

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

23 June 2022

**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: Test 6(d)
data on small arms cartridges**

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

Introduction

1. Based on proposal ST/SG/AC.10/C.3/2019/11, SAAMI agreed to chair an informal correspondence group reviewing the Test 6(d) unconfined package test. The work has been ongoing since 2019. The following documents have been published:

- ST/SG/AC.10/C.3/2019/11
Review of the criteria of Test 6(d)
- ST/SG/AC.10/C.3/2020/4
Report of the informal correspondence group (ICG) on the review of Test 6(d)
(Unconfined package test)
- ST/SG/AC.10/C.3/2021/14
Report of the 6d-ICG
- INF.10 (58th session)
- Report of the 6d-ICG Meeting of 20 May 2021 related to ST/SG/AC.10/C.3/2021/14
- ST/SG/AC.10/C.3/2023/26
Research in relation to exit from Class 1 and Test 6(d)

2. SAAMI and COSTHA's proposal in ST/SG/AC.10/C.3/2023/26 was submitted to allow a review of ongoing research related to exit from Class 1 and Test 6(d). A test report is attached (SMS-7221-R1, Rev 0) in the appendix which details the performance of 223 Remington and 308 Winchester small arms ammunition cartridges in Test 6(d) in certain configurations. These cartridges are similar to NATO 5.56 and 7.62X51.

3. A principal point of discussion within the 6d-ICG is whether the test currently assesses only "hazardous effects" per its stated intent¹, or whether the test criteria are assessing any effect, including non-hazardous effects.

¹ Section 16.7.1.1 of the Manual of Tests and Criteria states "This is a test on a single package to determine if there are hazardous effects outside the package arising from accidental ignition or initiation of the contents."

Test results

4. The current research provides information to facilitate discussion on whether the fourth criterion of Test 6(d) assesses any effects or only hazardous effects. That criterion is “A projection which passes completely through the packaging (a projection or fragment retained or stuck in the wall of the packaging is considered as non hazardous).” Please see 6.7.1.4(d).

5. Although small arms cartridges commonly pass the 6(d) test, certain configurations may not strictly conform to all criteria. In the current work, configurations were selected with the purpose of allowing a projectile to exit the package to assess the effect and facilitate a discussion on whether a low energy projection is a “hazardous effect”.

6. Following is a summary of the test results:

- Passing results were observed for Criteria 1, 2 and 3.
- In relation to Criteria #4, projectiles exited the package. Kinetic energies found using high speed video were as follows:
 - 223 Remington – Average 2.43 Joules
 - 308 Winchester – Average 1.94 Joules

The meaning of hazard in context with explosives

7. It should be noted that the Model Regulations define Division 1.4 in 2.1.1.4 as “Substances and articles which present no significant hazard”. Division 1.4 may have up to 8 metre flame balls and any size dent on the Test 6 (c) witness screen. Division 1.4 is commensurate to a GHS Subcategory 2B hazard level, which is described in GHS 2.1.4.2: “Sub-category 2B represents a medium explosion hazard. An explosive in this sub-category has the potential to cause serious damage to objects and moderate injuries to persons. Injuries may result in permanent impairment.”

8. It can be deduced from the Model Regulations and the GHS guidance that the description “no significant hazard” is not intended for comparison to non-dangerous chemicals, but is a comparison to divisions 1.1, 1.2, 1.3, 1.5, and in some cases 1.6. According to GHS, these high hazard explosives have: “... the potential to cause the complete destruction of objects and lethal or very severe injuries to persons.”

9. SAAMI questions whether the effects presented here are hazardous in the context of the explosives classification system. These effects would result in either no injury or a first aid injury, commensurate to low hazard, Division 1.4S explosives. According to GHS, low hazard explosives “can cause minor damage to objects and moderate injuries to persons. Injuries would not normally result in permanent impairment.” The term “hazardous effects” is intended to mean seriously hazardous effects which would not preclude first aid injuries likely to occur from exposure to any dangerous good. This intent is evidenced in the written proposals leading up to the adoption of Test 6(d).

