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Firework displays — General guidance

Artifices de divertissement — Lignes directrices générales

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 264, *Fireworks*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is intended to provide guidance on the organization of fireworks displays carried out by professionals in countries where such events are not fully covered by national legislation or industry codes of practice.

The target readership for this document is the following:

— the parties involved in fireworks displays;

— the designing, operating and management personnel for fireworks displays;

— the relevant authorities in charge of monitoring fireworks displays.

The recommendations of the present guidance were drawn up with a view to improve the approach of public safety where national provisions may be inadequate. In no case they are a full guarantee against the hazards and risks of the use of fireworks. Other practices may exist leading to better results and possible revisions of the present guidance. Organizers and operators of fireworks displays should be aware that the proposed recommendations are only a step on the way toward better practices and that only risk analyses can lead to maximize public safety in real and foreseeable conditions of firing, taking into account local culture and risk acceptability and the conditions that prevail when the display is fired. The examples given in this document are provided reference for the countries where they may be applicable.

Firework displays — General guidance

1 Scope

This document provides guidance on the operation of fireworks displays by professional teams of people with specialized knowledge. It is not applicable to the use of theatrical pyrotechnic articles on stage, in filming locations, or any other locations. It is not applicable to displays that involve only fireworks of categories 1, 2 and 3.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
fireworks displays
operations that are carried out at certain site and time, with choreography and design, by professional personnel handling and firing a certain number of fireworks such as display shells, batteries and combinations, lance fireworks, special fireworks, etc.

Note 1 to entry: This definition is also applicable to hand-fired fireworks.

3.2
display operation
operations that are related to *fireworks displays* (3.1) including installation, loading, connecting, firing system test, firing control and after show check and clean-up

3.3
electric firing device
device that delivers the firing electric current to the electric igniters of the fireworks

3.4
electric firing system
system that includes the *electric firing device* (3.3) and commands and controls the whole sequences of fireworks displays

3.5
electric igniter
electric igniting element that consists of leading wires, chips or bridge wires, ignition charge, protective paint, varnish or cover and short circuit caps or twisted bare conductors at the ends of the leading wires

3.6
effect radius
maximum horizontal distance to which the firework effect expands from the burst point

3.7
firing spot
place where a firework or group of fireworks is set and fired

3.8
firing zone
area where several *firing spots* (3.7) are located

3.9
operation zone
area where the operators carry out all operations that are necessary for preparing and setting up the *fireworks display* (3.1)

3.10
safety distance
minimum distance(s) of persons or flammable materials or obstructions from the article in the direction of the effect to reduce the risk to as low as reasonably practicable

Note 1 to entry: The notion of acceptable "risk" depends on national regulations and/or national best practices.

3.11
firing safety distance
minimum distance between the *firing zone* (3.8) and the operators of the *fireworks display* (3.1), taking into account the possible special protections that are set up

3.12
hazard zone
protection zone
area that is determined by the envelope of all safety distances of all the *firing spots* (3.7)

3.13
security zone
area where the access of unauthorised persons is forbidden by local authorities

Note 1 to entry: A security zone can be defined for the setup of the show and another security zone can be defined for the firing of the show.

Note 2 to entry: The security zone extends beyond the operation zone and may be merged with it (e.g. during the setup) or with the hazard zone (e.g. during the firing).

3.14
product group
several products to be fired in a sequence in a *firing spots* (3.7) and located at the same *firing spot* (3.7)

3.15
internal distance
minimum distance between products or *product groups* (3.14)

3.16
ground fireworks display
fireworks display (3.1) where no projected and/or propelled fireworks are fired

Note 1 to entry: For example, lancework, fountains, waterfalls, wheels etc.

3.17
aerial fireworks display
fireworks display (3.1) where projected and/ or propelled fireworks are fired

Note 1 to entry: For example, shells, rockets, batteries and combinations, Roman candles, aerial wheels etc. An aerial fireworks display may include the firing of ground effects (for example, lancework, fountains, waterfalls, wheels etc.).

4 Types, safety distance and categories of fireworks displays

4.1 Types of fireworks display

Fireworks displays are classified into two types, ground fireworks displays and aerial fireworks displays.

4.2 Safety distance

4.2.1 General

The meaning and interpretation of "safety distance" vary according to the countries and their local understanding of acceptable risk. It must be kept in mind that, whatever their definition and their calculation rules, the objective of determining safety distances is to reduce the risk to as low as reasonably practicable according to local cultures and rules.

4.2.2 Factors that should be considered for the determination of safety distances

4.2.2.1 Performance characteristics of products

The burst height of different types of firework products is one of the main factors considered to determine safety distances, but not the only one. The burst height is subject to the type and size of firework products. The higher the burst height, the larger the safety distances required. Other performance factors that could determine safety distances are the noise level of fireworks, the possibility of projections, the nature, type and weight of fallouts (e.g. rocket sticks), the nature of effects (e.g. multi-break shells).

