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# **STANDARD FOR PYROTECHNIC SPECIAL EFFECTS**

Classification and Authorization  
General and Detailed Requirements for F.3

February 2008

**Canada**

*This document is written in accordance with  
Part 3 of the proposed new Explosives Regulations  
to be published under the Explosives Act (R.S., c. E-15, s. 1.).  
Where F.3 is mentioned, it refers to the current 7.2.5  
Canadian class.*

**Table of Contents**

1. INTRODUCTION ..... 1

    1.1 Scope ..... 1

    1.2 Approvals - Authorization of the Explosives ..... 2

    1.3 Regulation of Use ..... 2

    1.4 Required Documentation ..... 2

2. REQUEST FOR AUTHORIZATION ..... 3

    2.1 List of Articles ..... 3

    2.2 Transport Classification ..... 3

    2.3 Outsourcing ..... 3

3. SUBMISSION REVIEW AND SAMPLING ..... 4

    3.1 Products Not Authorized in Canada ..... 4

    3.2 Tolerances ..... 4

        3.2.1 Chemical ..... 5

        3.2.2 Physical ..... 5

        3.2.3 Charge Weights ..... 5

    3.3 Marking and Labeling ..... 5

    3.4 Sampling of the Submission ..... 6

        3.4.1 One or Two Articles ..... 6

        3.4.2 More Than Two Articles or Types of Articles ..... 6

        3.4.3 Special Sampling - Chemical Stability ..... 6

4. TESTING AND AUTHORIZATION ..... 7

    4.1 Packaging for Samples ..... 7

    4.2 Chemical Analysis ..... 7

    4.3 Acceptance Criteria ..... 8

        4.3.1 For Each Article ..... 8

        4.3.2 Authorization of Articles and Submission ..... 8

    4.4 Transport Classification ..... 9

APPENDIX A - GENERAL REQUIREMENTS ..... 10

APPENDIX B - LIST OF PYROTECHNIC SPECIAL EFFECTS ..... 17

## Standard for Pyrotechnic Special Effects

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### 1. INTRODUCTION

This standard is written in accordance with Part 3 of the proposed new Explosives Regulations to be published under the *Explosives Act (R.S., c. E-15, s.1)*. It is written in conjunction with the Explosives Regulatory Division (ERD) document titled *Authorization and Classification of Explosives* and specifies the documentation and testing needed for authorization<sup>1</sup> of pyrotechnic special effects.

Pyrotechnic special effects, also known as theatrical effects or proximate pyrotechnics (as described in Part 3 of the proposed new Explosives Regulations and with a Canadian Type of F.3), are devices that are typically used by licensed pyrotechnicians in the entertainment industry and that may be similar in nature to consumer fireworks in terms of their chemical composition.

#### 1.1 Scope

This standard applies to manufactured pyrotechnic special effects intended to be used before a proximate audience. It specifies the requirements for obtaining a Canadian product authorization and classification. In addition, it specifies what must be declared by the manufacturer or the manufacturer's representative. It also describes minimum requirements for the design, technical information, performance, primary package and labeling requirements, and corresponding test methods for the product.

It does not apply to detonating cords (covered by the *Standard for the Authorization and Classification of Initiation Systems*), igniters and soft-jacketed detonators (e.g., bullet hits), or to black powder or smokeless powder and/or high explosives that may be used in combination with flammable liquids that are manufactured for a one-of-kind pyrotechnic special effect for the film and television industry. Such effects and/or their use are regulated by the *Pyrotechnics Special Effects Manual* and/or by the Local Authority Having Jurisdiction (AHJ).

Change(s) to any authorized products, unless otherwise indicated in the approval, void the authorization or approval.

This standard will be applied immediately to the authorization of all new explosives and to any currently authorized products that have been significantly modified or changed.

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<sup>1</sup> Authorization is the process by which an explosive substance or explosive article, as defined in the *Explosives Act* and Regulations, is declared authorized by the Chief Inspector, at which time it becomes legal to manufacture, sell, possess or use that explosive or explosive article in Canada or import it into Canada; only after approval is the item added to the list of authorized explosives. As part of this process, the explosive substances or explosive articles are classified in accordance with the Explosives Regulations. Only an explosive substance or explosive article under the care and control of the Department of National Defence is exempt from authorization. The authorization process is detailed in the ERD document titled *Authorization and Classification of Explosives*; as indicated in the document, supplementary documentation and test data may be requested in the product test plan. As a condition of authorization, explosive safety-related incidents involving authorized products are to be reported.

