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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

The two groups were originally installed at the Urfa TEK power plant and later at Malatya, and were transferred to Van late in 1975 (start-up March 1976). Group No. 4 with Deutz engine Serial No. 4.530.756 is owned by TEK and rented by the cement plant.

Characteristics: Eight cylinders, four-stroke cycle, direct injection, pressure intake air charging by exhaust gas turbocharger Brown-Boveri VTR 320 and aftercooling by Deutz heat exchanger.

Fueling: diesel oil with dual cartridge-type filters, gear-type fuel pump.

Dual water-cooling system: raw water with external rain-type cooling tower and separate electrically driven centrifugal booster pump; circulating water system with Deutz heat exchanger and gear-driven engine-mounted centrifugal pump.

Lubrication through single-stage crankshaft-driven gear pump with dual element filters and Deutz cooler in the circulating water system.

Lubricant used: Mobil Delvac H30 MIL 12104 B - conventional camshaft drive and valve arrangement. Two-valve cylinder heads.

Deutz single-case injection pump, gear-driven through transmission shaft.

Starting by compressed air.

Controlled by flyweight mechanical Deutz speed governor with Garbe-Lahmeyer electrical control motor and magnetic shutdown. Automatic safety switches to prevent inadequate engine-oil pressure, excessive cylinder-head water temperature and overspeed.

Brown-Boveri mesh-type air cleaner mounted on the turbocharger and aspirating inside the room.

Alternator: Siemens Schuchertwerke VFM 490/15-14, seven poles, 650 V, 120 A, 1310 kVA directly coupled with one on-line and one gear-driven VDF 530/66 Siemens 93V 165A exciters.

Main auxiliary facilities for serving Ruston and Deutz engines

Three heavy-fuel heaters for Ruston engines, with independent electrically driven transfer pumps and burners.

Two Alfa-Laval centrifugal purifiers for heavy fuel.

Compressed air system for engine starting with four high-pressure containers, electrically driven compressor and diesel-driven emergency compressor in case of power failure.

Machinery-room ventilation with horizontal shaft centrifugal blower directly coupled to an electric motor, mesh-type inlet air cleaner and sheet-metal air ducts.

Under-floor high voltage and control wiring. Separate electrical control room with switchboard and instrumentation for remote control.

Tooling and repair area, overhead 6-ton electrically operated bridge crane.

Conditions of the machinery

A. Group 1 - Ruston engine 9ATC Serial No. 5479/0600/1.

Completely stripped down after torsional breakage of the crankshaft at crankpin of cylinder No. 6.

Engine sump (bedplate) fatigue-cracked at several points along the intake and exhaust sides. Salvaged through welding and resurfacing.

Turbocharger inlet and exhaust casings cracked. Rotor bearings seized. Compressor and turbine blades damaged.

Crankshaft main bearing supports on crankcase damaged by the crankshaft breakage. Realignment job being carried out at an Istanbul shipyard through reaming and resurfacing.

Viscous torsional vibration damper ineffective owing to gelled fluid.

Electrical alternator and exciter completely stripped down.

Foundation concrete block requires checking to ensure that it is firmly anchored to the floor.

The complete rebuilding of this unit can be made only after the arrival of several new spare parts. Expected arrival: spring 1977 at earliest.

Group 2 - Ruston engine 9ATC Serial No. 5479/0600/2

Still in service.

Excessive crankcase blow-by and oil consumption. Reduced output and black exhaust smoke indicate worn piston, rings and liners. Crankshaft journals

and crankpins worn out beyond limits. Remetalization and regrinding required. Job to be carried out in the Netherlands.

Low camshaft oil pressure due to excessive bearing clearance consequent to wear.

Engine sump (bedplate) fatigue-cracked at several points along the intake and exhaust sides. Welding and resurfacing required.

Turbocharger temporarily field-fixed with locally made shaft. Heavy leakage. Overhaul urgently needed.

Viscous torsional vibration damper of dubious effectiveness. Overhaul required.

Electric alternator and exciter clogged with cement dust and oil moisture.

Foundation concrete block vibrating heavily. Apparently loose from the floor.

Engine and alternator safety automatic shutdown devices ineffective or missing.

Consistent fuel, lubricating oil, cooling water and exhaust smoke leaks at various locations.

Instrumentation partially out of order.

This group has accumulated a great many hours of operation (no details available) since the last general overhaul.

The conditions of the unit are extremely insecure and failures may occur at any time. Complete rebuilding is required. Best estimate for full operating capability: late summer or autumn 1977 if all spare parts are ordered immediately.

Group 3 - Ruston engine 9ATC Serial No. 5479/0600/3

Completely stripped down after crankshaft failure with crankpin of cylinder No. 5 cracked. Crankshaft currently in the Netherlands for remetalization and regrinding.

Engine sump (bedplate) fatigue-cracked at several points along the intake and exhaust sides. Salvaged through welding and resurfacing.

Turbocharger requires complete overhaul.

Crankshaft main bearing supports on crankcase already realigned through reaming and resurfacing.

Viscous torsional vibration damper ineffective owing to gelled fluid.

Electrical alternator and exciter completely stripped down.

Foundation concrete block requires checks to ensure it is firmly anchored to the floor.

The complete rebuilding of this unit can be made only after the arrival of the new or application of reconditioned spare parts.

Expected arrival: late summer 1977 at earliest.

B. Group 4 - Deutz engine BV8M545 Serial No. 4.530.756

In service after field repairs to the alternator stator windings. Top overhaul carried out during the mission.

The failure in the Siemens alternator - short circuit between two phases - was due to cement dust and oil vapours.

This group is operating in relatively good condition except for incorrect fuel injection pressure pipes to the injectors; worn-out lubricating oil pump; partially inoperative instrumentation; ineffective automatic safety shutdown devices and dust-clogged turbocharger air cleaner. Loose foundation stud bolts were tightened during the mission.

Group 5 - Deutz engine BV8M545 Serial No. 4.530.757

In service. Minor repairs carried out during the mission.

This group is operating in relatively good condition except for incorrect fuel injection pressure pipes to the injectors; fuel leakages from the injection pump; partially inoperative instrumentation; electrical alternator and exciter clogged with cement dust; exhaust pipe incorrectly supported with excessive vibrations that may damage the turbocharger; air cleaner clogged with cement dust; lubricating oil leaking from crankshaft oil catcher. Loose foundation studbolts were tightened during the mission. Concrete block to be checked and stud anchoring system to be improved.

Ineffective automatic safety shutdown devices.

Auxiliary equipment

Cooling-water towers, piping, valves, booster pumps heavily clogged with carbonate deposits. Severe leaks.

External oil bath inlet air cleaners for groups 1, 2, 3 coated with cement dust and oil; in evident need of cleaning and maintenance.

Engine-room ventilation system out of operation. Electric driving motor missing; air duct dismantled; inlet air filter clogged with cement dust.

Heavy fuel heaters for groups 1, 2, 3, piping, valves, booster pumps clogged with fuel sludge. Severe leaks.

Alfa-Laval centrifugal purifiers out of order. No repairs in sight, since the parts are not available nor on order.

Starting air bottles require checking and overhauling, emergency diesel-powered compressor not operating.

Output and power supply

Van lies 1,750 m above sea level; the maximum summer temperature is above 35°C.

According to DIN (Deutsche Industrie-Norm) ratings 6270 "Leistungsbegriffe, Leistungsangaben, Verbrauchsangaben, Bezugszustand", the derating coefficient for the engine output is 0.73 - 0.76, as related to the reference conditions of 280 m above sea level and 20°C, which are standard for acceptance trials. The above coefficient is valid, assuming a mechanical efficiency of 0.85, i.e. with the machinery in top condition. No correction for humidity is required.

No original acceptance certificates could be found for the engines installed in Van, to be used as a basis for calculating output. However, for all practical purposes, taking into account the engine's nominal name-plate ratings, the derating coefficient, the limits to the exhaust temperature set by the manufacturers, and the deterioration, the maximum output can be estimated at 900 kW for the Ruston and 600 kW for the Deutz units.

The total power station capacity is therefore (3 x 900) + (2 x 600) = 3,900 kW in the ideal condition in which all groups are operating at their highest efficiency. The sections of the cement plant add up to a total load of 3,800-4,500 kW, broken down as follows (kW):

Crusher and raw material mill	1,500–1,650
Cement oven	500– 600
Clinker mill	1,500–1,650
Accessories and ancillaries	300– 600
	3,800–4,500

The factory is thus underpowered by 600 kW, even in the ideal condition of having the power station operating at full capacity. Therefore, energy has to be obtained from the public TEK network if the plant is to be fully operational or if one or more of the diesel-electric groups is out of service. This is not always feasible, since TEK operates only one small hydroelectric power plant at Van. Moreover, because of the interconnexion problems in the electricity network and the inoperative safety shutdown devices, the paralleling of the power station with the TEK distribution system is not possible. The only alternative therefore is to feed the energy from the external source into an individual section of the cement plant that has been disconnected from the rest of the plant. This solution would create disturbances and unavoidable power cuts, and the full capacity of the plant would seldom be attained.

To overcome the power shortage, especially since the frequent failures of the diesel-electric machinery had become unacceptable, two 1,200 kW trailer-mounted Kongsberg gas turbine power plants were transferred by TEK to the cement plant early in 1976 to provide supplementary power during peak-load periods.

Similar troubles were experienced: a complete breakdown occurred in one of the turbines. Particles of cement dust, not trapped by the ineffective air cleaner, combined themselves in the combustion chamber with fuel and combustion by-products. Consequently, hard, stone-like bullets reached the diffuser and the rotor (18,000 rpm) and damaged both parts beyond repair.

The second gas turbine was still in service at the time of the mission; but, according to two Kongsberg service engineers who inspected it, a severe failure is unavoidable in the very near future. The power supply at Van is thus heavily deficient, and the prospects for the immediate future do not look very bright.

A solution could be offered by the addition of a 16,000 kW FIAT TG16 gas-powered turbine unit to the VAN TEK hydroelectric plant (job in progress) or by the planned completion of the interconnecting loop of the whole Turkish electricity network.

However, winter 1976/77 will slow down or stop the work on these projects, for whose completion no target date has been set.

Spare parts situation

The major reason for the power station's unreliability is inefficient management of spare parts.

The cement plant has a spare parts warehouse, in which a limited variety of components and replacement parts for the stationary and mobile equipment of the whole factory is stockpiled. The management of the warehouse is minimal; no inventory or stock control is maintained beyond the card system for recording warehouse input-output. Minimum quantities per item have not been established, nor have reordering dates been set. No pending file for incoming purchase orders is kept.

The stock of spare parts for the Ruston diesel engines is currently very low both in terms of number of items and of quantities. There is no guarantee of an efficient back-up of the units, especially in the present critical situation. The Deutz engines are not covered by any stock of spare parts, with the exception of three sets of Brown-Boveri turbocharger parts and tools originally sent along with the engines to Van. No stock is available for the electrical machinery, for the switchboards and transfer gears for the accessories or for the auxiliary equipment.

Any maintenance involving the exchange of components or any unexpected failure causes a crisis that inevitably leads to further deterioration of the machinery. No preventive maintenance is performed, while damaged or precariously fixed components are reused beyond their allowable wear limits until completely destroyed, which causes damage to other parts. The result is an impossible workload for the repair team and frequent recurrent power cut-offs that jeopardize the plant's production.

