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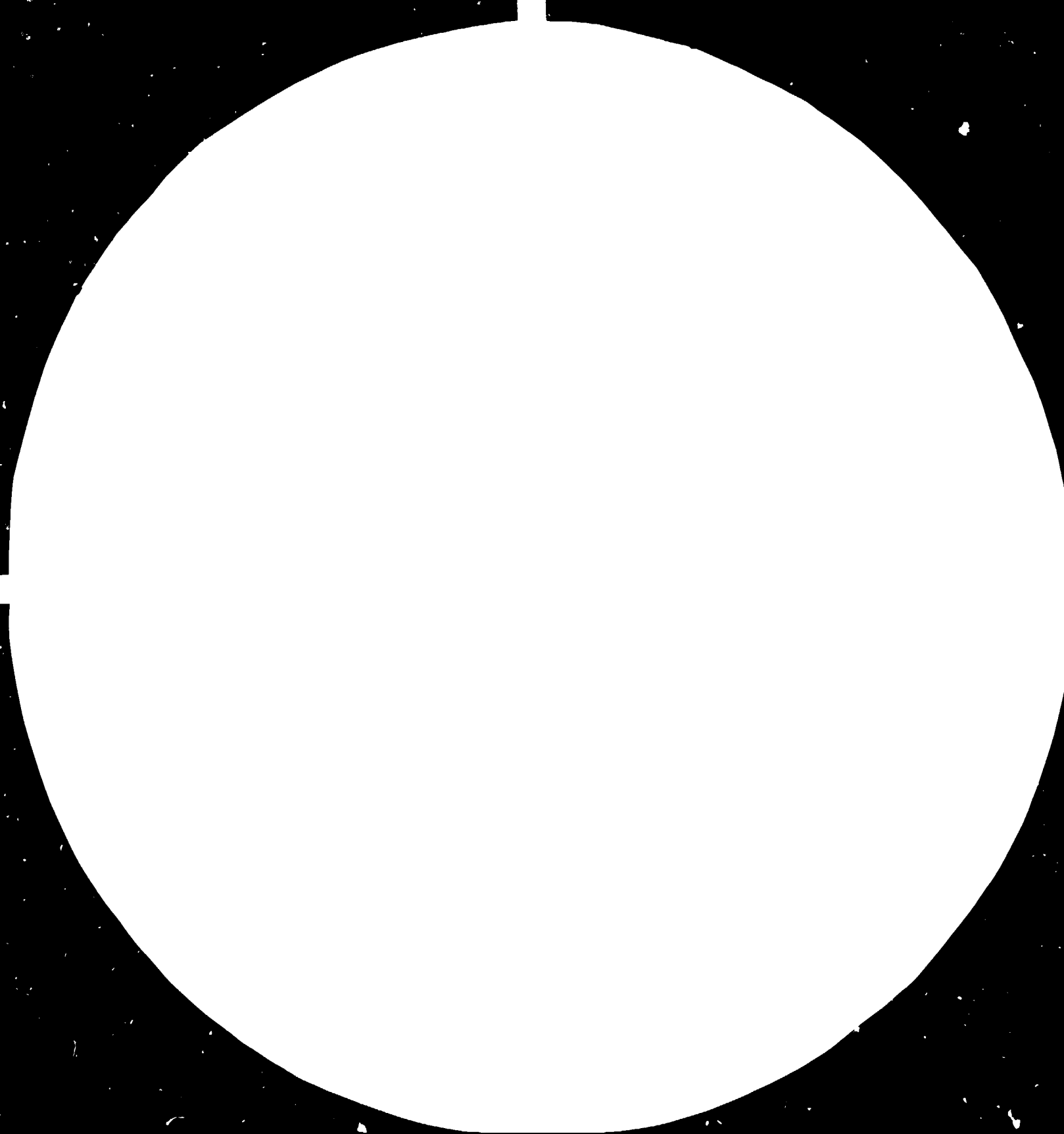
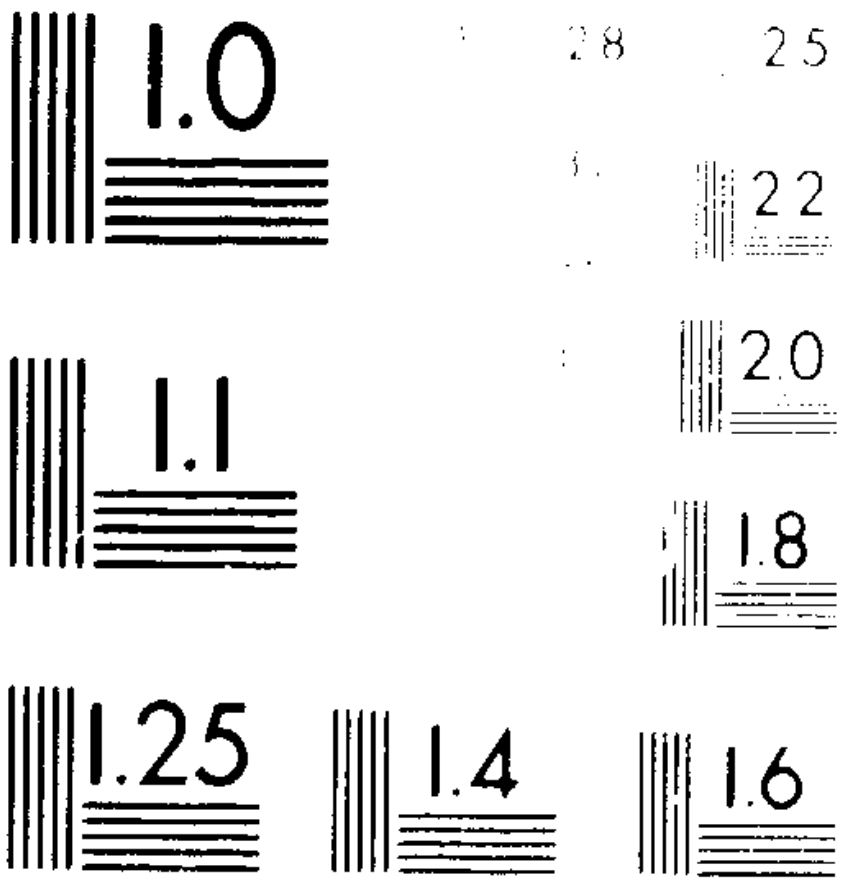




