

# Towards the New Pyrotechnics Directive 2013/29/EU – an Impact Assessment

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**Abstract:** *With the coming into force of the new European Directive 2013/29/EU (Official Journal of the European Union L 178/27; 28.6.2013) pyrotechnic articles are regulated in view of making them available on the Union market. This Directive is a recast of the current Directive 2007/23/EC (Official Journal of the European Union L 154/1; 14.6.2007) regarding the placing on the market of pyrotechnic articles and will replace it entirely by July 1st, 2015. In comparison with the current Directive, the complexity and level of detail are increased in the recast version. Furthermore, a variety of new requirements are implemented, which influence the activities of the economic operators and notified bodies. This contribution describes the relevant changes from the viewpoint of the notified body Bundesanstalt für Materialforschung und -prüfung (BAM), and gives an impact assessment of the new requirements and corresponding suggestions for solutions to problems. The illustrated reforms are not all-embracing, but reflect the most important decisions and consequences.*

## Background to the recast

The following illustrates briefly the reasons and the motivation of the European Commission (COM) for setting up a recast of the Pyrotechnics Directive.<sup>1,2</sup> The information presented in this chapter was taken from the published executive summary regarding the impact assessment of the new legislative framework (NLF) alignment package of the COM from 2011.<sup>3</sup>

EU Directives follow mainly two overarching objectives: First, they should ensure that articles made available in Europe safeguard public interests like health and safety, consumer and environmental protection at a high (and preferably uniform) level. Second, they should form the basis for the free movement of articles within the EU by applying harmonized requirements. However, stocktaking of the COM from 2004 revealed several shortcomings and the fact that these goals were not achieved. In conclusion, the following were observed:

- A significant number of non-compliant products still reaching the market,
- The performance of certain notified bodies (NBs) was not satisfactory, and

- Inconsistencies exist throughout the legislation making its application unnecessarily complicated for manufacturers and authorities.

Within the frame of a public consultation at that time 92% of the overall economic operators (manufacturers, importers and distributors) considered that their specific sector was affected by non-complying products. Generally speaking, non-compliance can be potentially harmful for product users in view of the above mentioned public interests and it hampers the competitiveness of compliant firms. Non-compliant economic operators can gain significant cost advantages (e.g. by avoiding costly conformity assessment procedures) in comparison with those who apply harmonized Union legislation or standards. This problem increases with less effective market surveillance in the Member States of the EU.

In addition, the executive summary of COM<sup>3</sup> reveals that 84% of the economic operators, 68% of the NBs and 53% of the public authorities had significant problems with the quality of services of the NBs in general. This was explained by the lack of necessary competence of certain NBs to carry out conformity assessments in a proper way (in spite of being accredited against respective standards). Another reason for the concerning and sometimes

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poor quality of the work of certain NBs is that, in order to issue their certificates at significantly lower rates, these NBs do not put the required level of effort into their assessment or into the application of procedures. This can be achieved e.g. by elimination or reduction of on-site controls or relaxed requirements regarding the frequency of periodic audits/inspections to considerably reduce the costs of assessments.

In consequence, and as part of the reaction of COM towards these concerning observations, the “New Legislative Framework” (NLF) was adopted as part of the goods package with the aim of minimizing the observed shortcomings. It consists of two complementary instruments:

- Regulation (EC) No 765/2008 on accreditation and market surveillance (NLF Regulation)<sup>4</sup>
- Decision No 768/2008/EC establishing a common framework for the marketing of products (NLF Decision)<sup>5</sup>

The NLF Regulation provides immediate legal force and effect and has been in force since January 1st, 2010. In contrast to this regulation, the NLF Decision has no immediate legal effect on the Member States or the economic operators. The NLF Decision basically sets the overarching frame for the requirements of the economic operators and NBs, which must be implemented in (existing) regulations. For this reason, COM identified a group of EU Directives for product harmonization (the so-called NLF-package), where all single Directives are horizontally aligned to the NLF Decision. This NLF-package consists of the following 10 Directives:

1. Pyrotechnic Articles Directive: Directive 2007/23/EC on the placing on the market of pyrotechnic articles
2. Civil Explosives Directive: Directive 93/15/EEC on the harmonisation of the provisions relating to the placing on the market and supervision of explosives for civil use
3. ATEX Directive: Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
4. Lifts Directive: Directive 95/16/EC of 29 June 1995 on the approximation of the laws of the Member States relating to lifts
5. Pressure Equipment Directive (PED): Directive 97/23/EC on the approximation of the laws of the Member States concerning pressure equipment
6. Measuring Instruments Directive (MID): Directive 2004/22/EC on measuring instruments

7. Electromagnetic Compatibility Directive (EMC): Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
8. Low Voltage Directive (LVD): Directive 2006/95/EEC on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
9. Non-automatic Weighing Instruments Directive (NAWI): Directive 2009/23/EC on non-automatic weighing instruments
10. Simple Pressure Vessels Directive (SPVD): Directive 2009/105/EC relating to simple pressure vessels

With this background the pyrotechnics recast Directive 2013/29/EU<sup>1</sup> was published and entirely replaces the Directive 2007/23/EC<sup>2</sup> by July 1st, 2015.

## Impact assessment and solution approaches

Several questions arise for the concerned economic operators, NBs and market surveillance authorities when existing Directives are replaced by new recast versions. One of the focus points is the situation of the certificates issued under the old Directive. This aspect is treated as a kind of ‘inventory keeping’, where certificates issued under Directive 2007/23/EC<sup>2</sup> shall remain valid under the Directive 2013/29/EU,<sup>1</sup> as well. Nevertheless, the requirements according to the new Directive apply, which differ to some extent in comparison with the old Directive (as shown further down this article). This situation could lead to ambiguities between all involved parties, such as economic operators, NBs and market surveillance authorities, e.g. when labelling details according to 2007/23/EC<sup>2</sup> as part of the respective conformity assessment certificates at that time differ from the requirements of the new Directive 2013/29/EU.<sup>1</sup> This requires an extensive knowledge and information exchange between the parties involved, especially with the market surveillance authorities. From the point of view of the NBs, this information exchange was already initiated with the competent EU board regarding market surveillance ADCO-PA (Administrative Coordination Working Group – Pyrotechnic articles).

As explained earlier in the text, the provisions of the new Directive 2013/29/EU<sup>1</sup> will be applicable by July 1st, 2015. A specific topic is the newly formulated essential safety requirement (ESR) number 4 in the Annex I to this Directive, which had to be adopted by the Member States by July 4th,

2013. According to the old ESR 4 (Annex of 2007/23/EC<sup>2</sup>) all pyrotechnic articles must not contain commercial blasting agents, except for black powder or flash composition and military explosives. However, several types of pyrotechnic articles, particularly those for vehicles such as airbag gas generators but also squibs/bullet hits, contain small amounts of commercial blasting agents and military explosives and have been placed on the market for many years. As these substances cannot be adequately replaced for their intended purpose, a modification was necessary:

*Pyrotechnic articles must not contain detonative explosives other than black powder and flash composition, except for pyrotechnic articles of categories P1, P2, T2 and fireworks of category F4 meeting the following conditions:*

*(a) the detonative explosive cannot be easily extracted from the pyrotechnic article;*

*(b) for category P1, the pyrotechnic article cannot function in a detonative manner, or cannot, as designed and manufactured, initiate secondary explosives;*

*(c) for categories F4, T2 and P2, the pyrotechnic article is designed and intended not to function in a detonative manner, or, if designed to detonate, it cannot as designed and manufactured initiate secondary explosives.*

According to this new requirement ESR no. 4, detonative explosives other than black powder and flash composition are still prohibited within the categories F1–F3 and T1, but under due consideration of the given properties and further tests these substances are not explicitly excluded any more for articles of the categories P1–P2, F4 and T2 (which would include airbag gas generators and squibs).

In order to prove that the requirement ESR 4 (c) is met, appropriate test and evaluation methods must be developed. Amongst others, the following aspects need clarification:

- Which secondary explosive has to be taken? Which form, shape and mass of this explosive are suitable?
- Test configuration (direct contact or not etc.)?
- Experimental proof as part of EU type-examination only (performed by or on behalf of the NBs) or also as part of subsequent QS batch tests (performed by manufacturers)?

