEASURES (2~5 YEARS)

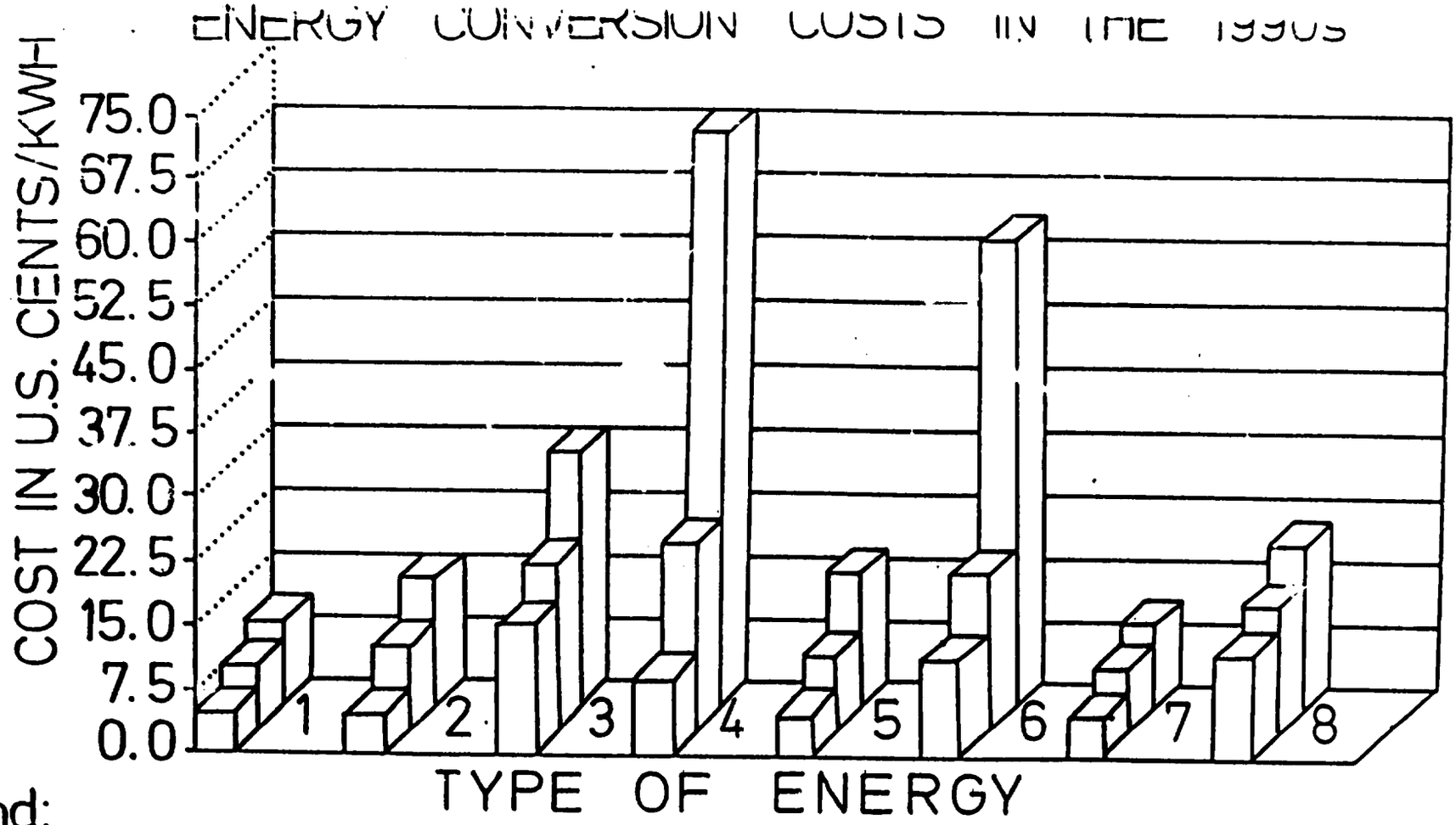
1. RETROFITTING & MINOR DESIGN CHANGES
2. MODERATE CAPITAL INVESTMENT

PAYBACK = 1~3 YRS

LONG TERM MEASURES (5~25 YEARS)

