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# **HOW TO DEAL WITH THE ESSENTIAL SAFETY REQUIREMENTS OF THE EU DIRECTIVE ON THE PLACING ON THE MARKET OF PYROTECHNIC ARTICLES**

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## **ABSTRACT**

For manufacturers and importers that generally have to comply with a different regulation in each country to get technical approvals for their products the principle "tested once, accepted everywhere" is a great expectancy. The Directive 2007/23/EC [1] concerning the placing on the market and the use of pyrotechnic articles could fulfil those dealing with automotive occupant restraint systems (mainly airbags and seat belts pretensioners). By introducing harmonised Essential Safety Requirements (ESR) this new Directive offers the possibilities to replace the National approval procedures concerned by a single legal framework throughout the European Union (EU) for these pyrotechnic articles.

Although this EU directive will reduce the administrative burden for everybody by introducing the CE marking and certification procedure, its substitution and application in replacement of the current National regulatory frameworks may create difficulties at the beginning.

In this paper we present the different parts of the Directive specifically these concerning pyrotechnic devices for automotive safety and how to comply with it. As Notified Body and Official Laboratory in France INERIS has gained lot of experience in testing, certifying and approving explosives and pyrotechnic devices. In order to ease the understanding of the CE marking and certification procedure for automotive pyrotechnic articles, we suggest and give examples of known test procedures to cope with the Essential Safety Requirements (ESR).

## **1 INTRODUCTION**

On May 23, 2007 the European Parliament (EP) and the Council adopted the Directive 2007/23/EC [1] on the placing on the market of pyrotechnic articles. This newly published text is another piece of the European regulation concerning explosives and pyrotechnic articles. It completes the Directive 93/15/EEC of 5 April 1993 [2] on the harmonisation of the provision relating to the placing on the market and supervision of explosives for civil uses. These two Directives following the "new approach" aim at ensuring the free movement of products within the European Union (EU), improving safety of both consumers and professionals and implementing harmonised safety requirements for such products in all Members States.

Pyrotechnic articles and ammunitions are explicitly excluded from the scope of the Directive 93/15/EEC. But we had to wait until 2004 and the adoption by the European Commission (EC) of the Directive 2004/57/EC of 23 April 2004 [3] (on the identification of pyrotechnic articles and certain ammunition) to know what the term pyrotechnic articles actually covers in the context of the former Directive.

Thus, the Directive 2007/23/EC applies specifically to pyrotechnic articles that include, mainly in term of article numbers, fireworks and pyrotechnic articles for vehicles. In Europe, obviously, firework and automotive pyrotechnic markets are significantly different.

Whereas on the one hand, EU is a net importer of fireworks, on the other hand, it is a net exporter of automotive components containing pyrotechnic articles.

The vast majority of fireworks on the EU market are imported from China. As a result of that, most of the stakeholders in this field are involved in purchasing, storing, distributing and professional displaying of fireworks. These articles are often directly sold to a large public and subject to various regional traditions and habits in each country. Easy access to consumer fireworks increases every year, and correlatively the number of accidents involving fireworks also increases, leading to a stringent reinforcement of the regulation in some countries. Then, the implementation of the new Directive is a real opportunity to achieve a higher safety level with fireworks articles through harmonised testing and quality assessment procedures.

By contrast, the EU appears as a major automotive pyrotechnics exporter, not only for manufactured components but also for parts of assembled vehicles. In this field, a large number of stakeholders are employed in designing, manufacturing and assembling. There is no direct consumer market for these products and only automotive factory workers or professional in repair shops buy, handle and use them. It seems that there are no records of accidents involving these products, most probably because of the lack of statistics in currently existing accidents/incidents database. Therefore, on this basis the application of an EU Directive can be seen less necessary. However, as the existing approval processes, regulations and laws were different from one Member State to another leading to the multiplication of delays and cost for approval, harmonisation was also chosen through a EU Directive for the placing on the market of automotive pyrotechnic articles. This solution was also preferred by the automotive supplier industry to other types of solutions as the "new approach" legislation only lays down essential safety requirements and offers more flexibility to the manufacturer (together with more responsibility) to comply with the regulation.

