



ARES

Less-Lethal Arms & Munitions Documented In Ferguson, Missouri

Stephen Semler & Peter White

RESEARCH REPORT No. 4



COPYRIGHT

Published in Australia by Armament Research Services (ARES)

© Armament Research Services Pty. Ltd.

Published in April 2015

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, without the prior permission in writing of Armament Research Services, or as expressly permitted by law, or under terms agreed with the appropriate reprographics rights organisation.

Enquiries concerning reproduction outside the scope of the above should be sent to the Publications Manager, Armament Research Services:
publications@armamentresearch.com

ISBN: 978-0-9924624-4-4

CREDITS

Authors: Stephen Semler & Peter White

Editor: N.R. Jenzen-Jones

Contributors: Joanne Michele & Michael Smallwood

Copy Editor: Jean Yew

Technical Review: Alex Becker & Michael Weber

Layout/Design: Yianna Paris, Green Shell Media

ABOUT **ARMAMENT RESEARCH SERVICES**

Armament Research Services (ARES) is a specialist consultancy which offers technical expertise and analysis to a range of government and non-government entities in the arms and munitions field. ARES fills a critical market gap, and offers unique technical support to other actors operating in the sector. Drawing on the extensive experience and broad-ranging skillsets of our staff and contractors, ARES delivers full-spectrum research and analysis, technical review, training, and project support services, often in support of national, regional, and international initiatives.

ARMAMENT RESEARCH SERVICES Pty. Ltd.

t + 61 8 6365 4401
e contact@armamentresearch.com
w www.armamentresearch.com

ABOUT THE AUTHORS

Stephen Semler

Stephen Semler is an Associate Researcher with Armament Research Services (ARES). Following his graduation from The Pennsylvania State University's Strategic and Global Security Program, Mr. Semler gained extensive knowledge of the U.S. defense industry and federal appropriations process through his employment with a Washington, D.C.-based consulting firm. While pursuing his graduate degree, he has assisted in the production of publications related to terrorism, development, guided light weapons, and less-lethal munitions. Mr. Semler's research interests include security sector reform, the political economy of conventional arms transfers, small arms proliferation, and public sector program evaluation. He lives in Beirut.

Peter White

Peter White has worked in the ammunition, arms control, and chemical weapons destruction fields for almost 20 years. Mr. White gained extensive experience working with hazardous materials within contaminated environments during his ten years at the Defense Science and Technology Laboratory (Dstl) in the United Kingdom. He subsequently undertook the role of Chemical Weapons/Munition Specialist at the Organisation for the Prohibition of Chemical Weapons (OPCW) in The Hague, travelling internationally to effect arms control inspections. Since 2010 he has been responsible for the verification of old and abandoned chemical weapons, and provides technical advice and expertise on issues related to chemical weapons, their identification and destruction, as well as riot control agents and their delivery systems. Mr. White has written a number of technical documents related to chemical weapons, riot control agents, and their identification. Further, he has delivered high-level lectures and training seminars and worked on active operations in a number of hostile environments, including Libya, Syria, and Yemen.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to Alex Becker, Stefan Elliott, N.R. Jenzen-Jones (ARES), Joanne Michele, Michael Smallwood (ARES), Michael Weber (ARES), and Jean Yew.

SAFETY INFORMATION

Remember, all arms and munitions are dangerous. Treat all firearms as if they were loaded, and all munitions as if they were live, until you have personally confirmed otherwise.

If you do not have specialist knowledge, never assume that arms or munitions are safe to handle until they have been inspected by a subject matter specialist. You should not approach, handle, move, operate, or modify arms and munitions unless explicitly trained to do so.

If you encounter any unexploded ordnance (UXO) or explosive remnants of war (ERW), always remember the '**ARMS**' acronym:

AVOID the area

RECORD all relevant information

MARK the area to warn others

SEEK assistance from the relevant authorities

DISCLAIMER

This report is presented for informational purposes only. It is not intended to provide instruction regarding the construction, handling, disposal, or modification of any weapons systems. Armament Research Services (ARES) strongly discourages non-qualified persons from handling arms and munitions. Arms or munitions of any variety should not be handled without the correct training, and then only in a manner consistent with such training. Subject matter experts, such as armourers, ATOs, and EOD specialists, should be consulted before interacting with arms and munitions. Make a full and informed appraisal of the local security situation before conducting any research related to arms or munitions.

ABBREVIATIONS AND ACRONYMS

AMTEC

Amtec Less-Lethal Systems

CN

1-chloroacetophenone (lachrymatory agent)

CR

dibenz(b,f)(1,4)oxazepine
(lachrymatory agent)

CS

2-chlorobenzylidene malononitrile
(lachrymatory agent)

CW

Chemical weapons

CTS

Combined Tactical Systems

FBI

Federal Bureau of Investigation

OC

Oleoresin capsicum (lachrymatory agent)

OPCW

The Organisation for the Prohibition of
Chemical Weapons

RCA

Riot control agent

US/USA

United States of America

TPRV1

Transient receptor potential vanilloid subtype 1

TABLE OF CONTENTS

ABOUT ARMAMENT RESEARCH SERVICES _____	1
ABOUT THE AUTHORS _____	2
ACKNOWLEDGEMENTS _____	2
SAFETY INFORMATION _____	3
DISCLAIMER _____	3
ABBREVIATIONS AND ACRONYMS _____	4
LIST OF PHOTOS _____	6
LIST OF BOXES _____	6
SCOPE OF RESEARCH _____	7
TIMELINE OF EVENTS _____	8
INTRODUCTION _____	9
TYPES OF LESS-LETHAL MUNITIONS DOCUMENTED IN FERGUSON _____	10
RIOT CONTROL AGENTS (LACHRYMATORY AGENTS) _____	10
IMPACT MUNITIONS _____	12
OPERATION FROM STAND-OFF DISTANCES _____	14
BOX 1: THE 1033 PROGRAM _____	16
CONCLUSION _____	16
NOTES _____	17
REFERENCES _____	18
ANNEXE 1: LESS-LETHAL ARM AND MUNITIONS DOCUMENTED IN FERGUSON _____	21
ANNEXE 2: CHARACTERISTICS OF CS and OC _____	30

LIST OF PHOTOS

- Cover** An officer fires a Penn Arms Pump-Action Multi-6 Shot Launcher near W. Florrisant Avenue, Ferguson on Monday, August 18, 2014.
Photo Credit: David Carson / St. Louis Post-Dispatch
- 1** A 37/38 mm Riot CS Smoke Projectile Model #3230, recovered on the 17th of August, 2014. 11
 - 2** A recovered Combined Tactical 6230 riot control agent CS canister. 11
 - 3** A fired 60 cal. stinger 37mm black powder rubber ball cartridge, manufactured by Defense Technology. 12
 - 4** A component of a Triple Chaser Separating Canister Pyrotechnic Grenade, manufactured by Defense Technology. 13
 - 5** A Mini Flash Bang grenade, produced by Combined Tactical, recovered on the 13th of August 2014 in Ferguson. 14
 - 6** A Smith & Wesson CS grenade, manufactured by the now defunct Smith & Wesson Chemical Co. Note the deformed sides of the munition. 15

LIST OF BOXES

- Box 1** The 1033 Program 16

SCOPE OF RESEARCH

This background report represents only an initial assessment of the less-lethal munitions observed during the civil unrest in Ferguson, Missouri in August 2014.