The respective European committee for standardization CEN/TC 212 Pyrotechnic articles and the Forum of Pyrotechnic NBs (coordination group between the notified bodies and the COM) currently deal with these aspects. Respective task

forces with intense involvement of BAM recently developed test and assessment criteria for the experimental investigation of ESR 4 (c). It is expected that these tests and assessment criteria will be implemented in the future into the corresponding product standards for display fireworks (F4), theatrical pyrotechnic articles (T2) and all other pyrotechnic articles (P1–P2). Parts of these tests and assessment criteria were already published by BAM within the *Journal of Pyrotechnics* (“Assessment of Explosives in Squibs”).<sup>6</sup>

In addition to this requirement, the question whether a detonative explosive cannot be easily extracted from the pyrotechnic article (ESR 4 (a)) needs thorough consideration and clarification.

The new Directive 2013/29/EU<sup>1</sup> doesn't apply any more to the placing on the market alone, but now comprises the entire procedure of making available on the market. This means any supply of a pyrotechnic article for distribution, consumption or use on the Union market in the course of a commercial activity, whether in return for payment or free of charge. One has to keep in mind that the old Directive was just limited to the placing on the market, which basically means the first making available of a pyrotechnic article on the Union market. With this formulation the entire chain of trade is covered.

Furthermore, it stands out that the extent or coverage of the Directive 2013/29/EU<sup>1</sup> was considerably increased, by a factor of nearly 3 concerning just the number of pages. This is mainly due to the fact that the obligations for all economic operators were strongly worded with an increased level of detail. This can be illustrated very well by an exemplary focus on the obligations of the distributors. Whereas the old Directive nearly neglected these specific obligations, the new Directive set up requirements within an entire article consisting of 5 paragraphs. Amongst others, the following aspects must be now acknowledged by the distributors from July 2015 on:

- Are the instructions and safety information in a language which can be easily understood by consumers and other end-users in the Member State in which the pyrotechnic article is to be made available on the market? What happens by the way if the distributor comes to a different conclusion regarding the required easy understandability for articles that successfully passed conformity assessment procedures?
- Verification of the labelling regarding the required details on the manufacturer and importer

- In case of a reason or suspicion of (formal) non-conformity to report to the competent national authorities of the Member States in which they made the pyrotechnic article available on the market to that effect, giving details, in particular, of the non-compliance and of any corrective measures taken.

As pointed out, the obligations of the manufacturers were also increased. They shall, when deemed appropriate in the view of potential risks for the health and safety of consumers, carry out sample testing of pyrotechnic articles that were already made available on the market and investigate regarding the non-conforming pyrotechnic articles. This needs further clarification, as the manufacturer already declared conformity to the Directive, and specific tests and assessments were also already carried by NBs (e.g. EU type-test and possibly batch tests) and the manufacturer (e.g. batch tests) himself. When articles are already made available on the Market, do the manufacturers have to repurchase their own articles for the purpose of these additional tests?

From the viewpoint of the fireworks industry an important aspect was “lifted” to a higher requirement level within the Directive 2013/29/EU.<sup>1</sup> The so-called “Lex Malta” in Article 2 g confirms further on that fireworks which are built by a manufacturer for his own use and approved for use exclusively in its territory by the Member State in which the manufacturer is established, and which remain in the territory of that Member State, don’t fall under the comprehensive scope of the Directive. Or in other words: conformity assessment procedures, aligned with extensive testing, are not mandatory in these cases. However, the interpretation of this will likely differ quite strongly in the Member states. The following brief example highlights this aspect: A manufacturer of professional fireworks sets up a display show and shoots these fireworks (without selling them, see Figure 1):

- Would this qualify as “own use”?
- Would such evaluation be dependent on the location (own company’s or public ground) or on the finances (audience pays or not)?
- Is the actual place of production important for this assessment (e.g. manufacturing site and lines within the EU or outside such as PR China)?
- How is this seen in the context of the definition of “making available on the market” itself (...means ...use on the Union market in the course of a commercial activity, whether in return for payment or free of charge)? This



**Figure 1.** Fireworks display in Malta 2012 (source: Lohrer; BAM).

definition might contradict the “Lex Malta” clause.

