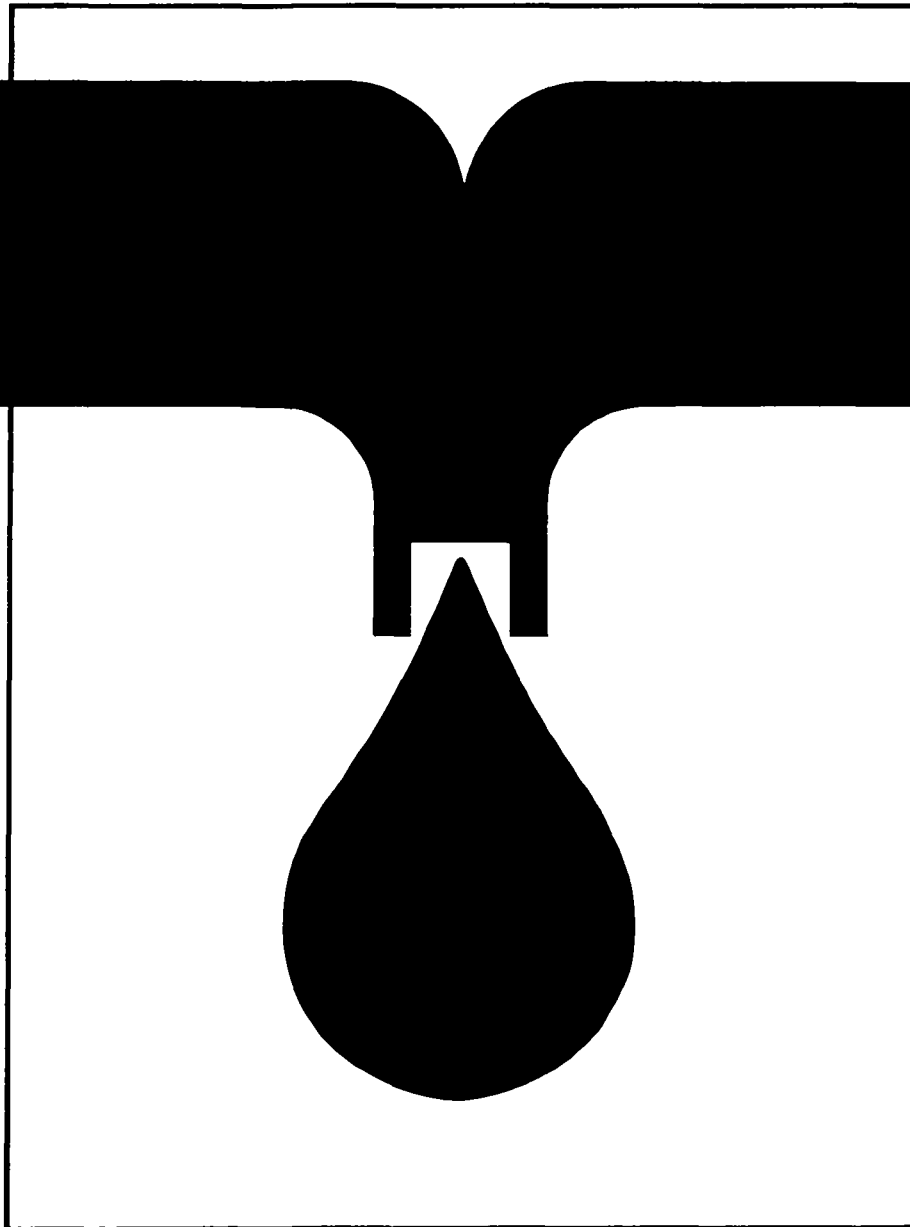




TRAINING MODULES FOR WATERWORKS PERSONNEL



Special Knowledge

2.10

Industrial safety and accident prevention

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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.

Our grateful thanks are due to

Prof. Dr.-Ing. H. P. Haug
and
Ing.-Grad. H. Hack

for their committed coordination work and also to the following co-authors
for preparing the modules:

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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.