1. MAJOR CHANGE & MODERNIZATION PROGRAM
2. HEAVY CAPITAL INVESTMENT

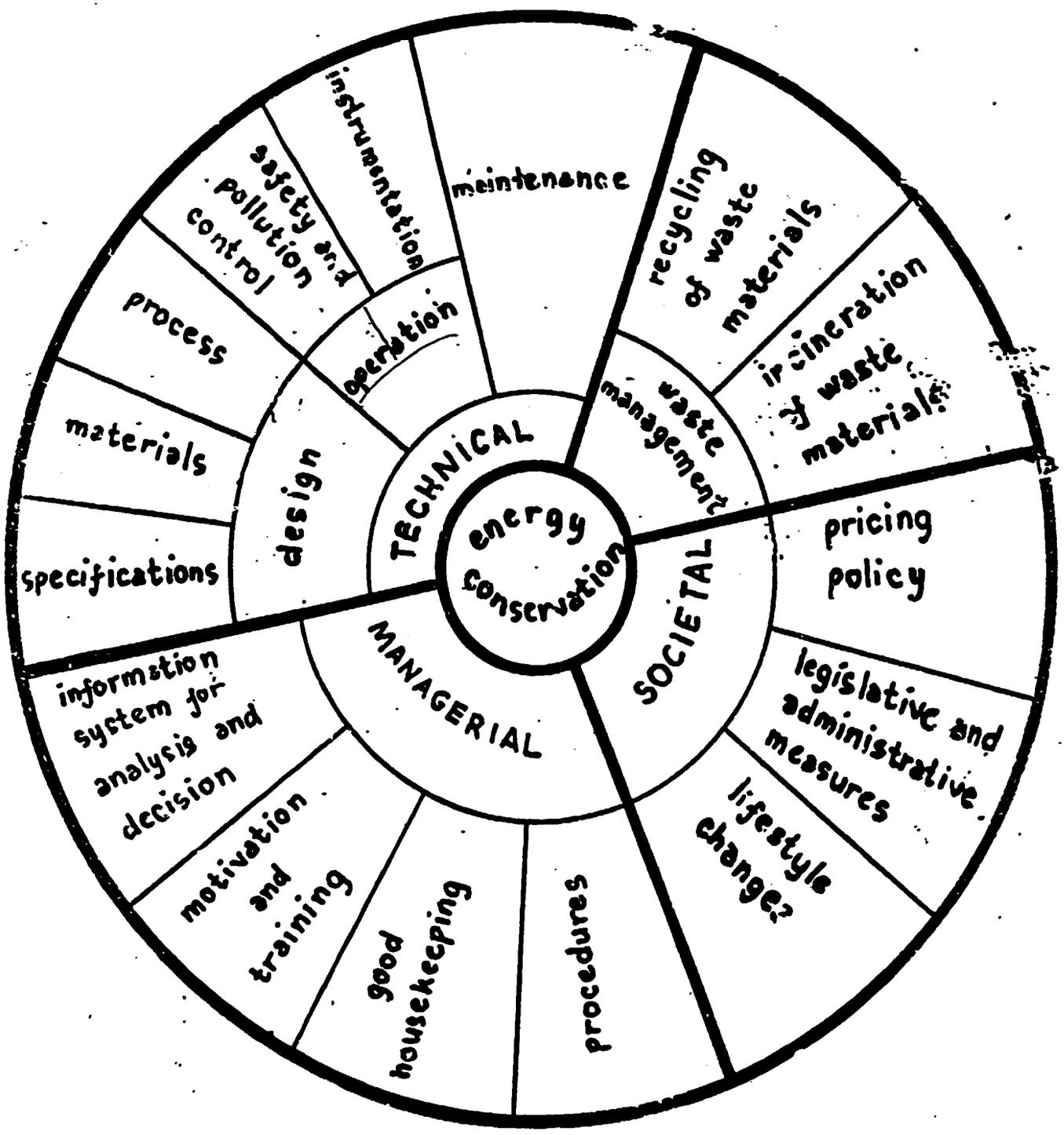
PAYBACK = 5~7 YRS



Legend:

- LEAST COST
- OPTIMUM COST
- MAXIMUM COST

1 Coal
2 Geothermal
3 Solar thermal
4 Solar electric
5 Wind
6 Fuel cell
7 Battery storage
8 Compressed-air storage


energy conservation
TECHNICAL
MANAGERIAL
SOCIETAL
design
operation
waste management
specifications
materials
process
safety and pollution control
instrumentation
maintenance
recycling of waste materials
incineration of waste materials
pricing policy
legislative and administrative measures
lifestyle change?
procedures
good housekeeping
motivation and training
information system for analysis and decision

Annex 9

LIST OF MANUALS/PUBLICATIONS ON ENERGY MANAGEMENT AND CONSERVATION

LIST OF PUBLICATIONS ON ENERGY MANAGEMENT AND CONSERVATION

1. Efficient Utilization of Steam and Condensate (Utilization of Steam for Process Heating)
2. Efficient Utilization of Steam and Condensate (Economics of Steam Usage)
3. Efficient Utilization of Steam and Condensate (How to Make the Best Use of Condensate)
4. Efficient Utilization of Compressed Air
5. How to Conduct an Energy Audit
6. Energy Conservation Considerations in Lighting and Air Conditioning Systems
7. Saving Energy in Vehicles
8. Saving Energy Through Efficient Combustion Control and Waste Heat Recovery
9. Waste Heat Management and Cogeneration
10. Energy Flow Measurements and Control System
11. Conserving Energy in Electric Motors, Pumps, and Compressors
12. Energy Conservation Laws
13. Guides to Quick Estimates of Energy Costs for Industrial Use
14. Guide to Retrofitting Oil-Fired Boilers, Kilns, and Other Furnaces to Use Alternative Fuels
15. The Industrial Energy Audit Manual
16. Energy Conservation Journal
17. Guides to Energy Conservation in the Food Processing Industry (for printing)
18. Guides to Industrial Preventive Maintenance for Energy Conservation (for printing)

~~19. Twelve (12) Manuals on Basic Engineering Practice as follows:~~

19 ~~a.~~ Drawing Office Procedures/Project Engineering Guidelines
20 ~~b.~~ Fluid Flow
21 ~~c.~~ Compressors and Pumps
22 ~~d.~~ Heat Exchange Equipment
23 ~~e.~~ Psychometry/Humidification/Cooling Towers/Driers
24 ~~f.~~ Woodfiring in Oil-Fired Boilers
25 ~~g.~~ Boilers and Furnaces
26 ~~h.~~ Refractories
27 ~~i.~~ Boiler Water Treatment
28 ~~j.~~ Steam Generating Unit Performance Evaluation
29 ~~k.~~ Industrial Cooling Water Treatment

Annex 10

ENERGY CONSUMPTION STATISTICS BY SECTOR

5.3.4.3 Health Facilities

Over the medium-term period, the capacity and capability of hospitals at the different levels will be upgraded to respond to the current and prospective needs of the community.

5.4 Energy

5.4.1 Overview

Since the quadrupling of oil prices in 1973-74, the Philippine energy sector has undergone an interenergy substitution process involving the development of indigenous energy sources for self-reliance. Oil has been partly replaced by coal, hydroelectric power, geothermal steam and nonconventional (mainly bagasse, agriwaste and dendrothermal) energy sources. Oil import dependence has been reduced to about 49.6 percent in 1985. The country has now the capability to displace more than a half of its commercial energy needs with nonoil sources.

A 620-megawatt nuclear power plant was constructed and completed in July 1985 to provide additional power to the Luzon grid. However, because of safety and environmental considerations, the nuclear plant has been mothballed. As a result of this decision, substitute power plants, i.e., Calaca II and Bacon-Manito, have to be constructed to avert a power shortage in Luzon in 1991.

The rural electrification program has expanded its coverage within the franchise areas of the 120 electric cooperatives. As of 1985, it had reached 1,255 municipalities and cities, 19,009 barangays and around 2.7 million households representing 45.6 percent of the total number of households. The rural electrification sector, however, is beset by deficiencies in the operating systems and procedures, as well as in the collection efficiency of the cooperatives.

Meanwhile, in 1986, oil prices substantially fell and there are indications that prices will remain soft for some time. Barring unforeseen political and security developments in the Middle East, prices within the range of US$18-20 per barrel are expected for the remainder of the decade. Realizing, however, that supplies of oil are exhaustible and irreplaceable in certain key economic functions, oil prices will tend to rise anew in the 1990s. This warrants the continued expansion of energy diversification and the continued promotion of oil exploration activities.

5.4.2 Objectives

The following are the primary goals in the energy sector:

(a) To ensure the availability of energy to the markets in the country at the most reasonable prices and to reduce the incidence of power interruptions.
(b) To promote the efficient and judicious use of energy.
(c) To accomplish the above with minimal adverse effects on the environment.

5.4.3 Targets

The total energy demand is estimated to grow by 3.8 percent per annum over the next six years, reaching 123.01 million barrels of fuel equivalent (MMBFOE) by 1992 from 98.52 MMBFOE in 1987. Energy use is expected to average at 1.73 barrels of fuel oil equivalent (BFOE) per capita in 1987 and 1.94 BFOE per capita in 1992. Oil import dependence will be further reduced from 49.6 percent in 1985 to 46.9 percent by 1992.

The indigenous energy supply mix will continue to rise from 47.15 MMBFOE in 1987 to 63.94 MMBFOE by 1992. Nonconventional energy will contribute 26.44 MMBFOE or 41.3 percent of total indigenous energy in 1992, while production of coal, hydro, geothermal and local oil is estimated at 13.71, 12.4 10.40 and 1.26 MMBFOE as shown in Table 10.19.

