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# **FRENCH APPROVAL PROCEDURES FOR PYROTECHNICAL AUTOMOTIVE SAFETY EQUIPMENTS**

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## **ABSTRACT**

**Pyrotechnical articles for civil uses may be subject to national procedures before placing on the market. According to the French decree n°90-153, 16 February 1990 as modified; explosives that are dispensed with EC marking and that are not excluded of the decree application have to conform to approved types. Pyrotechnical automotive safety equipments such gas generators for airbag modules or seat-belt pretensioners, pyrotechnic relay compositions and/or igniters inside those gas generators fall into that case. The approval procedure, test methods and criteria relating to those equipments are described. For a practical use, a flow-chart of the overall procedure applied to obtain the approval is given.**

## **1 INTRODUCTION**

For three decades pyrotechnic articles appeared in automotive industry and their uses grew rapidly as they showed their efficiency to save lives. In parallel, it was known that those articles by nature were potentially dangerous, that lead the French Government to require compulsory approval for pyrotechnical automotive safety equipments.

## **2 A BRIEF REVIEW**

Since 1990 and the publication of the decree n°90-153 of February 16, 1990<sup>1</sup> few evolutions concerning directly pyrotechnical automotive safety equipments have been done. The order of November 12, 1991<sup>2</sup> clearly specify that pyrotechnical devices for automotive safety, relay compositions and igniters in such devices have to be approved to be produced, sold, imported, exported, shipped, held or used. The order of July 30, 1997<sup>3</sup> approved the manual of test methods for pyrotechnical automotive safety equipments, see paragraph 5.

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## 3 WHAT THE DECREE N°90-153 SAYS?

Here we summarise some statements of the decree n°90-153 concerning the approval of pyrotechnical automotive safety equipments.

Request for the approval of a model should be submitted to the Ministry in charge of Industry by a natural or legal person established within a state of the European Community. Together with the request, one has to joint a record that at least should:

- Describe the product and its components (part drawings, characteristics, composition, origin...);
- Mention the trade name of the product;
- Justify the ability of the applicant to guarantee the future conformity of the product to the model.

INERIS as Official Laboratory (authorised by Order of December 20,1996<sup>4</sup>) is commissioned by the Ministry to carry out the approval test methods on representative samples of the model. If any, results of equivalent methods already done by relevant laboratories can be considered. INERIS writes a report on the base of the results obtained and the technical file provided and presents it in front of the “Commission des Substances Explosives CSE” (French Committee of Explosives). Then the Ministry in charge of Industry delivers the approval after consultation of “Commission des Substances Explosives CSE”. The approval bears the name of its holder and any transfer of it from the holder to another person requires a notice from the Ministry in charge of Industry to be done.

At any time, the Ministry in charge of Industry can prescribe tests or controls in order to check the conformity of a product to an approved model.

## 4 WHAT ARE THE ITEMS RELATED TO AUTOMOTIVE SAFETY TO BE APPROVED?

Considering the fast development of pyrotechnical automotive safety technology, one could difficulty give an exhaustive list of all items entering in that category. Even so such a list would not stay up to date very long. But the following families can be use to classify those items:

- Gas generator (found for example in airbag modules, sea-belt pretensioners...);
- Pyrotechnic relay composition;
- Igniter (electrical or not).

Taken separately or part of another object these items have to be approved before to be produced, sold, imported, exported, shipped, held or used. In addition, for production in EU and subsequent putting on the market, substances like gas generating material, propellant in seat belt equipment should be CE marked according to the Council Directive 93/15/EEC of 5 April 1993.

## 5 TEST METHODS AND CRITERIA FOR APPROVAL

The manual of approval test methods and criteria for pyrotechnical automotive safety equipments can be obtained on demand at INERIS.

According to items concerned specific test methods apply. All test methods required for the approval have been chosen with a view to ensure an acceptable level for public safety. The procedure of approval does not guarantee any performance reliabilities in the final use of the safety equipments. All trials have to be carried out on representative samples of the model to be approved.

### 5.1 GAS GENERATOR

Whatever the use that is intended for the gas generator submitted to approval, it is subjected to the eight test methods listed in table 1. To be carried out those tests usually required 11 representative gas generators of the model to be approved.

Besides of those test methods, compatibility of all components, ageing, effects of mechanical and climatic stresses, electromagnetic environment effect and properties in case of criminal uses are considered according to technical data submitted. Information regarding safety in a shaped of warning notice or information leaflet similar to material safety data sheet (MSDS) are also considered.

The minimum criteria to pass for the tests are:

- The normal operation in test N7 after each single test J8, I10, E10 and before any of them;

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- No splitting during test M7;
- Gas concentration in test R8 below 20 ppm/l of inflatable bag<sup>5</sup> for CO (carbon monoxide) and below 2 ppm/l of inflatable bag for NO<sub>x</sub> (nitrogen oxides).

