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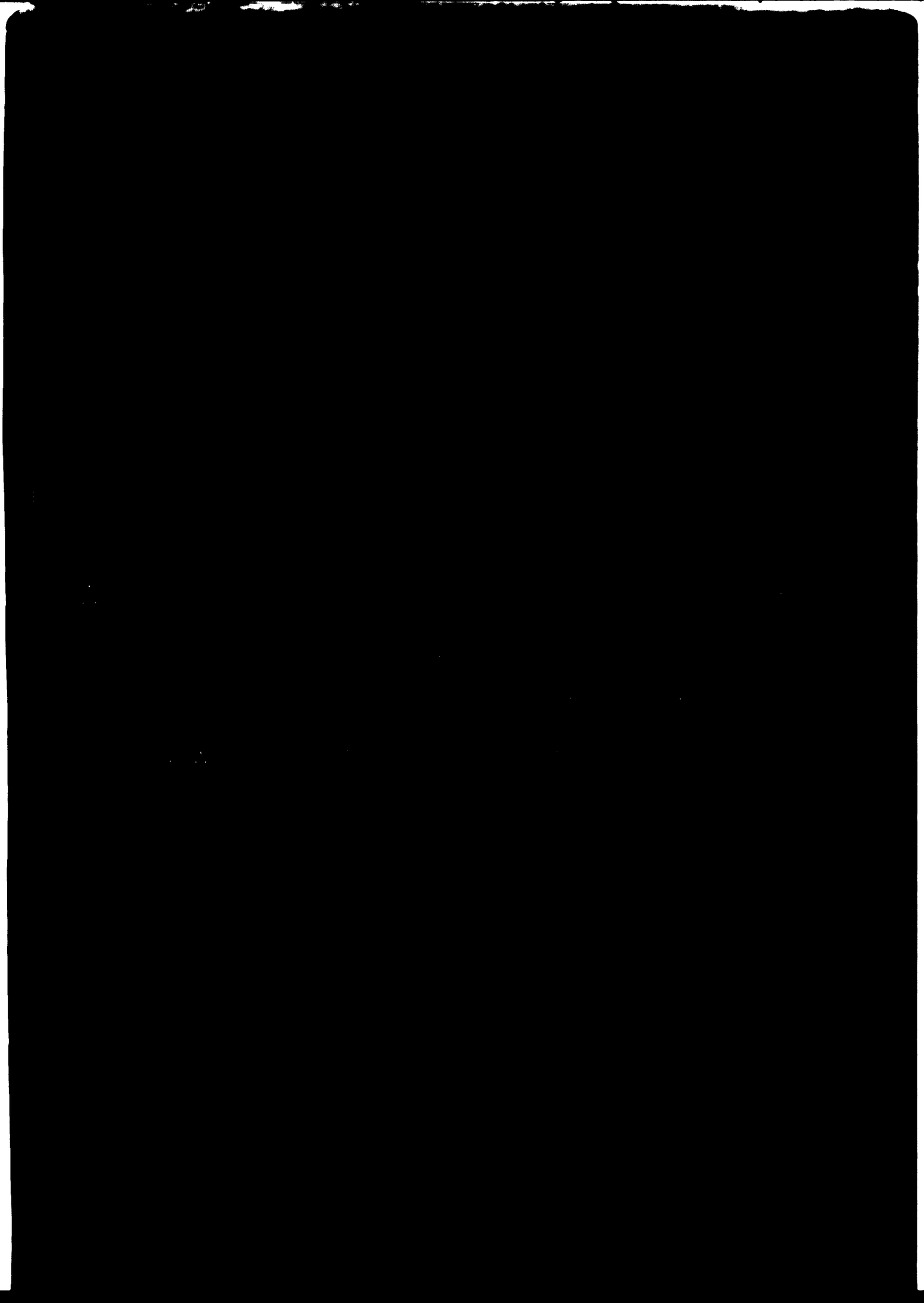

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MAINTENANCE AND REPAIR FACILITIES AND NEEDS IN IRAQ

January 1971

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Job No. 7163

The Research and Productivity Council
Fredericton, New Brunswick, Canada

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ABBREVIATIONS

M & R	- Maintenance and Repair
PM	- Preventive Maintenance
S.O.I.	- State Organisation of Industries
S.O.E.I.	- State Organisation of Engineering Industries
S.O.T.	- State Organisation of Textiles
I.D.	- Iraqi Dinar

1. INTRODUCTION

Authorisation and Purpose

This report was authorised by contract between United Nations Industrial Development Organisation (U.N.I.D.O.) of Vienna, Austria, and the Research and Productivity Council of New Brunswick, Canada.

The purpose was to enable the industrial sector in Iraq to organise and improve their maintenance and repair facilities.

Scope

The assignment was to investigate the needs of the industrial projects of the State Organisation of Industries for maintenance and repair of machinery and equipment, to determine the feasibility of establishing central M & R workshops, to recommend a sound training system, and to identify the industrial and economic opportunities for certain spare parts to be locally manufactured, as well as to identify others which should continue to be imported. Also, to prepare a programme of implementation for any necessary assistance by UNIDO.

In order to evaluate the existing facilities in M & R it was necessary to support our field and in-plant surveys by distributing questionnaires to a selected sample of industries (see Exhibit 3).

Furthermore, inquiries were made to government and local authorities in order to implement our investigations.

This study does not cover private industries employing less than 30 workers.

2. PRELIMINARY SECTION

Results of Findings

In the first section of this study, Sections 3, 4 and 5, we give a general picture of the industrial situation in Iraq, showing the existing M & R facilities in the manufacturing industries, utilities and agricultural equipment, existing centralized shops, spare parts stores and the availability of skilled personnel and training centres.

In Sections 6 and 7 we report the adequacy of existing facilities and the feasibility of setting up centralized shops according to industrial needs, location, availability of skills and M & R facilities.

Section 8 includes recommendations for future policy for M & R facilities and programmes in certain industries, spare parts manufacturing facilities, centralised shops and stores and training programmes.

General Conclusions

1. The economic focal point of Iraq is the capital, Baghdad, where 84 per cent of industry is concentrated and most of the facilities for sound repair and maintenance services are available.

2. Equipment for maintenance, repair and the manufacture of spare parts is available in Iraq although badly organized and widely scattered. In some industries facilities are completely inadequate while other industries have surplus capacity for repair and maintenance work. The workshop at the plant of the State Organization of Mechanical Industries in Iskandariya has adequate M & R facilities, high quality and variety in equipment and is in a satisfactory location.

3. Centralised workshops and stores do exist in leading industries but not as a public service or government organization. Spare parts are over-stocked as insurance against work stoppages and only a few companies control their inventories adequately.

4. The large amount of work performed on M & R and the questionable quality reflected the inadequacy of the maintenance programmes used. Basic organization techniques to achieve efficient M & R services are scarce and PM does not appear to be an established practice in Iraq.

5. Some key industries do not provide adequate maintenance services to prevent breakdowns and premature obsolescence of their costly equipment.

6. Lack of standardization is reflected by the great variety of machinery and equipment in existence due to inadequate buying policies and political/economic problems. As a result, stocks of parts and maintenance materials are almost doubled.

7. Government policies for the reorganization of repair and maintenance services do not exist in Iraq. The S.O.I. only acts as an advisory service for problems in industry, which include M & R problems.

8. Shortage of skilled personnel on M & R is acute in Iraq. Most have learnt their skills on the job and supervisors and foremen are chosen from the most experienced workers who may have no aptitude for command, organization or decision taking.

9. Only a few vocational training centres have adequate facilities and training programmes need upgrading. In-plant training facilities are not an established practice in Iraq.

Recommendations

1. Trained engineers should be available at each appropriate state organization to recommend policies and objectives of their industries.

2. The M & R sections of some important industries having a wide range of equipment but insufficient skilled workers should be reduced to cover emergency repairs and the necessary spare parts. High quality spare parts and major repairs should be made in a fully equipped workshop. New M & R facilities and a centralized workshop are recommended for agricultural equipment as a matter of urgency.

3. Central M & R workshops should be set up for the textile industries and for agricultural equipment, these to be controlled by the respective state organization.

4. Small industries with inexpensive equipment should use routine maintenance programmes while those having expensive equipment for automatic operation should also introduce preventive maintenance.

5. Although it is not necessary a present to establish centralized stores as a public service, each large industrial sector, such as the textile, food, cement and agricultural industries, should establish central stores for the spare parts and materials most frequently required. Stores require improved layout, lighting and dust protection. Inventory control systems should be used.

6. Training centres should be set up to give higher level courses for managers in maintenance management, upgrading and refresher courses for supervisors and foremen, vocational training courses for specialized industry groups and in-plant training in large plants. Courses in theory could be held at the Management Development Centre in Baghdad.

Suggested Programme of Implementation

This programme gives the main requirements for UNIDO's assistance to M & R facilities in Iraq.

State Organizations

Provide two consultants with industrial management background to select maintenance engineers for the following state organisations and to develop and initially monitor their programmes of work:

State Organization of Engineering Industries
Directorate of Agrarian Reform
State Organization of Textiles

The consultants should also study the feasibility of training engineers for other state organisations.

M & R Central Workshops

Provide two industrial engineers, one attached to the Iskandariya central workshop and the other to the textile and agricultural equipment central shops. Their main objectives will be to

- establish the central workshops policies, and organize their structure and procedures to achieve the overall objectives of the M & R policy
- set performance objectives, direct work towards standards and correct deviations from these standards
- control the effectiveness of established programmes and, where necessary, modify them to improve the results

Maintenance and Repair Facilities

Provide two or three industrial engineers to organise and upgrade M & R facilities and programmes in the following industries in this order:

1. agricultural equipment
2. textile and knitting
3. cement, sugar and chemical
4. electromechanical
5. others

Centralized and Local Stores for Spare Parts

Provide an expert with industrial accountancy and systems analysis experience to organise the centralised and important local stores by establishing policies and inventory control. He should also analyse existing stocks and set reasonable stock levels.

Training Programmes

Provide a training leader for management education to act as a co-ordinator between industry, educational centres and the

government and ensure an effective management education programme. He will control the team of training experts appointed at training centres and will conduct research on education requirements.

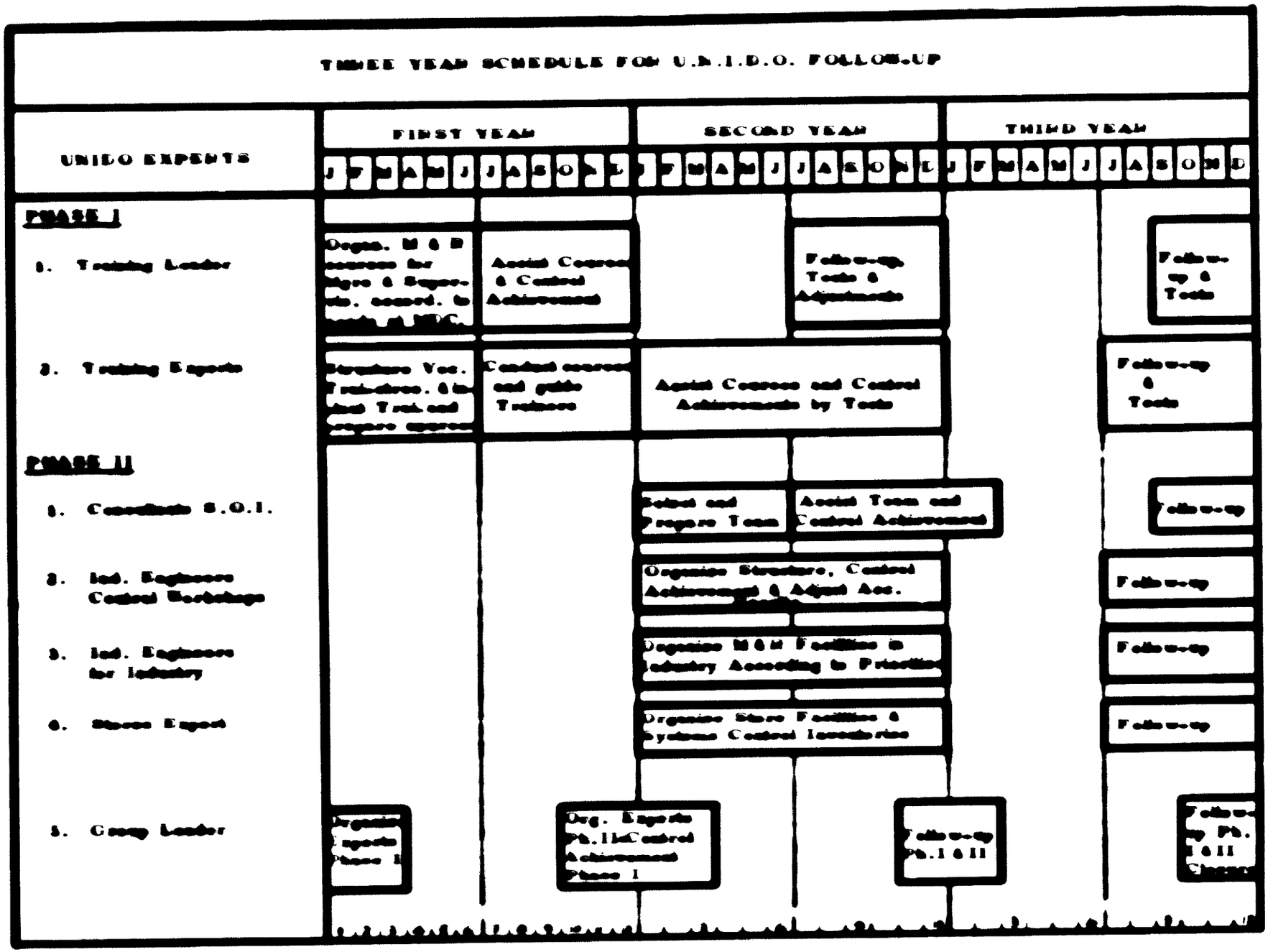
Provide a team of training experts (probably 6) with industrial background whose main object will be to design or upgrade M & R training in vocational training centres and in-plant training.

Group Leader

Appoint a group leader on a temporary basis to get the team of experts organised and working.

Summary of Experts Needs

No.	Type	Experience & Background	Location
2	Consultant	Industrial Management	State Organisations
2	Ind. Engineer	Maintenance & Repair	Central Workshops
3	Ind. Engineer	Maintenance & Repair	Industries
1	Stores Expert	Industrial Accountancy and systems analysis	Central and Local Stores
1	Training Leader	Management Education	Management Development Centre (M.D.C.) of Baghdad
6	Training Expert	Industry and M & R	Vocational Training Centres and Industries
1	Group Leader	Management Systems	Ministry of Industry and/or M.D.C. of Baghdad
16			


THREE YEAR SCHEDULE FOR U.N.I.D.O. FOLLOW-UP
UNIDO EXPERTS
FIRST YEAR
SECOND YEAR
THIRD YEAR
J F M A M J J A S O N D
PHASE I
1. Training Leader
Assist Courses & Control Achievements
Follow-up, Tests & Adjustments
Follow-up & Tests
2. Training Experts
Assist Courses and Control Achievements by Tests
Follow-up & Tests
PHASE II
1. Coordinate S.O.I.
Select and Prepare Team
Assist Team and Control Achievement
Follow-up
2. Ind. Engineers Control Workshops
Organize Structure, Control Achievement & Adjust Acc.
Follow-up
3. Ind. Engineers for Industry
Organize M & M Facilities in Industry According to Priorities
Follow-up
4. Stores Experts
Organize Store Facilities & Systems Control Inventories
Follow-up
5. Group Leader
Org. Experts Ph. I Control Achievement Phase I
Follow-up Ph. I & II
Follow-up Ph. I & II

3. INDUSTRIAL SITUATION

Population Employed by Economic Sector

Table 1 gives the employment situation in selected fields in 1969.

TABLE 1

Economic Sector	Population (000)	Per Cent
Total Employed	2,540	100.0
Agriculture	1,450	57.1
Mining	16	0.6
Manufact. and Utilities	161	6.4
Construction	60	2.4
Trade	145	5.7
Transport	143	5.6
Services	295	11.6
Armed Forces	270	10.6

Iraq is predominantly agricultural, that sector employing 57 per cent of the total labour force compared with only 6.4 per cent in the industrial sector. Manufacturing activity in Iraq is of recent origin, most firms having been established within the last 20 years. The industrial sector is, however, growing rapidly. Exhibit 1 shows that the increase in employment in the industrial sector between 1967 and 1969 was 5.2 per cent and the expected increase between 1969 and 1973 is 12.7 per cent (lines 3 and 4).

Work Force Employed in Industry

Of the 148,000 employed in the manufacturing industry in 1969, 66 per cent were employed in establishments with fewer than 20 workers and 34 per cent in those with over 20 workers. The distribution was as follows:

Group	Size (wks/est)	No. of Estab.	Work Force	Wks/est (avg.)
I	up to 30 wks	26,800	97,480 (66%)	3.6
II	more than 30 wks	354	50,520 (34%)	142.7

Electricity, gas and water services with establishments of more than 30 workers and a work force of 12,900 people in 1969 have not been included.

Source: U.N. Manpower Mission, 1969 report

All establishments included in Group I belong to private industry and are engaged in the following:

- sheet metal working and welding
- servicing and repair of automobiles
- brick production
- pressing dates
- small workshop operations

Most of the establishments included in Group II are government owned. Only these are considered in this report.

Location of Industries and Work Force

We have subdivided the country into three main areas as follows:

Baghdad area, covering a radius of 150 km.
North Area, which includes the main populated towns of Mosul, Kirkuk and Sulaimaniya
South area, in which the main towns are Basra and Amara

Table 2 shows the location of manufacturing industries in the three areas, by number of establishments per industry group and work force. It shows that the main industrial concentration is the Baghdad area which accounts for 84 per cent of the total establishments and work force in Iraq. The industrial concentration

in the North area accounts for 9 per cent of establishments employing 12.5 per cent of the work force. In the South area, the lowest industrial concentration, accounts for 7 per cent of establishments representing 3.5 per cent of the work force.

Note: Table 2 does not include electricity, gas and water services which are mainly located in the Baghdad area.
For further details on industry location by area and town see Exhibit 2, page 92.

Geographical Communications

The main means of communication in Iraq are by rail and road.

Railways

The main railway line in Iraq crosses the country from north to south through Mosul, Baghdad and Basra. A secondary railway line goes from Arbil through Kirkuk and connects in Baghdad with the main line. Thus, there is no rail connection between some important industrial centres, e.g. between Mosul and Sulaimaniya, Baghdad and Kut, and Amara and Basra.

Roads

Although the road system covers most parts of the country, there are few good roads providing a safe and efficient method of transportation. The main road goes from north to south of Iraq almost following the main railway line. Roads between important towns are normally in bad condition often making it necessary to travel by a longer but safer route.

As an example, the time spent driving from Baghdad to Mosul is less (395 km) and safer than from Mosul to Sulaimaniya (298 km).

Conclusions

1. Although employment in industry is low compared to that in agriculture, it is growing fast and is important for the mechanisation of agriculture.

TABLE 2

LOCATION OF INDUSTRIES AND ESTIMATED WORK FORCE IN IRAQ
(Employing over 30 workers)

Industry Group	150 km. radius of Baghdad		North Area		South Area		Total in Iraq		W.force by Ind.Group (%)
	No.of Estab.	W.force	No.of Estab.	W.force	No.of Estab.	W.force	No.of Estab.	W.force	
1. Food (except dates)	25	4,000	5	700	3	100	33	4,800	9.5
2. Drinks	11	2,400	3	600	3	600	17	3,600	7.1
3. Tobacco	1	2,000	2	1,000	-	-	3	3,000	6.0
4. Textile and Knitting	40	12,000	11	2,400	-	-	51	14,400	28.7
5. Ready Made Clothes	14	1,300	-	-	1	100	15	1,400	2.8
6. Leather Process and Products	5	2,200	1	300	-	-	6	2,500	5.0
7. Wood	4	200	2	100	-	-	6	300	0.6
8. Paper, Printing and Publishing	14	1,500	-	-	1*	-	14	1,500	3.0
9. Chemical (except oil refineries)	14	3,700	-	-	1*	-	14	3,700	7.4
10. Manufacture and repair of machinery, equipment and electric appliances	10	3,000	-	-	-	-	10	3,000	6.0
11. Metallic Products	9	500	-	-	1	50	10	550	1.0
12. Non-metallic Products	145	9,300	6	1,300	16	900	167**	11,500	22.9
Totals by Area	292	42,100	30	6,400	24	1,750	346	50,250	
Per cent by Area	84	84	9	12.5	7	3.5			

* Fertilizers and paper mill plants to be operated in 1971 and 1972 respectively.