The burst height of firework products (especially shells, rockets and aerial wheels) may be subject to limitations by local regulations.

4.2.2.2 Product installation methods

The products for fireworks displays may be installed vertically or obliquely, which is an important factor to be considered to determine safety distances. If the products are installed obliquely, the safety distances shall be increased accordingly in the direction of firing and may be reduced in the opposite direction. Appropriate software, charts or coefficients should be made available to calculate the safety distances for fireworks that are installed obliquely.

4.2.2.3 Environmental conditions

The environmental conditions for fireworks displays include wind speed and wind direction, which affect safety distances to a certain extent. The safety distance in the downwind direction should be increased according to the wind speed, as well as to the type and performance of fireworks. It may be done by application of a given additional percentage to a standard safety distance determined in reference conditions (e.g. vertical firing with a tolerance of ±Y° and wind speed smaller that X m/s). The additional percentage to be applied to the safety distance should be determined on the national basis, taking into account the local definition of safety distance, the level of risks acceptable and experience, etc.

The safety distance in the upwind direction may be reduced according to real conditions.

It should be reminded that wind speed measurements close to ground level give underestimated values of the wind speed profile along the shell trajectories. Weather forecasts may be a useful source of information in the preparation of fireworks displays.

If a weather front is approaching at display time, particular protection must be taken if there is a sudden change in wind strength or direction.

4.2.2.4 Other factors

Protection measures, constructions and natural geomorphic environment should be taken into consideration, and the safety distances may be changed accordingly, depending on real conditions of firing.

4.2.3 Determination of safety distance

The safety distance should be determined by considering the factors specified in 4.2.2, and in some countries the manner the safety distance should be calculated is defined by local regulations and/or agreed professional best practices

For information, Annex A gives examples of safety distances calculated in calm atmosphere according to the methods of various countries. These methods may change in the future and the displayed values don't replace the obligation of determining safety distances according to the applicable and possibly updated methods in real conditions of use.

4.3 Categories of firework display

According to the calibre and quantity of display shells of similar effect on the same firing conditions, batteries and combinations to be fired in fireworks displays, fireworks displays may be classified in categories, see Annex B for information.

5 Operating technology of fireworks displays

5.1 Personnel

The personnel involved in fireworks displays should be a team of persons with specialist knowledge. Applicants to such knowledge assessment may participate in the preparation of fireworks displays provided that they are placed under the responsibility of persons with specialist knowledge with the appropriate limitations in the tasks they are allowed to carry out.

The setup and the firing of the fireworks displays should be placed under the responsibility of a person who has the appropriate specialist knowledge and the appropriate license (in the countries where local regulations require it).

When the size of the firework display justifies separate firing zones, each zone should be placed under the responsibility of one person who have the appropriate specialist knowledge and refer to the person responsible of the whole display or have been given the appropriate delegations to take every necessary decision.

Each country may refer to the local regulations for the specialist knowledge and corresponding training to be required for the setting and firing of fireworks displays.

5.2 Site

5.2.1 The site where the firework display is to take place should be a large unobstructed area in the foreseen directions of trajectories and effects of all projected / propelled fireworks to be used. As mentioned in 4.2.2.4, some characteristics of the site may be used for their screening effect allowing to reduce safety distances in the desired or required directions.

For aquatic fireworks, moisture-protection measures should be taken for functioning in the expected effect.

When the firing of fireworks is authorized indoors, the area should be clean, flat, well-ventilated and non-flammable. The distance between the firing spot and the audience should meet the requirements on safety distances of 4.2. The presence of a roof should give a limitation to the effect height of projected

and/ or propelled effects. In any case, the use of fireworks of categories 1, 2, 3 and 4 indoors should be submitted to local restrictions.