With regard to one of the main reasons for the recast of the Directive, the problematic care and diligence of certain NBs as pointed out by COM<sup>3</sup> (see earlier in the text), the Directive 2013/29/EU<sup>1</sup> contains an increased number of requirements towards being notified in the first place. According to Article 25 (6), such a body shall be capable of carrying out all the conformity assessment tasks assigned to it by Annex II and in relation to which it has been notified, whether those tasks are carried out by the conformity assessment body itself or on its behalf and under its responsibility. This strict requirement is flanked by the respective requirements of the latest “The Blue Guide” – on the implementation of EU product rules.<sup>7</sup> It is here specifically stated that, in cases of subcontracting to bodies in third countries, the notified body must have appropriate facilities and staff to be able to verify test results in the EU. In addition, if accreditation is the chosen path for notification, it must cover the subsidiary companies of notified bodies to which they have recourse. These requirements set the bar quite high for all NBs, as the respective harmonized standards require a large amount of testing capabilities (wide test grounds, comprehensive equipment etc.). A notification alone, as commonly done in the past and under the current Directive, on the basis of conformity assessments carried out by subcontracted tests labs (“stamping” of test reports), appears to be against the new provisions of the Directive 2013/29/EU.<sup>1</sup> Furthermore, COM considered the strong need due to incidents in the past to require the NBs to participate in, or ensure that their personnel responsible for carrying out the conformity assessment tasks are informed of, the relevant standardization activities and the activities of the notified body coordination group (forum of NBs). The NBs are additionally required to apply as general guidance the administrative decisions and documents produced as a result of the work of that group.

With focus on the reporting obligations of the NBs an important aspect was added, which possibly has its reason in the lack of care and diligence of some NBs (observed by COM<sup>3</sup>). In accordance with article 35 (2), NBs shall provide the other bodies notified under this Directive carrying out similar conformity assessment activities covering the same pyrotechnic articles with relevant information on issues relating to negative and, on request, positive conformity assessment results. This is an interesting statement, as it requires all NBs to report to the other NBs all negative conformity assessment procedures, which is not limited to EU type-examinations (module B), but also includes QS-related modules (such as C2, D, and E). A further motivation of COM to set up such requirements might have been the attempt to minimize hawking activities of manufacturers trying to spot the weakest part of the chain between the NBs. Within this “negative” reporting procedure, however, many things are not clear and need further consideration and clarification, such as:

- *What information is provided?* This depends on the respective conformity assessment module. After a negative EU type-examination for example traceability information such as registration and lot numbers are not issued, whereas after a negative module C2 assessment such details present valuable and useful information. This has to be considered with due care, taken into account the confidentiality aspects between the manufacturers and the NBs.
- *When is the information to be provided to the others?* Do the NBs have to report right away after the performed negative tests? Do they have to consider periods for objection for the manufacturer (which could take weeks and would contradict one possible aim of this reporting procedure to reduce the likelihood of the manufacturers to look for another NBs meanwhile for the same unchanged articles)?
- *How is the information provided?* Is a simple email to the other NBs enough or is there a need to feed databases?
- *Consequences arising from these negative reports?* How to proceed for example, if one NB receives the negative assessment report prior or during a testing procedure for possibly the same article?

Another direct consequence of this procedure is the fact that a certain approval statistic between the NBs is generated, which reveals if (and how many) products were negatively assessed by the NBs. Possible out of balance scenarios for identical articles and procedures between the NBs might be minimized with this measure.

These above mentioned concerns are currently discussed within the forum of NBs and one can expect a harmonized operation procedure regarding this negative assessment reporting obligation in the near future.

Another change comes with the labelling requirements given in the new Directive 2013/29/EU.<sup>1</sup> The new provisions now explicitly require the registration number for traceability as part of the article label and in addition the product, batch or serial number.

Unfortunately, the COM missed the opportunity to require a clear traceability of the articles to the specific batch that was tested. Due to the fact that the article number in addition to the registration number was considered as sufficient, the necessary link to the tested batch is still not always given.