Table 10.19
ENERGY SUPPLY MIX
(In million barrels of fuel oil equivalent, MMFOE)

	1986		1987		1988		1989		1990		1991		1992	
	Vol.	Percent	Vol.	Percent	Vol.	Percent	Vol.	Percent	Vol.	Percent	Vol.	Percent	Vol.	Percent
INDIGENOUS ENERGY	43.65	45.06	47.15	47.86	50.13	48.60	52.74	48.99	54.70	48.42	60.38	50.90	63.94	51.06
I. CONVENTIONAL	24.40	25.19	27.06	27.47	28.97	28.09	30.37	28.21	31.08	27.51	35.42	29.86	37.51	30.49
Oil	2.45	2.53	1.66	1.68	1.33	1.29	.97	.90	.49	.43	1.62	1.37	1.26	1.02
Coal	3.55	3.66	6.20	6.29	7.25	7.03	8.50	7.90	9.56	8.45	11.35	9.57	13.71	11.15
Hydro	9.84	9.95	11.02	11.19	11.75	11.39	11.93	11.08	12.03	10.65	12.14	10.23	12.14	9.87
Geothermal	8.76	9.04	8.18	8.30	8.64	8.38	8.97	8.33	9.01	7.98	10.31	8.69	10.40	8.45
II. NONCONVENTIONAL	19.25	19.87	20.09	20.39	21.16	20.52	22.37	20.78	23.62	20.91	24.96	21.04	26.43	21.49
Bagasse	4.49	4.64	4.69	4.76	4.83	4.78	5.20	4.83	5.48	4.85	5.79	4.88	6.13	4.98
Agrowaste	14.33	14.79	14.27	15.19	15.72	15.24	16.58	15.40	17.50	15.49	18.46	15.56	19.57	15.91
Biogas	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.04	.03	.04	.03
Producer gas	.16	.17	.16	.16	.17	.16	.18	.17	.19	.17	.21	.18	.23	.19
Others	.24	.25	.24	.24	.31	.30	.38	.35	.42	.37	.46	.39	.46	.37
IMPORTED ENERGY	53.22	54.94	51.37	52.14	53.01	51.40	54.92	51.01	58.27	51.58	58.24	49.10	59.07	48.02
Oil	49.80	51.41	48.77	49.50	50.21	48.68	53.24	49.45	56.42	49.94	57.81	48.74	57.74	46.94
Coal	3.42	3.53	2.60	2.64	2.80	2.71	1.68	1.56	1.85	1.64	.43	.36	1.33	1.08
TOTAL ENERGY	96.87	100.00	98.52	100.00	103.14	100.00	107.66	100.00	112.97	100.00	118.62	100.00	123.01	100.00
Growth rate, % p.a.		2.28		1.70		4.69		4.38		4.93		5.00		3.70
Power use, % of total volume	37.08	38.28	40.17	40.77	43.48	42.17	45.55	42.31	48.96	43.36	51.71	43.59	54.29	44.13
Share in power use, %	11.72	31.61	12.36	30.77	13.38	30.77	14.80	32.49	17.23	35.18	18.57	35.91	16.87	31.07

Source of base data: DEA

The share of oil-based electricity in total power use will decrease from 34.1 percent in 1985 to 31.1 percent by 1992. This will be achieved through the use of coal and geothermal as the energy sources of new power plants to be constructed during the Plan period. The bulk of power mix will be sourced from hydro and geothermal, accounting for 41.5 percent in 1992.

The cumulative installed generating capacity of power plants will expand from 6,546.4 megawatts (MW) in 1987 to 7,050.1 MW in 1992, due to the commissioning of Bacon-Manito and Calaca II by 1992 as shown in Table 10.20. The effective generating capacity of existing oil-fired plants will likewise increase as soon as they are overhauled and rehabilitated.

Meanwhile, the rural electrification program will expand its coverage in 1992, servicing 1,395 municipalities and cities, 32,111 barangays and 4.0 million households. The percentage share of households electrified is targeted to increase from 52.0 percent in 1987 to 65.0 percent in 1992 as shown in Table 10.21.

To meet the targeted six-year energy program, the total public investment requirement for 1987-92 is expected to reach ₱70,983 million. A large part of the investments will be concentrated in the power development sector, amounting to ₱57,893 million, followed by the energy resource development activities. The energy agencies and corporations will explore schemes to harness greater amounts of private capital toward energy projects to reduce the amount of public investment.

Of the total financing, ₱48,694 million or 60 percent will be sourced from foreign funding and the balance will come from local sources, including funding and the balance will come from local sources, including the internal cash generation of the corporations, local loans, and the government and private equity.

The six-year energy program is expected to create about 42.7 million man-days of employment, of which 26.5 million or 62 percent will go into construction activities, while 16.2 million man-days or 38 percent will be utilized in operations.

5.1.4 Policies and and Strategies

There shall be a continued fuel diversification and development of indigenous resources although to a much reduced degree than in the past decade. The policy thrusts and strategies of the sector are as follows:

(a) Completion of energy projects that are now in the "committed" stage of implementation. These are among the more economical and least capital intensive sources of energy to meet demand during the period. The Philippine Nuclear Power Plant-1 (PNPP), however will not be operated with nuclear power. A comprehensive study will be conducted to determine the technical and economic feasibility of operating the non-nuclear components as a coal-fired power plant.

(b) Rehabilitation of existing oil-fired thermal plants to increase effective generating capacity and improve reliability.

(c) Review of the efficiency of the sector at all stages of production, transportation, distribution and consumption to increase load factors and capacity utilization, reduce costs, and maintain affordable prices.

(d) Continuance of viable energy conservation programs and projects.

(e) Restructuring of the power rates to reflect the financial and economic costs of generating, transmitting, and distributing power, taking into account the long-term marginal cost principle, as well as pricing of domestic petroleum products in consonance with international oil prices.

(f) Streamlining and improvement of operations of electric cooperatives and utilities to reduce system losses and increase efficiency of service.

Table 10.20
CUMULATIVE INSTALLED GENERATING CAPACITY
(In megawatts, except %)

	Program 1986	Percent share to total	Targets						Percent share to total
			1987	1988	1989	1990	1991	1992	
Hydro	2,132.30	33.03	2,221.30	2,235.30	2,254.30	2,275.30	2,297.30	2,.. .30	32.59
Coal[a]	534.70	8.28	534.70	534.70	534.70	534.70	534.70	934.70	13.26
Geothermal	894.00	13.85	894.00	894.00	894.00	894.00	1,004.00	1,004.00	14.24
Oil	1,925	29.82	1,925	1,925	1,925	1,925	1,925	1,925	27.30
Diesel	778.30	12.06	773.30	733.70	675.00	675.00	675.00	675.00	9.75
Nonconventional	191.10	2.96	196.10	205.10	210.10	214.10	214.10	214.10	3.04
Total	6,456.40	100.00	6,546.40	6,527.80	6,493.10	6,518.10	6,650.10	7,050.10	100.00

a. Coal capacity may be displaced by at least 110 MW of geothermal power plant if steam exploration is successful by late 1987.
Source of basic data: OEA.