** 143 establishments are brick factories and only 2 employ over 100 workers.

Source: Bureau of Statistics, Vol. 1969, M of P and Questionnaires.

2. The economic structure focal point of Iraq is the capital. Industry is concentrated mainly in the Baghdad area where most of the facilities for sound repair and maintenance services are located. In and around the city can be found metalworking and repair shops, vocational training centres, a higher availability of skills, better physical communications and transportation services.

3. Despite the efforts of the government to decentralize the industrial sector by building new plants in the north and south the great concentration remains in Baghdad. It is this group of repair and maintenance facilities which will be the focal point of our survey.

4. EXISTING REPAIR AND MAINTENANCE FACILITIES

Facilities in Various Factories and in the Country as a Whole

Questionnaires and Visits

At the beginning of the mission in Iraq about 50 questionnaires were distributed through the Ministry of Industry and the respective S.O.I. to a select sample of companies (see questionnaire, Exhibit 3). Thirty-seven were returned.

Evaluation of the answers on the returned questionnaires is shown in Table 3. Only 45 per cent of the answers were considered to be complete and accurate and the questionnaire was followed by in-plant surveys and interviews.

The managers of selected companies were interviewed to determine their managerial abilities and the suitability of the techniques used for maintenance and repair, stock control, etc. It was also of interest to know how they arrived at the data on the completed questionnaires.

Evaluation Matrix

To evaluate the data collected an evaluation matrix has been prepared. Each condition in the organization has been given a points rating for the efficiency achieved in a number of essential and less essential areas as shown in Exhibit 4. In the Exhibit, Column 10 shows the grading required for a plant using standard preventive maintenance system and Column 11 that using optimal preventive maintenance.

Independent Maintenance and Repair Sections

Every industrial establishment visited had its own independent maintenance and repair section with equipment which varied from one industry to another and from one plant to another.

The evaluation matrix shows that power stations and cement plants have good M & R sections while those in other industries are less satisfactory.

TABLE 3

Industry Group	Type of Industry	No. of Firms Questioned	Average No. of Answers per Questionnaire: Complete & Accurate	Partially Answered	No Answer	Unreliable Answer	Grade of Reliability %
Electromechanical	Mechanical equipment Electrical equipment	3	10	6	-	5	46
Special Industries (Expensive Equipment)	Electric Power Stations	1	12	5	3	1	57
	Cement Factories	7	9	7	-	6	41
Food & Beverage	Vegetable oils & soft drinks	2	8	3	-	11	36
	Food Canning	1	10	5	4	2	48
	Sugar Plants	1	15	5	-	1	71
Chemical Process	Matches	1	13	4	2	2	62
	Rayon Process	1	15	2	1	3	71
Textiles	Spinning & Weaving	4	9	6	-	9	37
	Knitting	2	6	6	1	10	26
	Clothing & Others	4	10	7	-	7	42
Leather	Shoes & Clothing	2	11	5	-	6	50
Tobacco	Cigarettes	2	5	8	1	9	22
Miscellaneous	Brick Factories	2	7	7	-	8	32
Agrarian Reform	Agriculture Stations	3	7	8	2	6	30
	Repair Workshops	1	11	3	3	4	52
Total		37	158	87	17	90	
% answered		-	43	23	5	25	

Table 4 illustrates the distribution of industries according to their maintenance and repair equipment, starting with those having the best equipped M & R sections and showing outstanding companies in each industry group.

Machine Utilization

The utilization of machine tools and equipment in the M & R sections did not depend on the size of the organization or on their particular applications when the survey was made. However, the central repair shops were working almost to capacity.

Maintenance and Repair Programmes, Present and Planned

The adequacy of M & R systems varies according to the type of industry. The leading industries having adequate M & R systems used is shown in Table 5.

TABLE 4

DISTRIBUTION OF INDUSTRIES SURVEYED ACCORDING TO THEIR M & R FACILITIES

Rank	Industry Group	M & R Facilities of Leading Companies(1)
1	Electro-Mechanical & Metalworking	a. <u>State Co, for Mechanical Industries, Iskandariya(2)</u> <u>Speciality:</u> Manufacture of Agriculture equipment, tractors and trucks. This plant is not in operation yet. First class buildings, machinery and equipment able to do a wide range of repairs and overhauls and to make all sizes of high precision spare parts and tools, and carry out heat treatment, casting, annealing, quality control and metallegraphic testing. <u>Conclusion:</u> Self-sufficient facilities to perform work for all industries b. <u>Company for Electrical Industries</u> <u>Speciality:</u> Manufacture of medium sized transformers, electric motors and fittings. Repair services for their customers. <u>Conclusion:</u> Same as (a) except for large castings and spare parts.
2	Textile & Knitting	a. <u>Mosul Textile Company</u> <u>Speciality:</u> Weaving and spinning of cotton. Buildings in good condition. Almost new high quality machinery and equipment which is suitable for their needs. Can do all their own repairs and overhauls and manufacture small and medium sized fair precision spare parts. Each main factory department has its own M & R shop with some parts in stock

(1) See Appendix 3
(2) Further details of this company in Section 7

Table 4 Cont'd

Rank	Industry Group	M & R. Facilities of Leading Companies
2	Textile and Knitting	and units ready to be changed. M & R Section: electro-mechanical workshop, foundry, heat treatment, blacksmith and welding, carpentry, quality control and testing. Conclusion: Insufficient facilities to perform work for other industries b. Other Textile Industries Structured as (a) although with a reduced variety of machinery and equipment. Conclusion: Insufficient to perform work for all their needs.
3	Power Generation and Cement	a. Baghdad South Power Station Speciality: Electric power generation. First class buildings and equipment. Able to undertake most repairs for their own needs, including fabrication in the small to medium size precision spare parts. Unable to handle large size work. Their M & R section does not include foundry shop, heat treatment or quality control facilities. The other electric power stations have similar M & R sections though of reduced capability. Conclusion: Insufficient facilities to meet their needs. B. Iraq Cement Company, Baghdad Buildings, machinery and equipment in fair condition. Can do all repair and overhaul work to satisfy their needs and manufacture small and medium sized, fair precision spare parts for emergencies.

Table 4 Cont'd

Rank	Industry Group	M & R Facilities of Leading Companies
3		Their M & R section includes: mechanical and electrical shop, foundry, welding and blacksmith. Other cement factories have similar M & R sections although less efficient. Conclusion: Insufficient facilities for their needs.
4	Agriculture Stations & Central Workshops	a. Heavy Equipment & Repair Workshops, Baghdad Speciality: Main repairs to and overhaul of vehicles and agricultural, earthmoving and irrigation equipment. Buildings, machinery and equipment in poor condition. The average age of machine tools is about 20 years, most of them outdated, some with overhead belt power. However, they can perform most of the repairs and overhauls and manufacture simple spare parts of small and medium size. Main M & R departments: engine repair shop, machine tool shop, general mechanics shop, small foundry, electric shop, body work and painting. Conclusion: Insufficient facilities to manufacture good quality spare parts. b. Hiring Station, Kut Speciality: Hiring and maintenance of agricultural, earthmoving and irrigation equipment indoors and in the field. M & R Section: general mechanics shop, machine tool shop, small furnace for castings and one mobile workshop.

Table 4 Cont'd

Rank	Industry Group	M & R Facilities of Leading Companies
4		Buildings in fair condition but insufficient variety of machine tools and equipment to perform emergency repairs and overhauls. (Main repairs and overhauls are performed in the central workshops out of the seasonal period). Their mobile unit is very modern and complete for emergency repairs in the field. Conclusion: Insufficient facilities to satisfy their needs.
5	Chemical, Food & Beverage, Tobacco and Leather Making	(No leading company concerning their M & R sections). Buildings, machinery and equipment in poor condition and insufficient facilities to satisfy their needs. Simple repairs and overhauls and the manufacture of simple spare parts for emergencies can be undertaken. For major overhauls and repairs, especially for large installations and equipment used in the chemical and sugar plants where production must be stopped sub-contractors are used. Conclusion: Insufficient facilities to satisfy their needs.

TABLE 3

Industry Group	Refer[1]	Maintenance & Repair Programmes Used
Electric Power Stations	20	Preventive maintenance organised on systematic basis 12 months schedule maintenance programme Inspection according to checklists and all breakdowns recorded Documents necessary for a well organised P.M. programme used. Monthly reports issued with M & R costs, man hours, quality and efficiency of work performed.
Cement Factories	14	Preventive maintenance organised on systematic basis only for key equipment. Long term schedule maintenance programme for kilns. Inspection according to checklists and breakdowns of main equipment recorded. No cost control or control of quality and efficiency of work performed.
Textile & Knitting	8	Preventive maintenance carried out but not organised on systematic basis. Medium term schedule maintenance programmes for key machines only. No cost control or control of the quality and efficiency of work performed. Trying to improve their M & R systems (see Appendix 2)
Chemical & Sugar Plants	6	P.M. organised on systematic basis for some key equipment only. Seasonal major overhauls are planned, normally once a year. Routine inspections and oiling, issue of work orders and recording of main repairs. No control of man-hours, cost control or control of quality and efficiency of work performed.

(1) See Exhibit 4, Items E-3 and E-4

Table 3 Cont'd

Industry Group	Rating	Maintenance & Repair Programmes Used
Electro-Mechanical & Metalworking	5.2	Starting with P.M., though not yet organised on systematic basis Inspection according to checklists for key machines. Routine inspection and oiling. Some machine breakdowns recorded. No work orders, control of manhours, cost control, or control of the quality and efficiency of work performed.
Agricultural Stations & Central Workshops	5	Breakdown maintenance following service manuals. Not organised on systematic basis. Emergency repairs and overhauls are performed in the field, otherwise equipment is sent to central workshops when season is finished. Manhours and materials are recorded. No records are kept, no cost control.
Tobacco, Food & Beverage	4	Breakdown maintenance. Not organised on systematic basis. Routine inspection and oiling. No records are kept, no cost control exercised.

Centralised Repair Shops

The few central workshops in Iraq belong to very specialized industries such as petroleum, railways, shipyards, power stations and agricultural equipment. There is also a metalworking plant, the State Company for Mechanical Industries in Iskandariya, which has adequate facilities and could be regarded as a central workshop.

Volume, Type and Quality of Work

We have insufficient data to assess the volume of work carried out in the central workshops. The quality of their work is generally good.

Railway and shipyard central workshops are equipped to perform heavy duty repairs and overhauls and to produce high quality spare parts of all sizes and with a range of materials.

Railway central workshops can carry out

- major repairs and overhauls of railway engines, diesel engines, boiler systems, electrical installations and motors, hydraulic circuits, metalwork and body work
- reconditioning of railway engine wheels, engine blocks, etc., manufacture of pistons, roller bearings and shafts
- structural work, foundry work and carpentry

The shipyard central workshop in Basra has carried out some outside work to utilise otherwise idle machine time. This included the manufacture of large spare parts and half ton castings and work similar to the railway workshops.

Power stations and agricultural central workshops are equipped to carry out major repairs and overhauls for their own needs and to manufacture fair quality spare parts of small and medium size.

Type and Condition of Equipment

Railway and shipyard central workshops are equipped with good quality machinery and equipment which is maintained in good working condition and this reflects the sound maintenance systems

employed. The average age of the equipment is about 15 years.

Electric power and agricultural central workshops are not equipped to carry out outside work and only cover their own needs.

Electric Power Central Workshop, Baghdad

This workshop is equipped to manufacture fittings and equipment for the electrical services in the country, such as electric line extensions, poles, H.T. switches, structural components and brackets, etc.

Heavy Equipment Repair Workshop, Baghdad

This workshop is equipped to manufacture simple spare parts of all sizes, e.g. cylinders and pistons for water pumps, and to do major repairs and overhauls to vehicles, agricultural machinery and earthmoving equipment.

Availability of Spare Parts

Present Suppliers and Services

In Iraq there are no services acting as intermediaries between the suppliers of imported spare parts and the industries using them. Spare parts are purchased individually by each company.

Imports - Availability and Restrictions

The annual cost of imported spare parts during the last ten years is shown in Table 6. All parts for machinery and equipment in the manufacturing industries and utilities, with the exception of vehicles, are included.

TABLE 6

Year	Cost in I.D.	Per Cent of 1961 figure
1961	2,353,576	100
1962	2,638,635	103
1963	1,563,485	66
1964	1,205,546	50
1965	1,486,315	58
1966	1,381,248	54
1967	1,987,160	78
1968	3,142,552(1)	123
1969	3,936,432(1)	154
1970 (10 mo.)	3,674,911(1)	173(assumed)

(1) Can be regarded as exact figures

Source: Directorate General of Imports, Baghdad

In addition to these amounts the cost of some spare parts is included in the price of the machinery and equipment. Spare parts imported require a government licence.

There are,however, long delays between the time of ordering and delivery of the parts. Delays of six months to two years cause down time for the machines and equipment and considerable losses in production. The delays depend on the availability of the parts with the suppliers but the problem is increased by administrative formalities which may take several months.

Present Inventories

The quantity of spare parts held in stock by the various industries, the annual consumption and the average number of years parts are held in stock are shown in Table 7. This shows clearly that most industries are overstocked and only the leading companies, such as power stations and a few cement and textile factories, have a moderate stock as these have good control systems.

TABLE 7

Industry Group	Stock Value I.D.	Annual Usage I.D.	Stock Length years
Food & Beverage	2,060,310	353,560	5.8
Tobacco	479,610	63,240	7.6
Textile & Knitting	1,441,670	529,930	2.7(2)
Clothes	36,200	5,600	6.5
Leather	125,500	35,300	3.6
Wood	24,000	4,100	5.8
Paper	108,400	27,100	4.0
Chemicals (except oil refineries)	669,000	125,800	5.3
Non-metallic prod.	1,956,000	677,100	2.9(2)
Metallic products	32,000	8,000	4.0
Electromech. Indust.	512,000	60,500	8.5(1)
Power Generation	1,250,000	500,000	2.5(2)
TOTAL	8,694,690	2,390,230	3.6

(1) This figure is influenced by newly built plants where the annual rotation is still very low.

(2) Excluding these companies, the average stock length is 6 years.

Source: Bureau of Statistics, 1968 survey, Ministry of Planning, checked with questionnaires and visits.

In some factories it was reported that several spare parts had become obsolete in their package while in stock.

Availability of Adequate Stores

Centralized stores acting as distributors between the suppliers and industry only exist in the automobile industry. In general each establishment has its own store although a few of the larger companies have centralized stores for their individual industries, for example the State Railway Co., the Power Generating Board(1) and the Agrarian Reform Central Shop.

Most of the stores have a mediocre layout and there are inadequate records. This does not apply in the three companies mentioned above or in some of the textile plants(2).

Manufacturing Facilities for Spare Parts

Ratio of Manufactured Parts to Total Consumption

The usual policy in Iraq is to import all spare parts. However, some parts are made locally for emergency repairs and when required to prevent serious work stoppages. On this basis, the ratio of manufactured parts to total consumption amounts to not more than 1 per cent.

Present Manufacturing Facilities

The majority of independent workshops for M & R are equipped to carry out repairs and overhauls and only for the manufacture of spare parts in an emergency. Even the best workshops of the following companies can only manufacture small and medium sized parts and have no equipment for high quality heat treatment or testing:

South Baghdad Power Station
Mosul Textile Company
Iraq Cement Public Company

(1) This company is organising its stores by electronic data processing methods.
(2) See Exhibit 4 for the adequacy grading.

There is only one metalworking plant in the country, The State Company for Mechanical Industries in Iskandariya, equipped to manufacture a wider range of spare parts, having equipment for heat treatment, annealing metals, metallegraphic analysis. Little work is being carried out at present as stated in Section 7.

Quality of Spare Parts

In general, the personnel in Iraq have neither the experience nor the skill to produce high quality parts in spite of the first class equipment available in some workshops. Workshops turning out good quality parts are

- the Railways central workshop
- the Shipyard central workshop
- the South Baghdad power station workshop
- the Electrical Industries Company workshop

Conclusions

1. Each industry visited and questioned had its independent repair and maintenance section and it would be unwise to eliminate these as they deal with emergencies caused by poor maintenance programmes. Maintenance and repair programmes are, with the exception of those of a few of the leading companies, inadequate.

2. Centralised workshops for maintenance and repair do not exist as a public service but the excellent repair facilities in the railways, shipyard, petroleum and cement workshops and some metalworking plants could form the nucleus for centralised services. At present all these facilities are directed to the particular industries.

3. Almost 100 per cent of the spare parts consumed by the manufacturing industries and utilities are imported. The long delay in delivery accounts for the excessive stocks of spare parts held as an insurance against work stoppages. The average stock life is, with a few exceptions, 6 years.

4. Some companies have good central stores but in general, they are inadequate, and control systems, if they exist, are poor. Manufacturing facilities for good quality spare parts of all sizes are only found in a few well-equipped workshops and metalworking plants.

3. PERSONNEL

Availability of Skilled Personnel on M & R

According to the Manpower Report No. 21, August, 1970, the labour force, employed and unemployed, was:

a. Employed Labour Force

• skilled and semi-skilled	29 per cent
• unskilled	71 per cent

b. Unemployed Labour Force

• skilled and semi-skilled	30 per cent
• unskilled	70 per cent

(As we do not have a good definition of how classification is made for skilled and semi-skilled, it could be expected that some more poorly-skilled or unskilled are included in the group semi-skilled and that the percentage of unskilled is still higher.)

The above figures show a 30 per cent unemployed labour force of skilled and semi-skilled workers. From the comments in the manpower report we assume that there could be a 10 per cent skilled labour force available although factory managers complain that lack of skill causes poor work performances and breakdowns. This can only mean that the skills are below the standards required to meet today's technology.

Previously Trained

The shortage of skilled M & R personnel is acute. Ninety per cent of the industries visited reported that their M & R personnel had learnt on the job.

Only a few leading companies, such as power stations, railways, shipyards, oil refineries and possibly the army, have high standard skilled personnel for M & R, and some of these reported a shortage of such personnel.

There are no statistics giving the number of skilled M & R personnel employed in the manufacturing industries. However, we found that an average of 12.5 per cent of direct labour employed in M & R services were considered to be skilled or semiskilled, although only about 5 per cent met the required standards.

Undergoing Training

Most of the work force employed in industry, including M & R personnel, had learnt their job by experience rather than by adequate training. Newcomers from other companies, fields or from the production lines are placed under the supervision of a senior M & R operator for 5 to 6 years, learning both the good and bad habits. A few companies have good training facilities for newcomers but there are no refresher courses for in-plant personnel.

M & R Supervision Personnel

Most supervisors and foremen for M & R have been promoted from experienced workers in the company and are not trained to take command, organise crews or make decisions.

Availability of Training Facilities

Vocational Training Centres

Table 8 lists the main vocational training centres in Iraq together with the subjects taught, location and output per annum. The most general and well located training centre for industry is that of the State Company for Mechanical Industries at Iskandariya. The others have good training facilities but are more specialised.

In-Plant Training Facilities

In-plant training facilities are not an established practice in Iraq. The textile industry has a pilot plant to give practical training to students from their Kut training centre and refresher courses to workers. Two other textile factories have in-plant training facilities, including those for maintenance and repair practices.