14566

Distr.
RESTRICTED

UNIDO/IO/R.154
8 March 1985

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ASSISTANCE TO THE SOUK EL KHAMIS CEMENT PLANT

SF/LIB/83/002

LIBYAN ARAB JAMAHIRIYA

Libya.

Technical report: Preparatory assistance to the Zliten Cement Company

Prepared for the Government of the Libyan Arab Jamahiriya
by the United Nations Industrial Development Organization

Based on the work of Boguslaw J. Walczenko,
process instrumentation engineer

V.85-23646
2016T

Explanatory notes

Reference to tonnes (t) is to metric tonnes.

In addition to the common abbreviations, symbols and terms, the following have been used in this report:

DWC Daewoo Corporation, Republic of Korea (the operation contractor)

KHI Kawasaki Heavy Industries Ltd., Japan (the contractor)

PLC Programmable logic controller

SHI Secretariat of Heavy Industries

SOE Secretariat of Electricity

WYP White Young and Partners, United Kingdom (the consultant)

ABSTRACT

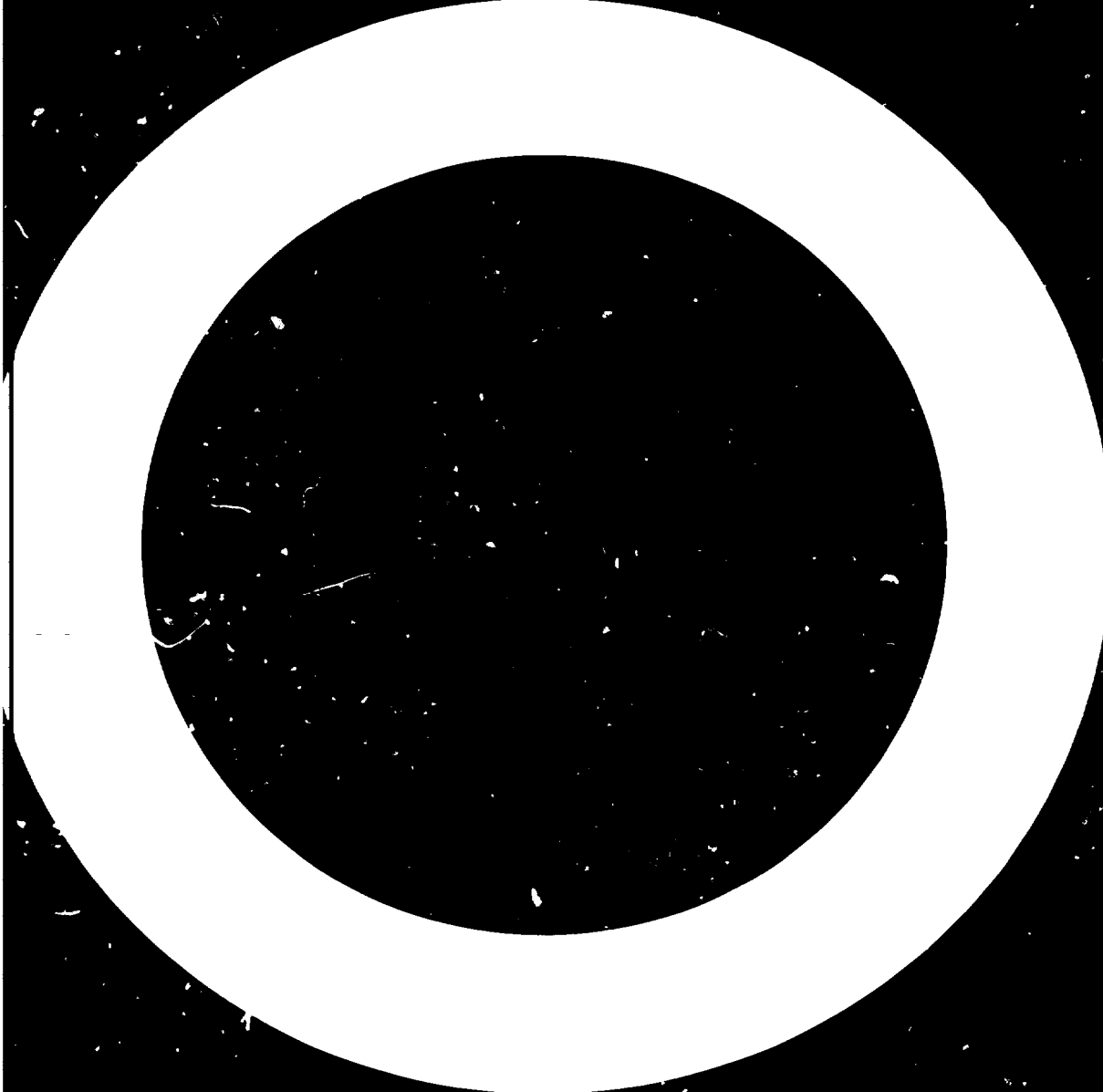
Under the project "Assistance to the Souk el Khamis Cement Plant" (SF/LIB/83/002), for which the United Nations Industrial Development Organization (UNIDO) is the executing agency, a process instrumentation engineer was assigned to assist the Zliten Cement Company for a period of six months, starting in September 1984.

The Zliten Cement Plant was supplied by Kawasaki Heavy Industries Ltd., Japan under a turnkey contract and was commissioned in the first half of 1984. The provisional taking over was completed on 27 June 1984. Since that day the plant has been under a one-year guarantee period.

The capacity of the plant is 1,000,000 t/y. The process is of the dry type, with reinforced suspension preheater (precalciner). The plant is built according to the latest technology, with fully centralized control and a computer-controlled blending of the raw materials.

The original purpose of the expert's mission was to design and implement a maintenance system for the electrical, process control and instrumentation equipment. On the request of the Execution Committee for the Zliten Cement Project the expert's prime duty became the follow-up of the project and technical advising.

