

Treatment of Lines for Mobile Devices and Appliances – Course: Basic Skills and Knowledge of Electrical Engineering. Methodical Guide for Instructors

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Institut für berufliche Entwicklung e.V.
Berlin

Original title:
Methodische Anleitung für den Lehrenden
"Bearbeiten von Leitungen für ortsveränderliche Betriebsmittel"

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First Edition © IBE

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13187 Berlin

Order No.: 91–32–3106/2

1. Aims and Contents of Practical Vocational Training in the Field of "Treatment of Lines for Mobile Devices and Appliances"

At the end of this studying unit, the trainees must have achieved the following aims:

- The trainees have acquired the necessary knowledge and skills for working lines for mobile devices and appliances.
- The trainees have command of the respective working techniques and operations for treating lines for mobile devices and appliances.
- The trainees are able to check completed operations as to their correctness.
- The trainees observe the labour safety regulations.

In order to achieve the required aims, the instructor has to impart to the trainees the below mentioned contents:

Knowledge

- On the working and connecting of lines to mobile devices and appliances.
- On the selection of the corresponding technique as required by the line and connection.

Skills

- Accurate preparation of the connecting points.
- Faultless working of the cable material.
- Making of perfect connection points.
- Testing of the work completed.

2. Organizational Preparation

In order to guarantee a smooth course of instructions and exercises, the training must be well organized. This includes the following measures:

2.1. Preparation of the Labour Safety Instructions

Before beginning with the exercises, a brief instruction has to be given as to the proper use of the working means and including hints on accident-free working.

To prove that the labour safety instructions were given, it is recommended start a book in which all instructions on accident-free working as well as on the correct use of tools and auxiliary means are entered in the form of keywords. The trainees confirm by their signatures that they have got the instructions.

The following hints should be given:

- Any work in or at electric plants has to be carried out only if and when the plant is in dead condition.
- This dead condition has to be verified with the help of continuity testers.
- It has to be made sure that no other person switches the plant on while it is being worked at.
- Do only use perfect tools. Defective tools have to be repaired or replaced by new or regenerated ones.
- When removing the insulation by the electrician's knife make sure that the blade is sharp. With a sharp blade there is less danger to slip off and hurt oneself.
- Always cut "a way" from the body.
- Do never leave electric devices or appliances alone in the factory or workshop.
- After use electric devices or appliances have to be switched off and mains plug has to be drawn out.

Further hints on labour safety that may perhaps be necessary should be given according to the local requirements.

2.2. Preparation of the Teaching Aids

For the theoretical instructions the trainees must have a place where they can take notes. Recommendable is a room equipped with blackboard, desks and electric connection.

If the instructions are held in a workshop or directly at the workshop place, clean desk pads should be placed on the working tables for the trainees to put their papers and exercises books on.

For demonstration during the instructions a workshop place for exercises should be prepared with the following outfit:

- Exercise pieces such as cables and electric devices and appliances
- Folding rule
- Combination pliers, side cutting pliers, round-nose pliers
- Screw driver, hexagonal spanner
- Electrician's knife
- Wire strippers
- Thermal deinsulating device
- Deinsulating fixtures
- Pressing fixture, pressing pliers
- Conductor end tubes, contact eyes
- Pressing tools with accessories
- Pressing cable eyes

- Pressing cable temples
- Binding material
- Soldering iron and soldering accessories

The "Trainees' handbook – treatment of lines for mobile devices and appliances" is distributed according to the number of trainees. Surveys and circuit diagrams are drawn on the blackboard before the lesson begins.

2.3. Preparation of the Working Means

As a theoretical basis, the "Instruction Examples for Practical Vocational Training / Treatment of Lines for Mobile Devices and Appliances" are distributed among the trainees according to their number. The materials which are required for doing the exercises have to be prepared and placed at the trainee's disposal on the basis the "Instruction Examples ..." in sufficient number and / or quantity. There must be a working place for each trainee.

2.4. Time Planning

Starting from the total number of teaching hours, the time for each step of this teaching unit should be planned individually.

