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**UNITED NATIONS DEVELOPMENT
ORGANIZATION (UNIDO)**

Project DP/INS/88/024

**INSTITUTION OF PREVENTIVE MAINTENANCE SYSTEMS
IN INDONESIAN INDUSTRY**

FINAL REPORT

BY DGS INTERNATIONAL N.V.

under UNIDO contract N° 90/103

-1

November 1990

BO: *Mr. Ishchenko*

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS**1. INTRODUCTION**

The Government of Indonesia has given high priority to the development of the engineering industries, both in terms of quantitative as well as of qualitative growth.

Improved productivity and international competitiveness are important requirements in the context of the emphasis which the Government puts on import substitution and on the enlargement of exports of manufactures.

Major problems that prevent the improvement of Indonesian industrial production today are a.o.:

1. the lack of proper maintenance systems, which in turn could improve productivity, quality, efficiency and safety and could decrease pay-back time for installed equipment, energy consumption and negative pressure on environment.
2. inadequate and inefficient training of manpower in the field of maintenance .
3. unawareness of national investors and senior management of the importance of maintenance.
4. lack of consulting capacity in the country to assist industry in developing maintenance systems in the plants.

On the request of the Government a UNDP/UNIDO preparatory assistance has been approved. A specialized consultant (DGS INTERNATIONAL), on behalf of UNIDO, has been fielded from august 24 till November 15 1990 . The objective of this mission was to make an in-depth study concerning the maintenance problems in 18 selected enterprises in Jakarta, Surabaya and Medan belonging to the subsector of the engineering industries. Moreover it was expected that the mission makes recommendations for improvement, together with a plan of action and the formulation of a project document for further UNDP/UNIDO assistance.

The consultants confirm that lack of maintenance management systems in the visited plants is a major constraint to reach the objectives put forward by Government. Moreover it generates high direct and indirect maintenance costs, reduces efficiency of production and shortens life-time of production equipment.

The consultants recommend to undertake quick action in following fields :

- the development of maintenance policy and strategies, both on national as well as on plant levels
- the development of national consulting, technical assistance and training capabilities
- the introduction of managed maintenance systems in industry
- the development of human resources for maintenance especially on management and supervisory levels.

2. ASSESSMENT OF THE PRESENT SITUATION

The prevailing technical problems, as have been stated in Indonesian industry, can be classified into 4 groups :

1. The production equipment

Production output ranges from 33-80% of nominal capacity.

Quality of final products are often below international standards.

Availability of equipment varies from 40 to 80%.

High downtime of production equipment has been stated in several plants, due to as many various reasons as there are lack of orders, lack of production planning, lack of machine-operators, high degree of breakdowns due to machine failures.

In case of plant extension, non-respect from original plant lay-out and material flow design, resulting in poor general lay-out and difficulties to master/rationalize production process.

the selected new equipment is in line with modern technology, nevertheless almost no measures are taken to ensure maintenance : no standardization, poor maintainability, poor adequacy to local circumstances of operation, insufficient maintenance instructions, no training for maintenance staff on the new machine etc.

Cleanliness and order have been considered as good in only 20% of the plants much of the damage to machines and major part of production losses are the result of either poor /erroneous maintenance methods or due to wrong operation.

2. Maintenance organization and management

Maintenance is not considered as a productive function and therefore poor attention is paid to its organization and resources. Awareness concerning the importance of maintenance both on micro- as well as on macro-level is very low.

In 55% of the plants, organized maintenance is non-existent, in 30% there is some repair and systematic lubrication and in 15% maintenance is really part of the organization but must be improved.

Organization charts hardly exist or their efficiency is low. Maintenance crews are headed by the production departments resulting in poor coordination and lack of time to execute maintenance works.

In 80% of the visited plant, maintenance activities are limited to trouble-shooting, repair and ad hoc lubrication. Only in 20% of the plants medium and long term operations are scheduled but even in this case, planning office was systematically understaffed and qualification too low.

Managed maintenance systems incl. equipment monitoring, cost control, systematic preventive and predictive maintenance are techniques which are in general absent.

MIS (management information systems) for maintenance do almost not exist. Data collection in terms of worked hours and consumed spares is not done. Even technical statistics, when they are registered, are often erroneous and cannot be used as a management tool. As this is the basis for computerization of maintenance management, an important work still has to be done upstream. It has been estimated that about 20% of the visited plants are ready for introduction of computerized systems.

3. Material resources

Due to a lack of technical documentation or an inadequate distribution of it, maintenance interventions are done by memory or based on previous experience or by trial and error. Even if instructions exist, they are hardly understood (language problems) or are not followed at all. In many cases, documentation disappeared. In the case of procurement of new equipment, no systematic demand of documentation is done, based on detailed terms of reference.

Spare parts are a problem which has not been tackled properly: it starts with the selection of the parts (due to insufficient documentation), their erroneous designation/coding and non-efficient stock administration techniques. Poor storage conditions result in yearly losses in terms of value from about 15% of average stock value. Overstocking for some parts, stock-outs for badly needed parts, lack of stock analyses etc. are part of the picture. To this point one should not forget that spare parts and lubricants represent approx. 25 to 35 % of maintenance cost.

Workshops are generally well equipped, in some cases over-equipped. 80% of the machine-tools are less than 20 years old, which is young. They are in a good shape. Many plants do local manufacturing of spare parts but quality is too low (no respect of tolerances, no specifications concerning materials...). This results in repeated breakdowns causing serious damages to machines. Electrical repair work is done both in-house or through subcontracting. For maintenance of electronic devices, plants often call upon the services of manufacturers through their after sales services.

Tools and measuring instruments are available to a certain extent, but are in a bad shape or wrongly used. There is a lack of diagnostic facilities which are necessary for condition based maintenance. These facilities must still be introduced and personnel trained, both in the utilization as well as in interpretation of results.

4. Human resources

As personnel is mainly recruited for production purposes, maintenance staff, both in number and qualification does hardly meet the needs of the plants. Function and job descriptions are rare, manning tables are not established and maintenance department, when it exists, is often the "overflow" of inappropriate production personnel.

Training on execution level is limited to on-the-job training by supervisors resulting in no further improvement of quality standards.

Engineers and foremen are sent abroad for study tours, mainly when procuring new equipment. Upon their return insufficient dissemination of know-how is ensured.

Motivation problems of maintenance personnel are a very serious constraints for smooth functioning of maintenance department. Maintenance personnel hardly benefits from installed incentives-policies as the latter are more intended for production staff.

REMARKS

The mission has also visited 6 training centres and 3 testing centres.

Training is given in different maintenance trades such as machine-tooling, welding, pneumatics, hydraulics etc. Equipment maintenance is hardly considered, and training in maintenance management was only found in 1 centre. Training programs do not meet the needs of the industries, concerning maintenance practice.

Testing centres are rather well equipped but the poor activities illustrate their lack of credibility in the industries. One of the main problems of these centres is to attract experienced staff and to propose them sufficiently attractive conditions to stay at the centre. Only in this case the centres could gain credibility through competent staff.

3. CONCLUSIONS AND RECOMMENDATIONS

After in-depth analysis of the above assessment, the mission concludes :

1. the problem of maintenance in the Indonesian engineering industries is very serious. A lack of managed maintenance systems and of a maintenance - friendly environment is at the basis of many production losses. Moreover it results in reduced quality of final product, in increased production costs and in uncertain continuity of production. The latter are main conditions to be fulfilled in export-oriented industries. Finally a lack of maintenance reduces life-time of production equipment, endanger safety of personnel and environment.
2. the problems mentioned in previous chapter are interdependent: solving only one of them will not solve the maintenance problem as such. Actions should be undertaken to solve all problems, may be not at the same time, but according to a predetermined degree of priority.
3. based on previous and on-going experiences of the consultant in Indonesia, the problems which have been stated in the engineering industries subsector, are very similar in other sectors, such as other industrial subsectors, transportation, public works, agriculture, agro-industry, telecommunication, health, buildings, laboratories and testing centres etc.
4. the solution of these problems do not only depend on the equipment owners. Other economic sectors are involved, such as national education, labour legislation, banking, customs, imports etc. They often precondition the downstream operators.

Consequently, a solution to the maintenance problems in the subsector concerned, must be seen in a broader framework.

In fact, the design of a national industrial maintenance policy and related strategies, is strongly recommended. These should be based on sectoral and subsectoral strategies in relation with the current Indonesian Five years plan and in close coordination with on-going projects, upstream of maintenance (such as new investments, rehabilitation or restructuring projects)

A maintenance policy and related strategies for implementation in the concerned subsector should focus on following headlines:

1. Upgrading of existing situation through :
 - better awareness at all levels concerning the importance of maintenance
 - improved maintenance organization and management, including efficient Management Information system.
 - motivation and training of staff
 - improved work programs
 - upgraded material resources (technical documentation, spare parts, budgets)

2. Implementation of measures to safeguard the future through :
 - design of a long term policy for the development of human resources
 - design of an integrated computerization policy on company level, of which maintenance will only be a part of
 - participation of maintenance specialists in the whole project cycle when procuring new equipment or when planning new investments.

The mission has developed in the study-report, a plan of action, including an outline of the interrelations between them.

Nevertheless either which action will be undertaken, be it in one subsector or in different subsectors at the same time, somehow a coordinating body must exist.

Moreover, from the managerial and technical point of view an experienced know-how in introducing managed maintenance systems will therefore have to be developed.

A first step in the framework of what has been discussed above, and in order to participate in the solution of the most urgent problems, the mission recommends to develop national capabilities in the field of maintenance consulting and auditing, technical assistance and training.

A core-group of consulting engineers should be set up in the framework of a Maintenance Consulting Centre (MCC), which in turn could generate a spill-over effect through assistance to selected pilot plants in the industrial regions. Apart of an activity in the field of maintenance promotion, this MCC would provide services to industries in consulting, assistance and training.

As to the selection of pilot plants for this purpose, and based on the diagnostics done in 13 plants in the regions of Jakarta, Surabaya and Medan following tentative choice of pilot plants is proposed.: Barata (Surabaya), Gahard (Medan) and Bakhri (Jakarta). Individual agreements have still to be made with these companies.

In order to launch above actions it is further proposed to call upon the assistance of UNDP/UNIDO for an integrated project aiming at introducing managed maintenance systems in industries. The major elements of this proposal have been presented shortly hereafter. In addition, the mission has prepared a Project Formulation Framework and a Project Document, which are submitted together with the present report.

4. PROJECT PROPOSAL FOR UNDP/UNIDO ASSISTANCE**4.1 Objectives and outputs**

The overall objective of the project is enhanced productivity and efficiency of Indonesian industry. This will be reached through following immediate objectives and related outputs:

1. Immediate objective no.1

To create a nucleus of capability based at a Maintenance Consulting Centre (MCC), for establishing managed maintenance systems in Indonesian industry through advisory services and technical assistance, development of human resources and implementation of a promotion and awareness-raising program. This MCC is to be established through cooperation with MIDC and selected industrial enterprises and located at MIDC premises in Bandung with outreach mechanisms in Jakarta, Surabaya and Medan.

Output 1

A structure for maintenance consulting services (Maintenance Consulting Centre) in full operation at MIDC.

Output 2

A core group of consulting engineers at MIDC, composed of 11 specialists, which will be capable to provide consulting, assistance and training to the industry in the field of maintenance.

Output 3

A promotion and awareness-raising program concerning maintenance management and organization throughout the country initiated.

Output 4

A framework for periodic training of maintenance personnel introduced.

2. Immediate objective 2

To provide direct support to industrial enterprises in improving the production through implementation of managed maintenance systems.

Output 1

3 pilot plants (one in each region i.e. Jakarta, Surabaya and Medan), which will have received consulting and technical assistance to improve their production by 15 to 40 % through better maintenance management. These plants will become "models" for the demonstration and training purposes of the project.

Output 2

30 industrial enterprises (10 in each region), will be able to improve their production as result of participation in training programs and receiving ad hoc advice and technical assistance in the field of maintenance organization. (Improvement of production can reach 5 to 30 % depending on the kind and magnitude of services rendered)

3. Immediate objective 3.

Upgraded skill of 60 maintenance and management personnel in the field of maintenance management

Output 1

60 maintenance engineers and supervisory staff of industrial enterprises will have been initiated or specialized in organization and management of maintenance.

4.2 Institutional framework

The mission confirms that MIDC is an appropriate institution to host the project.

Nevertheless, in order to attract national counterpart staff with sufficient experience (4 senior engineers and 7 junior engineers), institutional arrangements should be made in order to ensure enough flexibility and autonomy of operation for the proposed consulting structure.

Various alternatives have been discussed during the mission, and are listed below. They need further analysis by all parties concerned in relation to their viability.

The consulting structure can either be integrated in existing institutions or must be created. Discussed alternatives :

1. Change decree of MIDC in order to become more autonomous
2. Create mixed company state/private companies, banks, development institutes etc., based at MIDC.
3. Create autonomous structure by special decree by Minister (cfr TSG from Worldbank IRP projec!)
4. Integrate structure in existing institution with sufficient autonomy
5. Create a foundation with concerned beneficiaries
6. Supply of experienced national counterpart staff by some interested state owned or private enterprises, which in turn will be selected as pilot plants to implement planned maintenance systems. This staff could than be integrated in existing structure described in one of the alternatives above.

4.3 Budgets

Following inputs both from Government as well as from UNDP are proposed:

Budget Component	National Inputs rupiahs	External Inputs US\$
BL. 19 Personnel	117.000.000	1.505.313
BL. 29 Subcontracts	-	973.890
BL. 39 Training	6.000.000	264.000
BL. 49 Material / Equipment	118.800.000	177.000
BL. 50 Miscellaneous	18.000.000	30.000
TOTAL	259.800.000	2.960.203

1 US\$ = 1850 rupiah

5. **THE SITUATION EXPECTED AT THE END OF THE PROJECT**

The implementation of the above proposed project will last 3 years. Following situation is expected to be achieved at the end of the project :

- a) Enterprises throughout the country will be sensitized on the importance of sound maintenance organization and management. Top management will be informed about maintenance strategies both on national and on enterprise levels.
- b) There will be established a core group of engineers and technicians based in MIDC, which will be able to provide consulting services and all kind of technical assistance in introduction of managed maintenance systems.

This entity should reach after 3 years a level of credibility and efficiency which must allow it to be accepted by the enterprises as specialized consultant. Its services will be charged to the enterprises at competitive rates for consulting services. Nevertheless, it will not be possible to remunerate certain activities such as those related to maintenance promotion and awareness-raising. A complementary financial input, at least during 1 to 2 years after the project, will be necessary by Government or interested enterprises.

- c) It is further estimated that through direct assistance to be provided through this project to selected enterprises, their production will increase for about 15 to 40 %. Production costs will be decreased by 10 to 30 %. The quality of many final products of assisted enterprises will be upgraded). Curricula for specialized courses on all aspects of maintenance management will be worked out and distributed to national polytechnic schools, universities and training centres.

I INTRODUCTION**A. SUBJECT OF THE MISSION**

Present document is the final report of the "Preparatory Assistance for Institution of Preventive Maintenance Systems in Industries". (DP/INS/88/024).

This assistance has been provided by UNDP/UNIDO to the Government of the Republic of Indonesia. UNIDO has subcontracted the professional services to DGS International (see TOR appendix 1) - contract 90/32.

The subcontractor has implemented his mission in the field in the period from 24th of August till 16th of November 1990. The final report has been prepared in DGS' offices from 17 November to 6 December 1990.

B. OBJECTIVE OF THE PREPARATORY ASSISTANCE

The main objective of the mission was to make an in-depth analysis of the maintenance situation in engineering industries and to formulate recommendations to the Indonesian Government aiming at improving this situation. Moreover, it was expected that the mission formulates proposals for a further UNDP/UNIDO technical assistance project, to promote and institute managed maintenance systems in the industry.

During the mission the subcontractor had to :

- audit about 20 preselected production units (industrial companies) located in the Jakarta, Surabaya and Medan regions
- analyse the existing maintenance organizations in these units
- analyse capacity and experience of training and testing centres in relation to maintenance management and diagnostics
- analyse capability of the MIDC to install a core-group for consulting and training in maintenance.

The mission also had to evaluate a tentative list of 21 companies in order to select 1 or 2 pilot enterprises at each location. These enterprises will receive during the project concentrated technical assistance for upgrading their maintenance system, so that they can be used subsequently as referral and demonstration centres for training and upgrading the other enterprises of the region.

C. IMPLEMENTATION OF THE MISSION**1. Programme**

- Briefing in Vienna (3-5 July 1990)
- Preparatory work at DGS office in Belgium (13-8-90 to 24-8-90) :
 - set-up of the implementation strategy of the project
 - preparation of the questionnaires to be used for plant auditing
 - practical preparation of the mission
 - definition of the relations between project coordination, field work and UNIDO/UNDP/Counterpart
 - review of UNIDO procedures concerning formulation of project framework and project document

- Fielding of experts : P.DE GROOTE : 24/8/1990 till 1/9/1990 and
3/11/1990 till 14/11/1990
R. DEBOYSER : 24/8/1990 till 14/11/1990
C. DECLERCQ : 03/9/1990 till 15/11/1990
- Discussions with Ministry of Industry, MIDC and industrial associations.
Final selection of plants to be visited (by P. De Groote and R. Deboyser from
27/8/90 till 05/9/90)
- Diagnostics in plants, training & testing centres (by C. Declercq and R.
Deboyser) :
 - in Surabaya from 06/9/90 till 15/9/90
 - in Jakarta from 17/9/90 till 22/9/90
 - in Medan from 24/9/90 till 29/9/90
 - in Jakarta from 1/10/90 till 6/10/90
- Formulation of conclusions and recommendations from 08/10/90 till
20/10/90 by C. Declercq and R. Deboyser.
- Preparation of framework and project document, from 22/10/90 till
06/11/90 (P. De Groote, C. Declercq and R. Deboyser).
- Final discussions with UNDP, UNIDO and Government from 06-14/11/90
- Redaction of draft final report at DGS' offices in Ghent from 16/11/90 to
6/12/90

The international experts have been assisted by following counterparts :

- Mr. ASLAM Director General of MIDC
- Mr. SUPANDI Senior Engineer at MIDC
- Mr. ACHMAD KOMARA Junior Engineer at MIDC

The list of persons met is added in appendix 2.

2. Methodology

2.1 *Definition*

The implementation of the present mission contained following steps :

- definition of terminology and preparation of questionnaires
- diagnostics in selected enterprises, institutions and organizations
- conclusions and recommendations - set up of project strategy and related
plan of action
- formulation of project framework and project document
- final report

The objective of UNDP/UNIDO's assistance project is to institute and
provide training on managed maintenance systems at enterprise level and
additionally to provide diagnostic and consulting services in maintenance

practice, so that both the engineering and management aspects are addressed.