## Standard for Pyrotechnic Special Effects

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Products and systems that are now authorized and that now appear on the current list of authorized explosives, unless materially changed<sup>2</sup>, involved in safety-related incidents<sup>3</sup>, or any safety issues that may be currently unknown or not well understood, will not be required:

- a) to meet all requirements of this standard,
- b) to re-submit documentation, or
- c) to perform additional test results or testing.

ERD requires documentation to ascertain that the manufacturer has applied sound principles in design and exercised due diligence in evaluating the safety-related properties of the explosive.

As documentation reveals the details of design, which constitutes the intellectual property of the manufacturer, the submission will be kept confidential in accordance with the *Explosive Act* and Regulations.

### 1.2 Approvals - Authorization of the Explosives

Authorization of the explosives may be granted after review of required documentation, including any applicable test results. The ERD document titled *Authorization and Classification of Explosives* describes this process, including documentation, language and format; explosives are classified in accordance with the document and the detailed stages of this process are outlined in the same document, i.e., submission, review, test plan development, reporting, approval, etc.

### 1.3 Regulation of Use

ERD does not regulate the use of explosives in general, but does regulate the use of pyrotechnic special effects. The regulation that applies to their use is summarized in the ERD document titled *Pyrotechnics Special Effects Manual*. In addition, as part of the approval and testing process, ERD does request information to ensure that the item can be safely used as recommended by the manufacturer, e.g., company product information and technical data.

### 1.4 Required Documentation

This standard, in conjunction with the *Authorization and Classification of Explosives* document, outlines the requirements to be met by a manufacturer who applies for approval of an explosive and, when applicable, its use only with manufacturer-specified system components.

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<sup>2</sup> Refer to the ERD document titled *Authorization and Classification of Explosives* for the description.

<sup>3</sup> For example, significant reportable safety-related incidents are accidents or those that could necessitate product recall due to complete failure or ongoing malfunction.

## **Standard for Pyrotechnic Special Effects**

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The documentation for the authorization must:

- a) Be as specified and structured as set out in the ERD document titled *Authorization and Classification of Explosives* and include the mandatory<sup>4</sup> supporting documentation as identified in the following sections; and
- b) Be submitted by the manufacturer, who applies for approval, or by its delegate, to both the approved testing authority, the Canadian Explosives Research Laboratory (CERL), and also to the approving authority, the Explosives Regulatory Division.

### **2. REQUEST FOR AUTHORIZATION**

The requirements that indicate what must be present in the submission and how it will be judged are described in the *Authorization and Classification of Explosives* document. The submission is a legal declaration to the Government of Canada in order to obtain authorization. It is the first indication of the care a company exercises in achieving a product of acceptable quality. Poor submissions do affect perception.

Every submission must be accompanied by the *Submission Form for Authorization and Classification of Pyrotechnic Special Effects*, properly completed. The review process does not start until all information has been submitted.

#### **2.1 List of Articles**

A list of all the articles in the submission by name, effect (as per Appendix B), duration and height, preferably with an identifying part number, is required. If more than one colour is associated with a given name or part number, list all the colours that are being submitted for each name or part number. Different colours, being different chemicals, are considered to be separate articles.

#### **2.2 Transport Classification**

A letter of competent authority classifying the pyrotechnic article is to be submitted when available, accompanied by supporting information. If a letter of competent authority is not available, the applicant may indicate the expected classification.

#### **2.3 Outsourcing**

If some components of the pyrotechnic articles are purchased from another source, this must be indicated on the drawing and a reference to that source must be given. ERD will decide whether a separate testing scheme for the outsourced material will be required.

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<sup>4</sup> Mandatory documentation: This information is expected to accompany the authorization and classification application; when such information is not presented, an appropriate test plan will be prepared to develop the needed documentation in accordance with the authorization process. At that time, supplementary documentation may also be requested.

## **Standard for Pyrotechnic Special Effects**

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### **3. SUBMISSION REVIEW AND SAMPLING**

This section describes the requirements for the acceptance of a submission and the methodology that will be followed for the selection of samples.

