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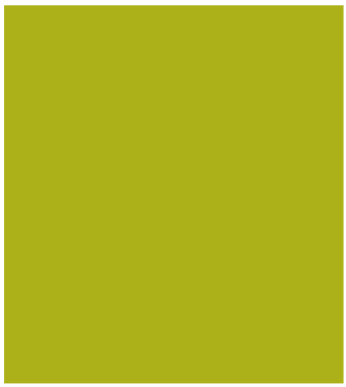

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DRY CLEANING OF LV INSTALLATION BY SUCTION

1. General

The wide use of electrical energy in all sectors of life results in steadily increasing requirements on safety and reliability of power supply. Therefore, the power supply companies take every effort to provide electrical energy without disturbances or interruptions. However, in order to achieve this, it is necessary to carry out maintenance and repair work in the electrical power networks which have been done only in de-energized systems so far. In networks which are not meshed it was often not possible to do this without interruption of the power supply. Also when working on parallel lines, the reliability of supply was not guaranteed when one of the systems was de-energized. It is one advantage of live working methods that it is possible to work in energized systems while the required safety of the personnel is fully guaranteed. Other advantages like the increasing reliability of electrical installations and less additional work activities have resulted in an increasing application of live working methods in many countries. The recourses of the transmission of electrical energy can be used to the maximum extent, because live working reduces the number of de-energized networks due to maintenance and care to the minimum. This saves costs for an expensive extension of the network which can then be determined exclusively by the required load power factor.
Live working in low-voltage installations has been a common practice for many years, e.g. the installation of service entrances, service boxes, worksite distribution boards, etc.

One of the priorities of live working with the guarantee of safety is:
The comprehensive new regulations for live working are not intended to create thoughts like: "It is better to know that voltage is present than to think that it is not." They are rather brought out with the aim to ensure safe work activity. When carrying out work, the weakest link with regard to safety is always the personnel - no matter which measure is applied. Therefore, working in electrical installations requires especially trained, responsible and reliable skilled persons.

2. Preconditions for Live Working

The following regulations for live working in accordance with VDE 0105 - 100 (EN 50110 Part 100) "Operation of electrical installations" are most essential:

- Depending on the type of work to be done, live working may only be carried out by electrically skilled or instructed persons who were especially trained for this work.
- On successful completion of the training a certificate must be given to the participants to confirm that the personnel are able to undertake live working for which they have been trained and according to their level of training.
- The ability to do live working should be maintained either by practice or by new training.
- The working method must be implemented, i.e.
  + working using insulated tools,
  + working with suitable protective clothing.
- Instructions for work should be worked out.
- Suitable tools, equipment, protective and supporting means should be selected.
- The environmental conditions (precipitation, fog, thunderstorm, wind, frost, dew) should be regarded.
- The equipment for cleaning including the vacuum cleaner with suction hose and the suction pipe with the various nozzles and brushes must be maintained and checked by a skilled person at least once a year.

Figure 1: LV cleaning set for live working

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Figure 2: Cleaning set for low-voltage installations with personal protective equipment

Figure 3: Application of the tubular brush

Figure 4: Application of the flat nozzle

- Unintended use is permitted and must be prevented by the instructed personnel.
- The enclosed instructions for use of the various equipment should be observed before starting the cleaning work.

This selected list shows that live working requires considerable investment with regard to the personnel (special training) as well as to the equipment to be used.

3. Basic Principles

3.1 Nominated person in control of the work activity/supervisor

3.1.1 Nominated person in control of the work activity

Before any work activity is started, a person in control of the work activity must be nominated for each working group (He must be an "electrically skilled person" in accordance with DIN VDE 0105). His task is to ensure that all relevant requirements, rules and instructions are complied with and that the work is carried out carefully. Furthermore, he is the contact person to the person in control of the electrical installation nominated by the employer. He must be authorized to instruct the personnel on the cleaning work to be done.

3.1.2 Supervisor

Source: VBG 4 DA, §8, Section 2

As part of the organizational safety measures, the work should be supervised by someone who has been trained in First Aid and who has received at least some instruction in electrical engineering (see § 7 of UVV (accident prevention regulations), "First Aid" (VBG 109)).

The safety measures must be defined in writing for each individual case or for certain regularly recurring cases, and must take into account the provisions of the electrical engineering standards.

The supervision as defined in VBG 4 DA, §7 is the continuous monitoring of the safety measures to be observed when working at the work location. The supervisor is only allowed to do work not preventing him from supervision. The supervision may be carried out by different persons within the group when doing the work. However, this must also be defined in writing beforehand.