2.2 *Terminology and questionnaires*

In the Indonesian Industry, the use of different terminologies for designing maintenance functions, has often been stated. Reasons for this situation originates from the multitude of suppliers of equipment originating from different countries world-wide and supplied with documentation in various languages. Chapter II (The Maintenance Function) contains the terminology and definitions of basic maintenance organization, used during this mission.

Appendix 3 gives a sample of the questionnaire. In appendix 4 details are given concerning DGS' methodology for maintenance audits.

2.3 *Audits in selected enterprises, institutions and organizations*

Aim of the audits was to assess :

1. the situation of maintenance practice and related links to various institutions in the country on various levels (national, sectoral, plant levels)
2. the situation of technical education and vocational training in the country
3. the situation of MIDC (including capacities, organization, facilities, etc.) in view of the development of national maintenance consulting services

II THE MAINTENANCE FUNCTION**A. THE ROLE OF THE MAINTENANCE**

The aim of the maintenance function is to assure the maximum availability of production equipment and utilities at an optimal cost, under satisfactory conditions of quality and safety.

The main objectives of the maintenance function are to :

- optimize reliability of equipment
- ensure continuously good functioning of the production equipment
- repair quickly any failure or break-down
- improve quality of production
- increase productivity of existing equipment and production capacity through modifications, extensions or small new constructions
- ensure operation of utilities
- improve work safety
- train personnel in the various specialized trades of maintenance
- give advice and assistance to the management and other departments of the plant

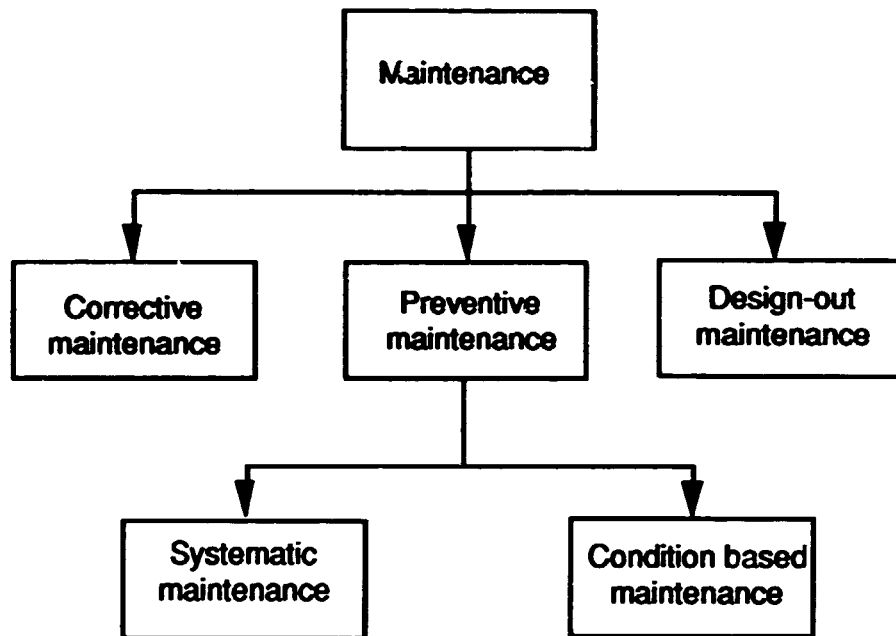
From this point of view the role of maintenance is substantially more important than that of a simple emergency or repair service : the maintenance function is a productive function and it is necessary to pay the same attention to it as to the operating function. Maintenance contributes not only towards assuring a continuity in production, a constant quality and a minimal cost of final product, but deals equally with the conservation of the equipment.

B. TYPES OF MAINTENANCE

In order to reach these objectives, maintenance will be put into practice in various forms :

- design-out maintenance (also called plant improvement maintenance) to design or adapt systematically the equipment in order to :
 - increase maintainability
 - ease operation
 - improve quality and quantity of final report
 - assure safety of personnel

The term "design-out" maintenance results from the objective in the design stage of an equipment to reduce maintenance work as much as possible.



- the principle of preventive maintenance is "anticipation" i.e. before a failure occurs. It consists of :

systematic maintenance : interventions at fixed periods (time-based or according to operating parameters) in order to :

- detect and prevent premature wear or failure
- limit reduction of life-time
- avoid bad operating conditions resulting in a decreased quality and quantity of production
- avoid or limit the risks of breakdowns of bottle-necks machines
- reduce unproductive time during overhaul or repair
- execute repair under better operating conditions
- avoid exaggerated consumption of spare parts and energy
- eliminate causes of severe damage and accidents
- reduce total workload of the maintenance department

It consists of :

- continuous inspections of the equipment
- systematic interventions in the framework of a predetermined programme
- various degrees of overhauls
- routine jobs such as lubrication, cleaning, adjustment, painting etc.

condition based maintenance : (also called "predictive maintenance) consists in monitoring the equipment during operation (by vibrations and sound analysis), leak and corrosion control, spectrometric oil analysis, thermography, ultrasonic controls, etc.).

By following-up the progress of analyzed parameters, an intervention program is set up, based on the "just in time" principle.

- corrective maintenance (also referred to as "breakdown maintenance"). It consists of interventions after breakdowns or failure through :
 - trouble shooting to put the equipment as soon as possible back into operation conditions (in most cases by replacement of a spare part)
 - repair i.e. disassembling of the machine or a subassembly (most of all in the workshop) to eliminate the causes of failure

As breakdowns are unexpected, corrective intervention needs a methodical approach in order to limit unproductive time or to avoid complicated re-assembling work.

C. TASKS OF MAINTENANCE

Maintenance covers various tasks :

1. Methods

The function of maintenance methods has in fact a job preparation task, which does not concern a specific job (this is carried out by the "work specification" of "preparation desk"), but consists in the organization of all elements in respect to planned maintenance, i.e. technical information, work instructions, spare parts, etc.

2. Engineering and construction monitoring

This function deals with small engineering studies and construction monitoring for modification or for small extensions of the existent equipment in order to improve capacity and efficiency, quality of final product, maintainability, operation or safety.

The tasks of the engineering and the construction monitoring function are : design-studies, construction monitoring of installations, monitoring of start-up and commissioning. The erection and installation works will be done by other maintenance sections (for instance workshops) or by an out-side sub-contractor.

3. Job preparation (or work specifications)

The job preparation function determines the details of the job to be carried out : different phases and operations of the work, instruments, accessories, tools, spare parts, other resources, time and man-power allocation. This task results immediately from the methods task and concerns a specific job. The job preparation work should include following topics :

- work phases : break-down of the job in different consecutive phases
- the break-down of each phase in sub-phases and operations
- the list of cutting tools, metrology instruments and accessories for machine tools
- time allocation of each operation
- the designation of the work-posts for each phase
- complementary informations for each operation (for instance spindle speed, feeding speed, etc.)

It is not justified to prepare each maintenance work. On the other hand a too detailed preparation for certain jobs should be avoided as it takes away all initiative of the foreman.

For machine-tooling works each job should be 100% prepared in detail.

For maintenance intervention work job analysis proved that detailed job preparation was only efficient in 25% of the cases.

4. Work programming and scheduling

The work programming function is responsible for making available in due time all material and human resources. Consequently this function is responsible for programming all maintenance work and is highly linked with the job preparation task. In particular this function should :

- make the long term planning of all maintenance works
- decide on the degree of urgency of job requests
- follow-up all sub-contracting orders and supplies which are necessary for programmed works
- control permanently the workload of shop-floor personnel and machine-tools and, if necessary, adjust
- check the respect of safety orders, rules and procedures by the craftsmen

The work scheduling function assures the planning of workload of the different craftsmen. It is responsible for the distribution of the work according to a predetermined planning taking into account work-progress of intervention teams and machine-tools. This planning includes a percentage for emergency works or urgent interventions.

5. Job execution

This function is assured by the maintenance staff in the production sections or by the workshop personnel in case of repair or manufacturing of spare parts. Time losses and risks of accidents can be avoided by a good job preparation and planning. In particular, job execution should be based on the respect of the work scheduling in order to avoid :

- bad synchronization of the successive steps during intervention
- too many problems to be solved on shop-floor during execution
- the use of non appropriate tools
- misuse of qualified craftsmen

In general a decentralization of intervention teams in the various production sections (assigned maintenance teams) avoids time losses between stores, workshops and the shop-floor. On the other hand a centralization has the advantage to improve organization and to reduce general costs. Therefore a physical decentralization of the intervention teams in a centralized organizational structure has given good results.

6. Inspection of the work

This function is assured by foremen and requires detailed instructions how to proceed and which tools or instruments are to be used for control. This function concerns particularly the quality of the executed work and the activity of the maintenance personnel.

7. Spare parts stock administration and control

The spare parts administration and store keeping function assures the availability of spare parts and maintenance supplies, in the right time and on the right place in an economical way. This function defines the quantities to be reordered, depending on stock level and various parameters (consumption, delivery delay, market constraints, minimum stock level, etc.)

Experiences in developing countries prove that it is more interesting to put the spare parts stock control function under the authority of the maintenance department rather than under the authority of the purchase department. In the stock management process, the tasks of both departments are limited as follows : maintenance department is responsible for issuing a purchase request (technical choice, coding and designation). Purchase department is responsible for the commercial process, preparation of order and follow-up of suppliers. A good cooperation between both departments is indispensable for a smooth spare parts stock control.

8. Maintenance personnel management

This function relates only to maintenance personnel and deals with following topics :

- professional qualification and experience of maintenance staff
- appropriate training
- set up of detailed job descriptions
- recruitment of maintenance personnel
- policy of salaries and motivating incentives

Special attention should further be paid to work-safety. There is a close link between maintenance and safety. This is one of the reasons why maintenance is very often in charge of work-safety.

9. Maintenance management

Each maintenance department can improve seriously the efficiency of the company by reduction of its costs. This includes a control of maintenance costs which require detailed information and management systems. In order to allow the maintenance manager to fulfil his task in this respect, a maintenance management section is a necessity for following reasons :

- to collect information about the maintenance activities (worked hours, consumption of spare parts, loss of production-time, etc)
- to analyse maintenance efficiency in respect to the production requirements
- to follow-up the impact of different maintenance systems : systematic, condition-based, corrective,...
- to prepare the annual budgets
- to analyze machine efficiency : breakdowns, output in terms of quality and quantity, life cycle cost, etc..
- to prepare the necessary informations for defining a renewal policy
- to define performance indicators of the maintenance department through the follow-up of selected management ratios (both economical and technical)

The development of micro-computers has facilitated the collection and follow-up of all maintenance data. Computerized maintenance management systems will be an interesting tool for future development.

10. Operation and maintenance of utilities

The maintenance department is in charge of operation and maintenance of utilities (installations for the production and distribution of energy and fluids) :

- production and distribution of electricity
- water treatment, distribution and sewerage
- production and distribution of compressed air
- production and distribution of steam
- air conditioning system
- storage and distribution of gasoil
- storage and distribution of various gasses

D. MAINTENANCE LEVELS

Five levels of maintenance can be considered depending on the complexity of work and urgency of intervention :

- a) first level : simple adjustments foreseen by the machine manufacturer to accessible components without any dismantling or opening of the equipment; replacement of consumable components which are accessible under good safety conditions such as filters, simple cleaning operations. This type of interventions can be done by the machine operator according to the instructions for users
- b) second level : trouble shooting through standard exchange of components and small preventive maintenance tasks such as lubrication, control of good functioning, various checks
- c) third level : identification and break-down diagnosis, repair through exchange of components and components, small mechanical repairs, all routine preventive maintenance operations, such as general adjustments and re-calibration of control and regulation instruments
- d) fourth level : all important works of corrective maintenance and overhauls except renovation and reconstruction. This level includes adjustment of measuring instruments and verifications of calipers by specialized organizations
- e) fifth level : renovation, reconstruction or execution of important repairs and overhauls which are done in a central workshop or by external subcontractors. Spare parts manufacturing.

III FACT-FINDING - ASSESSMENT OF THE PRESENT SITUATION**A. GENERAL SITUATION IN THE COUNTRY**

The Government of Indonesia has accorded high priority to the improvement of productivity and international competitiveness of Indonesian industry in the context of its emphasis of the enlargement of non-oil and gas exports, particularly exports of manufactures.

In order to support and sustain this export effort and promotion of local manufacture of industrial equipment, it is essential that optimal use be made of capital plant and equipment, which in turn calls for reduction of plant outages and costly repairs.

Product quality and delivery schedules are two major requisites in export marketing. Those major requisites can only be assured and sustained through correct maintenance of the equipment.

The fifth five years development plan (1990-1994) is the continuation of the basic fourth five years plan which was laying the basic frame for :

- 1) industrial development which, as far as possible, is directed to a penetration and stabilization of the industrial structure and to integrate it with the other economic sectors
- 2) development of machinery and electronic industries, producers of capital goods
- 3) development of small scale industries
- 4) expansion of industrial export programme
- 5) research - development and engineering capacity improvement particularly in software, development programmes and inventions
- 6) improvement of industrial manpower ability : management, expertise, specialization, skill and self-employment

Since the onset of the five-years development plan IV, following measures have been taken (establishment of the basic frame during plan V 1990-1994) :

- 1) optimization of installed capacity and enhancement of efficiency
- 2) safeguarding of projects according to schedule
- 3) programme implementation on integration of inter-industrial sectors and between the industrial sectors and the other economic sectors
- 4) continuous climate improvement
- 5) Effective utilization of domestic markets, in order to achieve :
 - optimum utilization of national capacities
 - preparing strong fundament for the implementation of export programmes

Companies in the engineering sector are state or private owned. They are often joint-ventures, producing under licence and receiving technical assistance both on production and maintenance level.

Some of the former joint-ventures are actually 100% Indonesian owned, still producing under licence but no longer benefiting from an external assistance.

B. AUDITS IN 18 ENTERPRISES. ASSESSMENT OF THE SITUATION ON PLANT LEVEL

The following enterprises were initially preselected for auditing in relation to maintenance

<u>Jakarta</u>	<u>Surabaya</u>	<u>Medan</u>
PT. SUCACO	PT. BBI Unit Indra	CV. Multi Mineral
PT. PIMSF	PT. BBI Unit Bisma	PT. Tenera
PT. ARCON PRIMA	PT. BARATA INDONESIA	PT. BINTANG HARAPAN
PT. TUMBAK MOS	PT. JATIM TAMAN STEEL	PT. GUNUNG BAHARA
PT. UNINDO	PT. TSJOKRO BERSANDARA	PT. ATMINDO
PT. ALAM ROYA	PT. MECO	PT. GUNUNG GAHAPI
PT. BAKRIE TOSANJAYA	PT. HANIL JAYA STEEL	
PT. BUKAKA TEKNIK UTAMA		

Together with the national Counterpart, it was decided that following enterprises would not be audited for reasons explained in appendix 5 :

<u>Jakarta</u>	<u>Surabaya</u>	<u>Medan</u>
PT. TUMBAK MOS	PT. HAMIL JAYA	PT. BINTANG HARAPAN
PT. UNINDO		
PT. ALAM RAYA		

Following enterprises have been audited, although they had not been preselected :

<u>Jakarta</u>	<u>Surabaya</u>	<u>Medan</u>
PT. MORITA	PT. AGRINDO	Mineral Machine Tools

In appendix 6 a summary of findings is given including general information concerning the audited enterprises.

An important difference between enterprises in the status of maintenance has been found : from no concern at all to organized maintenance structures supported by top management. Therefore the sample of selected enterprises is certainly representative for the engineering industries. No significant tendency nor common characteristic in one or another region or a type of industry has been stated.

The findings of the mission can be summarized as follows :

- a. The first objective of all plants is to produce in a minimum of time a possible highest quantity without considering the state of the equipment. Personnel is recruited for production purposes, without any job description. As a consequence, level of qualification and number of staff is rarely matching the real needs of the plant. Maintenance tasks are limited to repair and overhauls after breakdowns occurred.

There is no independent maintenance structure : mechanics, electricians, and other technicians are assigned to the different production sections. There is no coordination and maintenance interventions are only seen as a constraint for production.

- b. Plants in general and industrial installations in particular reach rarely full production capacity. Quality of final product needs to be improved. Availability of the production equipment varies from 40 to 80%, but a lot of equipment is not running for several reasons : lack of orders, lack of production planning and lack of operators. On the other hand, small scale workshops are so crowded that machine-tools are hardly to find between raw materials, semi-finished products, tools, boxes and crates with parts and sub-assemblies awaiting for repair.
- c. In 55% of the plants, organized maintenance is inexistant and in 30% there is only some repair and systematic lubricating. In 3 plants (15%) maintenance is really part of the organization although a lot of progress should still be made. Necessary measures have to be undertaken in the engineering phase and equipment ordering stage. Maintenance is generally underestimated in the production cycles. Its productive role and the fact that it is a condition for conservation of production equipment is not understood.
- d. Maintenance problems concern : awareness of senior management, skills of personnel, technical documentation, spare parts, workshops, planification and organization, preparation of specifications when ordering new equipment, socio-economical environment. As it has been stated that these problems are interdependent, they cannot be solved for instance only by developing local fabrication of spare parts or by starting massive training programs to absorb lack of qualified people. An integrated common approach, taking into consideration all problems in relation to pre-defined priorities, will be necessary to solve these maintenance problems.
- e. The origin of most of the maintenance problems is related to the attitude of personnel towards industrial demand : lack of maintenance spirit, which starts with cleanliness and order - even outside the framework of industry - , lack of motivation, discipline and team spirit are at the same time causes and consequences of a deficient maintenance. Insufficient technical qualification and unadapted professional training enhance the shortage of maintenance engineers, foremen and skilled workers.
- f. The technical documentation (drawings, operation manuals, maintenance manuals, spare parts lists, etc.) is mostly available, although rarely used for maintenance purposes. It is generally considered as property of the production department. In several cases the original language is Chinese, Japanese, Korean or German. Those languages are only known by some expatriates (joint-ventures), and even English is not accessible for all Indonesian technicians.

The instructions are not always understood correctly and are rarely adapted to the present local circumstances. This causes misunderstandings, waste of time while analysing breakdowns and lengthens the time to repair. For old machinery, documentation has disappeared and for new acquisitions there is no systematic

demand for documentation. Clear specifications when acquiring new equipment are needed in order to define the appropriate needs for technical documentation.

- g. The problems of spare parts represent generally a major headache for equipment owners. Underestimated measures as to climatological conditions, operational errors and deficient maintenance practice result in high consumption of spares compared to normal industrial environment. On the other hand, inappropriate technology results in excessive or accelerated wear, which in turn still increases the need for spare parts.
- h. Control of spare parts consumption is hardly done and precautions to limit their consumption are not taken. Conservation of stored parts is poor resulting in parts which cannot be used any more or have a reduced life span. Efficient stock and store management is also missing : items are not or badly identified or codified and are not properly stored or even impossible to find.