Table 10.21
CUMULATIVE TARGETS FOR RURAL ELECTRIFICATION

	Program 1986	Targets					
		1987	1988	1989	1990	1991	1992
Municipalities/cities	1,303	1,357	1,395	1,395	1,395	1,395	1,395
Barangays	19,798	20,569	22,168	24,290	26,680	29,376	32,111
Households, in thousands	2,739	2,829	2,929	3,129	3,379	3,679	3,979

Source of basic data: NEA.

(g) Reduction of new public investments in the sector by inviting private capital in the construction and operation of energy projects, such as "build and operate" schemes for new power plants, and joint ventures for coal and geothermal development projects.

(h) Maintenance evaluation and implementation procedures pertaining to environmental factors for all projects.

5.5 Communication

5.5.1 Overview

The telecommunications network, which is handled by both the government and the private sector, consists of some 55 telephone companies, seven domestic record carriers, four international record carriers, and two satellite systems (both domestic and international). The companies operate 216 telephone exchange stations, 2,131 telegraph main stations and substations, and 122 telex main stations and substations. Duplication and redundancies exist in most of these systems.

5.5.1.1 Telecommunications

About 73 percent of the total number of telephones in the Philippines are concentrated in Metro Manila and 27 percent in major cities and municipalities. While there are 5.73 main telephone lines per 100 persons in Metro Manila the telephone density is under 1.02 for the whole country. this is less than the 2.0 per 100 in Asia and below the less than 3.0 in developing countries. In addition, service quality still remains poor.

The record carriers duplicate in most areas. The private record carriers serve 22 percent of the 1,559 municipalities nationwide, while the government serves 82 percent of the municipalities with rudimentary, open wireless high-frequency facilities.

The telecommunications sector is highly segmented and fragmented by service, technology and geography. This imbalance has resulted in an overall lack or absence of adequate and reliable telecommunications services in the other urbanizing municipalities and population centers of the country.

5.5.1.2 Postal Communications

There are 2,106 post offices operating in the country, of which 123 are housed in buildings owned by the government. The rest are housed in rented or donated office spaces and buildings. Complementing these are 12 mail distribution centers, two submail distribution centers, and five central post offices. The construction of one mail distribution center is ongoing.

Recent improvements in mail distribution and processing systems, training, postal equipment, infrastructure and labor productivity have resulted in a significant upgrading of mail delivery service quality. Compared with the previous mail delivery performance of 3-4 days in Metro Manila (only 6 percent in 24 hours), and up to 10 days in the provinces, mail is now delivered as follows: 75-80 percent of Metro Manila mail delivered within 24 hours, and interprovincial mail in three days.

5.5.2 Objectives

The objective of the communications sector is the provision of adequate, efficient and economical telecommunication services, and the improvement of the quality of postal services.

5.5.2.1 Telecommunications

The major objectives in the communications sector are as follows:

(a) To rationalize the telecommunications industry;

(b) To provide adequate and efficient telecommunications services and facilities that will connect all municipalities to all parts of the country and the rest of the world;

1980 SPECIFIC ENERGY CONSUMPTION PERFORMANCE OF THE INDUSTRY SECTOR

PRODUCT	PRODUCT UNIT	SPECIFIC ENERGY CONSUMPT (BOE/Unit)
GLASS	MT	1.87 - 2.32
MINING:		
1. Chromite	DMT	0.32 - 0.38
2. Copper	DMT	3.67 -11.48
3. Gold	MT	58.471 -69.625
4. Nickel silicate	WMT	0.027 - 0.288
PETROLEUM:		
1. Crude oil	barrel	0.039 - 0.043
2. Petroleum refining	-do-	0.040 - 0.044
3. Lube oil refining	-do-	0.535 - 0.725
PULP AND PAPER	MT	2.17 - 9.52
RUBBER TIRES/PRODUCTS	MT	3.623 - 5.166
SUGAR	MT	3.321 -10.434
TEXTILE	MT	5.58 -27.87
WOOD	CU.M.	0.103 - 1.926

Table 7
1986 SPECIFIC ENERGY CONSUMPTION PERFORMANCE
OF THE INDUSTRY SECTOR

PRODUCT	PRODUCT UNIT	SPECIFIC ENERGY CONSUMPTION (MOE/Unit)
CEMENT:		
1. Wet process	MT	1.28 - 1.35
2. Dry process	MT	0.90 - 1.65
CERAMICS	MT	3.472 - 3.984
CHEMICALS:		
1. Activated carbon/ carbon black	MT	2.88 - 3.54
2. Alcohol	KL	0.479 - 4.747
3. Alkylbenzene	MT	1.46
4. Calcium carbide	MT	6.601 - 9.081
5. Fatty alcohol/ Refined glycerine	MT	3.88
6. Ferro silicon	MT	15.227 -16.121
7. Lime	MT	1.04
8. Oxygen/acetylene	Standard cylinder	0.046 - 0.066
9. Polypropylene films	MT	5.062 - 5.953
10. PVC films/sheets	MT	1.776 - 2.376
11. PVC resin	MT	1.004 - 1.150
12. Sodium tripolyphosphate/ tetrasodium pyrophosphate	MT	0.686 - 0.834
13. Solid/liquid silicates	MT	0.792 - 1.513
14. Urea/phenolformaldehyde	MT	0.537 - 2.112
COCONUT/VEGETABLE OILS	MT	0.203 - 1.571
FOOD/BEVERAGE:		
1. Banana	MT	0.08
2. Beer	Thousand cases	2.37 - 3.14
3. Flour	MT	0.13 - 0.18
4. Liquor	Thousand cases	0.941 - 3.215
5. Milk/milk products	KL	0.199 - 0.406
6. Fresh cow's milk	MT	0.25 - 0.31
7. Monosodium glutamate	KL	0.54
8. Pineapple	MT	15.83 -18.03
9. Poultry feeds	MT	0.130 - 0.176
10. Soft drinks	Thousand cases	6.76 - 7.07
	MT	0.04 - 0.11
	Thousand cases	1.17 - 1.28

TABLE 6
1996 REPORTED ENERGY SAVINGS AND INVESTMENTS BY SECTOR

SECTOR	No. of Reporting Cos.	Annual Savings (Million P)	Total Investments (Million P)
CHEMICALS	4	4 191	0 865
COCONUT/VEGETABLE OIL	2	3 667	0 190
FOOD PROCESSING	5	39 087	26 077
GLASS	5	12 153	2 520
MINING	9	67 268	16 510
POWER GENERATION	1	0 391	0 105
PULP AND PAPER	1	0.130	0 100
STEEL AND METAL	3	16 853	37 211
SUGAR	4	0 756	1 288
TEXTILE	2	20 324	14 286
WOOD	3	2 658	1 786
TOTAL	39	167 518	101 239

LIST OF CONSULTS AUDITED
1996

CEMENT

Prime Matter Cement Corp.

FOOD PROCESSING

New Sunrise Coconut Products
Food Fun Bakeries, Inc. (DA)*

POWER GENERATION

Semirara Coal Corp. (PA & DA)
UPC Calaca Coal Thermal Plant
UPC Naga Coal Thermal Plant

STEEL METAL

Pacific Metals Co., Ltd. (DA)
Pacific Metals Co., Ltd. - Laguna (DA)
Capitol Steel Corp.