Figure 5: cable distribution **before** cleaning

Figure 6: cable distribution **after** cleaning

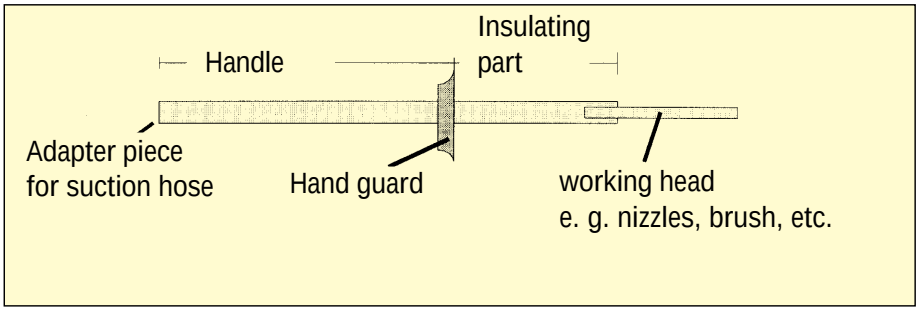

Figure 7: Suction pipe

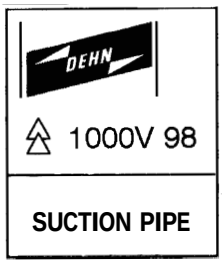

Figure 8: Type label of a suction pipe

3.2 Qualification of the personnel

A specific training program should be set out to develop the capacity of skilled or instructed persons to perform live working. The knowledge and skills of the personnel concerned must comply with the current state of engineering and tested at yearly intervals. The validity of live working authorization should be revised when the required knowledge cannot be proven. The ability to do live working must then be developed by new training.

3.3 Equipment for live cleaning

The new cleaning set for live working in low-voltage systems **(Figures 1 and 2)** was developed on the basis of the live working technology - dry cleaning of live installations by suction - proven for decades. It was harmonized with the regulations brought out by the trade association for Precision Mechanics and Electrical Engineering and tested in practice by power supply companies and in the services sector.

Brushes and nozzles of the cleaning set for live working **(Figures 3 and 4)** are especially developed for intensive cleaning of cable distribution boards **(Figures 5 and 6)**, open indoor switchgear and control boards.

3.4 Components of the Suction Pipe

(see Figure 7 and 8)

3.5 Clothing

Personnel should exclusively wear suitable close fitting, long-sleeved clothing of cotton or mixed cotton cloth (also in summer).

3.6 Personal protective equipment

The personal protective equipment comprises:

- safety helmet with face shield for electrical work (see DIN VDE 0680 Part 1)
- insulating gloves with cotton-made under-gloves (see DIN VDE 0680 Part 1)
- insulating tools in accordance with DIN VDE 0680 Part 2

3.7 Barriers

Before starting the work activity, the work location must be marked appropriately in order to prevent unintended access.

4. Handling of the Set

The handling of the cleaning set can be carried out in conformity with the regulations stipulated for “at a distance working” or “insulating glove working” (also valid for insulating tools). The equipment is manufactured and tested in accordance with DIN VDE 0680.

5. Live Cleaning Work

5.1 Hot stick working (at a distance working)

In Section 6.3.4.1 of DIN VDE 0105 - 100
"hot stick working" is defined as follows:
live working in which the worker remains at a specified distance from the live parts and carries out the work by means of insulating poles."
The “insulating pole” is the suction pipe when doing cleaning work. The suction pipe is designed according to the standard DIN VDE 0680 Part 3 (“operating rods”) and tested for electrical safety and mechanical strength.

5.2 Insulating glove working (contact working)

In Section 6.3.4.2 of DIN VDE 0105 - 100
"insulating glove working" is defined as follows:
live working in which the worker is electrically protected by insulating gloves and other insulating equipment (insulating arm sleeves), and carries out the work in direct mechanical

Figure 9: Cleaning of a low-voltage cable distribution board

Figure 10: Cleaning of LV switchgear applying the methods (5.1 + 5.2)

Figure 11: Cleaning of the frame of LV switchgear

Nominal voltage	Work activity	EF	EUP	L
up to AC 50 V up to DC 120 V	All work activities where danger of arcing can be excluded.	●	●	●
above AC 50 V above DC 120 V	1. Approaching of suitable test, measuring and equipment, e. g. voltage detectors, suitable tools for moving easily portable parts	●	●	
	2. Approaching of suitable tools and equipment for cleaning and the installation of suitable covering or barriers;	●	●	
	3. Removal and insertion of fuse bases which are not protected against direct contact using suitable equipment, if danger cannot arise from this;	●	●	
	4. Spraying of live parts for fire fighting or for cleaning of outdoor installations;	●	●	
	5. Working at batteries while providing suitable safety measures;	●	●	
	6. Working in test cabinets or laboratories while observing suitable safety measurs when required by the working conditions;	●	●	
	7. Removal of hoarfrost deposits with the help of suitable insulating poles;	●	●	
	8. Location of faults in auxiliary circuits (e. g. signal transmission in circuits, short-circuiting of partial circuits) as well as functional tests of equipment and circuit installations;	●	●	
	9. Other work activities when – 1. Compelling reasons were noted by the user of the installation and – 2. Persons authorized to give instructions, responsibilities, working methods and procedures (instruction for work) were nominated in writing. These persons must be especially trained for the work to be done.	●		
all other	All work activities when the circuits are intrinsically safe and no special danger is evident (e. g. hazards of explosion).	●	●	●
	Work activities to exclude hazards, e. g. und Gesundheit von Personen oder Brand- und Explosionsgefahr.	●		
	Working telecommunication systems with remote control, when the current is below AC 9 mA or DC 60 mA.	●	●	

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contact with live parts. When using this method in low-voltage installations, the use of insulating gloves does not exclude the use of insulating and isolated tools or a suitable isolation of the work location."