Training Programmes

According to statistics from the Ministry of Education for 1969, the output of graduate engineers from four Iraqi Universities

TABLE 8

VOCATIONAL TRAINING CENTRES

Training Centres	Speciality	Location	Trainees per year
Iraqui Railways	Machinists, fitters, welders, engine mechanics, electricians	Baghdad	50
State Co. for Mechanical Industries	Machine tool operation, tool & equipment repair, hand smith work, manual & automatic welding, bench work, foundry work, maintenance & overhaul	Iskandariya (Baghdad area)	400(1)
Kut Textile Factory	Textile machinists, loomfixer, maintenance & repairs and overhaul of machines & equipment	Kut (South Baghdad)	1000(1)
Telecommunications Training Centre	Morse operation, telephone switchboard (operation & maintenance) Installation of cables and lines	Baghdad	50

(1) Assumed figure for new Training Centre

Source: Ministry of Education and State Organisation of Industries

together with the students who specialized abroad, is more than sufficient to cover the needs of all existing and expanding fields for years to come. However the managers from several companies claimed that there is a shortage of qualified engineers and technicians who can apply their knowledge efficiently and economically.

The Management Development Centre of Baghdad was established under the direction of United Nations experts to provide management educational programmes of all types to companies. It is flexible in designing and making available new courses and seminars in response to changing needs.

There are several vocational training schools and institutes around the country but they do not train skilled workers in the needs of industry. Table 9 lists vocational industrial schools and the subjects studied in each.

Conclusions

The lack of high standard skilled personnel for M &R is evident. Most have learnt from the experience of others and supervisors and foremen are chosen from the most experienced workers without adequate training for commanding, organizing or taking decisions.

There are vocational schools and training centres in Iraq but few have adequate equipment and training programmes. In-plant training facilities are not an established practice except in the textile industry. Qualified managers, engineers and technicians are scarce despite the good training facilities at home and abroad.

TABLE 9

LIST OF SECONDARY INDUSTRIAL SCHOOLS FOR YEAR 1969/70, ACCORDING TO STATISTICS OF THE MINISTRY OF EDUCATION

	Name and Location	Trades - 3 Years										
		Foundry Blacksmith Welding	Fitting - Latheshaper Milling	Carpentry	Masonry	Plumbing	Pipe Fitting	Auto-mechanics	Electricity	Radio	Printing	Total Capacity 3 years
1.	Iraqi-German Secondary Industrial School, Baghdad		120					120	120			360
2.	Iraqi Secondary Ind.School, Baghdad	40	40	40	40	40	40	40	40	40	40	400
3.	Iraqi Sec. Ind. School (Officers' City)									150		150
4.	Iraqi Sec. Ind. School, Ananear Ramadi	45	45					45	45			180
5.	Iraqi Sec. Ind. School, Bakuba	45	45					45				135
6.	Iraqi Sec. Ind. School, Basrah	60	60	60				60	60			300
7.	Iraqi Sec. Ind. School, Kirkuk	45	45	60				60	60			270
8.	Iraqi Sec. Ind. School, Mosul	60	60	60	60			60	60			360
9.	Iraqi Sec. Ind. School, Najaf, nr Kerbala	45	45					60	45			195
10.	Iraqi Sec. Ind. School, Sulaimaniyah	45	45	45				45	45			225
	Total	385	505	265	100	40	40	535	475	190	40	2575
	Trainees per year	125	165	90	33	13	13	175	160	65	13	860

6. ANALYSIS OF PREVAILING MAINTENANCE AND REPAIR PRACTICES

The effectiveness of prevailing maintenance and repair practices was examined.

Adequacy of Present Facilities

Some standard of effectiveness of maintenance and repair must be developed to eliminate cases such as the following.

> One textile factory reported a loss of 140,000 I.D. in one year due to machine breakdowns and negligence of operators, representing more than 9 per cent of the production costs. A tobacco factory reported a loss of 489,300 I.D. in one year for the same reasons, representing 8 per cent of production costs.

In-plant surveys in many industries showed machine deterioration due to lack of maintenance and/or bad repair services.

The inefficiency of present maintenance and repair systems can be seen in Table 10 which shows the high cost of maintenance in industry in 1969 compared to production costs.

TABLE 10 (1)

a.	Production Costs	70,250,000 I.D.	100%
b.	Maintenance & Repair		
	Labour costs	25,000,000 I.D.	35%
	Spare Parts & Materials	2,500,000 I.D.	4%
	Production losses (assumed 5% of production costs)	3,512,500 I.D.	5%
		31,012,500 I.D.	44%

(1) Source: Bureau of Statistics, Volume 1969, Table 7.

Costs of maintenance and repair are 44 per cent of the direct costs of production and this does not take into account the deterioration of machinery and equipment due to lack of maintenance.

Key Industries and their M & R Systems

Industries in which breakdown of equipment can cause costly production losses should have first class M & R systems, e.g. railways, power stations and cement plants. However, these standards of service are not maintained for some cement plants and agricultural equipment.

Factors Affecting the Adequacy of M & R Facilities

1. The majority of companies visited were not making extensive use of basic organisation techniques in maintenance and time was consumed in solving detailed operating problems rather than in planning and organisation.

   A clear organisation structure supported by descriptions of responsibilities does not exist. Monthly reports giving performance standards, staffing and organisation of maintenance teams, the specific work procedures used and comparisons between the cost of maintenance and the cost of breakdowns are not general.

2. The shortage of skilled personnel, machine breakdowns and negligence were stated to be the main causes of losses in production, the shortage of skilled labour being more acute outside the Baghdad area.

3. From the analysis of the questionnaires it was found that the quality of the goods produced was directly proportional to the efficiency of the M & R services applied.

Some textile and metalworking industries are trying to solve the problem of poor maintenance by improving management techniques and by using appropriate training systems for their personnel.

Frequencies of major overhauls are not determined and recording methods and cost control systems are not applied.

Preventive maintenance is not an established practice in Iraq. Generally, breakdown maintenance is used although incorrectly applied, the common practice being to replace rather than repair.

Effect of Lack of Standardization

There is a lack of standardization of machinery and equipment used in the country as some industries bought unsatisfactory cheaper second-hand equipment while others did not order consistently from one country, e.g. the Agrarian Reform bought American, English, Czech and finally Russian equipment.

Lack of standardization leads to:

- a greater and unnecessary variety of equipment with the risk of early obsolescence
- a large stock of spare parts with a higher investment cost requiring more storage space and personnel
- a larger repair and maintenance section requiring more efficient maintenance systems and a larger crew of skilled operators.

All these factors represent a considerable loss of money and time.

Government Policies Affecting Maintenance and Repair

There are no government policies affecting maintenance and repair, inspection or industrial safety. The State organizations watch over their respective industries and it is assumed that they include inspection and personnel safety.

Conclusions

We found that, in general, the amount of work performed on maintenance and repair was excessive and the cost too high.

Some of the key industries which should use adequate M & R systems to prevent stoppages and obsolescence of expensive equipment do not do so.

Organization of M & R services in most industries does not exist or is of low standard. Preventive maintenance is not an established practice in Iraq, replacement of parts from readily available stocks being preferred. The shortage of skilled personnel at all levels is acute.

Lack of standardization leads to great variety in the machinery and equipment installed. There is no government institution to advise industry on the purchase of suitable equipment and decisions must be made by management. Large stocks of spare parts are therefore required and equipment becomes obsolete.

There are no government policies or services dealing with maintenance and repair and all decisions are left to management The state organizations act as advisers for industry and as mediators between ministries and industry.

9. FEASIBILITY OF CENTRAL M & R WORKSHOPS

Centralised M & R workshops might be developed for industrial requirements as follows:

The State Company of Mechanical Industries in Iskandriya
A workshop for the textile industries
An agricultural equipment workshop in Baghdad

The State Company for Mechanical Industries has a production capacity for about 30,000 tons a year and is equipped to produce agricultural plant components, tractors, medium sized trucks and centrifugal pumps(11). At present little work other than the assembly of tractors is undertaken. The main stores, workshops and laboratories are listed in Appendix 5. If the plant were manufacturing to full capacity there would be sufficient spare potential to carry out repairs, overhaul machines and manufacture spare parts up to 500 tons per year of manufactured tools, dies and spare parts and 1,000 units per year overhaul and repair work.

This would cover the requirements of industry in Iraq, other than those of the textile industry and agricultural equipment for which other arrangements are suggested.

This site was chosen for the central workshop for the following reasons:

- It is an ideal location in the industrial area of the country and road and rail facilities are available
- Adequate machinery and equipment is available
- Sufficient spare capacity is available for manufacturing required spare parts for industry in Iraq
- Skilled personnel are available
- A vocational training centre is already available on an adjacent site

Organisation

The requirements for manufacturing spare parts should be determined by the S.O.E.I. and industry. They should draw up

(11) Source: UNIDO-UNESCO mission on agricultural machinery and manufacturing industries. Republic of Iraq. April 28/30, 1970

long term programmes, giving priority to the needs of the more important industries, and control these programmes.

An adequate number of mobile workshops, such as that in the Kut agricultural station, should be added to the Iskandariya central workshop so that M & R work can be performed outside the shop when necessary. The central workshop will also be able to sub-contract.

The organisation structure of the central workshop must be defined with appropriate charts and job descriptions for the plant engineers, supervisors, foremen and skilled operators. It is essential that such a workshop should have adequate offices.

This organisation, having the best equipped workshop in Iraq, will be able to assist the textile and agricultural industries when their workshops are not equipped to carry out certain specialised work.(1)

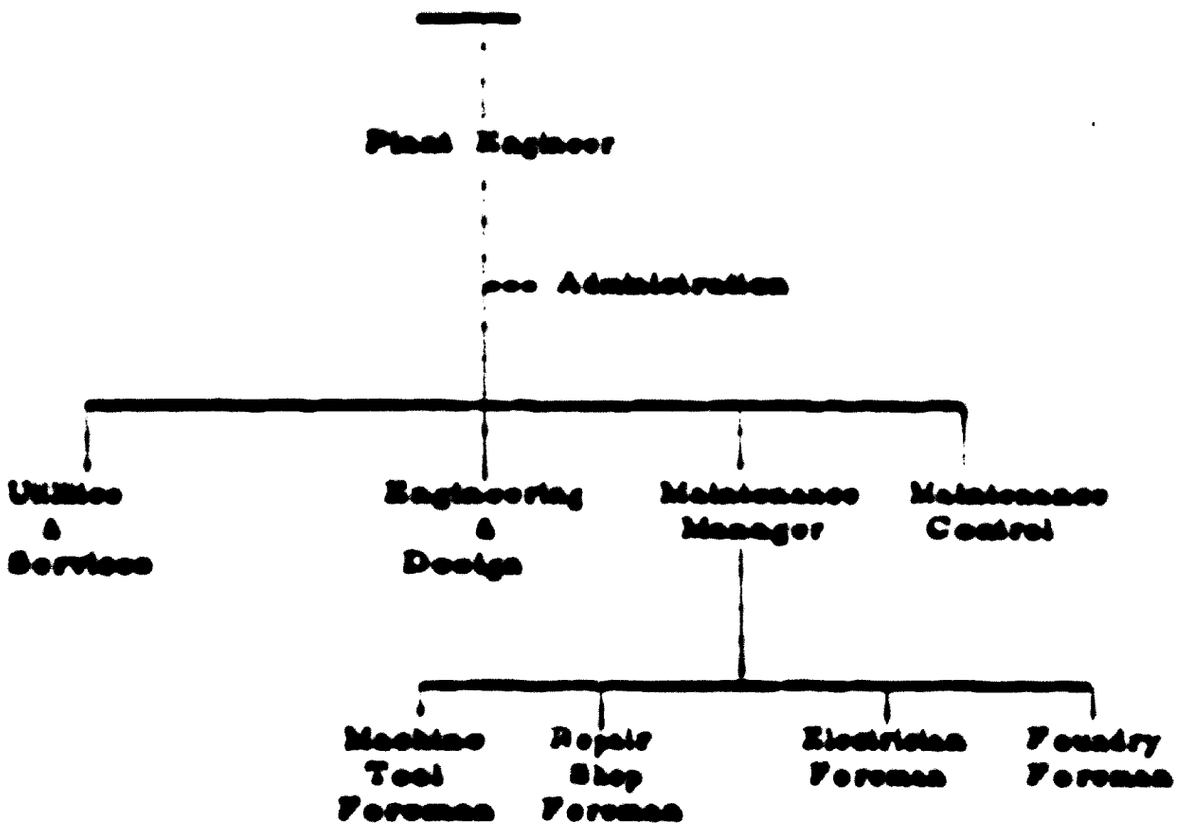
The S.O. of Textiles is considering building a centralised workshop for the textile industry which is one of the largest industries in Iraq. This should be encouraged as such a central workshop would reduce the facilities required in the factory shops to those for emergency repairs and overhauls.

Knitting industries form a small group with similar requirements and should share the same facilities.

There is one main central workshop for agricultural equipment and one central repair shop and hiring station. Neither of these has the facilities to satisfy their needs. A solution would be to merge these shops into one, preferably that located in Baghdad, and upgrade the existing equipment.

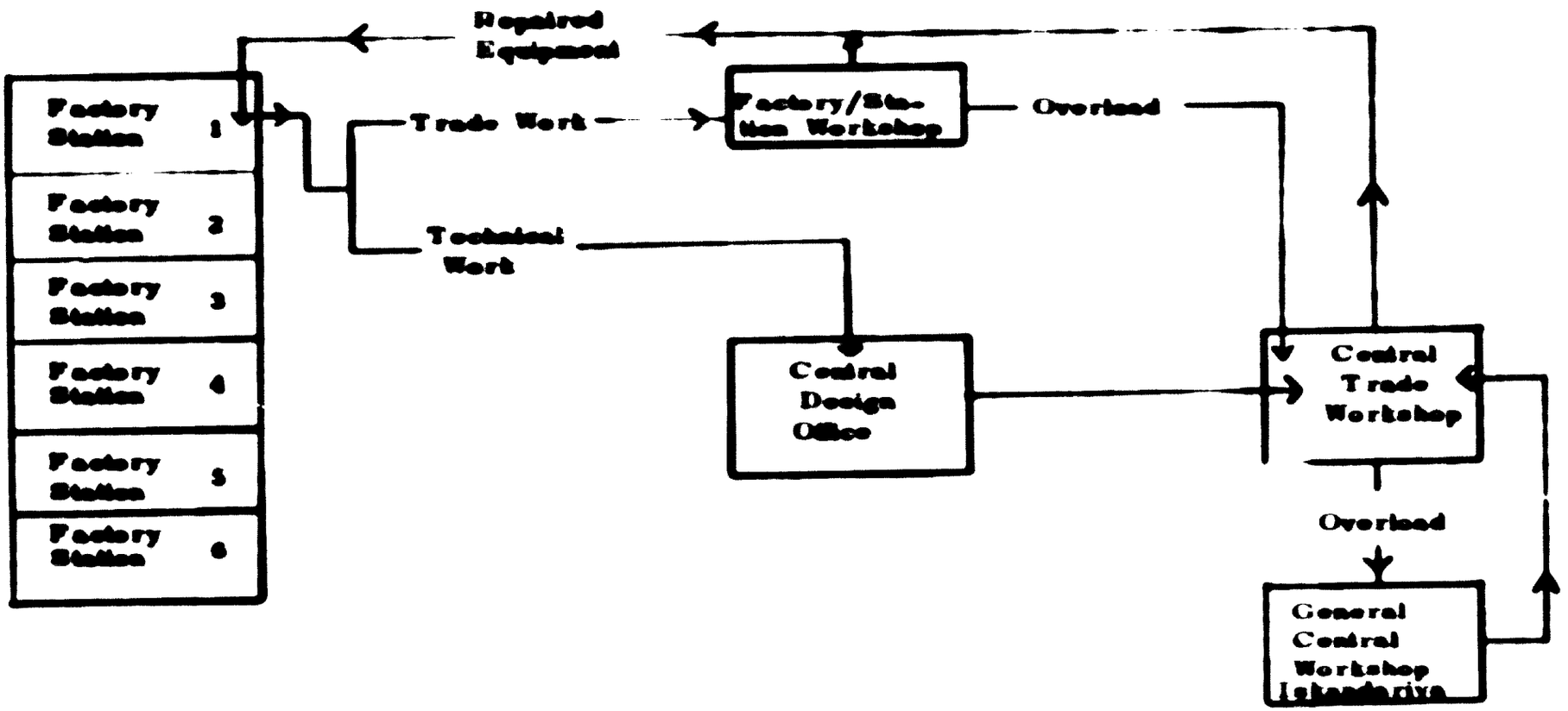
(1) For further details see Appendix 8, page 74.

ORGANIZATION CHART FOR MAINTENANCE DEPARTMENT



TEXTILE INDUSTRIES AND AGRICULTURAL STATIONS

TYPICAL WORK FLOW CHART FOR FACTORY/STATION ORGANIZATION



Flow Lines Developed for Factory/Station 1 Only; Similar Procedures for the Others

FIGURE 1

8. RECOMMENDATIONS ON FUTURE POLICY

M & R Organization

Organization

There should be a coordinator attached to each State organization to

- establish policies and procedures by defining the main objectives of M & R systems
- define M & R management responsibilities
- establish cooperative programmes to share the available facilities
- collaborate with the industries to control M & R systems and upgrade the quality of the work to prescribed standards
- coordinate and control stocks of spare parts in the central workshops
- control current M & R training programmes in the plant and in vocational training centres and determine their effectiveness by practical tests

Management Efficiency

A plant engineer should

- define the overall objectives of maintenance
- establish policies and procedures
- define the responsibilities of the subordinate engineering managers
- establish performance standards and define maintenance quality
- plan the maintenance workload
- approve maintenance programmes
- review performance and performance trends, taking corrective action where necessary
- review methods regularly and incorporate new procedures into the programmes by updating the standards
- provide for training management and operating personnel

A maintenance manager should

- prepare work schedules to guide day-to-day work
- make daily job assignments for men and equipment based on the work schedules
- review work performance and provide guidance and assistance where necessary to improve performance.

All companies should have charts to show where maintenance is placed and a manual showing the main objectives of the M & R section and managerial responsibilities.

M & R Objectives

M & R systems must be designed to

- ensure that maximum utilisation of machinery and equipment is made
- reduce wear and deterioration of the plant to a minimum.

In developing an organisation to handle maintenance engineering it must be realised that no structure is the most satisfactory one for all cases. It must be tailored to fit the particular technical, geographical and personnel conditions.

Upgrading of Existing Facilities

Power Stations

First class M & R facilities are tailored for this special type of industry and no upgrading is necessary.

Cement Plants

The plant having the best M & R facilities is the Iraqi Cement Factory in Baghdad. However, the available potential of machines, equipment and work force is excessive. The M & R personnel have insufficient skill to utilise the wide range of equipment available so that work is performed inefficiently at high cost. Large spare parts required in such industries cannot be manufactured.

We recommend that they reduce their M & R sections to a size which will satisfy emergency repairs and overhauls and manufacture simple parts for emergency breakdowns. The maintenance work force could then be used for routine maintenance. As the plant is large the maintenance section should be decentralised so that emergencies can be dealt with rapidly. The effect of decentralisation on down time should be studied.

Major repairs and overhauls should be given to a subcontractor and the manufacture of large and high quality spare parts to a fully equipped workshop, such as the State Company for Mechanical Industries.

M & R in most of the other cement plants are of low standard and we recommend collaboration through the State Organisation for setting up similar M & R facilities.

Textile and Knitting Factories

Some textile factories have very good M & R facilities, e.g. the Mosul Textile Factory, but their maintenance systems are not adequate for their needs and should be upgraded. It is suggested that there should be an agreement between the S.O. of the knitting, leather and tobacco industries and the S.O. of textiles to share such facilities as may be developed.

A fully equipped centralised workshop for these industries should be set up so that only emergency repairs are carried out in the factories.

