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FISUEL INFORMATION LETTER
International Federation for the Safety of Electricity Users

Editorial

As I hand over the presidency, I would like simply say how much, after three years as President of FISUEL, I believe I have understood the complexity, but also the richness and full meaning of the adjective that defines our Federation: "International".
In reality, to be "international", that is to say, being represented on four continents, 20 countries together, is both a difficulty, but also a great opportunity.

***A difficulty** first of all because of the languages, it is obvious, but also because of concepts respective: what is evident in one place, because cultural or historical reasons, can not be in another place. As examples, some require evidence of third-party verification; others self-certification, or yet others the full responsibility lies with the tenant. These three approaches, among others, are different, and may, at first, constitute misunderstandings between their adherents. They do not have at all the same vision.*

However,
*It is also **an opportunity**, because in this diversity - once those initial barriers are surmounted - exchanges start, the ideas of some can be a source of inspiration for others, work on new matters - examples photovoltaics, electric vehicles, energy efficiency, cogeneration, ... - will possibly be commenced in common, that is saving time and making progress for everyone. That is the goal of our working groups.*

***Conclusion**: we are very lucky. Thanks to FISUEL, even, if it is not a straight one way street, without any initial difficulties, we will reach more readily achieve, each in our own country, our common goal : **the safety of electricity users and uses**.*
In addition for countries that are still in shadow, and who have not yet become aware of their responsibilities in this area "to ensure the safety of their citizens", the existence of our Federation is a light.
Finally, thanking the Directors who have been alongside me since 2008 and all the members for the support they have given me during my term of office, and confident in the future, I wish "good luck" to the new President of our Federation.

Romualdo ARIAS
President

News: new member to join FISUEL

Active member

In New Caledonia (an overseas country, part of France), COTSUEL (Territorial Committee for Safety of Users of Electricity) is the only organisation authorized to issue the certificates of compliance for electrical installations.

Association (in accordance with the 1901 Metropolitan Law) created by the Government (territorial Deliberation No. 468 of November 3, 1982), this third party organization was born of the willingness of local authorities and the electricity sector (installers and energy distributors), who wanted to establish an independent body able to rule on the conformity of electrical installations.

CONSUEL, in Metropolitan France, has been one of the architects of the successful setting up of COTSUEL.

Indeed it is the Articles and working methods of this "brother", which were selected for its mission to require the verification of electrical installations.

Today, COTSUEL's know how is developed from nearly 30 years of experience of daily contacts on the ground, with all professionals in the electrical industry. A know-how inseparable from the uniqueness of the method used – verification by directed sampling, which combines efficiency and lower cost – and also from the rigour with which it is applied incarry out the mission entrusted to COTSUEL.

Installations are divided into two "families", the installation in residential buildings and those in buildings subject to specific regulations (ERT, ERP, IGH)

COTSUEL handles every year an average of 3,000 certificates of which 2,500 for dwellings.

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Inspection of electrical installations in homes

Measurements are absolutely necessary

Present situation

Europe has an ageing housing stock. There are many homes with outdated wiring that is deteriorating, inappropriately amended or insufficient for the electrical loads of a typical household today. Many of the homes have never undergone any renovation their electrical installation, while, at the same time, the use of electricity in homes has been increasing during the last 40 years.

Fortunately, the principle of periodic inspection of the electrical installation is growing rapidly.

In this paper we will focus on the practice of inspections and we will emphasise the importance of carrying out measurements, in addition to the visual inspection.

Why inspection?

We cannot imagine homes without electrical installations. But electricity in the home introduces two major hazards: **fire** and **electric shock**. Electrical defects are one of the common causes of fire. It is known that electrical fires in residential buildings result in more damage and higher death rates on average than non-electrical fires.

Various studies have alsoshown that the costs associated with electrical fires in residential buildings are much larger than the costs associated with electrical shock casualties.

To counteract these hazards, the authorities and the standardisation bodies drew up wiring rules, which apply to the design and erection of installations.