The procedure for reordering spare parts originates almost inevitably from emergencies and triggers off the following lengthy routine:

Power station notice to the Van purchasing office

Request for quotation from Van to the Central Purchasing Department of TCS in Ankara

Pro forma invoice request from TCS to the suppliers in the United Kingdom of Great Britain and Northern Ireland or in the Federal Republic of Germany

Processing and mailing of pro forma invoice from the suppliers to TCS

Confrontation of pro forma invoice with the original notice (Ankara to Van and back): amendments, if required

Procedure for the opening of letter of credit (L/C) and for the importation licence initiated by TCS with competent bankers and trade-control authorities

Official purchasing order issued by TCS and covered by L/C in favour of the suppliers

Processing, expediting and dispatching of orders at the suppliers' premises

Surface transportation to Istanbul

Customs formalities in Istanbul

Road transportation to Van

According to previous records, the total lead time from the original notice to the day the spare parts reach the power station ranges from eight months to three years. Under these circumstances, the groups are kept in service thanks to the emergency action of the repair team, with frequent stops until major failures put the machinery out of service for months.

In addition, an internal organizational bottle-neck makes things worse: the responsibility for ordering and stocking spare parts is not clearly defined. Orders are placed under the pressure of the power shortage and exclusively for the items badly needed for a specific repair. Thus, the repair situation usually has changed by the time a shipment reaches the power station. New failures have resulted in new emergency orders and so on. The critical spare parts shortage becomes therefore permanent.

Conditions of technical set-up

Facilities

As mentioned earlier, the main and auxiliary machinery has deteriorated to a dangerous point. Several factors combine to create a very unfortunate situation, among which are the following:

(a) Highly polluted environment. The power station is located right in the centre of the cement production area. Highly abrasive cement and clinker dust penetrates into all machinery recesses (diesel engines, generators, wirings) with consequent rapid wear and risk of serious damage, especially short circuiting in the generator windings and fire owing to a dust-oil mixture. Cement dust and combustible products combine as solid particles at high temperatures, damaging moving parts, especially in the turbocharger exhaust area. Scrupulous maintenance and greater care in planning a generously dimensioned power plant with an efficient spare parts back-up could have offset the adverse conditions. A contrary situation exists: maintenance has been below normal standards; power demand has normally exceeded the planned supply; and the spare parts have been kept to a minimum;

(b) Overloading. Apparently the derating coefficient was not considered when operating the power station. The number of hours accumulated until now by the Ruston units is largely below the engine service life, and there should be a margin for safe operation for a good number of years to come. However, the units have been constantly loaded above the derating limits, with consequent higher thermal and mechanical stress and unfavourable combustion and turbocharging conditions;

(c) Cannibalization. The regular practice of overcoming a chronical spare parts shortage by cannibalization, i.e. using components salvaged from out-of-order units, has reached the extreme limit; the engines are used as a source of spare parts instead of power. Rebuilding therefore becomes ever more difficult, if not impossible. The solutions adopted in the past as a temporary expedient appear to be ineffective:

(i) The addition of two groups of completely different design (Deutz/Siemens) to the existing ones (Ruston/AEI) would have required the establishment of a completely new spare parts store, the training of fresh personnel and the procurement of new maintenance tooling. The two engine/generator set-ups have very little in common and are dimensioned according to two different systems (British and metric). Not even basic hardware (bolts, nuts, washers) or standard tools (wrenches, pullers) can be applied to both types of machinery;

(ii) The fuels for Ruston and Deutz engines are different (heavy fuel and diesel oil), which creates double storage and refueling problems, raises operating costs and makes different maintenance procedures necessary;

(iii) The operation by TEK of two costly and highly sophisticated Kongsberg gas turbines located outdoors in the dusty environment of the cement plant, without any spare parts coverage or skilled operators and special repair facilities, appears to be technically unsafe. The gas turbine mobile power units could have been located 6 km from the cement factory, beside the hydroelectric power plant, if some improvements in the electrical transfer lines had been effected to supply the energy to the cement factory;

(iv) The machinery did not deteriorate suddenly: several warnings were given, including opinions expressed by the Ruston engineers visiting the plant (see as an example Ruston letters dated 14 March 1975 and 16 November 1972). Unfortunately, no corrective action was taken following the manufacturers' recommendations.

Manpower and methods

The operators of the power station have not been sufficiently trained, especially on Deutz engines and Brown-Boveri turbochargers. The language barrier makes impossible a complete understanding of instruction manuals, spare parts books and manufacturers' advice, given either through letters or technical consultations.

The lack of a well-defined spare parts purchasing procedure dramatizes any minor failure, while the maintenance team is constantly under pressure to make hasty emergency repairs.

The necessity for running the units until they fail has led to overlooking early warning signs (abnormal vibrations, knocks, leakages, smoke, pressures or temperatures beyond limits).

The routine recording of instrumentation readings has in fact become a mere bureaucratic obligation, and the round-the-clock attendants have not been trained to recognize the importance of critical factors as signals of abnormal conditions.

Methods applied during the mission

Since the problems had been analysed earlier and the duration of the mission was short, the expert tackled the crucial subjects first, instead of simply trying to effect rebuilding jobs, improvements or modifications to the facilities that could not be carried out efficiently for lack of spare parts, tooling, time and training of personnel.

On-the-spot training was given to the operators, especially in trouble-shooting, adjustment, design principles and the characteristics of the Deutz engines that are particularly unfamiliar to the Van personnel. The expert carried out a complete review of the supply of spare parts and tooling in co-operation with the power station foreman, advising and demonstrating the correct procedures for identifying, ordering, using and administering (see recommendations and annexes). This task is currently beyond the capabilities of the personnel, unless specific intensive training is given to a spare part clerk to be selected from among the technical staff of the cement plant. In meetings with the Van management and with TCS in Ankara, the expert placed particular emphasis on the gravity of the whole situation. He gave details illustrating the need for prompt decisions and action (see recommendations).

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CEMENT DEVELOPMENT AND RESEARCH CENTRE

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TURKEY

Technical report:
ASSISTANCE TO THE DIESEL ELECTRIC POWER STATION AT THE VAN CEMENT PLANT

Prepared for the Government of Turkey by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

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TURKEY

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Based on the work of Nicola G. Schioohi, diesel engine specialist

United Nations Industrial Development Organization
Vienna, 1977

II. RECOMMENDATIONS

To the plant management:

A. For immediate action to maintain present conditions and to avoid major breakdown

The power station runs at present at less than 50% of its full capacity rating and the group 2 (Ruston) is in urgent need of a general overhaul.

Repair parts (see annexes II and III)

Groups 1 and 3 (Ruston), currently out of order, will have to be rebuilt as soon as possible with new parts that are on order or being shipped by surface. The tabulation in annex II details the status of the various components and the expected date of availability at Van. However, some additional vital components were not considered when the orders were placed and some are not reusable.

Recommendations

1. The missing parts should be sent by air freight, since no rebuilding can be completed without them.

2. The purchasing order for the 12 items urgently needed for contingencies (see annex II) should be rushed in view of the suppliers' lead time and the currency formalities involved.

Shutdown safety devices

The present running conditions of the diesel generator groups are unsafe, since all automatic shutdown safety devices are ineffective or disconnected. This applies to the engine's protection against excessive cylinder-head outlet water temperature, low oil pressure and overspeeding as well as to some of the electrical relays and switches.

The emergency spare parts order to Ruston, as seen in annex II, contains most of the items (switches, shutdown solenoids) required to bring the engine safety devices back into operation.

The Deutz devices could not be tested but are apparently in working condition and would need only to be checked and rewired.

Note: Even in the case of a future solution to the power shortage in the Van area, the recommendations would still apply to the power station's diesel engines, irrespective of the destination and use of the machinery.

Recommendations

1. A general test of all shutdown safety devices should be carried out to avoid the risk of serious failures.

2. The recommended stocks of spare parts for three years' operation (see below) should include whatever safety devices for both engine models are required.

Vibration dampers

The crankshaft failures of groups 1 and 3 (Ruston) can be traced to ineffective vibration dampers. This has also been confirmed in writing by the damper manufacturers, Holset, after their analysis of a sample of the viscosity of oil taken from one of the dampers.

The reinstallation of the vibration dampers in their present condition is highly dangerous, since it would:

(a) Lower the whole spectrum of second-mode torsional vibration natural frequencies, allowing some of the resonance critical speeds to come too close to the running speed, which occurs because oil in the damper is solidified and therefore the mass of the free oscillating inner ring is solidified with the casing;

(b) Eliminates the damping effect of the inner ring, which amplifies the additional torsional stresses in the crankpins to very dangerous levels, with the possibility of crankshaft breakage.

Recommendation

The dampers of groups 1 and 3 (and later on of group 2) should be sent to Holset for highly specialized overhauling. Two units should be ordered in addition to the one already on order (see emergency order to Ruston and letter on proposal to Holset in annex II).

Power output

Operation of the power station at full capacity cannot be forecast for the near future owing to a combination of factors, among others, the lack of repair parts, the unsatisfactory conditions of the groups currently in service and the forthcoming major overhauls to be carried out. The most optimistic estimation is that a complete overhaul of the five groups and their accessories by summer 1977 can be expected, if no major failures occur meantime and if the necessary action is taken in due time.

Recommendation

In co-operation with TEK and electrical engineers of the cement plant, a solution to the problem of parallel operation of the power station with the TEK network should be worked out. The plant then could be partially supplied with power externally while the diesel electric groups are being overhauled or maintained. This suggestion still requires further investigation by electrical experts and cannot therefore be broken down into details in this report.

Engine foundations

Recommendations

1. Before groups 1 and 3 are rebuilt, and subsequently when the remaining three units are overhauled, the engine and generator foundation blocks and the studs securing the machinery to them should be checked. The blocks may have to be resurfaced and anchored to the floor and the studs fastened to the concrete foundation.

2. Great care should be taken during the periodic checking of the stud nut torque, retightening the nuts to avoid engine bedplate cracking and the possibility of additional bending stresses in the crankshaft and generator shaft caused by the misalignment of the crankcase bearing supports, as has happened in the past.

Repairs to Ruston engine

The diesel engine of group 2 is in urgent need of a general overhaul.

Recommendation

Since a general overhaul would require a long power cut-off and the availability of many spare parts, at least a top overhaul should be carried out. The conditions of the piston rings, camshaft, main and connecting rod bearings and turbocharger should be checked.

The bedplate shows several cracks on the intake and exhaust side, while the crankpins are worn out beyond the manufacturers' limits.

Recommendation

A maintenance stoppage should be planned for this unit for the minimum time needed for the most important repairs. Some of the parts required for this operation could be obtained by using parts removed from groups 1 and 3.

If this unavoidable repair is not carried out, major breakdowns are almost certain to occur in the main engine structure, which would jeopardize the power output for an unpredictable period.

Maintenance of the Deutz engines

The stock of Deutz parts is practically nil. Even the most simple, fast-moving maintenance parts are not available, and there is no indication of forthcoming shipments from the manufacturers.

Recommendations

1. A minimum quantity of replacement parts must be on hand in Van, since the prescribed maintenance cannot be carried out under the present circumstances. Included in annex III is a proposal for an emergency order of items to be shipped by air freight.
2. A request to Deutz for an updated English version of the spare parts catalogues (see annex III) should be sent by telex. The catalogues available at the power station are in German and cannot be understood by any of the Van personnel. There is thus a great risk of erroneous ordering.