The industries of the metalworking sector have generally good equipped mechanical workshops and a lot of parts are made "in-plant" (axes, pivots, gears, bushings,...). Quality control of this products is rather rare : either the correct sizes or tolerances are unknown, or the material specification is neglected. This results in new and repeated breakdowns due to replacements with low-quality parts. Electrical motors are often rewinded in house or send to subcontractors. Services for electronic repairs are available and suppliers give a good after sales service in this field.

- i. Many of the deficiencies enumerated above are caused by or start from poor maintenance organization. Tasks and responsibilities are not or poorly ascertained and interventions and information circuits are not formalized. Especially maintenance methods, job preparation and planning are neglected. Maintenance teams are considered as fire brigades, reacting after breakdown occurred.

As a consequent, preventive maintenance is inexistant : there are no inspection schemes, no work preparations, no job schedules, no diagnostic facilities, etc. Managed maintenance systems are unknown.

- j. Training maintenance staff is limited to on-the-job training by supervisors, resulting in no further improvement of quality standards. Engineers and foremen are sent abroad when new equipment is purchased. These study tours are not appropriate, as demonstrations on equipment happen in another technical more advanced environment. Moreover, transfer of know how, upon return of the trainers does not take place. Once a plant is in full operation, main care goes to the production and maintenance staff is neglected.
- k. In the mechanical workshops, inappropriate location of CNC machine-tools (lack of air-conditioned halls, in some cases even next to the foundry-section or welding area without efficient separation) results in numerous breakdowns of electronic components and accelerated wear of mechanical parts.

Neglected attitude towards equipment often causes down time, poor availability and delay in production. In several cases old and obsolete machines are still running while modern high productive but vulnerable machines are at stand-still.

1. In 30% of the plants, accountancy department gives some computerized information on total maintenance costs, including personnel, spare parts and depreciation of equipment. Those informations mostly concern repair and lubricating operations. Elementary computerized planning of maintenance is limited to inventory and global inspection of equipment. Details which are necessary both for long-term and short term workload planning are missing. The danger of computerizing non-organized maintenance exists which would result into still more negative consequences on production. It is absolutely necessary to master manual maintenance systems before introducing computerized management systems.

C. AUDIT OF TRAINING AND TESTING CENTRES

1. Training centres are mainly equipped for technical training in several trades : machine-tools, instrumentation, pneumatic and hydraulic engineering, welding, etc. Maintenance of equipment is rarely considered and training in the field of maintenance organization and management has only be found in Malang (Surabaya). Training programs in management information systems and maintenance management are an absolute priority.
2. Testing centres generally are well equipped but a rather poor work-load illustrates both lack of credibility in the enterprises and lack of motivation of the testing centres personnel. A much closer cooperation with industry and reactivation of these centres can save these institutions. One of the major problems to solve is how to interest experienced engineers and technicians to stay at the centres without shifting to the private industry, under better working conditions.

Detailed assessment of the situation in training and testing centres is given in appendix 7.

D. MIDC

MIDC (Metal Industries Development Centre) is a development centre for metal and engineering industries under the Agency for Industrial Research and Development of the Ministry of Industry, located in Bandung.

Main objectives

The main objectives of this institution are to increase the productivity of metal and engineering industries in the country and to improve the quality of their products.

MIDC has 3 types of activities :

- routine or research activities
- projects or development activities
- services to industries or technical assistance

The first two activities are 100% financed by Government and represent approximately 60% of the workload of MIDC.

The third activity is partially or totally financed by private enterprises.

Machine-tools-, welding-, foundry- and heat treatment workshops are very well equipped as well as the metrology laboratory.

MIDC has never developed marketing activities so the workload in all the sections is relatively low. Since the start-up of MIDC in 1969, a lot of equipment and technical assistance has been supplied through international and/or bilateral projects. At the issue of technical assistance, management and organization technics, planning, scheduling etc, ...both on production and on maintenance level, have been abandoned. A lot of machines are out of order since a long time. Even 6 of the 8 heat treatment furnaces never worked since installation in 1978.

The activities in the workshops are not subject of quality control and no delays can be given for the tasks prepared by the engineering department. Elementary cleaning and preventive maintenance is inexistant for all equipment. But as the equipment is far underloaded, it is still in a very good shape.

Concerning MIDC staff in relation to maintenance consulting services as developed further below, junior engineers are available but must be trained/upgraded. Senior staff will have to be recruited from the industry.

Supporting services (secretaries, drivers, etc.) and computer equipment are available at MIDC and are reliable.

The fact that MIDC intends to develop consulting activities to the industries will have promotional influence, resulting in the increase of workload of the different workshops and engineering department.

Building premises and facilities are very good and largely sufficient. Enough space is available for adding any activity in the field of consulting related assistance and training.

Details of MIDC's activities, equipments and premises are given in appendix 8.

IV RECOMMENDATIONS

Following recommendations to improve the prevailing situation are based on a practical approach. In order to institute managed maintenance systems in industry, a global strategy is proposed and actions on national and plant levels are specified.

As explained below, the definition of a national maintenance policy is strongly recommended focussing on following topics :

1. design, acquisition and operation of industrial equipment
2. maintenance management and organization
3. maintenance material resources : documentation, spare parts, maintenance-tools, diagnostic and measuring instruments
4. maintenance personnel : qualification, motivation, training

This national maintenance policy should become an important part of the industrial development policy of the Indonesian Government. A related strategy for implementation resulting in a plan of action (short and medium term) has also been explained below. Finally a proposal for further UNDP/UNIDO assistance in the implementation of above actions has been formulated.

A NATIONAL MAINTENANCE POLICY AND STRATEGIES - PLAN OF ACTION**1. Introduction**

Maintenance of production equipment affects the productivity of industrial enterprises and their export capacities. It influences consequently the national budget and external debt.

It is difficult to quantify in absolute monetary terms the impact of a better maintenance of the production equipment.

Analyzing the statistics concerning the performances of a maintenance service, it is possible to get an idea on the direct impact on both micro and macro - economical level through the study of the representative data.

The maintenance cost in industrial countries has been compared to main economic parameters. The most important are :

Total maintenance costs

value added : between 4 and 16 %

Total maintenance cost

Total production cost : between 6 and 12 %

Total maintenance cost	: between 5 and 27 %
<hr/>	
Assets to be maintained	
Cost of spare parts	: between 25 and 35 %
<hr/>	
Total maintenance cost	

In 1984, the total expenditure in the 9 EEC countries for maintenance of their production tool amounted to US\$ 86 billion.

These figures prove that improving the efficiency of maintenance of production equipment can represent an important source of benefits.

Indirectly a sound maintenance reduces down time and assures better quality of final products, under better conditions of safety and environment.

2. Findings

In analysing the prevailing maintenance problems in the Indonesian Industry as mentioned in the previous chapters, the mission formulates following findings :

1. the problem of maintenance in the Indonesian engineering industries is very serious. A lack of managed maintenance systems and of a maintenance - friendly environment is at the basis of many production losses. Moreover it results in reduced quality of final product, in increased production costs and in uncertain continuity of production. The latter are main conditions to be fulfilled in export-oriented industries. Finally a lack of maintenance reduces life-time of production equipment, endanger safety of personnel and environment.
2. the problems mentioned in previous chapters are interdependent: solving only one of them will not solve the maintenance problem as such. Actions should be undertaken to solve all problems, maybe not at the same time, but according to a predetermined degree of priority.
3. based on previous and on-going experiences of the consultant in Indonesia, the problems which have been stated in the engineering industries subsector, are very similar in other sectors, such as other industrial subsectors, transportation, public works, agriculture, agro-industry, telecommunication, health, buildings, laboratories and testing centres etc.
4. the solution of these problems do not only depend on the equipment owners. Other economic sectors are involved and they often precondition the downstream operators, such as national education, labour legislation, banking, customs, imports etc.

Consequently, a solution to the maintenance problems in the subsector concerned, must be seen in a broader framework.

In fact, the design of a national industrial maintenance policy and related strategies, is strongly recommended. These should be based on sector and subsector strategies in relation with the current Indonesian Five years plan and in close coordination with on-going projects, upstream of maintenance (such as new investments, rehabilitation or restructuring projects).

This policy has to be set up through the implementation of a strategy containing a plan of action for both national and enterprise levels. It has to be described so that interrelations and subsequent links between activities for the practical implementation appear clearly.

3. National maintenance policy and related strategies

A maintenance policy and related strategies for implementation in the concerned subsector should focus on following headlines:

1. **Upgrading of existing situation through :**
 - better awareness at all levels concerning the importance of maintenance
 - improved maintenance organization and management, including efficient Management Information system.
 - motivation and training of staff
 - improved work programs
 - upgraded material resources (technical documentation, spare parts, budgets)

2. **Implementation of measures to safeguard the future through :**
 - design of a long term policy for the development of human resources
 - design of an integrated computerization policy on company level, of which maintenance will only be a part of
 - participation of maintenance specialists in the whole project cycle when procuring new equipment or when planning new investments.

This policy may not be limited to the improvement of maintenance management in some enterprises only. The problem has to be solved for all sectors involved in running equipment. This necessitates a strategy focussing on priority sectors in the short run. The purpose is to create a permanent basis assuring dissemination of the results of maintenance up-grading through a progressive implementation of the proposed strategy in other sectors.

The only inconveniences of the implementation of such a national policy is the lead time which is needed to obtain the first measurable results in the enterprises. But it has been proved in the past that only permanent results can be produced through a real transfer of know-how in organization and management of the maintenance function. The experience of other countries where this approach has been applied has given convincing results. Similar projects have been implemented through UNIDO : in Madagascar, linked to an existing organization SERDI (Engineering company for industrial development); in Algeria, linked to the National Institute for Research and Development of Maintenance INMA; in

Angola, linked to the National Maintenance Company EMIN (Empresa de Manutencao Industrial); in the Philippines.

Hereafter, actions are specified according to their priority.

3.1 Principle of a Maintenance policy and strategy at national level

The need for coordination of maintenance activities and exchange of information and experiences between various industrial plants, groups and corporations has been felt during the audits.

A national structure for promotion and coordination of maintenance activities and for consulting and assistance to enterprises would contribute to satisfy this need.

This structure could be created under the form of a National Industrial Maintenance Institute or Committee under the authority of the Ministry of Industry or through the set up of a Maintenance consulting company (Maintenance Consulting Centre - MCC). In the present stage the latter seems more appropriate for the Indonesian industry and according to the findings of the mission.

The main objectives and tasks of this MCC can be summarized as follows :

- promote industrial maintenance on a national level
- coordinate industrial maintenance activities of plants, groups, cooperations, etc.
- coordinate the inter-company activities in the field of industrial maintenance (participate in actions setting up regional maintenance workshops, stores for standard and consumable parts, training centres for maintenance personnel, preparation of standard terms of reference for purchasing new equipment, setting up of regional teams for specialized maintenance works, etc.
- advise at the level of industrial planning
- make proposals to the Ministries concerned regarding e.g. administration improvements, imports of spare parts, training, etc.
- coordinate and stimulate the setting up of company and material standards
- make an inventory of the training needs for maintenance personnel
- organize training of maintenance personnel at different levels
- stimulate subcontracting activities in maintenance
- promote operational research in maintenance engineering
- fulfil an advisory role in companies and plants concerning the introduction of managed maintenance systems
- organize a system for exchanging inter-company information and experiences regarding industrial maintenance, etc.
- organize information circulation, seminars and workshops on maintenance, etc.
- participate in international maintenance activities

The MCC must have an operational function. In no case it should degenerate into a bureaucratic authority. One cannot draw enough attention to the fact that it must therefore be staffed with personnel which has excellent plant maintenance experience.

Technical assistance and logistic support from international experts would seem appropriate in an initial stage. Regional offices should be considered.

As consulting and promoting services are rarely self-sufficient in the beginning and as the MCC has to act on a national level it is obvious that an existing organization of the public sector could form the basis to host and develop such a structure.

Nevertheless, the MCC must be flexible enough from the operational side, to attract experienced staff. This approach would result in the recommendation for setting up a mixed company (state/private) providing consulting, technical assistance and training services to the industry and also assuring promotion and awareness-raising concerning maintenance on a national level. In a first step, services would focus on the metalworking engineering industries which has been defined as one of the priority-sectors of the Governments development policy.

During the present mission, in-depth analysis has been made of the capability of MIDC to host that kind of structure and to develop these services. It has been stated that MIDC is appropriate provided that institutional arrangements are made to ensure enough flexibility and autonomy of operation. Various alternatives have been discussed :

1. Change decree of MIDC in order to become more autonomous
2. Create mixed company state/private companies, banks, development institutes etc., basec at MIDC.
3. Create autonomous structure by special decree by Minister (cfr TSG from Worldbank IRP project)
4. Integrate structure in existing institution with sufficient autonomy
5. Create a foundation with concerned beneficiaries
6. Supply of experienced national counterpart staff by some interested state owned or private enterprises, which in turn will be selected as pilot plants to implement planned maintenance systems. This staff could than be integrated in existing structure described in one of the alternatives above.

To launch the MCC, as mentioned above, it is recommended to train a core-group of consulting engineers and to design an appropriate internal organization for the structure. Therefore it is further recommended to call for a UNDP/UNIDO technical assistance which objectives would be the establishment of managed maintenance systems in industry through the set

up and development of national consulting/assistance/training capacities and through appropriate awareness-raising and promotion activities.

With the assistance of experienced international consultants, national staff will be trained to :

- practical application of maintenance organization and management in industries
- analysing and solving maintenance problems in industry, including diagnostics
- implementation of recommendations to upgrade maintenance in industry
- organization of training of maintenance staff

3.2 At enterprise level

At enterprise level, a maintenance policy should also be devised, in relation with the national policy. It is recommended especially to :

- create a maintenance department or service which has to develop the maintenance policy of the enterprise and to control the results
- put the maintenance at the same hierarchical level as production
- decide for an appropriate organizational structure, depending on the size, kind of industry : centralized, decentralized or mixed ?
- devise a simple organization that can be easily adapted and upgraded based on a methodological approach and a correct data collecting. To do so, pilot-sections in a plant are very useful
- appoint a sufficient budget for maintenance to permit necessary expenses for personnel, machine-tools, measuring and diagnostic devices
- assign qualified people to maintenance department
- organize awareness-raising actions for production and maintenance staff on the importance of good maintenance and on proper operation of equipment
- define a training policy for maintenance personnel
- define a renewal policy for equipment based on life-cycle cost analysis, life-span control, technological evolution, production planning,....
- define a policy for acquiring new equipment taking into account precautions for maintenance, specifications, selection criteria, after sales guarantee and services, contractual negotiation
- activate and stimulate exchange of experiences and statistics between different plants/sections of the enterprise and also between enterprises.

The above headlines of a maintenance policy at enterprise level must be adapted and tuned up to the specific situation of each enterprise, after a critical and detailed audit of the maintenance department.

This can be done with the assistance of the MCC which has been described in the previous chapter.

First actions could be undertaken in selected pilot plants in the 3 industrial regions concerned by the present mission.

These pilot plants would than be used as demonstration and training ground and would subsequently be convincing elements for enterprise-management to start restructuring actions in the field of maintenance.

During the mission possible pilot-plants have been chosen among the audited plants and a recommendation of 2 for each region is listed below. Each second plant must be seen as an alternative in case the first cannot be selected.

Jakarta : 1. PT. Bakrie Tosanjaya
2. PT. Sucaco

Medan : 1. PT. Gunung Gahapi Sakti
2. PT. Atmindo

Surabaya : 1. PT. Barata Indonesia
2. PT. Agrindo

4. Plan of action

Recommended actions can be grouped into 7 categories :

- actions related to the definition and the implementation of the national maintenance strategy
- promotion and awareness-raising actions
- actions concerning the development of a core capacity of consulting engineers in maintenance
- actions concerning the development of human resources in enterprises
- actions concerning assistance and implementation of recommendations in industrial enterprises
- actions concerning acquisition of equipment
- actions concerning the set-up of a national maintenance structure.

Hereafter, a detailed plan of action is proposed.

A PERT planning explains the relations and links between the proposed actions, and a "GANTT" chart gives a time schedule (appendix 9 and 10)

a) Actions at government level

	Short term	Med term	Long term
1) National strategy			
- introduce the project proposal of UNIDO "Establishment of managed maintenance systems in industry". A detailed project proposal has been submitted together with this report.	x		
- come to an agreement on the present plan of action and accept it as the "National Maintenance Plan"	x		
- prepare a leaflet to divulgate the National Maintenance Plan towards enterprises, decision makers and institutes	x		
2) Promotion and awareness-raising			
- organize a national seminar on maintenance problems including the presentation of the National Maintenance Plan	x		
- organize a specialized seminar on maintenance management and organization for the intention of decision makers	x		
- organize awareness-raising campaigns through mass media and maintenance contests in enterprises		x	
3) Training of a core-group of consulting engineers			
- create a consulting and technical assistance capacity in maintenance covering following fields :	x		
- auditing			
- organization			
- methods and job preparation			

- programming and scheduling			
- diagnostics			
- spare parts management			
- technical documentation			
- maintenance management			
- costs and budget			
- personnel management			
- organize training of leaders of maintenance seminars and of maintenance courses		x	
- write "know-how" manual for the use of maintenance consulting engineers including auditing, organization, diagnostics and management	x		
4) Training of maintenance staff in industrial enterprises			
- assess needs for maintenance in industry and training capacities at schools, institutes, training centres, etc.		x	
- establish programmes for initiation and advanced training in maintenance management			x
- assist maintenance staff of industrial enterprises to audit and analyze own maintenance organization			x
- set up training courses for enterprises in maintenance organization and management - stock administration - cost control - personnel management			x
- give assistance to training managers of enterprises concerning assessment of training needs and search for training capacities			x
- inform and train production staff in basic maintenance understanding			x
5) Assistance and consulting services to industrial enterprises			
- execute audits in pilot-plants concerning maintenance organization		x	
- analyse data of survey and prepare recommendations for upgrading/restructuring maintenance services			x
- assist and implement recommendations in the 3 pilot plants		x	

b) Action at enterprise level

- | | |
|--|---|
| 1. Establish action plan in pilot plants for upgrading maintenance department/training of national maintenance consulting engineers | x |
| - in-depth audit of each pilot plant together with national maintenance consulting engineers | x |
| - analyse results and prepare recommendations and plan of action concerning : | x |
| - awareness-raising and information of personnel | |
| - maintenance policy | |
| - hierarchical position of maintenance in the plant | |
| - hierarchical position of central maintenance planning office | |
| - spare parts and stock management | |
| - preventive maintenance systems | |
| - diagnostic services | |
| - cost control and budgets | |
| - personnel management | |
| - analyse training needs (quantity, qualification and trade) | x |
| - analyse needs of technical assistance for implementation of proposed actions | x |
| 2. Implement proposed action plan in the 3 pilot plants with the assistance of the MCC and international experts | |
| - awareness-raising/information of maintenance personnel and operators : explanation of role/structure of maintenance and impact on production | |
| - definition of a maintenance policy | x |
| - dosage between corrective-preventive maintenance | |
| - repair and overhaul policy | |
| - equipment renewal and acquisition policy | |
| - subcontracting | |
| - centralized maintenance structure | |

- assist in the set up of on-the-job and in-plant training programs

3. Disseminate experience of the pilot plants towards other enterprises in Indonesian industry through consulting, technical assistance and training services

			x
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B. PROJECT PROPOSAL FOR UNDP/UNIDO ASSISTANCE

In order to implement above plan of action a project proposal for UNDP/UNIDO assistance has been formulated and submitted together with the present report and a project formulation framework.

