

Leakage current measurement of protective equipment insulating materials used in electrical installations

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Abstract. This research describes the behaviour of equipment and safety devices during use in extreme environmental conditions, in order to establish the technical conditions and additional health and safety requirements during operation, to ensure the health and safety of users, regardless of conditions and working environment in which they are use. The studies have been conducted both on new equipment and means of protection used in electrical installations. There has been evaluated protective equipment made of insulating rubber, reinforced fiberglass or PVC. They have been followed the technical characteristics and protection against electric shock by measuring the leakage current of different insulating materials.

1. Introduction

Following the studies in the power system regarding the risk assessment in transport, distribution and use of electricity, it was observed that a significant proportion of the overall risk factors generated by work equipment (means of production) is given by the equipment and means of protection. If this risk factor is detailed, it can be found that there is a large percentage of equipment and means of protection in use that are not checked regularly, and technically damaged and some of the workers do not know how to use them, including the technical characteristics and environmental conditions in which they can be used. A significant proportion is occupied by the protective equipment and means of protection which have not been diagnosed or assessed and certified from technical point of view to meet the essential safety and health requirements, in accordance with national and European legislation in force.

The total leakage current is obtained by adding the partial currents, namely, multiply leakage current circuit corresponds to the number of circuits and leakage currents are added intensity, then because of connecting motors and appliances. In figure 1 is presented a diagram regarding the weight of risk factors identified in the use of equipment and protective devices.

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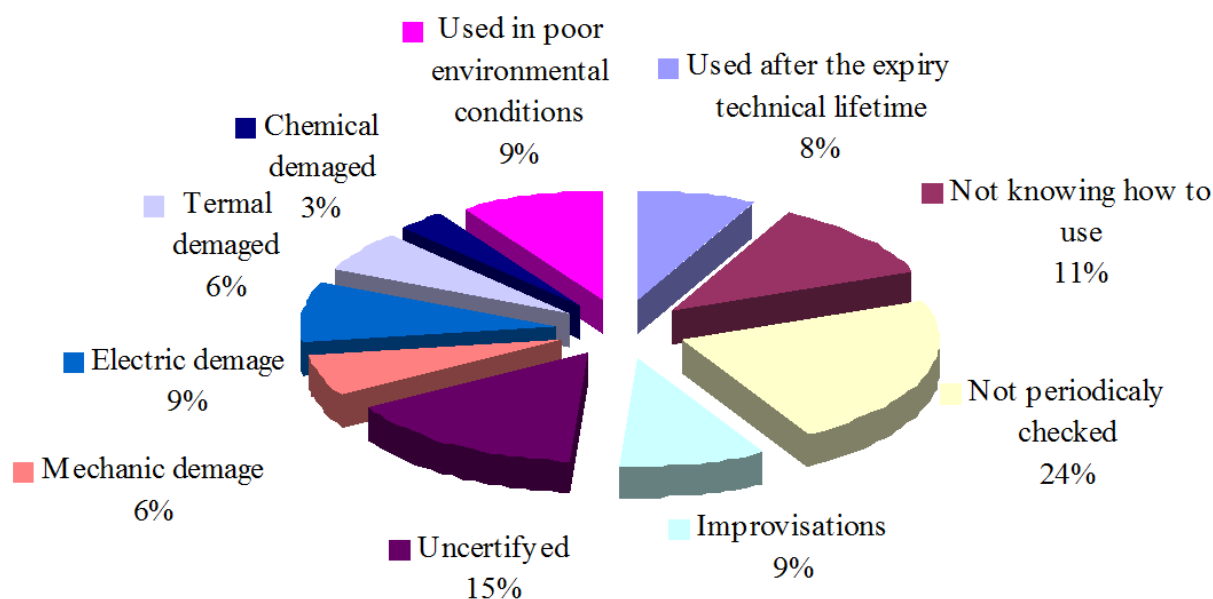


Figure 1. Weight of risk factors identified in the use of equipment and protective devices.

2. Safety requirements for equipment and means of protection used in electrical installations

Protective equipment and means of protection, used in electrical installations, are designed to protect workers and unskilled people in work areas, and near electrical installations, by the dangers of electricity.

