

## **Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals**

23 June 2023

### **Sub-Committee of Experts on the Transport of Dangerous Goods**

#### **Sixty-second session**

Geneva, 3-7 July 2023

Item 2 (a) of the provisional agenda

**Explosives and related matters:  
review of test series 6**

### **Information related to ST/SG/AC.10/C.3/2023/26: Exit from Class 1 testing of power loads, blanks and empty primed cases**

**Transmitted by the Sporting Arms & Ammunition Manufacturers'  
Institute**

#### **Introduction**

1. SAAMI's proposal ST/SG/AC.10/C.3/2023/26 was submitted to allow for test reports of ongoing research on this topic. A test report is attached which details the performance of power loads (UN 0014 for tools), blanks (UN 0014 for signal guns) and empty primed cases (UN 0055) in unpackaged bonfire tests and the exclusion test in 2.1.3.6.4 of the Model Regulations. These products are often used in tools as power device cartridges.
2. The research seeks to support the addition of separate criteria for these existing tests to manage the exit of these very low hazard energetic articles from Class 1, while retaining them in the dangerous goods system. This would establish scientific rather than use-based criteria, and help regulators issue safety-based classifications based on existing and additional tests.

#### **Testing approach**

3. While the 6c bonfire can result in five classifications, the exclusion test is only a pass/fail test and could be better utilized. The exclusion test of Model Regulations 2.1.3.6.4, which in the absence of other dangerous goods in the article, typically results in a full exclusion from the Model Regulations. An additional set of criteria could be established to use the test to manage the exit from Class 1 of very low hazard energetic articles which do not meet the very conservative criteria for full exclusion from the Model Regulations.
4. The bonfire test would also be augmented to determine whether articles are packaging-independent in terms of classification results.
5. The absence of mass explosion when unpackaged and in "bulk", plus a low hazard of individual articles, would indicate a suitable level of safety for exclusion from Class 1 but retention in Class 9.

## Test results

6. A test report is attached in the Appendix at the end of this document. Following is a summary of the test results for power loads, blanks and empty primed cases containing smokeless powder<sup>1</sup>:

- Kinetic energies less than 1 Joule.
- Movement and minor fragmentation exceeding the exclusion criteria.
- Sound exceeding the exclusion criteria but less than air bags.
- No ignition of paper in contact with the articles.
- Generally no smoke was produced.

## Proposal

7. SAAMI requests that the explosives working group consider this data along with data on other products to determine the suitability of these tests and additional criteria to manage the exit from Class 1 of very low hazard energetic articles.

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<sup>1</sup> An article containing black powder was tested to demonstrate results which may not pass the new criteria being developed. The speed of combustion was fast and significant smoke was produced. Black powder articles could still be considered for inclusion, but at lower quantities per article and potentially with a lower energetic content ratio compared to inert components.

## **Appendix**

### **Testing Support of Class 1**

#### **Low Hazard Explosive Articles to Class 9**

**- Power Loads**

**- Blanks**

**- Empty Primed Cases**



## **Test Report**

# **Testing Support of Class 1 Low Hazard Explosive Articles to Class 9**

## **Power Loads Blanks Empty Primed Cases**

Prepared For:  
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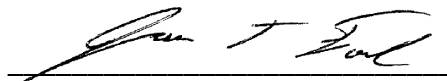
March 24, 2023  
SMS-7225-R1, Rev 0

Test Report

Testing Support of Class 1 Low Hazard Explosive Articles to Class 9

Power Loads  
Blanks  
Empty Primed Cases

March 24, 2023



Jason T. Ford  
DOT Explosive Examiner



Collin Boren  
Chemical Engineer

## TEST REPORT

### 1.0 OBJECTIVE

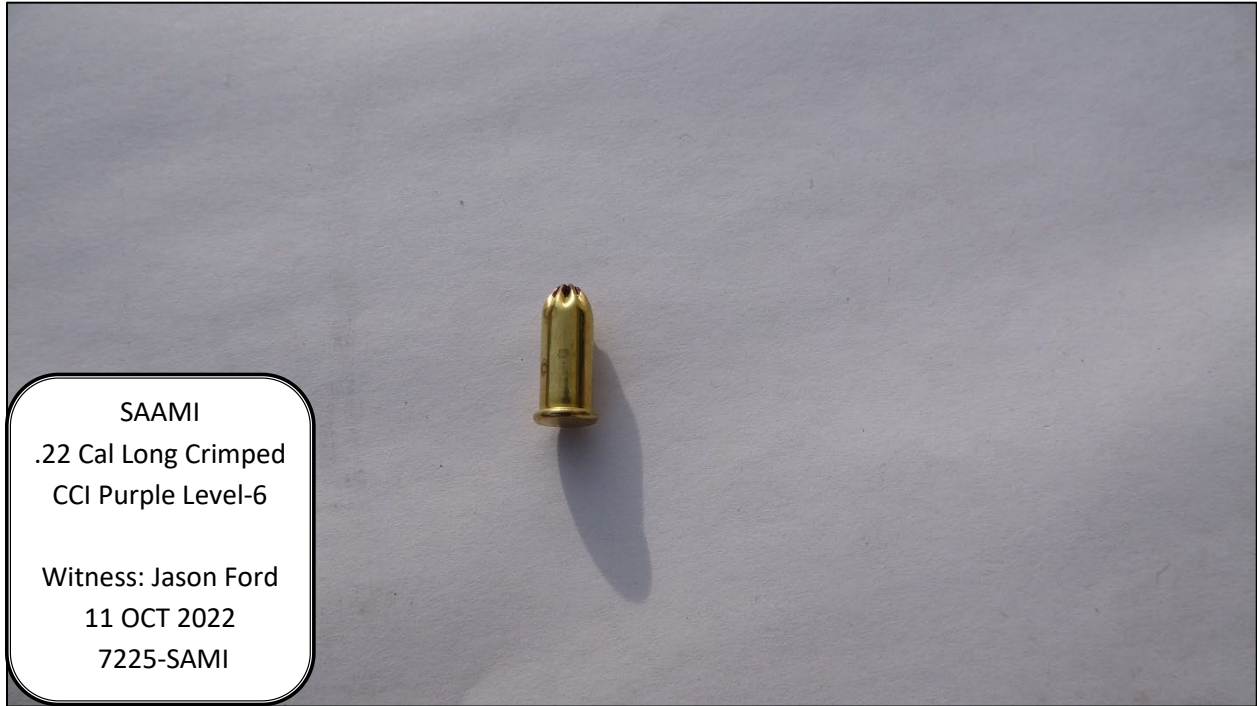
SAAMI requested that Safety Management Services, Inc. (SMS) perform Exclusion from Class 1 and Modified UN 6 (c) External Fire Testing on “power loads”, “blanks”, and “empty primed cases.” Testing was conducted in October of 2022 at SMS’ test site in Tooele, Utah.

