



Nederlands Forensisch Instituut
Ministerie van Justitie en Veiligheid

Factsheet

Danger assessment of salute rockets





Table of contents

- 1. The factsheet**
- 2. Introduction**
- 3. Description of salute rockets**
 - 3.1. Dimensions and appearances**
 - 3.2. Internal structure**
 - 3.3. Legal aspects**
- 4. Danger assessment salute rockets**
 - 4.1. Preface**
 - 4.2. Function and effects**
 - 4.3. Mass explosivity**
 - 4.4. Dangers when launched with a stick**
 - 4.5. Dangers when launched without a stick**

1. Factsheet in general

The Netherlands Forensic Institute (NFI) conducts a wide variety of investigations. An investigation report from the NFI may be accompanied by a factsheet. This serves as (additional) background information and is of an informative character.

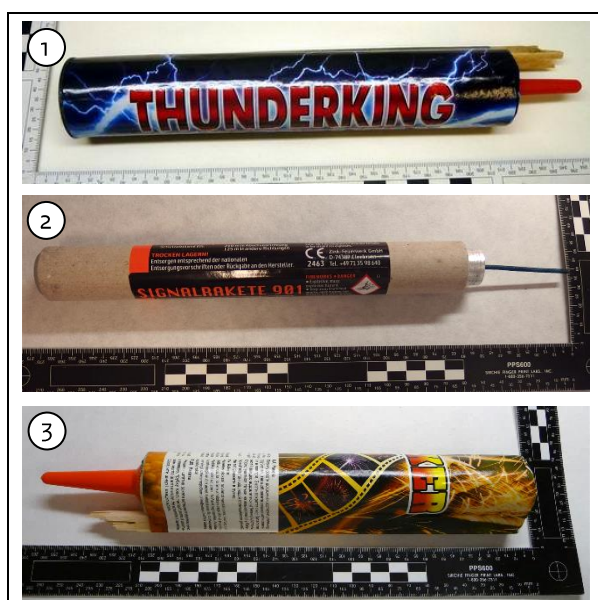
2. Introduction

The expert area of Explosions and Explosives at the NFI frequently receives questions about the dangers of fireworks. A dangerous firework article that frequently appears in the Netherlands is the salute rocket. This firework article and its effects have been investigated by the NFI. This factsheet summarizes the research results with the aim of providing a general overview of the dangers of an exploding salute rocket.

3. Description of salute rockets

3.1. External characteristics

Salute rockets are rockets whose only effect is a very loud bang. Salute rockets are also referred to as report rockets. However, they are rarely, if ever, used to trigger avalanches. They are used on a limited scale by fireworks companies during events. This is the only legal use of salute rockets. There are many different brands and appearances of salute rockets. Several examples are shown in photos 1 through 3.



Photos 1 - 3. Examples of salute rockets.

A salute rocket is a pyrotechnic article¹. This article typically consists of a cardboard tube measuring approximately 12 to 30 centimeters in length and a few centimeters in diameter. The cardboard tube may be attached to a wooden stick but is also often found without one. A fuse protrudes from the cardboard tube. This fuse is usually covered with a plastic safety cap (fuse cap), as shown in photos 1 and 3. The cardboard tube is often printed or labeled. If a label is present, the colors, images, and any printed text (language, fonts) may vary widely. If there is any doubt as to whether a particular firework article is a salute rocket, you should contact your forensic explosives expert.

3.2. Internal structure

The internal structure of a regular salute rocket always consists of two characteristic components: a 'motor' and a 'burst charge'. The smaller aluminum tube containing compressed black material shown in figure 4 is the motor. The motor casing may be made of aluminum, but can also be made of plastic or cardboard. The propellant charge in the motor of a salute rocket almost always consists of compressed black powder². The gray powder shown in figure 4 is the burst charge. The burst charge of a salute rocket always consists of flash powder.³ A salute rocket typically contains around 20 grams of flash powder, but both smaller and larger amounts also occur.

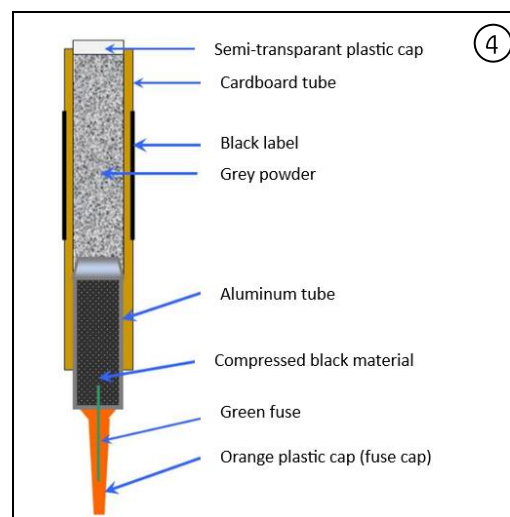


Figure 4. Example of the schematic overview of a salute rocket (this is the salute rocket shown in photo 2).