These munitions include riot control agents (RCA), as well as impact munitions and other types. The security forces involved in responding to the unrest include the Ferguson Police Department, St. Louis County Police Department, St. Louis Highway Patrol, St. Louis Metro Police, State Highway Patrol, City of Fenton Police Department, and the Missouri National Guard. The report relies primarily on publicly released material made available through mainstream media sources and social media platforms.

The munitions analysed in this report were collected in August 2014, before Missouri Governor Jay Nixon ordered the withdrawal of the National Guard. Though there was another wave of protests following a Missouri grand jury's decision not to indict police officer Darren Wilson in the shooting of Michael Brown in November of 2014, the scope of this report does not cover less-lethal munitions used during the second wave of protests. Nonetheless, it is important to note that no new law enforcement units were introduced, and that the sample of munitions recovered in August likely remains a reliable, albeit non-exhaustive, indicator of the less-lethal munitions deployed in Ferguson to date.

TIMELINE OF EVENTS¹

- **August 9**
A police officer fatally shoots an unarmed 18-year-old in Ferguson, a suburb of St. Louis, Missouri.
- **August 10**
Protesters begin to congregate outside the Ferguson Police Department. Overnight, approximately 300 police officers respond to reports of gunfire, looting, and arson. 32 are arrested and reports of several crowd-control measures begin to surface.
- **August 11**
Clashes between police and civilians escalate; St. Louis County police arrive in armoured vehicles and tactical units are deployed. Media reports emerge that law enforcement have begun to employ 'tear gas' and 'rubber bullets'. Total number of arrests since August 9 reaches 50. Missouri Governor Jay Nixon orders the State Highway Patrol to take over security operations from local law enforcement (Schwartz, Shear, and Paulson, 2014).
- **August 12**
The Federal Bureau of Investigation (FBI) begins investigation of the incident.
- **August 14**
Governor Nixon announces that the Missouri State Highway Patrol is scheduled to take over security operations in Ferguson.
- **August 16**
Governor Nixon declares a state of emergency and establishes a curfew for Ferguson residents. Tactical units deploy smoke-based deterrents to enforce curfew.
- **August 17**
Journalists are ushered into a designated area and asked to stop filming.
- **August 18**
Governor Nixon summons the National Guard (Dolan, 2014). Media reports that police units are using tear gas to suppress and disperse protesters.
- **August 21**
Governor Nixon orders withdrawal of the National Guard (Dolan, 2014).
- **August 23**
As protests continue, President Obama orders a review of the government's decade-old policy of sending military equipment to local police departments (CBS/AP, 2014).
- **November 17**
Governor Nixon declares a state of emergency. The National Guard is called in again (Swaine, 2014).
- **November 24**
A grand jury decides that Ferguson police officer Darren Wilson will not be indicted. This decision sparks a new wave of protests, violence and unrest (Wulfhorst, Wallis, and McAllister, 2014).

INTRODUCTION

The security measures taken by local, state, and federal authorities in Ferguson, Missouri highlight the use of current less-lethal technology in crowd control scenarios.

Likewise, analysis of the munitions deployed can provide insight into the crowd control tactics preferred by these security forces. In 2013, the global market for less-lethal weapons was \$880.5 million USD and it is expected to grow to \$1.14 billion USD by 2018 (Allway, 2014).

Many munitions and their associated delivery systems are designed for crowd dispersal, and are often non-discriminatory and affect multiple targets. These are typically deployed in a less precise fashion than those intended to target a specific individual, in the general direction of one or more intended targets. These include various lachrymatory riot control agents (RCA), obscurant smoke grenades, stun grenades, and impact munitions. The munitions are generally used to disperse or deter a crowd, or are deployed in an area denial role. Target-specific impact munitions, including cartridges containing multiple rubber or wooden projectiles, have also been documented during the unrest in Ferguson. These are typically employed to effect the temporary incapacitation of a single target, although in some cases may be employed against aggressive groups.

This report examines a range of less-lethal munitions of different types, documented during the unrest in Ferguson. The majority of the evidence referenced here is derived from various social media accounts and open source reporting. Additional information was provided by journalists working on the ground in Ferguson. This report is not an exhaustive account of all less-lethal munitions used during the unrest. Bearing these limitations in mind, the report presents the following findings:

- The frequency with which area effect munitions were employed in Ferguson indicates that security forces considered dispersing large crowds a priority;
- Evidence suggests that security forces preferred to perform crowd control operations from a distance, with most of the recovered tear gas canisters, stun grenades, and smoke grenades being models that are deployed from 37 mm or 40 mm launchers, or ones that are able to be fired from these;
- 29 different less-lethal munitions were documented in Ferguson. All were produced by companies based in the United States;
- Three US companies produced the majority of the munitions documented: AMTEC Less-Lethal Systems, Combined Systems, Inc., and Defense Technology.²

TYPES OF LESS-LETHAL MUNITIONS DOCUMENTED IN FERGUSON

Riot Control Agents (Lachrymatory Agents)

The first modern lachrymatory agents were developed by European scientists and were likely adopted by domestic police forces prior to the First World War (Swearingen, 1966). The first documented use of such agents in warfare was by the French military in August 1914, who utilised 26 mm cartridges filled with ethyl bromoacetate, taken from police stocks (Robinson and Leitenberg, 1971). In subsequent years, scientists have sought to develop more effective chemical agents for use in riot control. Attempts have focused on enhancing the instantaneous, short-duration lachrymatory effects, whilst attempting to reduce the less desirable long-term and potentially lethal effects. The three companies which have the largest market share of the US domestic RCA industry are Combined Systems, Inc., NonLethal Technologies Inc., and Defense Technology. Lachrymatory munitions produced by two of these three companies -- Combined Systems and Defense Technology -- were documented during the unrest in Ferguson.

RCA are not considered chemical weapons (CW) under international control instruments. Under Article VI of the Chemical Weapons Convention, CW are classified under one of three Schedules included in the convention. Any chemical not listed in a Schedule, which produces rapid sensory irritation or disabling physical effects that disappear shortly following exposure, is considered an RCA (OPCW, 1997).

The generic term 'tear gas' is used to describe various lachrymatory agents. The purpose of lachrymatory agents is to temporarily inhibit or disable a target by causing intense, short-term irritation to the eyes and respiratory system. The RCA systems employed in Ferguson have carried either an oleoresin capsicum (OC) irritant-- the active ingredient in pepper spray-- or the more widely used CS (2-chlorobenzalmalononitrile)³. Whilst CS is the most commonly employed, other RCAs such as CN (1-chloroacetophenone), and CR (dibenz[b,f][1,4]oxazepine) are still used around the world, with CN previously being the RCA of choice. From the 1950s, CN was phased out and replaced by the less toxic CS as the standard RCA in the United States (Sidell, 1997).