Dr. Ing. Klaus Erbel
Head of Division
Hydraulic Engineering,
Water Resources Development
Eschborn, May 1987

Title: Industrial Safety and Accident Protection

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Aids: Accident Protection Regulations from the Professional
Employers Liability Insurance Association

1 Wearing Protective Clothing.

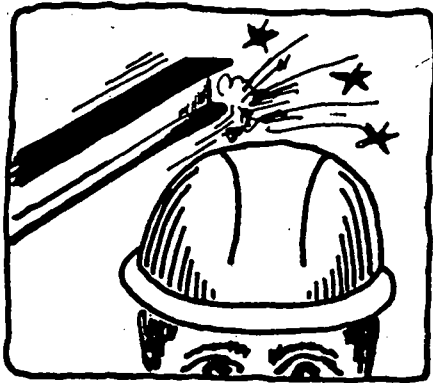


Figure 1

Safety Shoes:

If injuries to feet are to be expected by knocking or squeezing one's feet; from falling objects; by stepping on sharp objects or into hot or corrosive liquids.



Figure 2

Protective goggles:

If flying particles, for example when working with a cutting wheel or when welding, are to be expected.



Figure 3

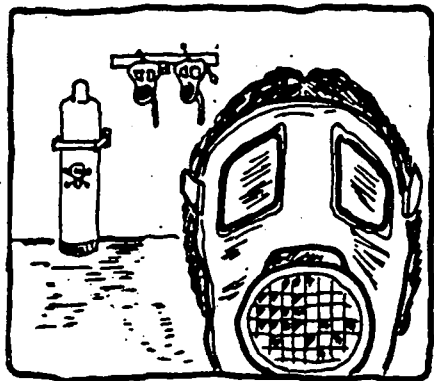


Figure 4

Breathing equipment:

When using toxic or corrosive gases or if lack of oxygen can occur, e.g. when using chlorine gas, when entering gas-endangered shafts, in painting and insulating work in closed or narrow spaces.



Figure 5

Ear protection:

In rooms with a high noise level, for example in enginehouses.

Bodily protection:

When working with substances leading to skin injuries and in cases of danger from burns and acid burns.



Figure 6

2 Dangerous work.

Dangerous work may only be carried out by persons who are aware of the dangers involved and have sufficient professional experience and knowledge.

If dangerous work is conducted by several persons jointly, a reliable person who is familiar with the work must supervise it.

If dangerous work is executed by one person alone, he must be monitored by visual checks or systems of acknowledgement determined at specific intervals.

Dangerous work in the field of Water Supply are as follows:

Entering restricted containers, subterranean shafts and well chambers

Work in explosion- or gas-endangered rooms.

Welding, painting or coating work in restricted spaces or shafts.

Pressure tests

Excavation of deep pipe trenches and construction pits.

Electrical work under special conditions.

3 Protective measures in containers, shafts and wells.

3.1 Dangers

Toxic, anaesthetizing or explodable gases can collect in containers, wells, and shafts and displace the air to be breathed on account of their high specific gravity.

Sources from which gases can be emitted in the case of wells are for example gas-retaining layers of soil, leakages from waste water or gas lines, exhaust gases in the proximity of roads with heavy traffic.

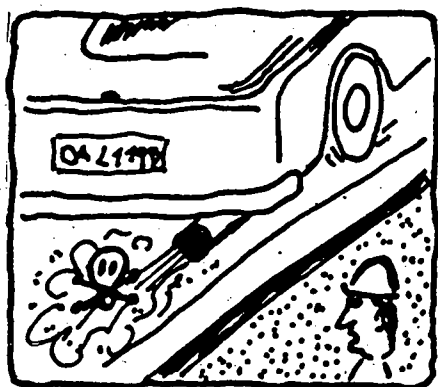


Figure 7

Furthermore, gases develop in the course of painting, insulation, welding and flame cutting. On account of the non-odorous nature of many gases, it is often not possible to detect them with the senses in time. Testing the atmosphere in shafts by introducing open flames intended to indicate a lack of oxygen when they are extinguished, is insufficient and too dangerous on account of the danger of explosion.