3.3. Legal aspects

Salute rockets are industrially manufactured as fireworks. The definition of fireworks according to the Dutch Fireworks Decree is: "pyrotechnic articles intended for entertainment." In short, a pyrotechnic article, such as a salute rocket, can only be considered fireworks if it is used for entertainment purposes. Whether a salute rocket meets this definition depends on the specific situation and circumstances in a given case. This is ultimately for the court to decide. Depending on the apparent intended use by the user, the NFI can, upon request, perform an assessment against the Dutch Fireworks Decree and the RAC⁴, or for example, the Dutch Weapons and Ammunition Act.

¹ A pyrotechnic article is a device containing a pyrotechnic charge. A pyrotechnic charge is a single substance or - in almost all cases - a mixture of two or more substances which together form an (explosive) flammable material. Pyrotechnic mixtures can for example be used in fireworks and firearms. Mixtures of this kind comprise at least one substance which serves as fuel (reductor) and one substance that serves as oxygen supplier (oxidizer).

² Black powder is a pyrotechnic mixture consisting of sodium- or potassium nitrate and charcoal, with or without sulfur (mostly with).

³ Flash powder is a pyrotechnic mixture consisting of a (per)chlorate- or nitrate-salt (oxidizer) with a metal powder, mostly aluminum and/or magnesium (fuel) which may or may not be mixed with sulphur.

⁴ RAC = Regulation on the Designation of Consumer Fireworks pursuant to Article 1.1.1 and Article 2.1.1 of the Dutch Fireworks Decree.

Furthermore, assuming the salute rocket qualifies as fireworks, it is always classified as professional fireworks under the Dutch Fireworks Decree⁵. Salute rockets are therefore exclusively intended for use by individuals with specialized knowledge (in accordance with Article 1.1.2a of the Dutch Fireworks Decree). Salute rockets must never be made available for private use.

4. Danger assessment of salute rockets

4.1. Preface

The danger assessment⁶ of an exploding salute rocket depends on many factors. It is not possible to include all scenarios in this factsheet. This factsheet only describes a general danger assessment for several general scenarios for which a burst charge of approximately 20 grams of flash powder is assumed. For salute rockets containing different amounts of burst charge, a different danger assessment applies. In such cases, it is advised to contact your forensic explosives expert.

This also applies if more specific information is needed (e.g. in a criminal case), or when more than one salute rocket is involved, or a salute rocket is combined with other firework articles (see also §4.3), or if modifications have been made to the salute rocket (such as the addition of a spray can, nails, a bottle of gasoline, etc.). In all these cases, it is strongly recommended to contact your forensic explosives expert.

4.2. Functioning and effects

The intended functioning of a salute rocket is as follows: the tube is attached to a wooden stick and placed in a suitable launch unit. The fuse is lit and ignites the propellant charge in the motor. This charge burns and propels the salute rocket into the air. After the entire propellant charge has burned away, an internal fuse or other form of transfer charge ignites the burst charge. This charge explodes immediately with a very loud bang and a flash of light. This produces heat, fire effects, and a pressure wave. The salute rocket bursts apart, and the hot cardboard, metal, clay, and/or plastic fragments are propelled outward.

4.3. Mass explosivity

Pyrotechnic articles containing flash powder can exhibit mass explosive behavior under certain conditions. This means that such a salute rocket may explode simultaneously with one or more other flash powder-containing articles when they are located in very close proximity. In that case, the flash powder in the other articles is not ignited by a fuse, but triggered by the explosion of another salute rocket.

Another sufficiently powerful explosion in the immediate vicinity of one or more mass-explosive salute rockets can also cause them to explode (simultaneously). This mass explosivity increases the overall dangers and is relevant in cases where more than one salute rocket is involved, or where a salute rocket is located near other flash powder-containing articles (for example, in a storage location or a backpack).

4.4. Dangers when launched with a stick

The wooden stick provides flight stability for the salute rocket. Thanks to the stick, the rocket flies almost straight upward so that it explodes high in the air. Dangers arise when the stick is not properly attached, is too short, the launch unit is faulty, or the salute rocket is not aimed straight upward at the moment of ignition. In such cases, the salute rocket may either explode in the launch unit or follow an uncontrolled flight path and detonate at an unknown (often too low) endpoint.

During such an uncontrolled flight, objects and people may be struck at high speed by the rocket, causing damage or (blunt) injury. The severity of the damage or injury from the impact of the rocket (i.e., before the burst charge explodes) depends on many factors, including the rocket's speed, weight, and point of impact. In cases of direct contact with the eyes, severe physical injury⁷ is possible.

⁵ Upon request, the NFI can provide full substantiation in the form of an assessment according to the Dutch Fireworks Decree.