It is recommended to work out a schedule for the following steps:

- For the introduction onto each respective working technique in the form of an instruction.
- For necessary demonstration.
- For a task-related instruction in preparation of the exercises
- For the carrying out of the exercises.
- For repetitions and control.

In scheduling, the following factors should also be taken into consideration:

- Level of education of the trainees
- Training conditions
- Future work of the trainees
- Degree of difficulty of the respective training section.

Focal point of each training section is the acquisition of the respective abilities and skills by exercises. If – despite a good planning – it should come to waiting periods, the trainees should be given smaller suitable tasks such as the preparation of materials for the exercises to bridge such slacks.

3. Recommendations for Practical Vocational Training in the Techniques of "Treatment of Lines for Mobile Devices and Appliances"

The following sections contain suggestions of how to structure the instruction of the trainees, the demonstration of the individual training steps as well as the exercises and tests.

3.1. Introductory Instructions, Demonstration and Exercises

The introductory instructions on each working technique may be held in a class-room. During these instructions, make sure that the trainees write down supplements or answers in the "Handbooks".

The contents of the "Handbook" is structured in a way corresponding to the introductory instruction.

The focal points contained in the "Handbook" have to be imparted to the trainees.

A precondition of learning the working techniques of treatment of lines for mobile devices and appliances is the command of the techniques of making of fastening and permanent joints.

Therefore, in imparting the knowledge, the last-named techniques should be referred to in the form of a repetition.

Elementary knowledge of the connection of lines for mobile devices and appliances and their use

Before the trainees get to know the various possibilities of treating lines for the connection of mobile devices and appliances, they should become familiar with the different kinds of such lines.

Here, it is recommendable to draw the trainees' attention to the ready-made products from their immediate working sphere such as extension cords, flexible cables, portable multiple sockets etc.

By showing these products the instructor points to the teaching objective.

After this, the typical and most commonly used kinds of cables and their abbreviated names should be mentioned. The mechanical and electric stressability of the individual cables should also be dealt with. Examples of application should be given.

The terms 'multiple-wire, fine-wire and finest-wire conductors' should be explained.

In connection with the use of the cables, the examples from the survey of the "Handbook" have to be discussed and, if required, to be extended corresponding to the local conditions.

Treatment of lines for mobile devices and appliances

Previous to the instruction and demonstration in this context, it is absolutely necessary that a working place is properly prepared and the tools and auxiliary means are arranged in an exemplary way. All the time, the trainees must be shown how to do the exercises and mistakes must be corrected immediately. If a certain mistake is made very frequently and becomes typical, the trainees should be called to one workshop place where they are explained the reasons of the respective mistake and where they are shown how the mistake can be avoided.

Removing the insulations

When demonstrating this sequence of operation make sure that all trainees are able to watch the demonstration well.

Each step of the process of removal should be demonstrated and explained. It is important to point to the different lengths of removal and write these on the blackboard.

Make sure that the insulation is very accurately removed from the conductor ends. There must be no remains of the insulation or notches on the conductor.

In this connection, the possible consequences of inaccurately removed insulations and/or damaged conductor insulations and conductors should be mentioned. When using wire strippers point out that the cutting edge used must correspond to the conductor cross-section. In this context, the advantages of deinsulating devices such as thermal devices for removing the insulation should be dealt with.

If such devices are used the operating instructions given by the manufacturer must be strictly observed.

When knives are used make sure that the cut is directed "away from the body".

Preparation of the conductors for further use

In this context, it is important to explain why mobile lines must be prepared in a special way for connection. The individual methods of working have to be mentioned or worked out together with the trainees or – if they are already known – to be repeated.

This refers mainly to operations such as

- cleaning the conductor
- tinning the conductor
- soldering on of cable eyes and
- pressing on of cable eyes.

Here it is recommendable again to use the handbook of "Making of Fastening and Permanent Joints". It should be made clear to the trainees that the tin-coating of cables and the use of sweating thimbles should be avoided to the farthest possible extent and that conductor end sleeves or contact eyes should be used instead.

The tinning of cables is required if eyes must be bent or if pressed cable eyes cannot be used.