Chemical and Food Processing Plants

As these plants are designed to operate for long periods with little maintenance, organised extensive overhauls are carried out during the off season or when there are signs of deterioration.

The sugar plant at Mosul can be overhauled and cleaned when the season is over and the following improvements would make the process more systematic:

- improvements in the recording systems for repairs and overhaul to the key equipment
- improvements in the cost control systems to decide which operations should be subcontracted.

If the use of subcontractors is more economical a M & R section for routine maintenance and emergency repairs is sufficient.

Non-automated Industries

Two plants manufacturing electrical and mechanical equipment and one shoe factory have good M & R facilities. Maintenance systems are inadequate and should be upgraded.

Small factories for brick making, leather processing, etc., have neither good M & R facilities nor adequate maintenance systems.

For such factories we recommend that

- routine maintenance be organized on a systematic basis and schedules, recording systems, costing and control procedures be set up for key equipment only
- the mobile unit from a centralized shop be used for major repairs and overhauls and the centralised shop for manufacturing spare parts.

Factories with Automatic Processing Equipment

Factories for the food and beverage industries and for cigarette making, etc., have inadequate M & R facilities for their needs. The manufacture of spare parts, major repairs and overhauls should be carried out by the centralised workshop. Maintenance systems require upgrading.

New M & R Facilities

Non-automatic Processes and Small Factories

Factories such as most of those for brickmaking and those for making clothing, metal furniture, etc., had neither good M & R facilities nor adequate maintenance systems. For these we recommend

- the use of routine maintenance organised on a systematic basis with established schedules, recording systems, costing and control procedures for the key equipment

- the availability of a M & R section to cover emergency repairs and overhauls
- the use of centralized shops for major repairs and overhauls, preferably the mobile unit, and for the manufacture of spare parts.

Agricultural Equipment

This industry is the responsibility of the Ministry of Agrarian Reform. Neither their M & R facilities nor their maintenance programmes are adequate for their needs and we recommend

- the establishment of a fully equipped centralized workshop where major repairs and overhauls can be carried out efficiently and high quality spare parts for emergency repairs can be manufactured
- an increase in the number of mobile units in the hiring stations, similar to the one in the Kut hiring station, to provide services in the field
- a reduction in the amount of equipment in the hiring station workshops to that necessary for emergency repairs and overhauls

Maintenance Programmes for Various Types of Industry

Agricultural Equipment and Vehicles

The use of preventive maintenance (PM) is recommended for the main earthmoving and agricultural equipment, transport vehicles and power generators. For secondary equipment, such as water pumps and simple items, routine maintenance with periodic oiling and cleaning is satisfactory.

Preventive maintenance must be organized on a systematic basis as follows:

- an inventory of equipment by type and location, central workshop or hiring station, must be prepared. This list must be kept up to date.

- maintenance must be broken down into type of job as an indication of the work required. The work can be scheduled as routine lubrication, cleaning, lamp replacement, etc., preventive maintenance inspection, regular equipment overhaul, emergency breakdown and repair or long-range capital improvements.
- equipment record charts for the individual items should be prepared from the service manuals. These should record the supplier, inventory number, technical specifications, type and frequency of overhauls, spare part stock lists, etc. The back of the charts should be used for recording major breakdowns and dates of overhauls.
- inspection and service orders should be prepared from these charts for each type of equipment showing the parts to be checked and the frequency of checking. A sample inspection and service order for transport vehicle equipment is shown in Figure 2.
- work orders issued for major repairs and overhauls must include the type of work to be performed and the priority. The report must show the time taken by each department, the labour employed, spare parts changed, etc., and the cost involved.

The above information should be held in the hiring stations and copies sent through the central services to the M & R headquarters of the Department of Agrarian Reform.

M & R headquarters should analyze all data received from central services and compare the cost of maintenance with that of breakdowns so as to provide the lowest cost between the two. They should dictate new policies necessary on M & R. Situations where high responsibility is required, such as replacement of equipment, should be taken only by M & R headquarters.

Figure 3 shows an organization flow chart between hiring stations, central services and M & R head office, connected to Iskandariya Central Workshop when high-quality work or testing is required.

CLARK EQUIPMENT COMPANY, SERVICE DIVISION

INSPECTION AND SERVICE ORDER
GAS AND ELECTRIC FORK TRUCKS AND TOWING TRACTORS

DRIVE AXLE AND DIFFERENTIAL

Item	1	2	3	4
Clean and Repack Gears and Bearings				■
Wheel Ends (Hypoid Axles)				■
Check Oil Level		■		
Drain and Refill				■
Drive Axle Air Vent		■		

BRAKES

Item	1	2	3	4
Service Brakes	■			
Seat Brake	○			
Master Cylinder and Lines		■		
Check Shoes Linings and Connections				■
Brake Adjustment				■
Check Hand Brake or Brake Lock	■			
Power Brakes (Hydrovac & Air Cleaner)				⊠

CLUTCH OR HYDRATORK DRIVE

Item	1	2	3	4
Throwout Bearing Grease Cup	⊠			
Clutch Pedal Adjustment		⊠		
[illegible]		⊠		

COOLING SYSTEM

Item	1	2	3	4
Radiator, Water Level & Anti-Freeze	⊠			
Examine Core, Hoses, Check for Leaks		⊠		
Water Pump, Check Lube and Mounting			⊠	
Fan and Fan Belt Tension		⊠		

ELECTRICAL SYSTEM

Item	1	2	3	4
[illegible]	○			
[illegible]		⊠		
Pump and Drive Motor Brushes			○	
[illegible]				○
Gauges: Ammeter and Etc.	■			
Contactor Panel, Clean & Adjust Points		○		
Generator Lubrication		⊠		
Starting Motor Lubrication			⊠	
Gen. and Start. Motor. Check Brushes			⊠	
Lubricate Distributor		⊠		
[illegible]			⊠	
Ignition Timing			⊠	
Spark Plugs: Check Gap & Clean			⊠	

ENGINE

Item	1	2	3	4
Check Crankcase Level	⊠			
Drain Oil & Refill, Check Oil Filter		⊠		
Valve Tappets, Inspect & Adjust			⊠	
Engine Compression			⊠	
Cylinder Head Nuts, Gasket & Leaks			⊠	
Manifold, Nuts, Gaskets & Leaks			⊠	
Muffler, Mounting, Condition			⊠	
Governor, Speed & Surge			⊠	

DATE ____________ MACHINE SERIAL NO. ____________

DRIVER ____________

SERVICEMAN ____________

FOREMAN ____________

FUEL SYSTEM

Item	1	2	3	4
Carburetor Adjustment			⊠	
Air Cleaner	⊠			
Fuel Pump		⊠		
Fuel Supply	⊠			
Fuel Filler Cap: Clean Screen		⊠		
Check Fuel Oil Filters (Diesel Only)		⊠		

HYDRAULIC SYSTEM

Item	1	2	3	4
Operation Tilt & Lift Oil Level	■			
Check Pump, Valve & Tank		■		
Clean Tank Filler Cap		■		
Lift Chain Adjustment		■		
Lift Brackets and Slides			■	
Check Tilt & Lift Cylinder Drift			■	
[illegible]			■	
Lift Cylinder, Packing Boots & Vent			■	
Inner Slides (Lubricate)		■		
Inspect Lift Forks				■

STEERING SYSTEM

Item	1	2	3	4
Wheel Bearings				■
Axle Grease Fittings		■		
Steering Gear, Lube & Mounting		■		
Drag Link Adjustment			■	
Check Turning Radius			■	
Inspect Tie Rod Ends			■	
Inspect Pivot Pins & Spindles			■	
Power Steering: Pump & Valve			⊠	
Power Steering Booster			⊠	

TRANSMISSION

Item	1	2	3	4
Hydratork: Check Oil Level	⊠			
Hydratork: Drain and Refill			⊠	
Hydratork: Check Oil Pressure		⊠		
Standard: Drain & Refill			⊠	
Standard: Check Level	⊠			
Drop Gear Case, Check Level			⊠	

MISCELLANEOUS

Item	1	2	3	4
Check Electrical Connections and Tips		○		
Check Tires	■			
Lights: Head and Stop	■			
Lubricate All Grease Fittings		■		
Miscellaneous Linkage & Clevis		■		
Steam Clean Machine		■		
Inspect Spring Shackles U Bolts & Clips			■	
Tighten All Bolts, Nuts & Capscrews			■	
Inspect U Joints			⊠	
[illegible]			⊠	

CODE: All Machines ■ Gas Models ⊠ Electric Models ○

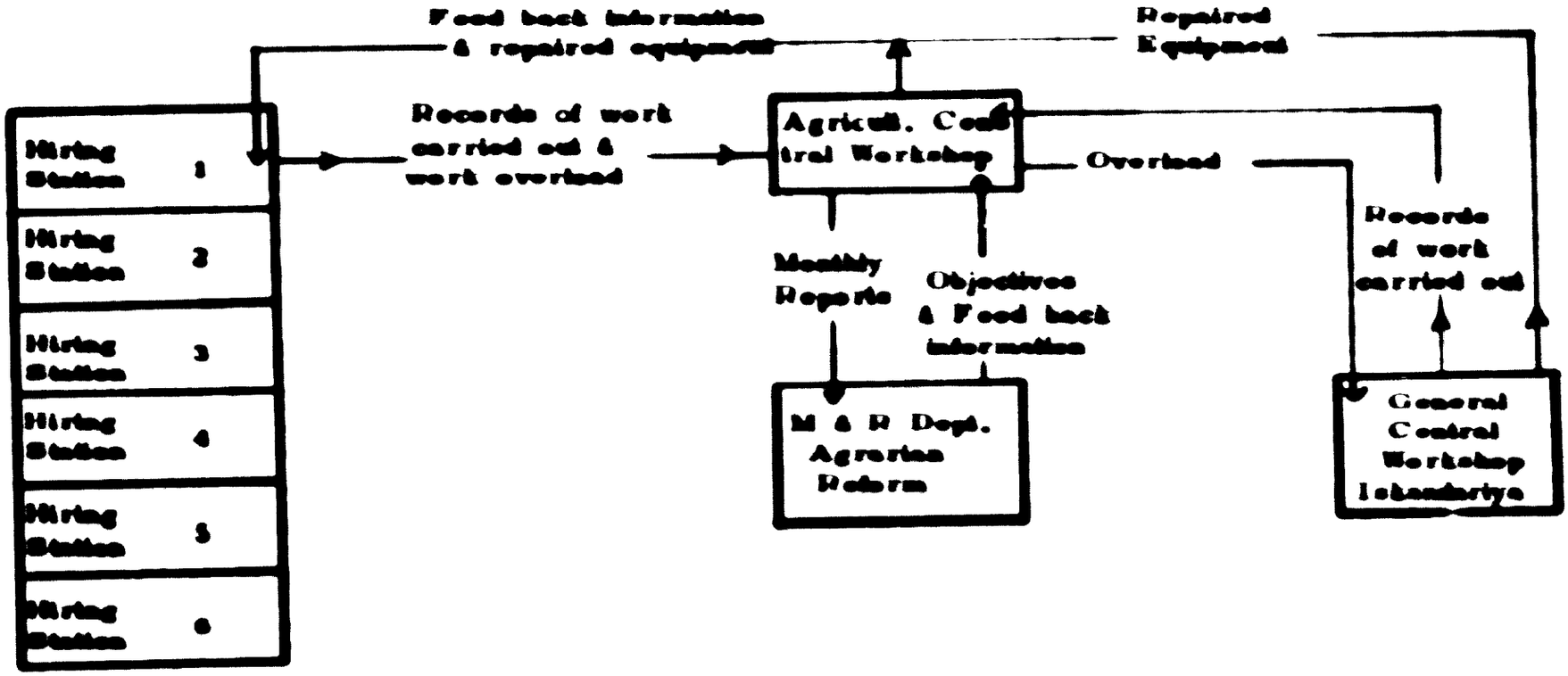
Time Intervals For Inspection Are Either ____________

REMARKS ____________

FIG. 2. A form that is used for both history and upkeep.

AGRICULTURAL EQUIPMENT

TYPICAL WORK FLOW CHART FOR HIRING STATIONS ORGANIZATION



Flow Lines Developed for Hiring Station 1 Only; Similar Procedures for other Hiring Stations

FIGURE 2

Chemical, Food Processing, Cement and Large Metalworking Plants

Equipment should be separated into two groups:

- Key equipment such as kilns, boilers and important items in which a breakdown can cause great production losses.
- Secondary equipment such as simple pumps.

For the first group PM should be scheduled for at least one year for major repairs and overhauls, rebuilding and cleaning. Accurate records of costs and efficiency of work performed should be kept in order to analyse and determine the most adequate and economical maintenance system.

For the second group routine maintenance, such as periodical oiling, cleaning and mechanical-electrical inspections, checking for leaks, vibration and unusual heating, etc., should be used.

Subcontractors should be used for scheduled repairs, rebuilding and overhauls, the plant M & M services being available only for emergencies. For small plants where the M & M services are at a minimum it is better to use subcontractors on a routine basis.

Automatic Processing Plants

Factories such as those for food packaging, beverage bottling, cigarette making, etc., should use sound preventive maintenance for their production lines to prevent the breakdown of certain key machines which form bottlenecks if they break down. An example of PM is shown in Appendix 4, page 62.

Improvement of Existing Stores and Establishment of New Ones

Local Stores

All factories visited had their own stores. Some local stores for large and medium size spare parts such as those of plants manufacturing machinery and equipment, agricultural equipment and cement plants have a poor layout. Wider aisles would improve handling. Protection against dust for delicate and expensive parts such as control instruments, crankshafts, etc., should be improved.

Stores for large and medium size factories and centralised stores should have a reception room for unpacking, cleaning and checking spare parts before storage.

Centralized Stores

Each large industrial sector such as textile and cement plants and agricultural stations should have one central store for common M & E spare parts and materials. This will permit more accurate control of stocks with minimum inventory and paper work and saving of space. The local stores in factories should maintain stocks at a level to cover their immediate requirements.

For industrial sectors of smaller size, or where the equipment varies from plant to plant, it is not advisable to have centralized stores.

Store Systems and Control Procedures

In general, for optimum economy in time store rooms should be located centrally.

Nuts, bolts, screws, electrical fuses, belts and other frequently used items should be located at the front of the stores room. Small quantities of these items should be on hand in uncontrolled storage in the area for maintenance mechanics.

Infrequently-used items should be placed at the back of the storeroom or on a second floor.

Except for power stations, the majority of stores need to improve their code systems and control procedures. Stocks must be reduced to a reasonable volume by using sound inventory control systems.

Good control is obtained by:

- selecting and training people to do the work accurately and efficiently
- standardizing spare parts, equipment and maintenance materials
- reducing the number of lubricants used on the advice of the suppliers
- using the following ABC method of inventory control

  Class A: small per cent of items in a stocks room that make up a large portion of the inventory investment. Special care is used to maintain the accuracy of the inventory records of these items.

Class B: items of average importance receiving a normal amount of attention.
Class C: unimportant items that normally make up only a small part of the inventory investment. Usually well over half the items in stock are in this class.

- using and ordering parts to maintain minimum stock level
- using adequate and uniform code systems to control stocks efficiently and to locate items rapidly

For centralised stores the benefit of electronic data processing (EDP) should be considered.

Classification of Spare Parts

To select which spare parts should be locally manufactured and which should still be imported we have classified them in four groups as follows:

- Spare parts requiring a high technology of manufacturing methods, treatment and testing, and high quality materials, e.g. crankshafts, propellers for turbines, ball bearing, high precision instruments, etc. These should still be imported.
- Spare parts consumed in large amounts but requiring a high technology of manufacturing methods, e.g. special needles used in textile and knitting industries. These parts should continue to be imported but it is suggested that the feasibility of building a plant for their production be considered.
- Spare parts or auxiliary material consumed in considerable amounts which do not require a special manufacturing technology, e.g. pulleys, nuts and bolts, hardware, etc. These items should be locally manufactured in specialised plants rather than in centralised shops.
- Spare parts and equipment not requiring special manufacturing technology and consumed in small to medium quantities, e.g. chain, gears, castings, etc. These items should be manufactured locally.

M & R Training Programmes

Management Courses

By improving managerial skills through management education programmes, existing M & R facilities may be upgraded.

We recommend the establishment of courses in maintenance management for M & R managers, plant engineers, storeroom controllers (for central and big stores) and all highly qualified personnel connected with M & R facilities in the manufacturing industries, including engineers from the State Organisations dealing with M & R.

These courses should include: maintenance and control systems, cost and budgetary control, inventory control and training systems, with visits to selected industries. The length of the course should be not less than two months full time and the group restricted to 15 to 20 participants. We recommend that theory courses be held at the Management Development Centre in Baghdad.

Supervisors and Foremen

Upgrading and refresher courses both to improve their technical competence on M & R and to enable them to train other personnel on a more efficient basis.

These courses given in selected vocational training centres should include: simple management techniques, maintenance and repair procedures, and training methods. Length of course to be 6 to 8 weeks. Groups should be selected according to industry group and educational level.

Work Force

Upgrading training courses should be accelerated and prepared for operators working on M & R, according to speciality in industry and grade of skill. All engineering personnel should be trade tested before joining the M & R section.

Training in vocational training centres should be compulsory for newcomers from secondary technical schools.

All industries require trained personnel, particularly the following, in this order:

- agricultural equipment (stations and workshops)
- cement and chemical
- food, beverage and tobacco
- manufacture of electro-mechanical equipment
- power generation
- textile and knitting

Training Centres

Management Training

The Management Development Centre of Baghdad is a well-established educational institution giving management courses. We, therefore, recommend that the courses already given be used and, if necessary, new or improved courses established.

Vocational Training Centres

Vocational training centres should be used according to their adequacy, speciality and location. We recommend:

- Iskandariya Training Centre for general mechanics and electricians should be equipped for M & R personnel working in plants such as food packaging, beverages, cigarettes, etc.
- Kut Textile Training Centre for textile and knitting trades
- Iraqui Railways Training Centre for cement, chemicals and industries employing heavy equipment (see Table 8)
- Abu-Ghraib Training Centre for agricultural equipment should be upgraded.

The following should be considered:

- the establishment of vocational training centres for important industries such as power generation and food industries
- establishment of a vocational training centre for electronics and instrumentation. If possible, use the Telecommunications Training Centre in Baghdad (see Table 8).

In-Plant Training

In-plant training should be established in key industries such as

- State Company for Mechanical Industry, Iskandariya
- Electrical Industries Co., Baghdad
- Mosul Textile Factory, Mosul
- Iraqi Cement Factory, Baghdad
- Mosul Sugar Co., Mosul
- Automatic process plants
- Chemical plants

N.B. References on training programmes are shown in Appendix 6, page 84.

APPENDIX 1

VISITS TO GOVERNMENT, LOCAL AUTHORITIES AND OTHER AGENCIES

Organization	Name	Position
Ministry of Industry	Najim K. Kassab	Deputy of the Minister
	Hamal Daffale	Manpower Officer
State Organization of Engineering Industries	Hussan Al-Najim	President
	Adnan Kaswini	Technical Manager
	Dhia Al-Okaby	Mech. Engineer and Industry Liaison with HPC expert
State Organization of Knitting, Clothing, Leather and Tobacco	Kadhum Al-Sheikh	Technical Manager
State Organization of Textile Industries	Mohamud Ali-Wasfe	Technical Manager
State Organization of Mech. Industries, Iskanderiya	Hassan Al-Kawi*	General Director
Ministry of Planning	Tadija Popovic	U.N.A.D. expert in Planning & Execution
	Georges Hamaoui	B.I.T. expert in Manpower Training
Ministry of Agrarian Reform	-	-

* Being replaced by a new man.

APPENDIX 2

RELEVANT CASES OF LEADING FIRMS HAVING MAINTENANCE AND REPAIR FACILITIES

A. Electricity Generating Board Company

Organization

The government owned company is the only one in Iraq and can be subdivided as follows:

- headquarter offices, Baghdad
- central workshop, Baghdad
- electric thermal station, South Baghdad
- 4 or 5 small electric power stations spread around the country

1. Central Workshop

Its main purpose is to manufacture all kinds of equipment and fittings such as electrical line connections, poles, H.T. switches, etc.