There is no point in setting up these rules if it is not *verified* that they have been followed and thus an adequate level of safety has been obtained.

But the majority of the domestic electrical installations in Europe were built more than 30 years ago and do not comply with the present safety standards.

It is therefore important that *existing* installations are also inspected.

Definitions

Throughout this document we will use the following definitions, as given in the IEC 60364-6 " Low-voltage installations - Part 6: Verifications".

- ***Verification**: all measures by means of which compliance of the electrical installation with the relevant requirements is checked.*
- ***Inspection**: examination of an electrical installation using all the senses in order to ascertain correct selection and proper erection of electrical equipment.*

Note: the word "inspection" has replaced "visual inspection" indicating that all the senses (touch, hearing and smell, as well as sight) must be used.

- ***Testing**: implementation of measures in an electrical installation by means of which its effectiveness is proved.*
- ***Maintenance**: combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function.*

Initial and periodic verification

A distinction is made between initial and periodic verification.

Initial verification

The initial verification takes place upon completion of a new installation or upon completion of additions or alterations to existing installations.

The aim of the **initial verification** is to determine whether the requirements of all the applicable prescriptions have been met. This is achieved by *inspection* and by *testing*.

Before testing begins it is important that a full **inspection** of the complete installation is carried out.

This is to confirm that the electrical equipment and materials:

- Are in compliance with the safety requirements of the relevant equipment standards
- Have been correctly selected and erected to the relevant rules and regulations and to the manufacturer's instructions, in order that is performance is not adversely affected
- Are not visibly damaged so as to impair safety
- Are suitable for the prevailing environmental conditions

This is done by checking the method of protection against electric shock, the protection against thermal effects, the precautions against propagation of fire, the selection of the conductors for current-carrying capacity and voltage drop, the choice and settings of the protective devices, the presence and the correct location of suitable isolating and switching devices, the selection of equipment and protective measures appropriate to external influences, the correct identification of the circuits, overcurrent protective devices, switches, terminals, ..., the presence of diagrams, warning notices or similar

information, the adequacy of the connections of the conductors, the presence and adequacy of protective conductors, including equipotential bonding, the accessibility of the equipment for convenience of operation, identification and maintenance.

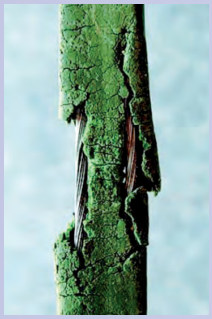
In practice, this means checking the following items: good workmanship, separate circuits, adequate number of circuits, adequate number of socket-outlets, all circuits suitably identified, a suitable main switch provided, main isolators to break all live conductors, main earthing terminal provided, correct fuses or circuit breakers installed, all connections secure, the installation earthed in accordance with national standards, main equipotential bonding connects services and other extraneous-conductive-parts to the main earth facility and supplementary bonding has been provided in all bath and shower rooms.

More specific, concerning the protection against direct contact, the following items will be checked:
- Insulation of live parts,
- Enclosures have a suitable degree of protection appropriate to external influences,
- Enclosures have cable entries correctly sealed,
- Enclosures have unused entries blanked off where necessary.

After inspection, **testing** will be carried out.

The following tests should be carried out: continuity of conductors, insulation resistance of the electrical installation, protection by SELV, PELV or by electrical separation, automatic disconnection of supply, measurement of the resistance of the earth electrode, measurement of the fault loop impedance, polarity test, functional and operational tests, voltage drop.

When the results of the initial verification are positive, the electrical installation is in a good condition. But does the installation retain its good



condition? Periodic verification will be necessary to verify that condition.

Periodic verification

Although is true that electrical installations do not deteriorate quickly, and therefore do not require much maintenance, they do not however retain their original condition: damage, corrosion, degradation of material, degradation of the insulation (the insulation hardens and it can crack), connections become loose, excessive electrical loading, ageing, environmental influences, normal wear and tear, …

Apart from deterioration over the years, the functionality of the electrical installations does not follow the ever-changing needs of its occupants:
- More power sockets are needed. A recent survey in the UK reveals that two-thirds of the Britons say that they don't' have enough plug sockets in their homes!
- More lighting points are needed,
- There is an increased awareness of safety, therefore:
  - There is a need for an earthing arrangement,
  - There is a need for RCD's (Residual Current Device).