B. Medium-term action

The recommendations outlined below are important; but, since an order of priority has to be established, they should be carried out immediately after the emergency actions listed in A. They are fundamental to ensure a continuous and reliable power output.

Environment

Recommendations

1. The machinery room openings (doors and windows) should be kept closed and tight. Double entrance doors for the personnel should be provided to keep out dust.

2. The ventilation system originally provided and currently dismantled should be repaired and put back in operation (driving motor missing and air ducts removed).

3. A second ventilator should be installed to supply fresh, filtered air to the two Deutz units.

4. The ventilator inlet filters should be cleaned periodically. A much better solution would be to install self-cleaning, rotary-type inlet screens and to build a ventilator chamber.

5. The air pressure in the machinery room should be maintained at slightly overpressure, 0.1 - 0.2 atm, if the ventilation system is properly operating and all openings are sealed. This would certainly prevent dust from entering, since no air stream could penetrate the room except through the filtered ventilation system.

6. The Air-Maze oil bath air cleaners for the three Ruston engines should be relocated inside the machinery room. The present arrangement (outside and close to exhaust mufflers) is inefficient. Their location inside would provide dual filtration. Sufficient space can be found inside the room in a suitable location, near the compressor side of the turbochargers.

7. The machinery room and equipment should be kept clean and the floor sprayed periodically with water. Currently the available space is fully occupied by dismantled engine generator parts, and there is slight possibility of removing the layer of oement dust and oil that covers everything.

8. In the service corridors of the machinery room, there should be a sufficient number of compressed air and water outlets to reach all areas when cleaning the area.

9. A concrete platform should be built around the external walls of the power station (width, 5 m; height, 20 cm) and periodically rinsed with water spray to keep dust from entering the room.

10. Parts removed from the engines or from any machine should be taken outside the room, whenever their weight and size allow it, and thoroughly washed and cleaned before repair or reassembly. In this respect an external cleaning bay equipped with steam-cleaning equipment, compressed air, fuel basin and, if possible, chemical solvents should be installed.

11. The maintenance schedule for the air cleaners should be strictly observed at the intervals prescribed by the operating instructions.

Spare parts system

As outlined earlier, one of the major sources of trouble and equipment downtime is the insufficient spare parts coverage. No improvement in the power station's reliability can be expected without a drastic change in the situation. The loss of production caused by the power shortage and the costs of the failures resulting from the lack of spare parts largely balance the money, time and efforts spent on solving this problem.

Recommendation

A comprehensive spare parts system should be set up for all the machinery of the power station and especially for the diesel engines and ancillary equipment. It should cover all aspects - purchase timing and procedures, warehousing methods, inventory control, reordering and exchange programme. The major aspects to be considered are described below.

Initial stock and inventory control

In annexes II and III the best estimations are shown for a minimum initial stock, based on the following:

Information contained in log book
Maintenance schedules as per instructions
Rate of consumption of parts
Estimated total reordering lead time
Frequency of reordering

The initial stock is just a starting point, and the system should be implemented by establishing minimum quantities and reordering points for each item to be carried.

The lists in annexes II and III for Ruston and Deutz engines cover an estimate for three years' operation with regular maintenance. The stock for Ruston is divided into two sections:

Major exchange components for back-up and overhauls (86 items)
Maintenance wear parts (177 items)

A similar list has been prepared for Deutz parts for a total of 266 items. The acquisition of the above-mentioned parts should be considered separately from the emergency orders to be placed immediately for urgent maintenance and overhauls for the Ruston and Deutz units. Parts and tools for Brown-Boveri VTR320 turbochargers were not considered part of the initial stock, since three sets originally supplied are still available. Brown-Boveri sets, however, must be included in the reordering system and replenished regularly.

Purchasing procedures

Inventory control, even if carefully established and administered, cannot entirely prevent unexpected shortages of parts. To ensure the operation of the power station even under these circumstances, an arrangement with the suppliers (Ruston, Deutz, Holset etc.) should be made whereby they would undertake to ship emergency spare parts orders cash on delivery (C.O.D.) or

on Open Account (O/A). This procedure would make the long period required to establish the letter of credit and to secure the currency unnecessary. Emergency orders for limited amounts should, if possible, be placed by the Van plant for air shipment direct to the Van airport.

Standardization

In future expansion programmes, if any, the introduction of engines or equipment of other manufacturers and models should be avoided to remove the need to maintain separate stocks of spare parts and tooling for each line of equipment, which multiplies the amount of money tied up in inventory and increases the risk of shortages of parts.

The initial stock detailed in annexes II and III amounts to a total of more than 520 line items for the two makes (Ruston and Deutz). It can be estimated that 60% of these would be sufficient with slight increases in the quantities per item to cover most of the requirements if the five groups were of the same model and from a single manufacturer.

Exchange programme

Components removed, as an assembly removed from the engines, because of unexpected failures or for preventive maintenance (e.g. turbochargers, pumps, dampers, governors, injectors) should be replaced by entirely new or rebuilt assemblies from the stock, while those removed should be rebuilt with new parts and kept in stock for future back-up. Such a continuous excharge programme would ensure faster repairs and better operating conditions, since complete new assemblies would be installed, and above all it would ease the pressure on the parts stock and lessen the risk of long downtimes resulting from the lack of minor, even inexpensive spare parts.

Such an exchange programme also has the advantage that the rebuilding can take place during the spare time of the maintenance team. Thus, manpower can be used more efficiently. The rebuilding jobs can be carried out without the usual pressure of time connected with failures and will be more accurate.

Water-cooling system

The hardness of the water available at Van for engine cooling is far beyond the limits accepted by the manufacturers. Calcium carbonate deposits obstruct all water ducts, reducing the cooling efficiency and increasing the operating temperature with the risk of clogging and abnormal wear.

Recommendation

Page 112 of Deutz operating instructions and pages 7-9 (6W) of Ruston instruction manual (see annexes II and III) setting down the recommended practices for water softening by the use of additives (trinatrium phosphate, rain water and others) should be studied and followed. The cement plant's chemical laboratory should analyse samples of the cooling water periodically to keep the hardness and other factors constantly under control.

The cooling towers, ventilators and piping, as well as all inlet and outlet water lines, should be stripped down and kept free of the heavy carbonate deposits that obstruct them. This job can be carried out in a short time while two of the groups are out of service and extended to the remaining units when they are hauled.

Operating schedule and output

Recommendations

1. Even after complete rebuilding of the five diesel-generator groups, only four groups should be kept in continuous operation. The fifth should be kept as a stand-by for emergencies or for periodic preventive maintenance. For all practical purposes, therefore, the capacity of the power station should not exceed 3,000 - 3,300 kW (due to the stand-by unit.)

2. The permanent interconnexion with external power sources (mobile gas turbine power plant or external network feeding) is necessary, and plans should be worked out in this respect with TEK, unless there are prospects for expanding the power station by at least two other diesel-powered units.

Tooling and maintenance

Tooling

Ruston engine dimensions are British while the Deutz ones are metric. Different sets of standard workshop tools have to be provided in addition to the special equipment for specific overhaul jobs for each engine make. The initial stock of spare parts in the annexes includes the most important Deutz special tools that are currently not available at the power station but are mandatory for the maintenance and repair of the engine and injecting systems.

Recommendations

1. The tools listed in annexes II and III should be made available as soon as possible.

2. A oomplete inventory of all tools available in the workshop should be made. They should be classified and items missing or damaged replaced.

Maintenance

The maintenance and repair facilities are inadequate. The service and parts literature is in English or German and not completely updated.

Recommendations

1. The workshop should be relocated to a larger area and the present location kept as a tool warehouse. The new workshop should be easily accessible but separate from the machinery room. Main equipment should include work benches, parts stripping area, mobile crane, injection system test bench, compressed air system, valve grinder, hydraulic press etc. Space is available on the west side of the power station.

2. All manuals, the latest versions of which should be purchased from the manufacturers, should be translated into Turkish. The technical personnel, responsible for the operation of the power station, cannot be expected to understand fully the details of correct operating, maintenance and spare parts if the language is unknown.

Personnel training

The technical skill of the power station operators and maintenance team is sufficient.

However, some additional training will be necessary for the power station manager and for the foreman of the repair and maintenance group to give them a deeper knowledge of the latest techniques for operating and overhauling diesel engines and of spare parts control.

Recommendations

1. The training should be carried out at the service training centres of the machinery manufacturers (Ruston, Napier, Deutz).

2. The operators should be given an "acquaintance course" at one of the most efficiently operated diesel electric power stations of TEK or of another similar corporation in Turkey.

To UNIDO

UNIDO should provide further support, at least until the power station is brought back to its full operating capability, and a reasonable chance of smooth operation and an economical energy supply is ensured.

Projects that appear suitable for an efficient back-up of the Van power station and are recommended to UNIDO assistance are described below.

Fellowship programme

At least two of the diesel operators - the power station foreman and his assistant - should be trained at the machinery factories so that they will become acquainted with the design, operation, trouble-shooting and maintenance of the diesel engines. Such training is essential for the operators of the Deutz units that have been installed recently. They are not familiar with the Deutz system, and problems will inevitably occur in the near future as soon as major repairs and overhauls become necessary.

The training itinerary of this fellowship programme should be worked out with the service departments of the manufacturers listed below.

Klöckner-Humboldt-Deutz AG

Cologne, Federal Republic of Germany

Two to three weeks of training on Deutz BV8M545 diesel engines and Brown-Boveri VTR320 exhaust gas turbochargers

Ruston Diesel Ltd

Vulcan Works, Newton-Le-Willows
Merseyside WA12BRU, England

Two weeks of training on Ruston 9ATC diesel engines

D. Napier and Son Ltd

Turbo Blower Division
East Lancashire Road
Liverpool 10, England

One week of training on Napier HP300 turbochargers

When the training programme is organized, care should be taken to ensure the availability of interpreters, since the trainers will speak only Turkish.

Expert missions

Diesel

An associate UNIDO diesel expert should be assigned to the Van power station for a period of at least six months starting after the arrival of an

Explanatory notes

The following abbreviations have been used in this document:

L/C	Letter of credit
TCS	Türkiye Cimento Sanayii (Turkish Cement Industry Corporation)
TEK	Turkish Electricity Board

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

adequate stock of spare parts and tools, as previously indicated, i.e. in April-May 1977 at the earliest. A proposed job description is given below.

Duties: To assist and advise the local personnel in carrying out the technical tasks as specified in the recommendations to the plant management and to TCS.

To implement the spare parts stock programme, training local personnel on correct store administration.

To establish guidelines for effective maintenance and repair procedures.

Qualifications: High school technician with knowledge of diesel engine operations and repair. Practical professional experience for at least five years.

Languages: English and/or German. Working knowledge of Turkish would be an asset.

As an alternative, or in addition to the associate expert mission, a senior diesel expert should be sent on a two- or three-week mission in the spring or summer of 1977 to verify the progress made in rebuilding the machinery and in carrying out the plan of action detailed in the present report.

Electrical expert

Because electrical aspects of the problems encountered at Van aggravate the difficulties with the diesel engines, UNIDO assistance in the electrical field (power generation, high-voltage distribution and control) is recommended.

An experienced power generation expert should be sent on a two- or three-month mission.

The start of this mission could be planned in conjunction with the mission of an associate diesel expert. A proposed job description is given below.

Duties: To assist the plant's electrical engineers in planning and implementing an overhaul programme for the entire power station's electrical system.

To establish procedures of control and maintenance.