The main departments are:

- mechanical-electrical shop
- forging and stamping
- assembly and welding
- painting
- stores for raw materials and parts

2. South Baghdad Power Station

Maintenance and Repair Facilities

The maintenance and repair systems are first class though tailored only for power stations. They use scheduled maintenance with various recording and control systems. Their lubricants are coded.

Workshop

They can do most of their repairs and manufacture high precision spare parts. Labour efficiency and machine utilization are very good.

Stores

- Very good physical conditions and layout.
- The spare parts are well coded and they use sound inventory control systems
- Their spare parts and raw materials in all stores of the company will be soon controlled by their computer centre.

Personnel for Maintenance and Repair

Highly skilled operators specialised in a range of fields, can tackle any emergency repair in the plant.

B. Mosul Textile Factory

The biggest textile factory in Iraq for spinning and weaving cotton.

Organisation

The State Organisation of Textile Industries controls about 10 government owned textile plants in the country.

In order to communicate with their industries and to make communications within the industries themselves, they hold monthly meetings either at the headquarters in Baghdad or in one of their plants according to the matter to be discussed.

I participated in one of their meetings in which the main topics were "needs for new management methods on cost and budgetary control and sound maintenance systems".

I was invited to give a talk on Preventive Maintenance, and this was welcomed by the audience.

Maintenance and Repair Facilities

They have subdivided their maintenance services into specialised areas, one for each main department such as: spinning, weaving, finishing, etc. Each department has its own maintenance shop provided with equipment suitable for common repairs and overhauls, some spare parts and assemblies units ready to be changed.

Scheduled maintenance is used for their key machines. As the recording and control systems are not very accurate they are going to replace this part of preventive maintenance soon.

Workshop and Foundry Shop

They have a first class new workshop with high precision machinery and equipment and a quality control section. They can handle most of the repair work needed and make most spare parts for urgent jobs.

The foundry shop is well equipped and can produce a wide range of cast iron components.

Stores

In good condition. The raw materials and spare parts are well kept and coded.

Personnel

All the production and maintenance personnel are trained in the training centre in Kut and pilot plant in Kirkuk and tested before starting on their jobs.

C. Iraq Cement Company, Baghdad

Organization

This government owned company has six cement plants in Iraq with headquarters in Baghdad. The Baghdad and Mosul factories are the largest in the country.

Their management systems are reasonably good and flexible.

Baghdad Cement Factory

Main departments:

- reception and preparation of raw materials
- four production lines with kilns
- silos for finished products and shipping area
- paper bag plant
- stores for small and medium size spare parts

- yard for large size spare parts
- mechanical shop
- electrical shop
- welding and blacksmith shop
- foundry shop

Maintenance and Repair Facilities

Their specialized and expensive equipment makes it necessary for them to apply sound maintenance systems. They use preventive maintenance with scheduled workload and overhauls, particularly for their key equipment such as kilns.

They are very concerned about this department as a normal repair can take two months, with high production losses.

Workshops

These are equipped to carry out most of their repairs including the manufacture of average precision spare parts, but do so only for emergencies. However, they are aware that it is more expensive to manufacture a spare part than to import it, but production downtime can make import economically impractable. Machine tool utilization is quite good, being around 80 per cent on an average.

Stores

Good physical condition and layout and their spare parts are well kept and coded. Effective control systems, such as minimum stock, cost control, inventory control, etc., are used.

Personnel

Their maintenance and repair personnel are reasonably skilled although there are no in-plant training facilities.

APPENDIX 3

ENTERPRISES QUESTIONED AND INTERVIEWED

Q = Questioned I = Interviewed B = Both Q & I

Industry Group	Sym	Name	Location
Electro-mechanical Metalworks	B	State Co. for Mechanical Industries	Iskandariya
	B	Electrical Industries Co.	Baghdad
	Q	State Dry Battery	"
	I	Foundry Works	"
	I	Shipyard & Docks Workshops	Basra
Power Generation	I	Electric Generating Board Co.	Baghdad
	B	NEA Power Station	"
	I	Central Workshop	"
Food and Beverage	B	Mosul Sugar Co.	Mosul
	B	General Co. for Vegetable Oil	Baghdad
	Q	State Co. for Canning	Kerbala
	Q	Soft Drink Co.	Baghdad
Chemical	Q	State Match Co.	Baghdad
	B	State Rayon Co.	Saddat Al-Hindiya
	I	Fertilizer Co.	Basra
Textile and Knitting	Q	State Fine Textile Co.	Hilla
	Q	Iraqi Spinning & Weaving Co.	Baghdad
	B	State Knitting Co.	Kut
	B	Kut Cotton Textile Co.	"
	Q	Army Mattresses	Baghdad
	Q	General Carpet Co.	"
	Q	State Co. for Woollen Textiles	"
	Q	State Co. for Jute Products	Kadhimain
	B	Mosul Textile Co.	Mosul
Clothes	Q	Sewing Factory	Baghdad
Leather	Q	State Leather Ind. Co.	Moasker-Al-Rashid
	B	Bata Shoe Factory	Baghdad
Tobacco	Q	Ahliya Cigarette Co.	Baghdad
	B	Cigarette Factory	Sulaimaniya
Paper	I	Paper Mill	Basra

APPENDIX 3
Cont'd.

Industry Group	Sym	Name	Location
Non-metallic Products	B	Sarchinar Cement Co.	Sulaimaniya
	Q	Hammam Al-Alil Cement Co.	Nineveh
	B	Iraq Public Cement Co.	Baghdad
	Q	" "	Samawah City
	Q	" "	Hindiyah Barrage
	B	Badoosh Cement Factory	Mosul
	Q	Public Asbestos Co.	Baghdad
	Q	Brick Factory	-
	Q	17th July Brick Factory	Baguba
Agricultural and Earth Moving Equipment	B	Hiring Station	Kut
	B	" "	Rumadi
	Q	" "	Kirkuk
	B	Heavy Equipment & Repair Workshop	Baghdad
	I	A.R. Hiring & Repair Station	Abu-Ghraib

APPENDIX 4

PREVENTIVE MAINTENANCE

By Geoffrey G. Corder, M.B.I.M.

(Taken from Modern Maintenance, published by The British Productivity Council)

"The best starting point is the drawing up of a complete list of the buildings, services, plant and equipment that represent the maintenance responsibility. Only in this way can the limits of responsibility be set and the total maintenance load assessed • often this list also reveals inconsistencies in the plant inventory or the insurance schedule as well as showing where responsibility overlaps, is duplicated, or even non-existent.

The next phase, using the foregoing schedule, is the listing of the various maintenance tasks which can be performed to advantage on a systematic basis. Most machinery, if well designed and well chosen for the work, is reliable; any breakdowns or malfunctions that occur usually stem from components that have suffered normal wear and tear or have got out of adjustment or reached the end of their useful life. These factors can be predicted to some degree of accuracy either on an elapsed-time or a running-time basis. The results of neglecting these factors (i.e., excessive wear, sub-standard product quality or breakdown involving expensive repairs, downtime and waste) can be avoided by taking suitable action prior to the critical point.

Hence, each item on the schedule is considered with the tasks that need to be performed to ensure normal performance. This shows the inspections necessary to check condition or adjustment, the making of these adjustments as required, lubrication, or replacement of standard components. At the same time, the type of labour required to do the work can be included, the periodicity at which the tasks should be done and a rough assessment of each task time.

Thus is established a basic system which is available to apply to the necessary degree in order to assume control

APPENDIX 4
Cont'd.

over a considerable load of repetitive checks, adjustments, tests and simple servicing of a preventative nature. To achieve optimum performance in this category, it is necessary to find the most economic answer to questions like the following:

(a) Need the task figure on the schedule at all? i.e., is it possible to design a way out of the need for maintenance work at all, economically. This is not propounding perpetual motion, but suggesting that the application of principles of self adjustment (example - spring loaded jockey wheel on driving chain) or the "throw-away concept" (Example - cost of replacing electric light bulb v. cost of replacing the filament) can eliminate or reduce very considerably the need to carry out routine inspections, adjustments and repairs.

Is it worth putting on the schedule for regular attention, however infrequent? (example - door hinges; let them signal the need for lubrication by squeaking - no damage is done by the neglect). To adopt this attitude to an expensive gear box which is a key component in a complex machine would obviously be folly - neglect would almost certainly increase wear, shorten life, promote a repair programme unnecessarily costly and cause costly downtime and perhaps waste. Hence it will be seen that good judgment, made in the knowledge of the cost of the consequences, is essential if the right decisions are to be made on this point.

(b) If the task must figure on the schedule, has the best signal for work to be done been adopted? There are several alternatives which include -

- scheduling on the basis of elapsed time which, by experience, just anticipates trouble.

- scheduling on the basis of cycles performed, e.g., fitting a cycle counter and giving attention, say, every 10,000 operations.

APPENDIX 4
(Contd.)

- scheduling on the basis of the inspection reports on the product turned out, e.g., when dimensional limits on the output of an automatic capstan lathe are exceeded.

- scheduling on the basis of the readings of a direct gauge of performance, e.g., a thermometer or pressure gauge, which is indicative of the acceptable condition of a component or sub assembly of a plant.

The point in that elapsed time, although desirable in order to build up balanced work loads, may not be the most economic routine.

(c) By the intensive application of work study and planning, has the one best way of doing the designated task been established, and the time spent on the job reduced to the practical minimum?

(d) By the same techniques, has the best material and the best method been established, which results in the effective use of the cheapest materials with minimum waste?

(e) Have the cheapest effective administrative methods, facilities and supervision been established, so that overheads are reduced to the minimum economic level?"

.....

Whatever system is used, its efficiency will depend on how up-to-date it is, the accuracy of the information fed into it and the constant vigilance from the plant engineer in order to maintain the frequency of inspection at a convenient level. Under normal working conditions the cost of preventive maintenance can be determined as shown in Fig.7, page 72.

A preventive maintenance scheme developed for a particular factory can seldom be adopted without change for another circumstance.

To clarify this appendix, a short description of an existing scheme which is operating successfully is included in Figures 1 to 6; Figure 7 is a decision flow chart showing how to treat the information once a job has been performed.

We emphasise, however, that this is for clarification only and industries are strongly recommended to develop their own system to meet their own needs.

PREVENTIVE MAINTENANCE • TYPICAL FLOW CHART FOR COMPLEX ORGANIZATION

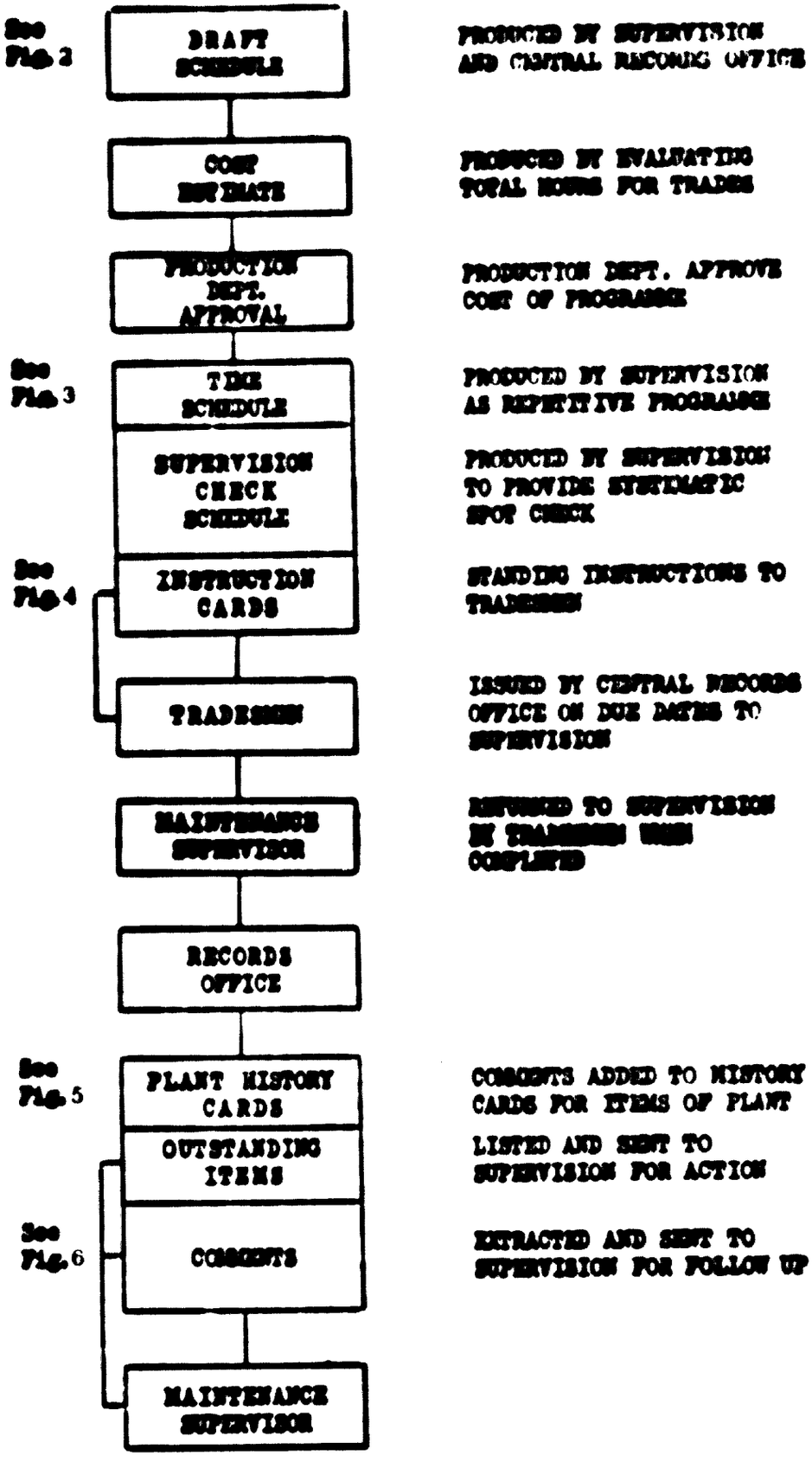


FIG. 1

SELECTED DOCUMENTS FOR COMPLEX SCHEME

Sch.Ref.No.1020

MAINTENANCE OF EQUIPMENT - BLDG.6. PAPER DEPT. NO. 9030 GUILLOTINE, CUTTING ROOM

Service Responsible:- Field Workshop. 9/60 Issue No.1.

Trade:- Fitter.

Item No.	EVERY 3 MOS. (Est.time 45 mins)	Item No.	EVERY YEAR (Est.time 2 hrs. 15 mins.)
	MAIN SHAFT		**MAIN SHAFT**
1	**Bearings** Ch. that throw of 19-21" is reached after the first 2" of stroke & is maintained during completion of stroke. Ch. that height from bed during maximum throw period is 6½-7".	7	**Clutch** Cone; Clean: Ex. for wear & dam.
2	**Mechanical linkage** Assembly screws; Fixings: Ens. sec. Springs: Insp. for dam. & fracture.	8	**L. Bolts** (2) 3.60 Ex. for wear & dam. Test tension.
	MAIN SHAFT	9	**Ball guard** Insp. for dam. & cor. Ens. sec.
3	**Clutch** Springs: Ens. adequate compression.		**PAPER HOLDER**
	PAPER HOLDER	10	**Fixing clutch** Dismantle & clean. Ex. for wear & dam. Re-assemble. Ens. correct operation.
4	**Operating Shaft** (Front) Cam spring: Test tension.	11	**Pinion shaft** Pinions; Cams Ex. for wear & dam.
5	**Treadle** Pivot pins: Ens. sec.		
6	**Operating shaft** (Rear) Return spring: Ens. adequate compression & sec.		

Annual Time : 5 hrs. 15 mins.

PREVENTIVE MAINTENANCE PLANNING SHEET

Code No.	Machine		Jan. 1 2 3 4	Feb. 1 2 3 4	Mar. 1 2 3 4	Apr. 1 2 3 4	May 1 2 3 4	June 1 2 3 4	July 1 2 3 4	Aug. 1 2 3 4	Sept. 1 2 3 4
8030	Guillotine	L	•	•	/	•	•	/	•	•	/
		M			/			/			/
		E	—						—		
	Lubrication	L									
	Mechanical	M									
	Electrical	E									

• 1 month
/ 3 "
— 6 "
X 1 year

FIG. 3

[illegible] DIVISION
MAINTENANCE

PERIOD: 3 MONTHS [illegible]

ITEM	INSTRUCTIONS	ITEM	INSTRUCTIONS
	[illegible]	3	DRIVE SHAFT [illegible] Springs: Ens. adequate compression.
1	[illegible] Ch. that throw of [illegible]" is reached after the first [illegible]" of stroke and is maintained during completion of stroke. Ch. that height from bed during maximum throw period is 6½ - 7".	4	PAPER [illegible] [illegible] shaft (Front) One spring: Test tension.
		5	[illegible] Pivot pins: Ens. sec.
2	[illegible] Assembly screws; Fixings: Ens. sec. Springs: Insp. for dam. and fracture.	6	[illegible] shaft (Rear) Return spring: Ens. adequate compression & sec.

P.T.O.

LOCATION: [illegible]
TITLE: [illegible]
TRADE: FITTER
DEPT. PAPER
[illegible] No. 6 [illegible]

ITEM	INSTRUCTIONS	ITEM	INSTRUCTIONS
	DRIVE SHAFT	11	[illegible] shaft [illegible]; [illegible]: Ex. for wear and dam.
7	[illegible] [illegible]; [illegible]: Ex. for wear and damage.		
8	[illegible] (?) [illegible] Ex. for wear and dam. Test tension.		
9	[illegible] Insp. for dam. and cor. Ens. sec.		
10	PAPER [illegible] [illegible] Clutch Dismantle and clean. Ex. for wear and dam. Re-assemble. Ens. correct operation.		