5.2.2 Safety distances are determined as specified in 4.2.

5.2.3 If appropriate, local regulations should be considered for the width of safety evacuation passageways.

5.3 Operation plan

5.3.1 Display operation plan may consist of technical design plan and/or organization and implementation plans.

5.3.2 Technical design plan may include the following content:

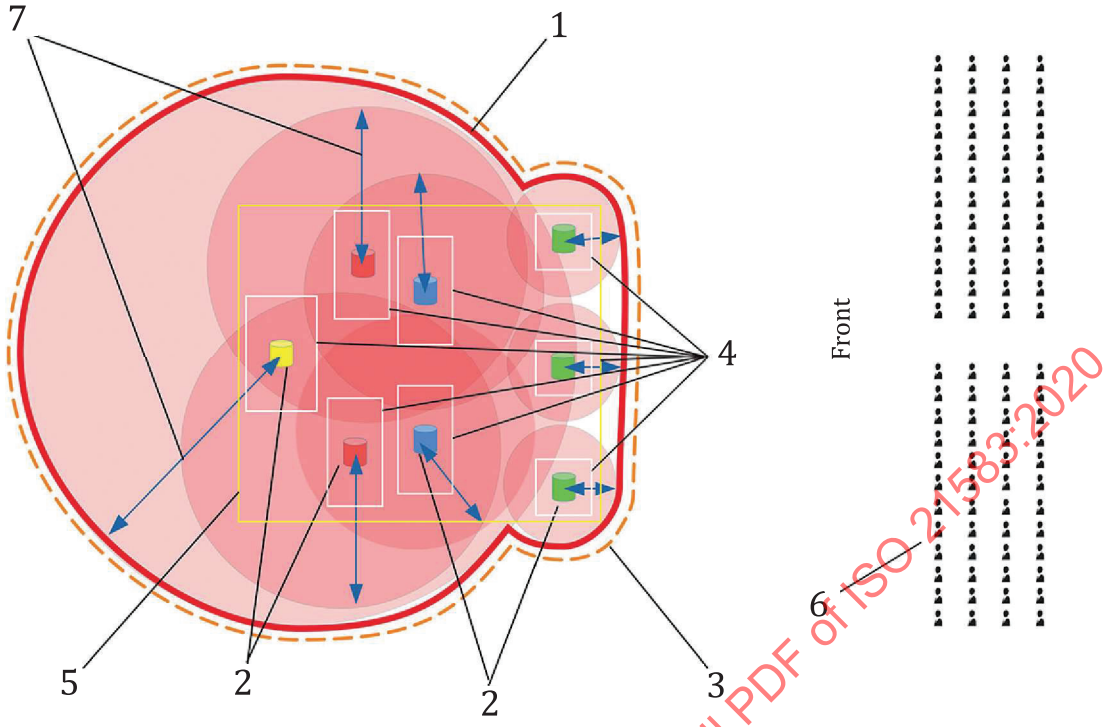
a) Description of category (if any required by local regulations), types and corresponding quantities of firework articles (including calibres of shells and other projected or propelled articles), total net explosive content of the whole display, time, site and event theme of firework display;

b) Layout diagram of the display site showing firing zones and corresponding firework products;

c) Basic information of display equipment and firing methods;

d) Hazard zone, security zone and operation zone (see Figure 1) for protection of public and property;

e) A risk analysis is strongly recommended. Risk analysis may be mandatory by national regulations in some contexts (See Clause 7).



Key

1	hazard zone	5	operation zone
2	firing spot	6	audience
3	security zone	7	safety distance
4	firing zone		

Figure 1 — Hazard zone, security zone, operation zone, firing zone and firing spot

5.3.3 Organization and execution plans may include the following content:

a) Description of the organizing team that shall be set up to take charge of safety, security, traffic control, firefighting, emergency operations; the composition of such team may depend on the category of firework display within the categorization system that is used locally for fireworks displays;

b) Onsite personnel assignment, position and responsibilities from setup to clean-up and corresponding specialist knowledge recognition (where appropriate or required by local regulations);

c) Safety measures for transporting, storing and safekeeping firework products and relevant equipment before, during and after the firework display;

d) Safety and security measures including firing safety distance for handling and setting up firework articles, firing the display and cleaning up the firing and operation zones;

e) Emergency measures for accident management for the operators. Emergency measures for the public may be determined by local services in charge of public protection such as firemen and first aid organizations with the possible help of the organizing team;

f) Display execution plan, including personnel assignments and responsibilities, operation procedures, on site safety management measures and contingency plans, etc.

5.4 Products, equipment and auxiliary materials and tools

5.4.1 Products should conform with the requirements of ISO 25947 and ISO 26261 standard series or local standards and/or rules as appropriate for the country of use.

5.4.2 Firing equipment such as mortars, mortar racks, electric firing device, electric firing system etc. should satisfy the intended use of fireworks and comply with relevant quality standards if any.

5.4.3 Auxiliary materials (e.g. protection bags and foils) and tools (e. g. knives, cutters and staplers etc.) should be compatible with the intended use of fireworks and conform with relevant quality standards if any.

5.5 Installation

5.5.1 Installation of articles

5.5.1.1 Firework articles should be installed at the firing spot as required by the display design and in compliance with the user's instructions and, for category 4 fireworks, with the applicable best practices that are part of the specialist knowledge of authorized users or with the local rules of the country where firework articles are installed.

5.5.1.2 Combinations and batteries should be installed on flat surfaces according to display design requirements and fixed if it is required by user's instructions.

5.5.1.3 Shot tubes should be installed according to display design requirements and be fixed on an appropriate stable support by taking certain measures according to user's instructions.