3.2 Safety measures:

3.2.1 Forced Ventilation

Before entering and during the stay in gas-endangered spaces, the atmosphere in the space should be checked for sufficient oxygen content. As in the majority of cases no measuring

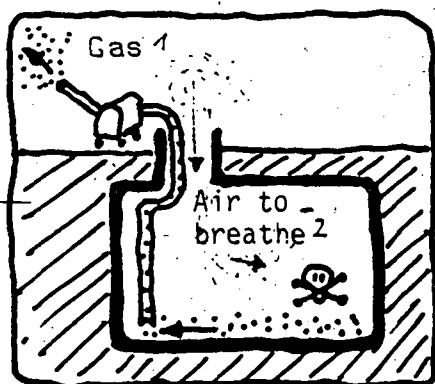


Figure 8

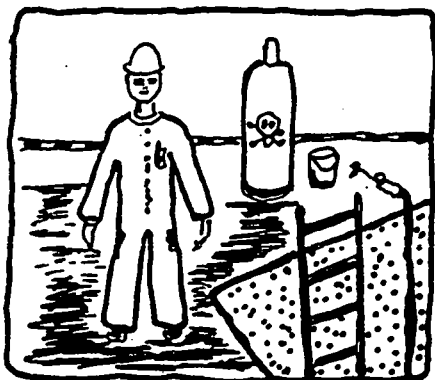
equipment is available, forced ventilation is recommended as the safest method. This consists of venting the atmosphere at the lowest point in the shaft with air-removal equipment and replacing this with fresh air. Small appliances are sufficient for normal shaft dimensions and can be supplied with energy from the accompanying vehicle.

3.2.2 Safety watch:

Persons entering gas-endangered spaces should be observed continuously during this period by a person standing on safety watch outside the shaft, well or container.

The safety watch must be able to summon other persons to give aid in cases of necessity. Rescuing steps should not be commenced until additional persons have arrived to give aid, whereby persons entering the shaft, etc., must be roped and where necessary equipped with breathing apparatus.

3.2.3 Preventive measures to be taken when welding, flame cutting and painting:



Compressed gas cylinders for cutting gases (oxygen and acetylene) may not be taken down into shafts, pits and containers. During interruptions to work, even during work-breaks, welding equipment must be removed from these spaces.

Figure 9

When applying or spraying paint or insulating agents containing solvents, the work should always be conducted from bottom to top. Care should be taken to guarantee a continuous supply of fresh air from above and effective venting at the lowest point. When using electric lighting and equipment in spaces endangered by humidity and gas, protective measures are necessary against too high contact voltages. Portable lamps may only be operated with the extra-low voltage of up to 42 V.

4 Safety when welding and cutting.

Protective goggles and hoods must be used for protection against sparks, heat and jets.

Work clothing soiled with easily inflammable substances such as oils, greases, petrol, may not be worn.

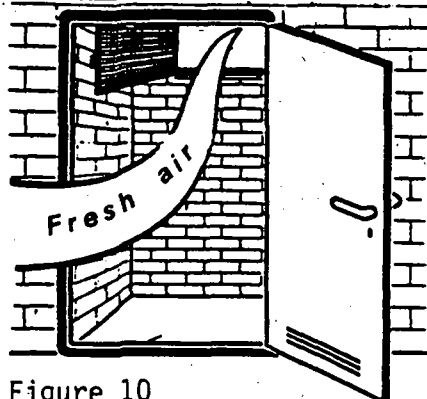


Figure 10

In the case of electric welding work over long periods in small rooms, and when welding and flame cutting galvanized, lead-coated or painted lines, the gases and vapours arising must be removed by ventilation.

Gas cylinders should be secured to stop them falling. Gas hoses should be protected against such cases of damage as being run over, buckled or burnt.

Preventive measures to prevent gas-cylinder explosions are as follows:

- Carefully connect pressure-reducing valve so as to be gas-tight.

- Only work with perfect burners.

- Do not hang burner and electrode-holder on the cylinder.

- Do not place cylinder in the proximity of sources of heat.

5 Working with chlorine


5.1 General

Chlorine, or chlorine compounds consisting predominantly of chlorine gas, are added to drinking water for disinfecting purposes and to oxidize damaging or disturbing substances contained in the water.

5.2 Properties:

Chlorine is a greenish yellow gas, non-flammable, 2.5 x heavier than air and very poisonous.

Chlorine



Notes on its dangerous properties:
Toxic when inhaled. Irritates eyes, breathing organs, skin.