To recommend improvements and modifications of the existing facilities.

Qualifications: University electrical engineer (high voltage) with at least 10 years professional experience in power generation and distribution.

Languages: English and/or German.

Annex I

JOB DESCRIPTION

Post title:	Expert in Maintenance and Repair of Diesel Engines
Duration:	One month
Date required:	As soon as possible
Duty station:	Ankara with travel within the country
Duties:	The expert will be attached to the Government of Turkey and will in close co-operation with the project manager and local counterparts advise and assist in planning and executing the main repairs of diesel engines and in introducing preventive maintenance of the same units. The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.
Qualifications:	Mechanical engineer with relevant experience in the maintenance and repair of diesel engines.
Language:	English
Background information:	The first cement plant in Turkey was set up at Darica, Istanbul, in 1911, with an annual capacity of 20,000 tons. This plant was expanded in 1923. Other factories and expansions followed in the period 1923 to 1960 where the installed capacity exceeded 2 million tons per year. Participating in the development and playing a role of growing importance since its establishment in 1953, the Turkish Cement Industry Corporation has a dominating position in the cement industry. The accelerated development of this industry is illustrated by the rapid doubling of both production and consumption. From about 2 million tons in 1960, 4 million was reached in 1966 and 8 million in 1972. The rapid growth of the cement industry in the past, and projected growth in the future, combined with the introduction of large and sophisticated plants with modern process control equipment, has not enabled the cement industry to train sufficient personnel to maintain and use the principles of modern production control in the factories. Process and plants are designed abroad and factories are erected and commissioned under the supervision of foreign experts. When local personnel continue operation after the guaranteed performance has been reached and plants are taken over, a deteriorating performance has been experienced. In particular, production size and economy have suffered because the instrumentation without proper maintenance has failed to record important production parameters. The results have been large, and incidental variations in production increase both fuel consumption and wear on equipment.

Annex II

RUSTON ENGINES

Repair parts situation (major components)

Part	Group 1		Group 2		Group 3	
	Days	Situation	Days	Situation	Days	Situation
Crankshaft	15	Istanbul	?	Remetallising required	45	In for remetallizing
Sump	0	Welded	75	Welding required in Istanbul	0	Welded
Damper	?	To England or in order	?	To England or in order	?	To England or in order
Turbo	45	Parts arriving	45	Parts arriving	45	Parts arriving
Crankcase	15	Istanbul reaming	?	To be checked	30	Istanbul reaming
Cylinder, heads	45	Parts arriving	45	To be checked	45	Parts arriving
Liners	0	In stock	0	In stock	0	In stock
Pistons	45	Arriving	?	To be checked	15	Using salvaged parts
Piston rings	45	Arriving	45	Arriving	45	Arriving
Gudgeon pins and connecting rods	0	In stock	0	In stock	0	In stock
Bearings	0	In stock	100	To order (L/C)	100	To order (L/C)
Camshaft bearings	45	Arriving	45	Arriving	45	Arriving
Camshaft and sprocket	0	Reusable	?	To be checked	0	Reusable
Chain	0	In stock	0	In stock	0	In stock
Oil pump	100	To order (L/C)	?	To be checked	100	To order (L/C)
Fuel pumps	45	Parts arriving	?	To be checked	45	Parts arriving

Part	Group 1		Group 2		Group 3	
	Days	Situation	Days	Situation	Days	Situation
Speed governor	0	Reusable	0	Reusable	0	Reusable
Injectors	100	To order (L/C)	?	To be checked	100	To order (L/C)
Water pump air starter	0	Reusable	0	Reusable	0	Reusable
Exhaust	100	To order (L/C)	100	To order (L/C)	100	To order (L/C)
Inter cooler	0	Reusable	?	To be checked	0	Reusable
Oil pump	100	To order (L/C)	100	To order (L/C)	100	To order (L/C)

Action recommended:

See order to Ruston

Letter to Holset

To: Ruston Diesels Ltd., England

Purchase order (air freight) by telex

Item	Part No.	Description	Quantity
1	9ATM-17210	Vibration damper	2
2	9ATCM-30220A	Oil pump, Varley DH.150	1
3	FAT-23015A	Injector, push rod	9
4	VLB-974	Injector, spring	9
5	61/58501027	Emergency shutdown solenoid 24 volts	3
6	61/58440013	Switch, lubrioating oil pressure	3
7	61/58440003	Switoh, camshaft lubricating oil pressure	3
8	61/58440073	Switoh, water temperature	3
9	ATM-66228	Mioro-switch, overspeed indioator	3
10	18AT-42059	Coupling, driven half	3
11	ATX-30046A	Coupling, centre	3
12	APC-31328B	Coupling, driver half	3
		Total	45

Note: Spare parts for engines type 9ATC Serial Nos. 547 /0600/1 and /3 coupled to AEI 1530 kW alternators operated by the Van Cement Co.,Van Turkey - Sets No 1 and 3. Please check suitability of parts and revise part Nos. accordingly.

Copy for Ruston Diesels Ltd.
Vulcan Works
Newton-Le-Willows
Merseyside WA12 8RU, England

Attention:
Mr. J.F. McGarvie
Service Manager (Industrial)

Messrs.
Holset Engineering Co. Ltd.
P.O. Box A9 Turnbridge
Huddersfield HD1 6FD,
England

Attention: Mr. M. Smyth
Technical Service Engineer
Damper and Transmission
Division

Van,

Dear Sirs,

Re: Ruston 9ATC engines with Holset torsional vibration dampers at Van Cement Works, Turkey

We wish to refer to our letter of 11 August 1976, ref. 12/11/63.

As recommended in your letter MS/PG of 29 June 1976, we have decided to have the two dampers overhauled at your Works and they are now being prepared for shipment to England from the Van Cement Plant.

Please arrange for pro forma invoices covering the costs for this job, in order to start the procedure for payment.

As requested, we hereby confirm the following data for your service records:

Damper No. 116352 hours 32319 Engine No. 5479/0600/1 Set No. 1

Damper No. 116351 hours 30538 Engine No. 5479/0600/1 Set No. 3.

We are meantime ordering two new vibration dampers from Messrs. Ruston Diesels Ltd., bringing the total up to three in order to fit them onto the 3 Ruston engines at the Van power station.

The overhauled dampers will be kept in stock for service exchange.

The damper currently fitted on Engine No. 5479/0600/2, Set No. 2 will also be sent to you for overhaul as soon as possible.

We would appreciate it very much if we could receive your prompt attention on this matter.

Yours faithfully.

Parts to be kept in stock
(approximately 3 years' operation)

Exchange major components for back-up and overhauls

Item	Part No.	Description	Quantity	Remarks
1	AT-10040	Cylinder head assembly complete with rocker	3	
2	AT-12241A/2	Sleeve cylinder liner	9	
3	AT-12242	Joint liner sleeve to cylinder block	9	
4	AT-12311D/1	Liner	9	
5	9AT 13611B	Sump	1	All three sumps cracked and welded
6	ATC-14010D	Piston assembly	9	
7	AT-14012/B/1	Gudgeon pin	9	
8	AT-14100B	Connecting rod assembly		
9	AT-15017	Sprocket, camshaft	1	
10	AT-17012	Sprocket, crankshaft	1	
11	9ATM-17210	Vibration damper	3	Use overhauled dampers back from Holset
12	FA2T-2000D	Fuel pump, complete	3	
13	FA2T-20080	Fuel pump tappet assembly	3	
14	1100G-01A	Governor base complete 1102/2G/15ABAC	1	
15	1100G 14A	Solenoid shutdown assembly	1	
16	1100G 16A	Speed control gear, motorized complete assembly	1	
17	AT-21217A	Gearwheel	1	
18	AT-21218A	Gearwheel, intermediate	1	
19	AT-21215A	Bevel gear	1	
20	AT-21219	Spindle, intermediate and bevel gear	1	
21	024701	Plugging, intermediate and bevel gear	1	

Item	Part No.	Description	Quantity	Remarks
22	029/30	Brush, spindle	1	
23	AT-2121 3A	Drive shaft	1	
24	AT-21216	Bevel gear, drive shaft	1	
25	029746	Brush, drive shaft	1	
26	FA2T/B-23003A	Injector, complete	3	
27	9ATC-30020B	Oil pump, varley DH150-STD ROTN	3	
28	AT-30511A	Body, camshaft lubricating oil pump	3	
29	AT-30512A	End cover, camshaft lubricating oil pump	3	
30	AT-30513A	Rotor, driver, camshaft lubricating oil pump	3	
31	AT-30514B	Rotor, driven camshaft lubricating oil pump	3	
32	AT-30515A	Sprocket, camshaft lubricating oil pump	3	
33	AT-30525A	Chain, camshaft lubricating oil pump No. 11046	3	
34	AT-37010	Filter, glacier CF218	6	
35	61/8700607	Turbocharger napier MS300	1	
36	61/87008003	Bellows expansion piece	3	
37	9AT-51000	Air starter distributor assembly	1	
38	VEB-77532	Pressure gauge, camshaft lubricating oil	3	
39	VEB-77512/1	Pressure gauge, engine oil	3	
40	VEB-77513/1	Pressure gauge, air boost	3	
41	VEB-77522	Pressure gauge, fuel	3	
42	61/77001027	Exhaust pyrometer	3	
43	APC-77011A	Thermocouple assembly	12	
44	APC-77011B	Thermocouple assembly	6	

Item	Part No.	Description	Quantity	Remarks
45	APC-77011C	Thermocouple assembly	6	
46	APC-77011D	Thermocouple assembly	3	
47	APC-77011E	Thermocouple assembly	12	
48	3613	Casing, turbine inlet napier MS300	1	
49	Order by title	Nozzle blades and ring	1	
50	3579	Bearing housing	1	
51	9ATC-46122A	Bellows expansion joint P.C. entry	1	
52	9ATC-46062	Joint-bellows expansion joint to P.C.	9	
53	3585	Resilient bearing	3	
54	3130	Ring nut	3	
55	31053	Retaining plate	1	
56	3168/1	Cover plate	1	
57	3615	Casing-turbine outlet	1	
58	3606	Plate seal	1	
59	Order by title	Diffuser	1	
60	3577	Shroud, cooling	1	
61	310272	Casing, compressor outlet, complete	1	
62	3601	Brush-oil seal	3	
63	3594	Bearing, resilient, assembly	3	
64	3130	Ring nut	3	
65	31052	Plate retaining	1	
66	Order by title	Rotor assembly, complete	1	
67	3616	Ball Bearing	6	
68	63310	Tubestack, intercooler	1	
69	61/42001005	Water pump, complete	3	Part number to be checked
70	18AT-42059	Coupling, driven half	3	
71	ATX-30046A	Couping, centre	3	

Item	Part No.	Description	Quantity	Remarks
72	APC-31323B	Couping, driver half	3	
73	61/5 440003	Switch, camshaft lubricating oil pressure	3	
74	61/53440073	Switch, water temperature	3	
75	61/53440013	Switch, lubricating oil pressure	3	
76	61/53501027	Emergency shutdown solenoid, 24 V	3	
77	ATM-66223	Micro-switch, overspeed indication	3	
78	017642	Indicator cock-maihak indicator	9	
79	AT-15213B	Jockey sprocket	6	
80	AT-15241C	Brush, steel, jockey sprocket	6	
81	AT-15214C	Pin, jockey sprocket	6	
82	AT-15228	Fulcrum piece, chain adjusting frame	1	
83	029760	Brush, fulcrum pin	6	
84	029758	Brush, fulcrum pin	6	
85	AT-15016B	Cam, fuel pump	3	
86	ATX-15015C	Cam, inlet and exhaust	3	

Note:

The list is tentative and should be modified according to past experience of parts flow.