The expert submitted his comments on various technical and contractual aspects which either had remained from the commissioning or had arisen during the guarantee period. Furthermore, he co-ordinated the technical assistance service provided by the contractor.



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INTRODUCTION

Under the project "Assistance to the Souk el Khamis Cement Plant" (SF/LIB/83/002) for which the United Nations Industrial Development Organization (UNIDO) is the executing agency, a process instrumentation engineer was delegated in September 1984 for a period of six months to the Zliten Cement Company.

According to his job description, the expert was to assist the Company in designing, implementing and supervising a proper maintenance system for its electrical, process control and instrumentation equipment. However, since the situation existing in the plant called for an expert to deal with the follow-up of the project during the period after the provisional taking over, he was requested by the Project Execution Committee to change the priorities of his assignment and to take care of the technical problems existing or arising in the plant during the guarantee period. His primary duty has therefore changed to technical advising and co-ordination, and the present report covers the first three months of the expert's assignment.

The Zliten Cement Plant, which has a capacity of 1,000,000 t/y, was supplied by Kawasaki Heavy Industries Ltd. (KHI), Japan, and since 27 June 1984, the date of provisional taking over, the plant is under guarantee for a period of one year.

As mentioned in the expert's preliminary report, the plant is operated by a technical team of 206 nationals of the Republic of Korea under a technical co-operation contract concluded between the Secretariat of Heavy Industries (SHI) and the Daewoo Corporation (DWC), Republic of Korea.

The operation contractor ought to run the plant in an economical, efficient and skilled manner, ensuring high productivity and a long life of the plant.