### 2.0 ARTICLES' DESCRIPTION

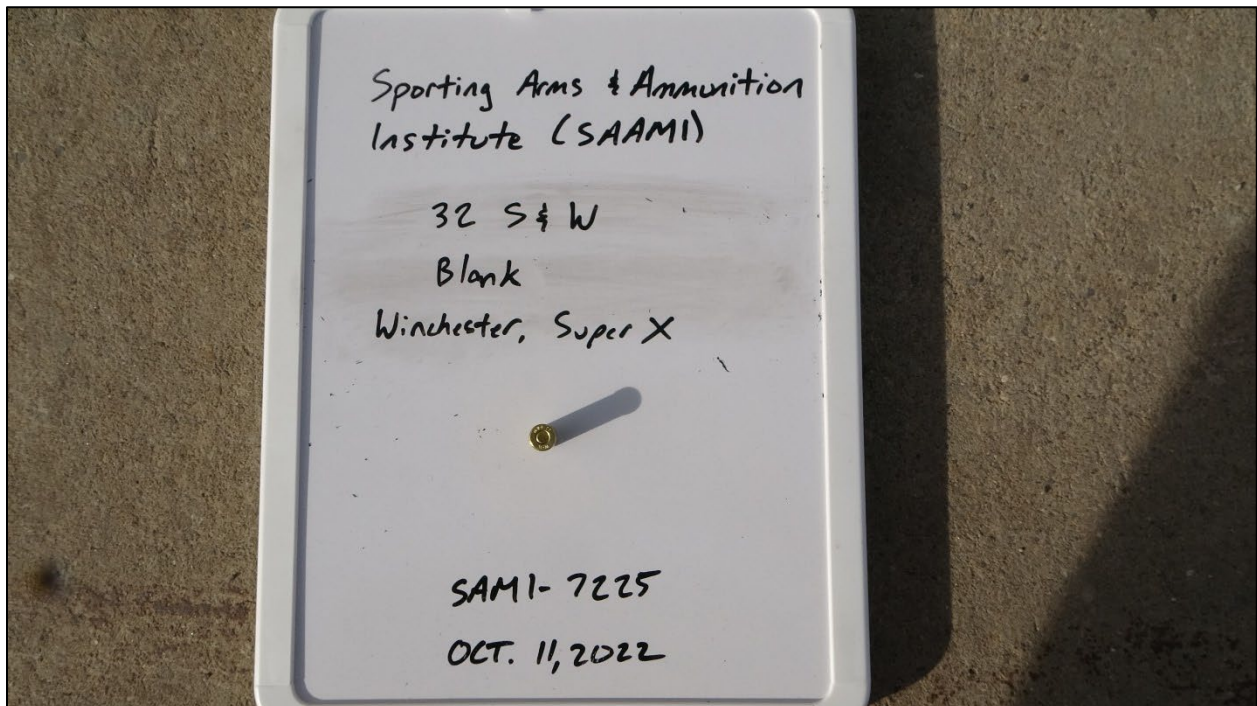
Descriptions of the tested articles are provided in Table 1 and are shown in Photos 1 – 6.

**Table 1: Description of Articles Tested**

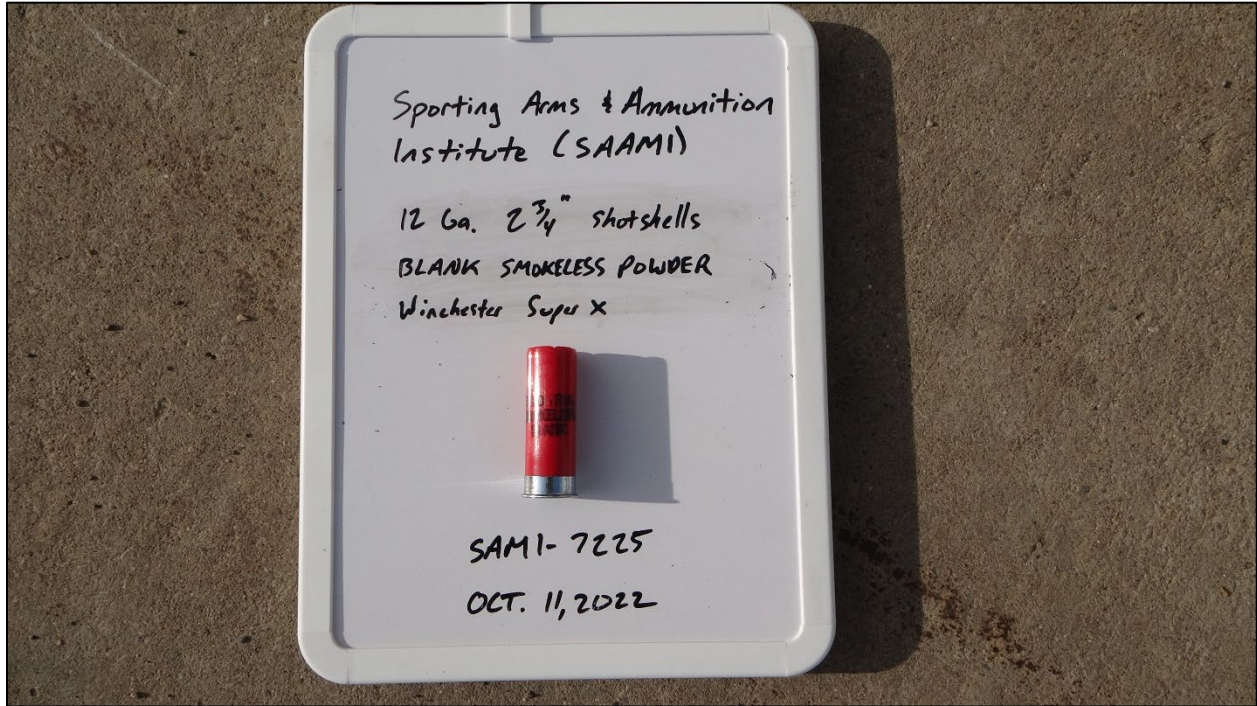
Type	Article	Description
Power Loads	Ammunition power device or tool cartridges which are blank rimfire ammunition. Currently classed as UN0014 Cartridges for tools, blank.	
	CCI .22 Power Load	They have a nominal charge of 310 mg of smokeless powder and approximately 15-22 mg of primer mix in the rim of the cartridge case.
Blanks	Articles that consist of a cartridge case with a center or rim fire primer and a confined charge of smokeless or black powder, but no projectile. Currently classed as UN0014 Cartridges for weapons, blank.	
	Winchester .32 S&W	Contain approximately 427.5 mg of powder and approximately 18 mg primer mix in the primer.
	Winchester 12 Gauge Smokeless Powder	Contain approximately 925.5 mg of powder and approximately 58 mg primer mix in the primer.
	Winchester 12 Gauge Black Powder	Contain approximately 8.424 grams of powder and approximately 58 mg primer mix in the primer.
Empty Primed Cases	Articles consisting of a cartridge case made from metal, plastics or other non-flammable materials, in which only the explosive component is the primer. Currently classed as UN0055/UN0379 Cases, cartridge, empty with primer.	
	WMA 5.56	Contain approximately 24 mg primer mix in the primer.
	Hornady 9mm	Contain approximately 23 mg primer mix in the primer.



