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RESTRICTED

ASSISTANCE IN

FEDERAL CHEMICAL AND CERAMICS CORPORATION (FCCCL)

(FCCCL)

REPORT ON

PREVENTIVE MAINTENANCE OF  
CHEMICAL PLANTS EQUIPMENT

(DB/PAL/82/000/11-01/22.1.0.1)

PREPARED FOR

THE GOVERNMENT OF ISLAMIC REPUBLIC OF PAKISTAN

BY

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This report has not been cleared with United Nations Industrial  
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Acknowledgement is also due to the Preventive Maintenance Development Centre Staff for their co-operation.

PART - I OBJECTIVES AND THE LOGIC OF THE PROJECT

The design of the project is logical and precise.  
THE IMMEDIATE OBJECTIVES are the following:

1. Establishment of a permanent Preventive Maintenance Development Centre with FOCOL.
2. To identify and formulate training programmes in Preventive and Predictive Maintenance Practices to be conducted at PMDC.
3. To attain a decrease of at least 5% of **present** down-time.

Objective 3 will be a result of objectives 1 and 2 and may only be achieved after implementation in the units, for which proper provision is lacking in the project document.

After these immediate objectives, the following DEVELOPMENT OBJECTIVES will be obtained:

1. Higher utilization of machines and avoidance of breakdown.
2. Increased profitability of the corporation through reducing the plant down-time caused by unforeseen equipment failure.
3. Saving the national resources through increasing the life of machinery.

PART - 2 ACTIVITIES\_CARRIED\_OUT\_AND\_OUTPUT\_PRODUCED


2.1 Preparatory Work

In October, 1984 the C.T.A. visited all the FCCCL Units (Annex-1) to evaluate the training needs in preventive maintenance, i.e.

- \* Number of trainees
- \* Skills/qualifications of trainees
- \* Levels of knowledge

All points were finalized after discussions with the National Project Director, General Manager and Maintenance Heads of the Units. As a result of these discussions, it was decided to run five courses for Craftmen, three courses for Supervisors and one course for Managers.

The number of trainees obtained in the first year was 135, which is equivalent to 1-2% percent of the personnel of FCCCL Units.

By the  end of March 1986, 145 persons will have been trained.

The kind of knowledge was also agreed (Annex-2) and the syllabus was established in a modular system consisting of 21 units (Annex-3). Each unit has 5 to 10 lessons consisting of :

- \* Manuals
- \* Tape, Slides
- \* Transparencies
- \* Models
- \* Posts
- \* Quiz and Exercises

All the above was prepared before April 1985 in order to start the first course.

## 2.2 Buildings

The erection of the building was completed in December, 1984. A detailed work plan to furnish the building was prepared. Finishing and furnishing of the building was completed by March, 1985.

## 2.7 Personnel

Appointment of the National Project Director took place in September 1983. The Head of the Preventive Maintenance Development Centre was appointed in October 1984. Two Training Engineers were appointed in February 1985. The rest of the personnel of the Centre (Typist, Peon, Driver, Workshop Instructor) were appointed between February to July 1985.

The C.T.A., Mr. Andrei Banescu, was in the field on 17 September, 1984 (16 months after the signing of the Project Document). The short term consultant on 'Safety', Mr. Youri Samshyn, arrived in the field on 24 March, 1985 for six weeks.

The short-term consultant on 'Non-destructive Testing' Mr. Richard Vogl, came on 20 March, 1985 for 6 weeks. The reports prepared by both these consultants are also attached for reference. (Annex ) The short term consultants on 'Instrumentation' and 'Inventory Control' also completed their assignments in the field.

The first consultant on 'Preventive Maintenance Training Workshop Equipment' was scheduled to be recruited in December, 1983. His visit was delayed and the post was cancelled. Hence the equipment for training was ordered by CTA at the beginning of October, 1984.

In this period, the CTA prepared job descriptions for three more short-term consultants on 'Welding', 'Rubber Lining' and 'Educational Technology'. In the last analysis, the Rubber Lining expert will not be required.

#### 3.4 Equipment

In the project budget covering the UNDP contribution, on budget line 49, value of equipment, was U.S.\$200,000 under the heading 'Non-expendable'. All the equipment, as given in Appendix-F of the project document, has been ordered.

The C.T.A. has also ordered some more equipment for non-destructive testing, safety, welding, machine balancing, instrumentation and the computer. The total value of the order was U.S. \$140,000.