In this regard, to ensure the safety and health of workers, new or in use protective equipment and means of protection must be evaluated, in terms of compliance with the minimum safety and health requirements, before being put on the market:

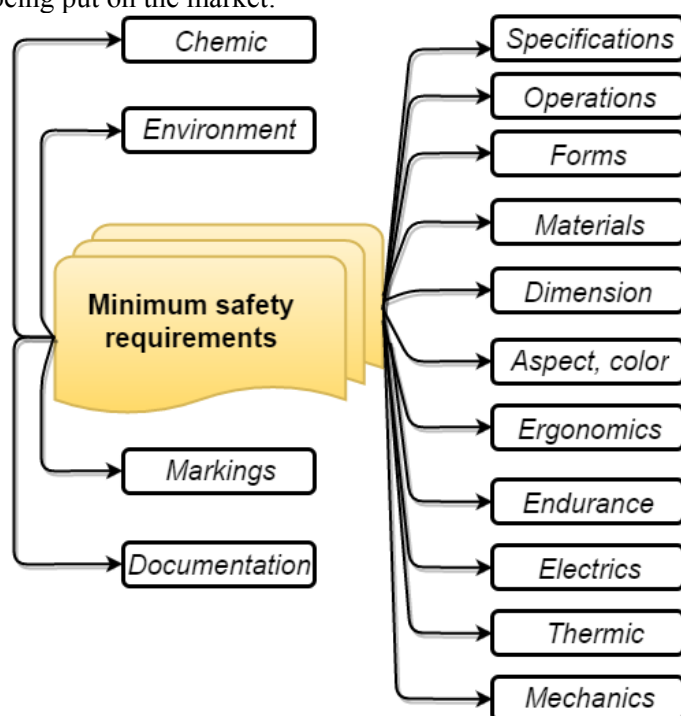


Figure 2. Minimum safety requirements for equipment and means of protection.

Consequently they must ensure the safety function for which they were made, so that failure or damage during use or malfunction does not endanger exposed persons. Protective equipment and means of protection used in electrical installations have to: (GD 457, 2004), (GD no. 1146, 2006)

Protect against dangers of electricity, so that:

- People should be protected from the danger of injury that can be caused by electric shock;
- Insulation of protective equipment and means of protection are appropriate for the provided conditions (e.g. rated voltage, work environment).
- Do not produce temperatures, arcs, radiation or fire;
- The construction of the protective equipment and means of protection is ergonomic and appropriate for working environment;

Provide safety against the dangers arising from external influence, so that:

- to meet requirements for physical and chemical conditions;
- to provide immunity to the effects resulting from environmental conditions;
- to provide immunity to electromagnetic interference and do not disrupt the operation of other electrical and electronic equipment.

Meeting these minimum requirements, are the main criteria for assessing the quality of safety of equipment and means of protection whether they are new or already in use.

2.1. Study on protective equipment and means of protection that are in use in electrical installations

In electrical installations there are possible many defects, complex as progress and the effects that they can produce. From the multitude of defects that can occur in electrical installation, it is of interest, for work equipment, equipment and means of protection, in terms of accidental voltage, the failures consisting in damage, breakthrough and creepage of insulation.

In this sense, the studies have been conducted both on new equipment and means of protection and in use in electrical installations. There has been evaluated protective equipment made of insulating rubber, reinforced fiber glass or PVC. They have been followed the technical characteristics and protection against electric shock.

There have been evaluated new means of protection which have been immersed in water, conditioned at extreme temperatures and oil. It was followed for three years the behavior of the technical and protection characteristics of equipment and means of protection for use in wet environments, environments with extreme temperatures, and environments with dust, static electricity and oil.

2.2. Results and discussions

From the tests conducted on various rubber insulating protective equipment and means of protection, it has been found, after verifying dielectric strength after conditioning, that the colour has an influence over insulation strength. It is found that for the same product with the same rubber recipe to which was added different color, the leakage current is different.

In figure 3, are presented the leakage current values of a group of 30 insulated mats having blue, black and red colour. Test voltage was 20 kV for Class 1 electrical insulating mats. The electrical insulating mats were tested in normal environment (ASRO, SR EN 61111:2010).

In order to validate this conclusion, it was tested and other protective equipment and means of protection, made of insulated rubber. A batch of insulated platforms of different colours (brown, grey, dark-grey, black), from the same producer, made of the same rubber, was evaluated and tested in normal dielectric environment, and conditioned by immersion in water and extreme temperatures.

In figures No. 4 ÷ 8 is presented the leakage current value for a group of 12 rubber insulated platforms, having brown, light grey, dark-grey and black colour. Test voltage was 40 kV. There is no national or European standard applicable for insulated platforms.

In figure 3, are presented the leakage current values of a group of 30 insulated mats having blue, black and red colour.