The designed production rate of the different departments of the plant and the capacity of the storage facilities for various materials for the process lines are given in annexes I and II respectively. However, the following changes were introduced to the way of operation outlined in annex I: the raw mill, the kiln and the cement mill are operated in two long shifts of 12 hours each; the packing plant is operated in two shifts and its production is dispatched also by bulk-loading facilities of 4 x 200 t/h.

RECOMMENDATIONS

To ensure a proper operation of the Zliten Cement Plant, the following recommendations should be implemented:

1. The co-operation between three parties involved in the project, namely SHI, DWC and KHI should be improved.

2. The weekly technical meetings should be continued, since they constitute the only forum for technical discussion.

3. The technical assistants should work much more closely with the local staff and that of the operation contractor. The reports prepared by the technical assistants should be clear, consistent and cover all technical problems in which they were involved during the week. A report on damages should be submitted promptly, the cause of a trouble studied, and results reported on time.

4. The storage-card system should be put into operation. Close monitoring of the consumption of the two-years' supply of spare parts should be continued and an evaluation of the consumption made after about nine months.

5. Reports on observation and progress regarding the major outstanding items should be submitted regularly and in accordance with the agreed procedure. (For instance, up to now no reports were made on the reliability of the gas analyser or the blending computer.)

6. The final drawings and manuals should be made available for checking as soon as possible.

7. To avoid unnecessary damage to the bags, pallets should be used for the transport of empty paper bags from Benghazi to Zliten.

8. Regular shipment of at least 60,000 bags per day should be arranged with the manufacturer in order to achieve continuous operation of the packing plant.

9. The fulfilment of the contractual obligation to achieve the rated capacity of the bucket elevators for raw meal supply to the kiln feed hopper should be monitored.

10. As the contractor is reluctant to settle technical deficiencies arising during the guarantee period it is recommended to balance the payments in accordance with the contractor's fulfilment of the contract.

PROJECT ACTIVITIES AND FINDINGS

A. Training abroad

The total number of local staff is somewhat more than 100, but only 20 engineers and technicians are directly involved in the technical operation of the plant.

The contractor, KHI, was obliged under the contract to arrange training abroad for the staff of SHI. Eight process and mechanical engineers or technicians received training at Ciements Lafarge, at different facilities of that company throughout Canada. The main supplier of the electrical, instrumentation and computer system being Siemens A.G., Federal Republic of Germany, training of the electrical and instrumentation engineers had been arranged with that company.

Annex III contains details of the training undertaken.

The engineers and technicians scheduled for training of six months completed their courses in July or August 1984 and are now working in the plant, while those scheduled for 12 months are still abroad and are due back in February 1985 to take up their duties in the plant.

At this stage it is too early to evaluate the result of the training; however, the trainees generally complained that the training was too short and not diversified enough for the different positions.

B. Technical assistance contract

Technical experts are provided by KHI in accordance with the contract, and they were available on the day of the provisional taking-over of the plant. The technical assistance team consists of 14 experts. Their fields of specialization and periods of assignment are given in annex IV, and an organigram of the operation contractor in annex V.

Unfortunately only three experts have a command of English, so that direct communication is very limited. KHI provided an interpreter to enhance the communication between the experts and the local personnel, but that arrangement is not functioning very effectively.

Recommendations, instructions or information, which could be given verbally, are submitted in writing, which causes some delay and lacks the interpersonal contact and discussion. Also, the technical experts of KHI have a common office which is at some distance from the production, maintenance and administration offices of SHI, which is another disadvantage.

As the plant is operated by a Korean team, technical assistants like a kiln operator or a raw meal operator could be confused as to whom they should report to or whom they should advise.

Reports concerning damaged or out-of-order equipment are usually submitted with delay or only after a request by SHI. Often only the trouble is reported and little or no information is given of its cause. Likewise, the use of spare parts, the ordering of a replacement, and technical advice from sub-suppliers are not promptly reported to the SHI engineers. Since such behaviour can easily create the negative impression that KHI try to cover problems arising during the guarantee period, these problems were recently discussed with management of KHI and an improvement is expected soon.

C. Process-control system and computers

The Zliten Cement Plant is equipped with a centralized process control system, based on analogue instrumentation and a sequence control system.

The analogue information from the control desk and mimic board is directly sent by field signal converters through a distribution centre. Distributed analogue signals are used for indication, recording, control, monitoring by computer, and alarm.

For the operational control of the process line a programmable logic controller (PLC) is installed. The PLC consists of a central processing unit, a stored program and an input/output unit. The signals between the central control room and each substation are transmitted through the serial data transmission network. The PLC receives the order from the control desk and adjusts the settings and monitors the adjusted process. It also gives the start and stop instruction in the correct order to the relay panel and the motor control centre.

