Maintenance of on-premise test equipment for high quality tests

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Abstract. The use of equipment in areas where flammable substances may be released requires explosion protection for them. Explosion protection must be confirmed in the certification process, which in addition to assessment also requires testing. The tests to which equipment must be subjected to confirm explosion protection are regulated by specific standards, depending on the type of protection adopted. This paper focuses on the issues involved in ensuring the quality of test results for low current equipment. For the quality assurance of test results the required aspects are: proficiency testing, use of certified reference materials, repetition of tests using the same methods, retesting of retained items, correlation of test results for different characteristics of a product and control chart where applicable. Another important aspect is the conditions of use and operating condition of the equipment. Thus, maintenance, periodic inspection and interim checks of laboratory equipment are an essential part of ensuring the quality of results. An important conclusion of the work is that the important aspect for quality assurance of test results is proficiency testing, which confirms not only the suitability of the equipment used but also the conformity of the test procedures.

1 Introduction

All the activities which involve flammable substance able to generate an explosive atmosphere when mixed with air, in the form of gases, vapors, flammable mists or combustible dust, may present an explosion hazard [1].

In the design phase of the equipment according to the operational role and the conditions provided for its operation, is chosen the type of protection that interferes the least with the operational role and that also offers the premises of acceptable production and use costs [2].

This paper aims to describe the maintenance and upkeep of laboratory equipment for the tests that take place in the LEExCs laboratory, focused on the issues involved in ensuring the quality of the results of frequent tests for low current equipment [3].

All equipment of an installation that processes flammable substances requires compliance with the requirements for explosion protection. The equipment must also meet the specific environmental conditions in which it operates.

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- to be properly protected against explosions;
- to maintain the level of protection for the conditions for which they were built;
- be able to withstand the (foreseeable) stresses to which they are subjected during storage, transport, installation and operation of the system.

Before equipment and protective systems used in potentially explosive atmospheres can be placed on the European market, they must comply with the ATEX Directive and the specific standards for explosion protection [4, 5].

The group of laboratories within INCD INSEMEX Petroșani is notified to NANDO with registration number 1809 for the competencies in the context of the ATEX Directive. The group of laboratories is also supervised by RENAR in terms of the ability to perform tests that comply with the specific standards of explosion protection.

The designed equipment is placed against the requirements of the specific standard in the equipment evaluation process. In this process, the equipment documentation and the specific standard are analysed.

In the next stage of the evaluation, one or more samples of the equipment are subjected to the tests required by the specific standard.

For samples initially tested, the capacity is confirmed by exposure to two full charge-discharge cycles in order to ensure that the tests can be performed with a galvanic element or a fully charged battery.

For the protection level ‘ic’ the maximum surface temperature is determined by testing the samples under normal operating conditions, with all protection devices in place.

For protection levels 'ia' and 'ib', each test sample (fully charged) shall be subjected to one of the most disadvantageous tests of the following: short circuit to discharge or other more disadvantageous conditions if otherwise specified by the manufacturer, and all current limiting devices outside the galvanic element or battery shall be short-circuited for testing.
Galvanic elements can be tested at any temperature between the ambient temperature in the laboratory and the specified maximum ambient temperature, under the most disadvantageous conditions [6-8].

1.1 Inspection and maintenance

Generally speaking, equipment maintenance is the set of all actions taken in order to maintain or restore the operating condition of an equipment, provided that it is intended to meet the requirements of the relevant specifications and to perform its intended functions.

In accordance with [9], ensuring the validity of the results is achieved by: regular use of reference materials; participation in inter-laboratory comparisons or proficiency testing programs; tests or calibrations replicated using the same or different methods; retesting of preserved objects; correlating the results for different characteristics of a product.

By controlling and monitoring the test equipment: the handling, storage and preservation of the test equipment shall be ensured in such a way as to maintain its accuracy and usability; the Yearly Plan for the verification and calibration of the test equipment used is maintained; only use and monitoring devices are used whose measurement uncertainty is known and compatible with the required measurement capability.

Periodic inspection and maintenance of laboratory equipment is an essential part of the activity of ensuring the quality of results. Many of the non-conformities can be attributed to improper use or maintenance of laboratory equipment.

For tests specific to the type of protection, there is used equipment which is functionally integrated in the test stands.
There have been taken into consideration the battery test stand and the small component ignition test stand according to [10] and the specific standard [4].

2 Stands description

2.1 Battery test stand

The battery test stand is intended for testing the maximum temperature of galvanic elements. It is used to test primary and secondary cells for use in Ex atmospheres.

The stand consists of AC/DC current probe E3N; digital precision multimeter FLUKE 87V; data acquisition and measurement AGILENT 34972A; with thermocouples type J; dual source TTi type CPX 200D; dynamometric screwdriver; high resolution digital oscilloscope model HD 09304; short-circuiting device type SIA-01; digital milliohmmeter CROPICO DO5001 (figure 1).