Proposal

10. SAAMI requests that the explosives working group consider this data and its relation to the meaning of “hazardous effects”.

Appendix

Testing of small arms ammunition in support of updating criteria outlined in UN 6(d) unconfined package test



Test Report

Testing of Small Arms Ammunition in Support of Updating Criteria Outlined in UN 6(d) Unconfined Package Test

Fiocchi .223 Sig Sauer 308 Win

Prepared For:
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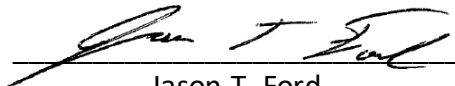
March 26, 2023
SMS-7221-R1, Rev 0

Test Report

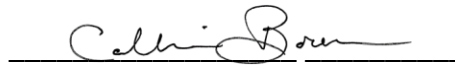
Testing of Small Arms Ammunition in Support of
Updating Criteria Outline in UN 6(d) Unconfined Package Test

Fiocchi .223
Sig Sauer 308 Win

February 24, 2023



Jason T. Ford
DOT Explosive Examiner



Collin Boren

TEST REPORT

1.0 OBJECTIVE

SAAMI requested that Safety Management Services, Inc. (SMS) perform the UN 6 (d) Unconfined Package Test supplemented with instrumentation on small-arms ammunition, specifically the Fiocchi .223 and Sig Sauer 308 Win. Testing was conducted in October of 2022 at SMS’ test site in Tooele, Utah.

2.0 ARTICLE DESCRIPTION

The tested cartridges are listed in Table 1 and are shown in Photo 1.

Table 1: Identification of Cartridges

Caliber	Specification
.223	Fiocchi; 223 Remington Full Metal Jacket Cartridges, 55 grain
308 Win	Sig Sauer; 308 Win Full Metal Jack Cartridges, 150 grain



Photo 1: Fiocchi .223 (Left) & Sig Sauer 308 Win (Right)

3.0 PACKAGING

3.1 Fiocchi .223 Packaging

The packaging of the Fiocchi .223 Cartridges as provided for testing is as follows:

- Inner: Tray, plastic; with a separation of 1 mm between rounds.
- Intermediate: Boxes, fiberboard; containing 50 rounds.
- Outer: Boxes, fiberboard (UN 4G); containing 20 intermediate packages and 1,000 rounds.

Each outer packaging is approximately $9.97 \times 10^{-3} \text{ m}^3$ ($12\frac{1}{2}'' \times 5'' \times 9\frac{3}{4}''$) and contains twenty intermediate packages with a total of 1,000 rounds. Each intermediate package is approximately $4.39 \times 10^{-4} \text{ m}^3$ ($2\frac{3}{8}'' \times 2\frac{3}{8}'' \times 4\frac{3}{4}''$) and contains 50 rounds. The packaging is shown in Photos 2 – 6 below.



Photo 2: Outer Packaging



Photo 3: Outer Packaging



Photo 4: Intermediate Packaging



Photo 5: Inner Packaging



Photo 6: Inner Packaging

3.2 Sig Sauer 308 Win Packaging

The packaging of the Sig Sauer 308 Win Cartridges as provided for testing is as follows:

- Inner: Tray, plastic; with a separation of 2.5 mm between rounds.
- Intermediate: Boxes, fiberboard; containing 20 rounds.
- Outer: Boxes, fiberboard (UN 4G); containing ten (10) intermediate packages and 1,000 rounds.

Each outer packaging is approximately $5.33 \times 10^{-3} \text{ m}^3$ ($6\frac{1}{4}'' \times 8'' \times 6\frac{1}{2}''$) and contains ten (10) intermediate packages with a total of 1,000 rounds. Each intermediate package is approximately $4.42 \times 10^{-4} \text{ m}^3$ ($6'' \times 3'' \times 1\frac{1}{2}''$) and contains 50 rounds. The packaging is shown in Photos 7 – 9 below.

