Question 3.3: What other recent innovations have been implemented or should be implemented to improve the safety of OHTL workers?

Contribution: From overhead transmission line workers point of view, the safety of linemen should be categorized into bare hand working and vicinity working. While in the former case the main risk is caused electric field, in the latter case the electromagnetic induction means a risk factor.

High electric field strength emitted by energized overhead transmission lines can cause health issues in the long term. Therefore, the health limit values regarding exposure values recommended by such international organizations like WHO or ICNIRP should be strictly kept during live working. The occupational limit of electric field exposure is 10 kV/m for a maximum time frame of 8 hours per day. Laboratory and field measurements showed that the electric field inside of a conductive clothing can exceed the limit set by the standard, which is caused by Faraday holes in the clothing. As the previous version of the main standard (IEC 60895) for conductive clothing inspection didn't require face protection the classify a garment as appropriate, several simulations and laboratory measurements had been carried out to find out the electric field strength inside a conductive clothing. The main results is how the electric field strength in the hood of the conductive clothing depending on the face mesh type, which is shown in Figure 1. The studies showed that the use of a face mesh effectively eliminates the problem of the exceeding limit values.

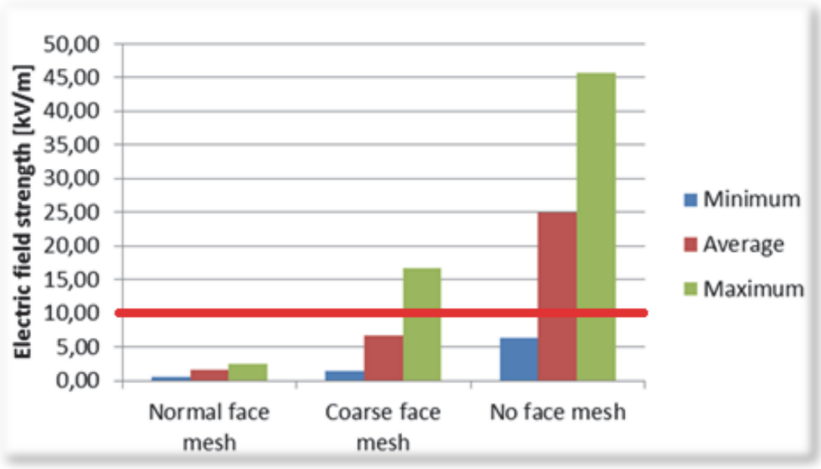

Figure 1. Electric field values in case of different scenarios regarding the use of face mesh

As the measurement of screening efficiency is performed in a vertical electric field according to the standard, a new method for screening efficiency measurement was proposed to filter out conductive clothes without face mesh. A mannequin with a conductive surface in the conductive clothing shall be placed in a homogenous, radial electric field with amplitude of 100 kV/m, as it is shown in Figure 2.

In the case of conductive clothing's fit for the new measurement methodology, it is guaranteed that the electric field strength inside the clothing doesn't exceed the 10 kV/m threshold limit.

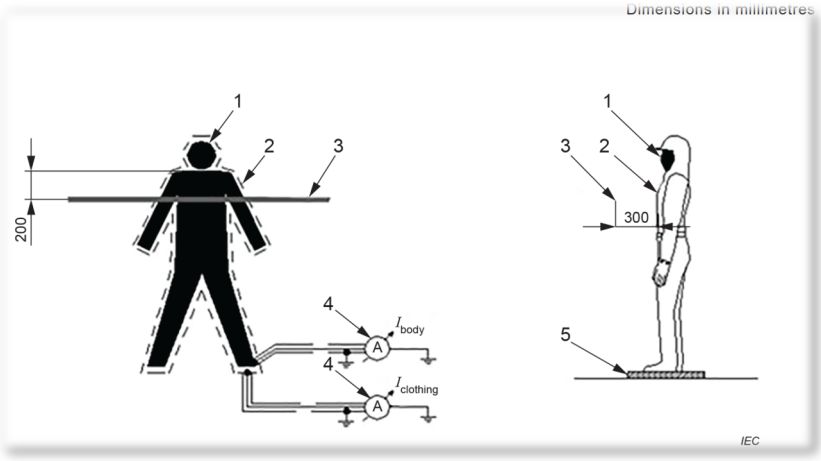

Figure 2. Proposed method for clothing examination

In the case of vicinity working, the linemen are working on the deenergized parts of the network, while energized elements can cause potential rise or loop current on the maintained equipment. This induction phenomenon poses a safety risk during vicinity working.
Therefore, a new type of clothing was developed to protect linemen during vicinity working (e.g.: passive side of a double circuit line, railway environment, line crossings, etc.). This special type of conductive suit can conduct 50 A current for 30 s time interval in order to protect humans against electric shock, while shunting the fault current from the human body. The purpose of the allowed low body current threshold value is to give an opportunity to the worker to disconnect from the electrical circuit in case of an electric hazard. This type of clothing ensures that no more than the let go current (6 mA) flow through the worker's body. During current injection, the resistance of the suit causes an increase in temperature, however, the suit also prevents 2nd degree burn injuries. Laboratory tests were carried out in the High Voltage Laboratory of Budapest University of Technology and Economics, where the developed AC induction suit was inspected in different body configurations, while the clothing current, body current and temperature profile of the clothing were continuously monitored, as it is shown in Figure 3. The laboratory tests showed that the developed garment can protect field workers from AC induction hazard, even in the case of human error or accidental coincidences.

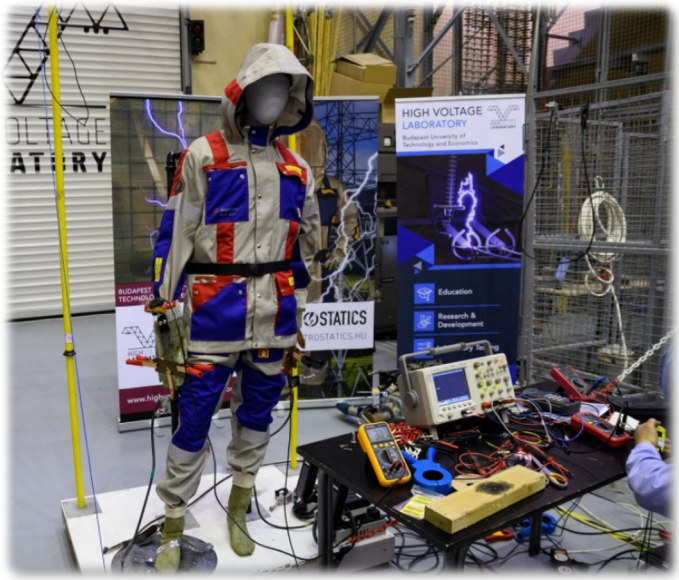

Figure 3. Laboratory testing of AC induction suit

State-of-the-art innovations include a concept and realization of a smart conductive clothing, which can sense if all the bondings are connected on the clothes and its accessories. If not, it warns the user about the potential hazard. Moreover, this solution can sense if the clothing is exposed to induced current in which case it warns for the re-examination of the clothing.

Figure 4. Conductive clothing with smart sensor