An application of programmable logic controllers ensures the reliability of complex sequential control, simplifies the signal transmission network (less cables and wiring) and permits an easy modification of the control program. The system generally requires no maintenance.

The raw-mix control computer has the following functions:

(a) Data processing for X-ray analysis. The X-ray analyser which analyses raw meal, raw materials, clinker and cement, is operated by the computer. Results of the analysis are converted into mixing indices (i.e. hydraulic, silica and alumina) which are required for the raw-mix control;

(b) Raw-mix control. By using the processed data, the chemical composition of the raw meal can be kept automatically constant in accordance with the specified mixing indices;

(c) Data logging. The chemical composition, mixing indices, mixing ratio etc. are printed out periodically, or upon the operator's request for a specific purpose such as the preparation of a chemical report;

(d) Man-machine communication. On the operator's request, the current chemical composition of the raw meal, the mixing indices etc. can be displayed on the respective monitor.

The process-monitoring computer has the following functions:

(a) Raising alarm. If an anomaly in the process conditions is detected, the alarm message corresponding to each anomaly is issued on the alpha-numeric display and on the printer in the central control room. This way, operators can easily perceive the kind of trouble and quickly take the appropriate corrective action;

(b) Data logging. The principal process variables are collected and stored. They are arranged and printed out periodically, and, on the operator's request, as an hourly or daily report;

(c) Man-machine communication. On the operator's request current process variables such as analogue values or performance data for operational sequences can be retrieved and displayed on the colour graphic display. Operators can thus easily recognize the process condition.

After a short overview of the process-control and computer systems, it is possible to appraise the sophistication of that equipment. While it does not require frequent maintenance, it needs, however, highly-qualified specialists to operate it. At present, as part of the technical assistance contract, there are two Siemens engineers in the plant (one for the computer and one for the PLC). This would be an excellent opportunity for transfer of know-how and on-the-job training, but unfortunately the local engineers do not have enough background for such training, and the technicians of the operation contractor cannot be trained due to their poor command of English.

According to the contract, the responsibility for the maintenance of the computer and the X-ray analyser does not lie with the operation contractor. The lack of specialists capable of servicing that equipment can, in the future, create a tremendous problem for the operation of the plant.

It should be pointed out that it is possible to run the plant without computers, but the operation without PLC is not possible. The Zliten Cement Plant is the first cement plant in the Libyan Arab Jamahiriya whose entire control system is based on PLC.

D. Electrical and instrumentation workshops

The workshop for the heavy electrical equipment is located in an area which is separated from the mechanical workshop. The instrumentation workshop is installed in a dustproof, air-conditioned room adjacent to the electrical workshop.

Tools, calibration equipment, testers etc. were provided by the contractor in sufficient quantity and quality to repair and maintain the sophisticated electronic equipment on site. The availability of such tools is very important for a future smooth operation of the plant (after the guarantee period) as it renders the plant independent of foreign services. Again, this type of work requires highly skilled technicians. At present there is no local technician in the electrical workshop, and the operation contractor's personnel is not skilled enough to undertake repairs of the more sophisticated electronic devices. As the Siemens specialist is at present on site as part of the technical assistance contract, the opportunity to transfer technical know-how to local technicians or to the operation contractor's personnel should not be foregone.

There are no facilities for the rewinding of electrical motors and coils. Since the operation contractor's specialists have the ability to perform such work and could even train local technicians, it would be advisable to look into that problem.

E. Final drawings and manuals

It was agreed that the final drawings and manuals would be delivered in six sets, except the drawings for the civil works.

The drawings and manuals have been distributed as follows:

(a) Mechanical drawings:

1 set in the records room of the administration building
1 set in the office of the mechanical department
1 set in the conference room of KHI's office
3 sets in the storing place of the central control building

(b) Electrical drawings:

1 set in the records room
1 set in the office of the electrical workshop
1 set in the substation No. 7
1 set distributed throughout the electrical substation as appropriate
2 sets in the storing place

(c) Civil works drawings:

1 set in the records room
7 sets in the storing place

In addition, all reproducible copies and microfilms are being kept in the records room of the administration building.

Up to now the drawings were not ready for checking because the delivery of corrected drawings is still outstanding. Recently KHI promised to have the drawings and manuals ready for verification by the end of December 1984. The drawings so far kept in the records room are neither suitably arranged nor classified. Before final checks can take place, those files have to be identified by a consistent numbering system and a list of drawings has to be prepared. It cannot be over-emphasized that properly classified and accurate documentation helps substantially to shorten the time for trouble-shooting and maintenance and facilitates the ordering of spare parts.

