

Robert Nader, Hubert Nowikow, Grzegorz Matusiak, Michał Włodarczyk
Hubix Sp. z o.o.

Emiliano Sammartino
Espacio Marketing

MV Substation Inspection and Cleaning in Live Working Technology

Inspekcja i czyszczenie podstacji SN w technologii pracy pod napięciem

Dirty insulation of devices causes losses and may cause emergency shutdowns. Depending on the contamination zone, cleaning of the devices may be required even several times a year. By using the Live Working Technology, network operators can adjust the frequency of cleaning operations to meet their needs and not the possibility of outages in each region. Additionally, thanks to the use of an electro-insulating camera, carrying out the cleaning can observe and register invisible parts of the device. The authors of the paper will present the equipment, procedure, and benefits of using the cleaning and inspection technique of power equipment based on the regulations in force in Poland.



Regulations for live working

- Ordinance of the minister about occupational safety and health with power equipment of August 28, 2019.
- Standard EN 50110-1 – Operation of electrical installations Part 1: General requirements.
- In-plant instruction for the organization of occupational safety and health with power equipment (OSH-I).
- In-plant instruction for the organization of live working (LW-I).

Requirements for employees (performing work, supervising work, and instructors):

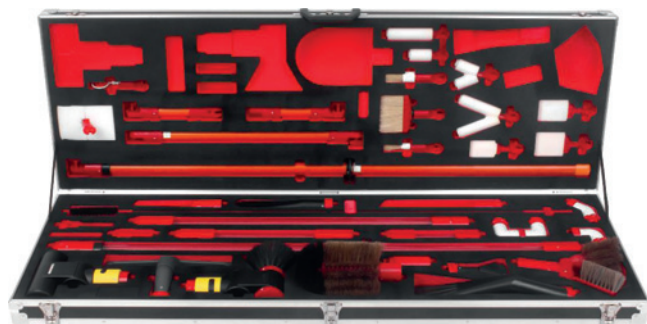
- qualification certificate E (executor) or D (supervision) > 1 kV,
- no contraindications for working under voltage – occupational medicine,

- completed training for live working, preceded by a minimum of one year of experience in the operation of devices (without Live Working technique).

Equipment necessary for MV Substation Inspection and Cleaning in Live Working Technology

Cleaning Tools

- Suction nozzles and brushes with shapes and sizes adapted to power equipment.
- Main elements consisting of a handle and an insulating part.
- Extension cords (hollow and foam-filled tube).
- Elbows and working heads enabling work at various angles.



Cleaning tools must be properly constructed to provide electrical insulating properties. This is a very important parameter because these tools are introduced between energized power equipment's elements with different potentials.

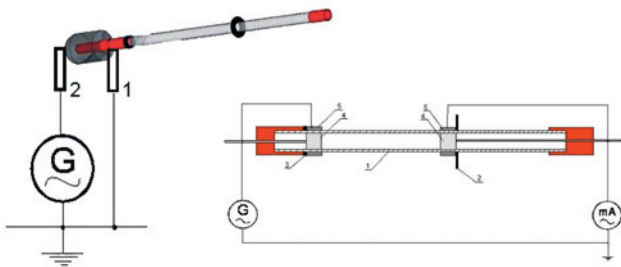
Electrical insulating properties are confirmed in tests performed in accordance with the requirements of the standards:

- DIN-VDE 0682-621 Live Working – Suction device for the cleaning of live parts with rated voltages above 1 kV up to 36 kV,
- EN 60832-1; Live Working – Insulating sticks and attachable devices – Part 1: Insulating sticks,
- EN 60832-2; Live Working – Insulating sticks and attachable devices – Part 2: Attachable devices.

Test voltages:

- 100 kV / 30 cm – sticks (foam-filled tube),
- 84 kV – pipes (hollow tube),
- 43,2 kV – tools,
- 43,2 kV / > 0,20 mA – pipes (hollow tubes).

Dielectric properties are confirmed in specialized laboratories, both before the first delivery and during use.



Vacuum Cleaner

An important element is an industrial vacuum cleaner with a minimum vacuum of 250 mbar.

Personal Protective Equipment

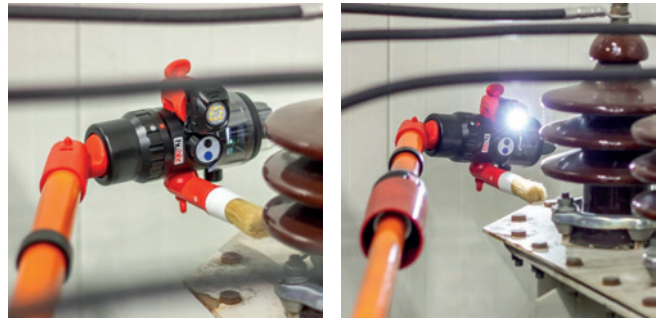
- Dielectric gloves adapted to the voltage of the cleaned power equipment.
- Electrically insulating helmet with face shield.
- Protective clothing made of flame-resistant material.