PAPER

Batangas Pulp and Paper Mills (DA)

FOOD

Central Azucarera de Bais

FOOD PROCESSING

Victorias Corp. (DA)
Asia Brewery Inc. (DA)
SMC Pilsen Brewery Inc.

BUILDINGS

Admiral Hotel
Rustan's Commercial Corp.
Office (Dec
Hotel Intercontinental
PLDT Bldg., East Ave.
University of Sto. Tomas
(DA)
PAL Inflight Center Bldg.
PAL Data Center Bldg.
PAL Office Bldg., Makati
PLDT Office Bldg., Makati
NMYC (DA)
Rustan's Commercial Corp.
(Cebu)
Cebu Plaza Hotel (Cebu)
Cebu Country Club (Cebu)

OTHERS

Sterling Products Int'l.,
Inc.
AC' Fiberglass Inc. (DA)
Sime Darby (DA)
Goodyear Tire & Rubber Co.
Loyola Memorial Chapels
Telefunken Semi-conductors
Advanced Micro Devices
Mitsu Mining Corp.
Consolidated Canning/
Plastic Cont. Corp.
Bundaberg Rattan Corp. (Cebu)
Atilio's Rattan and Wood
Industry (Cebu)
Royal Match, Inc. (Cebu)
Industry (Cebu)
Machine Industries Corp.
(Cebu)
Shemberge Marketing (Cebu)
Virginia Farms (Cebu)

*DA - Detailed audits, all others are preliminary audits (PA).

IN-PLANT ENERGY BRIEFINGS
1986

		DATE	NO. OF PARTICIPANTS
1.	"Energy Management and Preventive Maintenance" Semirara Coal Corp.	February 19 - 20	25
2.	"Coal Utilization" National Power Corp.	February 3	10
3.	"Combustion Technology" Armco - Marsteel - Taguig	March 5 - 7	20
4.	"Preventive Maintenance" Capitol Steal	November 14	5
5.	"Energy Management" Kustan's (Cebu)	November 20	15
6.	"Energy Management" Mindanao Rattan	November 22	6
7.	"Energy Management"	November 24	15
8.	"Energy Management" Rubberworld	November 26	15
9.	"Safety in Electrical Systems" Phil. Fisheries Dev. Corp.	December 4	30
10.	"Energy Management" University of Sto. Tomas	December 9	20
		TOTAL	161

Annex 1.1

LIST OF 88 COMPANIES AUDITED DURING THE PROJECT PHASE

LIST OF COMPANIES AUDITED

1983

Paper Processing

Canlubang Abaca Pulp Mill

Textile

Filipinas Textile Mills, Inc.

Mining

Benguet Corporation - Gold Operations

Sugar

Hawaiian-Philippines
Central Azucarera de la Carlota

Commercial Buildings

Philippine Daily Express Building

1984

Textile

Universal Robina Corporation
Central Textile Mills
Yupangco Cotton Mills, Inc.
Textiber Corporation
Indo-Phil Textile Mills

Chemical/Chemical Products

Consolidated Industrial Gases, Inc.
Universal Robina Corporation -
Detergent Plant
Edward Keller (Phil.) Inc.
Holden Products, Inc.
Polyphosphates, Inc.
Johnson and Johnson (Phils.) Inc.
Lakeview Industrial Corporation

Ceramic Manufacturing

[illegible] Ceramics
Royal Porcelain Corporation

Steel/Metal

Hooven-Comalco Industries
SMC - Metal Closure Plant
V-H Manufacturing

Mining

Irisan Lime Kilns

Food Processing

Wyeth Suaco Lab., Inc.
SMC - Magnolia Dairy Products
Cosmos Bottling Company
KI-M Corporation
SMC - Magnolia Poultry Products
Continental Milling Corporation
Universal Robina Corporation - Candy and
Cereal Plant
CFC Corporation
Universal Corn Products
SMC B-Meg Plant
Pepsi Cola Bottling Company
[illegible] Baker
SMC - San Fernando Brewery
SMC - Polo Brewery

Commercial Buildings

Manila Metropolitan Theater
Century Park Sheraton Hotel
Ruslan Commercial Corporation
PISO Bank
Phil. Long Distance & Telephone Co.
Asian Institute of Tourism
National Manpower Youth Council
Manila Hotel
Regent of Manila
Manila Mandarin Hotel
Manila Garden Hotel
Energy Research & Development Center
NEPI
Manila Hilton
Development Academy of the Philippines
Holiday Inn
Pilar Building
Hotel Intercontinental

Glass

ACI Fiberglass
Pacific Enamel and Glass Company

Sugar

Canlubang Sugar Estate
Insular Sugar Refining Corporation

Paper

Kimberly Clark Phil., Inc.

Others

Phelps Dodge Phil., Inc.
American Wire & Cable
SMC - Carton Plant
CARCO
Motorola

1985

Chemical/Chemical Products

Borden International (Davao)
Fuller Paint Manufacturing Co.
Integral Chemicals
Pacific Products, Inc.
Vinyl Products, Inc.

Steel/Metal

AG & P (Batangas)
AG & P (Manila)*
Armco-Marsteel*
Cebu Shipyard and Engineering Works
Goodyear Steel Pipe Corporation
M.A. Foundry, Inc.
PASAR Corporation

Food Processing

Asia Brewery Inc.
Coca-Cola Bottling Co. (Davao)
Coca-Cola Bottling Co. (Laguna)*
Coca-Cola Bottling Co. (Paco)*
Pacific Flour Mills
Pepsi-Bottling Co. (Cebu)
Pepsi-Bottling Co. (Davao)
Wrigley Phils., Inc.

Coco-Vegetable Oil

Central Vegetable Oil Manufacturing Co., Inc.
Franklin Baker (Davao)
Legaspi Oil (Davao)
New Sunripe Coconut (Candelaria,
New Sunripe Coconut (Magdalena)

Power Generation

Davao Light and Power Company

Sugar

Central Azucarera de Don Pedro

Paper

Container Corporation of the Philippines
United Pulp and Paper Company

(Jointly conducted with the National Engineering Center (NEC)

Mining

Benguet Corporation
Lepanto Mining
Itogon Suyoc Mines, Inc.

Buildings

Ministry of Energy Building
National Manpower & Youth Council
Philippine Village Hotel
Urdaneta Apartments
Ostrea Mineral Lab.
Rosario Investments
Benguet Center Building
PISO Bank
NEDA Building
Residential House
Asian Institute of Tourism
Others: Transport Training Center$
NEC Building$
Philippine Development and Industrial Corporation
Hydro-Pipes Phils., Inc.
Alhambra Industries, Inc.
Adamson & Adamson, Inc.
STANFILCO
Polycon Manufacturing Corp.
Manila Cordage Company
Panama Plastics
RAMCAR
PHILEC
Manila Plastic Products

Phil. Japan Activated Carbon
Philippine Fisheries Development Authority*
Universal Textile*
Filipinas Textile*
Stanwood
C. Alcantara and Sons
Pioneer Ceramics, Inc.