### Criteria For The Selection Of Equipment

- \* To order all the equipment which was in the approved project document.
- \* To assess the equipment needed for FCCCL Units.
- \* To ensure training requirements in preventive and predictive maintenance.
- \* Selection of latest model of equipment with computerized memory in order to ensure high level training.

In the list of equipment of the project document PAK/03/200/D one Micro-processor was added to be utilised for:

- \* Computerized Maintenance System for FCCCL Units.
- \* Implementation of Computer Aided Instruction in the Training Centre (CAI).

This computer will be ordered for a future phase of the project. Books and video-films for training purpose were ordered under "Expendable Equipment."

### 2.5 Building Training Materials

The principles involved in building training material are the following:

- \* Variety of training media to stimulate the interest of trainees.
  
- \* Appropriate methods of training according to the need of the students (Lesson in Urdu, audio-visual system for illiterate trainees, quizzes/exercises to evaluate progress of the students and application of knowledge to an on-the-job situation).
  
- \* Combination of theoretical knowledge in the lecture hall with practical work in the workshop. The training material for conducting the courses was prepared by utilising the equipment purchased from the inputs of the project. (Annex 4).

Lectures have been linked to a unit system (Annex 3) which has been divided into 21 units. Each unit has about 5 to 10 lessons, ranging from elementary topics like 'Trouble Shooting' to advance topics like 'Computerized Maintenance'.

Lessons are prepared by UNIDO Experts and the Chief Technical Advisor. These lessons have been translated into Urdu (Local Language), as most of the craftsmen have difficulty in understanding English. Lessons are added with slides, tapes (recorded and video) and transparencies in Urdu.

Activities in the workshop include laboratory work and each lesson is related to practical work in the laboratories. Each laboratory utilises models, (good pieces, defective pieces, cut-away types) demonstration units, and the latest equipment which helps students to familiarize themselves with the latest technology.

The concept of training in the workshop is progressive in maintenance problems, i.e.:

- \* Simple components (Gears, Shafts, Seals, Valves etc.)
- \* Complex components (Pump, Compressors, Motors)
- \* Plant (Dry-Unit, Filtration Units, Rectification Units)

For example, using models trainees identify the defects by comparison with a standard/good component and then find out the causes of the defects. The trainees are instructed on how to avoid these causes with the aid of a laboratory checklist. Each laboratory provides exercises which helps the trainees to improve their skills and evaluate their performance.

In the demonstration units, the trainees are exposed to real working conditions. Some defects are simulated and they are asked to identify and remove them by using the method given in the checklist. These checklists will be the basis for building 'job specifications' in the units.

A small studio has been set up at the centre to show films, which demonstrate the correct way of doing and solving various maintenance problems.

At present we have prepared and stored:

- 600 Slides
- 450 Transparencies
- 25 Tapes (Recorded)
- 18 Units Lessons Prepared
- 8 Films

#### 2.6 Training Courses

Training courses include lectures in the conference room and practical training in the workshop.

Lectures include tapes and slides/films for half an hour, self study for half an hour, discussion for 30 minutes and programmed exercises and quizzes.

In the workshop practical training is tied to study in the lecture hall. Models, posters, demonstration units and checklists are used (Annex-5).

One hundred Craftsmen and 25 Supervisors have been trained to-date, and 20 Managers have also been partially trained.

Those trained will return to their units to help raise the standard of maintenance, reduce down-time and minimise breakdown.

#### 2.7 Training Abroad

In November 1985 the CTA was in Vienna to arrange with the Training Branch programmes for Study Tours and Fellowships. The CTA obtained Government approval for Mr. Sarfraz Naeem to undertake a study tour in Germany, U.K. Switzerland and Netherlands in February 1986. The two fellowships are being processed by the Government of Pakistan. (Annex-16).

#### 2.8 Progress Report

First, second and third Progress Reports have been prepared and processed (Annex-6).

### PART-3 ACHIEVEMENT OF IMMEDIATE OBJECTIVES

The Preventive Maintenance Development Centre has been established at Kala Shah kaku, 35 kilometers from Lahore. The Organization chart is given at (Annex-7). The Centre has a training programme for Craftsmen, Supervisors and Managers. The third immediate objective i.e., decrease of at least 5% percent in present down-time, can only be achieved after the implementation of the Preventive Maintenance Programme in the units, for which proper provision is lacking in the project document. It may be concluded that some immediate objectives have been achieved at this stage of the project.

However, as an additional achievement three Engineers and one Foreman are being trained in the Preventive maintenance field to build training material at the centre and for on-the-job training in factories. These Engineers are now able to conduct training courses at the centre (Annex-8).