FIG. 4

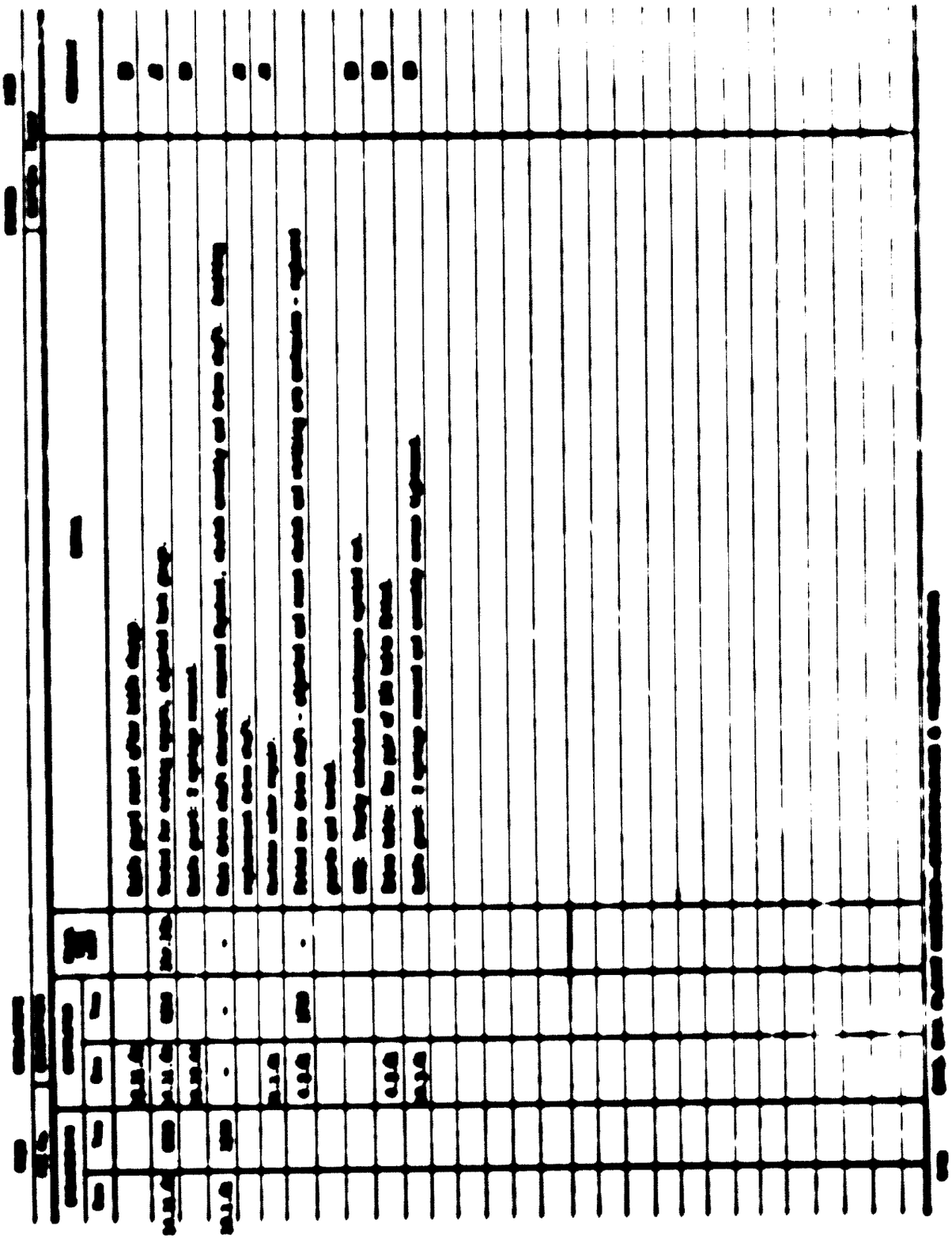


FIG. 5

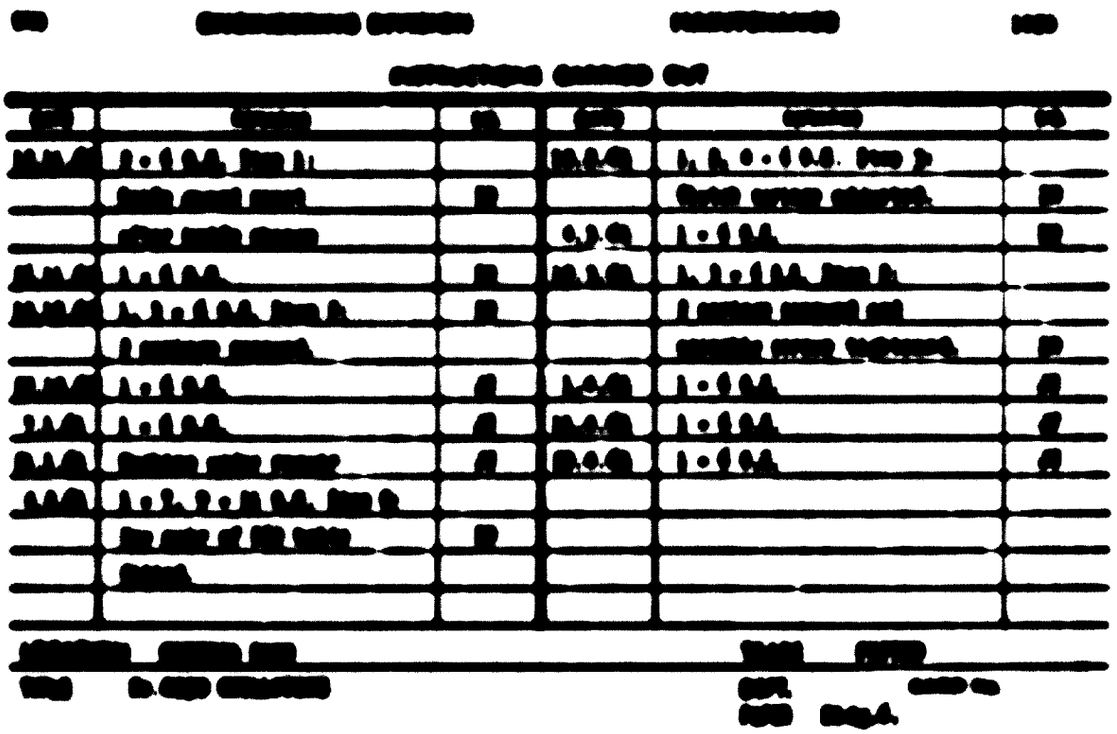


FIG. 6

DECISION FLOW CHART

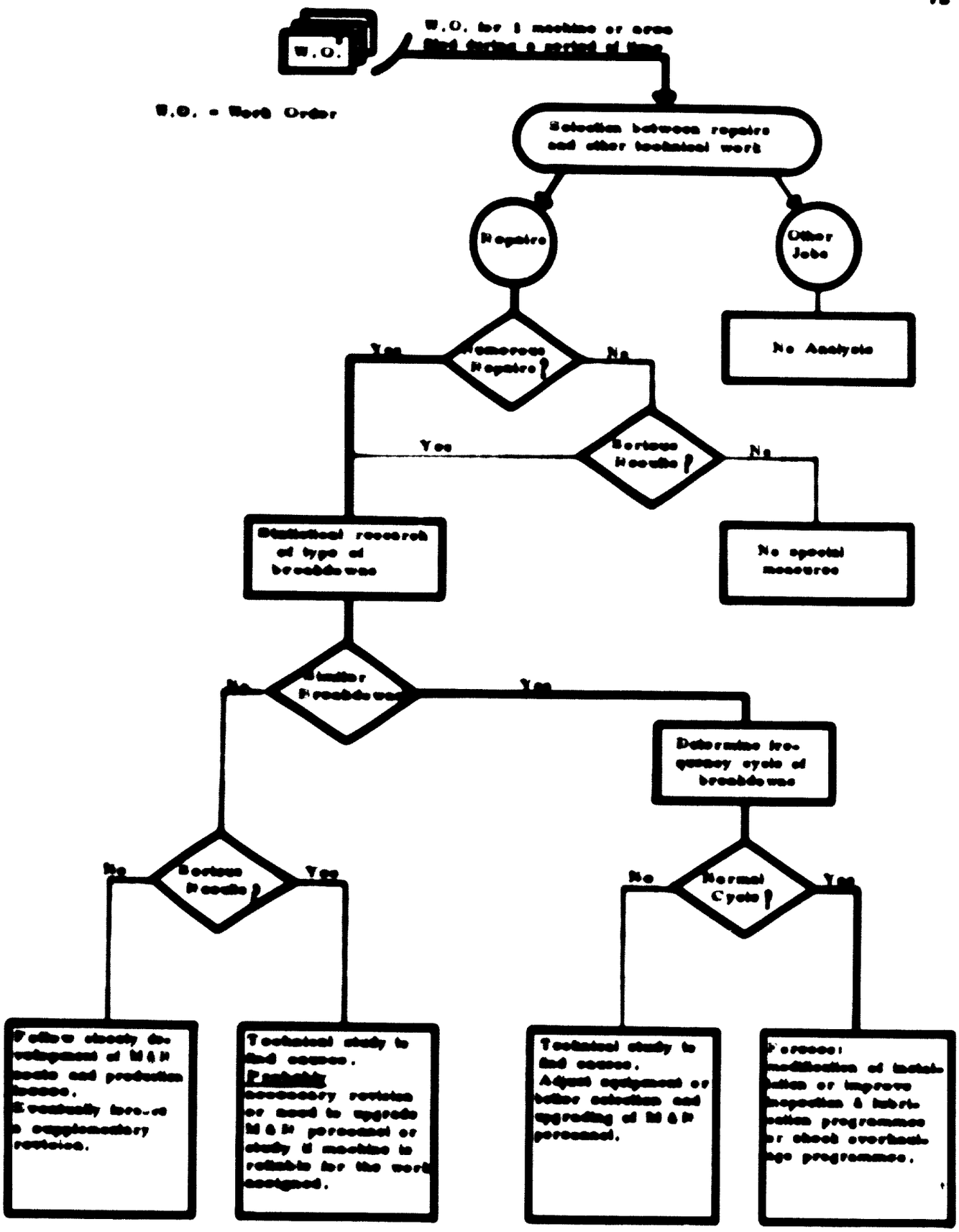
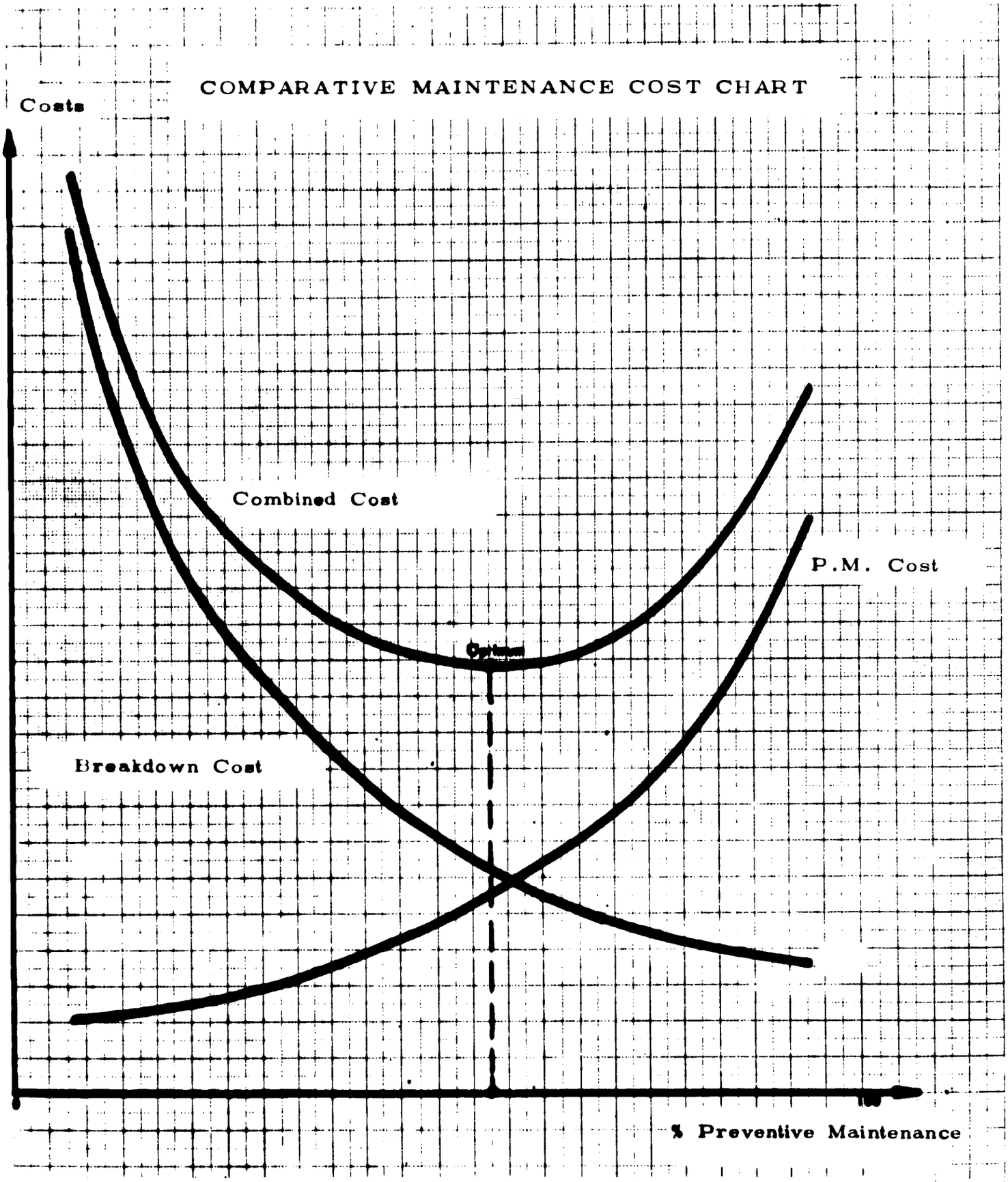


FIGURE 7



The maintenance programme should be established at the point where the combined cost is minimum.

FIG. 8

APPENDIX 5

LIST OF MACHINES AND EQUIPMENT AT ISKANDARIYA PLANT

STATE COMPANY FOR MECHANICAL INDUSTRIES (1)

1. Structure of the plant

The main departments are:

Ground floor

1. materials reception and preparation
2. machining section for production
3. manufacturing section for bolts, nuts and screws
4. forging section and blacksmith
5. press and stamping section
6. welding section
7. 2 painting sections (automatic process)
8. automatic heat treating section for production, heat treating for tools and plating
9. several assembly areas
10. fitting section
11. carpentry section
12. 2 tool sharpening sections
13. tool shop for the manufacture of tools and non-standard parts
14. repair shop
15. electric works and repair section
16. area stores for spare parts and tools
17. quality control area and final section
18. finished product stores
19. raw materials stores
20. spare parts stores - each section is provided with a stock area

First Floor

Metallographic and metal testing laboratories, engineering department and general offices

Outbuildings

Production, raw materials and spare parts stores and foundry shop are in separate buildings

(1) Source: Extract from Project Report Vol. 1, Agricultural Machinery Works - Iskandariya.

The foundry shop is fully mechanised with facilities for cast iron, cast steel and malleable products.

The covered area in the main building is 44,000 m^2.

The stores cover an area of 7,240 m^2.

The foundry shop covers an area of 9,240 m^2.

BASIC DATA AND TECHNICAL AND ECONOMIC INDICES

Nos.	Index	Unit of measuring	Tool shop	Repair machining shop
1.	Quantity of all works' production equipment served (except second programme equipment)	units	-	1,000
	(a) machine tools and wood-working equipment	units	240	-
	(b) stamping and cold-heading equipment	units	45	-
	(c) forging equipment	units	13	-
2.	Yearly output of foundry shop	tons	12,410	-
3.	The programme of additional output of cutting and fitting tools	tons	850	-
4.	Summary quantity of technological equipment	units	286	148
5.	Summary quantity of basic equipment, including:	units	257	137
	(a) for serving basic production	units	66	28
	(b) for serving second programme	units	109	44
	(c) for cutting and fitting tools manufacture	units	82	-
6.	Quantity of transport equipment	units	4	7
7.	Employed personnel	men	542	336
8.	Total area	m^2	6,080	3,826
9.	Production area	m^2	4,735	3,320
10.	Power defined, electric motors	kw	1,487	943
11.	Shop total area per unit of basic equipment	m^2	23.5	39.6
12.	Mean power per unit of basic equipment	kw	5.8	13.2

2. Structure of the shops

The tool shop is composed of sections for cutting and measuring tools, auxiliary tools and fixtures, press and forging dies, metal preparation, forging, heat treatment, chromium plating and ancillaries.

The repair machining shop is composed of machinery department, assembly area, electric repair department, steel construction, piping section and ancillaries.

SHOP EQUIPMENT

Name of equipment groups	Tool Shop					Repair Machining Shop				Total
	Forging	Heat treating	Hard chromium plating	Machining and fitting	Total in shop	Machining and assembly area	Electric repair	Steel construction and piping	Total in shop	
Basic equipment										
Machine tools	-	-	-	238	238	72	9	12	93	331
Forging equipment	2	-	-	-	2	-	-	-	-	2
Presses	-	-	-	1	1	-	6	5	11	12
Furnaces	3	25	-	-	28	-	1	1	2	30
Plating equipment	3	-	15	-	15	-	-	-	-	15
Welding equipment	-	2	-	-	2	-	2	5	7	9
Other	1	19	4	18	42	-	19	5	24	66

PLANT FLOOR AREA BY DEPARTMENT

Description	Tool Shop					Repair Machine Shop				Total auxiliary shops
	Forging	Heat treating	Hard chromium plating	Machining and fitting	Total in shop	Machining and assembly area	Electric repair	Steel construction and piping	Total in shop	
Production area in m^2	216	804	88	4,735	5,843	540	400	2,380	3,320	9,163
Service area in m^2	-	128	20	1,345	1,493	-	30	476	506	1,999
Total m^2	216	932	108	6,080	7,336	540	430	2,856	3,826	11,162

3. Works Central Laboratory

The works central laboratory has been designed for performing control work and testing, as well as for carrying out production and scientific research work.

It is considered necessary to control and test the metal and other materials on arrival at the works and during processing, to examine technological processes and new materials, to study wear of machines to determine reasons for rejects and to eliminate these.

The works central laboratory is composed of the following specialized laboratories: metallographic, metallophysical, mechanical, X-ray, spectroscopic, chemical, forging-and-pressing, pyrometric, technological-and-chemical, moulding materials and heat treating.

The laboratory services required include precision, mechanical engineering and metrology laboratory, photolaboratory and library.

In all, there are 509 units of equipment.

The works central laboratory is located on all three floors of the administrative and employee facilities block and covers 1512 m^2 of floor space, including production area of 1296 m^2 and service area of 216 m^2.

The laboratory staff consists of 28 engineer-technical workmen, 29 laboratory staff and 27 other workmen, in all 84 men.

Power required for laboratory equipment amounts to 440 kw.

4. Central Measuring Laboratory

The central measuring laboratory has been designed to carry out work on standardization, to control works measuring facilities and organize adequate techniques for the works.

Testing points having a complete set of instruments and measuring facilities for organizing shop control have been provided.

The central measuring laboratory is located in the administrative block, together with works central laboratory, and covers 81 m^2 of floor space.

To serve the laboratory, a staff of 3 engineers and service workmen and 4 laboratory inspectors is required.

The personnel for shop control testing points has been provided in the respective shops.

5. The Works Freight Turnover

The works freight turnover amounts to 321,763 tons a year including outward freight turnover of 165,254 tons a year, freight turnover between the sites of 41,120 tons a year, inter-shop freight turnover of Site No. 1 of 97,046 tons a year, and removal of 18,343 tons a year of waste from Site No. 1.

Eighty-eight per cent of outward works freight turnover is handled by rail transport. Motor transport, by which 50% of agricultural machinery and spare parts are shipped in the Baghdad area, is an auxiliary transport.

More details of freight turnover and the kind of transport used are given in the following table.

Distribution of inter-site and inter-shop freight

Turnover according to kinds of transport

Transportation	Kind of transport						Total
	Rail transport 1000mm gauge	Rail transport 750mm gauge	Motor car transport	Electric car transport	Truck tractor with or without trailer	Piping	
External transport							
Site No.1							
Arrival	89,839	-	4,500	-	-	-	94,339
Departure	26,529	-	14,826	-	-	-	41,355
Total tons	116,368	-	19,326	-	-	-	135,694
%	85.0	-	15.0	-	-	-	100
Site No.2							
Arrival	9,000	-	-	-	-	-	9,000
Departure	20,560	-	-	-	-	-	20,560
Total tons	29,560	-	-	-	-	-	29,560
%	100	-	-	-	-	-	100
TOTAL tons	145,928	-	19,326	-	-	-	165,254
%	88.0	-	12.0	-	-	-	100
Inter-site transport							
Site No.1 Site No.2	-	-	11,560	-	-	-	11,560
Site No.3 Site No.2	-	-	9,000	-	-	-	9,000
Site No.2 Site No.3	-	-	20,560	-	-	-	20,560
Total tons	-	-	41,120	-	-	-	41,120
%	-	-	100	-	-	-	100

Distribution of inter-site and inter-shop freight

Turnover according to kinds of transport (cont'd.)