Oleoresin capsicum (OC), commonly known as pepper spray, is derived from the extract of the capsicum pepper plant, and relies on the action of the active ingredient capsaicin (Chan et al, 2000). Originally developed as an animal repellent, OC was issued within the US Postal Service in the 1960s before being endorsed by the Federal Bureau of Investigation (FBI) as an effective means to subdue people in the late 1980s. By the 1990s, OC was being widely used as an alternative to CN for individual protection by US law enforcement personnel (Salem et al, 2008). Exposure to OC can cause intense pain, burning and inflammation to the eyes and exposed skin of the affected person. Airways are affected through coughing and decreased inhalation rates. Pain, vasodilation and secretion can occur in the airways when a large enough dosage is inhaled (Salem et al, 2008).

CS was discovered by two American scientists, Ben Corson and Roger Stoughton, at Middlebury College, Vermont in 1928, and the letters 'CS' are derived from the first letters of their surnames (Corson & Stoughton, 1928). CS exists in a solid state as a fine crystalline powder at room temperature and requires one of several processes to turn it into a usable RCA. Typically, this is achieved through the introduction of heat to the system, aerosolizing and dispersing the agent from the munition. In the case of CS projectiles and hand grenades, this is achieved through the action of a small pyrotechnic charge. This heat generation can make these canisters unsuitable for deployment indoors or near flammable material. Examples of munitions actuated in this manner include the Defense Technology Riot Control continuous discharge grenade (Defense Technology 1082, n.d.) and the Han-Ball Grenade (Defense Technology 1092, n.d.). Historically, other methods of dissemination have also been employed. During the Vietnam War, the United States delivered tons of bulk CS powder from helicopters as an area denial weapon. In order to increase its persistency to weeks, the CS was blended with silica to reduce breakdown due to moisture and humidity (Lindberg, 2006).



Photo 1 A 37/38 mm Riot CS Smoke Projectile Model #3230, recovered on the 17th of August, 2014.

Photo Credit: Twitter user @Polly_evro



Photo 2 A recovered Combined Tactical 6230 riot control agent CS canister.

Photo Credit: Twitter user @BrianHeff

RCA munitions are typically of either the instantaneous or continuous discharge type. Instantaneous discharge munitions produce a comparatively small but highly concentrated agent cloud, almost immediately upon functioning. Continuous discharge munitions, often pyrotechnically actuated, release an agent cloud over time and are often more easily visible (see Jenzen-Jones & White, 2015).

In addition to the thermal effects, the fact that these canisters can be projected to the target means that they also pose a kinetic impact risk to those targeted by these munitions. Many of the munitions documented in this report, such as Combined Tactical Systems' Model 6230 CS hand grenade, feature an aluminium body (Combined Tactical Systems 6230, n.d.). The projectiles documented in Ferguson from our sample have a mass between 100 and 426 grams; a mass that can prove lethal if they strike a person in vital areas such as the throat or head (Bozeman and Winslow, 2004). In Sitra, Bahrain, there is evidence to suggest that two teenage males were killed after being struck with tear gas canisters in August 2011. Another fatality occurred in Duraz, Bahrain, when a 21-year old male suffered blunt force trauma from a tear gas canister in February of 2012 (Physicians for Human Rights, 2012).

With only one exception, all RCA hand grenades documented in Ferguson can also be fired from an appropriate launcher ('launchable'). In addition to this standoff capability, many of the RCA munitions feature specific mechanisms which maximise area coverage. For example, Defense Technology's Triple-Chaser Grenade is comprised of three individual canisters that separate and disperse after firing, landing approximately 6.1 m (20 feet) apart (Defense Technology 1026, n.d.). AMTEC's Triple Action CS Grenade, pictured below, is of a similar design (Amtec Less-Lethal Systems ALSG273CS, n.d.).

Other RCA munitions documented include powder blast dispersion munitions with instantaneous discharge (Combined Tactical Systems 4630), CS pyrotechnic projectiles (Combined Tactical Systems 4233) with 20 to 40 second discharge times, and AMTEC Long Range Launchable CS (AMTEC Less-Lethal Systems ALS5727CS, n.d.) projectiles.

Impact Munitions

Whilst the majority of munitions documented in Ferguson for this report delivered an RCA payload, some impact munitions (also called 'kinetic impact munitions') were also observed. These munitions are designed to disable a target or degrade their will to fight, and have a low probability of causing serious bodily injury or death when they strike human targets (Hubbs & Klinger, 2004). Documented munitions include launchable hand grenades such as the Sting-Ball grenade manufactured by Combined Tactical Systems, which disperses a payload of .31 calibre rubber pellets (Combined Tactical Systems 9590, n.d.)⁴, and the 37 mm Black Powder 60-Cal Stinger manufactured by Defense Technology, pictured in the image below (Defense Technology 1199, n.d.), that disperses 42 rubber pellets. The 60-Cal Stinger is recommended to be 'skip' fired in the direction of the intended targets, or aimed low so to not have the rubber projectiles engage the targets above the breast line (Defense Technology 6297, n.d.). Other impact munitions include the 37mm Black Powder Wood Baton round manufactured by Defense Technology, and the Multi-5 Wood Baton round manufactured by Combined Tactical. Both of these rounds expel five wooden batons from the muzzle of the launcher. Finally, the Super Sock bean bag round, manufactured by Combined Tactical Systems was also documented.

Though less-lethal technology is designed to avoid lethal injury, there is an understanding that serious injury may occur even when these devices are employed properly. This leads less-lethal weapons to be categorised within the police use-of-force continuum directly below the use of deadly force (Suyama, et al., 2003). Hubbs and Klinger (2004) investigated 373 incidents of less-lethal weapon deployment and found eight deaths in this sample attributable to these types of munitions. Suyama, et al. (2003) elaborate on seven cases that resulted in the following injuries after being struck by a bean bag round: pulmonary contusion, rectus sheath hematoma, liver laceration, abdominal wall contusion, scalp laceration and closed head injury, traumatic laceration of the right Achilles tendon, a scalp de-gloving injury and post-concussive syndrome. Nonetheless, it is clear that less-lethal munitions, including impact munitions, can be considered safe relative to the likelihood of fatal injury when lethal munitions are employed, and data suggests that impact munitions are effective at resolving high-risk encounters without the need to resort to deadly force (Hubbs and Klinger, 2004).



Photo 3 A fired 60 cal. stinger 37mm black powder rubber ball cartridge, manufactured by Defense Technology.