Unfortunately, one important aspect regarding labelling of display fireworks remained unchanged in the new Directive. The COM kept the opinion to require a minimum safety distance on the label of display fireworks (and professional theatrical pyrotechnics, as well). This mandatory fixed value on the label of the display fireworks to be applied by users with specialist knowledge leaves no flexibility for the intended use. In addition, the term “safe distance” is misleading and not all-embracing. As recently shown by T. Smith and C. Lohrer<sup>8</sup> and C. Lohrer,<sup>9</sup> the philosophies of defining a “safe distance” differ significantly in Europe and other parts of the world. How can a NB assess or determine such a “safe distance” within a conformity assessment procedure (the respective certificates apply throughout the entire EU) with all the differing safety distance regulations? Distances for articles might be acceptable in Spain, but not in the Netherlands etc. Even if it were possible to find one approach for the entire EU, it could only be based on a standard use such as vertical firing, no windy conditions, no difficult terrain properties (just to name a few). The conditions onsite will, however, differ. There will be wind (considering direction and speed), rain or humidity, angling of the tubes, terrain elevation, houses etc. All of these factors will lead to either an increased or decreased applicable safety distance compared with the mandatory fixed value on the label. This will likely confuse the enforcement bodies onsite, responsible for the permission of such displays. The flexible and sensible approaches according to the applicable EU Standards for display fireworks and professional theatrical pyrotechnics were not considered during this recast. Within the testing and assessment of such articles according to these standards, only the relevant performance parameters will be recorded and displayed on the label. These values are the basis for the safety distance calculations in the Member states.



**Figure 2.** Airbag testing at BAM (source: Waschki/Dengel; BAM).

Promising experiences with such flexible systems (no fixed distances on display fireworks) already existed in the UK and in Germany before the implementation of the Directive 2007/23/EC<sup>2</sup> and had proven their sensible applicability in daily life.

The minimum labelling requirements for pyrotechnic articles for automotive purposes changed as well. As for fireworks for example, the product, batch or serial number is now mandatory. In addition, information towards the identification of manufacturer and importer must be accompanied by the address (single contact point). Figure 2 illustrates airbag testing during conformity assessment procedures at BAM.

The new Directive 2013/29/EU<sup>1</sup> pays more attention to formal aspects than the old Directive 2007/23/EC.<sup>2</sup> Examples for these observations are the detailed requirements on the conformity declarations and formal non-compliances.

Manufacturers must, at the end of the conformity assessment procedures (e.g. finished module B EU type-examination and QS according module D), draw up an EU declaration of conformity and affix the CE marking. Annex III of the Directive 2013/29/EU<sup>1</sup> gives now the minimum information that is necessary within such conformity declarations (not exhaustive):

- Registration number,
- Product, batch or serial number,
- Name and address of the manufacturer,
- Notified body issuing the certificate,
- References to the Directive and the corresponding standards, etc.

This is directly linked to article 42 dealing with formal non-compliant products. Even if pyrotechnic articles are technically safe and in compliance with the ESR of the Directive 2013/29/EU<sup>1</sup> (Annex I), they will be considered formally non-compliant, if one or

more of the following aspects are observed (not exhaustive):

- the CE marking has not or falsely been affixed,
- the identification number of the notified body, where that body is involved in the production control phase, has not or falsely been affixed,
- the EU declaration of conformity has not or falsely been drawn up,
- the technical documentation is either not available or not complete, etc.

In consequence of such formal non-compliance, the national authorities shall take all appropriate measures to restrict or prohibit the pyrotechnic article being made available on the market or ensure that it is recalled or withdrawn from the market.

Another relevant change concerned one of the applicable types of conformity assessment procedures. The module C (conformity to type, Annex II of 2007/23/EC<sup>2</sup>) was substituted by module C2 (conformity to type based on internal production control plus supervised product checks at random intervals, Annex II of 2013/29/EU<sup>1</sup>), which reveals higher or stricter requirements as it focuses also on internal production related aspects. It is therefore like module C + product checks at random intervals, or with other words “module D - light”. For more details refer to the Blue Guide.<sup>7</sup> As a consequence of this required assessment of the internal production control, the procedures and guidelines of the forum of NBs in the EU must be updated and changed accordingly. Several questions regarding this new conformity assessment procedure must be answered, such as:

- Are tests performed at the time of delivery of these articles in the EU sufficient (such as container deliveries from China)? This procedure is currently performed by NBs within module C testing, but would likely not satisfy the mandatory assessment of the internal production control that requires direct access to the production lines
- Are type or batch tests performed?
- What constitutes random intervals?