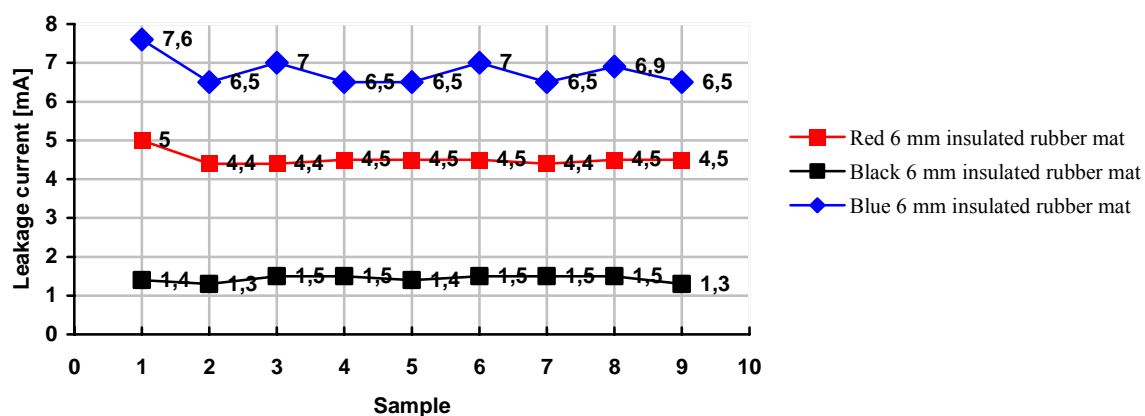


Figure 3. Leakage current – Electrical insulating matting.

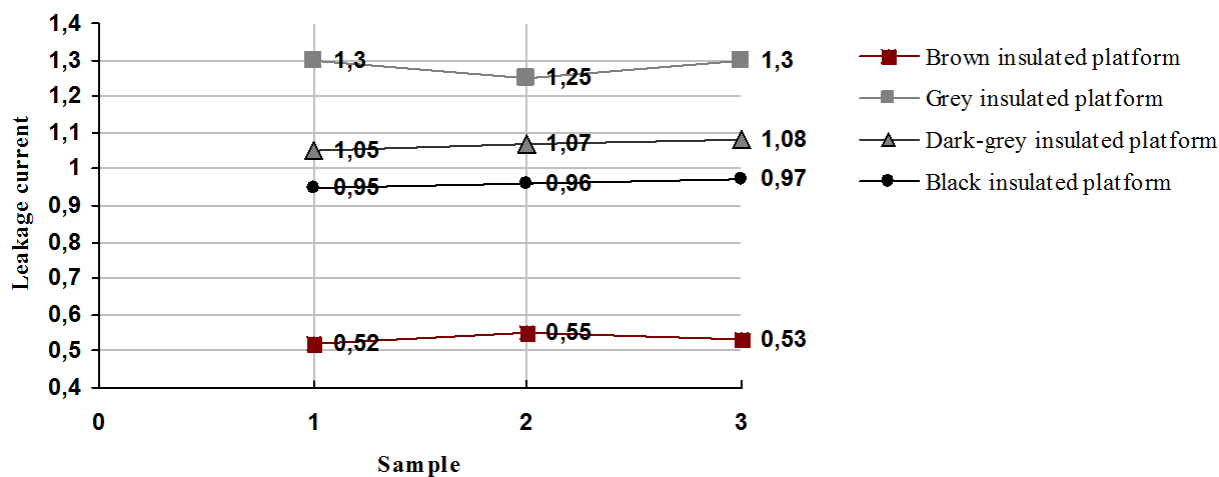
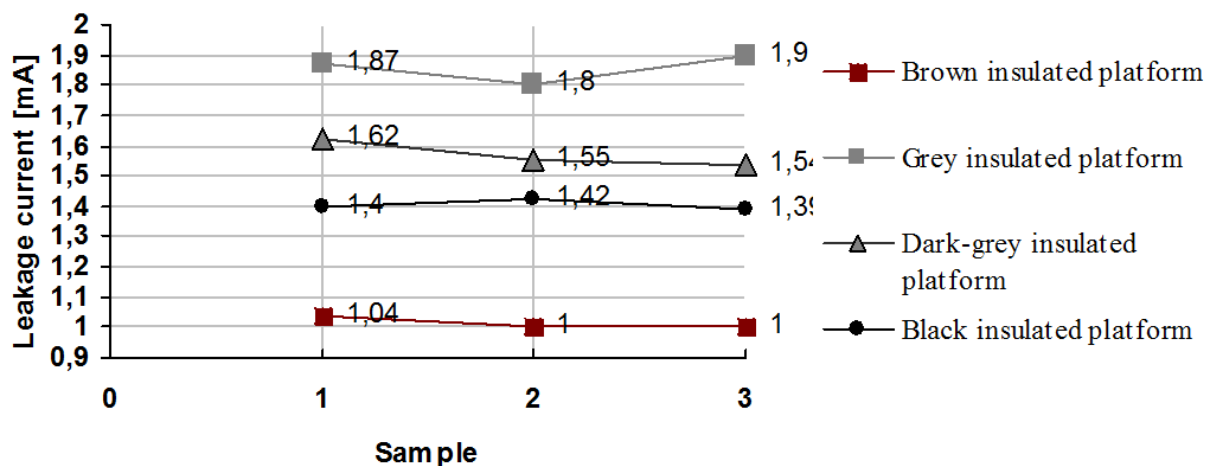
Figure 4. Leakage-current values - in normal environmental conditions ($20 \pm 23^{\circ}\text{C}$).