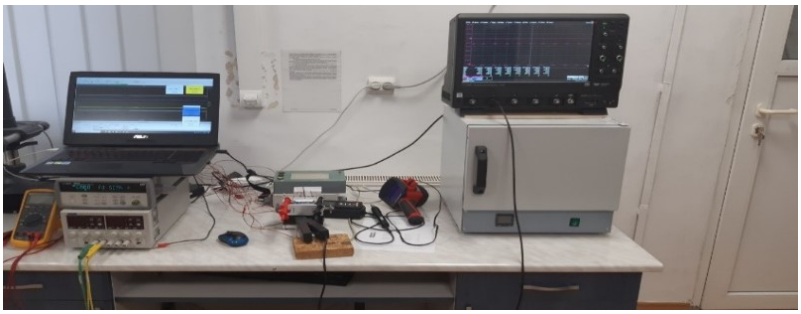

Fig. 1. Stand configuration for measuring the surface temperature of galvanic elements.

The maximum temperature obtained is influenced by the capacity of the galvanic element tested.

The parameters of the stand are:
- maximum measured temperature: 450^0C
- maximum intensity of short-circuit current: 100A
- maximum no-load voltage of the galvanic element tested: 9,999$V_{cc,}$
- maximum value of the internal resistance of the stand: 2,93 mΩ.

The thermocouple of type J is used for the temperature measurements (figure 2). The specifications of the thermocouple are shown as follows: Type J: Measuring range, -210°C to +760°C; diameter, 1.2 mm; Tolerance, ± 1.5K (for range -40°C ÷ 375°C);

According calibration certificate, the measurement loop uncertainty is 0.3 °C.

Elastic positioning of J type temperature sensor, with thermoconductive paste type ACCS0009 temperature range -50°C ÷ +205°C.

In the vicinity of the tested cell was installed the second J sensor intended for the ambient temperature meassurements.

The thermocouple is contacted to the surface with heat transfer compound. The used thermocouple is connected to a temperature recorder (Agilent 34972 A).

The fixing is done through elastic pressure of thermocouple wire to measured surface.

Fig. 2 Photos showing the used measurement devices for the temperature measurements.

The test procedure involves several phases (figure 3): verifying the integrity of the test stand, conditioning the test samples, testing, analysis and recording of results.

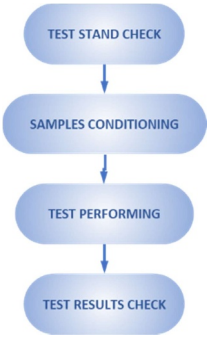

Fig. 3 Test phases.

Ensuring the validity of the results by ensuring the maintenance of the stand involves: periodic calibration of the equipment intended for measurements: current intensity, voltage, temperature but also intermediate checks during the tests.

Stand verification: verification of the operation of the power supply system; checking the control system; checking the electrical connection system of the test cells; checking the internal electrical parameters of the stand; checking the calibration of the measured parameters (temperature, current, voltage on the cell); cleaning the stand and the connection system of primary and secondary cells.

Stand overhaul: replacement of buttons, switches, limiters, measuring elements, other control / execution elements in the electrical circuit; recalibration / calibration / repair / acquisition of calibration elements used in the calibration of the test stand; replacement of elements for making electrical circuits for testing primary and secondary cells (testers, connection terminals, conductors, other components).

2.2 Stand for small components ignition testing

The small components ignition test stand (figure 4) is used to perform the ignition test for small components in electrical equipment intended for use in explosive atmospheres, components whose temperature exceeds the temperature allowed by the temperature class of the equipment.

Components: test chamber with glands; portable oxygen analyser type SERVOMEX MiniMP 5200 (0÷25 % v/v) provided with isolation valves; dual supply type CPX 200D or dual programmable source HAMEG type HMP 2020; igniter of the test mixture; data acquisition system type Agilent 34972A+Multiplexer 34901 A (20 CANALE); type K and/or J thermocouples; laptop ASUS G752VS with dedicated software for 34972A; flammable liquid supply system; flammable liquid evaporation vessel; thermal imaging room in IR type EasIR-4; isolation valves; ammeter pliers Chauvin Arnoux type KI;

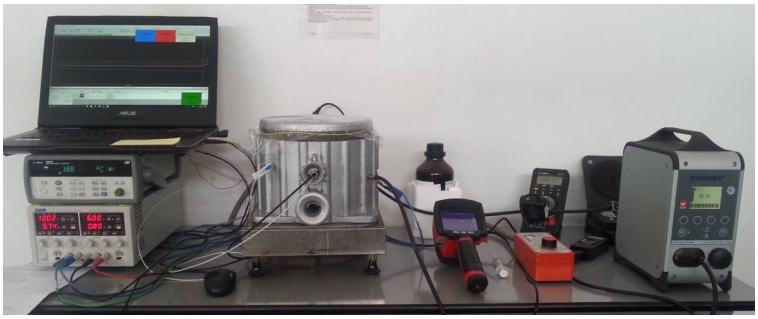

Fig. 4 Stand for small components ignition testing.