Photo Credit: Twitter user @PDPJ

Arms and munitions designed for crowd dispersal may emit RCA or projectiles over a wide area in order to effect crowd dispersal. These wide-area delivery devices may include systems such as RCA smoke generators, sprayers and foggers, as well as large calibre aerial munitions, mortars, and other area denial systems. However, the majority of the munitions documented in the annexe of this report disperse CS gas from small calibre munitions. The use of unitary tear gas canisters in Ferguson was commonplace, but a marked presence of multiple charge munitions that separate after functioning was documented. In addition to the AMTEC Triple Action CS Grenade described above, Combined Tactical Systems 40 mm CS Multi 3 Smoke and Defense Technology Triple Chaser Separating Canister Pyrotechnic Grenade models were also documented. These pyrotechnically actuated munitions consist of three submunitions with separating charges between each; the canisters are designed to separate after firing and land approximately 5 to 10 metres apart when deployed, allowing for increased area coverage in a short period of time (AMTEC ALSG273CS, n.d.). Whilst this system may not be considered a wide area dispersal device in the true sense, if multiple grenades were to be deployed simultaneously, the concentration of CS gas that could be generated would be consistent with such systems.



Photo 4 A component of a Triple Chaser Separating Canister Pyrotechnic Grenade, manufactured by Defense Technology. Photo Credit: Twitter user @caulkthewagon

Operation from Stand-off Distances

The predominance of less-lethal munitions intended for crowd dispersal rather than incapacitating individual suspects suggests that security forces in Ferguson considered crowd dispersal a priority. Additionally, the effective ranges of munitions designed to engage point targets are less suitable for maintaining a safe distance from potentially hostile crowds. For example, the effective range of the Combined Tactical 2581 Bean Bag Round is approximately 4.6-18.3 m (5-20 yards), compared to approximately 91.4 m (110 yards) for the 4230 40 mm Riot CS smoke. The frequency with which hand grenades (which may also be thrown) were fired from a launcher indicates that security forces sought to perform crowd-control measures at a standoff distance. Accordingly, almost all of the munitions documented in the annexe of this report -- with the exception of the Cold War-era Smith & Wesson Riot Agent Grenade and the Combined Tactical Mini Flash Bang -- are capable of being fired from a launcher. Regardless of manufacturer, these munitions are typically interoperable with a variety of launching platforms which allows for engagement from a stand-off range. For example, the AMTEC ALS5727 CS Smoke Projectile can be fired from any 37 mm or 40 mm launcher. This emphasis on interoperability extends beyond area effect munitions. The Combined Tactical 2581 Super Sock Bean Bag rounds recovered in Ferguson are designed to be compatible with standard 12 gauge shotguns with 2.75" and 3" chambers (Police Ordnance, n.d.). Less-lethal launchers are typically compatible with a wide range of munitions from various manufacturers. The Penn Arms Pump-Action Multi-6 Shot Launcher is able to fire all rimmed 37 mm ammunition up to 8" in length for the 37/38 mm version, and all rimmed 40 mm ammo up to 5.9" in length for 40 mm version (CTS Multi-6 Launcher, n.d.).



Photo 5 A Mini Flash Bang grenade, produced by Combined Tactical, recovered on the 13th of August 2014 in Ferguson.
Photo Credit: Twitter user @caulkthewagon

In at least one documented case, a recovered CS grenade (pictured below) has raised questions over whether munitions past their expiry date were used by police and security forces during the unrest. The grenade in question, a No. 5 Blast Dispersion Grenade, was manufactured by Smith & Wesson Chemical Company, a division of Smith & Wesson made defunct in the late 1980s. The grenade can be noted to have functioned (see Photo 6). Also documented was a Smith & Wesson Chemical Co. No. 2 Launchable Continuous Discharge Grenade, another CS munition. Unlike the No. 5, the No. 2 munition releases an agent cloud over time, rather than immediately upon functioning.

For comparison, most CS and OC munitions from Combined Tactical and Defense Technology documented in this report carry a manufacturer's warranty of five years, which reflects the recommended shelf life of these munitions. According to Safariland Group, Defense Technology products are covered by a five year manufacturer's warranty. Safariland recommends use of these products within the five year time frame, although they note that some products may remain useful past that point. For example, Defense Technology OC sprays begin to lose pressure after five years, but the OC compound is still viable – users will simply experience suboptimal agent dispersion and distance (Safariland, 2015). Combined Systems note that the primary factors influencing the product lifecycle for RCA munitions are related to environmental conditions, and that whilst products are covered by their warranty for five years, many munitions remain functional after ten or more years⁵.



Photo 6 A Smith & Wesson CS grenade, manufactured by the now defunct Smith & Wesson Chemical Co. Note the deformed sides of the munition.

Photo Credit: Twitter user @NastiaChurkina

Box 1: The 1033 Program

The Defense Logistics Agency's '1033' program has received much attention during the unfolding of events in Ferguson (Christian Science Monitor, 2014; Newsweek, 2014; BuzzFeed, 2014). Many reports claimed or inferred that military surplus materiel had been transferred to law enforcement forces involved in the Ferguson unrest. The program was launched in 1990 to provide surplus military equipment to local and state law enforcement, in order to assist in operations related to the 'war on drugs'. After the 11 September 2001 terrorist attacks in the United States, the program received a substantial boost in funding intended to assist with the supply of materiel for counterterrorism operations (Al-Jazeera, 2014). While the 1033 program is designed to pass equipment from 'warfighter to crimefighter' in its provision of military surplus equipment to police departments nationwide, the 1033 program itself did not provide the Ferguson Police Department with any of the less-lethal equipment detailed in this report or any of the tactical equipment observed by media sources. This conclusion is based on program inventory reports (Guzman, 2014; Musgrave, 2014).

CONCLUSION

There has been a dramatic rise in the use of less-lethal munitions in the recent past (Hubbs and Klinger, 2004). Less-lethal munitions have been employed in notable recent cases of civil unrest in Seattle, Quebec City, Tucson, and Cincinnati (Suyama et al, 2003) and across the Middle East during the Arab Spring. As a result of the increase in demand, the market for less-lethal munitions has been expanding and is expected to experience a 5.42% compound annual growth rate over the next four years, exceeding \$1 billion USD by 2018 (Allway, 2014). It is interesting to note that security forces operating in Ferguson have equipped themselves with American-made products from the larger manufacturers in the less-lethal industry.

Measures taken by police and security forces in response to the unrest in Ferguson provide an opportunity to examine current crowd control technology. The munitions used can reveal the preferred tactics of the security forces, bearing in mind that there are some types of less-lethal weapons that are less likely to be recovered by journalists and independent investigators from scenes of unrest, such as pepper spray, and that some methods of crowd control, such as the physical apprehension of suspects, must be directly observed. Despite these limitations, from the sample of less-lethal munitions recovered and analysed in this report, it can be inferred that managing crowds from a stand-off distance was a priority, given that many of the munitions catalogued were launched rather than projected by hand, even in cases where either option was available. The abundance of non-target specific munitions such as tear gas canisters, self-contained cartridges filled with rubber or wooden projectiles, grenades that project rubber projectiles or emit smoke, and flash bangs⁶ support this deduction. Research suggests that employing less-lethal weapons systems – as opposed to other forms of physical force – reduces the chances of injury to law enforcement officials and suspects alike (Smith, et al, 2010; Suyama, et al., 2003).