## 5.2 RELAY COMPOSITIONS

Such compositions to be approved are subjected to the nine test methods listed in table 1. The quantity of pyrotechnical composition required to perform all the tests is between 1 and 2 kg. The material safety data sheet (MSDS) required is also examined.

The criteria to pass the tests performed are the same than for other pyrotechnical compositions in those tests.

## 5.3 IGNITERS

Igniters either electrical or not are subjected to the six test methods listed in table 1 to be approved. Besides of those test methods, electrical properties and sensitivity, compatibility of all components, effects of mechanical and climatic stresses, electromagnetic environment effect are considered according to technical data submitted. In the case of non-electrical igniters, electrical features that are not relevant are replaced as needed. Usually 7 igniters of the model to be approved are required to carry out all those tests. Information regarding safety in a shaped of warning notice or information leaflet similar to material safety data sheet (MSDS) are also considered.

The minimum criteria to pass for the tests are:

- The normal operation in test N7 after each single test J8, I5, E10 and before any of them;
- No initiation of a detonation of explosive cartridge in test P8.

Table 1: List of test methods performed within the scope of the approval according to the decree n°90-153

	INERIS test reference	Name	Sample number												
			1	2	3	4	5	6	7	8	9	10	11		
Gas generators	A1	Description	•	•	•	•	•	•	•	•	•	•	•	•	•
	J8	Vibrations	•												
	I10	Fall		•											
	E10	Stability			•										
	N7	Operation	•	•	•	•									
	I11	Impact					•	•	•	•					
	M7 <sup>a)</sup>	Heating										•			
	R8 <sup>b)</sup>	Combustion products												•	•
Igniters	A1	Description	•	•	•	•	•	•	•						
	J8	Vibrations	•												
	I5	Fall		•											
	E10	Stability			•										
	N7	Operation	•	•	•	•									
	P8	Detonability					•	•	•						
Relay compositions	A1	Description	•												
	A3	Particle size distribution	•												
	B1	Density	•												
	E1	Stability	•												
	I1	Sensitiveness to impact	•												
	J1	Sensitiveness to friction	•												
	K1	Sensitiveness to electrical spark	•												
	F2	Progressive heating	•												
	M8	Deflagration to detonation transition	•												

<sup>a)</sup> Performed only for gas generator designed for air-bag module.

<sup>b)</sup> Not necessarily performed, in particular for hybrid gas generator.

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## 6 DESCRIPTION OF TEST METHODS

Hereafter we briefly describe the test methods listed in table 1.

Test method	Description
A1 Description	Description and comparison of the item sent to be approved with the technical data or drawing submitted.
J8 Vibrations	The object is submitted to vibrations (frequency 50 Hz, amplitude 0.5 mm) during 60 minutes.
I10 and I5 Fall	The object is dropped on a hard floor from a height of 1.20 m.
E10 Stability	The object is submitted to a temperature of 50°C and a relative humidity of 60% during 4 weeks.
N7 Operation	Operation of the object is compared to what it is suppose to be.
I11 Impact	The gas generator is struck with a 30-kg fallhammer dropped from 0.25 m and 0.50 m high on 2 different directions.
M7 Heating	The gas generator is heated with a gas burner until reaction.
R8 Combustion products	Analysis of the nature and quantities of the products emitted when the gas generator is initiated in a 2.5 m <sup>3</sup> chamber.
P8 Detonability	The igniter is used to initiate a cartridge of pentrite.
A3 Particle size distribution	100 g of pyrotechnical composition are screened through sieves of different mesh sizes.
B1 Density	Determination of the normal loading density.
E1 Stability	The material is submitted to a temperature of 75°C in an oven during 48h.
I1 Sensitiveness to impact	The material is submitted to various energy of impact and the energy corresponding to a probability of reaction of 50% is determined.
J1 Sensitiveness to friction	The material is submitted to various energy of friction and the energy corresponding to a probability of reaction of 50% is determined.
K1 Sensitiveness to electrical spark	A 3-mm-thick layer of pyrotechnical composition is submitted to electrical spark of different energy, a level of minimum energy of no-reaction is determined.
F2 Progressive heating	The material is progressively heated (heating rate 5°C/min), the temperature of runaway is determined.
M8 Deflagration to detonation transition	Determination of the length after which the deflagration of the confined material turns into detonation.