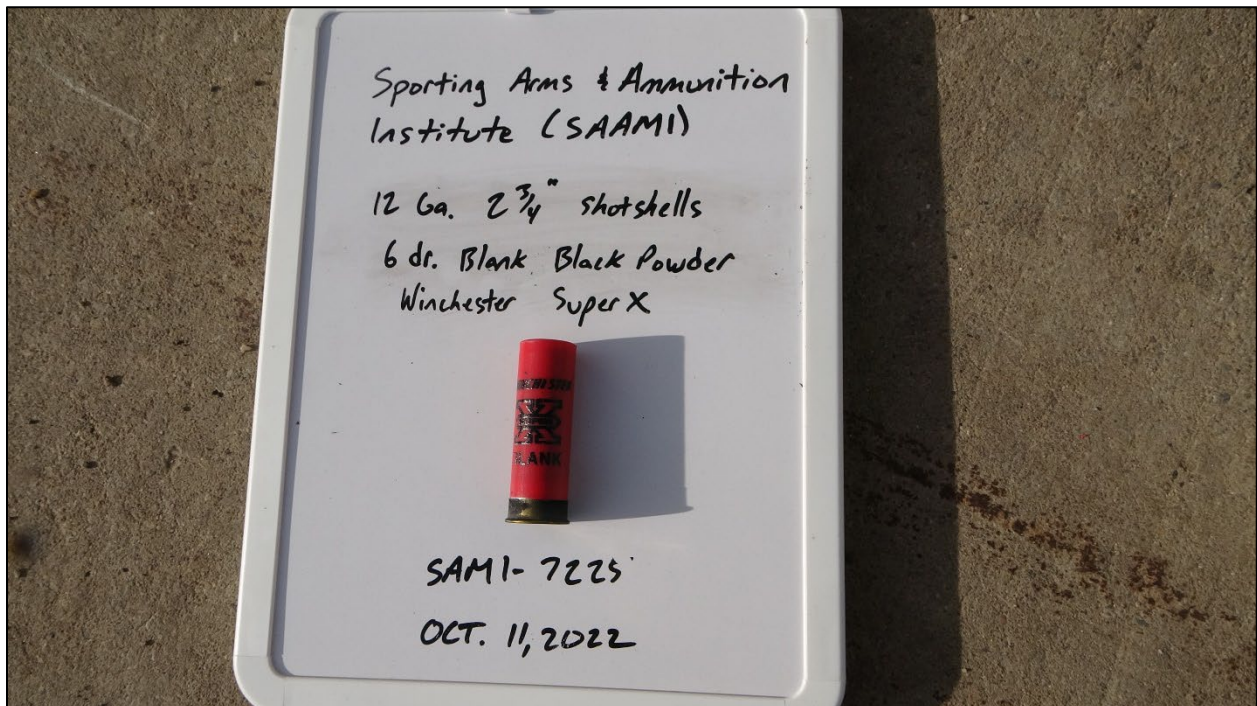
**Photo 1: .22 Power Load as Tested**



**Photo 2: .32 S&W Blank as Tested**

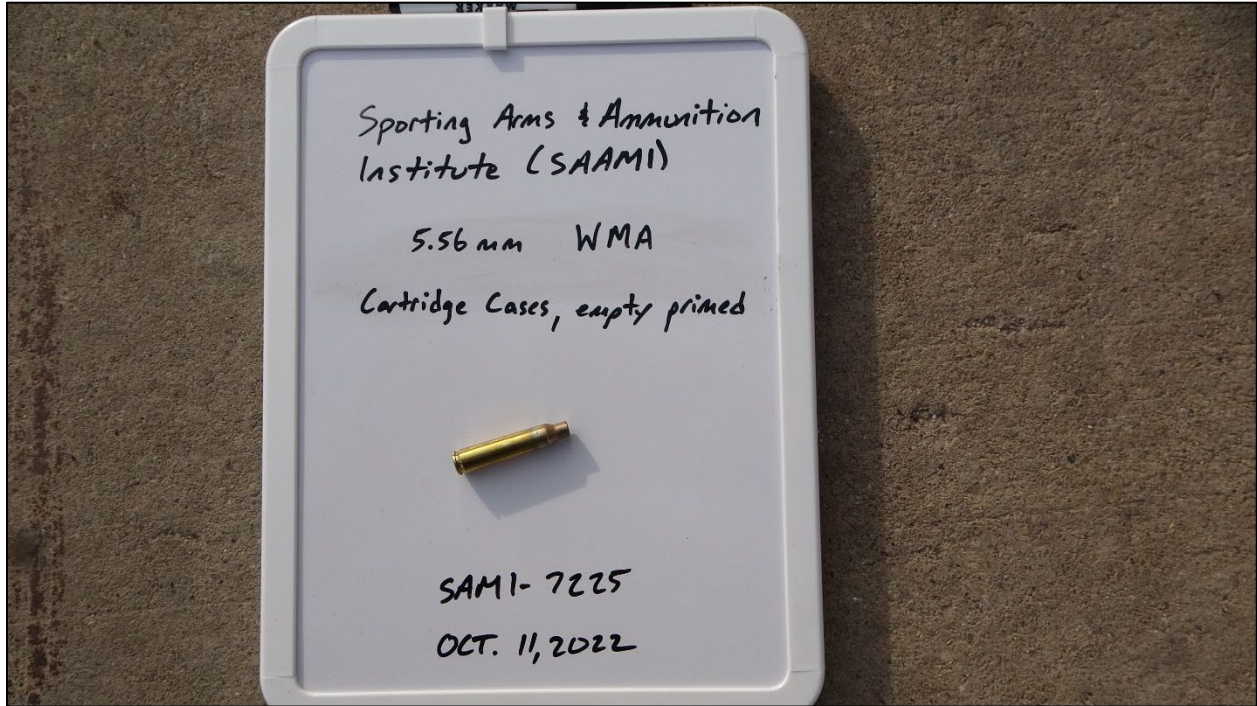


**Photo 3: 12 Gauge Smokeless Powder Blank as Tested**



**Photo 4: 12 Gauge Black Powder Blank as Tested**





**Photo 5: 5.56 Empty Primed Cases as Tested**



**Photo 6: 9mm Empty Primed Cases as Tested**

### 3.0 EXCLUSION FROM CLASS 1 TESTING

The Exclusion from Class 1 Tests were performed in accordance with the United Nations (UN) Recommendations on the Transport of Dangerous Goods, Model Regulations, Nineteenth revised edition (2015), Volume I, Section 2.1.3.6.4.