Currently the forum of NBs works on a harmonized applicable procedure to cover the obligations of module C2. The result will likely be published again by the COM after internal clearance.

The last but not least relevant change that is highlighted here deals with the application process for articles submitted to the EU type examination (module B). Manufacturers must submit for application, amongst others, the detailed technical documentation which shall include an adequate analysis and assessment of the risk(s). As commonly

known, one specific risk is the product of a certain expected hazard multiplied with its expected frequency. As shown by several studies in the past (one method was presented by T. Smith<sup>10</sup>), adequate risk assessments are comprehensive and require detailed information on many aspects that are not fully known at the beginning of the conformity assessment procedure, such as:

- type of expected failure (e.g. in-mortar explosion, blind shell on ground, blind stars on ground, burning matter, ...),
- conditions of use (e.g. angling mortar, short mortars, insufficient mortar materials, ...),
- environmental conditions (e.g. wind directions & speed, rain & humidity, temperature, dried grass, ...),
- surrounding conditions (terrain type and location itself, elevation, buildings nearby, ...).

And again, even if all sensible scenarios were foreseeable prior to type testing and certain risks in terms of precise values are generated, how are they assessed? There are no commonly accepted threshold values of risks applicable to the entire EU. Each Member state applies its own criteria and assessments and acceptable limits. It is therefore impossible for a NB to find an adequate risk assessment that fits for all EU member states. This must also be seen in the context of the differing safety distance approaches in the EU as discussed earlier in the text. It therefore remains unclear how this new requirement can be adequately treated by the manufacturers and NBs (e.g. by the application of harmonized standards alone or further measures in addition necessary?)

## Conclusions

The European Directive relating to the making available on the market of pyrotechnic articles (recast) comprises several new obligations for the economic operators, market surveillance authorities and notified bodies in this field. Some of these changes are considered helpful and necessary by the authors of this paper, such as the new ESR 4 and the additional labelling number (product, batch or serial). Other new obligations will likely complicate the entire procedure of making available of pyrotechnics on the EU market and it is expected that problems during the first months or years(s) of application of the new Directive will occur in Europe. In order to minimise misinterpretations and problems, an intensive knowledge and information exchange between the above mentioned involved parties is necessary and partly already initiated (notified bodies and market surveillance authorities aim at informing each other on a regular basis during the year).

## References

- 1 Directive 2013/29/EU of the European Parliament and of the Council of 12 June 2013 on the harmonisation of the laws of the Member States relating to the making available on the market of pyrotechnic articles (recast); *Official Journal of the European Union* L 178/27; 28.6.2013.
- 2 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; *Official Journal of the European Union* L 154/1; 14.6.2007.
- 3 New Legislative Framework (NLF) Alignment Package, Executive Summary of the Impact Assessment; COM(2011) 763 final; SEK(2011) 1375 final; European Commission, Brussels 21.11.2011.
- 4 regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93, *Official Journal of the European Union* L 218; 13.8.2008.
- 5 decision No 768/2008/EC of the European Parliament and of the council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC, *Official Journal of the European Union* L 218; 13.8.2008.
- 6 L. Kurth, H. Krebs, B. Theil, O. Mücke and C. Lohrer, Assessment of Explosives in Squibs, *Journal of Pyrotechnics*, Issue 32, 2013, pp. 57–66.
- 7 *The Blue Guide – on the implementation of EU product rules*, European Commission, DOI: 10.2769/9091; 2014.
- 8 T. Smith and C. Lohrer, “Comparison of national “safety distances” at professionally fired firework displays and distances derived from ShellCalc©”, *Journal of Pyrotechnics*, Issue 33, 2014, pp. 53–63.
- 9 C. Lohrer, “Display Fireworks And Stage Pyrotechnics In Use – Which Distances Are ‘Safe’ In Germany And Other Parts Of the EU?”, *Journal of Pyrotechnics*, Issue 33, 2014, pp. 39–51.
- 10 T. Smith, *Firework displays: Explosive entertainment*, Chemical Publishing Co., Inc., ISBN 978-0-8206-0090-1, 2011.