The rest of the document is focusing on the different points of the Directive 2007/23/EC dealing only with pyrotechnic articles for automotive devices, although, as mentioned previously, the Directive also deals with fireworks and other pyrotechnic articles.

## **2 SCOPE AND APPLICATION OF THE DIRECTIVE 2007/23/EC**

Many devices and items fulfil the definition of a pyrotechnic article in the context of Directive 2007/23/EC and considering the fast development of pyrotechnical automotive safety technology, one

could hardly give an exhaustive list of all items entering in that category. Such a provisional list would not stay anyway up to date very long. For that reason the Directive gives in Article 2 the following definitions:

*'Pyrotechnic article' means any article containing explosive substances or an explosive mixture of substances designed to produce heat, light, sound, gas or smoke or a combination of such effects through self-sustained exothermic chemical reactions.*

And

*'Pyrotechnic articles for vehicles' means components of safety devices in vehicles which contain pyrotechnic substances used to activate these or other devices.*

In the field of automotive pyrotechnics these two definitions cover not only articles like gas generators or inflators for airbags and airbag modules themselves but also seatbelt pretensioners, micro gas generators, igniters (electrical or not) and various pyrotechnical actuators for vehicles. These items fall in the scope of the Directive and have to be CE marked for their placing on the EU market. However the Directive do not apply for pyrotechnic articles intended for non-commercial use as it is usually the case of samples for the purpose of research, development and testing and provided that they bear a visible sign indicating their non-conformity and non-availability.

In addition, we remind that, substances like ignition mixture, gas generating material, propellant in seat belt equipment are in the scope and the provisions of the Council Directive 93/15/EEC of 5 April 1993 for their placing on the EU market.

## **Why the Directive 2007/23/EC is good for automotive pyrotechnic safety devices manufacturers**

Beyond the fact that some may see this Directive as one more regulation to comply with, it is in fact a great achievement in the regulation of pyrotechnic articles in the EU. And this is true not only for fireworks but also for automotive pyrotechnic devices.

The replacement of some 27 parallel National approval procedures (already hard enough to understand for local people) by a harmonised EU Directive based on the "new approach" legislation should ease the process to comply with the regulation in all the Member States. This solution was seen better than the EU alternative type approval system under the UN ECE 1958 Agreement [4] by the automotive components supplier industry. The "new approach" legislation by laying down essential safety requirements offers more flexibility to the manufacturers than the EU type approval system that determines everything in the least detail.

The other important point to which the automotive industry should be more receptive is the expected time and cost reduction due to less administrative and testing fees and less internal burden to prepare different documentation sets according to country of application.

As a result of the application of the Directive the manufacturers of pyrotechnic articles will be able to apply the CE marking on their products by themselves. If this CE marking procedure is already well known and can be found on many different products in Europe, it is also recognised world-wide as a proof of quality and safety and could constitute a plus for exportation outside the EU market.

The Directive entered into force on July 4, 2007 and Member States shall adopt and publish, by January 4, 2010, the appropriate laws, regulations and administrative provisions necessary to comply with this Directive. They shall apply those provisions by July 4, 2013 for other pyrotechnic articles for vehicles