#### **3.1 Products Not Authorized in Canada**

Certain articles or certain chemicals considered to be unsafe will not be authorized.

The following types of articles will not be authorized:

- articles self-propelled from the ground and rising in the air with unpredictable flight paths or moving erratically;
- articles judged excessively violent by the Chief Inspector of Explosives;
- articles not properly labeled; and
- articles that have a history of injuries.

The chemicals listed below will not be allowed:

- arsenic compounds - poisons;
- gallates or gallic acid - incompatible with many chemicals;
- lead and lead compounds or salts - poisons (except in igniters); and
- mercury compounds - poisons.

The chemicals listed below are restricted and are not allowed without a special dispensation:

- boron - readily oxidizable;
- chlorates with sulphur, sulphides, ammonium salts, elemental metals (such as magnesium or aluminum), or with copper or copper salts - such mixtures are friction sensitive and liable to spontaneous combustion;
- chromium or chromium compounds;
- phosphorus, except for red phosphorus in toy pistol caps;
- picric acid and picrates - incompatible with many chemicals;
- thiocyanates except for snakes - explosively oxidizable; and
- zirconium - explosively oxidizable.

If a dispensation is provided, it must appear on the certificate of authorization.

#### **3.2 Tolerances**

As indicated on the application form, tolerances are to be provided and must conform to those listed in this section. Otherwise, these will apply by default.

## Standard for Pyrotechnic Special Effects

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### 3.2.1 Chemical

Tolerances for chemicals must be less than  $\pm 20\%$  of the percentage for any component less than 25% of the composition and  $\pm 10\%$  of the percentage for any component present in more than 25%.

For example, if the amount is 30%, then 10% of 30 is 3% and the tolerance is  $30 \pm 3\%$ ; if the amount is 15%, then 20% of 15 is 3% and the tolerance is  $15 \pm 3\%$ . Companies may use more stringent tolerances.

All declared ingredients must be present. Ingredients not declared must not be present at more than 0.5% (mass/mass of composition analyzed).

Note: Wider tolerances might be accepted under the following conditions:

- the articles are manufactured for a specific venue or tour for which the formulation has to be adjusted depending on the location(s) and time of the year; or
- the articles are manufactured as per the end user request for performance requirements.

### 3.2.2 Physical

Tolerances on physical characteristic may be set by the company. They must be such so as not to interfere with proper function and must not be greater than  $\pm 25\%$  of the nominal.

### 3.2.3 Charge Weights

If maximum charge weights are specified in this document, they represent the maximum of the tolerance range. Otherwise, the following applies to charge weights:

Charge Weight	Tolerance
< 10 g	$\pm 25\%$
$\geq 10$ g	$\pm 10\%$

Wider tolerances might be accepted under the following conditions:

- the articles are manufactured for a specific venue or tour for which the formulation has to be adjusted depending on the location(s) and time of the year; or
- the articles are manufactured as per the end user request for performance requirements.

## 3.3 Marking and Labeling

In addition to the requirements described in the *Authorization and Classification of Explosives* document, precautions or instructions for the safe handling and use of the pyrotechnic article are expected. The instructions must be in both English and French, clear, legible, and with equal prominence given to the two languages.



## Standard for Pyrotechnic Special Effects

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### 3.4 Sampling of the Submission

Not all articles are tested. Submissions are sampled and the acceptance of the submission depends on the behaviour of the sample. New articles similar to existing articles from established and known companies may be authorized by analogy to existing products.

The choice to sample rests with the inspector and depends on previous experience, on the history of complaints, on the availability of articles from the same company to use as analogues, or on the lapse of time since articles from the company were last tested.

The description of sampling below represents minimum sampling. Inspectors may decide on more samples when they believe this would better evaluate a submission.

#### 3.4.1 *One or Two Articles*

It is common with pyrotechnic special effects to submit individual types of articles one at a time. Each such article will be evaluated on its merits.

#### 3.4.2 *More Than Two Articles or Types of Articles*

When more than two articles are submitted, the submission may be divided into types of articles based on construction and effect. Differing duration or height of effect within a type of article are considered to be variations of a type of article although listed as individual items in the list of authorized explosives. Each such type may be represented by a sample. Each set of five (5) variations is represented by a separate sample.

For example, if a type of article corresponds to a mine that has 14 different variations ( $14/5 = 2.8 = 3$ ), only 3 members of the family, each with 24 units, will be chosen to represent that family.