5.5.1.4 The framework that is required for the firing of ground fireworks, such as lancework fireworks, wheels, waterfalls etc., should be installed by persons with specialist knowledge and the fireworks should be fixed firmly to that framework. The resistance of the framework to the wind should be assured. The ignitability of the surrounding area should be taken into account, leading to possible specific measures to prevent ignition and propagation of accidental fire.

5.5.1.5 Roman candles have to be fixed firmly on an appropriate stable support at the intended angle in a way which takes into account the recoil effect during the functioning. If shooting obliquely, the safety distance should be increased according to the inclination angle.

5.5.1.6 Rockets should be fired from a specific frame which guides them safely at the very beginning of their flight. This guiding should be as loose as possible not to interrupt or slow down the take-off. Before installing the rockets, a visual examination of the guiding stick should be made to detect possible bending, breaks and damages to the fixing of the stick to the rocket.

5.5.1.7 Aerial wheels should be fired from a specific equipment which guides them safely at the very beginning of their flight. This guiding should be as loose as possible to assure a free and stable rotation of the wheel before it takes off.

5.5.1.8 For aquatic fireworks, the range over the water should be taken into consideration to determine the shooting angle of these articles, to ensure the trajectories and effect expansion remains within the designated hazard zone on water.

5.5.1.9 Firing special designed firework articles such as girandolas should meet relevant safety requirements specified by the manufacturer.

5.5.1.10 For preventing firework articles from accidental or untimely fire transmission, internal distances may preferably be set between firework articles within product groups under normal conditions, see Annex C for reference. In special circumstances, e.g. limited space as in the case of firing fireworks from barges, internal distances may be set according to real conditions.

NOTE Internal distances between fireworks within product groups reduce the risk of failure transmission between a defective firework and the surrounding ones, but do not eliminate that risk. Indeed, the larger the distance, the smaller the transmission risk. For shells and fireworks that project pyrotechnic units (Roman candles, shot tubes, mines ...), the mechanical characteristics of mortars and tubes (type of material, thickness, breaking mode ...) play a more important role in the prevention of failure transmission.

In the case of powerful fireworks, appropriate protection measures (e.g. screens) may also be placed between fireworks within product groups for the same purpose.

5.5.2 Installation of mortars

5.5.2.1 Shells should be fired from mortars according to 5.5.2.1 to 5.5.2.7. The mortars for spherical and cylindrical shells may be fixed in stable racks or buried up to at least half their height into sandy soil or large containers filled with dry sand. The second technique is recommended for large calibre shells and/or when mortars that are likely to project fragments (in case of shell explosion) are used.

5.5.2.2 For vertical firing, the bottom of shell mortar, combinations and batteries should be totally placed into full contact with the flat ground or a flat interface.

5.5.2.3 If the mortar is shooting obliquely, the space between the bottom and the ground or interface should be stuffed with mechanically resistant materials, and the requirements of 5.5.2.4 should be met.

5.5.2.4 The installation of shell mortars should conform with the following requirements:

a) Shell mortars shall be secured firmly and stably in racks or appropriate supports with proper degree of tightness, so as to avoid falling down or falling apart from the rack or their support during the firework display; mortars should not disrupt adjacent mortars if they do fail in a rack;

b) Shell mortars (Φ ≤ 153 mm) installed in racks refers to Annex C, and may be mixed with mortars of other calibres (Φ ≤ 153 mm);

c) Shell mortars (Φ ≥ 178 mm) installed in racks should be fixed separately according to respective internal distance and respective rack design, see Annex C;

d) It is recommended that the number of mortars in each independent rack is smaller than the maximum numbers of Table 1.

Table 1 — Maximum number of mortars in each group

Calibre of mortar of display shells	Maximum number of mortars in each group (in shots)
Φ76 mm	100
Φ103 mm	80
Φ127 mm	40
Φ153 mm	30
Φ178 mm	20
Φ205 mm	12
Φ>205 mm	4

e) For installation of shell mortars into sandy soil or in container filled with sand, see Annex C.

5.5.2.5 It is recommended that the ratio of the shortest length of the rack to the height of the highest mortar is no less than 1,5.

5.5.2.6 After the installation of mortars but before loading, inspection should be carried out by checking the stability of mortars and racks, angles and distance between mortars, etc.

5.5.2.7 In case that shells are fired from the platform of boats, barges, bridges and buildings, recoil mitigation measures may be taken at the bottom of mortars if necessary.

5.5.3 Loading, connecting and testing of shells

5.5.3.1 The operation zone should be clearly marked for the sites of shell loading, connecting and testing; safety protection measures should be taken for the firework articles still to be loaded.