## 7 FLOW-CHART OF THE OVERALL PROCESS

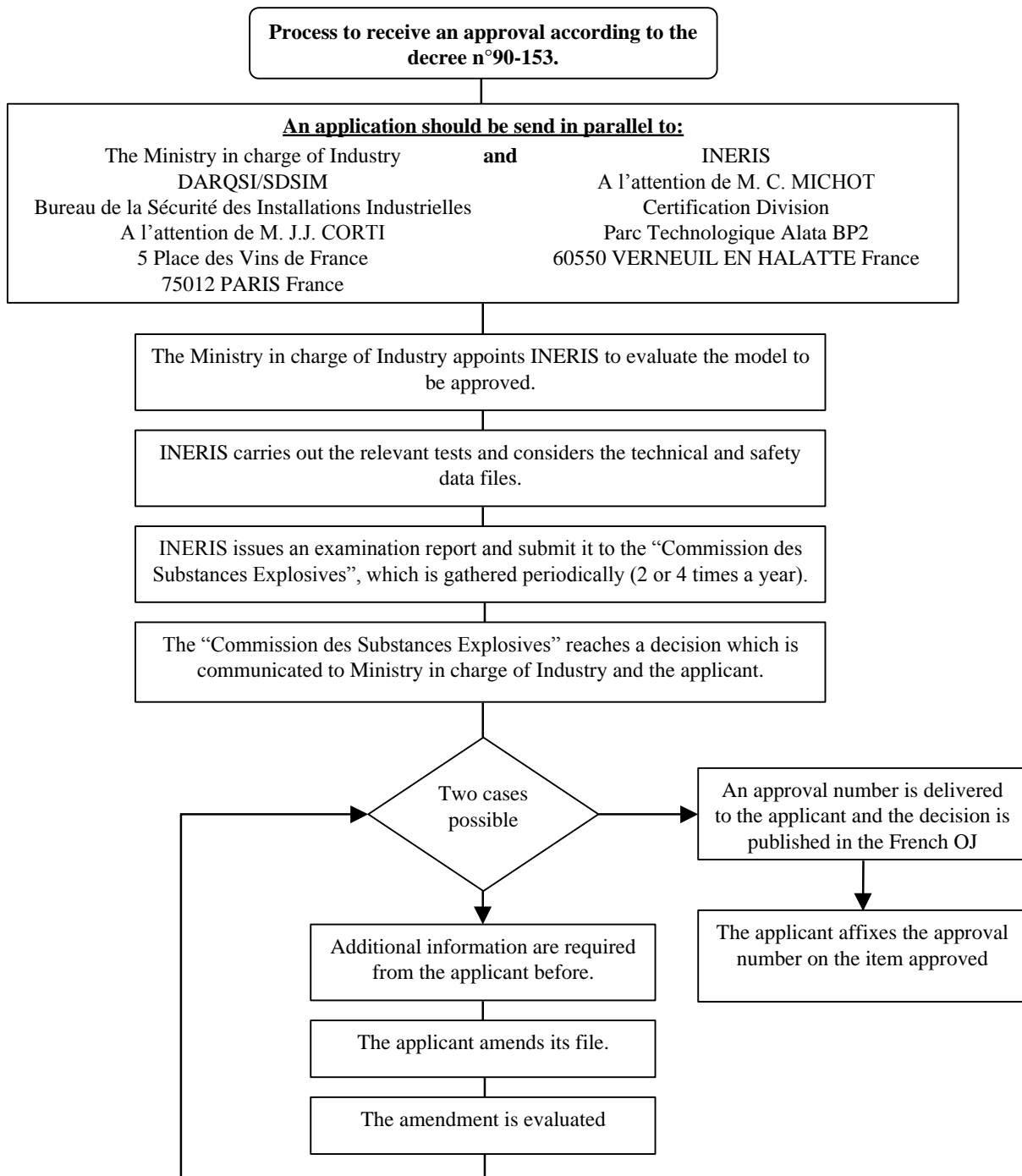
In the given chart (see below) we describe the main steps of the process to obtain an approval according to decree n°90-153. The time to get through the entire process can usually be estimated between 3 to 6 months.

## 8 CONCLUSION

As pyrotechnic articles are out of the scope of the Council Directive 93/15/EEC of 5 April 1993, the regulation we commented in this paper applies in France. In the coming years, pyrotechnic articles like pyrotechnical automotive safety equipments should fall under a Council Directive in preparation in which the requirements are the same than those cited in the 93/15/EEC Directive:

- Type examination (product certification) in accordance with some Essential Safety Requirements;
- Examination in term of periodic audits of the manufacturing and inspection conditions, audits depending of the level of quality existing in the manufacturer.

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<sup>1</sup> Decree n°90-153 of February 16, 1990 OJ n°42 of February 18, 1990.

<sup>2</sup> Order of November 12, 1991 OJ n°293 of December 17, 1991.

<sup>3</sup> Order of July 30, 1997 OJ n°192 of August 20, 1997.

<sup>4</sup> Order of December 20, 1996 OJ n°23 of January 28, 1997.

<sup>5</sup> ppm/l of inflatable bag: part per 10<sup>6</sup> per litre of inflatable bag for which the gas generator is designed.