The "insulating tools" for doing the cleaning work is the hand-operated **(Figure 10)**, fully or partly insulated equipment (e.g. brushes) enclosed in the cleaning set. The equipment is designed according to DIN VDE 0680 Part 2 (IEC 900) and tested for electrical safety and mechanical strength.

When applying this method, the requirements stipulated in DIN VDE 0105 - 100 Section 6.4 "Work in the vicinity of live parts", especially Section 6.4.2 "Protection by protective screens, barriers, enclosure or insulating covering" must additionally be observed.

Before starting any work activity, it must be ensured that all live parts in the vicinity zone which are not to be cleaned are protected against accidental contact.

6. Cleaning Work Procedure

1. Before starting and after completion of the work, the protocol for dry cleaning of low-voltage installations by suction is to be filled in. When the person nominated for the supervision of the work is not always one and the same, this must be indicated accordingly.
2. The personnel must use the appropriate personal protective equipment.
3. The work location must be protected against accidental contact by persons not involved in the work activity.
4. If parts of the installation or equipment are dewy, cleaning work is not allowed.
5. Before starting the cleaning work, circuit markings are to be noted down in order to be able to re-install them correctly when they were damaged or had fallen down during the work.
6. Separating walls which fell down are not removed and should be replaced by new ones during a necessary revision.

7. Current Standardization and Regulations on Live Working

Live working is standardized in DIN VDE 0105 - 100 "Operation of electrical installations" as well as in the accident prevention regulations of VBG 4 "Electrical installations and equipment". Out of the wide range of live working activities, the following explanations are only given for dry cleaning of low-voltage installations.

7.1 Live working: Standpoint of K 224 "Operation of electrical power installations"

DIN VDE 0105 - 100, Section 6.3 classifies three groups of live working activities:

a) generally accepted live working activities,
b) work activities which can only be carried out in energized states for technical reasons,
c) other live working activities which may be carried out in energized states under certain preconditions.

Cleaning of low-voltage installation is classified in group a) including, beside others,
“approaching of tools and equipment for cleaning of installations with nominal voltages up to 1000 V”.

7.2 Live working in accordance with the regulations for the prevention of accidents of the trade association of Precision Mechanics and Electrical Engineering “Electrical installations and equipment” (VBG 4)

Table 1 has undergone structural revision in accordance with the publication of the implementing regulations as part of VBG 4 in October 1996:
In the voltage ranges above AC 50 V and above DC 120 V, number 2. says:
"Approaching of suitable tools and equipment for cleaning and the installation of suitable covering or barriers”.
The live cleaning work described there may only be carried out by electrically skilled or instructed persons, **both especially trained**.

7.3 Final remarks

The advantages of live working become evident by uninterrupted power supply for the utility company as well as for the consumers.
When compared to dead working (de-energized state), live working (e.g. cleaning work) is generally of better quality, quicker and less expensive for the following reasons:

- less coordination of activities necessary,
- switching operation or earthing and short-circuiting measures are not necessary (adherence of the 5 safety rules),
- continuity of activity is possible.

Live working in medium-voltage indoor systems is of greater importance than live working on medium-voltage overhead lines. With regard to the frequency, cleaning of medium-voltage indoor systems is the main maintenance activity. Working to the principle of indirect contact has proved to be effective, economical and safe subject to compliance with the safety rules and regulations. Last but not least, the positive experiences with live working made over the past 20 years show that the methods are suitable with regard to both safety regulations and training programs.

A solution preventing trouble and saving costs: The Siemens AG, Erlangen, Design of Installations and Technical Services Dpt., carries out the live cleaning work of low-voltage installations up to 1000 V, and above this ecologically beneficial. De-energizing is not necessary. The methods applied conform with the valid regulations and rules (e.g. accident prevention regulations of VGB 4 “Electrical installations and equipment”, DIN VDE 0105-100 “Operation of electrical installations”).

8. Literature

[1] VBG 4 "Elektrische Anlagen und Betriebsmittel"
[2] VBG 125 "Sicherheits- und Gesundheitskennung am Arbeitsplatz
[3] DIN VDE 0105-100 "Betrieb von elektrischen Anlagen"
[4] DIN VDE 0680 "Körperschutzmittel, Schutzvorrichtungen und Geräte zum Arbeiten an unter Spannung stehenden Teilen up to 1000 Volt"
[5] VDE Schriftenreihe Heft 48 "Arbeitsschutz in elektrischen Anlagen"
[6] BG F&E Die Brücke, Ausgabe 4/96 "Arbeiten unter Spannung"

...MIT SICHERHEIT DEHN.

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