Figure 5. Leakage-current values – after immersion in water.

To establish the test voltage of 40 kV, it was taken into consideration the technical norm 3RE-I2-83 - "Instructions for electrical testing of the means of labour protection", "Test procedures on insulated

platforms / culverts" developed after following studies and research by the Electric Risks Laboratory through ICSPM-CS Certification Body within INCDPM "Al Darabont" institute and the Instructions issued by the transmission and distribution electricity facilities.

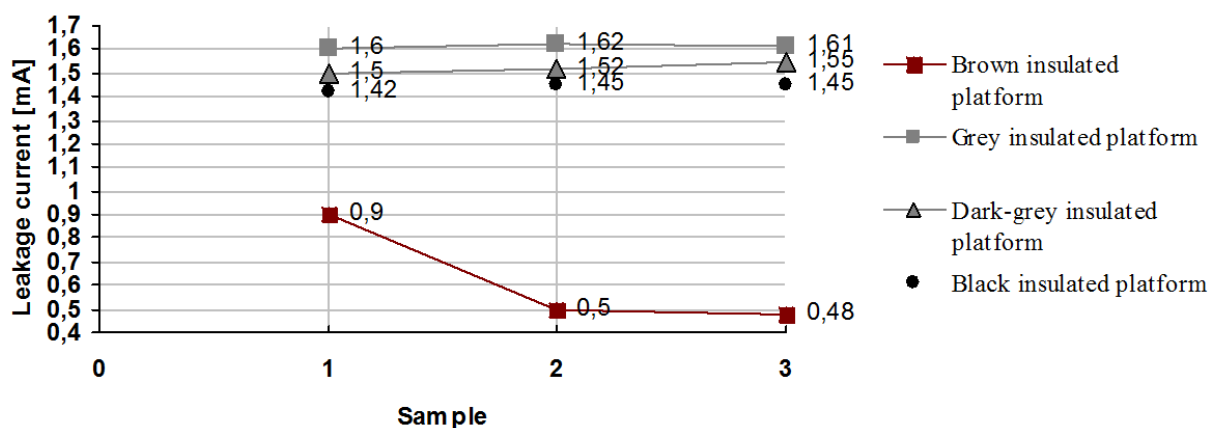


Figure 6. Leakage current values –low temperature conditioning (-30°C , 24 hours).

In concordance with the legal provisions on ensuring safety and health at work have established safety requirements for the following equipment and means of protection: insulated rods, carpets electrical, couplers fixed / mobile binding phase devices used in electrical installations with nominal voltage up to 1000 V ac 1500 V D.C.