Poison

Figure 11

Chlorine reacts with the humidity in the air to form hydrochloric acid which can cause severe corrosion.

5.3 Dangers to health

Chlorine gas irritates eyes and breathing organs and causes agonizing spasmodic coughing, where the acute symptoms generally occur immediately after inhaling. Death can occur after inhaling large quantities of chlorine gas. Liquid chlorine can cause severe burns to the skin and induces considerable inflammation including blistering, depending on the period of contact.

5.4 Protective measures

Chlorine gas plants and supplies of chlorine must be located in rooms secured against access by unauthorized persons. The doors to the rooms must open out and must be able to be opened from the inside at any time without a key. Only persons who have been instructed in their use may be entrusted with the operation and maintenance of chlorine gas plants and handling chlorine. Chlorine cylinders - both full and empty - should be secured individually by retaining clasps to prevent them falling, so that no damage can occur to the connection or the connecting line.

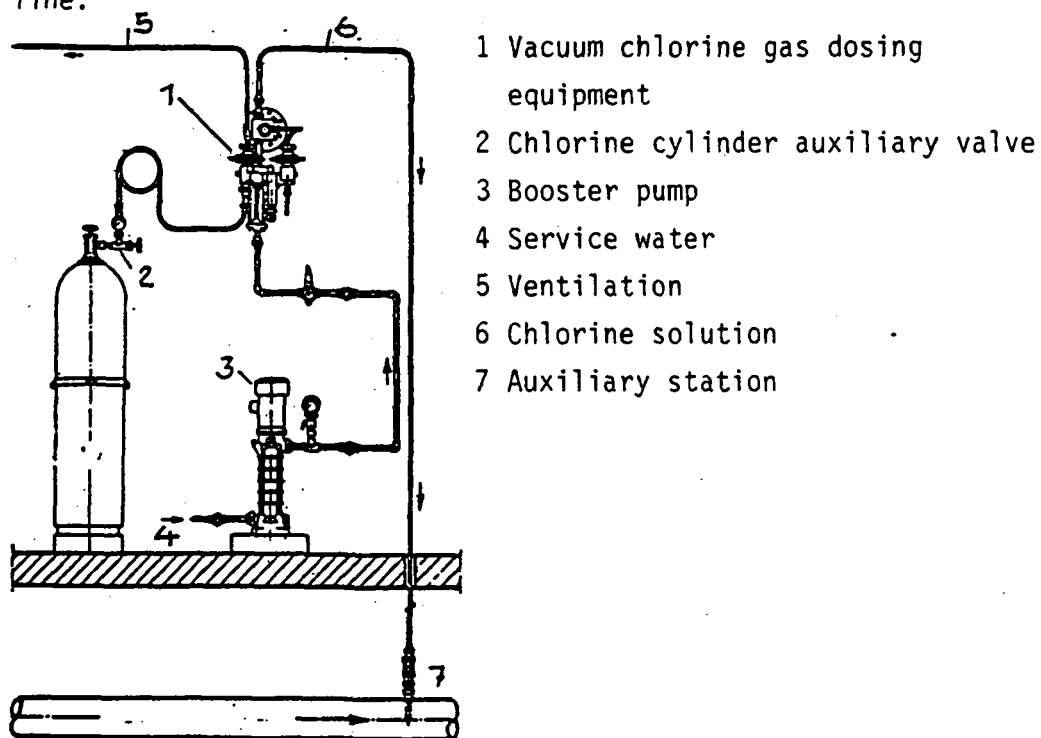


Figure 12 Chlorine gas plant

Chlorine gas dosing equipment must be fitted with stop valves (chlorine cylinder auxiliary valve as indicated in 2 on the technical drawing) by which the connecting lines can be closed when changing cylinders.

Work in which chlorine gas can escape should as far as possible be conducted in the open air protected from the weather, otherwise in well-ventilated rooms. If natural means of ventilation are insufficient, equipment must be made available and used for auxiliary ventilation.

Chlorine gas should not be subjected to direct sunlight or other sources of heat; it should be stored as far as possible in dry rooms.