NOTES

- ¹ All events are sourced from PBS (Pulliam-Moore and Myers, 2014) unless indicated otherwise.
- ² AMTEC Less-Lethal Systems is a subsidiary of AMTEC Corporation; Combined Tactical Systems and Penn Arms are both branches of Combined Systems, inc.; and Defense Technology is owned by Safariland, LLC.
- ³ CS (also known as 2-chlorophenyl-methylenepropanedinitrile, β,β -dicyano-o-chlorostyrene, and o-chlorobenzylidene malononitrile)
- ⁴ https://combinedsystems.com/_pdf/SpecSheets/9590%20CTS.pdf
- ⁵ Correspondence with confidential source at Combined Systems.
- ⁶ Also known by several other names including 'stun grenades' and 'flash grenades'.
- ⁷ Table taken from Salem et al., 2008.

REFERENCES

- Al-Jazeera. 2014. "Militarizing US police." Al-Jazeera. <<http://stream.aljazeera.com/projects/uspolice/>>
- Allway, Ryan. 2013. "Lamperd Less Lethal: Capitalize on a Growing Market for Non-Lethal Weapons." SECFilings.com, 7 November. <http://secfilings.com/News.aspx?title=lamperd_less_lethal:_capitalize_on_a_growing_market_for_non-lethal_weapons&naid=587>
- Amtec Less-Lethal Systems ALS5727CS. n.d. "37/40 mm Long Range Launchable, CS." <http://lesslethal.com/media/blfa_files/ALS5727CS.pdf>
- _____. "Triple Action CS Grenade, CS." <<http://lesslethal.com/alsg273-triple-action-cs-grenade.html>>
- Bozeman, William P. & Winslow, James E. Medical Aspects of Less Lethal Weapons. The Internet Journal of Rescue and Disaster Medicine. 2004 Volume 5 Number 1.
- CBS/AP. 2014. "Obama orders review of giving local police military gear." CBS News, 23 August. <<http://www.cbsnews.com/news/obama-orders-review-of-policy-of-giving-local-police-military-gear/>>
- Chan, Theodore, et al. 2000. "Impact of Oleoresin Capsicum Spray on Respiratory Function in Human Subjects in the Sitting and Prone Maximal Restraint Positions, Final Report." U.S. Department of Justice <<https://www.ncjrs.gov/pdffiles1/nij/grants/182433.pdf>>
- Combined Tactical Systems 4230. No date. "40 mm CS Smoke." <https://combinedsystems.com/_pdf/SpecSheets/4210-4220-4230%20CTS.pdf>
- Combined Tactical Systems 4233. No date. "40 mm CS Multi 3 Smoke." <https://combinedsystems.com/_pdf/SpecSheets/4213-4223-4233%20CTS.pdf>
- Combined Tactical Systems 4630. No date. "40 mm CS Muzzle Blast." <https://combinedsystems.com/_pdf/SpecSheets/4620-4630-4640%20CTS.pdf>
- Combined Tactical Systems 6230. No date. "Combined Tactical Systems Hand Grenade, CS." <https://www.combinedsystems.com/_pdf/SpecSheets/6230%20Rev%20F%20Grenade%20CS.pdf>
- Combined Tactical Systems 9590. n.d. "No Irritant Sting-Ball Grenade." <https://combinedsystems.com/_pdf/SpecSheets/9590%20CTS.pdf>
- Combined Tactical Systems Multi-6 Launcher. No date. "37/38 mm Pump-Action Multi-6 Shot Launcher and 40 mm Pump-Action Multi-6 Shot Launcher." <<http://www.skdtac.com/v/vspfiles/downloadables/PL-8%20&%20PGL-65%20RevA%20Tactical%20Launchers.pdf>>
- Corson, Ben B. & Roger W. Stoughton. 1928. "Reactions of Alpha, Beta-Unsaturated Dinitriles." *Journal of the American Chemical Society*: 2825. doi:10.1021/ja01397a037.
- Dalrymple, Jim. 2014. "War Zone in Ferguson: How Billions in Military Weapons Ended Up In The Hands Of Local Police." <<http://www.buzzfeed.com/jimdalyrpleii/war-zone-in-ferguson-how-billions-in-military-weapons-ended#.hjnNmKIR5>>
- Defense Technology 1026. No date. "Triple-Chaser Separating Canister, CS." <<http://www.safariland.com/triple-chaser/triple-chaser-separating-canister-cs-1012309.html>>
- Defense Technology 1082. No date. "Riot Control Continuous Discharge Grenade, CS." <<http://www.safariland.com/riot-control/riot-control-continuous-discharge-grenade-cs-1011574.html>>
- Defense Technology 1092. No date. "Han-Ball Grenade, CS." <<http://www.safariland.com/han-ball/han-ball-grenade-cs-1011584.html>>
- Defense Technology 1199. No date. "Stinger 37mm 60-Caliber Rubber Balls Round (8" Casing)." <<http://www.safariland.com/stinger-rubber-ball/stinger-37-mm-60-caliber-rubber-balls-round-8in-casing-1012191.html>>
- Defense Technology 6297. No date. "Stinger – 60-Caliber 37/40 MM Smokeless Powder Rubber Ball Round." <http://demandware.edgesuite.net/aaqv_prd/on/demandware.static/Sites-tsg-Site/Sites-tsg-Library/default/v1421126895128/resources/less-lethal/impact-munitions-techspecs/6297_37_40_mm_Stinger_Round.pdf>

Dolan, Matthew. 2014. "Governor Orders Withdrawal of National Guard From Ferguson." Wall Street Journal, 21 August 2014. <<http://online.wsj.com/articles/governor-orders-withdrawal-of-national-guard-from-ferguson-1408646124>>

Feldmann, Linda. 2014. "Ferguson: How Pentagon's '1033 program' helped militarize small-town police." 16 August. <<http://www.csmonitor.com/USA/DC-Decoder/2014/0816/Ferguson-How-Pentagon-s-1033-program-helped-militarize-small-town-police-video>>

Fraunfelder, FT. 2000. "Is CS gas dangerous?" British Medical Journal. February 19; 320(7233): 458-459. <<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1127513/>>

Guzman, Daniela. 2014. "From warfighter to crimefighter – the US 1033 program, and the risk of corruption and misuse of public funds." Association of Certified Financial Crime Specialists, 29 August. <<http://www.acfcs.org/from-warfighter-to-crimefighter-the-us-1033-program-and-the-risk-of-corruption-and-misuse-of-public-funds/>>

Hubbs, Ken & David Klinger. 2004. "Impact Munitions Data Base of Use and Effects." National Institute of Justice, US Department of Justice. <<https://www.ncjrs.gov/pdffiles1/nij/grants/204433.pdf>>

Jenzen-Jones, N.R. & Peter White. Dissemination Methods for Riot Control Agents. Research Note No. 8. Perth: Armament Research Services (ARES).