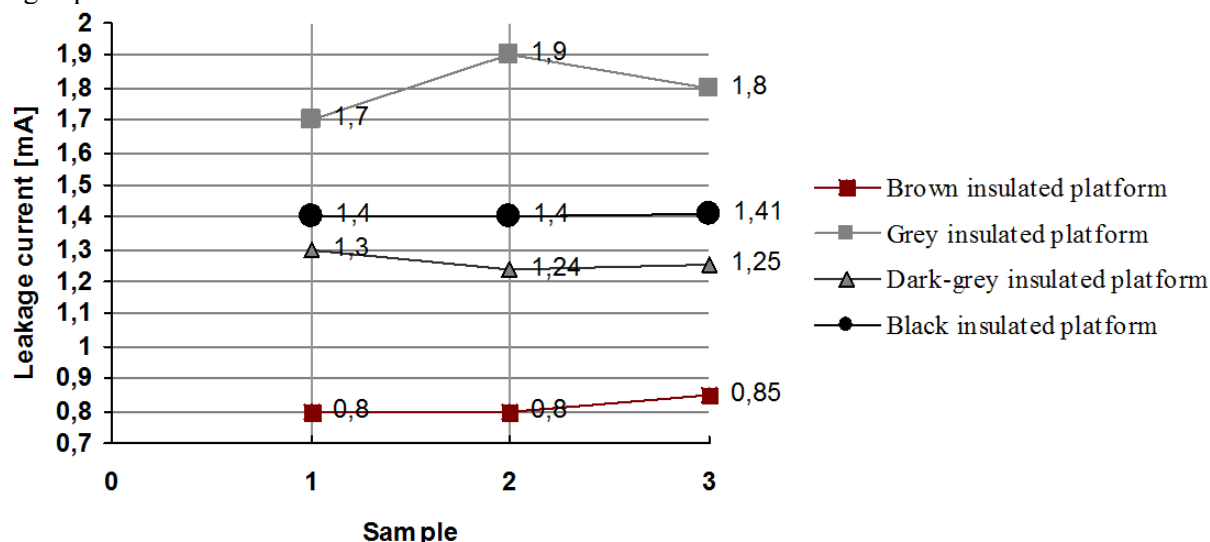


Figure 7. Leakage current values – high temperature conditioning ($+60^{\circ}\text{C}$, 24 hours).

The results have led to same conclusion that for the same product with the same rubber recipe for which was added different colour, the leakage current is different.

In this sense the producers of protective equipment and means of protection made from insulating rubber must take into consideration that the products on the market must be identical with the product submitted to the certification body for the certification procedure, respectively the safety assessment. Brown insulated platforms that have met health and safety requirements, have been certified and have been given in use for three years. It was followed during this time, technical and electrical insulation characteristics. Also it was monitored the protective behaviour in humid environments with extreme temperatures, with static electricity and steam edible oil, dust and lubricants for machines.

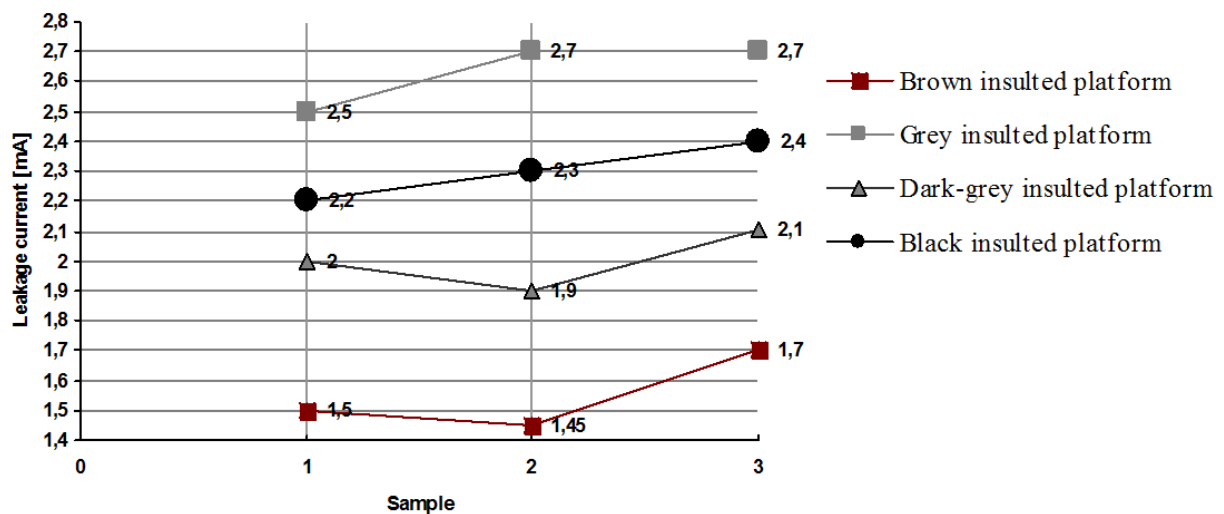


Figure 8. Leakage current values after conditioning in oil.

They must fully respect the characteristics (technical, functional, constructive) declared, including the colour, the material or the recipe. The results of the electrical characteristics respectively leakage current are shown in figure 9.