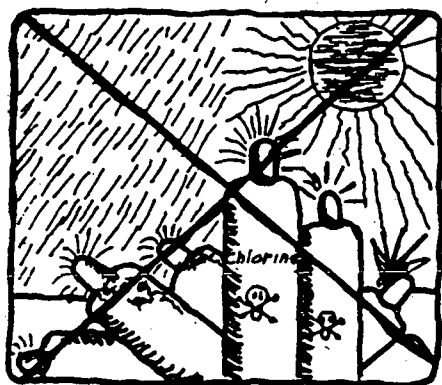


Figure 13

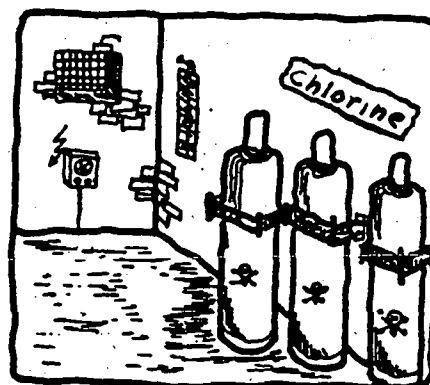


Figure 14

It is forbidden to heat containers, lines or valves filled with chlorine with an open flame; welding and cutting work may not be conducted on or in the vicinity of chlorine-retaining lines, or at least only when appropriate protective measures are taken.

In cases of small releases of chlorine, a filtering unit with B filter (colour code grey), can protect the respiratory tract from the effects of chlorine gas. In cases of large quantities of gas escaping, only breathing equipment independent of the surrounding air, e.g. fresh air apparatus, oxygen breathing apparatus or compressed air apparatus may be worn.

5.5 First aid

Persons who have inhaled chlorine gas must be taken to the doctor as soon as possible so that expert First Aid can be given.

After inhaling chlorine gas, the person should be immediately immobilised, as the affects of inhaling this gas can otherwise be aggravated. The person affected may only be transported lying down so that his breathing is not stimulated unnecessary.

Clothing infected with chlorine gas should be removed immediately. The body must under all circumstances be kept warm with woollen blankets or the additional use of hot-water bottles or heating pads.

No mouth-to-mouth resuscitation! Carry out resuscitation with an oxygen inhalation apparatus - in possible in alternation with water-vapour inhalation.

Burning of the eyes can be alleviated by rinsing with water.

Further aid must be left to the doctor. This aid should be sought as rapidly as possible, indicating that chlorine gas poisoning has occurred.

6 Excavating construction pits and trenches

6.1 General protective measures

Before carrying out earth-removing work, it should be determined whether such hindrances as for example power cables are located in the area of the intended pit or trench which could endanger the person working.

Construction pits and trenches should be protected against access by unauthorized persons.

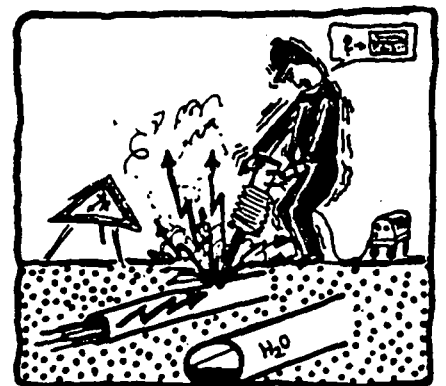


Figure 15

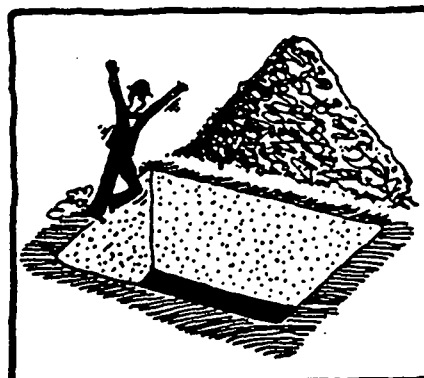


Figure 16 False

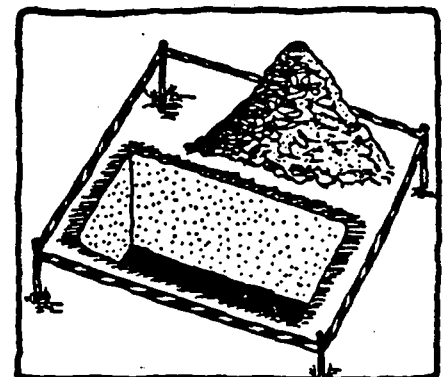


Figure 17 Correct

A protective strip of 60 cm width should be left free at the sides of trenches and pits to prevent the earth removed sliding back into the pit or trench.