Quantities should be checked against stock before purchasing order is issued.

Stock items, piping, wiring, joints and seals have not been considered. They should be added after considering existing stock.

A similar list should be established for generator, exciter, wiring and switchboard electrical and mechanical parts.

Components related to engine installation (air cleaner, fuel and water tanks, water-cooling system, fuel-heating equipment etc.) have not been considered in the list.

Initial stock should be replenished by regular stock purchase orders. Three or more times per year according to the desired inventory level and supplier lead time.

The components used for exchange should be replaced by salvaged ones overhauled with wear parts.

Maintenance wear parts

Item	Part No.	Description	Quantity	Remarks
1	AT-10017/1	Valve seat	200	Quantities based on (6) x 10,000 h Complete top overhauls less 10% approximately for all items
2	AT-10013B	Valve guide	200	
3	AT-10015	Tube, injector	50	
4	AT-10019	Joint ring, cylinder head to liner	50	
5	036732	Joint ring, water outlet	50	
6	AT-10063	Corrosion piece	100	Items 1 -25 cylinder head group
7	AT-10311C	Valve inlet	100	
8	AT-10346	Nimonic steel exhaust	100	
9	AT-10313	Valve spring, outer	100	Reduced quantity (50%)
10	AT 10312	Valve spring, inner	100	Reduced quantity (50%)
11	VEB-1117	Split cotter	200	
12	AT-10314	Collar, valve spring	100	
13	AT-10227A	Bridge piece	100	
14	AT-10229A	Adjusting screw	100	
15	AT-10271/1	Stem, bridge piece	100	
16	VK-841/2	Spring, bridge piece guide	50	
17	AT-10035C	Guide, bridge piece	100	
18	AT-10248/1	Fulcrum, rocker lever	50	
19	AT-10215	Distance piece, rocker lever	50	
20	AT-10257/1	Roller, rocker lever	100	
21	AT-10258A	Pin, rocker lever roller	100	
22	AT-10283	Brush, rocker lever roller	100	
23	029772	Brush, rocker lever fulcrum	100	
24	AT-10327A	CAD, exhaust valve	100	
25	VEB-10341	Spring clip, exhaust valve	100	
26	9AT-12124	Joint, cylinder block to crankcase	12	Crankcase and bearing group, items 26-30

ABSTRACT

At the request of the Government of Turkey to the United Nations Development Programme (UNDP), an expert in maintenance and repair of diesel engines was sent on a one-month mission to analyse problems occurring at the diesel electric power station of the Van Cement Plant in Van, East Turkey, The mission was part of the over-all project "Cement Development and Research Centre" (DP/TUR/72/03) that the United Nations Industrial Development Organization (UNIDO) is carrying out as executing agency for UNDP. The mission began on 29 September and ended on 28 October 1976. The expert was attached to the Cement Development and Research Centre.

The expert found that the problems originated in a combination of difficult operating conditions, overloading, insufficient supply of spare parts, incorrect maintenance procedures and lack of trained personnel. On the basis of his findings, he recommended further UNIDO assistance, to inolude:

Fellowships for local engineers

A mission of associate experts on diesel engine operation to assist in carrying out the recommendations

A follow-up mission of a senior diesel expert

A mission of a senior electrical expert to advise on power generation

During the mission the expert also visited two cement plants and advised on maintenance and on mechanioal problems.

Item	Part No.	Description	Quantity	Remarks
27	AT-13013	Joint, end cover to crankcase	12	
28	AT-13014/1	Oil catcher	12	
29	AT-17811C	Main bearing	50	
30	AT-17813	Thrust facing main bearing	130	
31	AT-12812	Joint ring, cylinder liner sleeve	150	Cylinder block and liners, items 31-35
32	AT-12229	Joint ring, cylinder block to cylinder head	40	
33	029405	Joint	5	
34	VEBM8129	Corrosion piece	15	
35	AT-12242	Joint liner sleeve	40	
36	9AT-13621	Joint, sump side	10	Sump, items 36-37
37	AT13622	Joint, sump end	10	
38	ATC-14010D	Piston assembly	27	Reduced quantity (50%)
39	500940	Circlip, gudgeon pin	100	
40	AT-14356	Spacer stud, gudgeon pin end plate	50	
41	AT-14012B/1	Gudgeon pin	27	Reduced quantity (50%)
42	AT-14014A	End plate, gudgeon pin	100	
43	036738	"O" ring, gudgeon pin end plate	100	
44	AT-14017A/1	Piston ring, square edged compression	100	Pistons and connecting rods, items 38-51
45	AT-14042	Piston ring, internal stepped scrapper	50	
46	504172	Piston ring, scraper	100	
47	AT-14115	S.G. brush, connecting rod	50	
48	AT-14114C	L.E. bearing (pairs)	50	
49	AT-14112A	Bolt, connecting rod, long	50	Reduced quantity (50%)
50	AT-14123A/1	Bolt, connecting rod, short	50	Reduced quantity (50%)
51	026306	Nut	100	Reduced quantity (50%)

Item	Part No.	Description	Quantity	Remarks
52	AT-16019/1	Bearing shell, top	50	Camshaft and drive parts, items 52-58
53	AT-16021	Bearing shell, bottom	50	
54	AT-16022A	Bearing shell, free end	10	
55	AT-16023	Bearing shell, drive end	10	
56	AT-16014A	Housing, bearing, bottom	50	
57	AT-16012A	Housing, bearing, top	50	
58	AT-15257	Reynolds chain - 144 pitches x 1.5"P	3	Reduced quantity (50%)
59	AT-17031	Oil thrower, flywheel end	5	Crankshaft parts, items 59-60
60	16AT-17031	Oil thrower	5	
61	AT-18332	Spacer-jockey sprocket spindle	10	Auxiliary chain drive parts, items 61-67
62	AT-18324A	Brush, jockey spindle spindle	10	
63	AT-18322A	Jockey sprocket, large	5	
64	AT-18321A	Jockey sprocket, small	5	
65	AT-18334	Chain-No. 114044	5	
66	AT-183158/1	Drive sprocket (two pumps)	5	
67	029770	Brush, drive sprooket	10	
68	FA2T-20010	Plunger and guide assembly	90	Fuel pump parts, items 68-89; overhaul every 5,000-6,000 hours
69	036733	"O" ring seal	180	
70	055004	Piston ring	90	
71	FA2T-20020A	Constant pressure unloading valve assembly	90	
72	FA2T-20048	Spring collar, top	90	
73	FA2T-20063	Outer spring	90	
74	FA2T-20064	Inner spring	90	
75	FA2T-20047	Spring collar, bottom	90	
76	FA2T-20104	Tappet, push rod	90	
77	FA2T-20065	Plunger operating pinion	40	Reduced quantity (50%)
78	NR4-55087	Graylook seal	180	

Item	Part No.	Description	Quantity	Remarks
79	036722	"O" ring seal	180	
80	FA2T-20066	Operating rack	40	Reduced quantity (50%)
81	FA2T-20093	Spring	40	Reduced quantity (50%)
82	F66-00197	Spring	90	
83	FA2T-20107P	Push rod guide	40	Reduced quantity (50%)
84	FA2T-20074P	Tappet guide	180	
85	FA2T-20067P	Tappet block	90	
86	FAO-20062P	Pin, tappet roller	90	
87	FAO-20045P	Brush, tappet roller	90	
88	FA2T-20046	Roller, tappet	90	
89	FAO-20106P	Nu-lip seal	90	
90	AT-22035AD	Pipe injector overflow	50	Fuel oil pipes, items 90-95
91	AT-22023C	Fuel injector pipe, pump injector	50	
92	AT-22346B/1	Flexible pipe, fuel pumps	90	
93	AT-22729/1	Pipe, free end cover to fuel pump	5	
94	6VM-2361	Washer	50	
95	AT-22731/1	Pipe, flexible, filter to filter cover	5	
96	F65-00251R	Needle and nozzle assembly	100	Injector parts, items 96-104; overhaul every 5,000-6,000 hours; injector body reduced quantity (10%)
97	FAT-23011B	Injector body	10	
98	FAT-23015A	Push rod	100	
99	VLB-0718	Spring stop	200	
100	VLB-974	Injector spring	100	
101	FYH-23025	Joint, overflow connexion	100	
102	FYH-23024	Overflow connexion	50	Reduced quantity (50%)
103	FAT-23070	Edge filter assembly	50	Reduced quantity (50%)

Item	Part No.	Description	Quantity	Remarks
104	FA-23012	Joint, injector to cylinder head	100	
105	C6323159	Element cartridge 61/24002040	120	Fuel oil filter parts, items 105-110
106	C6445054	Ring joint	120	
107	E66833	Body	3	Reduced quantity (10%)
108	DL-6315805	Plug valve	3	Reduced quantity (10%)
109	C62622/67	"O" ring seal	10	
110	C62622/42	"O" ring seal	10	
111	5362/1	Body, oil pump	3	Lubricating oil pumps and water pump parts, items 111-130; reduced quantity (50%)
112	5362/6	Rotor, oil pump	6	
113	5362/8	Spring guide, bypass	3	
114	5362/11	Spring bypass	3	
115	5362/12H	Valve, bypass	3	
116	5362/13B	Bearing disc	12	
117	5362/13A	Bearing housing	9	
118	5662/15	Mainshaft	3	
119	5362/16H1	Idler shaft	3	
120	5362/19	Outer race (Torrington HJ)	12	
121	5362/20	Inner race (Torrington IR)	12	
122	5362/21	Oil seal, seatrist	3	
123	5362/29	"O" ring	3	
124	5362/17	Thrust, washer	3	
125	3PO-327	Shaft	3	
126	SKF-6308	Bearing	6	
127	SC-50533	Flinger	3	
128	26600Z	Seal assembly	3	
129	029735	Brush rotor camshaft lubricating oil pump	12	
130	AT-31100E	Lubricating oil relief valve assembly	3	

Item	Part No.	Description	Quantity	Remarks
131	D6400169	Filter element assembly	12	Camshaft lubricating oil filter and main lubricating oil filter, items 131-132
132	C633162	Element cartridge	60	
133	9AT-51000	Air starter distributor assembly	3	Air starter parts, items 131-135
134	AT-51032A	Distributor valve	6	Assembly reduced quantity (50%)
135	VEB-3358	Distributor bush	6	
136	3578	Brush, turbine inlet casing	6	Pressure charger parts, items 136-171
137	3585	Resilient bearing group assembly	6	Overhaul every 8000 hours
138	31053	Cover oil pump	6	
139	3227	Cover oil pump	6	
140	31051	Plate oil collector	6	
141	3347/1	Cover plate, turbine end	6	Quantity reduced 50%
142	3579	Bearing housing	6	
143	Order by title	Diffuser	3	Quantity reduced 50%
144	3606	Plate seal	6	
145	3601	Brush, oil seal	6	
146	3594	Bearing resilient assembly	6	
147	31052	Plate retaining	6	
148	31050	Plate oil collector	6	
149	3227	Cover oil pump	6	
150	31067/1	Plate cover, complete	3	Quantity reduced 50%

Item	Part No.	Description	Quantity	Remarks
151	3329	Disc, oil pump	6	
152	3616	Ball bearing	10	
153	3331	Ring restrictor	6	
154	3646	Distance piece	6	
155	3648	Oil seal	6	
156	3071	Balancing washer	6	
157	3068	Ring nut	6	
158	3069	Lockwasher, ring nut	6	
159	3599	Washer, turbine adj.and rotor balancing	6	
160	3564	Cone locating, rear	6	
161	3653	Brush-cone, rear	6	
162	3655	Brush, split, rear	6	
163	3553/1	Impeller	3	Reduced quantity 50%
164	3652	Brush, split, front	6	
165	3651	Brush, cone, front	6	
166	3650	Cone, locating, front	6	
167	3649	Washer-impeller adj.	6	
168	3647	Oil seal	6	
169	3645	Distance piece	6	
170	3709	Shaft, subassembly	3	Reduced quantity 50%
171	61/77102005	Thermometer, intercooler	3	Reduced quantity 50%
172	61/20701094	Fuel pressure pump varley	3	Reduced quantity 50%
173	AT74200A	Crankshaft lifting gear	1	Tool
174	40067	Thermostatic valve amot	3	Accessory items 172-
175	1096X	Thermostat element assembly	6	
176	1182	Thermostat sleeve	6	
177	1183	Thermostat "O" ring	18	

Note: When ordering please specify:

Stock of spare parts for engines type 9ATC Serial Nos. 5479/0600/1, /2, /3 coupled to AEI 1530 kW alternators, operated by the Van Cement Co.; Van Turkey. Order No. 54/680028-30. Please check suitability of parts and revise part No. accordingly.