The proposed project has followed main components :

1. Objectives and outputs

The overall objective of the project is enhanced productivity and efficiency of Indonesian industry. This will be reached through following immediate objectives and related outputs:

1. Immediate objective no.1

To create a nucleus of capability based at a Maintenance Consulting Centre (MCC), for establishing managed maintenance systems in Indonesian industry through advisory services and technical assistance, development of human resources and implementation of a promotion and awareness-raising program. This MCC is to be established through cooperation with MIDC and selected industrial enterprises and located at MIDC premises in Bandung with outreach mechanisms in Jakarta, Surabaya and Medan.

Output 1

A structure for maintenance consulting services (Maintenance Consulting Centre) in full operation at MIDC.

Output 2

A core group of consulting engineers at MIDC , composed of 11 specialists, which will be capable to provide consulting, assistance and training to the industry in the field of maintenance.

Output 3

A promotion and awareness-raising program concerning maintenance management and organization throughout the country initiated.

Output 4

A framework for periodic training of maintenance personnel introduced.

2. Immediate objective 2

To provide direct support to industrial enterprises in improving the production through implementation of managed maintenance systems.

Output 1

3 pilot plants (one in each region i.e. Jakarta, Surabaya and Medan), which will have received consulting and technical assistance to improve their production by 15 to 40 % through better maintenance management. These plants will become "models" for the demonstration and training purposes of the project.

Output 2

30 industrial enterprises (10 in each region), will be able to improve their production as result of participation in training programs and receiving ad hoc advice and technical assistance in the field of maintenance organization. (Improvement of production can reach 5 to 30 % depending on the kind and magnitude of services rendered)

3. Immediate objective 3.

Upgraded skill of 60 maintenance and management personnel in the field of maintenance management

Output 1

60 maintenance engineers and supervisory staff of industrial enterprises will have been initiated or specialized in organization and management of maintenance.

2. Institutional framework

The mission confirms that MIDC is an appropriate institution to host the project.

Nevertheless, in order to attract national counterpart staff with sufficient experience (4 senior engineers and 7 junior engineers), institutional arrangements should be made in order to ensure enough flexibility and autonomy of operation for the proposed consulting structure.

Various alternatives have been discussed during the mission, and are listed below. They need further analysis by all parties concerned in relation to their viability.

The consulting structure can either be integrated in existing institutions or must be created. Discussed alternatives :

1. Change decree of MIDC in order to become more autonomous
2. Create mixed company state/private companies, banks, development institutes etc., based at MIDC.

3. Create autonomous structure by special decree by Minister (cfr TSG from Worldbank IRP project)
4. Integrate structure in existing institution with sufficient autonomy
5. Create a foundation with concerned beneficiaries
6. Supply of experienced national counterpart staff by some interested state owned or private enterprises, which in turn will be selected as pilot plants to implement planned maintenance systems. This staff could than be integrated in existing structure described in one of the alternatives above.

3 Budgets

Following inputs both from Government as well as from UNDP are proposed:

Budget Component	National Inputs rupiahs	External Inputs US\$
BL. 19 Personnel	117.000.000	1.505.313
BL. 29 Subcontracts	-	973.890
BL. 39 Training	6.000.000	264.000
BL. 49 Material / Equipment	118.800.000	177.000
BL. 50 Miscellaneous	18.000.000	30.000
TOTAL	259.800.000	2.960.203

1 US\$ = 1850 rupiah

C. SITUATION EXPECTED AT THE END OF THE PROJECT

The implementation of the above proposed project will last 3 years. Following situation is expected to be achieved at the end of the project :

- a) Enterprises throughout the country will be sensitized on the importance of sound maintenance organization and management. Top management will be informed about maintenance strategies both on national and on enterprise levels.
- b) There will be established a core group of engineers and technicians based in MIDC, which will be able to provide consulting services and all kind of technical assistance in introduction of managed maintenance systems.

This entity should reach after 3 years a level of credibility and efficiency which must allow it to be accepted by the enterprises as specialized consultant. Its services will be charged to the enterprises at competitive rates for consulting services. Nevertheless, it will not be possible to remunerate certain activities

such as those related to maintenance promotion and awareness-raising. A complementary financial input, at least during 1 to 2 years after the project, will be necessary by Government or interested enterprises.

- c) It is further estimated that through direct assistance to be provided through this project to selected enterprises, their production will increase for about 15 to 40 %. Production costs will be decreased by 10 to 30 %. The quality of many final products of assisted enterprises will be upgraded). Curricula for specialized courses on all aspects of maintenance management will be worked out and distributed to national polytechnic schools, universities and training centres.

APPENDICES

1. Terms of reference for professional services
2. List of persons met
3. Sample of questionnaire
4. Methodology for maintenance audits
5. Comments on list of selected enterprises
6. Summary of findings of audited enterprises
7. Assessment of the situation in training and testing centres
8. MIDC
9. PERT planning
10. GANTT planning

TERMS OF REFERENCE FOR SUBCONTRACTING SERVICES

Preparatory Assistance DP/INS/88/024
Institution of Preventive Maintenance Systems in Industry

A. GENERAL BACKGROUND INFORMATION OF THE PROJECT

The Government of Indonesia has accorded high priority to the improvement of productivity and international competitiveness of Indonesian industry in the context of its emphasis on the enlargement of non oil and gas exports, particularly exports of manufactures. In order to support and sustain the above-mentioned export effort, it is essential that optimal use be made of capital plant and equipment, which in turn calls for reduction in plant outages and costly repairs. The promotion and institution of the practice of preventive and predictive maintenance is considered to be a priority requirement for this purpose. The systematic introduction and expansion of preventive maintenance activities can also be a major conducive factor for ensuring product quality and adherence to delivery schedules, two important requisites in export marketing. On the other hand, a reduction in equipment breakdowns and consequent increased availability of equipment time can mitigate the need for new capacity additions.

Indonesia, as one of the advanced developing countries, has already achieved a certain level of industrial development. Mid-and small-scale enterprises have been set up in the country. The main issue now is how to improve profitability. As it is known, the major part of the problems in developing countries is connected with the introduction of proper maintenance, improving quality control, and training manpower with due consideration given to forthcoming technological changes.

At present, the level of maintenance in Indonesian factories, particularly the non-process type installations (batch production), is characterized by what may be described as breakdown maintenance mode. Obvious inadequacies in routine preventive maintenance can be found in most plants such as bad steam water and oil seals, lack of control devices or their improper setting, bad thermal and electric insulations, badly maintained bearings and clutches etc. More importantly, the importance of systematic preventive and predictive maintenance is not appreciated by senior management and maintenance is often viewed as a repair function.

The situation is probably the worst in the engineering, and especially in the metal working sector. The engineering industries, however, have been identified by the Government as a high priority sector for development. Amongst the engineering industries, much emphasis is placed on the local manufacturing of industrial machinery and equipment as well as rolled steel products both to meet increasing domestic demand as well as for exports. Rolled steel products already constitute a significant item of exports and a start has been made in the export of equipment. Improved productivity and price competitiveness are therefore important requirements for these industry branches which, additionally because they produce intermediate and capital goods, pass on their competitiveness (or lack of it) to sectors to which they provide inputs.

There is therefore urgent need to improve the standard of plant maintenance in Indonesian industry and for the introduction of preventive maintenance systems. A further goal, perhaps to be attempted for the next stage, would be the introduction and wide dissemination of the Total Productive Maintenance System concept with its emphasis on autonomous maintenance and operator responsibility for routine maintenance, a concept which was pioneered by Japan and has become very successful in Japanese plants.

It is in the above context that the Government of Indonesia has requested UNDP/UNIDO Technical Assistance to promote and institute modern preventive maintenance systems in Indonesian industry, initially focussing on a selected group of individual enterprises in the medium scale engineering sector. To this end an initial diagnostic is to be carried out by the subcontractor (preparatory phase of the full project). The enterprises selected are considered most promising of success from the point of view of general managerial abilities and interest as well as the existence of a minimum technological level of equipment and size of operations to ensure results. The units selected are in key engineering industry branches such as production of fabricated industrial equipment, diesel engine manufacture, steel rolling mills and general purpose engineering complexes capable of a wide assortment of fabricated and machined products. They are also highly visible enterprises in their respective industry branches and can therefore act as demonstration motivators for others. Three project locations are proposed at the major conglomerations of engineering capacity in the country namely Jakarta, Surabaya and Medan. Additionally, a core capability will be created at the Metal Industries Development Centre (which will be the active counterpart for the project on behalf of the Ministry of Industry) for providing consultancy and training, on its own, on completion of the project, for the extension of preventive maintenance systems to other units in the metal working sector, following the implementation mechanisms and the training materials developed during the project.

The following enterprises have been tentatively selected at the three locations mentioned after consultations with the enterprises concerned. However, one of the main objectives of the contract is to evaluate this tentative listing as well as to enlarge it if appropriate.

<u>Jakarta</u>	<u>Surabaya</u>	<u>Medan</u>
1. PT Sucaco	1. PT BBI Unit Indra	1. CV Multi Mineral
2. PT PIMSF	2. PT BBI Unit Bisma	2. PT Tenera
3. PT Arcon Prima Indonesia	3. PT Barata Indonesia	3. PT Bintang Harapan
4. PT Tumbak Mas Inti Mulia	4. PT Jatim Taman Steel	4. PT Gunung Bahara
5. PT Unindo	5. PT Cokro Bersaudara	5. PT Atmino
6. PT Alam Raya	6. PT Meco	6. PT Gunung Gahapi
7. PT Bakrie Tosanjaya	7. PT Hanil Jaya	
8. PT Bukaka Teknik Utama		

The Government Implementing Agency will be the Ministry of Industry's Agency for Research and Development acting through the Metal Industries Development Center (MIDC). In this sense, the de-facto Government counterpart will be the MIDC. MIDC will provide the core counterpart team at the three locations namely, Jakarta, Surabaya and Bandung.

The teams will also include personnel from the Ministry of Industry's Testing Centers at Medan and Surabaya and a center to be designated for Jakarta essentially for training in operation of diagnostic equipment and interpretation of results. At each of the locations a number of enterprises have been selected for direct assistance (see above). These enterprises have forward looking management and have agreed to be actively involved in the project and are, therefore, most promising of success. After the preventive maintenance systems have been instituted in these enterprises, they can serve as "demonstration enterprises" or referral points for MIDC to extend the work to other enterprises in the region. MIDC counterpart team will also be trained in providing consulting/extension services as well as training for institution of preventive maintenance systems which, together with training material developed, can ensure further extension of activities to other areas/enterprises. As far as the direct beneficiary enterprises are concerned, they are expected to be in a position, by the time the project terminates, to continue with the instituted systems on their own.

In this context, the possibility of setting up maintenance centers was examined and given up because of the problems faced in budgetary support for such center which will be difficult to be apportioned from government budget and will be difficult to muster from private industry. More so because credibility of such center takes time to develop to a level when generation of adequate finances by sale of services is possible. Consequently, the attempt has been to design and introduce pilot preventive maintenance systems in selected enterprises at three geographical locations and at the same time create a core of capable staff at the MIDC for providing consultancy and training to industries and continue the extension work in regard to preventive maintenance to other enterprises.

Thus while 21 units in total at three locations have been identified for direct enterprise level assistance, the intention is to choose one or two lead enterprises at each location which would receive in the first instance concentrated technical assistance for upgradation of their maintenance systems and to be used subsequently as referral and demonstration centers for training and upgrading the other target units.

A well designed strategy for introduction of preventive maintenance systems to the target group described would call for the following major components, all of which would, therefore, need to be addressed by the project.

- (a) A promotion and sensitization campaign mainly targeted towards senior management but extending also, at a different level, to front line supervisors and operators. This latter aspect is particularly important if, at a later stage, autonomous maintenance concepts with operator responsibility for routine maintenance are to be introduced.
- (b) Training of plant personnel
- (c) Provision of diagnostic facilities, to the largest extent of a portable variety, including also for calibration of measuring devices.
- (d) A consulting/extension capability including for advice on management and organizational modifications

In summary, the project of technical assistance should aim to actually institute and provide training on maintenance systems at enterprise level and additionally provide diagnostic consultancy services in maintenance practices so that both the engineering and managerial aspects are fully addressed.

B. AIM OF THE CONTRACT

The basic purpose of preparatory assistance is to carry out a diagnostic of the enterprises selected as well as others that may be considered appropriate in the three locations namely Jakarta, Surabaya and Medan, focussing on existing levels of technology, operator skills, maintenance organization and effectiveness, maintenance systems used and records maintained, training requirements for maintenance managers, organizational structure and top management commitment to maintenance, availability of diagnostic facilities and other pertinent aspects.

The contractor is also expected to examine alternative project implementation strategies and validate the proposed implementation modality. In particular, the exact requirements from the Metal Industries Development Center in each of the three locations as well as at their main facilities in Bandung and the precise roles and functions of the target enterprises including organizational arrangements will need to be specified in detail by the preparatory assistance. The exact manner in which the Metal Industries Development Center needs to organize this activity so as to ensure that it can sustain the momentum generated by the project should also be examined and elaborated upon.

In case of the Government wish to nominate a local consulting organization, the sub-contractor will team-up with this organization and will involve it in implementing the scope of subcontracting services.

C. SCOPE OF THE CONTRACTING SERVICES

1. The Subcontractor shall submit a detailed Study Report containing systematic collection of facts, analysis, conclusions and recommendations based on:

- review of the general situation in the country and institutional arrangements concerning preventive maintenance and repairs (classify and quantify nomenclature and age of equipment for preventive maintenance, available diagnostic facilities, repair facilities and spare parts, accepted practices; availability of technical documentation, readiness of equipment and the most common refuses; qualification, salary and availability of service personnel; contract conditions for imported equipment, existing computer facilities, existing training facilities, etc);

- visit of the twenty-one enterprises listed under "General Background Information" in order to collect and collate the necessary information and to fully assess their present status including workshops, computer facilities for maintenance procedures, organizational structure, equipment and parts requirements, service personnel, etc. make recommendation for better housekeeping in respect to maintenance and repair;

- interview of selected maintenance management personnel on macro-, sectoral-, and plant-level in order to get the general picture in respect of their knowledge, experience and awareness towards existing maintenance practice and future requirements. The analysis of this interview has to show the degree of sensibilization of senior managements in this field and will provide approaches in determination of the modalities of the project implementation, scope and structure of necessary activities and training programmes to obtain optimal results towards the achievement of the objectives for which the large-scale project is undertaken.

- the sub-contractor will also consider alternative strategies for introducing preventive maintenance strategies at industry- and national-wide levels and will give comparative analysis of their advantages and shortcomings. The counterpart organizations' capacity to establish a core of national specialists to continue the activities after the project termination has to be evaluated. A detailed plan of actions to reach this purpose has to be suggested.

- analyze the collected information, identify the principal factors to which the current lack of planned maintenance is attributed; and prepare recommendations for a systematic introduction and expansion of preventive maintenance and setting-up a relevant institutional arrangement in the country; make recommendations for the introduction of a computer-aided maintenance system based on personal computers. This analysis must contain the examination of alternative project implementation strategies. In view that this part of the Study Report will form a basis for a full-scale project document, it must include all necessary economical calculations and technical details necessary to support the future technical assistance in this field.

2. The subcontractor will also prepare and submit a detailed and complete draft Project Document, according to UNDP format for the full programme of TA, with a detailed work programme, estimates of equipment requirements, scope of training demands, necessity of international expertise, a list of financial inputs to the project.

Following the termination of the draft report, the team will be joined by a UNIDO mission in Jakarta for two weeks, in order to discuss and finalize with UNDP field office and National Authorities concerned the above-mentioned project document.

D. GENERAL TIME SCHEDULE (tentative)**Phase I: Initial activity****Time: week(s) after award of contract**

Finalization and distribution of questionnaires to the twenty-one enterprises for their advanced consideration (questionnaires should be distributed through the UNDP to the twenty-one enterprises selected. These questionnaires should include to the extent possible all the issues which will be discussed during the visits of those enterprises by the subcontractor's team. The timely availability of those questionnaires in the enterprises selected will enable their responsible staff to fill in the questionnaires and to submit them to UNIDO before briefing of the subcontractor)

Briefing in Vienna (UNIDO HQ) 1

Arrival in project area 1

Phase II: Activities in project area

1. Discussion with the Ministry of Industry, Metal Industries Development Center, Industry Associations and other related bodies 2

2. Visits to the plants 3-8

3. Formulation of conclusions and recommendations in accordance to points B,C (pages 4, 5) 9-10

4. Discussion of the above formulations with the National Counterpart/UNDP 10-11

5. Finalization of draft project document 11-12

6. Concluding discussion with UNIDO staff/ National Counterpart of draft project document (leave project area) 13

Phase III: Final activity

Submission of final report and draft project document 15

E. PERSONNEL IN THE FIELD

Total is estimated at 9.0 m/m.

A team should be composed of three high level experts in the following specializations:

- (a) Organization of plant maintenance with extensive experience (minimum 7 years) in engineering enterprises.
- (b) Training of maintenance personnel at supervisory and operational levels.
- (c) Diagnostic facilities and organizational arrangements for adequate preventive maintenance and training of personnel for diagnostic methods

The subcontractor may make alternative proposals for the make up of the team within the total 9m/m.