⁶ A danger assessment is generally only provided in broad terms, as there is usually no specific description of the location and circumstances in which an explosive device detonates. Materials present in the environment may either increase or decrease the level of danger to bystanders. Likewise, no account is taken of a person's posture (for example, standing upright or crouching) or the height at which the explosive device detonates relative to the person (for example, at eye level or foot level). The number and position of bystanders at the location also play a role in determining the level of danger. To accurately

assess the danger at one specifically defined location, one or more test detonations are generally required.

⁷ The Explosives and Explosions department at the NFI uses the following series for the level of injury (in ascending order):

- Physical injury: minor injuries requiring doctor's treatment and/or reversible injuries (ears – no deafness, eyes – no blindness)
- Severe physical injury: irreversible injuries (in the case of ears – deafness, eyes – blindness) or injuries which will have serious consequences if untreated.
- Very severe physical injury: permanent disfigurements which could lead to death, if untreated.
- Fatal injury: injury which results in almost instantaneous death..

The explosion of the burst charge of the salute rocket also poses significant danger to people and objects located near the detonating rocket. If a salute rocket explodes directly against an object, that object will almost always be damaged. The level of injury depends in part on their position relative to the explosion. For example, in the case of bodily contact with a single salute rocket at the moment of detonation, severe to very severe physical injury may occur due to the⁶ pressure wave and heat. In cases of (near) direct contact with, for example, the head, neck, or torso of an unprotected person, there is even a danger of fatal injury⁶. At greater distances, whether and to what extent the heat and pressure wave cause injury depends on the specific circumstances. For example, the heat released during the explosion can ignite flammable surrounding materials (such as synthetic clothing), potentially leading to fires involving nearby materials and resulting in burn injuries. The pressure wave can cause permanent hearing damage, such as eardrum rupture⁸, up to several meters from the explosion. Even at distances of tens of meters, this pressure wave may still cause other forms of (temporary) hearing damage. The occurrence and severity of hearing damage depend on specific local conditions and the physical condition of the individuals involved.⁹

In addition to the injuries described above caused by the pressure wave and heat of the explosion, injuries may also result from the impact of fragments and shards. At relatively short distances, hot fragments of cardboard, plastic, metal, and/or clay from the salute rocket itself may cause skin injuries. If the salute rocket damages an object in the surrounding environment, fragments and shards from that object can be propelled at high speeds. If those fragments are made of hard materials such as glass, metal, or stone, they may cause bodily injury. The severity of the injury depends on the shape, weight, and velocity of the fragment or shard. The likelihood of impact is directly related to the number of fragments/shard pieces released during the explosion and can vary greatly depending on specific local conditions.

In the specific scenario where a salute rocket is fired toward professional emergency responders or law enforcement officers, the above danger assessment applies if they are not wearing protective clothing or hearing protection and/or are struck on an unprotected part of their body. Without further investigation, the NFI cannot make a general statement about the effect of a detonating salute rocket on a person wearing protective gear, due to the significant variation in the properties of such clothing. Previous research conducted by TNO has shown that, in certain cases, the explosion of a salute rocket can penetrate protective clothing and cause injury in those cases.⁷

4.5. Dangers when launched without a stick

If a salute rocket is ignited by the fuse without a stick, it will follow an uncontrolled flight path. The dangers associated with this are the same as those described in §4.4 regarding the uncontrolled flight of a salute rocket with a stick.

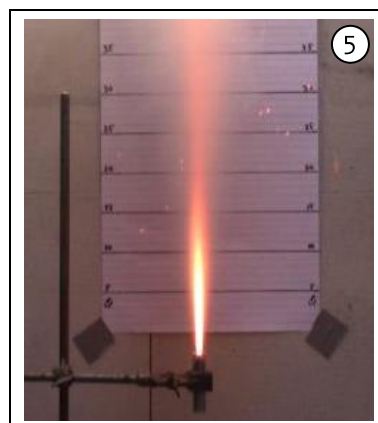


Photo 5. Example of the flame produced by the motor of a salute rocket.

If a salute rocket is fixed in place—by, for example, wedging it between objects or inserting it into something—the motor will first ignite with a jet of flame (see photo 5). This flame lasts approximately 5 to 10 seconds and can cause fire and burn injuries. After that, the burst charge of the salute rocket detonates. The dangers associated with this are described in §4.4.

⁸ TNO-rapport: TNO 2017 R10577 | 2, Onderzoek naar de impact van illegaal vuurwerk. Opdrachtgever: Politie, Staf Korpsleiding, Directie Operatiën, Den Haag.

⁹ Entitlement eligibility guidelines, hearing loss, MPC 00646, ICD-9 389.1 (Sensorineural Hearing Loss), 389.0 (Conductive Hearing Loss), veterans affairs Canada, April 2006.

For general questions, you can contact the NFI by phone +31(70) 888 68 88.

Netherlands Forensic Institute
Ministry of Justice and Security
PO box 24044 | 2490 AA The Hague

telephone +31(70) 888 66 66
www.forensischinstituut.nl

April 2024