Transportation	Kind of transport						Total
	Rail transport 1000mm gauge	Rail transport 750mm gauge	Motor car transport	Electric car transport	Truck tractor with or without trailer	Piping	
Intershop transportation (1) Site 1							
tons	-	7,755	2,513	36,530	35,148	15,100	97,046
%		8.0	2.6	37.6	36.2	15.6	100
Removal of wastes from site 1							
tons	-	-	18,343	-	-	-	18,343
%			100				100
TOTAL tons	145,928	7,755	81,302	36,530	35,148	15,100	321,763

(1) Intershop transportation and the removal of waste from Site No.2 have not been taken into account in freight turnover

APPENDIX 6

ILLUSTRATIVE MANAGEMENT GUIDE

(Reprinted from The Canadian Mining and Metallurgical Bulletin, April, 1970)

POSITION: Manager - Plant Engineering and Maintenance

PURPOSE: To provide engineering and craft services in relation to maintenance and construction operations and the generation and distribution of utilities at the most economic cost and so as to ensure that scheduled production rates are achieved

POSITION IN THE ORGANIZATION

Reports to the General Manager
Immediate subordinates are:

- Superintendent - mechanical maintenance
- Superintendent - Electrical maintenance
- Superintendent - utilities and services
- Supervisor - engineering and drafting
- Supervisor - maintenance planning

SCOPE OF POSITION

Supervise a work force of approximately 250 employees and administer a budget of $3,000,000 per year

KEY TASKS

1. Executes a maintenance policy that provides the most economic benefits to operations. The bases for assessment of such a policy are:

   - the relationship between the loss of revenue due to downtime and the cost of equipment and maintenance needed to eliminate such downtime.
   - the installation of preventive maintenance procedures that secure the maximum economic life of equipment.
   - production slowdowns or stoppage due to equipment failures are controlled within limits that do not adversely affect budgeted production rates.

2. Must ensure that maintenance and construction operations, new installations and alterations are carried out with the minimum consumption of labour and materials, and so as to meet operating requirements to maintain scheduled production rates.

3. Must ensure that the cost of engineering and maintenance inventories of replacement parts and other material stores is kept to a minimum consistent with the provision of satisfactory engineering and maintenance services.

4. Ensures that the generation and distribution of utilities is such as to meet production requirements and that necessary utilities are provided at minimum cost.

5. Ensures that contractors fulfil the terms of their contracts in all respects where construction, installation and alteration work is let to outside contractors.

6. Ensures that engineering and drafting services are conducted in such a manner as to produce work of the required quality, at minimum cost, and so as to meet over-all operating requirements.

7. Ensures that the work force of the department is properly trained, that individuals understand the nature and scope of their responsibilities, and that a sound organisation structure is maintained at all times in order to sustain production schedules.

8. Ensures the provision of adequate security and protection, including fire protection for facilities and equipment, at minimum cost.

DELEGATION OF AUTHORITY

The mine manager delegates to the manager - plant engineering and maintenance - the authority necessary to achieve the key tasks specified in this guide, except as to those decisions which are specifically reserved, as follows:

1. Hiring of persons for positions reporting directly to the manager - plant engineering and maintenance; discharge of present incumbents of these positions.

2. The promotion, transfer or demotion of persons in positions to, or in positions within, two organisation levels of the manager.

3. Changes in salary for persons within two levels of the manager.

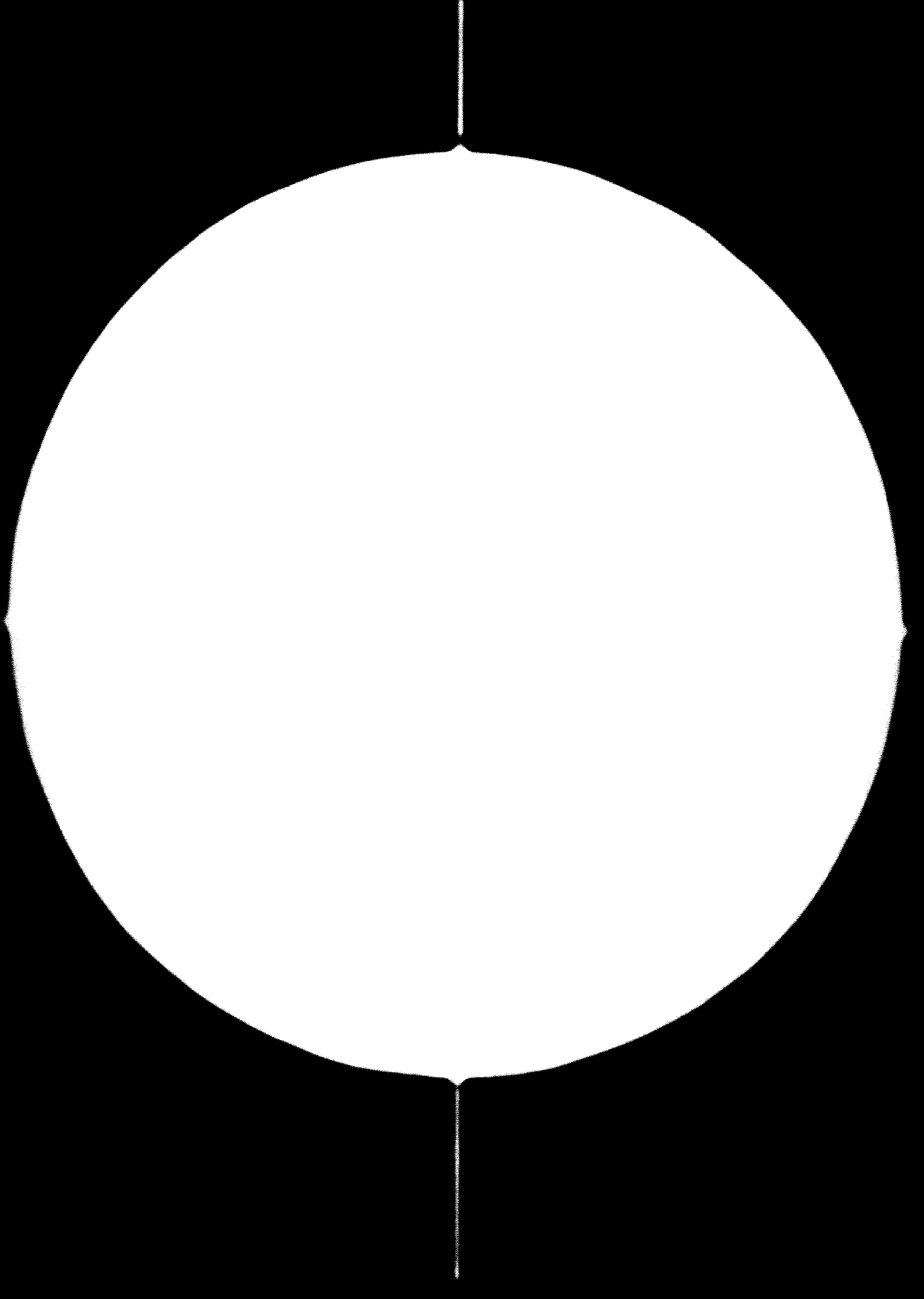
4. Approval of capital expenditures for items not included in the budget, and approval of such expenditures over $1,000 for items included in the budget.

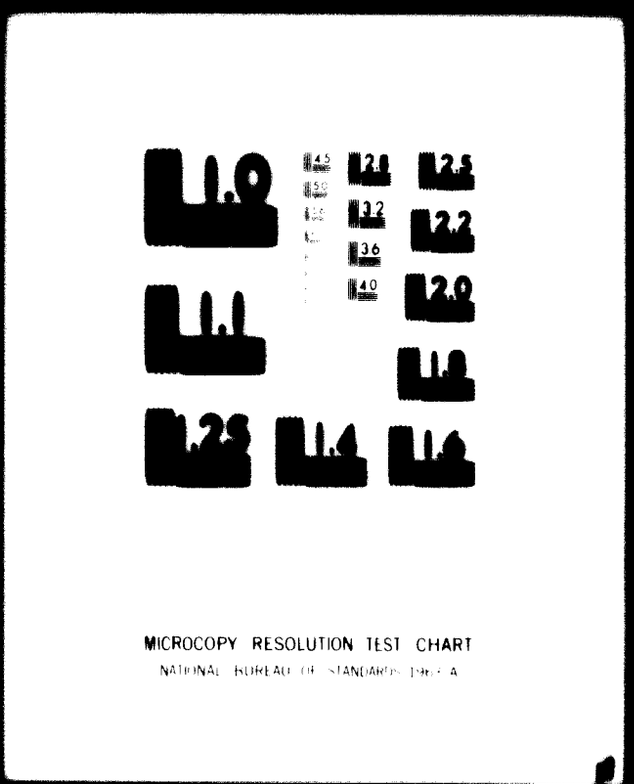
5. Any changes in maintenance procedures that may affect budgeted production rates.

6. Approval of the annual budget for the department and of any changes thereto.

B - 561

81.08.26





APPENDIX 7

SELECTED REFERENCES ON TRAINING

1. Training Maintenance Workers

(a) Selection Tests

Oscar Krisen Buros, ed. "The Fourth Mental Measurements Yearbook." The Gryphon Press, Highland Park, N.J., 1953. This is really the "Bible" on testing. It consists of two major sections: "Tests and Reviews," and "Books and Reviews." "Tests and Reviews" lists 712 tests, 885 original reviews by 335 reviewers, 53 review excerpts, and 4,447 references on the construction, validity, use, and limitations of specific tests. "Books and Reviews" lists 439 books on measurements and closely related fields and 703 excerpts from reviews of these books in 191 journals.

The Psychological Corporation, 522 5th Ave., New York 18, N.Y.

Science Research Associates, Inc., 57 West Grand Ave., Chicago 10, Ill. "Personnel Director's Booklet" describes a test battery designed to measure an individual's aptitude for each of 14 job elements. It contains recommended tests, together with a brief job description and required training, for electrician helper or apprentice, machinist apprentice, mechanic's helper, plumber apprentice, apprentice or helper structural worker, draftsman, and engineer trainee.

California Test Bureau, 5916 Hollywood Boulevard, Los Angeles 28, Calif.

Educational Test Division, Educational Testing Service, Princeton, N.J.

Harcourt, Brace Company, 1 Park Street, Boston 7, Mass.

Science Test Service, Box 359, Swarthmore, Pa.

Aptitude Association, Box 1129, Washington, D.C.

Institute for Personality & Ability Testing, 1602 Coronado Drive, Champaign, Ill.

Morgan, Howard K.: "Industrial Training and Testing." McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N.Y.

"Employee Rating: Methods of Appraising Ability, Efficiency, and Potentialities," National Industrial Conference Board, Inc., 247 Park Ave., New York 17, N.Y.

Hewett, Forrest V.: "Personnel Testing: A Field Check on the Current Status of Personnel Testing in One Hundred Organizations," California Council of Personnel Management, San Francisco, Calif.

Hoyt, Floyd: "How to Use Employment Tests," *Employment Testing Bulletin* 1, California Test Bureau, 5916 Hollywood Boulevard, Los Angeles 28, Calif.

"Experience with Psychological Tests," Studies in Personnel Policy, No. 69, National Industrial Conference Board, Inc., New York, 1948.

Some of these sources of aptitude tests may have restrictions as to who can purchase and administer their tests.

(b) Visual Aids

The following list of publications has been compiled by the Industrial Audio-Visual Association, P.O. Box 606, Old Post Office Annex, Chicago 90, Ill. Correspondence should be directed to the secretary at the above address.

Title	*Publisher*
Educational Film Guide	The H. W. Wilson Company
Filmstrip Guide	The H. W. Wilson Company
Educators Guide to Free Films	Educators Progress Service
NEMA Movie Guide	National Electrical Manufacturing Association
U.S. Government Films	Superintendent of Documents
The Blue Book of 16-mm Films	The Educational Screen, Inc.

(c) [redacted]

[redacted]: "Industrial Training and Testing," McGraw-Hill Book Company, Inc., [redacted]
"[redacted] Performance," Studies in Personnel Policy, No. 101, National Industrial [redacted], Inc., New York.
[redacted], ed.: "[redacted] Employee and Supervisory Performance," American [redacted] Association, New York.

(d) [redacted]

Bibliography of technical material in "Apprentice Training Standards," National Machine [redacted] Builders Association, 10525 Chicago Ave., Cleveland 6, Ohio.
Reference lists for training contained in booklet "Industrial Instrument Training Course Outline," Instrument Society of America, Pittsburgh, Pa.
List of reference books, maintenance educational department, The Dow Chemical Company, Midland, Mich.
Ziegler, John M.: "Training in New York State Industries," New York State School of Industrial and Labor Relations, Cornell University, Ithaca, N.Y.
Training courses of Caterpillar Tractor Co., Peoria, Ill.
"The Training Job and How to Meet It," International Correspondence Schools, Scranton 9, Pa.
Thermodynamics Industrial Institute, Minneapolis, Minn.
Morgan, H. K.: "Industrial Training and Testing," McGraw-Hill Book Company, Inc., New York.
"How Industry Determines the Need for and Effectiveness of Training," The Psychological Corp., New York.
Plant of the Future Training Plan, *Factory Management and Maintenance*, April, 1950.
Map—"The Perfect Training Plan" for Maintenance Apprentices, *Factory Management and Maintenance*, September, 1950.

(e) [redacted]

Factory Management and Maintenance, McGraw-Hill Publishing Company, Inc., New York.
Instruments and Automation, Instrument Publishing Co., Inc., Pittsburgh 30, Pa.
Instrumentation, Minneapolis Honeywell Reg. Co., Philadelphia 44, Pa.
Refrigeration Service and Contracting, Dickerson and Collins, Chicago 44, Ill.
Mill and Factory, Conover-Mast Publishers, Inc., New York.
Industrial Arts and Vocational Education, The Bruce Publishing Co., Milwaukee, Wis.
Technical Education News, McGraw-Hill Book Company, Inc., New York.
Tech Training, American Technical Society, Chicago 37, Ill.
Project Men, International Correspondence Schools, Scranton 9, Pa.
The Journal of Industrial Training, American Society of Training Directors.
Control Engineering, McGraw-Hill Publishing Company, Inc., New York.
Applied Hydraulics, Industrial Publishing Group, Division of Penton Publishing, Inc., Cleveland 13, Ohio.
Professional Education Book Club, American Technical Society, 848 East 58th St., Chicago 37, Ill.

3. Training Maintenance Supervisors

Comments on References

Consulting these references in detail should help to formulate answers to meet specific needs.

BNA Supervisory Development Service, American Management Association, 1515 Broadway, New York 19, N.Y., C. W. McDowell, Director. This subscription service, announced Mar. 16, 1955, is directed mainly to those responsible for first-line supervisory development. The service consists of:
a. 12 monthly issues of *Supervisory Development Today*, a review of current research and activities in the supervisory development field.
b. 12 monthly issues of *Supervisory Development Sourcebook*, detailing tested and successful company experiences in specific areas of supervisory development.
c. 2 semiannual research reports, investigations into the "how" aspect of some phase of supervisory development prepared under the guidance of experts.

Developments in Supervisory Training, National Industrial Conference Board, Inc., 247 Park Ave., New York 17, N.Y. This publication discusses philosophy of supervisory training, approaches to supervisory training, techniques of supervisory training, subjects for supervisory training, and training new supervisors, including examples from the supervisory training program of an imposing list of companies.

Training of Supervisors, Anglo-American Council on Productivity. Order from U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C. This is a report of a visit to 25 companies in the United States in 1951 by a specialist team to study supervisory training and selection.

"A Survey of Employee Training Programs," conducted by B. Beryl Bland, Jr., and W. G. Martin, Personnel Director, National Fireworks Ordnance Corp., Shumaker, Ark., April, 1954 (see pages 2-33, 2-34, and 2-37 for further comments).

"Selecting and Developing First-line Supervisors," by George D. Halsey, Harper & Brothers, New York, 1953. This book presents a program of supervisory selection and development which is a composite of many programs in use in a wide variety of organizations.

"Techniques of Conference Leadership," Studies in Personnel Policy, No. 77, National Industrial Conference Board, Inc., New York, 1951. The conference method is the method most frequently used in supervisory training. This report explains the conference method; tells how to plan the conference; discusses case problems, quizzes, questionnaires, and training aids; describes three conference situations in detail, namely, operating problems, training, and policy discussion; tells how to carry the conference plan into action; and presents a sample conference in detail.

"Conference Leadership," Esso Standard Oil Company Training Center, Elizabeth, N.J. A text to assist in the development of conference leaders for training programs, containing many examples from Esso's supervisor-training programs which illustrate important points and show the application of principles.

"Catalog of Training Materials," in the American Society of Training Directors' Library, operated in conjunction with The Purdue University Libraries, Lafayette, Ind. Contains over 100 items of supervisory training practices gathered from more than 50 companies.

"Experience with Foremen Training in 115 Plants," Report No. 583, The Dartnell Corporation, Chicago. Part One of this report is mainly concerned with the methods used by companies to bring foremen and management into closer relationship, and with the development in foremen of the ability to handle people. Part Two covers the formulation of training programs by means of foremen's policy manuals, conferences with the supervisory group, and the use of visual aids.

"Foreman Training," Survey No. 8 of BNA's Personnel Policies Forum, Washington, D.C., The Bureau of National Affairs, Inc., 1952. A survey of 160 companies, large and small, representing many types of industries. The survey covers such items as: Who handles foreman training? What subjects are covered? Ten different training methods used including comments from survey members, evaluation of the program, conference-leader-rating check sheet, informal training programs, books and magazines provided foremen, presupervisory training.

"Controlled Maintenance—Instructor's Lesson Plan," International Harvester Co. Detailed description of lesson plans used in controlled maintenance course consisting of three 1½-hr sessions. All supervisory plant personnel attend first session; service foremen only attend second and third sessions.

Session I. Importance of Controlled Maintenance.
Session II. Development of Basic Hours.
Session III. Records, Analysis, and Classification.

[redacted] Supervisory Techniques, Douglas Aircraft Co., Los Angeles, Calif. Detailed write-up of a 10-hr supervisory training course using the conference method supplemented with audio-visual aids, case studies, and role playing.

Course Content:

Sessions 1 and 2. The Supervisor's Responsibility to the Organization. 4 case studies are used in each session.

Sessions 3 and 4. Supervisor's Responsibility to the Employees. Employee needs are discussed in session 3. General Motors film "Manage Interviews" shown and discussed in session 4.

Session 5. Handling Complaints. A tape recording of 2 interviews between supervisors and employees, with discussion.

Session 6. Preventing Grievances. Discussion of causes and remedies of grievances.

Session 7. Discipline. Discussion of discipline by following a check sheet. Latter half of meeting devoted to filling out a form by each member stating his action in cases of company-rule violations. Discussion follows.

Session 8. Basic Principles of Human Behavior. Lecture and visual cast presentation.

Session 9. Orientation of Employees. Turnover rate of company discussed. Company orientation program described together with check list on proper employee orientation.

Session 10. Dealing with the Woman Worker. Basic differences between men and women developed on the blackboard. Conference series is graded by members. Certificates given to all who attend more than 80 per cent of the sessions.

3. Management Training

"Management Education in Business," by Lyndall F. Urwick. American Management Association. This report represents Part I of the study, "Management Education for Staff and Its Employees," which the American Management Association undertook at the request of and with the financial assistance of The Ford Foundation. An independent organization established by The Ford Foundation. Other reports in the series are:

Part II. "A Survey of Management Development: The Quantitative Aspects," by [redacted].

Part III. "Case Studies in Management Development: Theory and Practice in Ten Selected Companies," by Robert G. Simpson, with the assistance of Allison V. MacCullough and company personnel.

Part IV. "The Education of Employees: A Status Report," with a proposal for further research, by Douglas Williams and Stanley Peterfreund, with the assistance of Howie Eklund and Otis Lovelace.

Technical Aids Branch - Office of Industrial Resources - International Co-operation Administration, Washington, D.C.

These provide a series of training manuals for use in the development of industrial training programmes as a leader's guide. One of the courses is "Plant Maintenance and Housekeeping", Training Manual No. 88, for supervisors and plant managers.