The ignition test for small components shall be performed on the test specimen in normal working conditions or under specified fault conditions, which generate the highest value of the surface temperature.

Ensuring the validity of the results by ensuring the maintenance of the stand involves: periodic calibration of the equipment intended for measurements: current intensity, voltage, temperature but also intermediate checks during the tests.

Stand verification: checking the integrity of the housing and accessories, checking the connection cable of the measuring probe, checking the accumulation of dust and dirt, checking the operation of the field (s) of use.

Stand overhaul: replacement of the components of the evaluated electrical circuits (testers, plugs / sockets / electrical connectors, conductors), overhaul of the preparation and supply installation with flammable substance or test mixture, replacement of isolation valves, overhaul of Chauvin Arnoux type K1 ammeter pliers, calibration / metrological verification.

The prerequisites for conducting quality tests, i.e. obtaining valid results in the test process, depend on the availability of specific standards and test procedures, the involvement of technically competent persons but also in the field of testing, maintaining the metrological traceability of measuring equipment to national and international references, ensuring proper environmental conditions in the test laboratory and ensuring the structural and functional integrity of the test infrastructure (according to Figure 5).

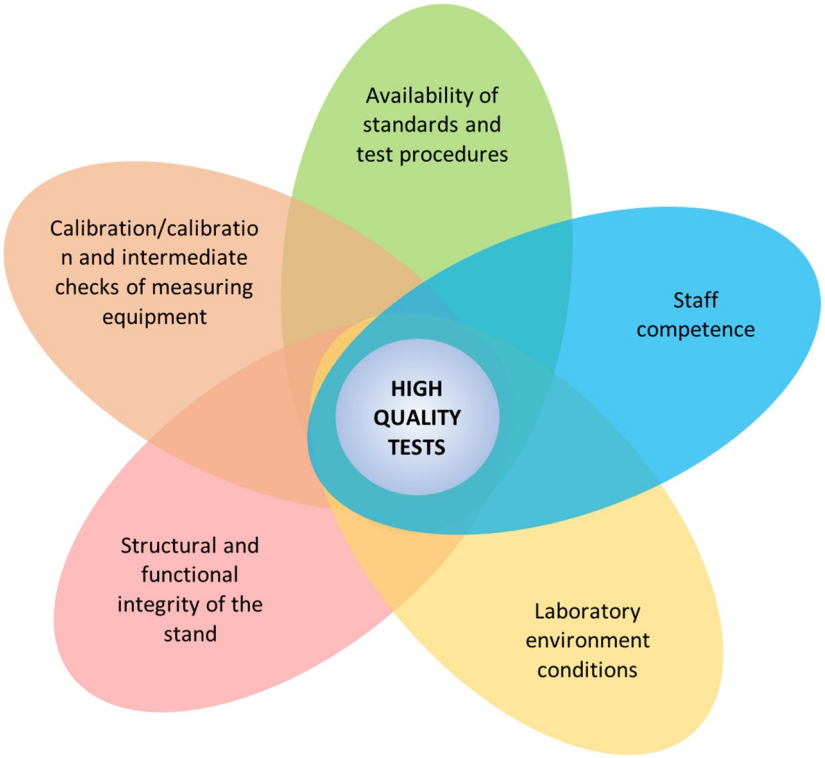

Fig. 5 Competing factors in ensuring the quality of tests.

3 Conclusions

In order to ensure proper quality level of the tests, several factors in the field of the quality system, in the field of human resources, and in the field of metrology are involved.

Increasing the quality level of the tests performed cannot be achieved without a holistic approach to the factors that influence the validity of the results.

The appreciation of maintenance activities can be considered as an investment, as it increases the productivity and accuracy of the equipment.

The quality of devices and tests is determined by an appreciable number of characteristics including those of reliability and maintenance, as an expression of them to the user.

It is necessary to increase the concerns for monitoring the devices through application of diagnostic methods and techniques specific to maintenance.

In conclusion, I wanted to highlight how important the maintenance and upkeep of laboratory equipment is in order to get the best possible results from laboratory tests.

4 References

1. MC-01 "Quality Manual"
2. Directive **2014/34/UE** (2014)
3. PS – 18 Ensuring Validity of Test Results
4. Standard EN IEC **60079-11** (2012)
5. Standard EN IEC **60079-0** (2018)
6. SR EN ISO/IEC **17025** (2018)
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8. SR EN ISO **9000** (2015)
9. PS -20 "The development and control of quality system documents can be ensured by monitoring and analysing the validation of laboratory tes t results"
10. PI-50 Safety tests for the type of protection Intrinsic safety