Therefore the electrical installations should be maintained in a good and safe condition to prevent danger. Part of this maintenance should be a regular verification that includes an appropriate system of inspection and testing.

A periodic inspection is an inspection on the condition of an existing electrical installation to identify, in order of priority, any deficiencies against the safety standards for electrical installations. Periodic inspections should comprise a detailed examination of the installation. They can be carried out without dismantling, or with partial dismantling the electrical installation.

A periodic inspection will reveal if any of the electrical circuits are overloaded (and thus that more circuits should be provided) and will reveal other potential electrical shock risks and fire hazards in the electrical installation.

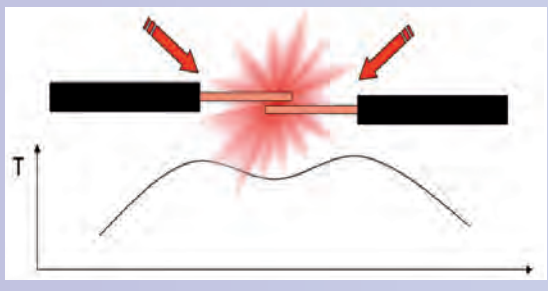
By using a simple, inexpensive system of looking for visible signs of damage or faults, some of the electrical risks can be controlled. But, this will need to be backed up by testing.

Is a periodic inspection needed?

Every installation deteriorates with use and age. Therefore one must be sure that the safety of users is not put at risk and that the installation continues to be in a safe and serviceable condition.

Let's have a closer look at the main parts of the installation that play a important role in the safety of an existing electrical installation.

Connections



In case of a bad contact, the resistance of the contact increases, causing a temperature rise. As this happens on a small surface, there is a limited heat drain and the temperature raises even more. Soon the insulation, or other materials in the vicinity, will lose their properties and a fire can occur.

A study has shown that a bad contact of 0,5 ohm had risen to 1 ohm after one week and to 10 ohm after one year!

The tables below give a good indication of the amount of heat generated by bad contacts, compared to contacts in good condition.

Values with a good connection:

Curent A	Voltage drop, mV	Heat developed, mW
20	4 – 10	80 - 200
15	3 – 8	45 - 120
10	2 – 5	20 - 50
5	1 – 3	5 – 15
0,8	0,15 - 0,4	0,1 - 0,3

Values with a bad connection:

Curent A	Voltage drop, mV	Heat developed, mW
20	1000 – 2000	20000 - 40000
15	1200 – 1400	18000 - 36000
10	1500 – 3000	15000 - 30000
5	2000 – 4000	10000 – 20000
0,8	4000 - 7000	3000 - 5000

One of the best methods of verifying this condition, and even visualising it, is by carrying out thermographic controls. Thermography is a non-contact method for measuring the temperature and is based on the fact that every body emits electromagnetic radiation.

Wiring

There are two types of risks:

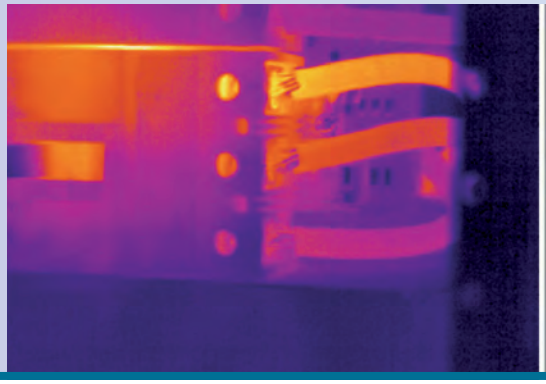
- External exposure of the cable to a fire originating in other combustible materials. The cables consist for the largest part of insulation material (70 %), which means that there is a lot of combustion material involved.
- Or internal overheating due to overloads or short circuits in cables.