#### 3.4.3 *Special Sampling - Chemical Stability*

Stability is a chief consideration for authorization. Although all samples are tested for stability, it is recognized that all articles submitted for authorization cannot be sampled. The following chemicals are recognized as components of stable pyrotechnic compositions and samples may not necessarily be requested to prove stability of all articles (samples will be required for any other chemical or if unusual combinations of any chemical are presented):

- aluminum;
- ammonium perchlorate;
- antimony, antimony sulphide;
- barium carbonate, barium nitrate, barium sulphate;
- boric acid;
- calcium carbonate, calcium sulphate;
- carbon or charcoal;
- copper metal, copper oxide;
- dextrine;

## Standard for Pyrotechnic Special Effects

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- hexamethylenetetramine;
- iron and iron alloys (ferro-titanium), iron oxide;
- magnalium, magnesium, magnesium carbonate, magnesium sulphate;
- nitrocellulose-based lacquers;
- red phosphorus (toy pistol caps only);
- potassium or sodium benzoate, potassium hydrogen phthalate, potassium nitrate, potassium perchlorate, potassium sulphate;
- sodium bicarbonate, sodium nitrate, sodium oxalate, sodium salicylate, sodium sulphate;
- strontium carbonate, strontium nitrate, strontium sulphate;
- sulphur; and
- titanium (mesh >100).

Organic compounds, such as lactose, lycopodium, shellac, red gum, chlorinated paraffin, chlorinated rubber (Parlon) and PVC, consisting of some combination of carbon with hydrogen and/or chlorine and nitrogen, may be present if it accounts for less than 10% by mass of the compound.

### 4. TESTING AND AUTHORIZATION

The *Authorization and Classification of Explosives* document describes the general authorization process. This includes the selection of samples by ERD, the preparation of a test plan by CERL, and the issuance of a CIE report by CERL to ERD that includes recommendations for the authorization and classification of the products. This section describes more specifically the basis under which pyrotechnic special effects will be given a classification and authorization.

Please note that specific construction and performance requirements are described in Appendix A. The section on general requirements identifies some characteristics with the letter "C," meaning critical. More stringent acceptance criteria are used for "C" characteristics.

#### 4.1 Packaging for Samples

When samples are sent to CERL for product testing, they are to be shipped in their intended packaging with the appropriate labeling and instructions. Improper packaging will result in rejection of the submission. Packaging must comply with the specification set out in the National Standard of Canada CAN/CGSB 43.151-97, *Packaging of Explosives (Class 1) for Transportation*.

#### 4.2 Chemical Analysis

Chemicals must meet the declaration within the tolerances set by the company.

Because analytical techniques do not always analyze exactly the components in a composition, the declaration will be modified to show the information in a manner similar to what the analyses will detect. For example, if the declaration included both aluminum and magnalium, the analyses would look for the aluminum and magnesium total.

## **Standard for Pyrotechnic Special Effects**

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In the case of certain more difficult analyses, analytical error will be taken into account. However, finding any of the following is considered to be a gross discrepancy and reason for rejection:

- detection of more than 0.5% of a component not present in the declaration;
- non-detection of a component present in the declaration;
- finding ingredients outside the tolerance of  $\pm 20\%$  of declared amounts for ingredients declared to be 25% of the composition or less; and
- finding ingredients outside the tolerance of  $\pm 10\%$  of the declared amount for ingredients declared to be more than 25% of the composition.

### **4.3 Acceptance Criteria**

#### *4.3.1 For Each Article*

Ten (10) units are functioned for each article tested at CERL. From these 10 units, 6 are subjected to abuse testing (e.g., 1 metre drop test, jolt test, etc.). It is mandatory that the 6 units remain functional and safe after such tests. Two (2) other units are dismantled and measured and they are subject to chemical analysis and thermal stability tests. The results of these tests must be consistent with the manufacturer's declaration while meeting the requirements listed in the standard. Overall, 10/10 must meet the critical requirements marked (C) and at least 8/10 must meet all the non-critical requirements. Failure to meet these requirements constitutes rejection of the article. For a submission with multiple articles of a specific type, all articles that were selected for testing must pass testing with success.