Cement

Central Cement Corporation
Filipinas Cement Corporation (Pasig)
Filipinas Cement Corporation (Teresa)
Davao Union Cement

1986

Cement

Prime White Cement Corp.

Coco - Vegetable Oil

New Sunripe Coconut Products
Franklin Baker Co. (DA)*

Power generation

Semirara Coil Corp. (PA & DA)
NPC Calaca Coil Thermal Plant
NPC Naga Coil Thermal Plant

Steel Metal

Armco-Marsteel - Novaliches (DA)
Armco-Marsteel - Taguig (DA)
Capitol Steel Corp.

Paper

Bataan Pulp and Paper Mills (DA)

Sugar

Central Azucarera de Tarlac

Food Processing

Vitarich Corp. (DA)
Asia Brewery Inc. (DA)
SMC Polo Brewery Inc.

Buildings

Admiral Hotel
Rustan's Commercial Corp. Office (DA)
Hotel Intercontinental
PLDT Bldg. , East Ave.
University of Sto. Tomas (DA)
PAL Inflight Center Bldg.
PAL Data Center Bldg.
PAL Office Bldg., Makati
PLDT Office Bldg., Makati
NMYC (DA)
Rustan's Commercial Corp. (Cebu)
Cebu Plaza Hotel (Cebu)
Cebu Country Club (Cebu)

Others

Sterling Products Int'l., Inc.
ACI Fiberglass Inc. (DA)
Sime Darby (DA)
Goodyear Tire & Rubber Co.
Loyola Memorial Chapels
Telefunken Semi-conductors
Advanced Micro-Devices
Atlas Mining Corp.
Consolidated Canning/Plastic Cont. Corp.
Mindanao Rattan Corp. (Cebu)
Alillo's Rattan & Wood Industry (Cebu)
Royal Match, Inc. (Cebu) Industry (Cebu)
Marlin Industries Corp. (Cebu)
Shemberge Marketing (Cebu)
Virginia Farms (Cebu)

1987

1. Central Azucarera de Don Pedro
   Nasugbu, Batangas
2. Capitol Medical Center
   Quezon Blvd.,Q.C.
3. Dyne-Sem Electronics Corp.
   Taguig Metro Manila
4. Central Knitting
   San Juan Metro Manila
5. PLDT East Avenue, Q.C.
6. Philex Mining Corp.
   Benguet
7. Limpscourt
8. Davao Insular Hotel
   Davao City
9. Davao Doctor's Hospital
   Davao City
10. Davao Union Cement Corp.
    Davao City
11. Cebu Oxygen Acetylene Co.
    Lanang Davao City
12. Consolidated Plywood Inc.
    Panacan Davao City
13. Hotel Maguindanao
    Davao City
14. San Pedro Hospital
    Davao City
15. Johnny Manila Textile
    Davao City
16. Davao Coca - Cola Plant
    Davao City
17. Borden Int'l Phil., Inc.
    Davao City
18. Alcantara & Sons Inc.
    Davao City
19. Earnsun Ltd.
    Davao City
20. Office of Energy Affairs Bldg.
    Fort Bonifacio, Makati, Metro Manila
21. Royal Match Co.
    Mandaue City, Cebu
22. Everready Battery
    Mandaue City, Cebu

Annex 12

MEASURES ADOPTED TO SAVE ENERGY

REPORTED ENERGY SAVINGS & INVESTMENTS FOR 1983

(Result of Follow Up Survey by BEU)

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings ₹	Investment ₹	Payback Period (yrs.)
Cement	2	1. Conversion from Liter oil to Coal Firing 2. Upgrading of kiln capacity 3. Proper start-up of electrical machineries 4. Proper scheduling of operating equipment	440,991	0	-
Chemicals/Chemical Products	3.	1. Lowered discharge pressure of utility air compressors 2. Proper scheduling of motor start-up 3. Proper scheduling of cooling water pumps 4. Reduced running time of deepwell 5. Relocated photo switches for lighting 6. Furnace insulation 7. Reduced impeller diameter of cooling water return pump 8. Automatic ON-OFF operation of pumps; elimination of stand pumps 9. Exhaust heat recovery 10. Insulation of steam lines 11. Use of diesel/butane fuel mix for spray dryer 12. Flue gas monitoring 13. Installation of level switch for deepwell pumps 14. Upgrading of lighting distribution 15. Installation of flue-gas analyzer.	1,223,314	270,700	0.2

REPORTED ENERGY SAVINGS & INVESTMENTS FOR 1984

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings ($)	Investment ($)	Payback Period (yrs.)
Coconut/Vegetable Oil	4	1. Mixed used oil with bunker fuel for boiler use	3,333,373	253,275	0.07
		2. Steam leak prevention			
		3. Condensate recovery			
		4. Proper operation & maintenance of boiler			
		5. Modification of drives of cake elevator/lift & Screw conveyor			
		6. Sequencing of copra elevators			
		7. Redesigning of condensate recovery system			
		8. Used oil recovery			
		9. Installation of small copra day bin			
		10. Optimization of Powders and Glycerine Evaporation operations			
		11. Provision of Individual steam pressure reducers for the deodorizer vacuum systems.			
		12. Improvement in Steam Generation and Utilization			
Electric Power Generation	2	1. Rehabilitation of boiler and turbo-generator	5,387,423	7,633,505	2.3
		2. Minimized aircon usage			
		3. Proper maintenance of vehicles			
		4. Skylighting			
		5. Waste oil recovery			
		6. Used fluorescent lamps for streetlighting			
Fertilizer	1	1. Replaced oversized motors with smaller units	89,231	40,000	0.4

REPORTED ENERGY SAVINGS & INVESTMENTS FOR 1981

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings ($)	Investment ($)	Payback Period (yrs.)
Glass	1	1. Installation of additional automatic switch/control for freight elevator motor drive	1,[illegible],323	113,331	0.1
		2. Waste heat recovery			
		3. Use of compressed air from centralized air systems instead of using portable compressor in spray painting			
		4. Switching off the 33-KVA transformer, 8 Drinking fountains after office hours			
		5. Use of water spray & air dryer instead of electric driven washing & drying machine for glass louvers processing			
		6. Conversion of furnace water cooling tower from forced draft to atmospheric type			
		7. Elimination of induced draft blower in boiler water cooling tower with the installation of water sprays and revision in operation			
		8. Increase use of cullet in furnace			
		9. Reduction in reversal time of furnace firing system			
		10. Conversion of forklift from gasoline to LPG			
		11. Used oil recovery			
Food Processing	5	1. Minimized aircon usage	13,513,283	5,919,930	0.4
		2. Installation of capacitor bank			
		3. Shift from self-generated power to gov't. electric power			
		4. Installation of used-oil purifier			