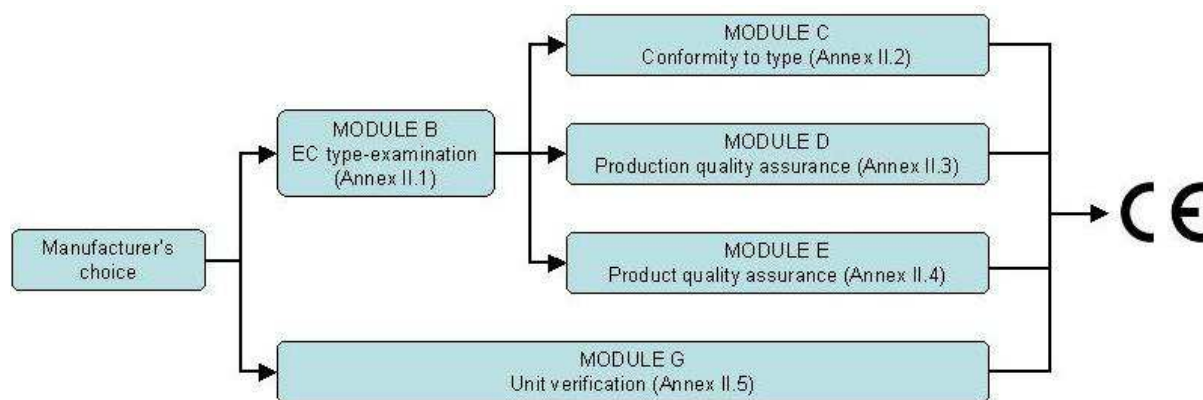
However, by way of derogation, National authorisations for pyrotechnic articles for vehicles granted before that date should continue to be valid until their expiry.

### 3 CONFORMITY ASSESSMENT PROCEDURES

The manufacturer or the importer of the pyrotechnic articles, established in the Community, has to lodge its application for the assessment of conformity by mean of one of the following procedures allowed by the Directive:

- (a) the EC type-examination (Module B) procedure, and, at the choice of the manufacturer, either:
  - (i) the conformity to type (Module C) procedure, or
  - (ii) the production quality assurance (Module D) procedure, or
  - (iii) the product quality assurance (Module E) procedure;
- (b) the unit verification (Module G) procedure. This module is applied alone for each single article and therefore seems less appropriate for pyrotechnic articles for vehicles.

This logical scheme can be represented by the following flow chart:



Without going in too much details in the content of each module, it is worth to point out that it is third body is requested for the application. Such a third body is called a Notified Body and stands as an organism appointed by Member States to carry out different tasks described in the modules. INERIS has officially applied for being notified for the Directive 2007/23/CE. It is likely that other organisms (lists of all Bodies notified for each directive can be found on the Internet [5]) have or will also apply for this notification. The notifications will be registered shortly after the transposition of the Directive by the different Member States.

According to our experience as Notified Body for the Directive 93/15/EC, most of the manufacturers will probably choose the application of Module B + Module D for the certification of their products. Whereas the Module B consists in describing the type of the article according to a technical documentation and test results and in assessing the conformity of representative samples with the Essential Safety Requirements given in the Annex I of the Directive, the Module D (or similarly Modules C or E) consists rather in assessing the later conformity of pyrotechnic articles produced with the type initially approved and thereby mainly by assessment of the quality system applied by the manufacturer. It also requires the marking of each article, the issuing of a written declaration of conformity and the archiving of specific documents by the manufacturer.

### Step by step brief overview of what an applicant for an approval shall do

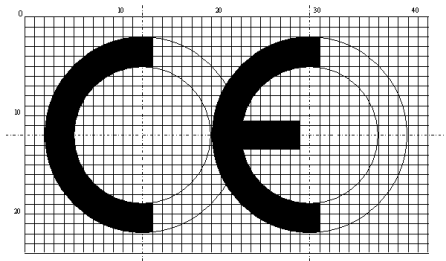
Contact the Notified Body (notified for the Directive 2007/23/EC) of your choice and lodge your application by submitting the necessary technical documentation to assess the Essential Safety Requirements.

The Notified Body will carry out the relevant testing procedures on representative samples you will provide in the frame of the EC type-examination procedure (module B).

The Notified Body issues an EC type-examination certificate to the applicant if the provisions of the Directive are satisfied.

The Notified Body will either perform examination at random interval on commercial articles (module C) or assess the quality system of the manufacturer (modules D or E). That is to confirm the later conformity of articles manufactured according to the type certified.

The manufacturer can affix the CE conformity marking on its certified products and issues the corresponding declaration of conformity to the Directive.



