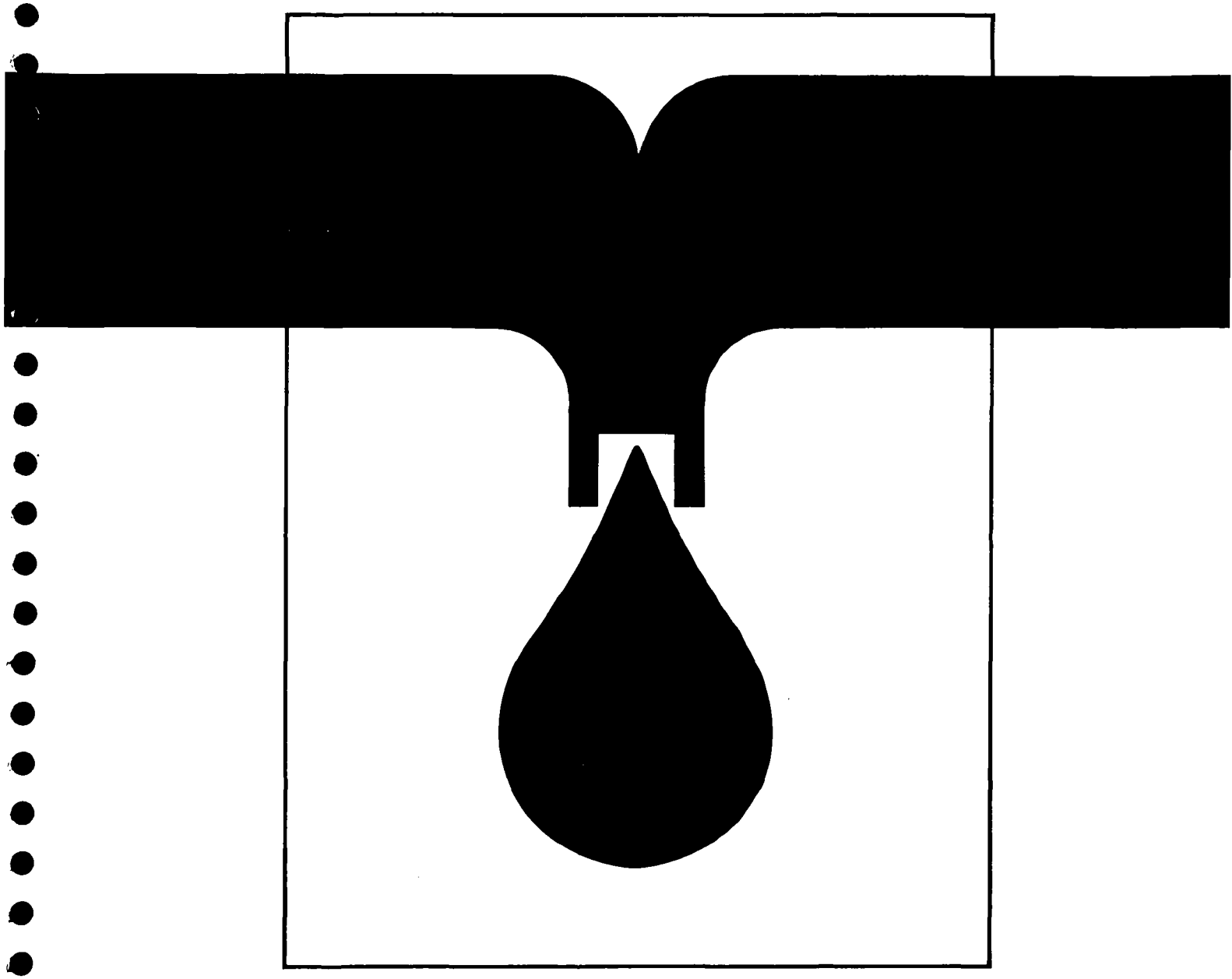
TRAINING MODULES
FOR
WATERWORKS PERSONNEL



Special Skills

3.3 d

Design and working principle
of power transmission mechanisms

Foreword

Even the greatest optimists are no longer sure that the goals of the UN "International Drinking Water Supply and Sanitation Decade", set in 1977 in Mar del Plata, can be achieved by 1990. High population growth in the Third World combined with stagnating financial and personnel resources have led to modifications to the strategies in cooperation with developing countries. A reorientation process has commenced which can be characterized by the following catchwords:

- use of appropriate, simple and – if possible – low-cost technologies,
- lowering of excessively high water-supply and disposal standards,
- priority to optimal operation and maintenance, rather than new investments,
- emphasis on institution-building and human resources development.

Our training modules are an effort to translate the last two strategies into practice. Experience has shown that a standardized training system for waterworks personnel in developing countries does not meet our partners' varying individual needs. But to prepare specific documents for each new project or compile them anew from existing materials on hand cannot be justified from the economic viewpoint. We have therefore opted for a flexible system of training modules which can be combined to suit the situation and needs of the target group in each case, and thus put existing personnel in a position to optimally maintain and operate the plant.