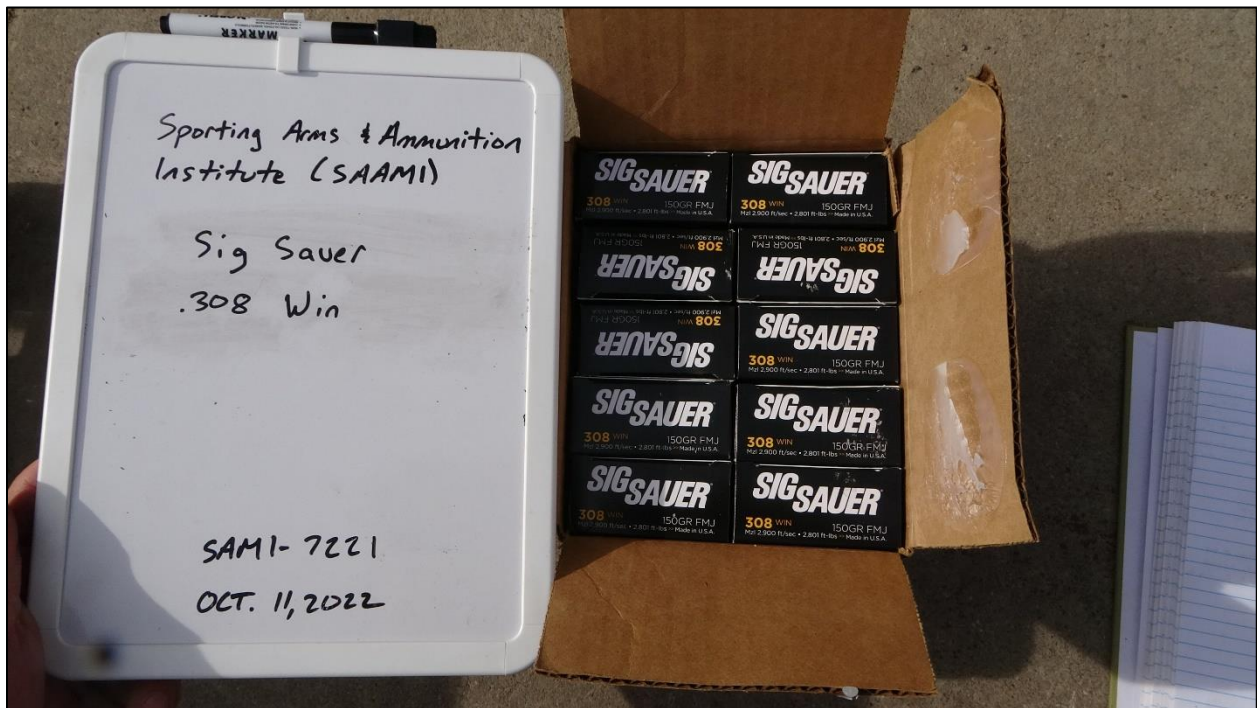


Photo 7: Outer Packaging

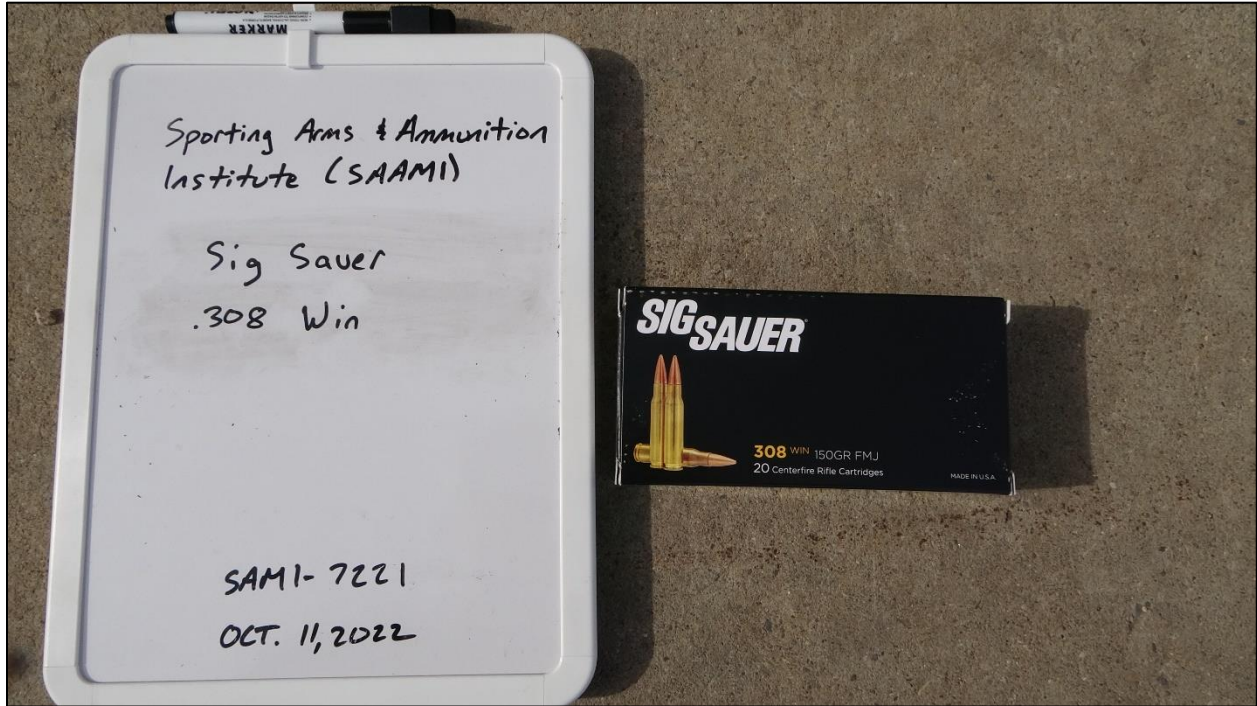


Photo 8: Intermediate Packaging

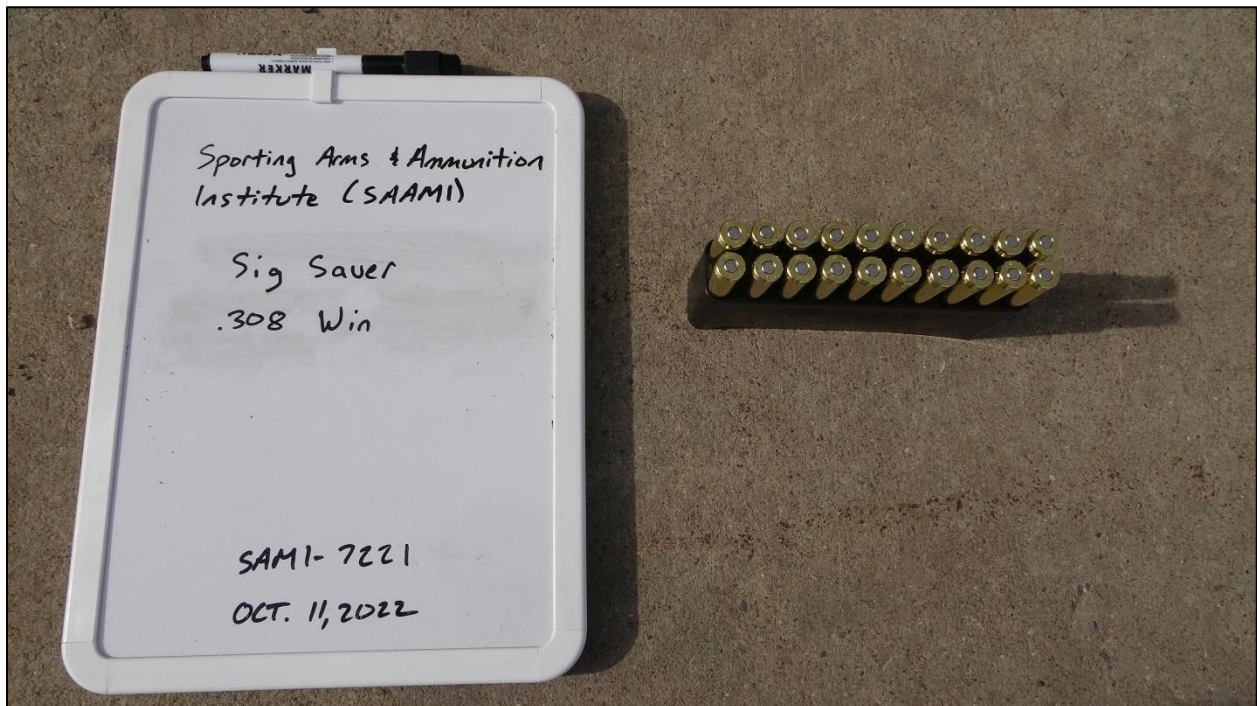


Photo 9: Inner Packaging

4.0 TESTING SUMMARY

Testing consisted of an instrumented UN 6 (d) Unconfined Package Test at SMS’ test site in Tooele, Utah. Tests were witnessed by Jason Ford. The test setup was in accordance with the test protocols as outlined in the United Nations (UN) Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Seventh revised edition (2019).

Additional instrumentation included (4) side-on overpressure probes and high-speed video. A summary of test results is provided in Table 2 which includes the exit velocity of the projectile from the outer package, the maximum kinetic energy of the bullet, and the maximum overpressure recorded.

Table 2: Estimated Projectile Velocity, Kinetic Energy & Max Pressure Recorded

Trial	Caliber	Exit Velocity (m/s)	Kinetic Energy (J)	Max Pressure (psi)