F. LANGUAGE

English

G. REPORTS

- (a) Draft final report: 5 copies
- (b) Final report: 15 copies
- (c) Draft Project Document: 15 copies

LIST OF PERSONS MET

ORGANIZATION	NAME	FUNCTION	LOCATION
UNDP - UNIDO	- G.L. NARASIMMAN	UNIDO Country Director	Jakarta
	- PAIVI KORVENMAA	J.P.O. (Junior Professional Officer)	Jakarta
	- MARIO T. MUSTAFA	S.P.A. (Senior Program Assistant)	Jakarta
MINISTRY OF INDUSTRY	- GARJITO P.S.	Chief of Research Centre (BPPI)	Jakarta
	- D. SUPARDI HAROEN A.R.	Director for Program Development (Directorate General of Machinery, Basic Metal and Electronics Industry)	Jakarta
	- JANNUS L. TOBING	Chief of multivarious Industry Division for Regional Medan	Medan
M.I.D.C. (BBLM)	- ASLAM B. DJANUN	Director	Bandung
	- SUPANDI	Counterpart	Bandung
	- ACHMAD KOMARA	Assistant Counterpart	Bandung
	- KOMARNA MIHARDJI	Planning	Bandung
TESTING CENTRES	- SUPRATO (BBBT)	Director Material and Engineering Product Testing	Bandung
	- BASOEKI	Chief of Institute for Research and Development of Industries	Surabaya
	- PANDER SITINDAON	Industrial Advisory Service (Counterpart for GTZ : Deutsche Gesellschaft für Technische Zusammen- arbeit) BPLM	Medan
	- MARTHIN SILALAH	Chief of BPLM (Balai Penelitian Logam Medan)	Medan

ORGANIZATION	NAME	FUNCTION	LOCATION
TRAINING CENTRES			
<i>A. Ministry of Education</i>			
1) Brawiyaya University Polytechnical School Malang	- Siamsul HADI - R. Edy Purwanto	Maintenance & repair management construction, automation, tools & machines	Surabaya repair Surabaya repair
	- Bambang Suglyomo - Wirawan	Business management Product design	Surabaya repair Surabaya repair
2) Institute for Practical Technical Education (Balai Latihan Pendidikan Teknik)	- M. Sibarani	Director	Medan
3) I.T.B. (Institute of Technology Bandung) - University	- Dr. Ir. Rochim Suratman - Prof. Ir. Tota Surdia	Faculty of metallurgy Faculty of metallurgy	
<i>B. Ministry of Manpower</i>			
1) Singosari Training Centre (near Malang-Surabaya)	- Slamet Goenadi	Director	Malang (Surabaya)
2) Trainers and small scale Industry Training	-		Jakarta

ORGANIZATION	NAME	FUNCTION	LOCATION
<p><i>C. Private Training Centros</i></p> <p>1) P.T. Nusantara Cyberneic Eka Perdan "Festo"</p> <p>2) Technical Highschool Medan "Multi Karya"</p>	<p>- R. Kirchgassner - Jin Budiharjo</p> <p>- Marsimin</p>	<p>General manager Didactic manager</p> <p>Director</p>	<p>Jakarta Jakarta</p> <p>Medan</p>
INDUSTRIES			
<i>1. Jakarta Region</i>			
<p>1.1 Bukaka Teknik Utama</p>	<p>- Kusnan Nuryadi - Johannes Schut - Koestiono P. - Herry Priana - Hasibuan E. - Barangin</p>	<p>Factory director Technical advisor (training) Chief of quality control Quality control manager Chief of electrical division Chief of maintenance section</p>	<p>Jakarta Region</p>
<p>1.2 PIMSF (Tjokro Group) - Factory for machining and repair (Pabrik Mesin & Repair)</p>	<p>- Warneri Moerad</p>	<p>Technical staff</p>	<p>Jakarta region</p>
<p>1.3 Morita Tjokro Gearindo (Tjokro Group)</p>	<p>- Benjamin Soesetyo</p>	<p>Maintenance manager</p>	<p>Jakarta Region</p>

ORGANIZATION	NAME	FUNCTION	LOCATION
1.4 Arkon Prima Indonesia	<ul style="list-style-type: none"> - Suwito Padmosedono - Kemal Mahdy 	Manufacturing manager Works manager	Jakarta Region
1.5 Sucaco (Supreme Cable Manuf. Corp. P.T.)	<ul style="list-style-type: none"> - Purnawan Arijanto - Robert Tanto - Djoni Setyadi - Irsan Koesno - Jeffry Djamin 	Manufacturing director Product engineer Mgr. R & D manager Plant engineering Manager Preventive maint. & workshop Supervisor (P.E. Dept.)	
1.6 P.T. Bakrie Tosanjaya	<ul style="list-style-type: none"> - Sukidjo Hadi Santoso - Turmudhy - Bambang Hartanto - Prosetya 	Manager engineering Manager manufacturing Ass. Manager maintenance Marketing manager	
1.7 UNINDO (Switchgear, Distribution & Power Trar.sformer manuf.) GEC-Alsthom	Cancelled		
1.8 Tumbak	Cancelled		
1.9 Alam Raya	Cancelled		

ORGANIZATION	NAME	FUNCTION	LOCATION
2. Surabaya Region			
2.1 P.T. Boma - Bisma - Indra Unit Indra	- Djajadi Rachmot - Ananda Soejoso - Ketut Rasdita - Juardianto	Headquarters, planning division unit manager Production division manager Maintenance section	
2.2 P.T. Boma - Bisma - Indra Unit Bisma II	- M. Ardani	Chief subdivision production (in charge of maintenance Bisma I + II)	
2.3 P.T. Agrindo (Rutan Machinery Trading Co)	- Arief Gunawan - Cuk Sotoyo - Rayendra Rasmin	President director Production planning Supervisor Umun (Jakarta Office)	
2.4 P.T. Meco Inoxprima	- Djoko Wahjuwijono	Production manager	
2.5 Barata Indonesia Heavy Equipment Branch	- Mudjianto - Soeparwoto - D. Winoto	Branch manager Director of production and engineering (at group level) Chief of maintenance machines	
2.6 Jatin Tamar Steel Manufacturing	- Karyomo S. - Kesuma Tjandra	Production manager Product planning control and quality Control chief	
2.7 BENGKEL Bersandara (Tjokro Group)	- Soekartono	Manager	
2.8 Hanil Jaya Metal Works	- Choi Dong Hyeun - Frans A.W. Rumambi	President director Director	

ORGANIZATION	NAME	FUNCTION	LOCATION
<p>3. Medan Region</p> <p>3.1 Logam</p> <p>3.2 Multi-Mineral</p> <p>3.3 Pabrik Mesin Tenera (Unit PMT, part of PTP VII Palm Oil)</p>	<ul style="list-style-type: none"> - Suwardi Wongso - Marsimin - Tomo Atmaja - M. Sabri - Katio Sumantri - T. Pasaribu - Dalimunte - Nasution - Purba 	<p>Mechanical engineer</p> <p>Director Production director Planning & quality control (production) Machine tools</p> <p>Unit manager Design Production manager Administration</p>	

UNIDO DP/INS/88/024

QUESTIONNAIRE FOR MAPPING OF SELECTED ENTERPRISES
FOR ENVISAGED UNDP/UNIDO PROJECT (DP/INS/88/024)

GENERAL INFORMATION

1. Organization/Institution Abbreviated Name :
.....
2. Full Name; Type of Organization :
.....
.....
3. Address :
.....
.....
4. Telephone : 5. Telex :
Telefax :
6. Cable address :
7. Head/Director (Name) :
.....
8. Person to contact/ Position :
.....
9. Other Persons/ Position :
.....
.....
10. Branch Office Location :
.....
.....
.....
11. Type :
 - private owned
 - state owned
 - mixed

TABLE OF INVESTIGATION	Result of observations	Remarks
1	2	3
GENERAL INFORMATIONS CONCERNING VISITED PLANTS		
<ul style="list-style-type: none"> - Location <ul style="list-style-type: none"> - Region - Distance to center of region (km) 		
<ul style="list-style-type: none"> - Nationality of the main equipment manufacturers 		
<ul style="list-style-type: none"> - Type of contract of the factory 		
<ul style="list-style-type: none"> - Year of start-up 		
<ul style="list-style-type: none"> - Year of important extensions since start-up 		
<ul style="list-style-type: none"> - Number of persons employed 		
DESCRIPTION OF THE PRODUCTION EQUIPMENT		
<ul style="list-style-type: none"> - Generalities 		
<ul style="list-style-type: none"> - Complexity of the installations 		
<ul style="list-style-type: none"> - Mechanical equipment <ul style="list-style-type: none"> - diversification of suppliers/manufacturers 		
<ul style="list-style-type: none"> - standardisation - maintainability/accessibility for maintenance purposes 		
<ul style="list-style-type: none"> - state of main production equipment - state of accessories of the production equipment 		

1	2	3
<ul style="list-style-type: none"> - Electrical equipment <ul style="list-style-type: none"> - tension - variety of suppliers: manufacturers - maintainability - state of machinery and equipment - standardisation - Instrumentation equipment <ul style="list-style-type: none"> - variety of suppliers - standardisation - maintainability - state of equipment 		
<p>ORGANIZATION AND SERVICES OF THE MAINTENANCE DEPARTMENT</p>		
<ul style="list-style-type: none"> - Existence of main organization chart of the plant - Existence of detailed organization chart of the maintenance department - Existence of the following maintenance services and their dependence <ul style="list-style-type: none"> - Central maintenance planning office - Central workshops (electro-mechanical): <ul style="list-style-type: none"> - mechanical - electrical - instrumentation - Maintenance of rolling/mobile equipment - General services - Spare parts management and stores services (SPMS) - Central maintenance planning office <ul style="list-style-type: none"> - Existence of the following sections : 		

1	2	3
<ul style="list-style-type: none"> - archives and central technical documentation - maintenance methods (MM) - maintenance engineering and construction (CONSTR)=(ET) - maintenance management (MMA)=(GM) - reprography - planning section (PL) = (DPL) <ul style="list-style-type: none"> - programming - job preparation - work scheduling - visitors - Efficiency of the above mentioned sections <ul style="list-style-type: none"> - technical documentation : <ul style="list-style-type: none"> - complete in % - drawings, manuals, technical instructions - maintenance scheduling, preventive programme - uniform codification of drawings - itemisation of machines - accessibility - updating - central job-preparation efficiency of the job-preparation - paperwork/conception/efficiency <ul style="list-style-type: none"> - machine-file - machine history record - preventive maintenance cards 		

1	2	3
<ul style="list-style-type: none"> - lubricating - scheduling - execution - efficiency - standardisation of lubricants - preventive maintenance <ul style="list-style-type: none"> - scheduling - execution - efficiency - flow of forms and information in the CMPO (MIS) - Mechanical service <ul style="list-style-type: none"> - Existence of centralized workshop - location of work shop(s) versus production - capacity of work shops : - job preparation - presence of intervention teams - presence of specialized teams for special works - tools - quality of work - Electrical service <ul style="list-style-type: none"> - existance of centralized workshops - location of work shop versus production - capacity of workshop: - job preparation - presence of intervention teams - presence of rewinding workshop - tools and equipment - quality of work - Instrumentation services 		

1	2	3
<ul style="list-style-type: none"> - Existence of : - intervention teams: - workshop for instrumentation service - tools, instruments, equipments - quality of work - Spare parts management and stores services (SPMS) - Existence of a core for codification <ul style="list-style-type: none"> - uniform codification - quality of the codification grid - Existence of a core for stock management: <ul style="list-style-type: none"> - computerized stock management - efficiency - Existence of a core <ul style="list-style-type: none"> - for spare parts selection <ul style="list-style-type: none"> - specific parts - standard parts - efficiency - Existence of stores <ul style="list-style-type: none"> - centralized - decentralized - total surface of the floor - store catalogue - preservation of parts - number of stock items - stock value - Sufficient quantity of stocks <ul style="list-style-type: none"> - specific parts - standard parts - consumables 		

1	2	3
<ul style="list-style-type: none"> - Number of movements per month - Labour force for the SPMS - Reordering <ul style="list-style-type: none"> - delays in the plant - organization - efficiency - Utility services <ul style="list-style-type: none"> - Existence of a maintenance workshop for the rolling equipment - Technical equipment of the workshop - Independent stores for rolling equipment - General maintenance service <ul style="list-style-type: none"> - production and distribution of energy and fluids - transport and handling - Building maintenance <ul style="list-style-type: none"> - personnel - quantity of work - Complexity of maintenance works <ul style="list-style-type: none"> - % of routine works - % of specialized works - % of very specialized works - Maintenance personnel <ul style="list-style-type: none"> - labour force in maintenance - detailed qualifications (total for each qualification group) <ul style="list-style-type: none"> - cadres - foremen level 		

1	2	3
<ul style="list-style-type: none"> - skilled - low skilled - vocational training - labour force of training section - training equipment <ul style="list-style-type: none"> - buildings, etc - training on the job - training outside the plant <ul style="list-style-type: none"> - forecast - in progress - complementary training - result of training sections - discipline - turn-over of personnel - respect of internal procedures and rules - Accountants department in relation to maintenance continue enregistrement of : <ul style="list-style-type: none"> - costs for spare parts - costs for personnel - depreciation of equipments - costs for vocational training - stock value - Budget <ul style="list-style-type: none"> - establishment of a global budget for maintenance - establishment of a budget for vocational training for maintenance personnel - verification of budget 		

- weak : little effort has been made by the constructor to use standard machine parts and equipment components
- non-existent : no effort has been made to use standard material.
- maintainability
- good: excellent disassembling condition of parts and easy access to several subassemblies, even with special tools. Easy access to machine-handling equipment (lifting devices, etc.). Maintenance facilities and accessories provided
- average : fair disassembling conditions and access. Bad access to machine-handling equipment
- bad : very bad conditions of disassembly and access. Transport of subassemblies next to impossible without removal of other machines, removal of walls, etc.
- State of equipment
- good: operation secured, no abnormal wear-out
- average : operation secured but apparent wear-out and ageing
- bad : frequent break-downs and stand-stills and equipment too old to secure an operation under acceptable conditions.

Organization and sections of maintenance

The data with regard to the organization chart of the plant are set out to show the hierarchical level of the maintenance department in the plant. To this end, questions concerning the centralization of maintenance, its place in the organization chart, the existence and interdependence of its different services are raised.

The obtained data make it possible to check whether the organization system enables maintenance to fulfil its task or whether maintenance is regarded as an inevitable evil.

The maintenance department is said to be centralized when all the sections with a maintenance activity are under the authority of one department with one person in charge.

The questions concerning the Central Maintenance Planning Office are related to the organization, the role and the efficiency of this division in the plant. If the Central Technical Maintenance Planning Office does not exist as such, data have to be collected in order to check whether other sections carry out the tasks of such a office.

In addition, questions will be raised regarding the existence and efficiency of :

- preventive maintenance and lubrication;
- technical documentation;
- job preparation;
- information systems.

The results of these enquiries will reflect to which degree maintenance is scheduled or improvised.

It will be checked whether technical documentation is complete. The efficiency is also reviewed and is judged by checking the uniformity of the codification, the access to documentation and its updating :

- good : the parameters mentioned above are adequate for normal maintenance
- average : the parameters are only partly satisfied but show improvement
- bad and very bad : the technical documentation is very incomplete and no attempt at improvement is undertaken.

The efficiency of the job preparation (work-specifications) is evaluated as follows :

- good : maintenance work is prepared in such a way that improvisations are reduced to a minimum. The qualifications of the personnel are excellent and they have at their disposal the material they require
- average : the job-preparation desk only partly carries out the work it is expected to do; a tendency towards improvement exists
- bad or very bad : the job-preparation desk does not carry out its job and nothing is undertaken to remedy this situation.

Information regarding the situation of the Mechanical, Electrical and the Instrumentation Services is collected :

- the existence of a central workshop and/or decentralized workshops and their locations;
- planning section;
- capacity of the workshop (mechanical and electrical division) or of the laboratory (instrumentation divisions);
- intervention teams and special teams (hydraulic, pneumatic, electronic, etc...);
- machinery and equipment;
- quality of work.

The evaluation which relates to the location of workshops :

- good : workshops with a central location
- average : workshops with a favourable location
- bad and very bad : badly-located workshops with long distances to working-places

The technical equipment and tools of these divisions are evaluated as follows :

- good : complete set of tools, special tools included
- average : sufficient tools available for normal maintenance
- bad and very bad : the execution of maintenance work is hampered by insufficient or bad tools.

The review of the quality of work is based on the analysis of the state of equipment on the one hand and on the investigation of work in the maintenance workshops on the other :

- good : the quality and the precision of locally manufactured spare-parts are in conformity with those indicated on the drawings, the repairs on site are done in the approved way, sound state of production equipment,
- average : the quality and the precision of the locally manufactured spare-parts are only partly in conformity with the drawings, nevertheless these parts can be used; the state of equipment indicates improvisations but does not causes unavailability,
- bad and very bad : the quality and the precision of the locally manufactured spare parts on site are mediocre. The state of installations is very bad, due to repairs and interventions being carried out poorly.

Within the field of Spare-parts management and stores the following issues are analysed :

- existence, nature and codification of spare-parts;
- organization and efficiency of stock management;
- choice of spare-parts and their required quantity;
- paperwork and information systems;
- problems of reordering;
- storage facilities.

The following criteria are used as far as the paperwork and the information flows are concerned :

- good : data-collecting (paperwork, codification grid, various cards, etc.) is clear and correct. The information systems operate in an excellent way,
- average : although data collecting is not done in the most favourable way it can be used. The information system is all right,.
- bad or very bad : data collection and the information system do not fulfil the requirements

The efficiency is evaluated as follows :

- good : the works in the various sections are correctly carried out and meet the requirements
- average : the works in the various sections are not always correctly carried out but attempts at improvement are undertaken
- bad or very bad : the various sections exist but are not capable of carrying out their tasks properly, which hampers or makes maintenance impossible.

The evaluation of the stores is as follows :

- good the storage facilities meet the requirements. The parts are properly stored
- average the storage facilities do not always meet the requirements and the actual storage of parts is poor.
- bad or very bad the storage facilities do not meet the requirements at all and actual storage is very poor.

In the field of Utilities, the enquiry covers the maintenance of rolling-stock, buildings, tracks, roads, sewerage and equipment for production and distribution of energy and fluids. Both the quality of the work and the means to carry it out (equipment, spare parts), will be examined.

An estimation of the degree of complexity of maintenance works makes it possible to have an idea of the required personnel and their necessary qualifications.

The following categories exist :

- routine : maintenance of machines based on simple technology
- special works : maintenance of machines and equipment with an average rate of automation
- very special works : maintenance of very complicated and automatic machines with a high precision rate.

Personnel

The **labour force of maintenance** is all the personnel belonging to sections which have a maintenance task and which are included in the maintenance organization chart as it exists in the plant.

Questions regarding **professional training** of maintenance personnel will essentially relate to the actions which have been undertaken in this field.

Attention will also be given to the discipline of the personnel (follow up of orders, filling in of paperwork, presence at work, etc.) and to the safety of work (respect of safety orders, fire-prevention measures and devices, etc.).

Maintenance cost and budget

The existence and the application of accounting in the field of maintenance is reviewed by analysing the use of cost accounting in the Company.

With regard to investments the enquiry will examine whether investments in maintenance are treated independantly from other investments. In addition questions dealing with the value of stocks and the amount of sub-contracted maintenance work are raised.

It will be determined whether breakdown costs are known and evaluated and whether detailed maintenance budgets exist.