The test criteria for the Exclusion from Class 1 test are summarized as follows:

- a) No external surface temperature exceeding 65 °C other than a momentary spike not exceeding 200 °C.
- b) No rupture or fragmentation of the external casing or movement of the article or detached parts to exceed 1 meter in any direction.

**Note:** *Where the integrity of the article may be affected in the event of an external fire these criteria shall be examined by a fire test, such as described in ISO 12097-3.*

- c) No audible report exceeding 135 dB(C) peak at 1 meter.
- d) No flash or flame capable of igniting common paper in contact with the article.
- e) No production of smoke, fumes, or dust with specific density requirements in a 1-cubic meter enclosure.

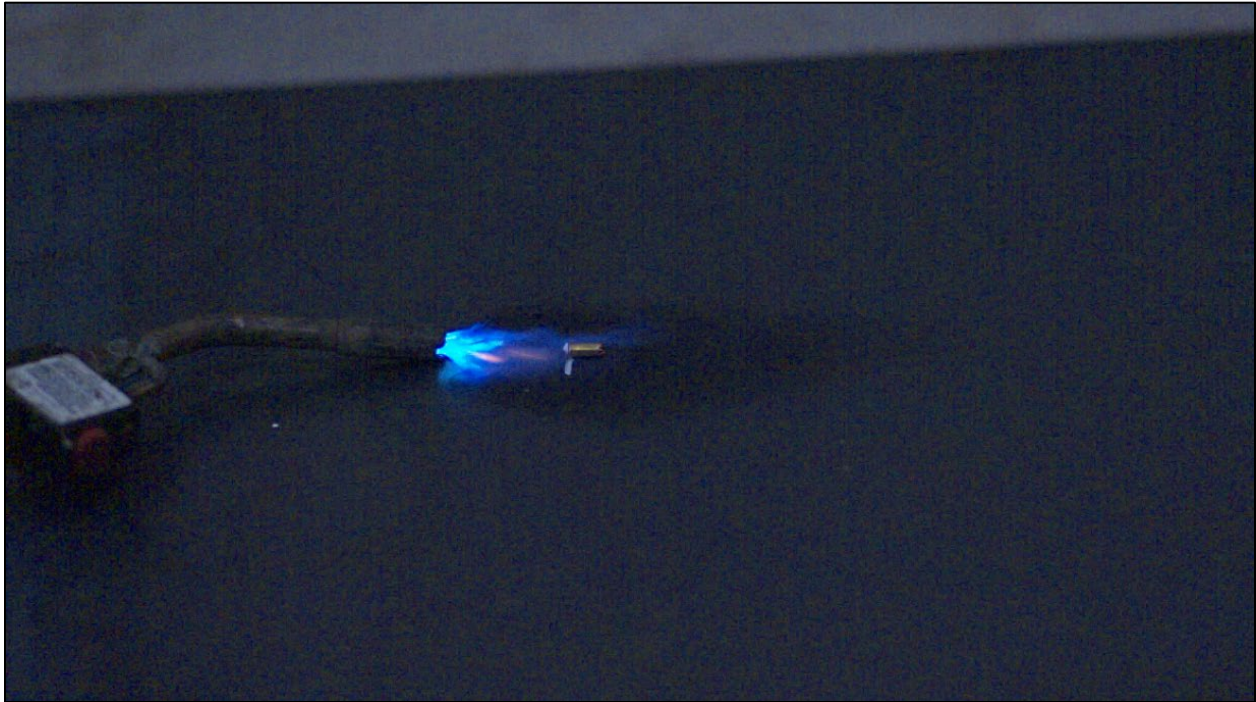
**Note 1:** *If during the tests addressing criteria (a), (b), (c), and (d) no or very little smoke is observed the test described in (e) may be waived.*

**Note 2:** *The competent authority may require testing in the packaged form if it is determined that, as packaged for transport, the article may pose a greater risk.*

Additionally, SAAMI desired high-speed video to be utilized during testing to determine the estimated speed of the articles after initiation. Kinetic energies were then calculated using the velocity of the determined experimental velocities and the weight of the recovered articles using the formula below.

$$E_k = \frac{1}{2}mv^2$$

Where  $E_k$ , is the kinetic energy,  $m$  is the mass of the bullet, and  $v$  is the bullet velocity or speed.



**Photo 7: Exclusion from Class 1 Test Setup with High-Speed Video**

### **3.1 Exclusion from Class 1 Testing Results**

A summary of the test results is provided in Tables 2 – 7 below and photos of the post-test articles are shown in Photos 8 – 11. SMS initially performed trials without recording the movement of the articles because the mass of the mechanism utilized to initiate the articles – the Klieboldt Apparatus – inhibited the articles from moving freely. In additional trials, SMS functioned the articles with a torch and used a high-speed video camera to capture the speed of the articles upon initiation. SMS did NOT perform additional tests on the 12 Ga. Black Powder Blanks due to the production of smoke, fumes, or dust when the cartridges were initiated with the Klieboldt Device and due to the results of the External Fire Test.