F. Spare parts

According to the contract, KHI was obliged to supply spare parts for a two-year operation of the plant. About 95 per cent of the scheduled spare parts are already on site. The deliveries have been checked on behalf of SHI by the consultant.

Until now the spare parts could not be properly arranged in the storage area because the building is undergoing some modification. The storage area foreseen in the original design was inadequate for spare parts for two reasons: it was not dustproof and the storing surface was insufficient. At a late stage of the project it was decided to improve the storage and workshop facilities by sealing four unused doors and constructing a second storage deck. Unfortunately these modifications started only after a great deal of spare parts had arrived but were not yet stored on the assigned shelves. At present the civil works are near completion so that proper storing can be arranged soon.

During the transitional period a temporary system of records of the spare parts consumption was in use. The contractor recently submitted part of the spare-part cards, however a spare-parts control system has not yet been established for the plant. The said system will be motor-driven, with a capacity of 32,000 cards, which should enable easy search and inventory control of the spares.

The total number of spare parts is:

Mechanical spares - approximately 5,500 items
Electrical spares - approximately 3,500 items
Vehicle spares - approximately 1,500 items.

The control system should be put into operation without further delay as it is essential for the monitoring of the consumption of spare parts during the guarantee period. The evaluation of the availability and consumption of guarantee spare parts is due in March 1985.

Furthermore the operation contractor often makes use - without proper recording - of the rest of the spare parts from the commissioning period, which are in the custody of KHI. Such practice has to be strictly controlled as it distorts the real consumption figures.

G. Outstanding items

Outstanding items and deficiencies became apparent from several sources such as performance test reports, minutes of special meetings, machine certificates etc., and were collected by each department. The consultant then divided the outstanding items into two categories - major and minor.

The major outstanding items were further broken down into the following categories:

(a) Items for which technical solutions had been implemented, but which required special observation during the guarantee period. The details for the special observations were provided by KHI and approved by the consultant;

(b) Items for which approved technical solutions were not available at the time. In those cases KHI provided solutions for approval with completion dates.

In that way the following list of major outstanding items has been established.

1. Process/mechanical

(a) Mixed limestone reclaimer rails to be checked for settlement during the guarantee period;

(b) Problem of build-up in mixed limestone hopper to be resolved;

(c) Problem of raw mill vibration and problems arising from water injection with some of the mills to be resolved;

(d) Corrective action to be taken on damage caused by settlement of the homogenizing silos. Further changes in the foundation of the silos to be observed during the guarantee period;

(e) Problems in connection with the fan of the reinforced suspension pre-heater to be resolved: vibration, temperature of bearings and support structure;

(f) Kiln girth gear meshing to be checked during the guarantee period;

(g) Problem of tile adhesion in the gravel bed filter to be resolved;

(h) Problem of build-up in gypsum hopper to be resolved;

(i) Corrective action to be taken on damage caused by differential settlement of the cement silos. Observation to be carried out for further settlement of silos during the guarantee period;

(j) Improvement of the empty paper-bag handling system;

(k) Failure rate of the cooler plates, due to uneven distribution of clinker, to be monitored during the guarantee period.

2. Electrical

Jointing on 6 kV ring main cables to be checked during the guarantee period.

3. Instrumentation

(a) Problem of variations/drift in the accuracy of weigh belts/weigh feeders and of the kiln feeders to be resolved;

(b) Reliability of the gas analyser system to be improved to ensure effective protection of the electrofilters;

(c) The "on-line" and "off-line" pneumatic sampling systems, the sample preparation and the blending computer to be monitored during the guarantee period.

Those major outstanding items have to be monitored carefully during the guarantee period. Progress has to be reported promptly by KHI and shall be the subject of profound study before any approval. Since not all agreed observation records are submitted regularly, SHI can easily get the impression that no progress has been made.

Reminders concerning the outstanding minor items are [illegible] in the form of a schedule by each department. By now almost 80 [illegible] those items are completed and the remaining ones are generally [illegible] for which a first attempt at problem resolution was unsuccessful.

All those items need a great deal of observation and study prior to approval. The expert made an evaluation of the prices of all outstanding items in order to settle the problem of a possible retention of payments to KHI.

H. Electric power supply

According to the design the plant should be supplied by four 30 kV overhead transmission lines, erected by the Secretariat of Electricity (SOE). The four 30 kV transmission lines are divided into two groups, the Zliten and the Souk el Giuma lines. Any two lines of the four shall normally be in service, and the other two used as stand-by. Each of the four lines should be rated for the total demand of power estimated at about 25 MVA.