#### PART-4 UTILIZATION OF PROJECT RESULTS

Maximum utilization of project results is linked with the follow-up stage of the project (Annex-9). In 1985 the establishment of the Preventive Maintenance Centre was completed. In 1986, building training material, training courses, advisory services, training on-the-job and implementation in units will be carried out.

The data obtained from the units will constitute preparatory work for the next stage.

In 1987 a computerized system involving preventive maintenance and Computer Aided Instructions will be initiated.

#### 4.1 Advisory Services

Three trained Engineers and one Foreman will provide advisory services to the units on specific maintenance problems. Latest equipment like the Computerized Balancing Machine, Non-destructive Testing Equipment (X-Ray control, Ultra-sonic control) and special tools for the mounting and dismounting of bearings, vibration analyser, special welding and metalizing equipment may provide services to the units on a payment basis, which will help

the

centre to work independently on an economic basis in the future. Material which may be used in the services is listed at Annex-10.

#### 4.2 On The Job Trainings

Each course is completed with an evaluation.(Annex-11). The trainees who obtain a very good evaluation will help provide on-the-job training to others in their units.The Preventive Maintenance Development Centre and units will provide models and training material.

Some of the instruments and tools will be ordered to be used in the units in the training process.

#### 4.3 Implementation In The Units

The process of implementation is linked with the training of the Managers of the units at the Preventive Maintenance Development Centre. This training is divided in three phases (Annex-12):

- Preparation
- Documentation
- Operation

In the preparation phase managers will be trained in plant inventory,selection of equipment to be inspected, development of the route for inspection, coding procedures and organizational procedures, after which they will return to their units and perform these tasks.

In the documentation phase, the managers will be trained at the Preventive maintenance Development Centre to fill in and introduce specialized forms for maintenance schedules, job specifications, weekly work plan, job reports, history records. Then they will establish the documentation system in the units.

In the operational phase, they will be trained in monitoring the programme, adjusting inspection intervals and controlling activities.

Evaluation of these phases may be done by physical checking/ inspection of the system in each unit. The next development in the project will be a computerized system. After sufficient basic data is obtained from the units (after minimum of six months of operation) data may be translated to computer.

## PART-5 FINDINGS

### 5.1 Observations Made During Factory Visits

During the factory visits the expert was interested in the main features and weakness of the units, (Table-1).



Table - 1

UNIT	Experience of craftsmen (field of good experience)	Workshop and special existing equipment.	Type of problems according to maint. aims.	Equipment with trouble.
Ittehad Chemicals.	Good (rubber lining)	Good welding Equip. inst. repair.	Corrosion	NaCl line preparation
Ittehad Pesticides.	Good (glass lining) replacing)	Good	Ventilation corrosion	Vessels flanges.
Ravi Rayon	Very good. (safety Dep. materials)	Good inst. shop tool shop Ultrasonic Test.	Corrosion	Acetic Acid Sulph. Acid Molasses Ac. Anhyd.
Ravi Engineering.	Very good (welding)	Good plate rollers welding Argon welding.	Space.	None
Kurram Chemical.	Good.	Small Workshop.	Fluction in Voltage of cement. Bldg. Maint.	None.
Swat Elutriation	Good	Small Workshop	Corrosion.	Pumps.
Nowshera DOT.	Good but to improve.	Good Workshop	Old factory (Corrosion)	All(pipelines Elect. instal).
National Fibres.	Good.	Very good instrumentation	Quality of product.	Old equipment.
Nowshera PVC.	Good (Maint. form)	Small	Quality of product.	Old equipment.
Sind Alkalis	Good (Maint. Scheme)	Good balancing machine sound analysis.	Corrosion.	Compressors

5.1 Evaluation\_of\_maintenance\_Cost

Based on the FCCCL figures available (Table-2 to 4) evaluation of the cost of maintenance in the units has been made.

There is a shortage of accurate information on the cost of maintenance. The figures differ according to the various accounting procedures used. In some factories, for example, fuel costs are included in the maintenance budget.

The maintenance cost as a percentage of net output of maintenance labour varies widely with the degree of automation.

In general, factories employ their own maintenance staff, and expenditure on contractors is low.