**Table 2: Results of Exclusion from Class 1 Tests for .32 SW Blanks**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	37	27.5	34.5
Rupture	Yes	Yes	Yes
Movement (cm)	22	30	46
Audible report (dB(C))	153	152.6	155.5
Flash/flame	Pass <sup>1</sup>	Pass <sup>1</sup>	Pass <sup>1</sup>
Production of smoke, fumes, or dust	None	None	None
Post-test weight of the article (g)	2.77	2.77	2.77
Velocity of article (mph)	2.8	13.9	10.1
Estimated Kinetic Energy (J)	0.002	0.053	0.028

- <sup>1</sup> Large flash/sparks scorched the paper, but the paper did not ignite

**Table 3: Results of Exclusion from Class 1 Tests for 5.56 Primed Cases**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	29.5	26	28.8
Rupture	Yes	Yes	Yes
Movement (cm)	> 1 m	> 1 m	> 1 m
Audible report (dB(C))	153.8	152.8	151.2
Flash/flame	Pass <sup>1</sup>	Pass <sup>1</sup>	Pass <sup>1</sup>
Production of smoke, fumes, or dust	None	None	None
Post-test weight of the article (g)	6.03	6.01	6.09
Velocity of article (mph)	8.8	7.5	10.8
Estimated Kinetic Energy (J)	0.047	0.034	0.071

- <sup>1</sup> Large flash/sparks scorched the paper, but the paper did not ignite

**Table 4: Results of Exclusion from Class 1 Tests for .22 Power Loads**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	32.5	26.25	28.9
Rupture	Yes	Yes	Yes
Movement (cm)	> 1 m	> 1 m	> 1 m
Audible report (dB(C))	155.8	149.2	149.7
Flash/flare	Pass <sup>1</sup>	Pass <sup>1</sup>	Pass <sup>1</sup>
Production of smoke, fumes, or dust	None	None	None
Post-test weight of the article (g)	0.62	0.62	0.58
Velocity of article (mph)	65.8	69.1	40.2
Estimated Kinetic Energy (J)	0.268	0.296	0.094

- <sup>1</sup> Large flash/sparks scorched the paper, but the paper did not ignite

**Table 5: Results of Exclusion from Class 1 Tests for 12 Ga. Black Powder Blanks**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	77 <sup>1</sup>	-	-
Rupture or movement (cm)	-	-	-
Audible report (dB(C))	Fail <sup>2</sup>	-	-
Flash/flare	Pass <sup>3</sup>	Pass <sup>3</sup>	Pass <sup>3</sup>
Production of smoke, fumes, or dust	Yes <sup>4</sup>	-	-

- <sup>1</sup> Momentary spike only
- <sup>2</sup> Noise meter was not functioning properly, but based on other test results, the noise is exceeding the 135 dB(C) peak criterion
- <sup>3</sup> Large flash/sparks scorched the paper, but the paper did not ignite
- <sup>4</sup> Based on the smoke produced during this trial, additional trials are required to determine if the optical density is reduced by more than 50% per the criterion

**Table 6: Results of Exclusion from Class 1 Tests for 12 Ga. Smokeless Powder Blank**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	28	26	30
Rupture	Yes	Yes	Yes
Movement (cm)	> 1 m	> 1 m	> 1 m
Audible report (dB(C))	155.4	154.1	155.2
Flash/flame	Pass <sup>1</sup>	Pass <sup>1</sup>	Pass <sup>1</sup>
Production of smoke, fumes, or dust	None	None	None
Post-test weight of the article (g)	10.60	9.93	11.68
Velocity of article (mph)	10.2	10.7	10.5
Estimated Kinetic Energy (J)	0.110	0.114	0.129

- 1 Large flash/sparks scorched the paper, but the paper did not ignite

**Table 7: Results of Exclusion from Class 1 Tests for 9mm Primed Cases**

Section 2.1.3.6.4 Test Criteria	Conditions and Results		
	Trial 1	Trial 2	Trial 3
External surface temperature (°C)	20.25	20.5	21.1
Rupture	Yes	Yes	Yes
Movement (cm)	> 1 m	> 1 m	> 1 m
Audible report (dB(C))	147.6	147.4	150.2
Flash/flame	Pass <sup>1</sup>	Pass <sup>1</sup>	Pass <sup>1</sup>
Production of smoke, fumes, or dust	None	None	None
Post-test weight of the article (g)	3.48	3.52	3.48
Velocity of article (mph)	13.9	14.8	14.9
Estimated Kinetic Energy (J)	0.067	0.077	0.331