Annex III

DEUTZ ENGINES

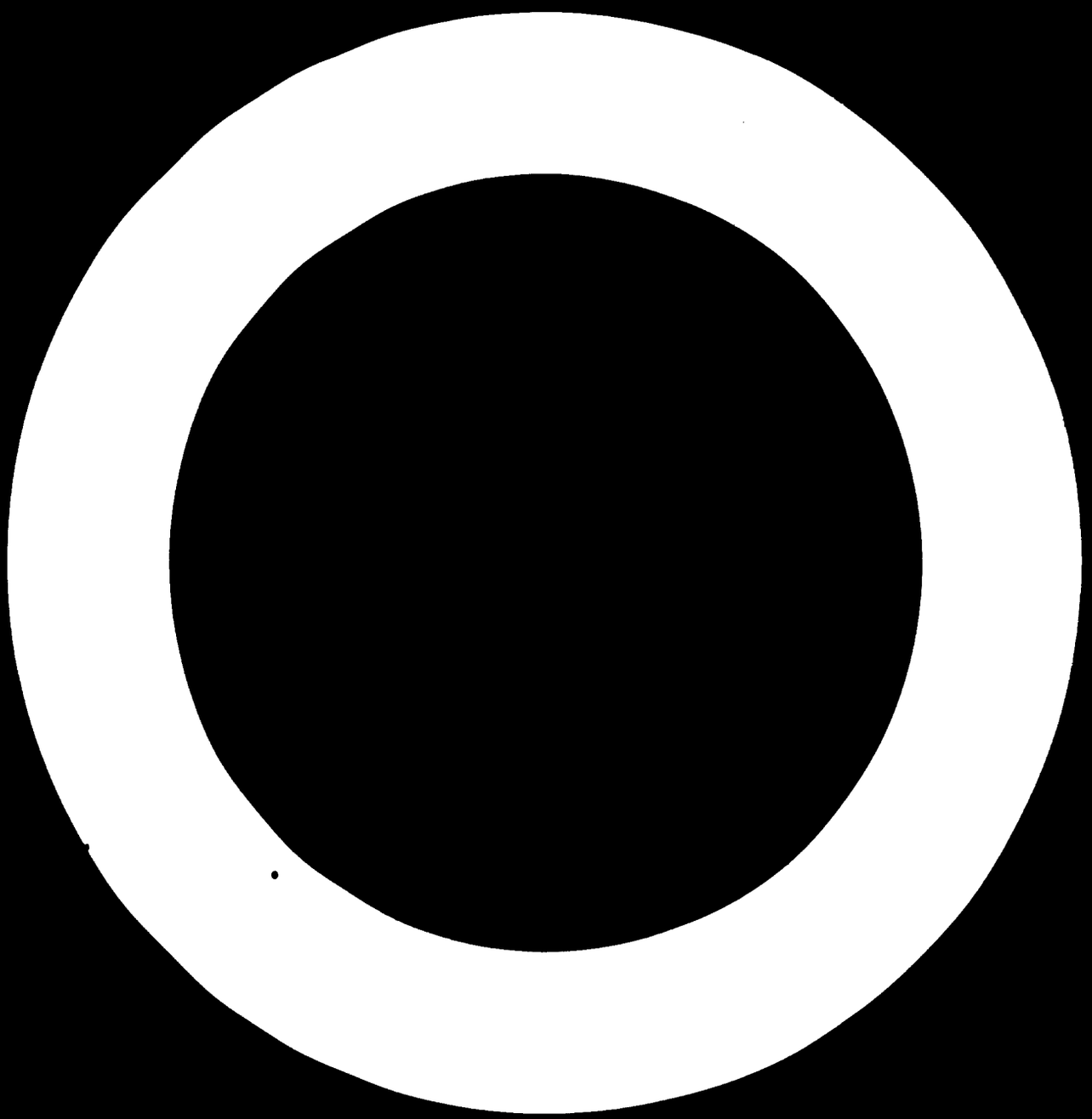
DEUTZ BV8M-545 Engines Serial Nos. 4530756/.757:
parts to be kept in stock for approximately 3 years' operation
(Exchange major components and maintenance wear parts)
(2 x 3 x 6,000 hours)

Item	Part No.	Description	Quantity	Remarks
1	01-114	OBERE LAGERSCHALE	60	MAIN BEARINGS
2	01-115	UNTERE LAGERSCHALE	60	
3	04-35	LAGERBUECHSE	2	GEAR TRAIN
4	04-86	LAGERBUECHSE	2	
5	05-4	ZYLINDERLAUFBUECHSE	8	LINER
6	05-2	DICHTUNGSRING, KUPFER	40	
7	05-3	RUNDGUMMIRING 3700x4	40	
8	05-5	RUNDGUMMIRING 3500x3	90	
9	06-21	KOLBEN 320Ø	20	PISTON
10	06-3	INNEN-SICHERUNGSRING 130x4	90	
11	06-4	KOLBENBOLZEN	20	
12	06-21	OELABSTREIFRING 320Ø	40	
13	06-22	KOLBENRING 320Ø	150	
14	06-7	OELABSTREIFSCHLITZRING 320Ø	40	
15	07-3	OBERE LAGERSCHALE	40	CONN.ROD
16	07-4	UNTERE LAGERSCHALE	40	
17	07-5	KOLBENBOLZENBUECHSE	20	
18	07-7	KRONENMUTTER MIT HALS W42x1/8	8	
19	07-8	PLEUELSTANGENSCHRAUBE W42x1/8	8	
20	08-2	ZYLINDERKOPF KOMPL.	2	CYL. HEAD
21	08-28	FUEHRUNGSBUCHSE	40	
22	08-73	INDIZIERVENTIL	24	
23	08-49	RUNDGUMMIRING 25Øx6	40	
24	08-54	THERMOMETER BE-H 780	40	
25	08-60	ASBEST-GRAPHIT-PACKUNG B4x6x180	40	
26	08-69	RUNDGUMMIRING 18Øx6	40	
27	09-31	UNGEK. EINSPRITZVENTIL	16	INJECTOR
28	09-37	SCHRAUBENFEDER	16	
29	09-38	BUECHSE MIT BRENNSTOFF NADEL	40	
30	09-39	DICHTRING A 38 x 44	40	
31	09-41	DUESE	40	
32	09-42	FEDERTELLER	16	
33	09-46	SCHEIBE 0.1 MM DICK	30	
34	09-47	SCHEIBE 0.2 MM DICK	30	
35	09-48	SCHEIBE 0.5 MM DICK	10	
36	09-49	DRUCKSCHRAUBE	16	
37	09-50	DICHTRING A 10 x 14	40	
38	09-52	SCHRAUBSTUTZEN	8	
39	10-31	ANLASSVENTIL	4	AIR STARTING VALVE
40	10-32	VENTILSPINDEL	4	

Item	Part No.	Description	Quantity	Remarks
41	10-33	FEDERTELLER	4	
42	10-34	SCHRAUBENFEDER	4	
43	10-49	KOLBENRING 52 x 2,5	24	
44	11-3	VENTILKEGEL FÜR EINLASSVENTIL	40	INTAKE AND EXHAUST
45	11-4	VENTILKEGEL FÜR AUSLASSVENTIL	40	VALVE
46	11-5	FUEHRUNGSBUCHSE	80	
47	11-7	SCHRAUBENFEDER	80	
48	11-8	FEDERTELLER	80	
49	11-9	INNEN-SICHERRUNGSRING 50x2	80	
50	11-10	GETEILTER KLEMMKEGEL	80	
51	12-9	ROLLENHEBEL	8	ROCKER LEVER AND PUSH RODS
52	12-10	DECKEL	4	
53	12-11	BLANKERSTELLRING B35	32	
54	12-12	DRUCKPFANNE	16	
55	12-13	DRUCKSCHRAUBE M 18 x 1,5	32	
56	12-14	SECHSKANTMUTTER M 18 x 1,5	32	
57	12-17	KUGELKOPF	32	
58	12-18	KUGELPFANNE	32	
59	12-19	SPRINGRING	32	
60	12-20	SCHWINGHEBEL FUER AUSLASS	4	
61	12-22	BOLZEN	4	
62	12-24	SCHWINGHEBEL FUER EINLASS	4	
63	12-25	SCHEIBE	8	
64	12-26	AUSSEN-SICHERUNGSRING 45x1,75	16	
65	12-27	LAGERBUCHSE	16	
66	12-28	RUNDGUMMIRING 40Ø x 4	32	
67	12-30	ACHSE	8	
68	12-32	BUCHSE	8	
69	12-33	BUCHSE	8	
70	12-35	NOCKENROLLE	16	
71	12-37	BOLZEN	16	
72	12-38	AUSSEN-SICHERUNGSRING 20x1.2	32	
73	12-39	DRUCKPFANNE	16	
74	12-41	DRUCKSTUCK	16	
75	12-42	STOSSSTANGE	8	
76	14-5	ZYLINDEROELER FUER 8 ZYL.	1	LINER LUBRICATION
77	14-13	STOPFBUCHSE	4	
78	14-14	MITNEHMER	11	
79	14-22	FUEHRUNG	1	
80	14-43	SCHRAUBENFEDER	2	
81	14-45	STOESSEL	2	
82	14-46	EXZENTER	2	
83	14-47	GEHÄUSE	1	
84	08-38	VENTILSITZ	40	
85	08-43	ZINKSTUECK	16	
86				