REPORTED ENERGY SAVINGS & INVESTMENT FOR 1984

	Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings	Investment ($)	Payback Period (yrs.)
			5. Conversion from steam ejector to motor driven vacuum pump			
			6. Replacement of steam traps			
			7. Installation of fuel economizer for boiler			
			8. Installation of translucent roofings			
			9. Insulated cookers, mixing tank.			
			10. Replaced incandescent lamps with fluorescent lamps			
			11. Installation of mesh cone wind deflectors on 90-ft. van trailers			
			12. Installation of timer switch for staff houses			
			13. Installation of traction preheat for 2-ton plant boiler			
			14. Installation of 3-frame falling film evaporator			
			15. Used oil recycling			
			16. Switching off lights at meetings			
			17. Installation of solar water heater			
			18. Replacement of waste blower with bucket conveyors			
9.	Mining	1	1. Waste oil recycling	$3,113,170	$2,333,248	0.4
			2. Modification to waste heat recovery boilers			
			3. Pre-mixing of Gel chemicals drilling mud before pouring into the mud tank hence needs no additional diesel fuel			
			4. Minimized energy consumption & operating cost of coal feeding system to boilers			
			5. Recycling unburned/combustible coal fly ash			
			6. Reducing pumping interval of shovels & drills			
			7. Conversion of service vehicles from gasoline to LPG			

REPORTED ENERGY SAVINGS & INVESTMENTS FOR 1981

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings ($)	Investment ($)	Payback Period (yr.)
Petroleum	2	Condensate recovery, equipment modification	22,219,577	8,589,545	0.4
Pulp and Paper	3	1. Conversion of steam generating unit from oil to solid fuel, 2. Revision of steam distribution condensate removal and recovery	8,518,161	22,000,000	2.497
Steel & Metal	3	1. Replacement of all worn-out burner parts. 2. Use of hi-sun lamps in street lighting; 3. Close control sinter screen plates, 4. Installation of inside partition on ignition furnace. 5. Reduction of conditional air supply using corridors/lobby 6. Power factor improvement 7. Auxiliary oil filter 8. Conversion of mechanical draft to natural draft cooling tower 9. Reduction in operating hours of all air-conditioning units. 10. Change of air intake of compressors to cooler location 11. Monitoring of production performance based on standard specific energy consumption ratios.	44,900,239	70,000	0.0015

REPORTED ENERGY SAVINGS & INVESTMENTS FOR 1981

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings (₹)	Investment (₹)	Payback Period (yrs.)
Sugar	5	1. Use of exhaust steam to replace live steam being used by processing units.		313,333	
		2. Used of baled sugar cane trash as supplementing fuel			
		3. Partial use of bagas as supplementing fuel			
		4. Scheduling the use of live steam by users to minimize peak drawings of steam			
		5. Steam trapping			
		6. Maximum turbogeneration operation			
		7. Steam line insulation			
		8. Lube oil consumption monitoring			
		9. Technical training for lube technicians & mechanics			
		10. Extension of sugar bin belt conveyor			
		11. Schedule brown-outs for residential power supply			
		12. Sterilization of molasses west is done by chlorination instead of using steam			
Textile	5	1. Elimination of torch blowing in Greigeroom.	22,461,136	13,325,633	0.6
		2. Replacement of thin insulation of pipeline of hot thermal oil			
		3. Shutdown of 168 kw drive-air compressor during partial plant operation, instead, using 15KW-drive air compressor.			

REPORTED ENERGY SAVINGS & INVESTMENT FOR 1984

Sector	No. of Reporting Cos.	Implemented Measures	Annual Savings ($)	Investment ($)	Payback Period (mo.)
		4. Installation of cooling tower to recycle the cooling water of co-generation plant condensate.			
		5. Insulation of hot air piping & drying machine			
		6. Minimization of steam wastes by repair of leaks, repair/replacement of malfunctioning steam traps, insulation of hot steam lines.			
		7. Reduction of lighting and			
		8. Minimization of water leaks thru repair/ replacement of defective valves, faucets and fittings.			
		9. Acquisition of co-generation plant			
		10. Utilization of single steam boiler			
		11. Maintaining high power factor & use of capacitors			
		12. Maintain efficient operation of boilers			
		13. Soft water recovery systems			
		14. Switching of air conditioning unit during third shift			
		15. Reduction of lighting load			
		16. Reduction of waste disposal costs			
		17. Sun drying of enamel paint			
		18. Boiler economizer/condensate recovery			

Annex 13

SPECIFIC ENERGY CONSUMPTION OF DIFFERENT INDUSTRIES

EMCS PROJECT
POTENTIAL SAVINGS IDENTIFIED
October 1983 - December 1985

Sector	No. of Companies	Estimated Annual Savings	
		Fuel (FOEL)	FOREX (U.S.$)
Textile	6	983,620	173,216
Chemical/Chemical Products	12	2,790,[illegible]1	491,478
Ceramics	2	1,702,960	299,982
Steel/Metal Processing	10	3,098,650	545,674
Mining	5	982,615	173,039
Food Processing	22	8,070,129	1,421,155
Glass	2	1,246,900	219,580
Sugar	5	26,980,186	4,751,228
Paper Processing	4	1,385,008	243,901
Cement	4	2,495,000	439,371
Power Generation	1	523,300	92,153
Coco-Vegetable Oil	5	4,006,115	705,479
Commercial Buildings	31	1,836,992	323,495
Others	24	1,705,640	300,364
T O T A L	133	57,908,006	10,180,025

EMCS PROJECT
POTENTIAL SAVINGS IDENTIFIED
October 1983 - December 1985

Sector	No. of Companies	Estimated Annual Savings	
		Fuel (FOEL)	FOREX (U.S.$)
Textile	6	983,620	173,216
Chemical/Chemical Products	12	2,790,891	491,478
Ceramics	2	1,702,960	299,982
Steel/Metal Processing	10	3,098,650	545,674
Mining	5	982,615	173,039
Food Processing	22	8,070,129	1,421,155
Glass	2	1,246,900	219,580
Sugar	5	26,980,186	4,751,228
Paper Processing	4	1,385,008	243,901
Cement	4	2,495,000	439,371
Power Generation	1	523,300	92,153
Coco-Vegetable Oil	5	4,006,115	705,479
Commercial Buildings	31	1,836,992	323,495
Others	24	1,705,640	300,364
T O T A L	133	57,808,006	10,180,025

POTENTIAL SAVINGS IDENTIFIED
(1985)

Sectors	No. of Companies	Estimated Annual Savings	
		Fuel (FOEL) 1/	Forex (US$) 2/
Cement	4	2,495,000	439,371
Chemical/Chemical Products	5	1,745,451	307,375
Coco-Vegetable Oil	5	4,006,115	705,479
Food Processing	8	1,068,750	188,208
Paper	2	1,110,008	195,473
Power Generation	1	523,300	92,153
Sugar	1	6,840,000	1,204,528
Steel/Metal Processing	7	1,091,950	192,293
Mining	3	328,815	57,905
Commercial Buildings	13	782,044	137,718
Others	18	922,150	162,391
TOTAL	67	20,913,583	3,682,894