The two Zliten lines were put into operation in November 1983; however, the capacity of each line had been limited by SOE to 15 MVA. The Souk el Giuma lines were not ready in the beginning of November 1984 due to a lack of material, as reported by SOE.

The plant suffered many times from power cut-offs, even during the performance tests. During summer, the disturbances were mainly attributed to a flash-over on the 220 kV grid, which was beyond the control of the Zliten substation.

In September 1984 the insulators, on the receiving tower adjacent to the plant, became a source of trouble. The contractor and consultant pointed out to SOE that the insulators were not adequate for 30 kV transmission lines, but the problem was ignored. Later in September the condition of the insulators had deteriorated to the extent that some discharge arcs were produced.

The SOE office at Zliten was informed immediately that maintenance or replacement of the insulators was required, but repair was delayed due to lack of manpower and material. As a consequence, the power supply tripped off many times during October and November, and as a precaution one line was disconnected. Those imposed power limits at 15 MVA allowed to operate only the kiln, the raw mill and the packing plant, while the cement mill was working overnight when the packing plant was stopped.

After several meetings with SOE, it was agreed to complete the Souk el Giuma lines as soon as possible. SOE activated those lines on 20 November 1984, however again limited to 15 MVA. This way it was possible to disconnect Zliten lines and to perform the necessary repair work. On 27 November the Zliten lines were reconnected, and now the plant operates without troublesome power limits. The new insulators and jumpers shall be the subject of further observation.

Although it was well known to the management of the operation contractor that the power supply was limited during November, it happened three times that, due to the lack of co-ordination, operators of the crushing plant and the packing plant started the machines at the same time and tripped-off the whole plant. The contractor has been instructed accordingly, and at present the possibility of implementing a selective trip-off of substations for the cement mill department, the crushing plant and the packing plant in order to protect the kiln operation, is under consideration.

I. Cement packing and loading facilities

Four silos with a total capacity of 45,000 m^3 (approximately 63,000 t) are provided for 20 days of production. The cement is dispatched either in bulk or in bags.

For the bulk cement there are four loading points, one for each silo. The loading capacity is 200 t/h.

The packing plant is provided with four fully automatic roto-packers with a feeding system for bags, each having a capacity of 100 t/h. Bags are loaded onto trucks by four automatic palletizing machines.

The empty-bags storage on the ground level has a capacity of at least 7,000,000 bags.

Production reports for the last months show a shift from bulk loading to bag loading; at present about 65 per cent of the cement is shipped in bags, as can be seen from the following figures:

1984	Bulk	Bags	Total
	tonnes		
July	21,152	38,665	59,817
August	18,695	38,352	57,047
September	19,232	30,609	49,841
October	23,306	43,066	66,372

The packing plant is working six days a week and two shifts per day, and there is no time for proper daily and periodical maintenance.

The reason for the increased demand for bagged cement is most probably a decrease in the number of large-scale industrial projects and an increase of small-scale projects. Also, private customers prefer cement in bags. Since that tendency will grow over the next years, the possibility of increasing the number of loading lines should be considered. Also, the Libyan Arab Jamahiriya can become an exporter of cement in the near future and it will thus be necessary to have a loading equipment which complies with export requirements.

Meanwhile, as some cement plants in the country have a marketing problem, it is imperative to maintain a high output of the packing and palletizing equipment in order to attract customers.

The present output of the bagging machines and palletizers could be increased by using an automatic bag feeder. Because of its automatic operation, the quality and the condition of empty bags such as dog-ears, folds etc. become a most critical point, and the quality control of paper bags, as well as their piling, transporting and handling deserve particular attention. It is, for instance, necessary to improve the quality of bags manufactured at Benghazi. Furthermore, to maintain a good condition of empty paper bags, they should be piled on the pallet by the manufacturer, which would improve the unloading procedure in the Zliten Cement Plant. At present bags are handled without any care when they are unloaded from trucks into the empty-bags store.

Recently the quality of bags was changed from three plies to four plies. This resulted in a decrease of the number of broken bags from a maximum of 9.2 per cent to approximately 1.5 per cent. However, the number of unusable bags has increased due to insufficient glue application.

J. Technical meetings

Weekly technical meetings were introduced in mid-October, and until now eight weekly meetings took place. The main purpose of those meetings is to discuss openly the whole range of technical problems which are faced during the operation of the plant by the three parties, the owner, the operation contractor and the supplier. It turned out that a great deal of technical problems had accumulated since the date of provisional take-over, and the meetings were very timely. As previously mentioned, there is a serious language problem, as the technical assistants and the operation personnel have almost no English, while the local engineers and technicians have quite a good command of that language.