2 THE PLANT VISIT

General data are collected at a meeting with the plant management during which the audit program is made. The persons in charge of the various sections concerned are then notified in order that they may give their full assistance.

The audit on the production equipments has to be carried out per production area. A production operator will be asked to give explanations if necessary. The audit will be carried out in the form as described in the previous chapter.

After having checked the state of production equipment and its operation the different maintenance divisions are examined.

In order to obtain objective information, questions will not only be asked to the Maintenance or Production Manager but also to foremen and workers.

One will proceed according to the following priorities:

1. store of spare parts
2. central maintenance planning office
3. mechanical workshop
4. mechanical interventions
5. electrical workshop
6. electrical interventions
7. instrumentation
8. general maintenance
9. accounting
10. personnel section.

It is of the greatest importance to get an overview during the survey which goes beyond the specific questions marked on the chart. The interdependencies which often exist in a plant may influence the various subjects of the enquiry considerably. Only a complete overview will allow the correct approach to the answers received.

3. ANALYSIS OF THE SURVEY

The analysis of the collected data aims at assessing the existing problems in a plant or a group of plants in order to recommend improvements.

The overall review charts will show :

- average distance from the plant to the industrial centre of the region;
- type of construction contract;
- delays in construction as compared with initial scheduling;
- complexity of machinery equipment;
- variety of manufacturers and suppliers;
- standardization of mechanical and electrical equipment;
- accessibility to the equipment for maintenance work;
- state of machinery and equipment;
- the position of maintenance within the plant's organization chart;
- existence and efficiency of maintenance divisions or sections mentioned in the previous chapters;
- amount and quality of technical documentation and the access to it;
- preparation of a systematic organization of preventive maintenance and lubrication;
- the circuits of data and the paperwork;
- the efficiency of data collection;
- maintenance machinery and equipment;
- the study of spare-parts;
- the uniform codification of parts;
- efficiency of spare parts management and reordering;
- level of stocks of spare parts;

- efficiency of storage facilities;
- satisfaction of requests for parts;
- the qualifications of the maintenance labour force;
- the training carried out;
- data collection of maintenance costs;
- data-processing of maintenance costs.

4. EVALUATION OF THE AUDIT

From the overall review chart a detailed survey of the situation will be made which will make it possible to set out the priorities and proposed measures for improvement.

These measures concern :

- equipment;
- personnel;
- material means (spare parts, technical documentation, tools, equipments, etc.) ;
- organization;
- management of the plant
- actions to be taken when purchasing new equipment.

COMMENTS ON LIST OF SELECTED ENTERPRISES

Following enterprises have not been audited for reasons listed below :

- P.T. UNINDO : Joint Venture Government/Alstohm France.
Manufacturer of Big Transformers (up to 150 KW).
Contracts with Indonesian Government.

The company has international technical assistance from Alstohm and is not interested in other assistance. The present mission obtained finally an appointment with the public relations manager, but it was impossible to meet somebody of the technical or senior management.
- P.T. Tumbak Mas : MIDC has been informed by official letter that the company was no longer interested in the programme.
- P.T. Alam Raya : Although preparations were made by MIDC, final appointment has never been reached.
- P.T. Hamil Jaya Steel : Steel mill with electrical furnace and continuous casting.
Private company, Joint venture with Korean Company.
The President director general is Korean.
Production and maintenance responsables are all Korean.
Only the director is Indonesian but he is principally concerned with personnel and public relations affairs.
There is no transfer of technology.
The company is not interested in external technical assistance as there is even no access to the plant for outsiders.
- P.T. Bintang Harapan : No arrangements could be made for meeting.

SUMMARY OF FINDINGS OF AUDITED ENTERPRISES

Activities of audited plants		
Region	Name and address of Company	Main activity (ies)
1. West Java (Jakarta)		
1.1.	P.T. BUKAKA TEKNIK UTAMA Jl. Raya Bekasi Cibeonng km 19,5 Cileungsi, Kab. Bogor, Jabar	Steel tower construction, machine tool shop, galva- nizing plant, plate works, mechanical assembling, bronze casting, mechanical construction engineering
1.2.	P.T. PULO GADUNG INDONESIA MACHINE & SPARE PARTS FACTORY (P.T. PIMSF PULO GADUNG) Jaban Pulo Gadung 12, Kawasa Industri Pulo Gadung Jakarta Timur 13920	machine tool manufacturing and spare parts manufac- turing
1.3.	MORITA T.JOKRO GEARINDO Kawasan Industri Pulo Gadung Jl Rawa Terata 1 n° 9 Jakarta Timur 13920	Gear hobbing and automotive spare parts
1.4.	P.T. ARKON PRIMA INDONESIA	structural steel designers, fabricator and erector (process plant and industrial structures : platework in flues, silos, hoppers, bridges, etc.)
1.5.	SUCACO (P.T. Supreme Cable Manufacturing corporation) Factory : Jl Daan Mogot, km 16 Jakarta Barat	Manufacturing of electric power and telephone cables
1.6.	P.T. Bakril - Tosanjaya Jaban Bekasi Raya km 27 Bekasi, P.O. Box 624 Jakarta 11001	Platework and foundry (malleable pipe fittings and general castings, malleable grey or ductile iron)

TABLE OF INVESTIGATION	1.1	1.2	1.3	1.4	1.5	1.6
GENERAL INFORMATIONS CONCERNING VISITED PLANTS						
- Location	Bog	Jak	Jak	Jak	Jak	Jak
- Region	Jak	Jak	Jak	Jak	Jak	Jak
- Distance to center of region (km)	35	10	10	20	16	37
- Nationality of the main equipment manufacturers: diversification	high	high	high	high	high	high
- Type of contract of the factory	private	private	private	private	private	private
- Year of start-up	'78	'72	'85	'73	'70	'75
- Year of important extensions since start-up	'81 cont.	cont.	'88	'80	cont.	'84
- Number of persons employed	1250	370	350	300	1000	450
DESCRIPTION OF THE PRODUCTION EQUIPMENT						
- Generalities	Mach. Tools (also CNC)	Mach. Tools	Gear Hob (CNC)	Process. plnt	Cable Mfg. eqp.	Fdry Eqpmt CNC
- Complexity of the installations	high	high	high	avrg	high	high
- Mechanical equipment						
- diversification of suppliers/manufacturers	high	high	avrg	avrg	high	high
- standardisation	poor	bad	avrg	good	low	none
- maintainability/ accessibility for maintenance purposes	good	good	good	good	good	good
- state of main production equipment	avrg 70% availb	avrg	avrg	good	good	avrg

- state of accessories of the production equipment	avrg	avrg	good	good	good	avrg
- Electrical equipment						
- alimentation tension	20 KV +6x250 KVA GS	20KV	20 KV	20KV	20KV	20KV
- variety of suppliers manufacturers	high	high	avrg	avrg	high	high
- maintainability	good	poor	good	good	good	good
- state of machinery and equipment	avrg	avrg	good	good	good	avrg
- standardisation	poor	bad	good	avrg	poor	none
- Instrumentation equipment						
- variety of suppliers	low	high	low	none	high	avrg
- standardisation	good	bad	good	-	low	none
- maintainability	good	avrg	good	-	avrg	good
- state of equipment	good	avrg	good	-	avrg	good
ORGANIZATION AND SERVICES OF THE MAINTENANCE DEPARTMENT						
- Existence of main organization chart of the plant	yes	yes	yes	yes	yes	yes
- Existence of detailed organization chart of the maintenance department	yes	yes	yes	yes	yes	yes
- Existence of the following maintenance services and their dependence						
- Central maintenance planning office	no	no	yes	yes	yes	yes
- Central workshops (electro-mechanical)	no	no	yes	yes	yes	yes
- mechanical	yes	yes	yes	yes	yes	yes
- electrical	yes	yes	yes	yes	yes	yes
- instrumentation	no	no	no	no	yes	no
	(prod)					
- Maintenance of rolling/mobile equipment	yes	yes	no	yes	yes	yes
- General services	yes	yes	yes	yes	yes	yes
- Spare parts management and stores services (SPMS)	no	no	no	no	yes	yes
	(prod)					
- Central maintenance planning office	no	no	no	yes	yes	yes

- Existence of the following sections :							
- archives and central technical documentation	no(pr)	no	yes	yes	yes	yes	yes
- maintenance methods (MM)	no	no	no	no	no	no	poor
- maintenance engineering and construction (CONSTR)	no	no	no	no	yes	no	
- maintenance management (MMA)	no	no	yes	no	yes	yes	yes
- reprography	no	no	no	no	no	no	no
- planning section (PL)							
- programming	no	no	yes	yes	yes	yes	yes
- job preparation	no	no	no	poor	no	poor	poor
- work scheduling	poor	no	no	yes	yes	yes	yes
- visitors	no	no	no	no	yes	yes	yes
- Efficiency of the above mentioned sections							
- technical documentation :	none	none	good				
- complete in %	unestimable	0	95 %	80%	90%	95%	
- drawings, manuals, technical instructions	none	none	good	good	good	good	good
- maintenance scheduling, preventive programme	none	none	avrg	avrg	good	good	good
- uniform codification of drawings	none	none	none	none	none	none	none
- itemisation of machines	none	none	yes	good	yes	yes	yes
- accessibility	good	good	avrg	good	good	good	good
- updating	none	none	not appl.	avrg	yes	yes	yes
- central job-preparation efficiency of the job-preparation	none	none	none	none	good	poor	
- paperwork/conception/efficiency							
- machine-file	none	none	none	avrg	good	none	none
- machine history record	none	none	avrg	avrg	good	good	good
- preventive maintenance cards	none	none	none	none	avrg	avrg	avrg
- duplicating							
- scheduling	opt	opt	good	good	good	good	good

- execution	oprt	oprt	good	avrg	avrg	good
- efficiency	avrg	avrg	good	avrg	avrg	good
- standardisation of lubricants	none	yes	yes	good	yes	none
- preventive maintenance						
- scheduling	none	none	yes	yes	yes	yes
- execution	none	poor	avrg	avrg	good	good
- efficiency	none	none	avrg	avrg	avrg	good
- flow of formulars and information in the CMPO	none	poor	avrg	poor	good	good
- Mechanical service						
- Existence of central- ized workshop	no	no	no	yes	yes	yes
- location of work shop(s) versus production	prod. worksh	prod. works	prod. works	good	good	good
- capacity of work shops :	good	good	good	good	good	insuf
- job preparation	none	yes	yes	no	avrg	no
- presence of inter- vention teams	yes	yes	yes	yes	yes	yes
- presence of speci- alized teams for special works	no	no	no	no	yes	yes
- tools	good	avrg	good	avrg	good	poor
- quality of work	poor	avrg	good	avrg	avrg	poor
- Electrical service						
- existance of central- ized workshops	yes	no	yes	yes	yes	yes
- location of work shop versus produc- tion	good	-	good	good	good	good
- capacity of workshop	suffic.	-	suffc.	good	good	insuf
- job preparation	no	-	no	no	avrg	no
- presence of interven- tion teams *	yes	yes	yes	yes	yes	yes
- presence of rewind- ing workshop	no	yes	yes	no	yes	yes
- tools and equipment	good	avrg	good	avrg	good	poor
- quality of work	avrg	bsd	avrg	avrg	avrg	poor
- Instrumentation servi- ces						
	no (prod. facil.	no	yes	no	yes	no
- Existence of :						
- regulation service		no	no	no	yes	no
- intervention teams		no	no	no	yes	no
- work shop for instru- mentation ser- vice		no	no	no	good	no

- tools, instruments, equipments	no	no	oscil	no	good	no
- quality of work	no	no	good	no	good	no
- Spare parts management and stores services (SPMS)	no (or organized by product)					
- Existence of a core for codification	yes	no	no	no	no	yes
- uniform codification	yes	-	-	no	no	yes
- quality of the codification grid	avrg	-	-	no	no	avrg
- Existence of a core for stock management	(prod. only)	no	no	no	yes	yes
- computerized stock management	yes	no	no	no	no	no
- efficiency	good	no	no	no	avrg	avrg
- Existence of a core for spare parts selection	no	no	no	no	yes	no
- specific parts	-	-	-	-	yes	-
- standard parts	-	-	-	-	no	-
- efficiency	none	none	none	none	avrg	avrg
- Existence of stores						
- centralized	yes (prod)	yes (prd)	yes (prd)	yes (prd)	yes (prd)	yes (prd)
- total surface of the floor	togeth. w.prod	15 m2	32 m2	-	400m2	1000
- store catalogue	no	no	no	yes	no	no
- preservation of parts	good	poor	good	avrg	good	avrg
- number of stock items	unknown	100	100	500	1000	2000
- stock value	unknown	unknown	unknown	15 mln rp	unknown	unknown
- Sufficient quantity of stocks	not for maint.					
- specific parts		bad	good	poor	good	avrg
- standard parts		bad	good	good	good	good
- consumables		bad	good	good	good	good
- Number of movements per month	unknown	unknown	unknown	unknown	500	300
- Labour force for the SPMS	(prod)	(prd)	(prd)	(prd)	6	6
- Reporting						

- delays in the plant	2 week	1 wk	1 wk	2 day	3 day	3 day
- organization	avrg	avrg	avrg	good	good	good
- efficiency	avrg	poor	poor	good	good	good
- Utility services						
- Existence of a maintenance workshop for the rolling equipment	yes	no	no	yes	yes	yes
- Technical equipment of the workshop	avrg	-	-	avrg	avrg.	avrg
- Independent stores for rolling equipment	no	-	-	no	no	no
- General maintenance service	yes	no	no	yes	yes	yes
		done by				
		maint				
- production and distribution of energy and fluids	yes	(mec)	(mec)	yes	yes	good
- transport and handling	yes	(mec)	no	yes	yes	good
- Building maintenance	no	no	no	no	yes	yes
- personnel	-	-	-	-	30	4
- quantity of work	-	-	-	-	avrg	good
- Complexity of maintenance works						
- % of routine works	70	60	90	90	70	80
- % of specialized works	15	30	5	5	20	10
- % of very specialized works	15	10	5	5	10	10
- Maintenance personnel						
- labour force in maintenance	27	5	9	14	56	45
- detailed qualifications (total for each qualification group)						
- cadres	partly	0	1	0	4	3
- foremen level	2	2	1	3	17	7
- skilled	10	3	7	6	35	35
- low skilled	14	-	-	5	-	-
- Vocational training	yes	no	no	no	yes	no
- labour force of training section	2	0	0	0	0	0
- training equipment: buildings, etc	yes	no	no	no	no	no
- training on the job	yes	no	no	yes	yes	yes

- training outside the plant	no	no	yes	no	yes	yes
- forecast	no	no	yes	no	no	no
- in progress	no	no	no	no	no	no
- complementary training	no	no	no	no	no	yes
- result of training sections	avrg	0	avrg	0	poor	avrg
- discipline	poor	good	good	good	avrg	good
- turn-over of personnel	low	low	low	low	low	low
- respect of internal procedures and rules	poor	avrg	poor	avrg	good	good
- Accountants department in relation to maintenance continue enregistering of :						
- costs for spare parts	no	no	avrg	no	no	no
- costs for personnel	no	no	yes	no	yes	no
- depreciation of equipments	no	no	no	no	yes	yes
- costs for vocational training	no	no	yes	no	no	no
- stock value	yes	no	yes	yes	no	unknown
- Budget						
- establishment of a global budget for maintenance	no	no	no	no	yes	yes
- establishment of a budget for vocational training for maintenance personnel	no	no	no	no	no	no
- verification of budget	no	no	no	no	yes	yes

Region	Name and address of Company	Main activity (ies)
2. East Java (Surabaya)		
2.1	P.T. BOMO BISMA INDRA (Persero) Unit Indra (P.T. BBI - Indra) Jl. Imam Bonjol n° 18, Pasuzuau Surabaya	Foundry - metal construction - machine tools - platework - heavy equipment
2.2	P.T. BOMA BISMA INDRA (Persero) Unit Bisma II (P.T. BBI - Bisma II) Jl. KHM Mangyur 229, Surabaya	Basic metal & machinery industry Manufacturer of diesel engines
2.3	P.T. AGRINDO Jl. Slompretan 16 Surabaya 60161	Machine-tools-foundry
2.4	MECO Jl. Kalipaten 114 SEPANJANG 61257 Surabaya	Mechanical constructions (Machine factory and construction works) High pressure vessels, boiler works
2.5	P.T. Barata Indonesia (Persero) Heavy equipment Branch Jl Ngagel 109 Surabaya	Manufacturing of heavy equipment, ISO containers
2.6	P.T. Jatim Taman Steel Manufactu- ring Jl Raya Taman Sidoargo Surabaya	Steel making unit (electrical furnace, rolling mill, foundry)
2.7	Bengel Bersandara Jl Kemayoran Baru 19 Surabaya (P.T. Tjokro Group)	Subcontracting works (Machine tools - assembling, few welding works)

TABLE OF INVESTIGATION	2.1	2.2	2.3	2.4	2.5	2.6	2.7
GENERAL INFORMATIONS CONCERNING VISITED PLANTS							
- Location	Pas	Sur	Sur	Sur	Sur	Sur	Sur
- Region	E. Java	E. Jav	E. Jav	E. Jav	E. Jav	E. Jav	E. Jav
- Distance to center of region (km)	60	0	20	15	0	10	0
- Nationality of the main equipment manufacturers: difersification	New. low high	low	high	high	high	low	high
- Type of contract of the factory	state	state	private	private	state	private	private
- Year of start-up	'88	'76	'76	'80	'69	'73	'73
- Year of important extensions since start-up	none	none	'79 '81	'87	cont '88	'76 '87	cont
- Number of persons employed	670	150	645	400	516	800	210
DESCRIPTION OF THE PRODUCTION EQUIPMENT							
- Generalities	fdry mach. T plate work	Mach. Tools	Mach. Tool fdry	Pres- ser vess	Mach. Tool plate work	Steel Mill fdry	Mach Tools
- Complexity of the installations	high	avrg	high	avrg	high	high	high
- Mechanical equipment							
- diversification of suppliers/manufacturers	high	avrg	high	high	high	avrg	high
- standardisation	poor	none	none	poor	none	good	bad
- maintainability/ accessibility for maintenance purposes	good	good	good	good	avrg	good	bad
- state of main production equipment	good	good	good	good	avrg	avrg	avrg