- 1 Large flash/sparks scorched the paper, but the paper did not ignite



Photo 8: Exclusion from Class 1 Test Results - .22 Power Loads

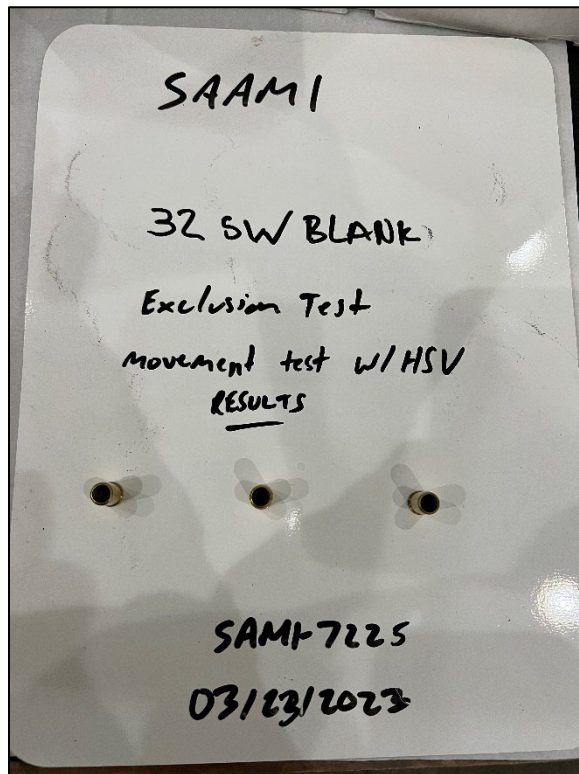


Photo 9: Exclusion from Class 1 Test Results - .32 S&W Blanks

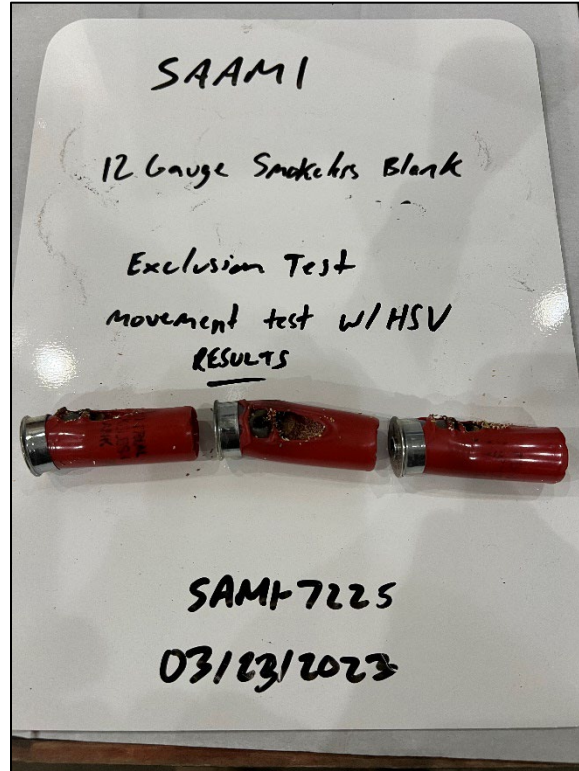
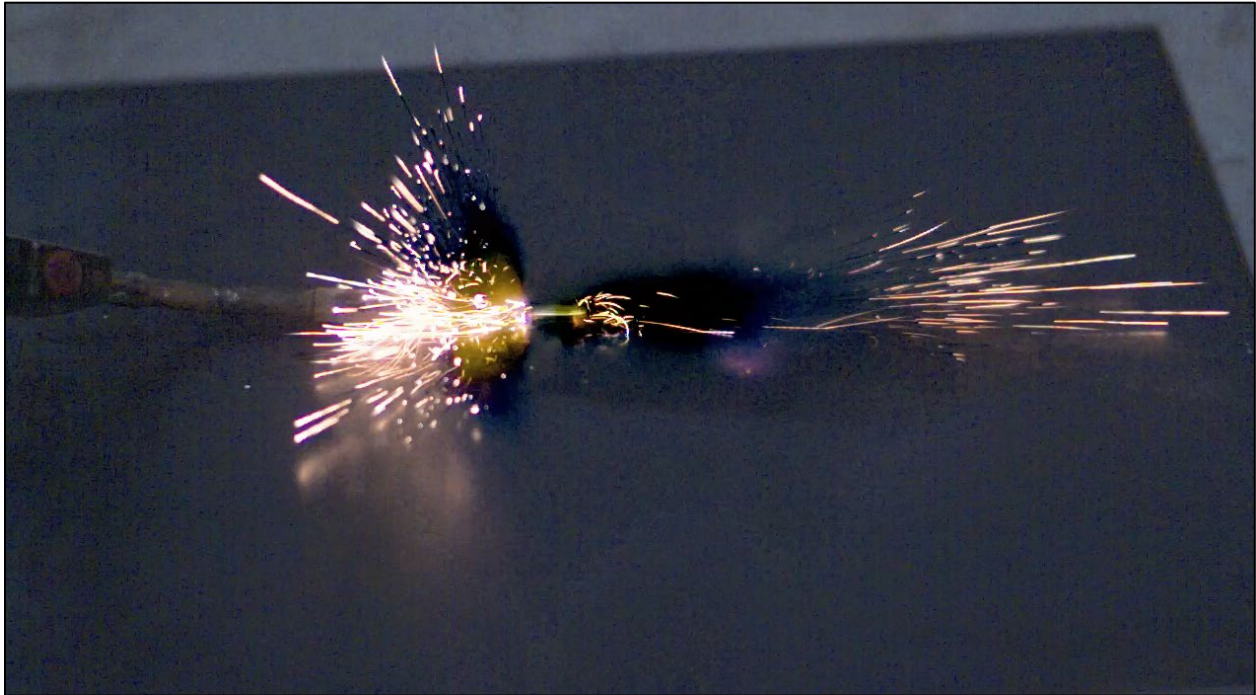


Photo 10: Exclusion from Class 1 Test Results - 12 Ga. Smokeless Powder Blanks

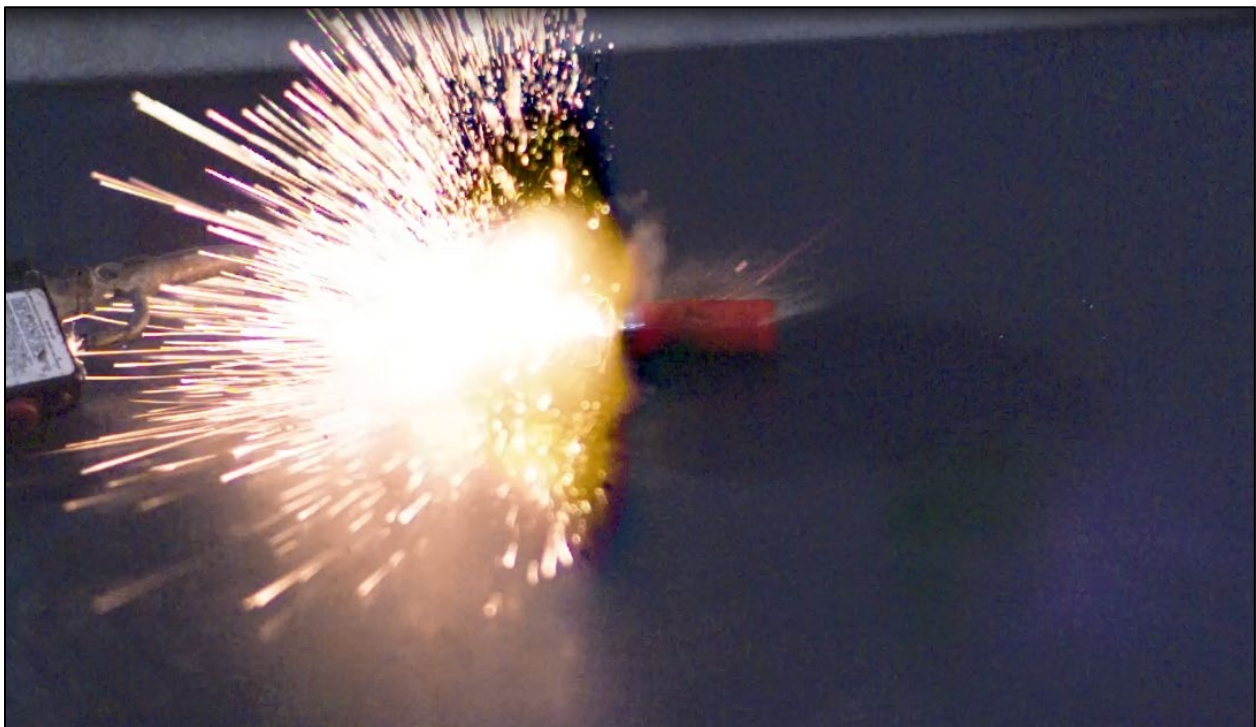


Photo 11: Exclusion from Class 1 Test Results - 9mm Primed Cases





**Photo 12: Representative Exclusion from Class 1 Test Results with High-Speed Video**



**Photo 13: Representative Exclusion from Class 1 Test Results with High-Speed Video**

#### 4.0 MODIFIED UN SERIES 6 (C) EXTERNAL FIRE (BONFIRE) TEST

Testing consisted of a modified UN 6 (c) External Fire Test at SMS' test site in Tooele, Utah in October of 2022. Tests were witnessed by Jason Ford and performed with the United Nations (UN) Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Seventh revised edition (2019) as a basis. Testing was performed on unpackaged articles in a cage.