Notes: 1/ Fuel Oil Equivalent Liters (FOEL)
2/ At US $20/bbl; 159 liters bbl

ENERGY AUDIT
POTENTIAL SAVINGS IDENTIFIED
1986

SECTORS	NO. OF COMPANIES		ESTIMATED ANNUAL SAVINGS	
	PA	DA	FUEL (FUEL)	FOREX (US$)
Cement	1	-	83,500	7,200
Coco-Vegetable Oil	1	1	1,121,200	96,677
Power Generation	3	1	11,599,000	1,000,140
Steel/Metal	1	2	1,811,800	156,225
Paper	-	1	1,086 600	93,694
Sugar	1	-	5,314,400	458,242
Food Processing	1	2	19,992.200	1,723,856
Buildings	9	3	3,685,500	317,787
Others	14	2	331,900	28,618
TOTAL	31	12	45,024,100	3,882,439

Notes: Fuel Oil Equivalent liters (FUEL)
At US $ 13.71/661 (Ave. CIF Prices, Crude Oil, Jan. - Oct. 1986);
159 liters/661

EMCS PROJECT
POTENTIAL SAVINGS IDENTIFIED
October 1983 - December 1986

SECTOR	NO. OF COMPANIES	ESTIMATED ANNUAL SAVINGS	
		FUEL (FOEL) 1/	FOREX (U.S.$) 2/
TEXTILE	6	983,620	108,446
CHEMICAL/CHEMICAL PRODUCTS	12	2,790,891	307,700
CERAMICS	2	1,702,960	187,753
STEEL/METAL PROCESSING	13	4,910,450	541,304
MINING	5	982,615	108,335
FOOD PROCESSING	25	28,062,329	3,093,991
GLASS	2	1,246,900	137,472
SUGAR	6	32,294,586	3,560,523
PAPER PROCESSING	5	2,471,608	272,498
CEMENT	5	2,589,500	284,283
POWER GENERATION	5	12,122,300	1,336,501
COCO-VEGETABLE OIL	7	5,127,315	565,294
COMMERCIAL BUILDINGS	43	5,522,492	608,862
OTHERS	40	2,037,540	224,642
T O T A L	176	102,834,106	11,337,684

1/ FOEL means Fuel Oil Equivalent Liters
2/ At $17.53/BBL; 1 BBL = 159 Liters

ESTIMATED POTENTIAL SAVINGS
1986

SECTOR	COMPANY	POTENTIAL ANNUAL SAVINGS, FOEL
CEMENT	Prime White Cement Corp.	83,500
COCO-VEGETABLE OIL	New Sumitomo Coco-Products	1,058,900
	Franklin Baker Co.	62,300
POWER GENERATION	Semirara Coal Corporation	11,599,000
	NPC Calaca Coal Thermal Plant	N.E.
	NPC Naga Coal Thermal Plant	N.E.
STEEL/METAL	ARMCO-Marsteel-Novaliches	1,084,800
	ARMCO-Marsteel-Taguig	650,000
	Capitol Steel Corp.	77,000
PAPER	Bataan Pulp and Paper Mills	1,086,600
SUGAR	Central Azucarera de Tarlac	5,314,400
FOOD PROCESSING	Vitarich Corporation	134,000
	Asia Brewery Inc.	1,032,900
	SMC Polo Brewery	18,825,300
BUILDINGS	Admiral Hotel	N.E.
	Ruston's Comm'l. Corp. (Office)	16,500
	Hotel Intercontinental	2,151,500
	PLDT Bldg. East Avenue	611,300
	Univ. of Sto. Tomas	621,500
	PAL Inflight Center Bldg.	N.E.
	PAL Data Center Bldg.	32,900
	PAL Office Bldg., Makati	48,200
	PLDT Office Bldg., Makati	203,600
	MMYC	N.E.
	Ruston's Commercial Corp. (Cebu)	N.A.
	Cebu Plaza Hotel (Cebu)	N.A.
	Cebu Country Club (Cebu)	N.A.
OTHERS	Sterling Products International	12,700
	ACI Fiberglass Inc.	86,400
	Sime Darby	146,000
	Goodyear Tire & Rubber Co.	81,800
	Loyola Memorial Chapels	5,000
	Telefunken Semi-Conductors	N.E.

SECTOR	COMPANY	POTENTIAL ANNUAL SAVINGS, FUEL
	Advanced Micro-Devices	N.E.
	Atlas Mining Corp.	N.E.
	Consolidated Canning/ Plastic Cont. Corp.	N.E.
	Mindanao Rattan Corp. (Cebu)	N.A.
	Atillo's Rattan and Wood Ind. (Cebu)	N.A.
	Royal Match Inc. (Cebu)	N.A.
	Mackie Industries Corp. (Cebu)	N.A.
	Shemberg Marketing (Cebu)	N.A.
	Rubberworld Phil. (Cebu)	N.A.
	Virginia Farms (Cebu)	N.A.
	Total Estimated Savings	45,026,100

1) FUEL means Fuel Oil Equivalent Liters
2) N.E. means No Estimate
3) NA means Not Available (Still waiting for copies of report from Cebu Division)

[illegible] TABLE
ESTIMATED POTENTIAL SAVINGS
1986

SECTOR	COMPANY	POTENTIAL ANNUAL SAVINGS, FOEL
CEMENT	Prime White Cement Corp.	83,500
COCO-VEGETABLE OIL	New Sunrise Coco-Products	1,058,900
	Franklin Baker Co.	62,500
POWER GENERATION	Semirara Coal Corporation	11,599,000
	NPC Calaca Coal Thermal Plant	N.E.
	NPC Naga Coal Thermal Plant	N.E.
STEEL/METAL	ARMCO-Marsteel-Novaliches	1,084,800
	ARMCO-Marsteel-Taguig	650,000
	Capitol Steel Corp.	77,000
PAPER	Bataan Pulp and Paper Mills	1,086,600
SUGAR	Central Azucarera de Tarlac	5,314,400
FOOD PROCESSING	Vitarich Corporation	134,000
	Asia Brewery Inc.	1,032,900
	SMC Polo Brewery	18,825,300
BUILDINGS	Admiral Hotel	N.E.
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	Rustan's Commercial Corp. (Cebu)	N.A.
	Cebu Plaza Hotel (Cebu)	N.A.
	Cebu Country Club (Cebu)	N.A.
OTHERS	Sterling Products International	12,700
	ACI Fiberglass Inc.	86,400
	Rimo Darby	146,000
	Goodyear Tire & Rubber Co.	81,000
	Loyola Memorial Chapels	5,000
	Telefunken Semi-Conductors	N.E.

SECTOR	COMPANY	POTENTIAL ANNUAL SAVINGS, FUEL
	Advanced Micro-Devices	N.E.
	Atlas Mining Corp.	N.E.
	Consolidated Canning/ Plastic Cont. Corp.	N.E.
	Mindanao Rattan Corp. (Cebu)	N.A.
	Atillo's Rattan and Wood Ind. (Cebu)	N.A.
	Royal Match Inc. (Cebu)	N.A.
	Mackie Industries Corp. (Cebu)	N.A.
	Shemberg Marketing (Cebu)	N.A.
	Rubberworld Phil. (Cebu)	N.A.
	Virginia Farms (Cebu)	N.A.
	Total Estimated Savings	45,026,100

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ENERGY AUDIT
POTENTIAL SAVINGS IDENTIFIED
1986

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