Once again the trainees' attention should be drawn to the following point in connection with soldering:

- For soldering in electrical plants soldering irons of 80 watt are used according to the cross-section of the conductor.
- On principle, tin-base solder (thread or bar tin) of 60% tin content is used for soldering in electrical plants.
- Only acid-free flux such as colophony solved in spirit or acid-free soldering grease must be used.

It is also important to mention the characteristics of a faultless soldered joint and to explain the care of an electric soldering iron.

Bending of eyes

Here, the two methods of bending eyes are explained.

- Either, to shape the twisted and tinned conductor into an eye with the help of round-nose pliers,
- or to form an eye of the untinned twisted conductor by an arbor or round-nose pliers, or dividing the untinned conductor, twisting the two halves separately, put them around the arbor, join them and twist them one another.

Then tin-coat them.

When making eyes pay attention, that

- the eye is 0.1 to 0.2 mm larger than the diameter of the locking bolt,
- the eye is placed evenly on the junction block in order to avoid contact problems.

Putting on of conductor end sleeves and contact eyes

Especially hint to the advantages compared with tinning. Give very careful demonstration of the sequences of operation for conductor end sleeves and contact eyes and explain them.

In doing so, deal with the special characteristics of these techniques and demonstrate the correct operation of pressing tools so that any risk is avoided.

The trainees must be made familiar with the assignment of conductor end sleeves to the appropriate conductor cross-sections, and it has to be pointed out to them that this is of special importance because the conductor end sleeves and contacts eyes are not marked.

Connection of cables to mobile devices and appliances

Making of screw connections

In this paragraph all important requirements of the connection of mobile devices and appliances should be combined and imparted to the trainees. In doing so, it should be pointed out to the trainees that these requirements must be met at all devices, machines and clamping points.

It is recommendable to show and explain the trainees the order of the screwing elements such as screws and bolts as well as the arrangement of the conductors on terminals with the help of blackboard drawings or transparencies for overhead projection before giving them demonstration and have them exercise afterwards.

Only then the special kinds and characteristics should be dealt with.

The following focal points should be given special attention:

- Lengths of removal of insulation
- Putting the conductor into the connection space
- Connection of the protective conductor
- Number of conductors to be connected to one terminal (connecting point)
- Connection to cap–screws with or without clamping bow or conductor fixing device
- Connection to connection bolts
- Washers to be used
- Use of conductors with conductor end sleeves or contact eyes.

Tension relieving

In this context make clear why tension relieving is absolutely at mobile devices and appliances. Then, pass to the various ways of tension relieving. Also, point to the fact that tension relieving is possible inside and outside the connection space of mobile devices and appliances.

The protective system of an electric device or appliance must not be lowered by an external tension relieving.

It is also important to point out that there must be a buckling protection at device entrances and exits.

Boltings that only serve to maintain the protective system must not be used as tension relieving.

Basic rules on plug and socket connectors

Here especially the direction of the energy flux must be considered.

Plug and socket or coupler socket must be installed in such way that, under no circumstances, the plug pins are alive as long as the plug is not put into the socket.

Combination of mobile lines in bank cables or formed cables

First of all the trainees are explained that in addition to cables for the connection of mobile devices there are cab cables which consist of multiple–wire or fine–wire conductors.

- This is mainly the case with plants exposed to strong vibration and great mechanical strain.
- The combination of conductors in bunches is a method of cable laying.
- If, in such plants, conductors are combined in bunches, this is called "bunch wiring" and prefabrication in the form of preformed cables is recommendable.

In this context it would be helpful to use the handbook "Manufacture of Preformed Cables".

In the course of demonstration the following focal points should be referred to:

- Making of templates
- Laying of the cables and combining them in bunches
- Tying the bunches up with binding material
- Testing and marking of the cables.

In this context it is important to explain that the cables always have to be tested as to their conductivity before they are laid and afterwards as to correct cable running.

When marking the conductor make sure that the marking will remain and be legible even after a longer period of time and that also other people will be able to read it.