#### 4.1 External Fire Test Setups

##### 4.1.1 External Fire Test #1 Setup – .22 Power Load & 9mm Empty Primed Cases

Two (2) metal cages were used for the external fire with a total of one (1) cage containing 10,000 .22 Power Loads and one (1) metal cage containing 6,000 9mm Empty Primed Cases on the fire. Wood pallets were used as the fuel source. Diesel and gasoline were used as an accelerant for the ignition of the wood. Witness screens were used, and the test setup is shown below in Photo 14. The environmental conditions at the start of the test were as follows:

- Wind: 5 mph
- Temperature: 69 °F
- Relative Humidity: 21%
- Air Pressure: 29.89 in Hg



Photo 14: UN Series 6 (c) External Fire Test #1 Setup

#### 4.1.2 External Fire Test #2 Setup – 5.56 Empty Primed Cases & .32 S&W Blanks

Two (2) metal cages were used for the external fire with a total of one (1) cage containing 8,700 5.56 Empty Primed Cases and one (1) metal cage containing 4,000 32 S&W Blanks on the fire. Wood pallets were used as the fuel source. Diesel and gasoline were used as an accelerant for the ignition of the wood. Witness screens were used, and the test setup is shown below in Photo 15. The environmental conditions at the start of the test were as follows:

- Wind: 2 mph
- Temperature: 61 °F
- Relative Humidity: 51%
- Air Pressure: 30.14 in Hg



Photo 15: UN Series 6 (c) External Fire Test #2 Setup

### 4.1.3 External Fire Test #3 Setup – 12 Ga. Blank Black Powder & 12 Ga. Blank Smokeless Powder

Two (2) metal cages were used for the external fire with a total of one (1) cage containing 2,500 12 Ga. Blanks containing black powder and one (1) metal cage containing 2,500 12 Ga. Blanks containing smokeless powder on the fire. Wood pallets were used as the fuel source. Diesel and gasoline were used as an accelerant for the ignition of the wood. Witness screens were used, and the test setup is shown below in Photo 16. The environmental conditions at the start of the test were as follows:

- Wind: 3 mph
- Temperature: 59 °F
- Relative Humidity: 53%
- Air Pressure: 30.17 in Hg



Photo 16: UN Series 6 (c) External Fire Test #3 Setup

#### 4.2 Modified UN Series 6 (c) External Fire (Bonfire) Test Results

A summary of the testing is provided in Tables 8 – 10 below. Photos 17 – 26 below show the test results.

**Table 8: Testing Summary on External Fire Test #1**

<b>Product</b>	<b>Conditions and Results</b>
.22 Power Load	An approximate 2-foot fireball surrounded the cage during initiations, and all 10,000 power loads were consumed within 3-5 seconds.
9mm Empty Primed Cases	The events from the articles could not be distinguished from the flames of the fire.

**Table 9: Testing Summary on External Fire Test #2**

<b>Product</b>	<b>Conditions and Results</b>
5.56 Empty Primed Cases	“Popcorn” reactions as primed cases reacted on an individual basis.
.32 S&W Blanks	Initial events were evidenced by smoke trails from individual blanks being initiated. Approximately 1 minute into the fire the majority of the 32 S&W reacted over about a 15-second timeframe.

**Table 10: Testing Summary on External Fire Test #3**

<b>Product</b>	<b>Conditions and Results</b>
12 Ga. Smokeless Powder Blanks	Reactions were spread out as individual reactions during the fire.
12 Ga. Smokeless Black Blanks	A reaction occurred within seconds of initiation of the fire. Almost all the B.P. rounds (2,500) reacted within approximately 2 seconds. Some B.P. shells were thrown out of the cage and subsequent reactions were observed.