Lindberg, Kip. 2006. "The use of riot control agents during the Vietnam War." <http://www.wood.army.mil/chmdsd/images/pdfs/Jan-June_2007/Lindberg-Final.pdf>

Musgrave, Shawn. 2014. "Every item distributed to local law enforcement by the Pentagon's 1033 program over two years." MuckRock. 15 August. <<https://www.muckrock.com/news/archives/2014/aug/15/we-have-pentagon-1033-program-data/>>

OPCW. 1997. Article II: Definitions and Criteria. <<http://www.opcw.org/chemical-weapons-convention/articles/article-ii-definitions-and-criteria/>>

Perry Robinson, J. and Leitenberg, M. 1971. The Problem of Chemical and Biological Warfare. Volume 1: The Rise of CB Weapons. SIPRI.

Physicians for Human Rights. 2012. "Tear-Gas Related Deaths in Bahrain." <<http://physiciansforhumanrights.org/issues/persecution-of-health-workers/bahrain/bahrain-tear-gas-deaths.html>>

Police Ordnance. No date. "CTS 12 Gauge Munitions: 12ga Super-Sock TM Bean Bag." <<http://192.139.188.71/index.asp?id1=121>>

Pulliam-Moore, Charles, and Myers, Margaret. 2014. "Timeline of Events in Ferguson." PBS Newshour, 20 August. <<http://www.pbs.org/newshour/rundown/timeline-events-ferguson/>>

Safariland (Safariland Group). 2015. Email correspondence with customer care team. 19 February 2015.

Salem, Harry, Bradford W. Gutting, Timothy A. Kluchinsky, Jr, Charles H. Boardman, Shirley D. Tuorinsky, and Joseph J. Hout. 2008. "Riot Control Agents". In Tuorinsky et al., Medical Aspects of Chemical Warfare. San Antonio: Borden Institute, US Army Medical Department.

Schwartz, John, Shear, Michael D, and Paulson, Michael. 2014. "New Tack on Unrest Eases Tension in Missouri." The New York Times. 14 August. <<http://www.nytimes.com/2014/08/15/us/ferguson-missouri-police-shooting.html>>

Smith, Michael R., et al. 2010. "A Multi-Method Evaluation of Police Use of Force Outcomes: Final Report to the National Institute of Justice." <<https://www.ncjrs.gov/pdffiles1/nij/grants/231176.pdf>>

Swaine, Jon. 2014. "Missouri governor declares state of emergency as national guard called in to Ferguson." The Guardian, 17 November. <<http://www.theguardian.com/us-news/2014/nov/17/missouri-governor-state-of-emergency-ferguson>>

Suyama, Joe, et al. 2003. "Injury patterns related to use of less-lethal weapons during a period of

civil unrest." The Journal of Emergency Medicine, Volume 25, Issue 2, pp. 219-227.

Swearingen, TF. 1996. Tear Gas Munitions – An Analysis of Commercial Riot Gas Guns, Tear Gas Projectiles, Grenades, Small Arms Ammunition, and Related Tear Gas Devices. Springfield, Ill: Charles C Thomas.

Wofford, Taylor. 2014. "How America's Police Became an Army: The 1033 Program." 14 August. <<http://www.newsweek.com/how-americas-police-became-army-1033-program-264537>>

Wulforth, Ellen, Wallis, Daniel and McAllister, Edward. "More troops deployed in Ferguson to guard against fresh riots." Reuters, 25 November. <<http://www.reuters.com/article/2014/11/25/us-usa-missouri-shooting-idUSKCN0J80PR20141125>>

Annexe 1: Less-lethal arm and munitions documented in Ferguson

ANNEXE 1

Less-lethal arm and munitions documented in Ferguson

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
11/8/2014	Riot control agent [CS] hand grenade	Triple Chaser Separating Canister Pyrotechnic Grenade DT102 (Part ID 1026)	Defense Technology (USA)		Launchable; Consists of three separate canisters pressed together with separating charges between each. When deployed, the canisters separate and land approximately 20 feet apart allowing increased area coverage in a short period of time. This grenade can be hand thrown or launched from a fired delivery system.
11/8/2014	Smoke hand grenade	Military-style smoke grenade (black)	Defense Technology (USA)		Launchable; 30-40 second smoke discharge
13/8/2014	Riot control agent [CS] hand grenade	No. 5 Blast Dispersion Grenade	Smith & Wesson Chemical Co. (USA)		Launchable; instantaneous discharge; explosively actuated
13/8/2014	Stun hand grenade	7290M Mini Flash Bang (Part ID 7290)	Combined Tactical (USA)		Zirconium Nickel alloy delay composition
13/8/2014	Riot control agent [CS] hand grenade	Launchable flameless expulsion hand grenade CS (Part ID 5430)	Combined Tactical (USA)		Launchable; instantaneous discharge time; weight: 335 grams.

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
13/8/2014	Riot control agent [CS] hand grenade	No. 2 Launchable Continuous Discharge Grenade	Smith & Wesson Chemical Co. (USA)		Launchable; continuous discharge; pyrotechnically actuated
13/8/2014	Riot control agent [CS] hand grenade	62-Series 59MM Grenade CS -- Part ID 6230	Combined Tactical (USA)		Launchable; 30-40 second discharge time; weight: 415 grams (chemical weight 255 grams)
13/8/2014	Impact projectile hand grenade	Sting Ball 9590 Grenade (No Irritant Model)	Combined Tactical (USA)		Launchable; payload of .31 calibre rubber pellets.

Annexe 1: Less-lethal arm and munitions documented in Ferguson

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
13/8/2014	Impact projectile cartridge	Super Sock bean bag rounds -- Part ID 2581	Combined Tactical (USA)		Fits most 12ga shotguns; stopping power from 5-20 yards.
13/8/2014	Launcher	Pump-action 37/38 mm, 40 mm Multi-6 Shot Launcher	Penn Arms (produced by Combined Systems) (USA)		Can fire six shots in ~4 seconds; 37/38 mm version has 12" smooth bore barrel, 40 mm version has 12" rifled barrel. Fires all rimmed 37 mm ammunition up to 8" in length for 37/38 mm version; can fire all rimmed 40 mm ammo up to 5.9" in length for 40 mm version.
13/8/2014	Riot control agent [CS] cartridge	4630 40 mm Riot CS Powder Muzzle Blast -- Part ID 4630	Combined Tactical (USA)		From the line of Powder Blast Dispersion Munitions; effective range of 10-30 feet; instantaneous discharge; compatible with all 40 mm Launchers, M203, M79 and Multi-Launcher Type.
13/8/2014	Riot control agent [CS] hand grenade	Riot Control Continuous Discharge Grenade CS	Defense Technology (USA)		Launchable; 30-40 second discharge time; 75.6g of active agent.