EXHIBIT 1

EMPLOYED POPULATION DISTRIBUTED BY ECONOMIC SECTORS AND TOTAL LABOUR FORCE

	1967	1968	1969	1970	1971	1972	1973
Agriculture	1,339,360	1,399,175	1,449,824	1,516,600	1,575,100	1,637,100	1,702,100
Mining	14,500	15,000	15,500	16,000	16,500	17,500	18,500
Manufacturing	140,000	146,000	148,000	150,000	160,000	165,000	170,000
Electricity, Gas, Water	12,600	12,800	12,900	13,000	13,400	13,900	14,300
Construction	50,100	58,000	60,000	60,000	62,000	64,000	66,000
Trade	135,000	140,000	145,000	150,000	155,000	160,000	164,000
Transport	137,000	140,000	143,000	150,000	154,000	158,000	162,000
Services	285,000	290,000	295,000	300,000	310,000	320,000	330,000
Armed Forces	260,000	280,000	270,000	275,000	280,000	285,000	290,000
Total Employed	2,362,560	2,461,975	2,539,224	2,630,600	2,726,000	2,820,500	2,916,900
Percentage of Increase Employed Population Excluding Armed Forces	3.15	3.73	3.05	3.00	3.06	3.06	3.00
Population Unemployed	117,736	105,319	121,004	216,800	137,800	156,000	177,800
Labour Force	2,480,296	2,567,294	2,660,228	2,757,400	2,863,800	2,976,500	3,094,700
Percentage of Increase Labour Force	3.40	3.50	3.61	3.66	3.69	3.94	3.97

Source: UN Manpower Mission - Report D... 1969 (Employment Trends)

EXHIBIT 2

DISTRIBUTION OF INDUSTRIES IN IRAQ (EMPLOYING OVER 20 WORKERS)

Description	100 km. radius of Baghdad								South Area					South Area				Total
	1	2	3	4	5	6	7	ST	8	9	10	11	ST	12	13	14	ST	
Food (except dates)	20				1	1		22	3	1	1		5	3			3	30
Drinks	10				1			11	2	1			3	3			3	17
Tobacco	1							1				2	2					3
Textile	20	1	1	2	1	2		26	0				0					26
Knitting	10			1				11	2				2					13
Ready-made Clothes	14							14						1			1	15
Leather Processing & Products	5							5	1				1					6
Wood Products	6							6	1	1			2					8
Paper making & products, printing and publishing	14							14										14
Chemical (except oil refineries)	13				1			14										14
Plastic Products	9							9						1			1	10
Machines & repair of machinery, appliances & electric appliances	10							10										10
Non-metallic Products	100	2	1	0	0	0	0	103	0	1		1	0	1	30	1	30	137
Miscellaneous	2							2										2
GRAND TOTAL	235	3	2	3	13	7	0	263	22	4	1	3	30	9	30	1	40	333

References:
1 Baghdad
2 Diyala
3 Karbala
4 Kut
5 Hilla
6 Karbala
7 Diwan
8 Basra
9 Amara
10 Nasiriy
11 Muthanna
ST Sub-total
12 Basra
13 Amara
14 Nasiriy

SOURCE: Bureau of Statistics, 1969 volume, Ministry of Planning, Iraq

EXHIBIT 3

QUESTIONNAIRE

Factory _____ Location _____

Specialty _____ Date _____

_____

_____

If you do not have enough room to answer, please use additional sheets stating letter and number of question, i.e. A-3 ------

_____

A. PRODUCTION

1. Give volume of work and cost per year, if possible by article or item

_____

_____

_____

2. Give quality of parts produced (good-medium-bad)

Remarks: _____

_____

_____

3. Give production losses due to machine breakdowns, expressed in hours or dinars per year

_____

_____

_____

4. To what extent do breakdowns or lack of maintenance penalize customers? How many orders have you lost because of failures?

_____

_____

5. MACHINERY AND EQUIPMENT

1. Have you recorded the idle time (hours per month or year) for important machines or equipment?

2. What are the most and the least likely sources of failure?

3. Have you got available an inventory list for machinery, electric motors and equipment? Yes _____ No ____
If not, prepare a list of your main machines, electric motors and equipment.

4. Are the machines coded according to product and function? Yes _____ No _____

5. How is the present operating conditions of machines and equipment?

6. Are the machines and equipment colour coded for identification? Yes _____ No _____

7. Are your safety guards in machines and equipment kept well? Yes _____ No _____

8. Do you record maintenance and repair costs and frequency of breakdowns of each machine and equipment? Yes _____ No _____
If yes, prepare a list with costs and frequency of breakdowns of at least one year.

9. Do you have supplier catalogues or service manuals from the manufacturers? Yes _____ No ___

10. Do you record the annual operating hours of each machine for maintenance and repair work?
Yes _____ No _____ . If yes, prepare a detailed list giving the annual operating hours per machine.

11. Do you have any policy to replace machinery?
Yes _____ No _____. If yes, explain in a few words which policy do you adopt.

_____

_____

_____

_____

C. PERSONNEL

1. Give number of direct labour employed per department, indicating speciality and labour costs per year

_____

_____

_____

2. Give number of indirect labour employed: management, foremen, controllers, office staff, etc., and costs per year

_____

_____

_____

3. Give detailed list of maintenance labour employed, giving position and speciality of each operator.

4. Give maintenance and repair labour hours spent per year.

5. Give direct and indirect labour hours spent per year.

6. Do you use any incentive system for your maintenance and repair personnel? Yes _____ No _____

7. Do you use labour standards for production and maintenance? Yes _____ No _____

8. Can you describe in a few words the grade of skill of your maintenance and repair operators? If possible give a summary description of each operator about his:

   - background
   - studies and courses taken
   - previous experience and years

9. Do you use in-plant training facilities for maintenance and repair operators? Yes _____ No _____
If yes, explain method used

_____

_____

_____

10. Do you have a comparison between maintenance man-hours and production man-hours? Yes _____ No _____

D. MAINTENANCE AND REPAIR

1. Do you use a long term (6 to 12 months) schedule maintenance programme? Yes _____ No _____

2. Is maintenance organised on a systematic basis?
Yes _____ No _____

3. If not, what is the present maintenance programme and what regular inspections take place?

_____

_____

_____

4. Do you use a method of recording maintenance in breakdowns? Yes _____ No _____

5. If yes, does the recording show:

   a. breakdowns by machine Yes _____ No _____

   b. cost of breakdowns by machine and product Yes _____ No _____

   c. is the recording systematic Yes _____ No _____

6. Have you compared the cost of regular maintenance with the cost of breakdowns so as to provide the lowest cost between them? Yes _____ No _____

7. Do you have a plant layout showing machine location?
   Yes _____ No _____

8. Do you inspect according to checklists and established procedures? Yes _____ No _____

9. Can you allocate the frequency of major overhauls?
   Yes _____ No _____

10. As a result of inspections, do you issue work orders?
    Yes _____ No _____

11. If yes, do you retain all repair work orders whether completed or not? Yes _____ No _____

12. Do you record cost inspection of work orders?
    Yes _____ No _____

13. Are the repair records available per machine?
    Yes _____ No _____. If yes, prepare copies of repair records of your main machines to cover a period of at least one year.

14. Is maintenance recorded on a monthly basis:

    a. by machine Yes _____ No _____

    b. by product Yes _____ No _____

15. Can you estimate the breakdowns by direct and indirect costs? Yes _____ No _____

16. Do you have inspection checklists with frequencies?
    Yes _____ No _____

17. Do you record maintenance times:

    a. by operation Yes _____ No _____

    b. by machine or equipment Yes _____ No _____

    c. daily Yes _____ No _____

18. Do you establish a maintenance workload and how is it related to the production schedule?

_____

_____

_____

19. Do you carry out mechanical and electrical inspections?
Yes _____ No _____

20. Do you check for leaks, vibration, unusual heating, insufficient lubrication, tension of belts, paint jobs, etc?
Yes _____ No _____. If yes, explain or show checklist available.

_____

_____

_____

21. Do you use monthly reports giving maintenance and repair costs, labour hours, quality and efficiency of work performed? Yes _____ No _____

22. Is maintenance budgeted by department or by machine?

_____

23. Do you budget by predictable items like: inspections, routine oiling, painting, cleaning, etc.?

_____

_____

E. STORES AND TOOL ROOM

1. Are your parts in the stores properly coded and easy to locate at the right moment? Yes _____ No _____

2. If yes, does the recording system per spare parts show:

   - name of part with indication of machine(s) involved? Yes _____ No ____
   - stock available? Yes _____ No ____
   - entries, withdrawals and costs? Yes _____ No ____
   - maximum quantity to be purchased? Yes _____ No ____
   - minimum stock allowed? Yes _____ No ____

3. Are your parts in the stores well protected against fire, dust and theft? Yes _____ No _____

4. Are your parts, motors, oils, belts, hardware, etc., standardized? Yes _____ No _____

5. Do you use the correct lubricant for each machine, according to function and temperature of operation? Yes _____ No _____. Prepare a list of all lubricants used, giving name and characteristic of each.

6. Are your parts kept to a strict minimum to avoid high cost investment? Yes _____ No _____
   If not, explain reason

   _____

   _____

   _____

7. Do you use any inventory control system in your stores? Yes _____ No _____. If yes, explain system or method used, and give approximate capital cost in stock.

   _____

   _____

   _____

8. Do you keep your lubricants in a special room and is it well protected against fire? Yes _____ No _____

9. Are lubricant containers and fittings coded by colour or symbol to eliminate confusion? Yes _____ No ____

10. Do you have a special tool room and is it well protected against fire and theft? Yes _____ No _____

11. Do you have a list of the necessary tools for maintenance and repair? Yes _____ No _____ If not, write down what tools for repairs you have.

12. Do you use special machinery for sharpening all cutting tools? Yes _____ No _____. If yes, write down type of machine and function.

_____

_____

_____

13. Do you use the policy of having double set of cutting tools in order to always have one set ready to operate? Yes _____ No _____

Relevant Information or Remarks you wish to add:

_____

_____

_____

_____

_____

_____

_____

_____

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EXHIBIT 4

EVALUATION MATRIX Each rating point on col. 2 to 9 correspond to a mean scored by a number of industries included in each Industry Group.	Rank	Industry Group								Preventive Maintenance	
		Electro-Mechan.	Food & Beverage	Chemical	Textiles, Knitting & Clothing	Electric Power Stations	Cement	Tobacco & Leather Making	Agriculture Studio. & Workshops	Standard	Optimal
	1	2	3	4	5	6	7	8	9	10	11
A. Physical Conditions											
1. Buildings and Fittings	II	3.3	2.0	4.0	4.5	5.0	4.0	4.0	2.0	4.0	5.0
2. Factory Layout	II	2.0	1.0	4.0	4.5	5.0	3.0	4.0	2.0	4.0	5.0
	Sub-total	5.3	3.0	8.0	9.0	10.0	7.0	8.0	4.0	8.0	10.0
B. Production											
1. Quality of Goods	II	4.0	2.5	3.0	3.6	5.0	5.0	3.0	3.0	4.0	5.0
2. Production loses due to machine breakdown	I	5.3	4.0	6.0	6.0	10.0	6.0	4.0	4.0	8.0	10.0
	Sub-total	9.3	6.5	9.0	9.6	15.0	11.0	7.0	7.0	12.0	15.0
C. Personnel											
1. Management Skills	I	2.0	2.0	4.0	7.0	10.0	6.0	4.0	2.0	8.0	10.0
2. Supervisors & Foremen skills	I	6.0	4.0	4.0	7.0	8.0	6.0	4.0	2.0	6.0	10.0
3. Maintenance & repair team adequacy & skills	I	5.3	4.0	5.0	6.0	8.0	4.0	3.0	3.0	6.0	10.0
4. In-plant training facilities	I	3.3	0.0	0.0	5.3	0.0	2.0	1.0	3.0	5.0	10.0
	Sub-total	16.6	10.0	13.0	25.3	26.0	18.0	12.0	10.0	25.0	40.0
D. Machinery and Equipment											
1. Condition of machinery & equipment	I	5.3	5.0	4.0	6.6	10.0	8.0	6.0	4.0	6.0	10.0
2. Adequacy of equipment	II	2.0	2.0	4.0	4.0	5.0	5.0	4.0	3.0	4.0	5.0
3. Safety devices	I	4.0	4.0	6.0	7.0	10.0	8.0	8.0	4.0	8.0	10.0
4. Materials Handling	I	6.0	4.0	6.0	4.0	10.0	8.0	5.0	6.0	6.0	10.0
5. Frequency of breakdowns	I	6.0	4.0	6.0	5.3	8.0	6.0	4.0	4.0	6.0	10.0
6. Machine information	I	6.6	6.0	4.0	6.0	10.0	6.0	6.0	4.0	6.0	10.0
7. Layout	II	3.0	1.0	3.0	4.3	5.0	3.0	4.0	3.0	4.0	5.0
8. Machinery replacement policy	I	0.0	0.0	2.0	3.3	2.0	6.0	2.0	0.0	5.0	10.0
	Sub-total	32.9	26.0	35.0	40.5	80.0	50.0	39.0	29.0	45.0	70.0
E. Maintenance and Repair											
1. Workshop adequacy (is it self-sufficient)	I	9.0	4.0	4.0	7.0	6.0	6.0	4.0	5.0	6.0	10.0
2. Machine utilization	I	6.0	6.0	4.0	6.0	8.0	8.0	5.0	7.0	6.0	10.0
3. Adequacy of maintenance systems	I	4.6	3.0	5.0	5.3	10.0	8.0	3.0	3.0	8.0	10.0
4. Adequacy of recording & cost control system	I	0.6	1.0	1.0	2.6	10.0	6.0	1.0	2.0	8.0	10.0
	Sub-total	20.2	14.0	14.0	20.9	34.0	28.0	13.0	18.0	28.0	40.0
F. Spare Parts Stores											
1. Physical conditions	I	4.0	4.0	4.0	7.0	10.0	8.0	6.0	4.0	6.0	10.0
2. Inventory & cost control systems - coding systems	I	4.0	5.3	4.0	8.0	10.0	6.0	2.0	3.0	8.0	10.0
3. Team adequacy and skills	I	4.0	8.0	4.0	7.0	8.0	8.0	3.0	3.0	8.0	10.0
	Sub-total	12.0	17.3	12.0	20.0	28.0	22.0	11.0	10.0	22.0	30.0
G. Tool Room											
1. Physical conditions and/or adequacy of equipment	I	7.3	3.3	6.0	4.6	8.0	6.0	4.0	2.0	8.0	10.0
H. Lubricants Room											
1. Location and adequacy	I	4.6	1.3	4.0	4.6	8.0	8.0	0.0	6.0	6.0	10.0
2. Code systems	I	4.6	3.0	3.0	4.6	10.0	6.0	3.0	2.0	6.0	10.0
	Sub-total	9.2	4.3	7.0	9.2	18.0	14.0	3.0	8.0	12.0	20.0
TOTAL		113	84	104	139	199	156	97	84	160	235
Above Standard %						24					
Under Standard %		29	47	35	13		2	39	46		

EXPLANATION OF THE EVALUATION MATRIX (EXHIBIT 4)

To evaluate the data collected from a selected sample of industries, each condition in the organization affecting maintenance management has been allocated with a rating point according to the efficiency achieved, physical conditions and other relevant factors.

The following table shows a rating point distribution by rank according to the importance of the various conditions concerned. Thus, the condition of the machinery and equipment in a factory, the availability of skilled personnel, etc., are of primary importance when related to the maintenance services applied (Rank I), while the quality of goods produced or the factory layout, though affecting the organisation, is of secondary importance (Rank II).

Rank I	Rank II	Condition
0	0	non-existent
2	1	poor
4	2	mediocre
6-8	3-4	good but insufficient
10	5	optimal

(Note that the rating points of the table are for comparative purposes only, but individually they are not significant.)

Each rating point in columns 2 to 9 of the Evaluation Matrix corresponds to a mean scored by a number of industries included in each industry group and for each condition. Thus, in point C.(3) "Maintenance & repair team adequacy and skills", the rating points scored by three electro-mechanical industries was 8, 6 and 2, which mean is 5.3.

The numerical scoring presented in column 10, taken as standard, is the result of experience in many plants where preventive maintenance is used effectively; in column 11 it is assumed to be optimal. Thus, the matrix is designed to be a maintenance performance yardstick by which to measure what maintenance management does and how well they do it.

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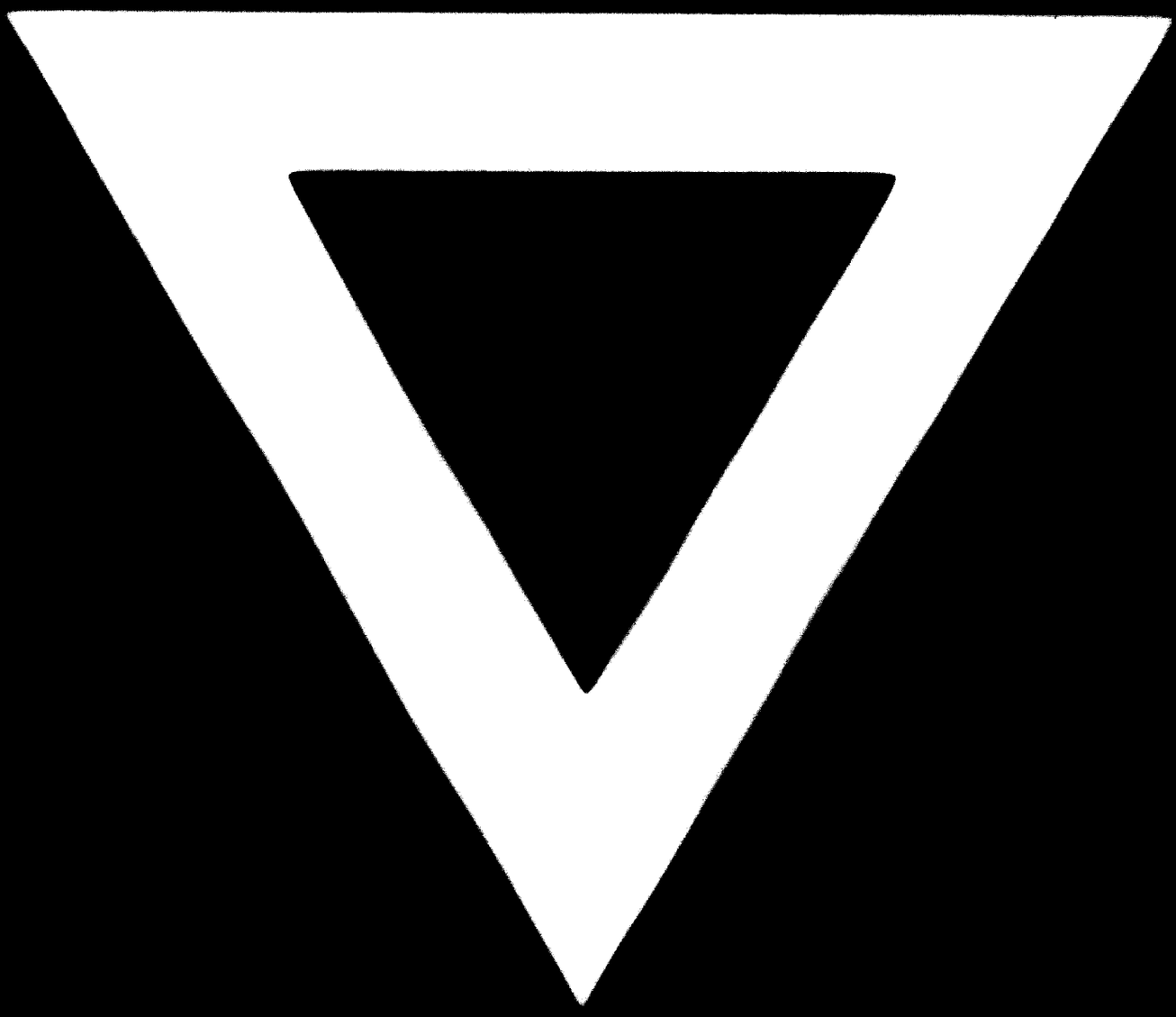

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