#### *4.3.2 Authorization of Articles and Submission*

For a submission where an applicant has elected to have one or multiple articles authorized on an individual basis, the authorization of each article will be as described in the previous section (4.3.1).

For a submission that includes one or more type of articles, the authorization of types of articles will be based on the following:

- each type of articles will be treated individually, i.e., if one or additional types from a submission successfully pass testing at CERL, and an additional type from the same submission fails testing, only the failed type will not be authorized; and
- for a type of article to be authorized, all articles that were selected for testing from that type must successfully pass testing as per the requirements of Section 4.3.1.

Note: For a large submission, it is important for the applicant, when submitting a submission, to distinguish what the various types of articles are.

## Standard for Pyrotechnic Special Effects

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### 4.4 Transport Classification

As per the 14th edition of the United Nations' *Recommendations on the Transport of Dangerous Goods - Model Regulations*, the pyrotechnic special effects are classified as shown in Table 1.

*Table 1 – UN Classification*

Shipping Name	UN Number	Classification
ARTICLES, PYROTECHNIC	0428	1.1G
ARTICLES, PYROTECHNIC	0429	1.2G
ARTICLES, PYROTECHNIC	0430	1.3G
ARTICLES, PYROTECHNIC	0431	1.4G
ARTICLES, PYROTECHNIC	0432	1.4S

**APPENDIX A - GENERAL REQUIREMENTS**

**Standard for Pyrotechnic Special Effects**

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b><u>1.</u>     <u>Packaging</u></b>  <b><u>1.1</u>    <u>Labeling (C)</u><sup>5</sup></b>  Shipping name (either English or French)  Product identification number (UN number)  Dangerous goods label (orange label)  Name of product manufacturer  Registration number for packaging</p> <p><b><u>1.2</u>    <u>Condition of Packaging</u></b>  Loose composition (C)</p>	<p>Must meet <i>Transportation of Dangerous Goods Act</i>, its Regulations, and/or its referred standards.</p> <p>Not allowed.</p>

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<sup>5</sup> (C): Critical requirement.

## Standard for Pyrotechnic Special Effects

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b>2. Labeling of Articles</b>            English and French.            Brand or trade name.            Logo or code that identifies the manufacturer.            Precautions and instructions for safe handling (see individual items for details):</p> <ul style="list-style-type: none"> <li>• If marking the article is not practical, the markings must appear on every inner package. In the absence of the inner package, the marking must appear on the shipping container.</li> <li>• When the article is too small to carry all the markings and is to be sold outside the shipping packaging, it must carry the most important safety messages appropriate to its mode of functioning and the markings must be approved by ERD.</li> <li>• Any alternative to the labeling proposed by this document must be approved by the Chief Inspector.</li> </ul> <p>(The cautionary warning must capture the method of functioning of the individual components. Instructions such as “This way up” or “for mounting” shall be added to those articles requiring special precautions due to the design of the article. In the specific requirements, a choice is given as to which instruction best meets the design of the article.)</p> <p>An indication of whether the article is recommended for indoor use.            The duration of the effect.</p>	<p>Must be present.</p>

## Standard for Pyrotechnic Special Effects

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b><u>Labeling of Articles cont'd</u></b></p> <p>The height or diameter of the effect.            An arrow indicating the exit direction of the effect or the direction of travel for line rockets.            A batch/lot number.            Product expiration date.</p> <p><b>3. Physical Integrity</b></p> <p><b><u>3.1 Construction of Articles</u></b></p> <p>Containing metal, such as staples or wire, or hard plastic, which could be a possible missile hazard when functioned or malfunctioned (C).            _____ Pyrotechnics falling out of the article (C).</p> <p>Loose pyrotechnic powder present in an unintended part of the article (C).            Construction of roll paper tubes, which would allow composition to migrate under the inner layer of paper.            Signs of breaking or cracking in casing or composition.</p>	<p>Must be present.</p> <p>Not allowed for all.</p>
<p><b><u>3.1.1 Tubes, Cones and Boxes</u></b></p> <p>Metallic construction (C).            Damaged by shipping or handling.</p>	<p>Not allowed.</p>