- state of accessories of the production equipment	good	good	good	good	avrg	avrg	avrg
- Electrical equipment							
- alimention tension	20 KV	20KV	20 KV	20 KV	20 KV	20 KV	20 KV
			tg				
- variety of suppliers manufacturers	high	low	high	high	high	avrg	high
- maintainability	good	good	avrg	good	avrg	good	avrg
- state of machinery and equipment	good	good	avrg	good	avrg	avrg	avrg
- standardisation	poor	good	none	poor	none	good	poor
- Instrumentation equipment							
- variety of suppliers	low	high	low	high	high	low	low
- standardisation	avrg	poor	avrg	avrg	none	good	poor
- maintainability	avrg	good	good	avrg	bad	good	poor
- state of equipment	good	good	good	good	avrg	good	avrg
ORGANIZATION AND SERVICES OF THE MAINTENANCE DEPARTMENT							
- Existence of main organization chart of the plant	yes	yes	yes	yes	yes	yes	no
- Existence of detailed organization chart of the maintenance department	yes	yes	no	yes	yes	yes (only mech)	no
- Existence of the following maintenance services and their dependence							
- Central maintenance planning office	yes	yes	no	no	yes	no	no
- Central workshops (M:yes (electro-mechanical) (E:no	M:yes (E:no	M:yes (E:no	no	no	yes	yes	no
- mechanical	yes	yes	no	yes	yes	yes	yes
- electrical	yes	no	no	yes	yes	yes	yes
- instrumentation	no	no	no	no	no	no	no
- Maintenance of rolling/mobile equipment	no	no	yes	no	no	no	no
- General services	yes	yes	no	no	yes	no	no
- Spare parts management and stores services (SPMS)	yes	yes	no	no	no	no	no
- Central maintenance planning office							
- Existence of the following sections :							

- archives and central technical documentation	at BismaI	at Bisma	yes	no	yes	no	no
- maintenance methods (MM)	no	no	no	no	no	no	no
- maintenance engineering and construction (CONSTR)	no	no	no	no	no	no	no
- maintenance management (MMA)	no	no	no	no	no	no	no
- reprography	no	no	no	no	no	no	no
- planning section (PL)							
- programming	yes	no	no	no	yes	no	no
- job preparation	yes	no	no	no	no	no	no
- work scheduling	yes	no	no	no	yes	no	no
- visitors	no	no	no	no	no	no	no
- Efficiency of the above mentioned sections							
- technical documentation :							
- complete in %	80 %	90 %	25 %	50%	40%	40%	40 %
- drawings, manuals, technical instructions	good	good	poor	poor	avrg	avrg	poor
- maintenance scheduling, preventive programme	avrg	good	avrg	none	avrg	poor	non
- uniform codification of drawings	none	none	none	none	none	none	none
- itemisation of machines	yes	yes	yes	no	yes	no	no
- accessibility	poor	good	poor	bad	good	avrg	poor
- updating	yes	yes	poor	none	avrg	non	none
- central job-preparation							
- efficiency of the job-preparation	none	yes	yes	none	none	none	none
- paperwork/conception/efficiency							
- machine-file	poor	poor	poor	none	avrg	poor	none
- machine history record	poor	poor	poor	none	good	poor	none
- preventive maintenance cards	poor	poor	poor	none	none	none	none
- lubricating							
- scheduling	yes	yes	yes	yes	yes	yes	yes
- education	good	avrg	avrg	avrg	avrg	avrg	avrg
- efficiency	good	avrg	low	low	avrg	avrg	avrg
- standardisation							
- lubricants	yes	yes	yes	avrg	yes	yes	yes

- preventive maintenance	(lub)	yes	yes	no	no	no	no
- scheduling	avrg	poor	avrg	none	none	none	none
- execution	avrg	poor	avrg	none	none	none	none
- efficiency	avrg	bad	poor	none	none	none	none
- flow of formulars and information in the CMPO	poor	bad	poor	none	poor	none	none
- Mechanical service							
- Existence of centralized workshop	yes	yes	yes	no	yes	yes	no
- location of work shop(s) versus production	good	good	avrg	-	good	good	-
- capacity of work shops :	good	good	good	-	good	good	-
- job preparation	none	bad	poor	none	none	avrg	none
- presence of intervention teams	yes	yes	yes	yes	yes	yes	yes
- presence of specialized teams for special works	no	yes	no	no	no	no	no
- tools	good	avrg	avrg	poor	poor	poor	good
- quality of work	avrg	avrg	avrg	avrg	avrg	avrg	good
- Electrical service							
- existance of centralized workshops	no	no	no	yes	yes	yes	yes
- location of work shop versus production	-	-	-	good	good	good	good
- capacity of workshop	-	-	-	good	bad	good	good
- job preparation	none	bad	poor	none	none	avrg	none
- presence of intervention teams	yes	yes	yes	yes	yes	yes	yes
- presence of rewinding workshop	no	no	no	no	no	yes	yes
- tools and equipment	avrg	avrg	avrg	poor	good	avrg	avrg
- quality of work	avrg	avrg	avrg	avrg	poor	avrg	avrg
- Instrumentation services							
- Existence of :							
- regulation service	-	yes	-	-	-	-	-
- intervention teams	-	yes	-	-	-	-	-
- workshop for instrumentation service	-	no	-	-	-	-	-
- tools, instruments, equipments	-	avrg	-	-	-	-	-
- quality of work	-	avrg	-	-	-	-	-

- Spare parts management and stores services (SPMS)								
- Existence of a core for codification	no	no	no	no	no	no	no	no
- uniform codification	-	-	-	-	-	-	-	-
- quality of the codification grid	-	-	-	-	-	-	-	-
- Existence of a core for stock management	no	no	no	no	no	no	no	no
- computerized stock management	no	no	no	no	no	no	no	no
- efficiency	no	no	no	no	no	no	no	no
- Existence of a core for spare parts selection	no	no	no	no	no	no	no	no
- specific parts	-	-	-	-	-	-	-	-
- standard parts	-	-	-	-	-	-	-	-
- efficiency	none	none	none	none	none	none	none	none
- Existence of stores								
- centralized	yes	yes	yes	no	yes	yes	no	
- total surface of the floor	150 m2	200m2	-	-	50 m2	250 m2	-	
- store catalogue	no	no	no	-	no	no	-	
- preservation of parts	poor	bad	avrg	-	bad	avrg	-	
- number of stock items	500	known	known	-	known	4100	-	
- stock value	un- known	un- known	un- known	un- known	un- known	un- known	un- known	un- known
- Sufficient quantity of stocks	no	no	no	no	no	avrg	no	
- specific parts	-	-	-	-	-	bad	-	
- standard parts	-	-	-	-	-	good	-	
- consumables	-	-	-	-	-	good	-	
- Number of movements per month	unkwn	unknw	unknw	-	unknw	unknw	-	
- Labour force for the SPMS	3	3	0	0	-	10	0	
- Reordering								
- delays in the plant	2 week	unknw	1 wk	o.a.b	o.a.b	1 wk	o.a.b	
- organization	poor	bad	avrg	-	-	avrg	-	
- efficiency	poor	bad	avrg	-	-	avrg	-	
- Utility services	no	no	no	no	no	no	no	
- Existence of a maintenance workshop for the existing equipment	-	-	-	-	-	-	-	

- Technical equipment of the workshop	-	-	-	-	-	-	-
- Independent stores for rolling equipment	-	-	-	-	-	-	-
- General maintenance service	yes	no	no	no	no	no	no
- production and distribution of energy and fluids	good	-	-	-	-	-	-
- transport and handling	good	-	-	-	-	-	-
- Building maintenance	subc.	subc.	subc.	subc.	subc.	subc.	subc.
- personnel	-	-	-	-	-	-	-
- quantity of work	-	-	-	-	-	-	-
- Complexity of maintenance works							
- % of routine works	80	80	85	80	50	90	95
- % of specialized works	10	10	10	10	30	5	-
- % of very specialized works	10	10	5	10	20	5	5
- Maintenance personnel							
- labour force in maintenance	37	18	36	5	21	95	7
- detailed qualifications (total for each qualification group)			partly used for mnt.,				
- cadres	6	2	main	0	0	2	0
- foremen level	8	3	job	1	4	8	0
- skilled	23	13	is	4	17	55	7
- low skilled	-	-	prod.	-	-	30	-
- vocational training	no	no	no	no	no	no	no
- labour force of training section	-	-	-	-	-	-	-
- training equipment, buildings, etc.	-	-	-	-	-	-	-
- training on the job	poor	poor	poor	poor	poor	poor	poor
- training outside the plant	no	bad	no	no	poor	no	no
- forecast	-	-	-	-	-	-	-
- in progress	-	-	-	-	-	-	-
- complementary training	none	none	none	none	poor	none	-
- result of training	poor	poor	good	poor	poor	poor	poor
- discipline	avg	good	good	poor	bad	good	poor
- turnover of personnel	low	low	low	low	low	low	low

- respect of internal procedures and rules	poor	avrg	avrg	bad	poor	avrg	poor
- Accountants department in relation to maintenance continue enregistering of :	no	no	no	no	no	no	no
- costs for spare parts	-	-	-	-	-	-	-
- costs for personnel	-	-	-	-	yes	yes	-
- depreciation of equipments	-	-	-	-	-	-	-
- costs for vocational training	-	-	-	-	-	-	-
- stock value	-	-	-	-	-	-	-
- Budget	no	yes	no	no	no	no	no
- establishment of a global budget for maintenance	-	avrg	-	-	-	-	-
- establishment of a budget for vocational training for maintenance personnel	-	poor	-	-	-	-	-
- verification of budget	-	none	-	-	-	-	-

Region	Name and address of Company	Main activity (ies)
3. North Sumatra (Medan)		
3.1	LOGAM JI K.L. Yos Sudarso 130 Medan	Foundry and machine shop
3.2	MULTI MINERAL FOUNDRY Jalan Mustafa Lor VIII n° 36 Medan	Foundry
3.2 bis	MULTI MINERAL JI STM GG Sukur 17 Medan	Machine shop
3.3	Fabrik Mesin Tenera Simalungun North Sumatra (situated at 120 km from Medan)	Producing and repairing equipment for palm oil Factory (P.T. P. VII)
3.4	P.T. Atmindo (Atelier Mécaniques de l'Indonésie) JLn Kom. LAUT. YOS SUDARSO n° 1 P.O. Box 255 Medan	Boiler makers for palm oil industry - machine tool works - plate work - welding
3.5	P.T. Gunung Gahapi Sakti (BAHARA) JI Medan - Belawan km 10 Medan 20 242	Steel mill plant with electrical furnace and conti- nuous casting

TABLE OF INVESTIGATION	3.1	3.2	3.2	3.3	3.4	3.5
GENERAL INFORMATIONS CONCERNING VISITED PLANTS						
- Location	Med	Med	Med	Med	Med	Med
- Region	N. Sum	N. Sum	N. Sum	N. Sum	N. Sum	N. Sum
- Distance to center of region (km)	10	10	15	120	10	10
- Nationality of the main equipment manufacturers: difersification	high	low	low	high	high	low
- Type of contract of the factory	pri- vate	pri- vate	pri- vate	state	pri- vate	pri- vate
- Year of start-up	'60	'81	'81	'68	'72	'70
- Year of important extensions since start-up	'78	cont	cont	'83	cont	'84
- Number of persons employed	25+65	75	25	264	370	1420
DESCRIPTION OF THE PRODUCTION EQUIPMENT						
- Generalities	mach. T fdry	fdry.	Mach shop	Falm oil eqpt	Mach. Tool, plate work	Rod Mill fdry
- Complexity of the installations	avrg	low	low	low	avrg	high
- Mechanical equipment						
- diversification of suppliers/manufacturers	high	low	low	high	high	high
- standardization	none	none	none	low	none	none
- maintainability/ accessibility for maintenance purposes	poor	poor	avrg	good	good	poor
- quality of their production equipment	D. poor N. avrg	avrg	good	avrg	good	avrg

- state of accessories of the production equipment	avrg	avrg	good	avrg	good	poor
- Electrical equipment						
- alimentation tension	20 KV	20KV	20 KV	10 KV	20 KV	20 KV
- variety of suppliers manufacturers	avrg	low	low	high	high	high
- maintainability	poor	poor	good	good	good	poor
- state of machinery and equipment	avrg	avrg	avrg	avrg	good	avrg
- standardisation	none	none	none	none	poor	none
- Instrumentation equipment	none	none	none	none	none	-
- variety of suppliers	-	-	-	-	-	high
- standardisation	-	-	-	-	-	none
- maintainability	-	-	-	-	-	avrg
- state of equipment	-	-	-	-	-	good
ORGANIZATION AND SERVICES OF THE MAINTENANCE DEPARTMENT						
- Existence of main organization chart of the plant	no	yes	yes	no	no	not forml
- Existence of detailed organization chart of the maintenance department	no	no	no	no	no	not forml
- Existence of the following maintenance services and their dependence						
- Central maintenance planning office	no	no	no	no	no	no
- Central workshops (electro-mechanical)	yes	no	prod. ws	prod. ws	prod. ws	yes
- mechanical	yes	no	no	yes	yes	yes
- electrical	yes	no	no	yes	yes	yes
- instrumentation	no	no	no	no	no	no
- Maintenance of rolling/mobile equipment	yes	no	no	yes	no	yes
- General services	no	no	no	yes	yes	yes
- Spare parts management and stores services (SPMS)	no	no	no	no	prod	prod
- Central maintenance planning office	no	no	no	no	no	no
- Existence of the following sections						
- archives and technical documentation	no	no	no	no	no	no

- maintenance methods (MM)	no	no	no	no	no	no
- maintenance engineering and construction (CONSTR)	no	no	no	no	no	no
- maintenance management (MMA)	no	no	no	no	no	no
- reprography	no	no	no	no	no	no
- planning section (PL)						
- programming	no	no	no	no	no	no
- job preparation	no	no	no	no	no	no
- work scheduling	no	no	no	no	no	no
- visitors	no	no	no	no	no	no
- Efficiency of the above mentioned sections						
- technical documentation :	none	none	none	none	-	none
- complete in %				35%	90%	35%
- drawings, manuals, technical instructions				avrg	good	poor
- maintenance scheduling, preventive programme				none	none	poor
- uniform codification of drawings				none	yes	none
- itemisation of machines				yes	yes	no
- accessibility				good	good	poor
- updating				none	yes	none
- central job-preparation						
efficiency of the job-preparation	none	none	none	none	none	none
- paperwork/conception/efficiency						
- machine-file	none	none	none	none	yes	none
- machine history record	-	-	-	-	yes	-
- preventive maintenance cards	-	-	-	-	no	-
- lubricating	oprt	oprt	oprt			oprt
- scheduling	daily	daily	daily	none	none	-
- efficiency	avrg	good	good	poor	good	-
- efficiency	avrg	avrg	avrg	poor	good	-
- standardisation of lubricants	yes	yes	yes	yes	yes	yes

- preventive maintenance		no	no	no	no	prtly
- scheduling	yes					
- execution	poor					
- efficiency	poor					poor
- flow of formulars and information in the CMPO	none	none	none	none	none	none
- Mechanical service						
- Existence of centralized workshop	prod worksh	prod wrks	prod wrks	prod wrks	prod wrks	yes
- location of workshop(s) versus production	good	good	good	good	good	good
- capacity of work shops :	good	good	good	good	good	good
- job preparation	none	none	none	none	yes	poor
- presence of intervention teams	yes	no	yes	yes	yes	yes
- presence of specialized teams for special works	no	no	no	no	yes	yes
- tools	poor	poor	poor	poor	avrg	poor
- quality of work	avrg	avrg	avrg	avrg	avrg	avrg
- Electrical service						
- existance of centralized workshops	no	no	no	no	yes	yes
- location of workshop versus production	-	-	-	-	good	good
- capacity of workshop	-	-	-	-	good	good
- job preparation	none	none	none	none	none	none
- presence of intervention teams	yes	no	yes	yes	yes	yes
- presence of rewinding workshop	no	no	no	no	yes	yes
- tools and equipment	poor	poor	poor	poor	good	poor
- quality of work	poor	avrg	avrg	poor	good	poor
- Instrumentation services	none	none	none	none	none	none
- Existence of :						
- regulation service	-	-	-	-	-	-
- intervention teams	-	-	-	-	-	-
- workshop for instrumentation service	-	-	-	-	-	-
- quality of work	-	-	-	-	-	avrg
- quality of work	-	-	-	-	-	poor
- Management						
- Management						

vices (SPMS)						
- Existence of a core for codification	no	no	no	prod	prod	prod
- uniform codification	-	-	-	yes	yes	yes
- quality of the codification grid	-	-	-	good	good	good
- Existence of a core for stock management				no	yes	yes
- computerized stock management					yes	yes
- efficiency					good	good
- Existence of a core for spare parts selection	no	no	no	no	no	yes
- specific parts	-	-	-	-	-	yes
- standard parts	-	-	-	-	-	yes
- efficiency	none	none	none	none	none	avrg
- Existence of stores	no	no	no	yes	yes	yes
- centralized				yes	yes	yes
- total surface of the floor				1000	1500	1000
- store catalogue				no	yes	no
- preservation of parts				bad	good	avrg
- number of stock items				10000	10000	10000
- stock value				un- known	un- known	un- known
- Sufficient quantity of stocks		no	no	un- known	yes	yes
- specific parts	-	-	-	-	-	good
- standard parts	-	-	-	-	-	good
- consumables	-	-	-	-	-	good
- Number of movements per month	-	-	-	150	unknw	500
- Labour force for the SPMS				6prod	9prod	10prd
- Reordering						
- delays in the plant				1 wk	2 day	1 day
- organization				avrg	good	good
- efficiency				avrg	good	good
- Investment in equipment						
- Existence of a maintenance department	no	no	no	yes	no	yes

- Technical equipment of the workshop	-	-	-	poor	-	bad
- Independent stores for rolling equipment	-	-	-	-	-	-
- General maintenance service	no	no	no	yes	yes	yes
- production and distribution of energy and fluids	-	-	-	yes	yes	yes
- transport and handling	-	-	-	yes	no	yes
- Building maintenance	no	no	no	yes	yes	no
- personnel	-	-	-	8	-	-
- quantity of work	-	-	-	poor	good	-
- Complexity of maintenance works						
- % of routine works	95	90	90	95	95	50
- % of specialized works	5	10	10	5	5	25
- % of very specialized works	-	-	-	-	-	25
- Maintenance personnel						
- labour force in maintenance	3	0	3	27	12	unknow
- detailed qualifications (total for each qualification group)						
- cadres	0	0	1	0	1	-
- foremen level	0	-	2	-	1	-
- skilled	-	-	-	20	4	-
- low skilled	-	-	-	7	6	-
- vocational training	yes	yes	yes	yes	no	no
- labour force of training section	-	own	own	-	-	-
- training equipment, buildings, etc	no	-	-	no	no	-
- training on the job	yes	-	-	yes	yes	-
- training outside the plant	-	-	-	-	-	-
- fire ass	-	-	-	-	-	-
- fire protection	-	-	-	-	-	-
- independent	-	-	-	-	-	-
- maintenance	no	no	none	none	none	no
- maintenance	no	-	-	poor	poor	no
- maintenance	no	-	-	poor	poor	no
- maintenance	no	-	-	low	low	no

- respect of internal procedures and rules	poor	-	avrg	poor	avrg	poor	
- Accountants department in relation to maintenance continue enregistering of :	no	no	no	no	yes	no	
- costs for spare parts	-	-	-	-	yes	-	
- costs for personnel	-	-	-	-	yes	-	
- depreciation of equipments	-	-	-	-	yes	-	
- costs for vocational training	-	-	-	-	no	-	
- stock value	-	-	-	-	yes	-	
- Budget	no	no	no	no	yes	no	
- establishment of a global budget for maintenance	-	-	-	-	yes	-	
- establishment of a budget for vocational training for maintenance personnel	-	-	-	-	no	-	
- verification of budget	-	-	-	-	yes	-	

TRAINING AND TESTING CENTRES**1. Region : East Java (Surabaya)****1.1 Bram Jaya University (training centre)****a) *Situation***

Bram Jaya University - Malang (1.050.000).
At 90 km from Surabaya
Depending of Ministry of Education.
Started in 1984

b) *Educational aim*

Higher technicians in mechanical engineering :
- plant engineering, maintenance and repair
- production

Level of admission : technical high school SMA or STM

c) *Technical staff for maintenance training* : 3 engineers**d) *Capacity***

48 trainees/year (2 sections of 24 trainees)

e) *Level of trained people* : Polytechnician**f) *Duration of training* : 3 years.
2/3 theory and 1/3 practical exercises.
Specialization in third year (production or
maintenance)****g) *Comments***

- good equipment, premises and facilities, housing facilities
- training for maintenance engineers, CPMO
- should develop contact with industry, MIDC, ...

