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CONSIDERATIONS REGARDING THE RESISTANCE TO IMPACT TEST APPLICABLE TO ELECTRICAL EQUIPMENT DESIGNED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES

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Abstract: For some types of protection, the equipment enclosure has an important role in providing explosion protection. Therefore, the explosion characteristics must be maintained even in case of a mechanical impact produced by an object falling on equipment's enclosure. The property of enclosure to provide mechanical protection against the damage produced by falling objects must be tested to mechanical impact.

In this paper the specific requirements for performing the resistance to impact tests applicable to equipment designed for use in explosive atmospheres are considered, together with the new requirements provided by the latest standards.

Keywords: electric equipment, type of protection, resistance to impact

1. GENERALITIES

According to ATEX Directive 2014/34/EU, equipment and protective systems which may be exposed to certain types of external stresses must be equipped, where necessary, with additional means of protection [7]. Equipment must withstand relevant stresses, without adverse effect on explosion protection. In this category of external stresses that may influence explosion protection is also included the mechanical impact.

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This is because an impact on the external surfaces of an equipment enclosure (that may result in damaging the enclosure) may affect the technical solution used in order to provide the explosion protection of equipment (type of protection) [1]. Some types of protections (like intrinsic safety or non-incendive nL) are not affected by a mechanical impact because the technical solution is to limit energy [3] in circuits that can ignite an explosive atmosphere. But, on the other hand, there are other types of protection that can be affected by a mechanical impact (flameproof enclosure, increased safety, pressurization, encapsulation etc.) – in these cases a damage to the enclosure can affect the explosion protection.

In the assessment process of characteristics providing protection to explosion of electrical apparatus, the SR EN 60079 series are used. The standard SR EN 60079-0 is used together with one or more standards containing the specific requirements for the type(s) of protection applied to equipment (ex. SR EN 60079-1 for the type of protection flameproof enclosure "d", SR EN 60079-7 for the type of protection increased safety "e", SR EN 60079-11 for the type of protection intrinsic safety "i"). For evaluation of explosion-proof electrical equipment, these shall be subjected to type tests [2]. In the type tests category is also included the resistance to impact test.

2. CONDITIONS FOR RESISTANCE TO IMPACT TEST

The protection provided by enclosures against a mechanical impact must be verified by tests. According to the test method mentioned in SR EN 60079-0:2013, the resistance to impact test shall be made on electrical equipment which is completely assembled and ready for use. If this is not possible (for example, in case of light transmitting parts), the test shall be made with the relevant parts removed but fixed in their mounting or an equivalent frame. The tests can be performed on an empty enclosure with appropriate justification in the documentation (Ex component enclosures, etc.) [4].

The electrical equipment is submitted to the drop effect of a test mass of 1 kg that falls vertically from a height h as specified in Table 1 according to the application, risk of mechanical danger and part subjected to test of the electrical equipment.

The mass is fitted with an impact head made of hardened steel in the form of a hemisphere of 25 mm diameter [4, 5]. The test is performed on at least two samples. In case of light-transmitting parts made of glass, the test is performed only once on each sample. In other cases, the test is performed at two separate places on each sample [4].

The impact points are considered to be the weakest places on the external parts which may be exposed to impact. If the enclosure is protected by another enclosure, only the external parts of the assembly shall be subjected to the resistance to impact tests [4].

When performing the test, the electrical equipment is mounted on a steel base so that the direction of the impact is normal to the surface being tested if it is flat, or normal to the tangent to the surface at the point of impact if it is not flat. The base is represented by a mass of at least 20 kg or be rigidly fixed or inserted in the floor, for example, secured in concrete [4, 5]. The test rig used for the tests within INSEMEX-GLI laboratory is presented in figure 1 and the test mass (including impact head) is presented in figure 2.

Fig.1 Test rig for resistance to impact test

Fig.2 Test mass and impact head

Table 1. ***Parameters for the resistance to impact test [3]***

	Drop height $h\ ^{0}_{+0,01}$ [m] with $1\ ^{0}_{+0,01}$ kg mass			
Equipment grouping	**Group I**		**Group II or III**	
Risk of mechanical danger	**High**	**Low**	**High**	**Low**
Enclosures and external accessible parts of enclosures (other than light-transmitting parts)	2	0,7	0,7	0,4
Guards, protective covers, fan hoods, cable glands	2	0,7	0,7	0,4
Light-transmitting parts without guard	0,7	0,4	0,4	0,2
Light-transmitting parts with guard having individual openings from 625 mm^2 to 2500 mm^2; (tested without guard)	0,4	0,2	0,2	0,1
NOTE A guard for light-transmitting parts having individual openings from 625 mm^2 to 2 500 mm^2 reduces the risk of impact, but does not prevent impact.				

If the impact head strikes and exhibits one or more “bounces” when striking the test sample, the impact head shall not be removed from the surface of the test sample until it has come to rest [4].