**Standard for Pyrotechnic Special Effects**

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b>3.1.2 Base</b></p> <p>_____ When present, becomes detached or is not secure during handling.            _____ Toppling over of articles' bases when tilted at 12° (C).</p>	<p>Not allowed.</p>
<p><b>3.1.3 Means of Ignition</b></p> <p>_____ The presence for the means of ignition of a pyrotechnic special effect, if present, shall be clearly visible and in accordance with the manufacturer's declaration (C).</p> <p><u>Attachment of igniter or electrical contacts (C)</u>: for pyrotechnic special effects with integral means of ignition, the attachment of the means of ignition to the article shall be secure.</p> <p><u>Protection of electrical contacts (C)</u>: the electrical contacts shall be covered or joined (shunted) in a short circuit or protected by an insulated connecting device.</p>	<p>Conformity verified by visual examination.</p> <p>The means of ignition shall not become loose when subjected to a pull test.</p> <p>Conformity verified by visual examination.</p>

## Standard for Pyrotechnic Special Effects

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b>4. <u>Performance</u></b></p> <p><b>4.1 <u>Function</u></b></p> <p>Did not function as described on the label (C).</p> <p>Did not function in a safe, reliable, reproducible and predictable manner (C).</p> <p>Bases that come loose during functioning (C).</p> <p>Unconsumed pyrotechnic composition after functioning.</p> <p>Loose plugs on tubes with plugs at the base affecting performance or safety.</p> <p><b>4.1.1 <u>Height, Diameter and Duration of Effect(s)</u></b></p> <p>The height, diameter and duration of effect(s) were not in accordance with the manufacturer's declaration (C).</p> <p><b>4.1.2 <u>Stability</u></b></p> <p>For free-standing pyrotechnic special effects that are not supported in any other way, did not remain upright while functioning.</p> <p><b>4.1.3 <u>Burning of Articles</u></b></p> <p>After functioning, articles must not burn for more than 5 seconds unless otherwise indicated on the safety labels of the article (C).</p>	<p>Not allowed.</p> <p>The height must not exceed declared value.</p> <p>The duration must not exceed declared duration.</p> <p>The diameter of the effect must not exceed declared value.</p> <p>Not allowed.</p> <p>Not allowed.</p>

## Standard for Pyrotechnic Special Effects

<b>General Requirements for Pyrotechnic Special Effects</b>	
CHARACTERISTICS	REQUIREMENTS
<p><b>4.2 Effects</b> Explosion of article (C). Projection of unlit composition.</p> <p><b>4.2.1 Sound Pressure Level</b> Maximum A-weighted impulse sound pressure level (<math>L_{almax}</math>) at a horizontal distance of 5 m from the testing point and at a height of 1.0 m above ground.</p> <p><b>4.2.2 Scatter of Burning Effect or Debris from Lighting on Ground,</b> unless declared to do so by the manufacturer and that this fallout distance is taken into consideration for the separation distance to spectators as stated on the label safety information or the instructions for use; this separation distance shall be at least twice the projection distance (C). Note: As a reference, the minimum separation distance to spectators is 5 m.</p> <p><b>4.2.3 Hard Body or Case Including Plastics, Cardboard, or Composite:</b> When functioned, the hard body or case of the pyrotechnic special effect or its holding device splinters (C) .</p>	<p>Not allowed (unless designed to do so). None.</p> <p>140 dB (A) max. unless specific instructions are provided by the manufacturer (e.g., “concussion” that is to be used remotely).</p> <p>2 m max.</p> <p>Not allowed.</p>
<p><b>5. Physical Measurements (Compared to Technical Declaration)</b> Gross weight. Explosive charge weights.</p>	<p>List on a separate report.</p>

**APPENDIX B - LIST OF PYROTECHNIC SPECIAL EFFECTS**

## **Standard for Pyrotechnic Special Effects**

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List of the various pyrotechnic special effects articles:

- Air Burst
- Binary Kits
- Comet (meteor)
- Preloaded Comet
- Preloaded Mine
- Preloaded Smoke Pot
- Preloaded Report (concussion tube)
- Falls
- Fireballs/Mortar Hits
- Flame Projector
- Flare (torch)
- Flash Cotton (sparkle string)
- Flash Paper
- Flash Pot
- Flash Tray (split mine)
- Gerb (including fountain, whistle and waterfall)
- Lance
- Line Rockets
- Multi-Tube Article (multi-shot plate, multiple-shot repeater boards, bombard board; designed to function in sequence)
- Pre-Mixed Powders
- Squib
- Strobe
- Wheel (saxon)