5.5.3.2 The loading of shells should conform with the following requirements:

a) Electric igniters should be short circuited before and during installation;

b) Electric igniters should not be fitted before loading, unless igniters are integral to the shells and fitted prior to loading (In this case, igniters should be protected to reduce the risk of accidental ignition by friction, ESD, etc);

c) Mortars should be dry and clean, without water or other residues, and one mortar should be loaded with only one shell, and no repetitive loading should be allowed;

d) Shells should be carefully loaded right to the bottom of the mortar of correct calibre, and should not be loaded upside down;

e) A visual inspection of the firework articles shall be made before loading. Damp shells, damaged shells, shells exhibiting powder leakage or abnormal shape shall not be loaded;

f) Waterproof and fireproof protection measures should be taken promptly after loading if needed;

g) In case of bad weather such as thunder storm, the installation of shells should be suspended. In case of heavy rain and intense snowfalls, the installation of shells should be carried out under appropriate protection.

5.5.3.3 Fuses should be connected properly and firmly, with waterproof and fireproof measures applied if necessary.

5.5.3.4 Firing system test should be carried out after cable laying and connection is completed; when testing, unauthorised persons should move to outside the hazard zone or protected area inside operation and hazard zones.

5.6 Ignition

5.6.1 It is recommended that fireworks displays of any category are fired electrically with remote firing system(s). When fireworks of calibre larger than 150 mm are used, the firework display should preferably be fired with remote firing system(s), such as simple firing system or computerised firing system, etc. The same recommendation may be linked to total NEC limits in some countries.

5.6.2 Safety protection measures should be taken for the place where the electric firing system is located if it is in the operation zone.

5.6.3 Firing should not start until all safety requirements are confirmed to be satisfied onsite.

5.7 Suspension or termination of displays

The fireworks displays should be suspended or terminated in case of any of the following situations:

a) The current wind suddenly blows in another direction than foreseen or observed during the installation of the firework display, which may endanger the audience; for the foreseen or observed wind speeds and directions, if protection measures are taken or contingency plans are used to modify the display to avoid the endanger of the audience, the firework display may not be suspended or terminated.

b) The increase of wind speed may endanger the safety of the public and of buildings, electric power and telecommunication facilities and other sensitive locations outside the hazard zone as well as buildings that are allowed to be included in the hazard zone to be safely enlightened by fireworks according to the display design;

c) Fireworks displays are hampered by lightning strikes, etc.;

d) Abnormal events that endanger human safety, like tube blow out, low height explosion, muzzle explosion, etc. occur accidentally;

e) The onsite display operation supervisor considers it is necessary to suspend or terminate the display.

f) Unauthorised person(s) enter the hazard zone.

6 Safety management

6.1 During installation, firework display and site clean-up, all operators should wear appropriate personal protective equipment (such as safety helmets, anti-static penetration-proof shoes, eyes and ears protection) and clear identification as team member.

6.2 All operators should follow working and safety instructions.

6.3 The security zone should be set for fireworks displays.

6.4 The security zone and operation zone should be marked with obvious and unambiguous signs.

6.5 Cleanup should comply with the following requirements:

a) After fireworks displays, the operators should turn off the firing system(s) and cut off electric power in time; clean-up of display site should not be carried out until at least 15 minutes after fireworks displays have finished; designated persons should be assigned on site for safety during the clean-up so that no unauthorised people can have access to the display site.

b) The firing zone for shells should be inspected first, and dud shells or other unfired fireworks should be carefully extracted from mortars and placed in appropriate containers. Dud shells and unfired fireworks that remain in mortars should only be extracted by persons who have been specially trained for such operation and should apply the specified precautions.

c) The unfired or incompletely fired fireworks should be disconnected safely from their electric igniters on site, and then properly packed. These electric igniters should be grouped and placed in appropriate packages after having been shunted (e.g. by twisting together the bare conductors at the ends of the leading wires)

d) After the firework display, the check for compositions remaining in functioned fireworks should be carried out by persons who have been specially trained for such verification and should apply the specified precautions. The check for possible dud shells may also be carried out in and outside the

operation zone. A second check may be carried out on the next morning (not necessary if no unfired fireworks occur).

6.6 Damaged or unfired firework products should be transported back to the facilities of the company in charge of the firework display and then back to the manufacturer or importer or in the appropriate waste elimination network. In case the fireworks are not suitable for transportation, they should be destroyed onsite or nearby by persons who have been specially trained for such destruction and should apply the specified procedures and precautions, if safety is ensured.

7 Risk analysis

If risk analysis is required, it may include the following aspects:

a) Determination of the category of firework display according to the categorization system that is locally applicable or the system given in Annex B;

b) A qualified and instructed team;

c) Technical design plan and/or organization and execution plans;

d) Safety and reliability of all firework products and equipment for firework display;

e) Safety and reliability of firing systems and methods;

f) Impact of surrounding environmental and meteorological conditions on the safety of display site;

g) Predetermination of operational measures that should be put in application if the weather conditions deviate from what was foreseen and taken into account in the preparation of the firework display;

h) Rationality and reliability of the defining of hazard zone and security zone;

i) Workers' safety measures;

j) Completeness and rationality of safety protection measures for security, traffic control, firefighting, health aid and emergency treatment, etc., if necessary.