The modules will primarily be used as guidelines and basic training aids by GTZ staff and GTZ consultants in institution-building and operation and maintenance projects. In the medium term, however, they could be used by local instructors, trainers, plant managers and operating personnel in their daily work, as check lists and working instructions.

45 modules are presently available, each covering subject-specific knowledge and skills required in individual areas of waterworks operations, preventive maintenance and repair. Different combinations of modules will be required for classroom work, exercises, and practical application, to suit in each case the type of project, size of plant and the previous qualifications and practical experience of potential users.

Practical day-to-day use will of course generate hints on how to supplement or modify the texts. In other words: this edition is by no means a finalized version. We hope to receive your critical comments on the modules so that they can be optimized over the course of time.

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It is my sincere wish that these training modules will be put to successful use and will thus support world-wide efforts in improving water supply and raising living standards.

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Eschborn, May 1987

Title: Power transmission mechanisms

Table of contents:

		Page
1.	Introduction	1
2.	Operation and maintenance of actuators for valves and fittings	1
3.	Maintenance of slider-crank mechanisms	2
4.	Maintenance of belt drives	2
5.	Gear mechanisms	4
6.	Accessories - clutches	5

1. Introduction

Mechanisms are made up of moving parts. The ratio of the drive forces is either reduced or increased, while the direction of drive varies according to the type of mechanism. The material also differs from one unit to another.

Almost all mechanisms, however, have one thing in common: They must be serviced and lubricated at regular intervals.

It is of the utmost importance that a check be kept on wearing parts. These must be replaced in good time, since otherwise the whole mechanism can be damaged (e.g. if a gear breaks). It is also important to use the type of transmission oil or grease specified by the manufacturer, as the viscosity is matched to the play in the mechanism.

2. Operation and maintenance of actuators for valves and fittings

Actuators for valves and fittings must be operated regularly during periods when they are not in service.

A check should be made at the same time to determine whether relubrication is necessary. In order to disassemble an actuator (Fig. 13, Module 2.3.d), the handwheel and the switchbox cover must be removed.

Acid-free grease must be used for relubrication. The condition of the limit switches and counter wheels should be checked at the same time.

Before removing the actuator from the shutoff device, it is advisable to move the entire control device into one of the end positions; this facilitates reassembly after inspection.

In the case of electric actuators the operating instructions and an exploded-view drawing of the mechanism must be available at the waterworks.

3. Maintenance of slider-crank mechanisms

Slider-crank mechanism must be lubricated regularly, as they transform rotary motion into linear motion (see Fig. 15, Module 2.3.d).

The crankshaft must be regularly supplied with hydraulic oil via special oil ducts to ensure that the vrosshead does not overheat in the vicinity of the bearings, which are generally made of red brass.

The crosshead guideway must be inspected at regular intervals, particularly if the piston pumps have pressure-feed oil lubrication. Such lubrication systems can function only if the ducts provided for the oil circuit and oil discharge are cleaned regularly.

In some types of slider-crank mechanism the crankshaft runs in oil. In the case of such designs the oil must be changed regularly and the entire oil pan cleaned before the new oil is poured in.

Particular attention should be paid to the seals in a slider-crank mechanism. These are subject to extreme wear and must be replaced in good time in order to prevent lubricant losses and penetration of lubricant into the drinking-water area.

4. Maintenance of belt drives

A particularly careful watch must be kept on belt drives so that excessive belt slip can be avoided (see Fig. 16, Module 2.3.d).

The shafts of the driving and driven pulleys can be adjusted by means of locking bolts. This maintenance operation must be performed regularly. The belt is simultaneously to be inspected for damage and a new belt fitted in good time.

When a new belt is being fitted, attention must be paid to the direction of running. The approximate elongation figure of 1 - 3 % must be observed as regards the belt length.

Furthermore, the alignment of the pulley shafts must be checked to ensure that they are parallel before a new belt is fitted. A variety of devices are used for fitting a new belt.

- In the case of mainly long distances between shafts
Split pulleys: One half of the pulley is removed and the other half secured on the shaft by means of a clamp. The sharp edges are covered with a protective material (cardboard, rubber, sheet metal or similar). The belt is fitted, the pulley half rotated through 180°, the protective material and the clamp removed and the pulley reassembled.

Solid pulleys: The belt is placed on the small pulley. A rounded-off bard or similar, which is supported against the shaft with another bord, is placed on the large pulley below the deviation point. The belt is then attached to the large pulley with a cord. The belt must be protected against damage at the attachment point by inserting cardboard, rubber or similar.

- In the case of mainly short distances between shafts
Eccentric tensioning device: The pulley equipped with an eccentric is moved towards the other pulley, by means of radial swivelling, such that the belt, pretensioned on the basis of operational factors, can be fitted without tension. When the pulley is swivelled back through 180° the pretension is drawn out.