All the information necessary on how to reproduce the CE mark can be found the Internet [6].

## 4 ESSENTIAL SAFETY REQUIREMENTS (ESR)

The Essential Safety Requirements are minimum requirements to be satisfied by the pyrotechnic articles in order to ensure a high level of protection of human health and safety and the protection of consumers and professional end users. Although the ESR do not really intend to guarantee any performance reliabilities in the final use of the articles, an adequate and complete operation of the articles according to what it is expected is in some way a basic condition for safety.

Hereafter, we list the relevant ESR of the Directive 2007/23/EC relevant to pyrotechnic articles for vehicles and comment them (numbering according to the annex II of the Directive).

***(1) Each pyrotechnic article must attain the performance characteristics specified by the manufacturer to the notified body in order to ensure maximum safety and reliability.***

The performance characteristics have to be specified in the technical documentation given by the manufacturer to the Notified Body. Usually some of the characteristics are given in the Material Safety Data Sheet (MSDS). The Notified Body carries out an examination of this documentation and the results obtain in the different test procedures carried out. The correct and complete functioning of the pyrotechnic article is checked to assess its performance as well as the conformity to the specified effect.

***(2) Each pyrotechnic article must be designed and manufactured in such a way that it can be disposed of safely by a suitable process with minimum effect on the environment.***

The way of disposal must be described in the technical documentation and has to be given in the MSDS. The chemical composition of the different pyrotechnic mixtures must be given as well as information on their toxicity profile.

***(3) Each pyrotechnic article must function correctly when used for its intended purpose.***

It is somehow the main objective of the EC type-examination and of the following requirements. Functioning accordingly to what they are expected to do is a basic condition for pyrotechnic articles to achieve a good level of safety for consumers or professional end users. The Notified Body examines the documentation and the results obtained in the different tests performed.

***Each pyrotechnic article must be tested under realistic conditions. If this is not possible in a laboratory, the tests must be carried out in the conditions in which the pyrotechnic article is to be used.***

***The following information and properties - where applicable - must be considered or tested:***

***(3)(a) Design, construction and characteristic properties, including detailed chemical composition (mass and percentage of substances used) and dimensions;***

Most of these information have to be provided in the technical documentation. Some of them like dimensions, weight, electrical resistance of igniters... can be easily checked by careful examination of samples.

***(3)(b) The physical and chemical stability of the pyrotechnic article in all normal, foreseeable environmental conditions;***

Indications on what are the foreseeable environmental conditions have to be given in the technical documentation and in the MSDS (minimum and maximum temperatures and hygrometry recommended for storage and use, shelf life time...). Description of all the chemical components and provision of known chemical or thermal stabilities data as well as data regarding ageing behaviour through testing must also be given on articles or on the pyrotechnic materials they contain.

***(3)(c) Sensitivity to normal, foreseeable handling and transportation;***

The description of the design, assembling and suitable packaging in the technical documentation together with results obtained in mechanical tests (shock, vibration, drop...) on bared or packaged article could answer this requirement.

***(3)(d) Compatibility of all components as regards their chemical stability;***

Description of all chemical components and of their know chemical stability in the technical documentation, results of exposure to low temperatures, high temperatures, thermal cycles, harsh environmental conditions or ageing testing could answer this requirement.

***(3)(e) Resistance of the pyrotechnic article to moisture where it is intended to be used in humid or wet conditions and where its safety or reliability may be adversely affected by moisture;***

The technical documentation should specify the environmental conditions where the article is intended to be use (minimum and maximum temperatures and hygrometry recommended for storage and use...), these information should be mentioned in the MSDS. Testing in harsh environmental conditions or after thermal cycles or ageing could answer this requirement.

***(3)(f) Resistance to low and high temperatures, where the pyrotechnic article is intended to be kept or used at such temperatures and its safety or reliability may be adversely affected by cooling or heating of a component or of the pyrotechnic article as a whole;***

The technical documentation should specify the environmental conditions where the article is intended to be use (minimum and maximum temperatures and hygrometry recommended for storage and use...), these information should be mentioned in the MSDS. Testing in harsh environmental conditions or after thermal cycles or ageing could answer this requirement.