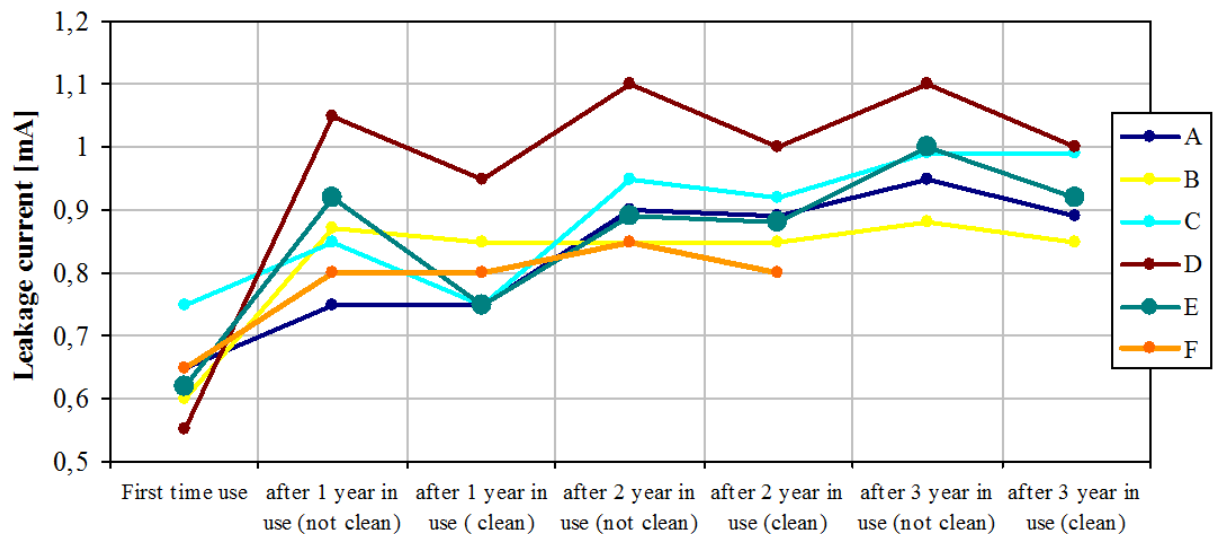


Figure 9. Leakage current values – insulated platforms.

The insulated platforms have been installed in front or behind the electrical board and electrical panels in production facilities. At the first time use and annually they were tested. The test method used was the “plate” method with the test voltage of 40 kV.

It was found that in time insulated material loses the electrical insulation properties due to ageing, coming into contact with oily solutions, with dust and so on, by the increasing leakage current, unable to keep the equipment clean.

Evaluating the results, it is recommended that the protective equipment and means of protection to be periodically tested for insulation characteristics, even if the producer or distributor do not specify in the technical documentation, and before every use, each worker should check visually the equipment for physical condition, including cleaning and if there are no faults (missing parts /components, cracks, nicks, burrs, foreign inclusions, etc.).

National legislation provides that electrical protective equipment and means of protection to be tested in accordance with the regulations and technical rules applicable before use, at the first time in use, after repairs or modifications and then periodically (in use) (GD no. 1146, 2006), (GD no 1091, 2006), but health and safety legislation in force does not specify which equipment and tools are subject to be periodically tested and their periodicity.

Periodically test of the protective equipment and means of protection used in electrical installations is a safety requirement. It must be required by the producers, meaning that it must be included in the technical specifications or in the instructions for use and to be imposed to users.

Health and safety policy at work with the integrated with environmental protection policy made by the management at the highest level and appropriated by all employees must include objectives concerning the protective equipment and means of protection in use in electrical installations.

The results of periodic safety tests and visual examinations are important information in risk management in an efficient enterprise for a better selection of protective equipment for the most appropriate control measures. Besides, management of risks generated by the protective equipment and means of protection in use, allow targeting the studies and research to develop better assessment procedures, diagnosis and testing.

3. Conclusions

When running the protective equipment suffers degradations and damage that alter the technical and safety characteristics and in this sense it should be periodically tested. Regular safety verifications guarantee efficiency of maintenance applied to protective equipment in use. Safety and health policy at work integrated with the environmental protection policy made by management at the highest level must include objectives concerning the protective equipment and means of protection. The results of periodic safety tests and examinations are important information in risk management in an efficient enterprise both for a better selection of protective equipment and for improving OSH measures.

For certain categories of equipment and protection devices there are not covered conditions related to design and production and there are no specific requirements established in the national or European standards, so in this papers was presented some technical criteria about security and methods evaluation.

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