The above-mentioned equipment must be selected in terms of the category or class of hazards that may occur during use for a given power device, including voltage and arc rating.



Electrically Insulating Inspection Camera

Portable, remote-controlled, and stabilized electrical insulating camera designed for inspection of energized power equipment's elements.



Insulating Liquid

For wet cleaning, a liquid with electrically insulating properties is used, intended for cleaning power equipment.

Tools Storage

The tools are stored in transport boxes.

Training

It takes up to 5 weekdays, at an adapted training ground and on an energized network. The training is conducted by Trainers and it's based on the LW-I.

It is completed with the issuance of a certificate of increasing professional qualifications.

Sample training plan:

- Day 1 – familiarization with the organization of live work and the requirements for tools.
- Day 2 – getting to know the training ground, tools. First works.
- Day 3 – live works on training ground equipment.
- Day 4 – live work on energized network.
- Day 5 – theoretical and practical exam at the training ground.

Procedure for the performance of works

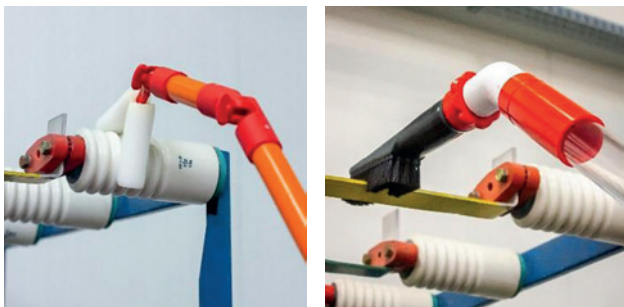
MV Substation Inspection and Cleaning in Live Working technology is performed on a written order.

The MV live working zone is strictly defined in the LW-I. This is an area into which only Live Working Tools may be introduced.

For the safety of operators, air humidity and temperature are checked before starting work. The indications refer to the respective cutoff values or algorithm given in the LW-I. If they are exceeded, starting or continuing work is prohibited. It is a good practice to check with a thermal imaging camera. Any extraordinary values may be a reason to discontinue the Live Working procedure.

The tools are subject to inspection before starting work, the following are checked:

- legibility of markings,
- test validity date,
- general technical condition.



Tools that do not meet at least one of the above parameters cannot be used in the Live Working technology, they should be referred to a laboratory for verification.

Cleaning is done from top to bottom, using various brushes and nozzles along with other accessories in such a way as to remove dirt from all surfaces, both insulating, conductive and the structure of the device.



The suction nozzles and brushes must be kept clean while the work is in progress.



The first of the technologies performed is dry cleaning – by vacuuming and then, as needed, we clean it with the wet method. After cleaning, inspection is carried out with a camera.

Novelty

Until now, the inspection of the parts of the device that are invisible to the operator was carried out using a mirror. Due to the insulating properties, the mirror could not have a large area.

So, it wasn't the most convenient tool. The camera not only allows you to observe the live image, but also allows you to record this image. In conjunction with the wet cleaning method, it makes it possible to wash and read the rating plate of the device located in the inaccessible area. It can also be used to check the invisible parts of the device before cleaning it under power. It makes it possible to find elements left by other people conducting the other maintenance operation.

Benefits of using this technology

The aim is to rebuild the surface insulation of the device and to improve the heat transfer in the heat sinks.

Additional losses are eliminated (excessive overheating and leakage from contaminated insulators).

A natural overview of the entire device is made by observing the cleaned surface.

Parts of the device that are not visible to the operator can be carefully checked with a camera after cleaning.

No shutdown of the device for the time of cleaning and inspection.



Conclusions

Inspection and cleaning of MV substations in the technology of working under voltage allows to check the technical condition of the device without the need to turn it off.

BIBLIOGRAPHY

- [1] Ordinance of the minister on health and safety at electrical power equipment of August 28, 2019.
- [2] Standard EN 50110-1 – Operation of electrical installations Part 1: General requirements.
- [3] DIN-VDE 0682-621 Live Working – Suction device for the cleaning of live parts with rated voltages above 1 kV up to 36 kV.
- [4] EN 60832-1; Live Working – Insulating sticks and attachable devices – Part 1: Insulating sticks.
- [5] EN 60832-2; Live Working – Insulating sticks and attachable devices – Part 2: Attachable devices.
- [6] Instructions for the organization of Live Working of Polish power grid operators.

www.hubix.pl

hubix
SAFETY IN POWER