***(3)(g) Safety features intended to prevent untimely or inadvertent initiation or ignition;***

Ability of the article to withstand various stresses (mechanical, electrical, environmental...) without functioning, presence of effective protection features (shunt, ESD/EMI protection...) could answer this requirement.

***(3)(h) Suitable instructions and, where necessary, markings in respect of safe handling, storage, use (including safety distances) and disposal in the official language or languages of the recipient Member State;***

The technical documentation and/or the MSDS have to describe or give these information. In the case of pyrotechnic articles for vehicles the Article 13 of the Directive specifies the minimum information for the labelling and refers to the Directive 2001/58/EC amending the Directive 91/155/EEC [7] for the drafting of the MSDS.

***(3)(i) The ability of the pyrotechnic article, its wrapping or other components to withstand deterioration under normal, foreseeable storage conditions;***

The description of the design, assembling and suitable packaging in the technical documentation together with results obtained in mechanical tests (shock, vibration, drop...) on a bared or wrapped article could answer this requirement.

***(3)(j) Specification of all devices and accessories needed and operating instructions for safe functioning of the pyrotechnic article.***

The technical documentation and/or specific instructions for the user have to described or give these information and some of them can also appear in the MSDS.

***During transportation and normal handling, unless specified by the manufacturer's instructions, the pyrotechnic articles should contain the pyrotechnic composition.***

The description of the design, assembling and suitable packaging in the technical documentation could allow to answer this requirement.

***(4) Pyrotechnic articles must not contain:***

***(4)(a) commercial blasting agents, except for black powder or flash composition;***

***(4)(b) military explosives.***

Description of the design and all the chemical components contained in the article in the technical documentation could answer these requirements.

***(5) The various groups of pyrotechnic articles must at least also comply with the following requirements:***

***(5)A. Fireworks:*** This paragraph specific to fireworks is not discussed in this paper.

***(5)B. Other pyrotechnic articles***

***(5)B(1) Pyrotechnic articles must be designed in such a way as to minimise risk to health, property and the environment during normal use.***

The description of the design, assembling and of all necessary accessories for a correct operation must be given in the technical documentation. The Notified Body examines this documentation and the results obtained in the different test procedures carried out. The correct and complete functioning of the pyrotechnic article is checked to assess the conformity to the expected effect.



***(5)B(2) The method of ignition must be clearly visible or must be indicated by labelling or instructions.***

The description of the design and of all necessary accessories for a correct operation must be given in the technical documentation and/or in an instruction notice for the users. The Notified Body examines these documents and the results obtained in the different test procedures carried out.

***(5)B(3) The pyrotechnic article must be designed in such a way as to minimise risk to health, property and the environment from debris when initiated inadvertently.***

The description of the design, assembling and of all necessary accessories for a correct operation must be given in the technical documentation. The Notified Body examines this documentation and the results obtain in the different test procedures carried out. The correct and complete functioning of the pyrotechnic article is checked to assess the conformity to the expected effect.

***(5)B(4) Where appropriate, the pyrotechnic article must function properly until the ‘use by’ date specified by the manufacturer.***

The description of the design, assembling and of all necessary accessories for a correct operation must be given in the technical documentation. The Notified Body examines this documentation and the results obtain in the different test procedures carried out. The correct and complete functioning of the pyrotechnic article, after suitable ageing or environmental conditioning, is checked to assess the conformity to the expected effect.