3.2. Recommendations for Working with the Instruction Examples for Practical Vocational Training

In the instruction examples the sequence of operation is described and a survey of how to carry out the required operations is given.

Furthermore, a list of materials, tools, measuring and testing equipment, auxiliary means as well as required basic knowledge is attached to each instruction example.

During the practical exercises corresponding remarks are made so that the trainees are given all required information to do their work properly and to observe the protective measures.

When organizing the work on the basis of the instruction examples the following hint should be taken into consideration:

- The trainees put the instruction examples into practice independently and without assistance.

So the instructor will be able to supervise the work of each trainee, to correct it and to assess it justly.

3.3. Examples for Recapitulation and Tests

This section includes tasks for the consolidation and checking of the knowledge and skills acquired by the trainees. To each task the corresponding answer is given.

Tasks, which are included in the "Handbook" are marked by the letter "A".

1. What is the difference between lines for the connection of mobile devices and appliances and such for permanent wiring?

"A" (Mobile lines are meant for mobile and/or portable electric devices and appliances. They are flexible and the conductors consist of fine wire.)

Lines for permanent wiring are single-wire or multiple-wire lines, they are fixed – permanent wiring – and can be bent only once and according to a certain bending radius.)

2. On what criteria does the selection and use of lines for mobile devices and appliances depend?

"A" (Rated voltage; kind of mechanical strain; range of temperature; place of use.)

3. Why must mobile lines be treated in a special way before connection?

"A" (Connections made with the help of bolts, clamping nuts and others exert torques and spreading forces on the twisted conductor. If these are not tinned or provided with a conductor end sleeve, the fine conductor cores will give way to the pressure and leave the point of connection. This may cause a reduction of the cross-sectional area and perhaps to the destruction of the connection by thermal influences.)

4. What sequences of operation have to be carried out before the connection can be made?

"A" (Cleaning of the conductors; twisting of the conductors; tinning of the conductors; bending of eyes; soldering–on of cable eyes; pressing–on of cable eyes; fixing of conductor end sleeves and contact eyes.)

5. What must be considered when bending eyes for connection?

(Do only use arbors or roun–nose pliers; do not damage the conductor; the eye for connection must be closed; the eye must be in accordance with the diameter of the thread or bolt.)

6. What are the advantages of conductor end sleeves and contact eyes compared with tinning?

"A" (Saving of working time by the simple and problem–free assembly; better movability of the core up to directly to the point of connection and thus reduction of the risk of breaking; saving of auxiliary materials such as tin; colophony and/or other fluxes as well as electric energy; replacement of tools susceptible to interference such as soldering irons by mechanically robust tools for pressing–on.)

7. Why should with lines for mobile devices and appliances preferably conductor end sleeves and contact eyes as well as cable eyes be applied?

"A" (Easier working technology; less sources of error; substitution of material; with soldering – valuable tin, with pressing–on copper; better contacts; better movability of the core up to the point of connection.)

8. What must be taken into consideration with the pressing–on of cable eyes?

(The cable eye must be in accordance with the conductor cross–section; pressing inserts must correspond to the cable eye; V–shaped slots are made only at copper conductors; alternation of length with hexagonal pressing; contact areas of cable eyes and conductors must be free of contamination and layers of oxide; if required wire binding for putting in sector–shaped, multiple–wire conductors; with hexagonal pressing, remove the burr occurring at the cable eye.)

9. Why must the protective conductor in the connecting space of the device or appliance be the longest connecting core?

"A" (This guarantees the effect of the protective measure even if – with extreme tensile strain – the rest of the conductors are torn from the point of connection.)

10. Why is tension relieving required with mobile devices and appliances?

"A" (Additional securing of the functioning of the device; the tearing–off of the connections is prevented; the effectiveness of the protective measure is increased.)

11. What is the importance of the breaking protection at devices entrances and exits?

"A" (Prolongation of the service life of the device or appliance; avoiding of body contact and thus reduction of accident hazard.)

12. What could be the consequences of transposing connection within a plant?

"A" (Non–functioning of the plant; extensive testing and controlling; time and material–consuming reworking of the preformed cable; short circuits and body contact in the plant.)