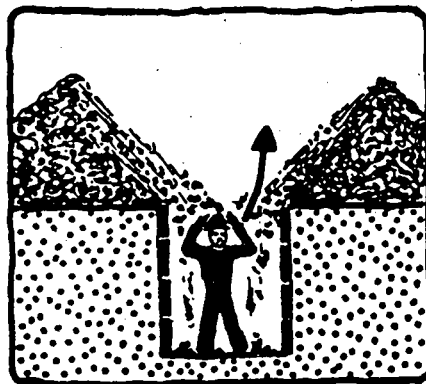


Figure 18 False

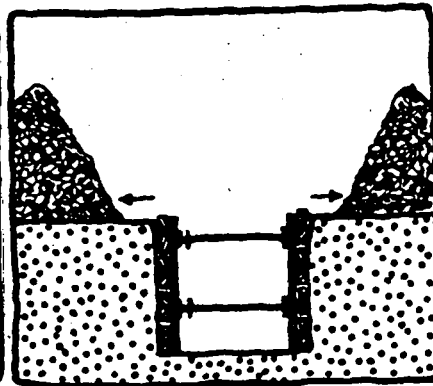


Figure 19 Correct

It is particularly recommended to wear protective clothing - protective helmets and safety shoes - in executing earth-removing work.



Figure 20 Correct

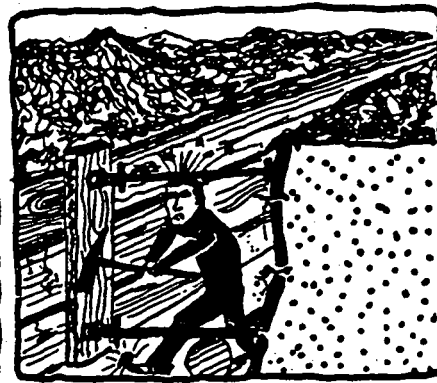


Figure 21 False

6.2 Securing pipeline trenches

Pipe trenches to a depth of approximately 1.25 m can be excavated in the case of cohesive earth without particular safety precaution measures. In cases of consistent cohesive earth and rock, excavations can be made to a depth of approximately 1.75 m if the top area of the trench is secured, as shown in Figures 22 and 23.

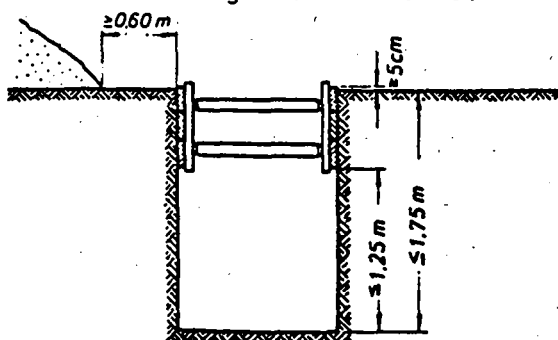


Figure 22

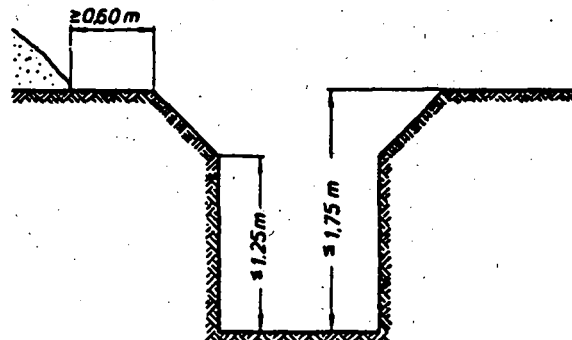


Figure 23

Slopes

Deeper pipe trenches can be secured with sloping walls.