Tensioning device with turnbuckle: The belt, pretensioned on the basis of operational factors, is placed over the removed pulleys free of tension. With the aid of the tensioning device (corresponding to the load imposed by one or more turnbuckles) the pulleys are moved away from each other until the precise distance between the shafts is reached.

Adhesive pastes are available from the various belt manufacturers to prevent noise (whistling). It should be borne in mind, however, that noise is generally causes by inadequate belt tension and the resultant belt slip.

Automatic belt tensioning rollers are useful; they reduce maintenance work in the long term and improve efficiency.

By changing the weight or spring force these tensioning rollers can be easily adjusted, with the belt material being saved from wear at the same time.

5. Gear mechanisms

The gear flages must have a continuous film of grease or oil, particularly at high speeds.

Gear housings are often filled with oil and are fitted with a sight glass so that it can be seen when more lubricant is required.

It is therefore important to top up the oil via the opening provided for this purpose and to change the oil regularly in accordance with the manufacturer's specifications.

The abraded particles accumulating in the course of time are also removed only when a complete oil change is carried out and the gear mechanism subsequently cleaned.

It is also important to keep a check on the play in the longitudinal and transverse directions in a gear mechanism. The ball bearings must also be included in the maintenance work.

As a rule, however, it is sufficient to change the grease regularly and to remove the abraded particles.
The temperature of the gear mechanism must also be checked during operation. An increased operating temperature exceeding 60°C generally indicates overloading or a fault in the mechanism. A shortage of lubricant may also lead to increased temperatures.
Oil changes must be carried out while the mechanism is warm, i.e. shortly after it has ceased operation.

This should be carried out after every 5000 hours of operation; however, the interval should not be longer than 18 months.

6. Accessories - clutches

Clutches are also subject to a certain amount of wear and must be inspected at regular intervals. Particular attention is to be paid to the flexible components.

Torque peaks many times greater than the normal torque can occur during start-up and connection.

Clutches are often also fitted with overload protection.

It is advisable to replace wearing parts at regular intervals before major damage is done to the mechanism or anything else.

When performing maintenance work it is particularly important to refit the clutch guard, as this will help to protect the user.

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The government-owned GTZ operates in the field of Technical Cooperation. Some 4,500 German experts are working together with partners from some 100 countries in Africa, Asia and Latin America in projects covering practically every sector of agriculture, forestry, economic development, social services and institutional and physical infrastructure. – The GTZ is commissioned to do this work by the Government of the Federal Republic of Germany and by other national and international organizations.

GTZ activities encompass:

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- provision of materials and equipment for projects, planning work, selection, purchasing and shipment to the developing countries
- management of all financial obligations to the partnercountry.

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TRAINING MODULES FOR WATERWORKS PERSONNEL

List of training modules:

Basic Knowledge

0.1 Basic and applied arithmetic
0.2 Basic concepts of physics
0.3 Basic concepts of water chemistry
0.4 Basic principles of water transport
1.1 The function and technical composition of a watersupply system
1.2 Organisation and administration of waterworks

Special Knowledge

2.1 Engineering, building and auxiliary materials
2.2 Hygienic standards of drinking water
2.3a Maintenance and repair of diesel engines and petrol engines
2.3b Maintenance and repair of electric motors
2.3c Maintenance and repair of simple driven systems
2.3d Design, functioning, operation, maintenance and repair of power transmission mechanisms
2.3e Maintenance and repair of pumps
2.3f Maintenance and repair of blowers and compressors
2.3g Design, functioning, operation, maintenance and repair of pipe fittings
2.3h Design, functioning, operation, maintenance and repair of hoisting gear
2.3i Maintenance and repair of electrical motor controls and protective equipment
2.4 Process control and instrumentation
2.5 Principal components of water-treatment systems (definition and description)
2.6 Pipe laying procedures and testing of water mains
2.7 General operation of water main systems
2.8 Construction of water supply units
2.9 Maintenance of water supply units Principles and general procedures
2.10 Industrial safety and accident prevention
2.11 Simple surveying and technical drawing

Special Skills

3.1 Basic skills in workshop technology
3.2 Performance of simple water analysis
3.3a Design and working principles of diesel engines and petrol engines
3.3b Design and working principles of electric motors
3.3c –
3.3d Design and working principle of power transmission mechanisms
3.3e Installation, operation, maintenance and repair of pumps
3.3f Handling, maintenance and repair of blowers and compressors
3.3g Handling, maintenance and repair of pipe fittings
3.3h Handling, maintenance and repair of hoisting gear
3.3i Servicing and maintaining electrical equipment
3.4 Servicing and maintaining process controls and instrumentation
3.5 Water-treatment systems: construction and operation of principal components: Part I - Part II
3.6 Pipe-laying procedures and testing of water mains
3.7 Inspection, maintenance and repair of water mains
3.8a Construction in concrete and masonry
3.8b Installation of appurtenances
3.9 Maintenance of water supply units Inspection and action guide
3.10 –
3.11 Simple surveying and drawing work

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