**Photo 17: UN Series 6 (c) External Fire Test #1 Results**



**Photo 18: UN Series 6 (c) External Fire Test #1 Results**

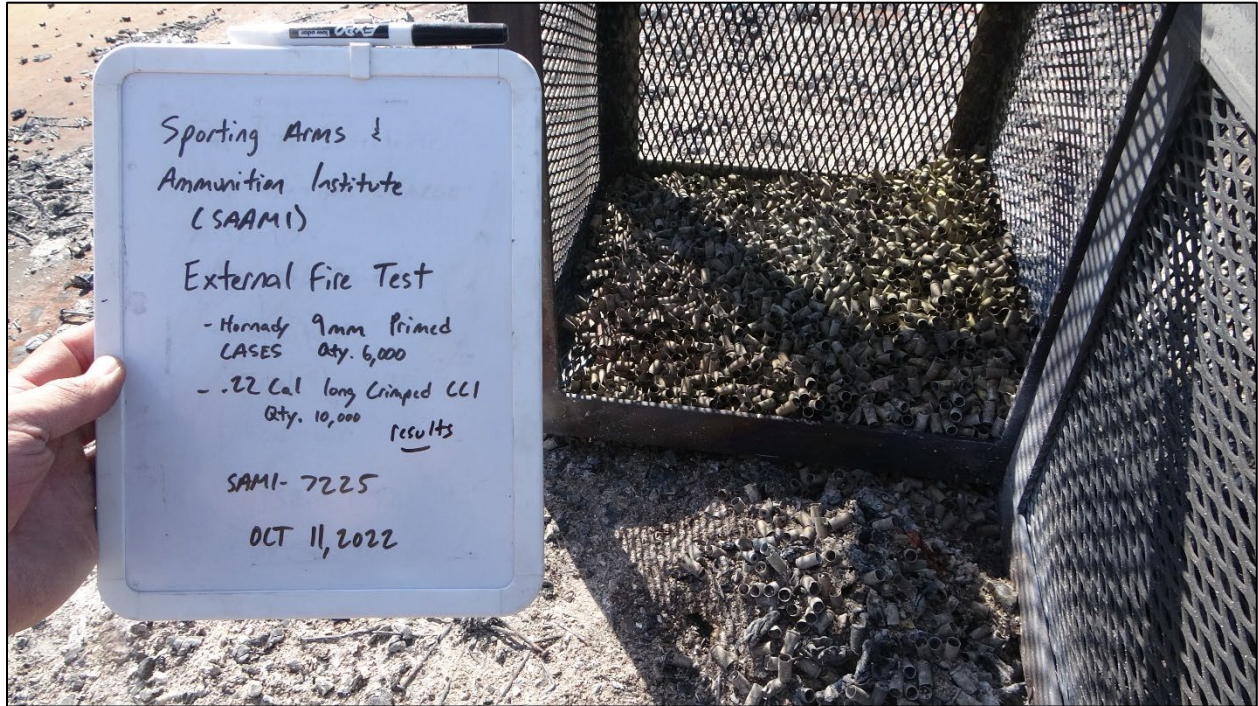


Photo 19: UN Series 6 (c) External Fire Test #1 Results

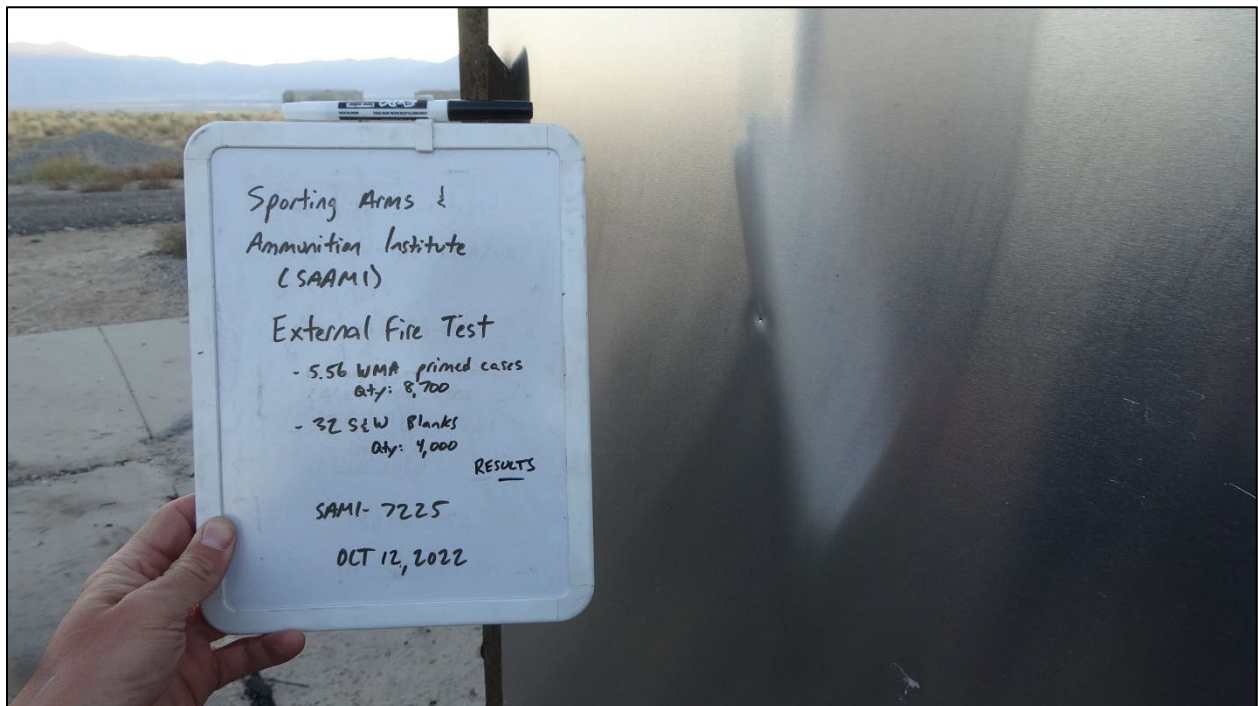


Photo 20: UN Series 6 (c) External Fire Test #2 Results



Photo 21: UN Series 6 (c) External Fire Test #2 Results



Photo 22: UN Series 6 (c) External Fire Test #2 Results





Photo 23: UN Series 6 (c) External Fire Test #3 Results



Photo 24: UN Series 6 (c) External Fire Test #3 Results

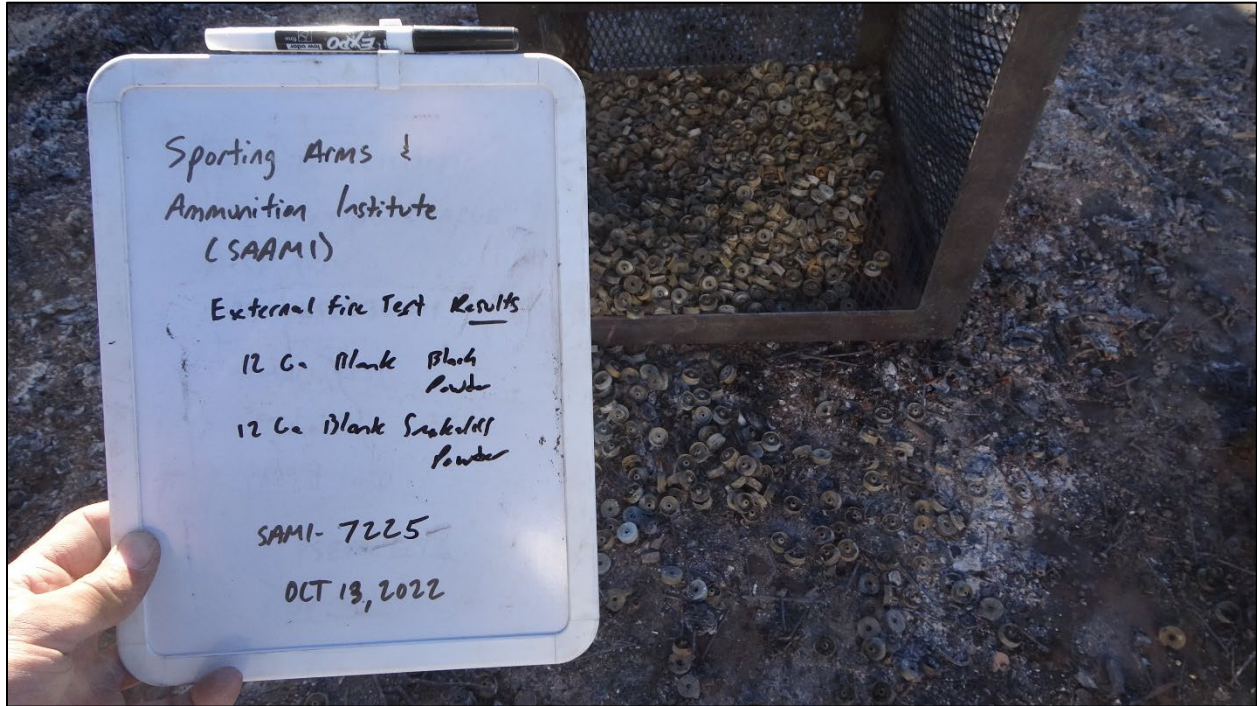


Photo 25: UN Series 6 (c) External Fire Test #3 Results



Photo 26: UN Series 6 (c) External Fire Test #3 Results