The angle of slope depends on the soil present. The following angles of slope should not be exceeded:

- β 45° in soft soil
- β 60° in cohesive soil
- β 80° in rock

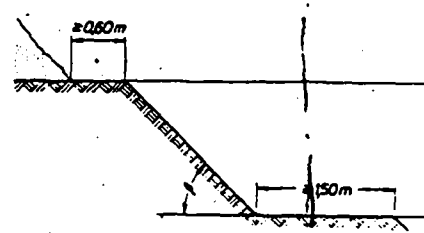


Figure 24 Slopes

Lower heights of walls or smaller angles of slope should be provided, for example, in cases of ground water infiltration from formations and shifting sandy soil.

Horizontal trench sheeting and bracing

Pipe trenches should be sheeted and braced if the trench walls are not provided with slopes as described above. The top edge of the sheeting must extend at least 5 cm above the surface of the surrounding area. The planks of the sheeting should be in contact over their total surface with the earth. Cavities behind the sheeting should be filled tightly. No loose materials may be allowed to trickle through gaps and joints in the sheeting.

A working space of approximately 35 cm should be provided between the outside diameter of the pipe and the trench wall for laying and testing pipelines.

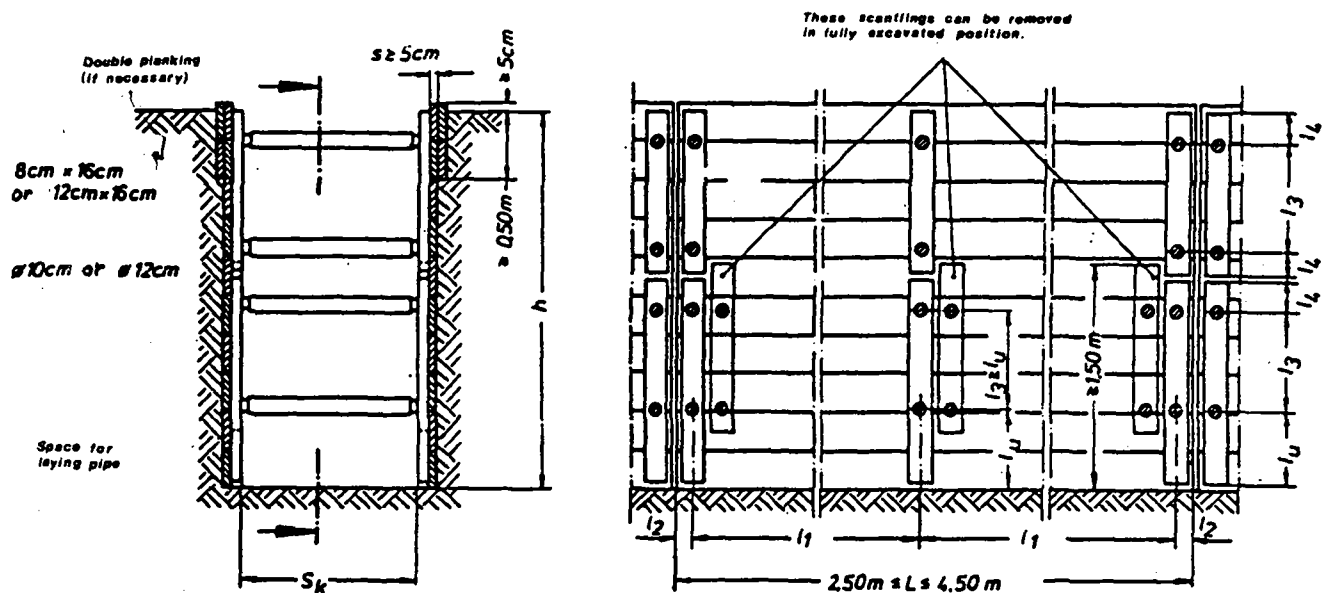


Figure 25 Horizontal trench sheeting and bracing

Revised:



The horizontal trench sheeting and bracing in Figure 25 must always be inserted as excavations progress from the top to the bottom.



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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.

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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.

The series “**Sonderpublikationen der GTZ**” includes more than 190 publications. A list detailing the subjects covered can be obtained from the GTZ-Unit 02: Press and Public Relations, or from the TZ-Verlagsgesellschaft mbH, Postfach 36, D 6101 Roßdorf 1, Federal Republic of Germany.

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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