Annexe 1: Less-lethal arm and munitions documented in Ferguson

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
15/8/2014	Riot control agent [CS] hand grenade	Han-Ball Grenade CS	Defense Technology (USA)		Launchable with 1.6oz of active CS agent; 15-20 second discharge time; rubber exterior
15/8/2014; 18/8/2014	Riot control agent [CS] hand grenade	Triple Chaser Separating Canister Pyrotechnic Grenade DT102 -- Part ID 1026	Defense Technology (USA)		Launchable; consists of three separate canisters pressed together with separating charges between each. When deployed, the canisters separate and land approximately 20 feet apart allowing increased area coverage in a short period of time. This grenade can be hand thrown or launched from a fired delivery system.
17/8/2014	Riot control agent [CS] projectile cartridge	37/38 mm Riot CS Smoke Projectile Model #3230	Combined Tactical (USA)		Short-range projectile; designed for crowd dispersal.
17/8/2014	Riot control agent [CS] projectile cartridge	37/38 mm Riot CS Smoke Multi-5 Projectile Model #3235	Combined Tactical (USA)		Short-range projectile; designed for crowd dispersal.
17/8/2014	Smoke hand grenade	Military-style smoke grenade (black) -- Part ID 1062	Defense Technology (USA)		Launchable; delivers continuous billows of concealing smoke for 30-40 seconds

Annexe 1: Less-lethal arm and munitions documented in Ferguson

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
17/8/2014; 18/8/2014	Riot control agent [CS] hand grenade	Riot Control Continuous Discharge Grenade CS -- Part ID 1082	Defense Technology (USA)		Launchable; 30-40 second discharge time of pelletised chemical agent.
17/8/2014	Riot control agent [OC/CS] hand grenade	6343 OC/CS -- Part ID 6343	Combined Tactical (USA)		Launchable; 1-5 second discharge time of OC-CS vapour.
17/8/2014	Impact projectile cartridge	37MM Black Powder Wood Baton -- Part ID 1176	Defense Technology (USA)		This 37mm round contains five wooden (baton) projectiles; uses a black powder propellant.
17/8/2014	Impact projectile cartridge	37/38 mm 50-cal Sting Ball Pellets	Combined Tactical (USA)		8 inch cartridge; approx 15m range
17/8/2014	Riot control agent [CS] hand grenade	ALSG272CS: Continuous Discharge Grenade -- Part ID 272	Amtec (USA)		Launchable; disperses chemical agent for 30-40 seconds.
18/8/2014	Riot control agent [CS] hand grenade	ALSG273CS: Triple Action CS Grenade, CS -- Part ID 273	Amtec (USA)		Launchable; when fuze is initiated, the canister separates into three submunitions and will discharge agent for approximately 30-40 seconds; each submunition will generally separate between 5m-10m apart, providing a wide area of coverage for the dispersal and control of crowds.

Date Documented	Munition Type	Product Name (Product ID Number)	Manufacturer (Location)	Image	Notes
18/8/2014	Impact projectile cartridge	Multi-5 wood baton -- Part ID 3565	Combined Tactical (USA)		Designed for 'multi-effect' in riot situations.
18/8/2014	Riot control agent [CS] projectile cartridge	40 mm CS Multi 3 smoke -- Part ID 4233	Combined Tactical (USA)		Compatible with all 40 mm Launchers, M203, M79 and Multi-Launcher Type; effective range is 80 yards; 20-40 second discharge time.
18/8/2014	Riot control agent [CS] projectile cartridge	40 mm Riot CS smoke -- Part ID 4230s	Combined Tactical (USA)		Compatible with all 40 mm Launchers, M203, M79 and Multi-Launcher Type; effective range is 110 yards; 20-40 second discharge time.
18/8/2014	Riot control agent [CS] projectile cartridge	ALS5727 CS Smoke Projectile Long Range -- Part ID 5727	Amtec (USA)		Comes in either 37mm or 40 mm rounds; projectile has maximum effective range of 450 feet; takes 30-40 seconds to discharge its 100 grams of CS agent.
18/8/2014	Smoke hand grenade	Green Smoke Canister Grenade -- Part ID 6210G	Combined Tactical (USA)		Launchable; discharge time of 20-45 seconds; total weight is 410 grams.

ANNEXE 1: SOURCES FOR IMAGES AND TECHNICAL DETAILS

- [1] Source: Image: <https://twitter.com/caulkthewagon/status/499343235295481856>; Technical: http://demandware.edgesuite.net/aaqv_prd/on/demandware.static/Sites-tsg-Site/Sites-tsg-Library/default/v1420850323788/resources/less-lethal/chemical-techspecs/Triple-Chaser_Grenade.pdf
- [2] Source: Image: <https://twitter.com/PDPJ/status/499310092790288384>; Technical: <http://www.defense-technology.com/pdfs/specs/37MM%2060-Cal%20Stinger.pdf>
- [3] Source: Image: <https://twitter.com/PDPJ/status/499598115888848896>
- [4] Source: Image: <https://twitter.com/PDPJ/status/499598115888848896>; Technical: <http://www.defense-technology.com/pdfs/specs/Colored%20Smoke%20Grenade%20Rev%2011-11.pdf>
- [5] Source: Image: <http://www.truth-out.org/news/item/25669-police-in-ferguson-are-firing-tear-gas-canisters-manufactured-during-the-cold-war-era>;
- [6] Source: Image: <https://twitter.com/caulkthewagon/status/499762095110766592>; Technical: https://www.combinedsystems.com/_pdf/MSDS/MSDS%207290M%20Rev%20C%20Mini%20Flash-Bang.pdf
- [7] Image: <http://instagram.com/p/rtGVh5JPMk/?modal=true>; Technical: https://combinedsystems.com/_pdf/SpecSheets/5400-5420-5430-5440%20CTS.pdf
- [8] Image: <https://twitter.com/BrianHeff/status/499940618215251968>; Technical: https://www.combinedsystems.com/_pdf/SpecSheets/6230%20Rev%20F%20Grenade%20CS.pdf
- [9] Image: <http://instagram.com/p/rtGVh5JPMk/?modal=true>; Technical: https://combinedsystems.com/_pdf/SpecSheets/9590%20CTS.pdf
- [10] Image: <https://twitter.com/BrianHeff/status/499944720873701376>; Technical: <http://www.officerstore.com/store/product.aspx/productId/18425/CTS-12ga-Super-Sock-Bean-Bag-Impact-Round-Box-of-5/>
- 10b** 10b Image: <https://twitter.com/RoadRunnerSTL/status/500999319772995584>
- [11] Image: <https://twitter.com/mattdpearce/status/501684986919919616>; Technical: https://www.combinedsystems.com/_pdf/SpecSheets/PL-8%20&%20PGL-65%20Spec%20Page.pdf
- [12] Image: <http://instagram.com/p/rtGVh5JPMk/?modal=true>; Technical: https://combinedsystems.com/_pdf/SpecSheets/4620-4630-4640%20CTS.pdf
- [13] Image: <http://instagram.com/p/rqvilJCrhz>; Technical: <http://www.defense-technology.com/pdfs/specs/Riot%20Control.pdf>
- [14] Image: <https://twitter.com/WesleyLowery/status/500537457780477954>; Technical: <http://www.defense-technology.com/pdfs/specs/Han-Ball%20Grenade%20Rev%207-12.pdf>
- [15] Image: https://twitter.com/fl0wn_/status/500543780228194304; Technical: <http://www.defense-technology.com/products.aspx?pid=1026>