1	.223 Mass = 3.6 gram	32.99	1.96	0.038
2		34.65	2.16	0.041
3		41.97	3.17	0.029
Avg		36.52	2.43	0.036
1	308 Win Mass = 9.6 gram	20.02	1.93	0.168
2		19.36	1.80	0.141
3		20.92	2.10	0.282
Avg		20.11	1.94	0.197

The kinetic energy was determined by using equation 1 below. The maximum velocity, or exit velocity, was used as the projectile immediately exited the outer package. The mass of the projectiles is found in Table 2. All projectiles exiting the outer packaging were found to have less than 8 joules of kinetic energy.

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

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

The overpressure peak measurements were evident for each trial however it should be noted that the peaks were just beyond the noise of the ambient recording.

4.1 UN Series 6 (d) Unconfined Package Test

The UN Series 6 (d) Unconfined Package test was conducted on the packaged rounds in the described packaging. One cartridge was selected as the donor article and was initiated with a Klieboldt Apparatus. The Klieboldt Apparatus is a universal igniter designed to fire small-arms ammunition of all types and calibers in an unconfined configuration. Figure 1 shows the components of the Klieboldt Apparatus, and Photo 10 – Photo 15 shows the test setup. The donor article was in the intermediate package that was in direct contact with the sidewall (not a centrally located intermediate package). The donor article’s projectile was faced toward the sidewall to demonstrate a worst-case initiation scenario. Typically the donor articles are located in the center of the package but a centralized position would not show a worst-case scenario.

Velocities of the projectiles were captured with a high-speed cameras, and overpressure was recorded with a data acquisition unit using air-blast pressure probes placed 18” from the outer package. The high-speed video was captured at 4,100 frames per second. The overpressure sensors were collecting at 100,000 samples/sec.