1.2 Singosari (training centre)**a) *Situation***

At 80 km from Surabaya.
Depending on Ministry of Manpower.
Started in 1972-1973

b) *Educational aim*

Practical training of technical skilled people.

Level of admission :

- primary school
- junior high school
- also training of engineer students from the Private University of Malang

c) *Technical staff for maintenance training*

- 53 teachers - instructors
- searching for instructors in hydraulics, heavy equipment maintenance, pneumatics

d) *Capacity*

1.500 trainees/year
Actually : 600 from primary school and 400 from industry

e) *Level of trained people*

Technicians in :

- mechanics : platework - welding
- electric : installations - electronics
- machine-tool operator
- automotive welding, gasoline, diesel, motorcycles

f) *Duration and kind of training*

6 months. Tailor made training.

Training in the field :

- cementry
- mining
- petrochemical industry
- air craft

Mobile training workshops
30 % theory - 70 % practice.

g) Comments

- good workshop and facilities
- capacity underused
- training for execution level for maintenance services

1.3 Balai Penelitian Dan Pengembangan Industry (testing centre)**a) Name and location**

Balai Penelitian Dan Pengembangam Industry
Jl. Jagie Wonokromo N° 360
Surabaya
Department : Perindustrian

Year of start-up : 1947

The testing centre moved 5 times and is since 1975 installed in Surabaya. Metal testing has started in 1980.

b) Main activities

- testing of raw materials
- research and development for small scale industries
- testing of products and equipment
- standardization for industrial products.

c) Technical staff

Total number of people employed : 130
engineers : 20
analysts : 20
high school level and administration : 90

Total of staff involqed in the metal section :14. Two of them are engineers.

d) Capacity

Testing of 15.000 samples/year. Actual output : 5.000 samples/year
Most of the research and testing is related to food industry, chemical industry and building materials.

From the few statistics we saw metal testing is limited to about 100 tests/year.

A development program is on-going, subsidized by the World Bank and bilateral aid (Holland and Belgium). The counterpart is MIDC. Action has been taken to contact 42 companies in the Surabaya Region.
The above development program concerns metallography.

As the number of client companies is unknown, the impact of this testing centre is difficult to evaluate.

e) *Installed facilities in the metal section*

- laboratory for mechanical testing (traction and bending tests, charpy-V or ductility tests)
- laboratory for metalographical analyses
- laboratory for NDT testing (only X-ray, no γ ray)
- laboratory for testing sand samples (foundry)
- small workshop with lathe, drilling machine and saw

f) *Comments*

- high turn-over of the skilled employees (average experience : 5 years)
- difficulties concerning staff capability sources (universities, high schools) due to the difference in salaries offered compared to industry
- this centre should have experienced engineers for the research and development branch
- actually, the metalographic centre has no work-load and the situation at the mechanical workshop is the same
- this centre offers a lot of possibilities for training (quality control, research and development) and should be assisted in order to reactivate their contacts with the industry
- there are no facilities for training in pure maintenance activities.

2 **Region : North Sumatra (Medan)**

2.1 **Balai Latiman Pendidikan Teknik (training centre)**

a) *Name and situation*

Balai Latiman Pendidikan Teknik (Institute for practical technical education)
Director : Drs. M. Şibarani

Situated at 10 km of centre of Medan (Jln Karya - Medan).

b) *Educational aim*

Practical training for senior technical high-school students.

Branches :

- machine tools
- automotive
- electricity
- electronics
- building

Level of admission : junior high-school

c) *Technical staff for maintenance training*

- 180 instructors : polytechnicians and university graduates
- some of them have been trained overseas in relation to maintenance organization.

d) *Capacity*

2.500 trainees yearly coming from all the technical schools from Medan.

e) *Level of trained people*

Senior Technical High School

f) *Duration of training*

3 years.

Mainly practical training in the above specified branches. Some theoretical courses directly related to different applications are also given.

g) *Comments*

- sufficient and good equipment in all workshops and electronic laboratories
- the machine-tools section shall be enlarged and CNC machines will be installed (bilateral cooperation with the Netherlands)
- the training school will develop cooperation with industry which has to specify their typical needs so that adapted training can be given
- there is no training in relation to hydraulics or pneumatics maintenance
- as several instructors have been trained in Switzerland, West Germany, Austria, United Kingdom and the Netherlands, they have a good basic knowledge of English. Some have been trained in maintenance organization and this school could easily develop a maintenance section for execution level
- attention is already paid to basic maintenance operations (cleaning, lubricating, tool preparation and storage).

2.2 Metal Research Institute of Medan (testing centre)**a) *Name and location***

Balai Penelitian Logan Medan
Jalan Janjung Morawa km 7,3 Telp
Medan

The metal research institute of Medan is the real name of the MITC mentioned in the terms of reference and is part of the ministry of Industry (research and development).

b) Aim of the institute

- testing for :
 - mechanical industries
 - metallography
 - foundries
 - chemical industries
- produce prototypes for agro- and mechanical industries
- implementation of projects :
 - industrial advisory service (in collaboration with West Germany) started in 1986 and ended 9/90
 - foundries for grey cast iron, brass and aluminium
 - blocksmiths for agricultural tools and equipments
 - other metal working industries (on demand)
 - calibration testing service network (financed by the World Bank). This project is in take-off stage

c) Technical staff

10 university graduates
7 polytechnicians
31 senior technical high school
3 low skilled

d) Capacity

- foundry : especially sand testing. The foundry is only operated 10 times a year
- metallography : micro structure testing of ferro and non ferro metals
- mechanical testing : hardness-bending and torsion resistance and ductility tests
- chemical laboratory : equipped for testing samples of the food industry.

e) Results of testing

Certificates agreed by the Government are delivered after testing, accompanied with a detailed testing report.

f) Volume of served industries

103 industries are considered as clients. Only 10 % of these are regular clients.

g) Comments

- the laboratories were originally well equipped (equipment supplied through UNIDO). No attention has been paid to necessary complementary conservation installations (air conditioning for the laboratories, especially to the metallographic laboratory). Equipment is already damaged through moisture and dust

- there is also a lack of activities and as the equipment is not protected, corrosion and wear is very high
- the employed staff is not motivated
- actually there is no activity at all in the :
 - metallographic section
 - chemical laboratory
- this institute should be reactivated to save it from "slowly dying". Assistance should be given to this institute in order to restore the confidence of potential interested enterprises
- Knowledge of English is a necessity for a research and development centre. At the institute only the director and the man in charge of the foundry have a basic knowledge of English.

3. Jakarta region

3.1 Pusat Instruktur dan Pembinaan Industri Yecil (training centre)

a) *Name and location*

Pusat Instruktur dan Pembinaan Industri Yecil (trainers and small scale industry training centre) CEVEST

Jl. Guntur Raya 1
Pekasi
Tel.no. 99-71147

Responsible institution (up to 1989) :
Directorate General of Small Scale Industry (Ministry of Industry) in cooperation with Japan International Cooperation Agency (JICA)

Present responsible institution : Ministry of Manpower

b) *Training facilities*

- | | |
|------------------------------------|------------|
| - buildings (workshop and office) | ± 1.000 m2 |
| - class rooms | ± 300 m2 |
| - workshops | |
| - workshop for wood working : | |
| - lathe machine | 1 unit |
| - shaping machine | 1 unit |
| - sawing machine | 1 unit |
| - workshop for metal working : | |
| - lathe machine | 1 unit |
| - drilling machine | 1 unit |
| - hand press | 1 unit |

- acetylene welding equipment 1 unit
- electric welding equipment 1 unit

c) Technical staff

Government official - Department of industry
4 persons : 2 of them are engineers

Lecturers/instructors from :

- metal industries development centre (MIDC)
- directorate general of small scale industry
- association of quality management of Indonesia (Perhimpunan Management Mutu Indonesia - PMMI)

Training has been carried out by Directorate of Small Scale Industry in the following fields :

- forging for small scale industry
- trainers training quality control I and II
- company auditing on standardization for small scale industry, etc.

Participated by 20-25 persons from :

- small scale industries
- regional representatives of the Ministry Industry from 27 provinces.

3.2 FESTO Indonesia (Private training centre)

Full name : P.T. NUSANTARA CYBERNETIC EKA PERDANA

a) Location

Jakarta

Address : Perkantoran Kota Grogol Permai
Block C - 35/36 JL Prof. Dz Latemeten
Jakarta 11460
Indonesia

Phone : 560.06.14 / 560.48.70

Fax : 566.14.99

b) Aim of training

- started with trainings in pneumatics 2/1/89
- control technology, including hydraulics, electronics and pneumatics
- maintenance of pneumatical and hydraulical equipment.

c) Admission level

- for basic training courses, no specific admission conditions
- for advanced training, selection based on interviews to create homogeneous groups (max 20 people).

d) Staff

- manager is an expatriate of the Festo international group with headquarters in Germany
- one experienced national instructor (dipl. Ing. Germany).

e) Capacity of trainings

- duration 4 days (50% theory, 50% practical exercise)
- frequency : 20/year equivalent to 400 trainees/year.

f) Results

Specialized technicians in :

- pneumatics
- hydraulics
- control technology
- maintenance installation and repair of above mentioned equipment.

A certificate is delivered to all selected participants.

g) Comments**1) Facilities**

- well equipped classrooms with overhead projectors, audio visual aids, magnetic boards
- didactic panels with components for modular design of control technology
- handbooks, courses, maintenance manuals, trouble shooting
- practical exercises.

2) Training is not limited to users of Festo equipment but is a basic and specialized training on pneumatics and hydraulics and is open to users of equipment made by other manufacturers.

- 3) Festo also sells the didactic equipment to technical schools and universities.
- 4) The offered facilities are very interesting for people considered with hydraulics and pneumatics electronics and controls and that on different levels (design - engineering - operators and maintenance).

ITB in Bandung and ITPN also in Bandung are using the didactic equipment of Festo.

3.3 ITB - Bandung (Training Institute)

a) *Location*

Bandung

b) *Aim of the institute*

Most recommended institute for training of civil engineers.

- 5 facilities :
- Industrial technology
 - design : tests, civil works, ...
 - Mineral & Resources : geology, mining, oil,...
 - arts
 - mathematics and sciences

The Industrial Technology has 5 departments :

- Electrical Engineering
- Mechanical Engineering
- Industrial Engineering
- Chemical Engineering
- Physical Engineering

The department of Mechanical Engineering has 4 sections :

- Mechanical Constructions
- Energy Conversion
- Production & Material
- Aeronautics

Actually, 5000 audits/year

Number of graduates :

- In-level : Senior high school
- Out-level : Civil engineer
Doctor in science

c) Comments

The most important training institute for engineers in Indonesia. Many cooperation programs with the Netherlands (Trente) and Belgium (Leuven - Ghent). Good contacts with industry and MIDC.

Laboratories and workshops are well equipped including didactic material :

- used motors, gear boxes, hydraulic installations as demonstration and testing material
- new machine-tools, testing and measuring equipment, electronic devices, ...

Educational staff is well qualified and follows continuous training abroad. Pedagogical methods are various : technical courses, groupwork and practical exercises.

MIDC**Functional services**

- to carry out research activities to improve the production capability as well as to formulate the design of technological development in the metal and machinery industries.
- to carry out technical assistance as a tangible follow-up of the research & development results in the field of metal and machinery industry.
- to carry out the development activities to improve the productivity and quality of products through various research programs, services to industry and job training for technicians coming from industry.

Technical approach

- engineering design
- manufacturing capability
- product evaluation
- repair and maintenance of production facilities
- production management

Scope of activities

MIDC activities are complying with their envisaged objectives, covering :

a) Technological improvement

To carry out applied research, experimentation and material utilization in the field of the metal and machinery industry, product development, machining technology, casting, construction and welding technology, heat treatment and metal finishing.

b) Industrial development

To solve all kinds of problems found on mechanical engineering, metal processing, standardization and quality control, industrial processing by performing development studies, consultations and upgradings based on literature studies or research studies carried out with other institutions.

Scope of studies

- substitute materials selection
- process improvement
- product design and product development
- prototyping
- jigs and fixture design

- quality control system development
- standardization

Scope of dissemination

- training
- seminars
- publications
- consultations
- visualizations
- exhibitions

Staff composition

1. Technical graduates engineers	: 25
2. Technical junior engineers	: 16
3. Non technical graduates	: 12
4. Junior non technical (bachelor)	: 11
5. Technical operators	: 82
6. Administrative staff	: 79
TOTAL	: 225

Facilities

MIDC is located on a site of approximately 24,000 m². The premises are composed of :

- main office	: 2.600 m ²
- foundry	: 1.730 m ²
- machine shop	: 1.050 m ²
- construction & welding	: 1.020 m ²
- cafeteria	: 300 m ²
- dormitory	: 800 m ²
- guest house	: 120 m ²

Workshops

- Foundry shop

There are machines and equipment for sand moulding, non-ferro melting furnace, cast iron melting furnace, finishing and equipment for pattern making.

- Machine shop

There are 37 machine tools, various kinds of lathes, milling and boring machines, grinding, universal tool sharpeners and EDM.

- Construction and welding shop

There are manual and semi automatic electrical welding machines, circomatic-, vertomatic-, oxy acethylene welding machines, pipe welding, machine and steel plate forming.

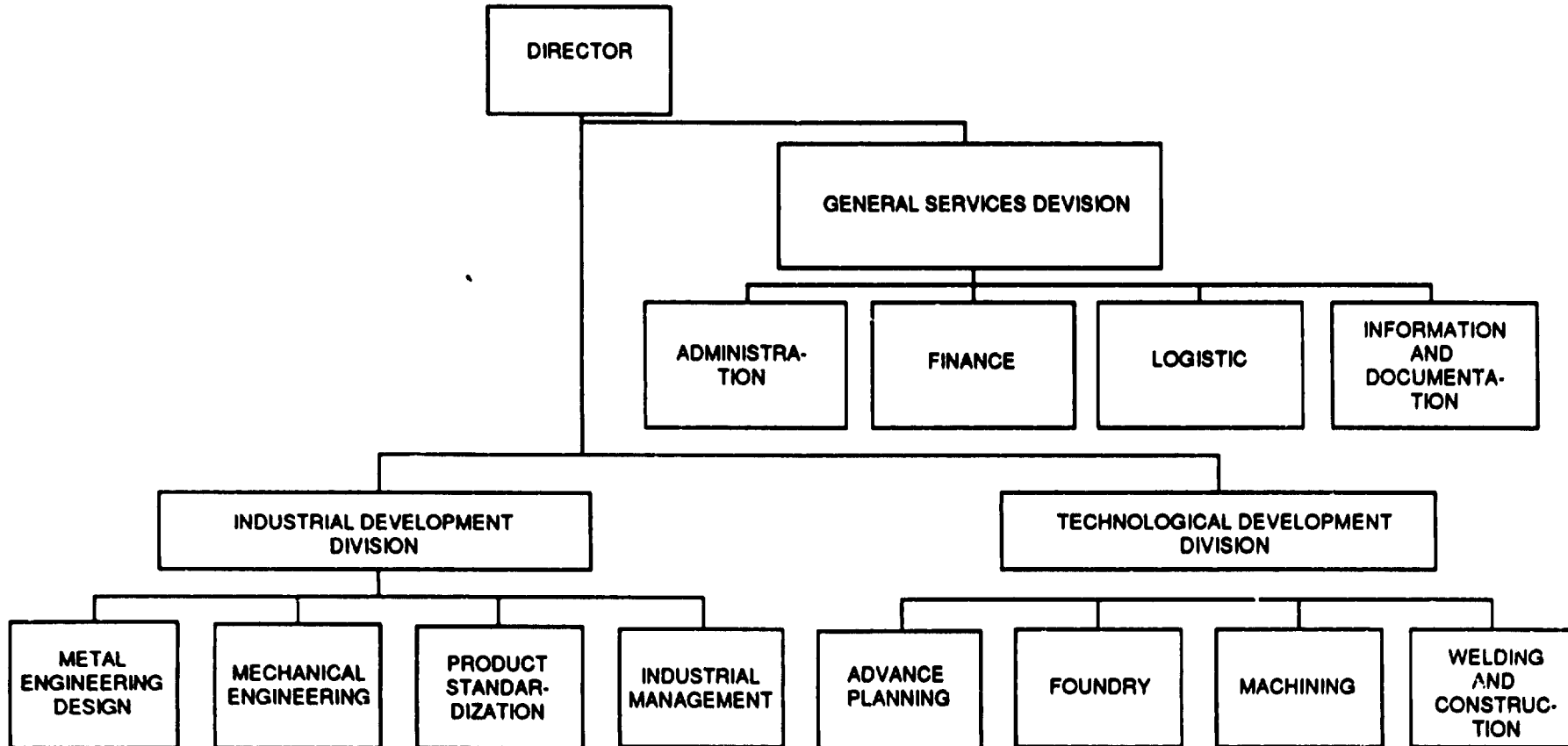
Laboratories

- Laboratory for moulding sand
- Mechanical laboratory for destructive testing
- Laboratory for measurement (metrology)
- CAD CAM centre
- Heat treatment, shop, with electrical furnaces and salt bath for cementation, nitration, annealing, tempering
- metalography
- chemical laboratory.

Other facilities

- Library
- Classroom and audio-visual equipment for training and seminars.

ORGANIZATION CHART



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