Annex A
(informative)

Reference Data of Safety Distances

The following data are provided by some countries and are applicable locally. In this document, they are only given for information. They show that the understanding of safety distances varies according to the countries. In all cases, national regulations or appropriate best practices apply as a minimum.

Table A.1 — Safety distances in China

Type of article	Size (mm)	Minimum burst height (m)	Maximum burst height (m)	Safety distances to the audience (m)	Safety distances to the buildings (m)
Display shells	75	50	120	100	45
	100	60	140	120	60
	125	80	190	150	80
	150	100	220	180	100
	175	110	240	200	110
	200	130	260	220	130
	250	140	280	280	140
	300	160	300	300	160
Batteries and Combination and Roman candles	≤50,8			50	35
Guided fireworks				30	

Table A.2 — Safety distances in European countries

Type of article	Size (mm)	Burst/effect height (m)	Safety distances to the audience in 'standard' conditions (m)					
			Germany	France	Spain	Netherlands	Italy	Portugal
Spherical shell-peony (starts as main effect)	75	136	109	109	45	120	100	60
	100	184	147	147	60	165	100	80
	150	240	192	192	120	230	150	120
	200	285	228	228	200	265	150	160
Spherical shell-salut (report as main effect)	75	136	136	136	45	120	100	60
	100	184	184	184	60	165	100	80
	150	240	240	240	120	230	150	120
	200	285	285	285	200	265	150	160
Mine (star as effect)	50	25	30	40	25	60	50	25
	75	50	50	60	35	60	100	60
Roman candles (stars as effect)	30	50	50	25	25	75	50	9
	60	75	50	38	48	120	100	48
Fountain (small effect width)	30	25	30	15	12	60	30	9
	40	50	50	15	14	60	30	20

Table A.2 *(continued)*

Type of article	Size (mm)	Burst/effect height (m)	Safety distances to the audience in 'standard' conditions (m)					
			Germany	France	Spain	Netherlands	Italy	Portugal
Shot tube (comet/star effect)	30	25	30	13	25	75	50	9
	50	75	30	38	25	75	50	25
Shot tube (Bombette/report effect)	30	75	50	60	25	75	50	9
	50	75	60	60	25	75	50	25
Rocket (calibre for rocket motor)	15	70	125	110	50	125	100	75
	20	150	125	230	50	125	100	100
Ground fireworks (no movements)	20	10	20	15	10	30	30	6

Table A.3 — Safety distances in Israel

Type of article	Size (mm)	Minimum safety distance (m)
Fireworks up to 1.5''	38,1	25
Fireworks above 1.5'' up to 3''	38,1–76,2	50
Fireworks 3''	76,2	65
Fireworks 4''	101,6	85
Fireworks 5''	127	110
Fireworks 6''	152,4	130
Fireworks 7''	177,8	150
Fireworks 8''	203,2	170
Fireworks 10''	254	215
Fireworks 12''	304,8	255

Table A.4 — Safety distances in Japan

Type of article	Size (mm)	Bust/effect height (m)	Safety distance Audience (>m)
Spherical shell-peony (starts as main effect)	69	80	65
	86	120	100
	115	150	110
	144	200	180
	173	220	190
	230	280	210
	285	300	240
	580	450	300
Mine (star as effect)			20
Roman candles (stars as effect)			20
Fountain			20

Table A.4 *(continued)*

Type of article	Size (mm)	Bust/effect height (m)	Safety distance Audience (>m)
Shot tube (comet/star effect)			20
Combination			Shell Device: 40
			Other: 20
Ground fireworks (no movements)			20

Table A.5 — Safety distances in Finland

Type and size of article	Diameter of the hazard zone during display	Distance to spectators, traffic roads or residential buildings[c]	Distance to special objects[d]
Mines, comets, products without separation charge[a]		The safety distance is 11 m/25 mm of internal diameter of mortar	Distance is always 2x safety distance
30 mm	28 m	14 m	
45 mm	40 m	20 m	
Starshells[b]		The safety distance is 11 m/25 mm of internal diameter of mortar	Distance is always 2x safety distance
1" or smaller	46 m	23 m	
1.5"	64 m	32 m	
2"	85 m	43 m	
2.5"	107 m	54 m	
3"	128 m	64 m	
4"	171 m	85 m	
5"	213 m	107 m	
6"	256 m	128 m	
7"	299 m	149 m	
8"	341 m	171 m	
10"	472 m	213 m	
12"	512 m	256 m	

[a] The separation charge is the charge inside the rising part of an effect that will make the parts of the effect to disperse in various directions.