Item	Part No.	Description	Quantity	Remarks
87	16-59	SCHEIBENFEDER 8 x 13	16	FUEL PUMP DRIVE
88	16-60	SECHSKANT-DEHNSCHRAUBE M121	16	
89	16-61	SCHEIBE	16	
90	16-64	SECHSKANT-DEHNSCHRAUBE M20x1	16	
91	16-65	SCHEIBE	16	
92	16-66	SECHSKANT-MUTTER M20x1,5	48	
93	0117-293	EINSPRITZPUMPE 8 ZYL. LINKS	1	INJECTION PUMP AND
94	0117-295	ROLLENBOLZEN MIT STOPFEN	16	FUEL LIFT PUMP
95	0117-16	ZYLINDERROLLENLAGER	2	
96	0117-18	PENDELROLLENLAGER 21 313	2	
97	0117-19	ABSTANDROHR	2	
98	0117-20	SICHERUNGSRING 65 x 2,5	2	
99	0117-23	AUSGLEICHRING	2	
100	0117-27	ABDICHTRING A	2	
101	0117-28	ROLLENBUCHSE	16	
102	0117-45	FEDERTELLER	16	
103	0117-46	SCHRAUBENFEDER	16	
104	0117-47	FEDERTELLER	16	
105	0117-141	ÖLSCHMIERPUMPE	2	
106	0117-155	UEBERDRUCKVENTIL	1	
107	0117-219	SCHMIERÖLFILTEREINSATZ	2	
108	0117-220	DECKELDICHTUNG	2	
109	0117-275	SIEBFILTER	2	
110	0117-278	NOCKENROLLE	2	
111	0117-279	BOLZEN	2	
112	0117-301	EINSTECKELEMENT LM	16	
113	0117-58	AUSGLEICHSCHEIBE 0.25 MM	8	
114	0117-61	DRUCKSCHRAUBE	8	
115	0120-B-2	ANTRIEB FÜR 1 KRAFTSTOFF-FÖRD.P.	2	
116	0120-B-27	KRAFTSTOFF-FÖRDERPUMPE	2	
117	0120-B-106	SAUG-UND DRUCK VENTIL	10	
118	0120-B-119	VORPUMPE	2	
119	0120-B-138	ZAHNRAD MIT WELLE	2	
120	0120-B-141	ZAHNRAD MIT WELLE	2	
121	0117-208	RUNDGUMMIRING	40	
122	0117-209	RUNDGUMMIRING	40	
123	18-2	DRUCKLUFT-ANLASSSTEUERUNG 8 ZYL.	1	AIR STARTING DISTRIBUTOR
124	18-3	BUCHSE	8	
125	18-7	FEDERRING	8	
126	18-8	SCHRAUBENFEDER	8	
127	19-13	ROHRBUENDEL	1	OIL COOLER
128	19-9	RUNDGUMMIRING 180Øx8	16	
129	19-23	RUNDGUMMIRING 22Øx4	8	
130				

Item	Part No.	Description	Quantity	Remarks
131	21-36	KRAFTSTOFF-DOPPELFILTER	1	DUPLEX FUEL FILTERS
132	21-39	FILTEREINSATZ	40	
133	21-41	UEBERSTROMVENTIL	2	
134	21-44	ANSCHLUSSSTUECK	4	
135	21-45	HOHLSCHRAUBE A13	4	
136	22-43	RUECKSCHLAGVENTIL	1	OIL SYSTEM AND SWITCHES
137	22-1	MISCHHAHN	1	
138	22-10	RUNDGUMMIRING 18 x 0.4	4	
139	22-51	SCHMIEROEL-DOPPELFILTER	1	
140	22-54	AUSSERER SIEBKÖRPER F.SCHM.	36	
141	22-55	INNERER SIEBKÖRPER FÜR SCHMIER.	36	
142	22-70	ASBEST-GRAPHIT-PACKUNG B 5x7x. 500	2	
143	22-71	GRUNDRING	2	
144	22-25	OLDRUCKREGULIERVENTIL	1	
145	22-92	ROHRLEITUNG	1	
146	22-106	ZYLINDERSCHRAUBE AM6x8	4	
147	22-107	FEDERRING B6	4	
148	22-108	SCHMIERÖL-DRUCKWAECHTER	2	
149	22-114	WARNANLAGE-ENDUMSCHALTER	2	
150	51-9	ANTRIEBSLAGER	2	CAMSHAFT
151	51-26	SCHEIBE	2	
152	51-51	KUPPLUNGSFLANSCH	2	
153	51-53	OBERE LAGERSCHALE	14	
154	51-57	DRUCKRINGHAELFTE	4	
155	51-58	OBERE LAGERSCHALE	2	
156	51-59	UNTERE LAGERSCHALE	14	
157	51-60	UNTERE LAGERSCHALE	2	
158	52-1	DREHZAHL-REGLER	1	SPEED GOVERNOR
159	52-19	SCHEIBE	1	
160	52-20	REIBSCHEIBE	1	
161	52-23	RILLENKUGELLAGER 6310	1	
162	52-24	REIBSCHEIBE	1	
163	52-37	SCHWUNGKÖRPER	1	
164	52-38	DRUCKSTUECK	1	
165	52-39	FEDERTELLER	1	
166	52-29	AXIAL-RILLENKUGELLAGER 51406	1	
167	52-15	ZYLINDERROLLENLAGER NL45	1	
168	52-53	ROLLENKUGELLAGER 5303	1	
169	52-55	DRUCKTELLER	1	
170	52-57	BUCHSE	1	
171	52-112	ABSTELL-HUBMAGNET	2	
172	55-1	ZAHNRAD-EINFACHPUMPE	2	OIL PUMP
173	55-2	ANTRIEBSWELLE	2	
174	55-4	LAGERBUCHSE	2	
175	55-6	LAGEREINSATZ	2	



Item	Part No.	Description	Quantity	Remarks
176	55-8	LAGERBUCHSE	2	
177	55-10	LAUFWELLE	2	
178	55-11	LAGERBUCHSE	2	
179	55-12	LAGERBUCHSE	2	
180	55-15	VENTILEINSATZ	2	
181	55-16	VENTILFEDER	2	
182	55-17	VENTILKEGEL	2	
183	58-151	KUEL WASSER-KREISEL PUMPE	1	WATER PUMP
184	58-166	LAUFRAD	2	
185	58-167	SCHLEISSRING	4	
	58-170	RING	2	
186	58-171	HUTMUTTER M 14 x 1.5	2	
187	58-174	GLEITRING-DICHTUNG	2	
188	58-181	RUNDFLANSCHDICHTUNG	2	
189	58-183	ABDICHTRING A 30 x 52	2	
190	58-188	HOCHSCHULTER-KUGELLAGER 6205	2	
191	58-189	WELLE	2	
192	58-190	SECHSKANTMUTTER M 32 x 1,5	2	
193	58-192	RITZEL	2	
194	58-193	HOCHSCHULTER-KUGELLAGER 6206	2	
195	58-197	DECKEL	2	
196	05-6	DICHTRING WEICHEISEN	16	MODIFIED PARTS CYLINDER LINER
197	05-7	BEILAGERING KUPFER	16	
198	0159-3	ZWOELFKANT-STECKSCHLUESSEL SW19	1	INJECTION PUMP TOOLS
199	0159-6	RINGSCHLUESSEL	1	
200	0159-7	SPANNVORRICHTUNG FUR SCHRAUBENF.	1	
201	0159-14	VORPUMPHEBEL	2	
202	0159-25	EIN-UND AUSBAUVORRICHTUNG F. ROLLENB.	1	
203	0159-39	STECKSCHLÜSSEL F. FÜLLUNGS.	1	
204	0159-43	SPANNVORRICHTUNG F. EINSTECKEL.	1	
205	0159-6-44	EIN-UND AUSBAUVORRICHTUNG	1	
206	59-831	ANFAHRSTEUERVENTIL	1	STARTING VALVE CONTROL
207	59-832	VENTIL	2	
208	63-60	RINGSCHRAUBE R 5/8	1	TOOLS
209	63-61	STECKSCHLÜSSEL	1	
210	63-63	MITNEHMERSTIFT	1	
211	63-65	BÜGEL	1	
212	63-75	AUSBAUVORRICHTUNG F. ZYLIND.	1	
213	63-90	AUSBAUVORRICHTUNG F. EINSPRITZV.	1	
214	63-95	ZIEHVORRICHTUNG F. BÜCHSE U.N.	1	
215	63-151	ABZIEHVORRICHTUNG F. SCH.	1	
216	66-1	SCHWINGUNGSDÄMPFER MIT KREUZSCH.	1	VIBRATION DAMPER
217	66-2	SCHRAUBENFEDER	16	
218	66-3	SCHRAUBENFEDER	16	
219	66-4	KREUZSCHEIBE	2	

Item	Part No.	Description	Quantity	Remarks
220	65-10	REIBBELAG	15	
221	65-11	ZYLINDERNIETE D5x20	144	
222	65-12	GLEITPLATTE	3	
223	65-13	MITNEHMER	3	
224	83-1	DREHZAHLVERSTELLUNG M.EL.ANTRIEB	1	ELECTRICAL SPEED CONTROL
225	83-23	DREHSTROM-MOTOR	1	
226	83-53	ENDLAGENSCHALTER	1	
227	85-5	AUSPUFFTEMPERATUR-MESSSTUTZEN	15	EXHAUST MANIFOLD
228	85-6	KUGELAUSGLEICHER HINTER LADER	2	
229	85-8	AUSGLEICHER ZW.DEM AUSPUFFROHR	3	
230	85-9	AUSGLEICHER ZW.AUSPUFF. U.LADER	3	
231	85-39	VERDICHTUNGSRING A140 x 4	36	
232	85-41	DICHTUNG	32	
233	85-29	DICHTUNG	32	
234	85-51	DICHTUNG	4	
235	85-66	ZWISCHENFLANSCH	2	
236	85-67	RUNDFLANSCH-DICHTUNG	4	
237	85-82	DICHTUNG	3	
238	85-84	FLANSCH	8	
239	85-140	THERMOMETER	4	AIR COOLER
240	85-206	MANOMETER	2	
241	85-204	ROHRLEITUNG M. ANSCHL.T.	2	
242	85-216	MANOMETER-ABSPERRVENTIL	2	
243	85-169	RUNDGUMMIRING 18Øx8	8	
244	85-130	ROHRBÜNDEL	1	
245	85-364	FILTERKORB	1	TURBO AIR FILTER
246	85-366	SPANN-VERSCHLUSS	9	
247	85-367	GELOCHTES BLECH	3	
248	85-368	FILTERMATTE	12	
249	21-220	SATZ EINSPRITZLEITUNGEN	2	
250	21-227	EINSPRITZLEITUNG WINKEL-ANSCH.	16	
251	21-233	WINKELSTUTZEN	8	
252	21-237	DURCHGANGSSTUTZEN	8	

Note: When ordering specify:

Stock of spare parts for engines type BV8M545 Serial Nos. 4.530.756 and 4.530.757 coupled to Siemens VFM 49/15-14 generators (Anlage Urfa) with Brown-Boveri VTF320 turbochargers.

Please check suitability of parts and revise accordingly (spare parts catalogue D-7758-3 Band II, 3.Auglage and Anhang Seite 513 bis 728)

Note: The lists are tentative and should be modified according to experience.

Engine installation items and electrical components have not been considered.

Initial stock should be controlled regularly and purchase orders issued quarterly or more frequently according to the desired inventory level and supplied lead time.

Updated parts catalogues should be ordered from Deutz, in English language (see telex proposal below).

Turbocharger parts and tools have not been considered, since stock is available.

Tools for Deutz repairs are included in the order for stock.