3. CONSIDERATIONS REGARDING THE RESISTANCE TO IMPACT TEST

If an impact energy is considered, as it was considered in the past – according SR EN 50014:2003 [6], by converting the drop height to energy ($E = m \cdot g \cdot h$), the presented table will transform as follows (table 2). This probably would give a more homogenous results for the testing laboratories (this is due to the variation of gravitational acceleration function of the testing laboratory localization), but each laboratory needs to have the value of the gravitational acceleration. Also, the loss of energy due to friction with air should be considered.

Table 2. ***Tests for resistance to impact – Impact energy***

	Impact energy [J]			
Equipment grouping	**Group I**		**Group II or III**	
Risk of mechanical danger	**High**	**Low**	**High**	**Low**
Enclosures and external accessible parts of enclosures (other than light-transmitting parts)	20	7	7	4
Guards, protective covers, fan hoods, cable glands	20	7	7	4
Light-transmitting parts without guard	7	4	4	2
Light-transmitting parts with guard having individual openings from 625 mm^2 to 2500 mm^2; (tested without guard)	4	2	2	1
Note: gravitational acceleration – 10 m/s^2				

When, at the request of the manufacturer, electrical equipment is submitted to tests corresponding to the low risk of mechanical danger, it shall be marked with the symbol "X" to indicate this specific condition of use [4, 5]. Therefore, the user must perform a risk assessment in order to adequately select the equipment, by considering also the risk of mechanical danger (the risk of objects to fall on equipment) and to take the necessary measures in order to reduce it when required.

The test shall be carried out at an ambient temperature of (20 ± 5) °C, except where the material data shows it to have a reduction in resistance to impact at lower temperatures within the specified ambient range. In this case, the test shall be performed at the lower test temperature, that is represented by the minimum service temperature reduced by 5 ÷10 K [4].

When the electrical equipment has an enclosure or a part of an enclosure made of a non-metallic material, including non-metallic fan hoods and ventilation screens in rotating electrical machines, the test shall be carried out at the upper and lower test temperatures. The upper test temperature is considered to be the maximum service temperature increased by at least 10 K but at most 15 K [4]. Conditioning of equipment is performed with the help of a climate chamber (fig. 3).

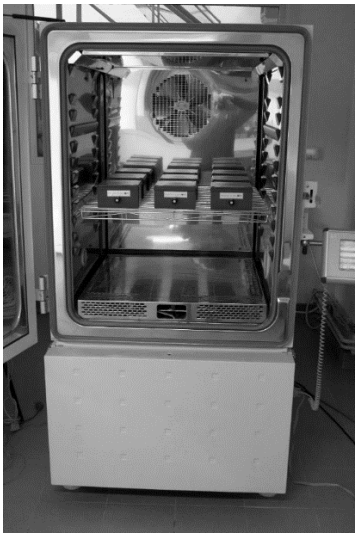

Fig. 3 Climate chamber used for conditioning of test samples

For example, in case of an equipment, designed for use at ambient temperatures between -30˚C to +50˚C, having an enclosure made of plastic materials, the lower test temperature will be considered to be any temperature between -35˚C to -40˚C. In case the service temperature is determined to be 90˚C, the upper test temperature will be considered to be any temperature between 100˚C and 105˚C.

In order to consider the most adverse conditions that can be attained in practice, before the impact test, in case of enclosures made of non-metallic materials, the thermal endurance test to heat and cold must be performed [4]. The thermal endurance tests stress the non-metallic parts of the equipment, therefore an impact on equipment enclosure will produce more damage than in normal conditions.

Also, after performing the impact tests, the enclosures have to be submitted to the degree of protection (IP) tests, and to the other tests required by the type(s) of protection applied to equipment [4].

The new edition of the standard (SR EN 60079-0:2018) introduces some new prescription regarding the test mass [5]:

- the diameter of the test mass should not be significantly larger than the 25 mm impact head so that the impact head is not restricted from contacting portions of the equipment under test.
- if a guide tube is used for the test mass, the diameter of the guide tube or pressure relief holes shall be such that the movement of the test mass is not restricted by the compression of air created by the dropping of the test mass.

The testing laboratory INSEMEX-GLI participated in a proficiency testing program organized by PTB Germany with the old test rig and the obtained results were considered to be in the tolerances of the test scheme. The tests had in view were thermal endurance to heat and cold, resistance to impact test and IP degree tests. Some of the

testing laboratories that participated in the test round had their impact testing rigs already adapted to the provisions of the new standard [8].

But, in order to satisfy the new requirements regarding the resistance to impact test some modifications to the test rig will be performed, especially to the shape of the test mass and to the guide tube.

4. CONCLUSIONS

Equipment designed for use in explosive atmospheres must preserve explosion protection characteristics even in the most adverse conditions that can be met in practice. To verify the characteristics on which explosion protection is maintained specific type tests shall be performed (type tests). In this category is also included the resistance to impact test. Resistance to impact test is performed to verify that the equipment enclosure (in case the equipment enclosure is considered as a part of explosion protection) can withstand an impact caused by falling objects without affecting explosion protection.

The conditions for performing the resistance to impact tests were presented in the first part of the paper.

In the last part of the paper were exposed some specific considerations (related to impact energy, order of type tests and provisions of the new editions of applicable standards), considered to be useful information on performing the resistance to impact tests.

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