TABLE - 2

(Rs. in million)

1987-83

NAME OF UNITS	Total Production Cost	Fixed Assets Value	Equipment Cost	Personal Cost	Maintenance	Total Sales Value	Total Personal
F. Industries (P) Ltd	23.00	18.89	10.73	2.31	0.59	29.30	303
Etchems Chemicals	177.80	162.84	133.00	35.00	15.03	229.41	1304
Etchems Pesticides	14.37	13.25	14.32	3.99	0.74	24.31	135
Kurran Chemicals	1.04	8.54	2.11	1.11	0.12	2.18	64
Vadpara DDT	7.05	7.54	4.11	2.44	3.30	9.51	77
National Fibres	153.04	204.97	511.51	15.02	21.15	123.79	510
Pur Dye & Chemicals	13.11	1.04	49.54	2.29	0.25	10.29	143
Pakistan PVC	40.04	127.82	112.10	15.31	2.35	137.81	534
Rawl Rayon	151.71	237.92	217.10	15.24	12.29	235.37	1214
Rawl Engineering	14.00	5.26	3.92	5.23	3.13	17.48	154
Sind Alkali	22.07	216.14	177.53	17.14	4.06	86.31	793
Suit Ceramics	24.25	113.00	52.00	7.34	2.74	40.40	427
Suit Chlorination Plant	4.00	11.14	7.11	2.74	3.15	3.05	100
	754.31	1742.45	1221.72	142.71	59.21	908.12	6217

(Rs. in million)

Table - 3

1981-84

NAME OF UNITS	Total Production Cost	Fixed Assets Value	Equipment Cost	Personal Cost	Maintenance Cost	Total Sales Value	Total Personal
Industries (P) Ltd	23.00	-	-	11.51	-	35.57	365
Etchems Chemicals	177.80	113.50	157.12	34.97	23.29	224.32	1304
Etchems Pesticides	14.37	10.20	11.31	4.48	0.38	24.70	135
Kurran Chemicals	2.53	5.40	2.13	1.25	0.15	4.28	84
Vadpara DDT	3.75	7.51	4.37	1.50	0.29	9.14	67
National Fibres	242.57	-	-	24.35	-	351.88	511
Pur Dye & Chemicals	13.10	8.22	4.34	3.45	0.24	13.87	140
Pakistan PVC	115.81	-	-	20.14	-	130.41	647
Rawl Rayon Ltd	154.70	101.35	243.25	52.27	20.13	254.65	1554
Rawl Engineering	14.54	5.30	3.94	5.53	0.18	18.81	152
Sind Alkali	51.27	-	-	25.10	-	98.77	770
Suit Ceramics	27.13	112.42	91.83	7.31	3.23	34.13	424
Suit Chlorination Plant	4.34	11.34	7.34	2.10	0.24	9.42	153
Totals	901.21			148.21		1204.33	8370

Table 4

	Years of first oper.	MAINTENANCE COST AS PERCENTAGE OF SALES VALUE			MAINT. COST AS PERCENTAGE OF OUTPUT COST			MAINT. COST AS % of Equip. COST		MAINT. COST AS % OF FIXED ASSETS VALUE	
		1978/79	1982/83	1983/84	1979/80	1982/83	1983/84	1982/83	1983/84	1982/83	1983/84
Kurram Chemical.	1952	1.8	5.5	3.73	1.4	6.55	5.9	5.58	7.33	1.83	2.50
Nowshera DDT.	1954	0.68	0.63	0.87	0.3	0.8	0.91	1.48	1.96	0.99	1.05
Antibiotics.	1957	0.5	2.0	-	0.2	2.46	-	5.49	-	3.48	-
Pakdyes & Chemicals.	1959	2.9	2.29	1.75	4.3	2.45	2.37	5.14	4.81	3.07	2.9
Sind Alkalis.	1960	5.9	6.07	-	0.9	7.85	-	3.18	-	1.87	-
Ittehad Chemicals.	1954	7.6	6.5	10.44	-	8.4	12.45	11.82	14.67	7.95	11.90
Ittehad Pesticides.	1966	-	0.15	0.23	0.9	0.2	0.3	11.27	0.62	0.21	0.47
Ravi Rayon.	1966	6.3	5.9	8.11	6.7	7.9	12.96	5.64	-	4.13	6.65
Pakistan PVC.	1957	-	2.18	-	1.3	2.7	-	2.07	-	1.63	-
Ravi Engineering.	1959	-	0.74	0.8	0.9	0.89	1.09	3.59	4.12	2.42	2.68
Swat Elutriation.	1974	4.2	2.27	2.8	6.3	3.43	5.15	2.27	3.40	1.43	2.11
Swat Ceramics.	1977	0.8	6.7	8.2	2.1	10.43	11.9	3.23	3.85	2.41	2.84
National Fibres.	1982	-	10.1	-	-	13.95	-	3.57	-	2.95	-
U.K.	1.94	-	3.4	6.9	-	0.6	-	13.8	-	-	-
Japan.	1.7	-	3.4	2.0	-	3.8	-	4.9	-	5.3	-