To Klöckner-Humboldt-Deutz, Federal Republic of Germany

Purchase order (air freight) by telex

Emergency spares for maintenance

Item	Part No.	Description	Quantity
1	05-2	Dichtungsring, Kupfer	8
2	05-3	Rundgummiring 370Ø x 4	16
3	05-5	Rundgummiring 350Ø x 8	32
4	06-23	Verdichtungsring	32
5	06-22	Verdichtungsring	8
6	06-7	Oelschlitzring	8
7	09-31	Ungekuehltes Einspritzventil	14
8	09-41	Duese	16
9	0117-301	Einsteckelement, LM	4
10	21-39	Filtereinsatz	4
11	22-54	Aeusserer Siebkörper	4
12	22-55	Innerer Siebkörper	4
13	55-1	Zahnrad-Einfachpumpe	1
14	0117-275	Siebfilter	2
15	0117-208	Rundgummiring	8
16	0117-209	Rundgummiring	8

Note: Maintenance parts for BV8M545 Serial Nos. 4.530.756 and 4.530.757 coupled to Siemens VFM 490/15-14 Anlage Urfa.

Spare parts catalogue D 7758-3 Band II 3. Auflage and Anhang.

Please check if part Nos. are correct.

Telex to
KLÖCKNER HUMBOLDT DEUTZ AG.
5 KÖLN - DEUTZ 1
Post Box 440
KUD-ABTEILUNG

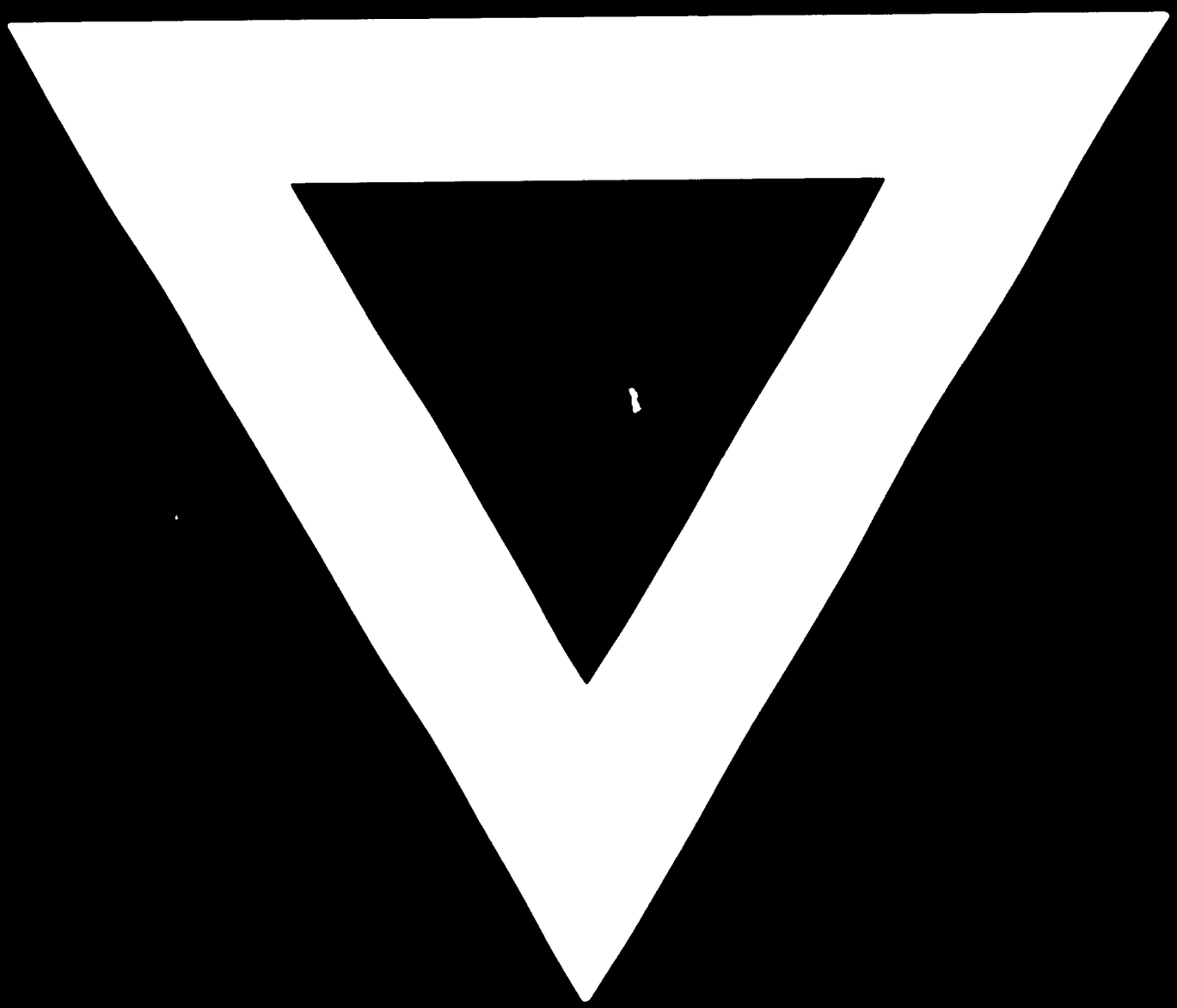
Telex No. 08/873 311
Cable: DEUTZMOTOR KÖLN

We operate BV8M545 engines Serial Nos. 4.530.756 and 4.530.757 coupled to Siemens VFM 490/19-14 alternators.

Please airmail updated spare parts list 7753-3 in English enabling correct ordering - regards

VAN CIMENTO FABRIKASI
VAN-TURKEY

G-331



77.09.23

CONTENTS

INTRODUCTION

The Turkish Cement Industry Corporation (Türkiye Cimento Sanayii - TCS) plays a leading role in the cement industry in Turkey and has various plants throughout the country. The rapid growth of cement production resulting from an ever-increasing demand experienced up to now and projected for the future has led to the introduction of large, modern plants designed and built abroad, most of which are being installed and started-up initially under the supervision of foreign specialists.

This expansion of capacity and technological increase have not been accompanied by equivalent progress in training an adequate number of local technicians in the most advanced methods of use and maintenance of the facilities. As a consequence, production has often been undependable, and the installations have deteriorated when the factories have been taken over by local personnel.

To improve this situation, the Government of Turkey requested the assistance of the United Nations Industrial Development Organization (UNIDO) for the Turkish cement industry.

A comprehensive project was worked out in co-operation with TCS. UNIDO is currently assisting Turkish counterparts in establishing a cement research and development centre that will have as its primary objective the training of local engineers in various fields of operation, process control and plant maintenance and the introduction of the most modern systems and equipment. UNIDO is carrying out this project (DP/TUR/72/03) as executing agency for UNDP. A full-time UNIDO project co-ordinator and UNIDO experts on short-term missions provide supporting services for the project.

The construction of impressive facilities in the outskirts of Ankara, which started in April 1976, is now in its last stages. According to schedule, construction is expected to be finished early in 1977, while a full-scale, sophisticated range of process-control equipment is ready to be installed, thanks to bilateral aid.

The technical assistance mission to the diesel electrical power station at the Van Cement Plant (Van Cimento Fabrikasi Müdürlügü) was planned as a supplementary field activity within the framework of the cement development and research centre project with the specific objective of assisting the Van plant to overcome a severe power shortage.

The Van Cement Plant is one of the 14 factories that form the TCS Group. It is located in the eastern part of Turkey, bordering on Iran. The region is a plateau, 1,700 m above sea level, with severe climatic conditions, a scarce population and no industrial centres. In the heart of the region lies the biggest lake in Turkey. Road communications with the main industrial and commercial points have been very poor in the past. Ankara is over 1,200 km away.

In the last few years, however, because of the booming trade between Iran and western Europe, Van has become the transit point for most of the shipments to Iran, especially since overland container links have been established at the Turkish Mediterranean ports. Co-operation between Turkey and Iran has recently brought about significant improvements in means of communications such as the ferry service across the Van lake connecting the terminal railway station of Tatvan with Van and a new railway line across the border from Van to Teheran, linking Iran to Western Anatolia and the Mediterranean. Thus, the prospects for the development of this region appear to be good, and the demand for cement and capital goods has increased significantly. The local cement production has, moreover, a substantial potential for export to the nearby markets of Iran and Iraq.

The Van plant started operations in 1969 with a planned maximum capacity of 650 tons/day, using the dry process. Most of the equipment was manufactured in the Federal Republic of Germany.

Electric power in the region is in short supply and is not connected with the rest of the country. The plant cannot, therefore, be supplied by the public network. The Turkish Electricity Board (TEK) operated a small hydroelectric power plant only at Van with a limited output, especially during the summer, when part of the water flow is diverted for irrigation.

An independent power station was designed for the cement plant, to be operated by the plant's own personnel, and consisting originally of three diesel-electric power units. Throughout the years the performance of the power station has deteriorated sharply with recurrent cut-offs that lead finally to a permanent shortage of power.

Additional power was therefore requested from the TEK hydroelectric plant, and two additional diesel-electric power units of a different make were installed in the power station early in 1976, while TEK transferred two 1,200 kW gas turbine mobile power units mounted on trailers to the cement plant.

The failure of one of the turbines and further troubles with the diesel engines have, however, produced an energy crisis, and TSC requested that a UNIDO diesel expert be sent to assist the Van plant engineers in planning corrective measures to ensure a reliable and economic power supply.

Owing to the short duration of the mission and to the lack of spare parts and tooling, no practical improvements could be achieved on site apart from the on-the-spot training of the diesel engine operators and maintenance team.

The problems related to the diesel engines are interconnected with those pertaining to the generators, the switchboard and the power lines, the factory load cycle, the financial and organizational restrictions and with the manpower situation.

During the mission the expert also visited two cement plants and advised on maintenance and on mechanical problems.

I. FINDINGS

Description of existing facilities

An outline of existing facilities is given below.

Diesel-electric groups

A. Three Ruston 9ATC diesel engines Serial Nos. 5479/0600/1, -/2, -/3; built in 1966; reference rating, 1,200 kW at 600 rpm; hours of operation, approximately 30,000 each.

Characteristics: nine cylinders, four-stroke cycle, direct injection, pressure intake air charging by exhaust gas turbocharger NAPIER HP 300 and aftercooling with Serk heat exchanger.

Fueling: No. 5/6 heavy fuel, previously heated, filtered and fed by an electrically driven transfer pump and pressure hot tank.

Dual water-cooling system: raw water with external rain-type cooling tower and separate electrically driven centrifugal booster pump; circulating water system with Serk heat exchanger and centrifugal pump with engine gear drive.

Lubrication through gear-case-driven gear pump with dual element-type filters and Serk cooler in the circulating water system. Lubricant used: Mobil Delvac H30 MIL 12104 B. Separate lubricating pump for camshaft.

Camshaft driven by chain, directly activating the valve mechanism and the individual injection pumps. Four-valve cylinder heads.

Starting by compressed air.

Controlled by flyweight hydraulic speed controller 1102-26-15ABAC of Regulator Europe with electrical control motor and magnetic shutdown.

Automatic safety switches to prevent low pressure of lubricating oil on engine and camshaft, excessive cylinder-head water temperature and overspeed.

Air Maze LP 60 oil-bath air cleaner located outside the machinery room.

Alternator: AEI five poles, 1,530 kW, directly coupled with on-line external exciter.

B. Two Deutz BV8M 545 diesel engines, Serial Nos. 4.530.756 -.757; built in 1966; reference rating (estimated), 900 kW at 428 rpm; hours of operation after last general overhaul, 3,500 and 700 hours.