That situation constitutes a big obstacle in the transfer of information and know-how, and ad hoc technical discussions in the plant between SHI engineers and the technical assistants are impossible, as an interpreter is usually not within reach. For the above-mentioned reasons, regular technical meetings as a means to resolve technical problems are useful only as long as all English-speaking technical assistants are present. At the same time, they are a good opportunity for local engineers to gather more knowledge about the operation of the plant.

It has to be underlined that SHI's engineers have become more active during the last meetings and they are raising an increasing number of technical matters. At the beginning the management of the technical assistance contract was very reluctant to discuss openly all technical matters

during the meetings attended by 12 or more engineers, as this could generate further unresolved problems during the guarantee period. But SHI strongly requested to continue the weekly meetings.

After each weekly meeting minutes are prepared and the progress is monitored.

Annex 1

PRODUCTION RATES BY DEPARTMENT

Department	Operating time: Number of shifts	Hours per shift	Days per week	Weeks per year	Hours per week: Operation	Hours per week: Maintenance	Production output: Rated (tons/hour)	Production output: Actual Tons/week	Production output: Actual Tons/year
Limestone quarry (excavation and transport)	1	8	6	47	36	12	1 400	28 600	1 344 000
Clay quarry (excavation and transport)	1	8	6	47	36	12	217	5 300	248 000
Limestone and clay crushing	1	8	6	47	36	12	1 400	28 600	1 344 000
Additional raw materials crushing	1	8	6	47	3		80	170	8 000
Raw mill plant a/									
Reclaiming and transport	2	8	7	47	88	24	500	34 000	1 600 000
Raw milling	3	8	7	47	151	17	270	34 000	1 600 000
Kiln operation	3	8	7	48	168		125	21 000	1 000 000
Cement milling	3	8	6	47	122	22	100 x 2	22 000	1 030 000
Packing and dispatch	1	8	6	52	40 b/	8 b/	100 x 4	19 800	1 030 000

a/ Average raw meal composition: limestone 84 per cent, clay 15.5 per cent, iron ore 0.5 per cent.

b/ Estimated.

Annex II

STORAGE CAPACITIES

Material stored	Days of plant operation	Capacity		Type of storage
		Tonnes a/	m^3 b/	
Limestone and clay	20	96 000	60 000	Storage shed
High grade limestone	30	7 200	4 500	Storage shed
Iron ore	30	3 000	1 300	Storage shed
Gypsum	30	4 500	3 200	Storage shed
Additives	-	2 000-2 500	1 300	Storage shed
Clinker	20	60 000	43 000	Storage shed
Unburnt clinker	-	600	400	Storage shed
Fuel oil	30	6 880	8 000	Steel plate tanks
Cement	21	63 000	45 000	Reinforced concrete silos
Industrial water	3	9 000	9 000	Reinforced concrete pond
Drinking water	-	500	500	Reinforced concrete tower
Raw meal (homogenized)	4	19 200	19 200	Reinforced concrete silos

a/ Estimate.

b/ Verified.

Annex III

TRAINING ABROAD

Number of staff	Position	Duration (months)	Location
1	Production engineer	12	
1	Mechanical engineer	12	
1	Quality control chemist	6	
1	Shift leader	6	Clements Lafarge, Canada
2	Kiln operator	6	
2	Mechanical technician	6	
1	Electrical engineer	12	Siemens A.G., Fed. Rep. of Germany
1	Instrumentation engineer	6	
10	Total	66	

Annex IV

TECHNICAL ASSISTANCE STAFF

Number of staff	Field of specialization	Man-months	Function
1	Process engineer	24	Process control; checks raw materials, raw mix, fuel and power consumption, and product quality
1	Mechanical engineer	24	Supervises machine operation and maintenance
1	Electrical engineer	24	Supervises electrical equipment operation and maintenance
1	Mining engineer	24	Plans and controls new material exploitation in the quarry, including removal of overburden in accordance with daily process requirements
1	Chemist for laboratory (process)	24	Quality control; assists the process engineer
1	Chemist for laboratory (analyst)	24	Quality control and supervision of laboratory function
1	Mechanical specialist	24	Fitter
1	Mechanical specialist	12	Plate worker
1	Mechanical specialist	12	Rigger
1	Electrical specialist	24	Instrumentation
1	Electrical specialist	24	Computer control
1	Operator (mill)	6	Mill operation
1	Operator (kiln)	12	Kiln operation
1	Administrator	24	Administrative office work
14	Total	282	

Annex V

ORGANIGRAM OF THE OPERATION CONTRACTOR