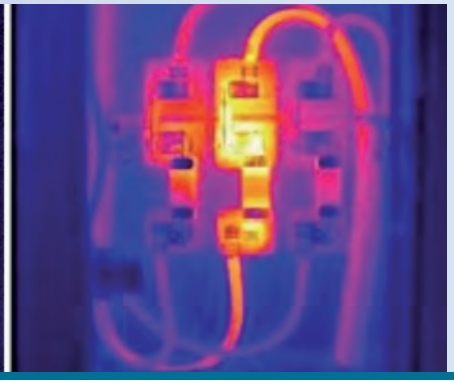
Across the UK, there are over 9,000 electrical fires each year, and more than a third of those fires are being caused by inadequate or faulty wiring. A periodic inspection and testing of the condition of the cables could be a lifesaver.

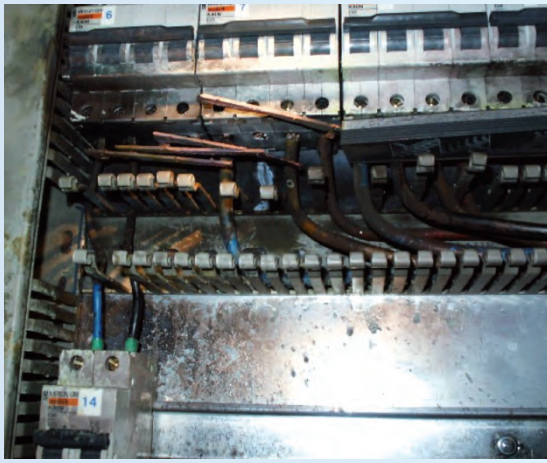
An American study revealed that the leading item first ignited in residential electrical fires is the insulation around electrical wires and cables (30,2%). The study showed that 38% of all deaths from fires in residential buildings came from insulation around electrical wires.

In most cases, the fires caused by defective or worn insulation were closely related to old electrical wiring.

Fires initiated by arcs can be caused by short circuit arcs, due to by defective or worn insulation, or caused by arcs from faulty, loose or broken conductors, or from switches.







Aluminium wiring poses additional hazards. High temperatures develop at failing circuits and bad connections, which can lead to fires. Studies have shown that aluminium-wired connections in homes have a very high probability of overheating compared to copper-wired homes. A large number of connection burnouts have occurred in aluminium-wired homes, resulting in many fires involving injuries and deaths.

When is a periodic inspection needed?

It is generally accepted that an electrical installation should be inspected every 10 years. In IEC 60364 the 10-year interval is referred to. Unfortunately periodic inspection is not compulsory in all countries.

When a circuit breaker trips frequently, or sockets or switches or fuse panels become hot or display burn marks, an inspection and further maintenance is required.

Another reason to have a periodic inspection is when modifications have been made to old or existing installations. Structural changes, or changes in the use of an installation, can impair the safety of the installation. Another good reason is to have an inspection of the electrical installation, as is done in Belgium, when there is a change of ownership.

What to inspect?

The periodic verification will mainly take into account the following:

- Adequacy of the earthing and bonding
- Suitability of the switchgear and controlgear
- Serviceability of the equipment (switches, socket-outlets, light fittings) by careful examination for signs of overheating
- The wiring system and its condition (old types of cables, insulation of the cables);
- Provision of RCD's;
- Presence of adequate identification and notices;
- Extent of any wear and tear, damage or other notices;
- Changes in the use of the premises, which can lead to deficiencies in the installation.

As during the initial verification, it is necessary to have both inspection and tests and measurements. The measurements will give a good indication of the status of the electrical installation and particularly of the cables and the contacts.

Some tests will have to be carried out without the supply connected, whilst others can only be performed with the installation energised.

Tests that can be carried out with the supply connected: continuity of the protective conductors, equipotential bonding, earth electrode resistance, earth-fault loop impedance, correct operation of the RCD's, correct operation of switches and isolators, …

Taking into account the importance of the cables and contacts in an electrical installation, the testing of their condition requires tests to be carried out without the supply connected.