[b] The table for starshells applies to any effect that contains a separation charge.

[c] Mortars can be installed in oblique fashion to compensate for wind and to guarantee that falling debris will stay inside the hazard zone. Mortars may never however be tilted towards spectators. Tilting mortars due to reasons above does not change the size of the hazard zone. Mortars can be mounted obliquely due to aesthetic reasons, and this respectively extends the hazard zone. There can be buildings or objects inside the hazard zone, however not residential buildings or special objects The direct distance to non-flammable objects, to the surface of a building or material, can be 10–40 m depending on mortar dimension.

[d] The special objects are defined as a building difficult to evacuate (hospital, home for aged persons, etc.) or a above earth storage of combustible liquids or gases. A fuel tank in a vehicle inside the area is not included.

Annex B
(informative)

Categories of Fireworks Displays

According to the calibre and quantity of display shells, batteries and combinations to be fired in fireworks displays, fireworks displays may be classified into eight categories including A, B, C, D, E, F, G and H, see Table B.1 for details.

Table B.1 — Categories of fireworks displays

Categories	Conditions (under one of the following conditions)
A	Fireworks including professional fireworks of no more than 30 mm in size and Category 1, 2, 3 & 4 fireworks
B	Other professional fireworks except display shells (including other Category 1, 2 & 3 fireworks)
C	Fireworks including display shells (mortars of maximum internal diameter ≤76 mm)
D	Fireworks including display shells (mortars of maximum internal diameter ≤103 mm)
E	Fireworks including display shells (mortars of maximum internal diameter ≤127 mm)
F	Fireworks including display shells (mortars of maximum internal diameter ≤153 mm)
G	Fireworks including display shells (mortars of maximum internal diameter ≤205 mm)
H	Fireworks including display shells (mortars of maximum internal diameter >205 mm)

Other categorization systems may be used instead of the one given in the above table, e.g. based on total NEC limits for fireworks displays as well as on the categories of fireworks that are used in such displays. They may be linked to different legal requirements depending on the categories of fireworks displays and shall then prevail.

Annex C
(informative)

Internal Distances and Examples of Installation of Shell Mortars

Shell type, mortar construction, rack construction and separation between mortars are factors to be taken into account in the installation of shell mortars on the firing site.

The recommended internal distances for installation of shell mortars are shown in Table C.1.

Table C.1 — Internal distances (product groups)

Specifications	Internal distances (mm)
Distance between battery/combination groups	≥200
Shell mortars (Φ = 178 mm, Φ = 205 mm)	≥200
Shell mortars (Φ > 205 mm)	≥1 000

The installation of shell mortars is shown in the following examples, which are provided by some countries and are applicable locally. They are only given for information in this document.

NOTE The above-mentioned internal distances and the following examples could be forbidden in some countries by their prevailing national regulations.

Examples of installation of shell mortars in China

C.1 Steel tube rack fixing method

Installation of mortars of shells (Φ = 76 mm, 103 mm) with steel tube racks is as given in Figure C.1:

Measurement unit in mm

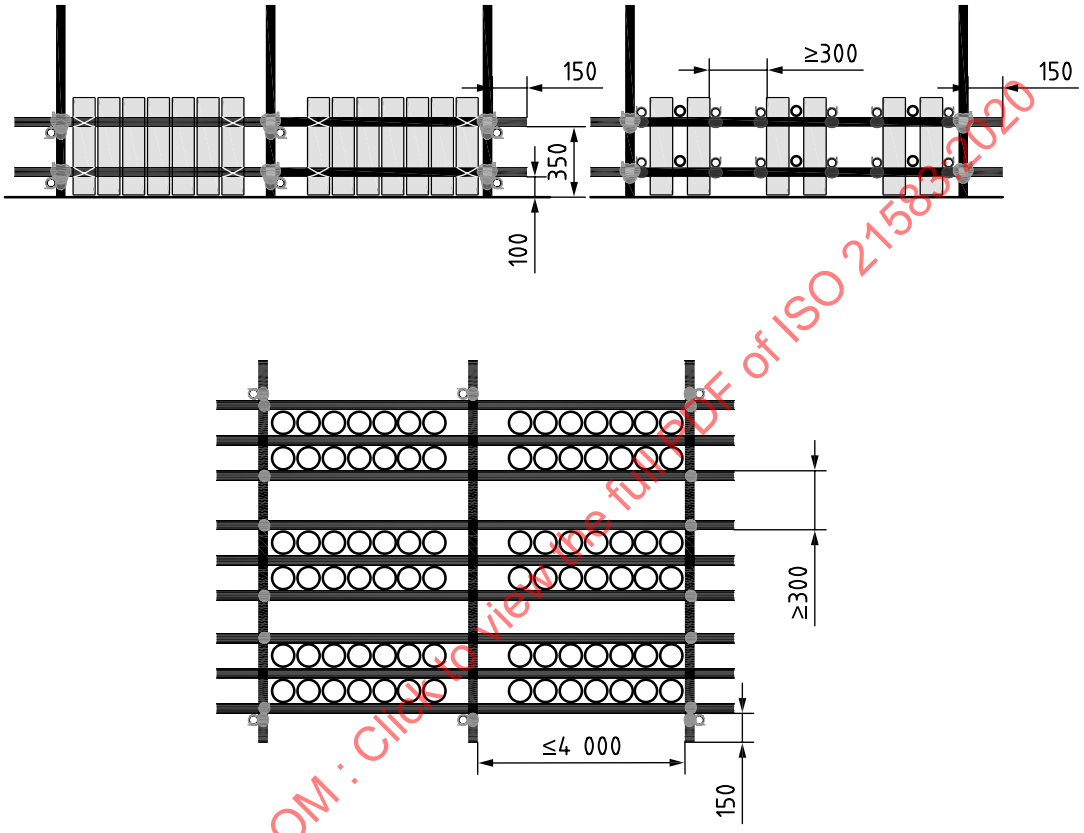


Figure C.1 — Example of installation of mortars of shells (Φ = 76 mm, 103 mm) with steel tube racks

Installation of mortars of shells (Φ = 127 mm, 153 mm) with steel tube racks is as given in Figure C.2:

Measurement unit in mm

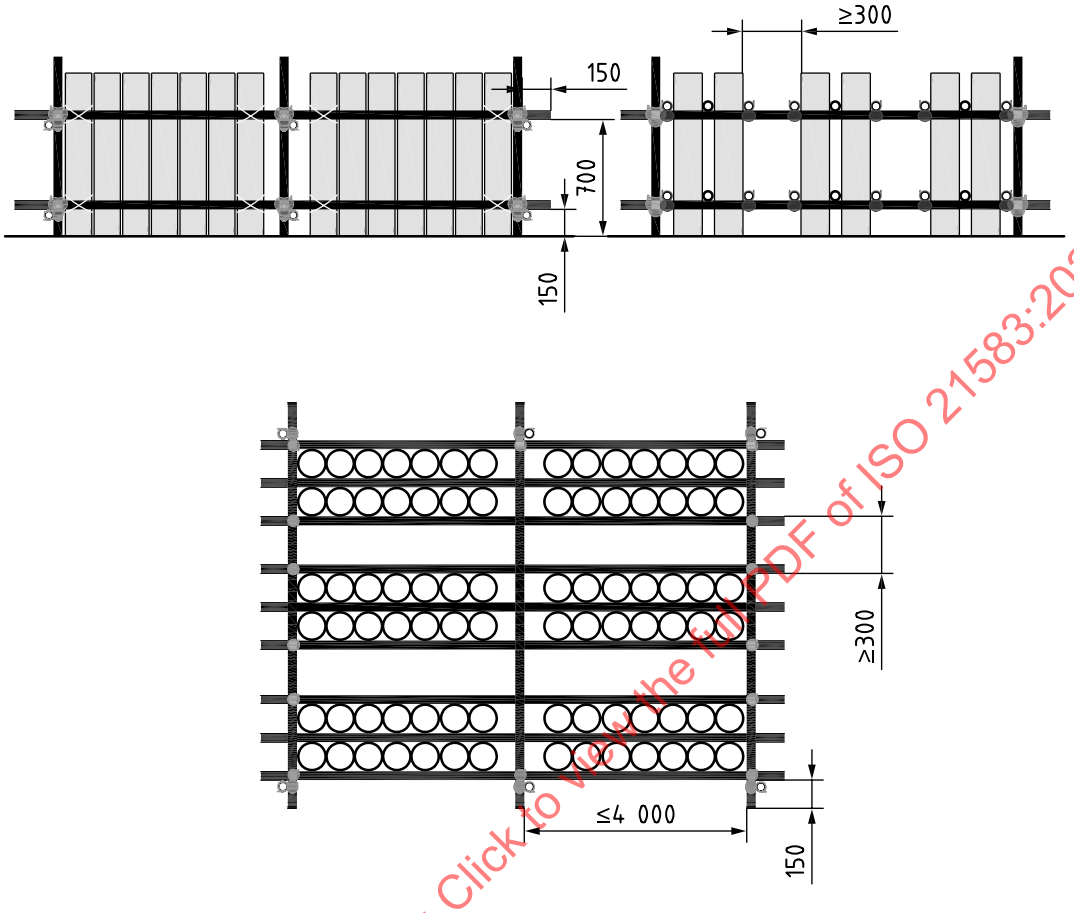


Figure C.2 — Example of installation of mortars of shells (Φ = 127 mm, 153 mm) with steel tube racks