The figures in the table below are based on the survey made in U.K. and Japan (Table-5):

TABLE - 5

Indication	U.K.			JAPAN	
	Drink Ind.	Textile Ind.	Drv. Ind.	Heavy Ind.	Light Ind.
Maintenance cost as percentage of sale value	1.94	3.16	3.44	3.4	1.7
Maintenance cost as percentage of net output	6.92	8.62	7.6	3.8	2.0
Maintenance cost as percentage of fixed assets value	-	-	-	5.3	4.9

This maintenance costs may be analysed according to the first years of operation, equipment costs and production costs. The following observations analysis compares expenditure in the same units of U.K. and Japan:

All units are increasing maintenance costs, except Pakdyes.

- Some units have high maintenance costs, which means they will have to exercise caution. (Sind Alkalis, Ittehad Chemicals, Ravi Rayon and Swat Ceramics).
- Other units began to increase maintenance costs in the last two years. This means they will have to analyse their maintenance expenditure and undertake definite measures to reduce engineering and repair costs (Swat Elutriation, Swat Ceramics, Ravi Rayon, Ittehad Chemicals).
- Some units spend too little on maintenance and repair (Pakistan PVC, Nowshera Chemicals, Ittehad Pesticides, Ravi Engineering).

Conclusions are given in Table 6 below:

Table 6

	High Maint. Cost	Tending to increase maint. cost	Too small Maint. Cost
Ittehad Chemicals	x	x	
Ravi Rayon	x	x	
Sind Alkalis	x		
Swat Ceramics		x	x
Swat Elutriation			x
Ittehad Pesticides			x
Pakistan PVC			x
Nowshera Chemicals			x
Ravi Engineering			x

PART-6 RECOMMENDATIONS

- 1\* Extension of the project up to December, 1987 which will be the phase of implementation of the Preventive Maintenance System in the units, the initiation of the computerised system, and a decrease of at least 10% of the down-time of FCCCL (instead of 5% which was in project document)-(Annex-17).
- 2\* The Pakistani Engineers are now able to conduct classes and build training material without daily monitoring. In the Tripartite Meeting held in Sept. 1985, suggestions were made to extend the assignment period of the Chief Technical Advisor for another six months in three split periods of two months each namely October-November, 1986, March-April, 1987 and September-October, 1987.
- 3\* The personnel at the Centre is required to prepare and supply training material in the form of manuals or charts in order to facilitate on-the-job training in the units.
- 4\* A specialized technical team will be chosen from the best trained technicians of the FCCCL units and will be assigned with the responsibility of resolving technical problems, as and when they arise.
- 5\* The teachers from the Centre will provide technical advice (Consultancy) to resolve emergency problems, as and when they arise in FCCCL units.
- 6\* The implementation of the Preventive Maintenance and Inventory Control Systems, which are being introduced in Ittehad Chemicals and Pavi Rayon, will be a continuous process which will be extended to other units.

7. In order to preserve the sensitive equipment in the summer season, an area has been allocated for its storage in the workshop (see outlay plan) and an air conditioner will be provided which is already on order. The proposal plan has been sent to Ravi Rayon and FCCCL (Annex-14).
8. A package for the computerised system has been ordered and bidding will take place in March at UNIDO Headquarters (Vienna). The Chief Technical Advisor's office will become the computer room and an air conditioner provided by Ravi Rayon will be installed.
9. An air conditioner will also be installed in the Conference Room which is already on order.
10. In the library, a laboratory for the maintenance and inventory control system will be set up.
11. In view of the increase in the number of students, class room facilities for training students will be extended by providing a roof over the terrace where classes will also be held (Annex-15).
12. A mobile workshop for transporting training equipment and teachers to the FCCCL units will be provided.
13. All safety rules and precautionary measures will be strictly adhered to by all the personnel at the centre. Special care will be taken in the summer season.
14. In the end the training centre will be able to provide technical services and extend training factories units in the public and private sectors in Pakistan, and even in the middle East and Asia. The Centre has all the potential to work on an economic basis.



- 15\* It is proposed to organise a regional demonstration workshop under UNIDO on 'Preventive Maintenance Systems in the Chemical Industry' for the Asian countries in Lahore. The aim of the conference will be to discuss and identify immediate problems and areas of assistance needed in the maintenance field.
  
- 16\* The scope of work will be extended to computerise the Maintenance System in the next stage of the project in 1987.