#### ***(5)C. Ignition devices***

***(5)C(1) Ignition devices must be capable of being reliably initiated and be of sufficient initiation capability under all normal, foreseeable conditions of use.***

***(5)C(2) Ignition devices must be protected against electrostatic discharge under normal, foreseeable conditions of storage and use.***

***(5)C(3) Electric igniters must be protected against electromagnetic fields under normal, foreseeable conditions of storage and use.***

***(5)C(4) The covering of fuses must be of adequate mechanical strength and adequately protect the explosive filling when exposed to normal, foreseeable mechanical stress.***

***(5)C(5) The parameters for the burning times of fuses must be provided with the article.***

***(5)C(6) The electrical characteristics (e.g. no-fire current, resistance, etc.) of electric igniters must be provided with the article.***

***(5)C(7) The wires of electric igniters must be sufficiently insulated and must be of sufficient mechanical strength, including the solidity of the link to the igniter, taking account of their intended use.***

Some or all of these requirements can apply to automotive igniters depending on their design or their uses. The technical documentation should specify the design and the intended uses. The ability to withstand electrostatic discharges or electromagnetic fields without operation, as well as the electrical characteristics can be evaluated by relevant testing procedures already used by the automotive industry.

## **Harmonised standards**

In order to facilitate the process of demonstrating compliance with the essential safety requirements, harmonised standards for the design, manufacture and testing of pyrotechnic articles are being developed. In line with the ‘New Approach to technical harmonisation and standardisation’, pyrotechnic articles manufactured in compliance with harmonised standards should benefit from a presumption of conformity with the essential safety requirements provided for in the Directive.

However, these harmonised standards will not be available before a few years and the demonstration of the compliance with the ESR will have meantime to be made by the mean of other relevant standards. As far as it concerns pyrotechnic articles for vehicles – especially inflator assemblies or airbag modules – the relevant international ISO standards (for example the ISO 12097 Road vehicles – Airbag components) should be taken into account. Other existing testing procedures used in the frame of the national approvals of pyrotechnic articles could also be considered during the transition period.

## **5 CONCLUSION**

In the recently implemented new process of the certification of pyrotechnic articles, to prove their compliance with essential safety requirements is one thing and to prove the ability to produce them in conformity with the type certified is another thing. The manufacturer of pyrotechnic articles for vehicles has to do both in the frame of the Directive 2007/23/EC. The application of the Directive requires the intervention of a Notified Body to carry out different tasks. In the one hand, it proceeds to a type examination (product certification) in accordance with Essential Safety Requirements based on the manufacturer technical documentation and on test results. And on the other hand, it brings a complementary contribution in the control procedures in terms of periodic audits of the manufacturing and inspection conditions.

## **6 REFERENCES**

- [1] OJ L 154, 14.6.2007, p.1. Directive 2007/23/EC of the European Parliament and of the Council of 23 May 2007 on the placing on the market of pyrotechnic articles.
- [2] OJ L 121, 15.5.1993, p. 20. Council Directive 93/15/EEC of 5 April 1993 on the harmonization of the provisions relating to the placing on the market and supervision of explosives for civil uses.
- [3] OJ L 127, 29.4.2004, p. 73. Commission Directive 2004/57/EC of 23 April 2004 on the identification of pyrotechnic articles and certain ammunition for the purposes of Council Directive 93/15/EEC on the harmonisation of the provisions relating to the placing on the market and supervision of explosives for civil uses.
- [4] Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts of 20 March 1958.
- [5] <<http://ec.europa.eu/enterprise/newapproach/nando/index.cfm?fuseaction=directive.main>>
- [6] <<http://ec.europa.eu/enterprise/faq/ce-mark.htm>>
- [7] OJ L 212, 7.8.2001, p. 24. Commission Directive 2001/58/EC of 27 July 2001 amending for the second time Directive 91/155/EEC defining and laying down the detailed arrangements for the system of specific information relating to dangerous preparations in implementation of Article 14 of European Parliament and Council Directive 1999/45/EC and relating to dangerous substances in implementation of Article 27 of Council Directive 67/548/EEC (safety data sheets).
- [8] Not cited in the text but of general interest is a document known as the "guide blue" – Guide to the Implementation of Directives Based on New Approach and Global Approach – can be downloaded at: <<http://ec.europa.eu/enterprise/newapproach/legislation/guide/index.htm>>