How to test the quality of the cables?

The most important test carried out during the verification of an electrical installation is related to the verification of the insulation quality. As said before, insulation deteriorates with age, some insulation will have been subjected to mechanical wear and tear, cables might have been subjected to overloads, which causes excessive heat, etc…

What happens when the insulation deteriorates? The current flowing through the insulation will increase and can attain dangerous values, causing electrical shocks and fire.

The quality and the condition of the cables is verified by measuring the *insulation resistance.*

How to measure the insulation resistance?

Principle: apply during a defined time a stable continuous voltage, measure the resulting current in between the two parts under test and check with the ohmic law that the insulation resistance is higher than the minimum value required by the standards.

The measurements are carried out with an insulation tester. The insulation tester will be used during the initial verification and will eliminate shirt-circuits or short to earth faults. During periodic verification, the insulation tester will help to test the integrity of the cables by revealing insulation failures, which could result in shock and fire.

The test is made between the active conductors (phase and neutral) and the PE (protective conductor) connected to the earthing arrangement. For the purpose of this test, active conductors may be connected together.

The dc voltage applied between the live conductors (de-energized) and the earthing arrangement will cause a very small current to flow through the conductor and the insulation. The higher the current, the lower the resistance (R=E/I). The current will increase as insulation deteriorates.

A low insulation resistance means that a leakage current is flowing through the insulation to earth. This leakage current could shock an individual if there is no RCD or if there is an accidental interruption of the Protective Earth conductor. A leakage current of 500 mA can generate enough heat to ignite the surrounding materials and this can give rise to a fire.

According to the IEC 60364-6, the following table applies:

Minimal values of insulation resistance

Nominal circuit voltage V	Test voltage d.c. V	Insulation resistance MΩ
SELV and PELV	250	≥ 0,5
Up to and including 500 V, including FELV	500	≥ 1,0
Above 500 V	1000	≥ 1,0

The insulation resistance, measured with the test voltage indicated in the table, is satisfactory if each circuit, with the appliances disconnected, has an insulation resistance not less than the appropriate value given in the table.

However, where a reading of less than 2 MΩ is recorded for an individual circuit, there is the possibility

of defective insulation and it may be necessary to remedy the situation by replacing the cable.

Costs involved

The cost of the insulation tester is not excessive and the extra time needed to measure the insulation resistance when carrying out a verification is small compared to the advantage of having a good picture of the quality of the electrical installation. Bad contacts can be remedied and bad cables can be replaced before a fire breaks out.

Conclusions and recommendations

One must not necessarily say that all old wiring in the homes is a hazard. The main point is: what is the condition of the cables and their insulation? Insulation becomes damaged when it is pierced or when it undergoes other mechanical damage, but also when a circuit is overloaded. The cable becomes hot and after a certain period of time, the insulation will crack.

It is clear that a verification of an existing electrical installation without testing does not go far enough to give a good indication of the state of the most important safety issue of an existing installation: the insulation quality of the cables. It will only reveal visible damage to the electrical equipment due to wear and tear and mechanical damage and, when no test and measurements are carried out, it could give a false sense of safety.

Therefore verification should always comprise an inspection and tests.

A lot of home fires can be avoided if the electrical installation is tested with an insulation tester and if the cables that are not up to standard, are replaced.

To avoid the problem of bad contacts, it is a good practice to replace the cable completely when a section of a cable is damaged.

It is good practice to remove obsolete cables to reduce potential fire load. There is better fire performances by the new vinyl compounds, compared to that of traditional compounds

Due to the specific hazards related to the use of aluminium wiring, as was used in the homes in Eastern Europe, it would be a good practice of replacing them by copper wiring at the first sign of degradation or bad contacts.

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From left to right: Deputy Minister for Electricity Mr Saleh H. Alawaji, Philippe André, Treasurer vice-president of Fisuel, M. Saud Al Jibreen (AMAD) Riyadh Forum, 6-7 December 2010.

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