- [16] Image: <https://twitter.com/WPowell19/status/500892552531566593>; Technical: https://www.combinedsystems.com/userfiles/CTS_LL_Catalog_2011.pdf
- [17] Image: <https://twitter.com/bkesling/status/500894789517451266>; Technical: https://www.combinedsystems.com/userfiles/CTS_LL_Catalog_2011.pdf
- [18] Image: <https://twitter.com/ryanjreilly/status/500926958994481152>; Technical: <http://www.defense-technology.com/pdfs/specs/Colored%20Smoke%20Grenade%20Rev%2011-11.pdf>
- [19] Image: <https://twitter.com/GeorgeSells/status/500982779237371904/photo/1>; Technical: <http://defense-technology.com/pdfs/specs/Riot%20Control%20Grenade%20Rev%207-12.pdf>
- [20] Image: https://twitter.com/Polly_evro/status/501211887913402368; Technical: https://www.combinedsystems.com/_pdf/SpecSheets/6343%20OC-CS%20Spec%20Rev%20A%20Grenade%20Aerosol%20OC-CS%20Vapor.pdf
- [21] Image: Technical: <http://www.defense-technology.com/pdfs/specs/SAF-SMOKE.pdf>
- [22] Image: <https://twitter.com/RoadRunnerSTL/status/501394251796996096/photo/1>; Technical: <http://www.defense-technology.com/pdfs/specs/37MM%20Wood%20Baton%20Round.pdf>
- [23] Image: <https://twitter.com/RoadRunnerSTL/status/500998806486667264>
- [24] Image: <https://twitter.com/thencarolsaid/status/501222969050681344>; Technical: http://lesslethal.com/media/blfa_files/ALSG272CS.pdf
- [25] Image: <https://twitter.com/rdevro/status/501609970346254336/photo/1>; Technical: http://lesslethal.com/media/blfa_files/ALSG273CS.pdf
- [26] Image: https://twitter.com/D_Towski/status/501236115916218368; Technical: https://www.combinedsystems.com/userfiles/CTS_LL_Catalog_2011.pdf
- [27] Image: <https://twitter.com/deray/status/501599137939595264>; Technical: https://combinedsystems.com/_pdf/SpecSheets/4213-4223-4233%20CTS.pdf
- [28] Image: <https://twitter.com/deray/status/501599137939595264>; Technical: https://combinedsystems.com/_pdf/SpecSheets/4210-4220-4230%20CTS.pdf
- [29] Image: <http://instagram.com/p/r5cqV-HQsG/?modal=true>; Technical: http://lesslethal.com/media/blfa_files/ALS5727CS.pdf
- [30] Image: https://twitter.com/Bluebandit_/status/501596911758221312; Technical: https://www.combinedsystems.com/_pdf/SpecSheets/6210%20Rev%20F%20Grenade%20smoke.pdf

Annexe 2: Characteristics of CS and OC⁷

ANNEXE 2

Characteristics of CS and OC⁷

		CS	OC
Molecular formula		C ₁₀ H ₈ ClN ₂	C ₁₃ H ₂₇ NO ₃
Former/current use		RCA/RCA	Food additive/RCA
Physical state*		White crystalline solid	Colourless solid
Odour		Pungent pepper-like	Pungent, irritating
Freezing or melting point		Melting point: 95°C–96°C	Freezing point: 65°C
Vapour pressure		0.00034 mm Hg at 20°C	1.5 × 10 ⁻⁷ mm Hg at 65°C (extrapolated)
Density:	Vapour (relative to air)	6.5 times heavier (calculated)	10.5 times heavier (calculated)
	Solid	Bulk: 0.24-0.26 g/cm ³ Crystal: 1.04 g/cm ³	Data not available
Solubility:	In water	Insoluble in water	Solubility in water is 0.090 g at 37°C
	In other solvents	Moderate in alcohol; good in organic solvents such as acetone, chloroform, methylene dichloride, ethyl acetate, and benzene	Soluble in alcohol, ether, oil, chloroform, aromatic solvents, hydrocarbons, ketones, and aqueous alkali
Hydrolysis products		Data not available	Alkaline hydrolysis yields vanillylamine and isomeric decenoic acid
Decontamination:	Clothing	Stand in front of a fan or flap arms to remove dry powder, protect airway. Wash clothing after removal	Sticks to clothing if in liquid solution. If in powder form, remove dry powder. Wash clothing after removal
	Skin	Copious soap and water; do not use oil-based lotions or bleach	Copious soap and water. Can also use alcohol, baby shampoo, or flush skin with vegetable oil followed by soap and water (not for OC/CS-CN mixtures); flush eyes with copious water or baby shampoo; use milk or ice packs to reduce pain
	Equipment	Wash with soap and water	Wash with soap and water or place in sun to degrade
Persistence:	In soil	Varies	Degrades with sun and moisture
	On material	Varies	Degrades with sun and moisture
Skin and eye effects		Skin irritant; itching, stinging and erythema; may cause blistering and allergic contact dermatitis. Burning and irritation to eyes with lacrimation and accompanying blepharospasm	Causes sensation of intense pain and burning through the activation of the TRPV1 sensory neuron, causing release of substance P. May cause allergic dermatitis with excessive skin exposure. Lacrimation, redness, burning sensation in the eyes and blepharospasm
Respiratory effects		Salivation, coughing, choking, and a feeling of chest tightness. May cause reactive airway disease syndrome requiring medical intervention	Tingling sensation followed by coughing and decreased inhalation rates. Pain, vasodilation, and secretion can occur in the airways depending on the dose inhaled

*At standard temperature and pressure.

Data sources: (1) Sidell F. Riot control agents. In: Sidell F, Takafuji E, Franz D, eds. Medical Aspects of Chemical and Biological Warfare. In: Zajchuk R, Bellamy RF, eds. Textbook of Military Medicine. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute; 1997: Chap 12. (2) US Department of the Army. Potential Military Chemical/Biological Agents and Compounds, Multiservice Tactics, Techniques, and Procedures. Washington, DC: DA; January 10, 2005. FM 3-11.9. (3) Somani SM, Romano JA Jr, eds. Chemical Warfare Agents: Toxicity at Low Levels. Boca Raton, Fla: CRC Press; 2001.



ARMAMENT RESEARCH SERVICES Pty. Ltd.

+ 61 8 6365 4401

contact@armamentresearch.com

www.armamentresearch.com