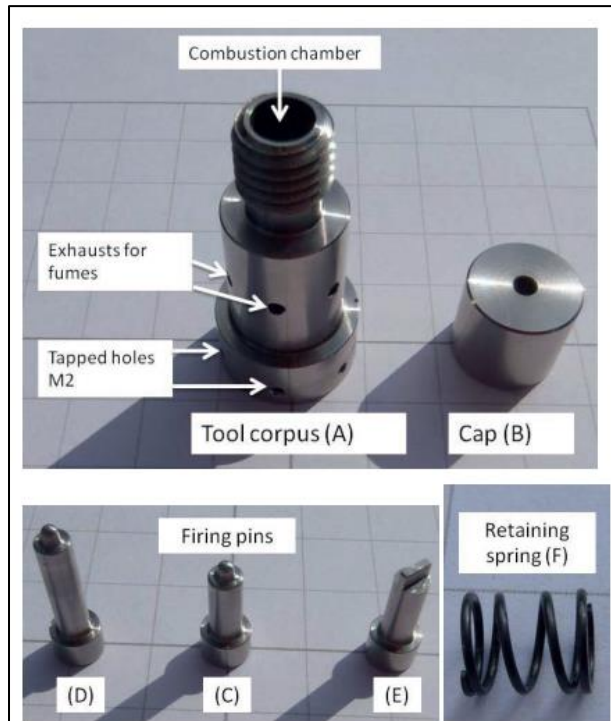


Figure 1: Components of the Klieboldt Apparatus

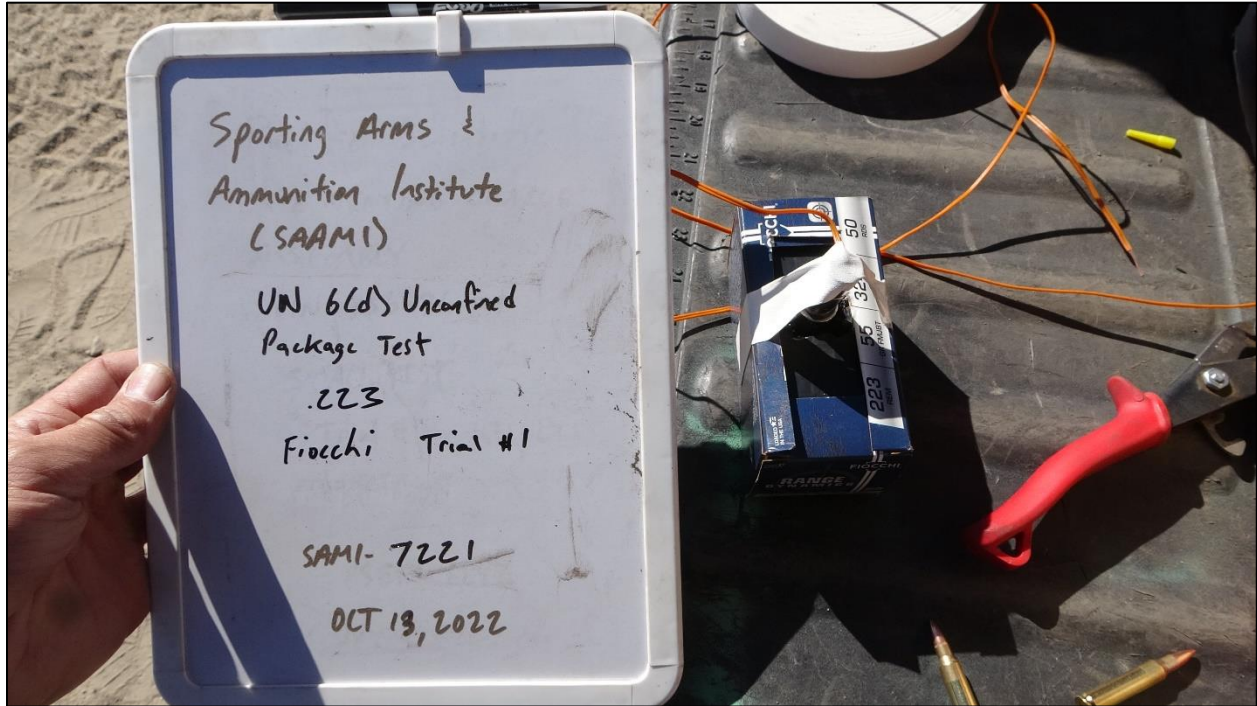


Photo 10: Intermediate Package Prepared with Igniter – FIOCCHI .223

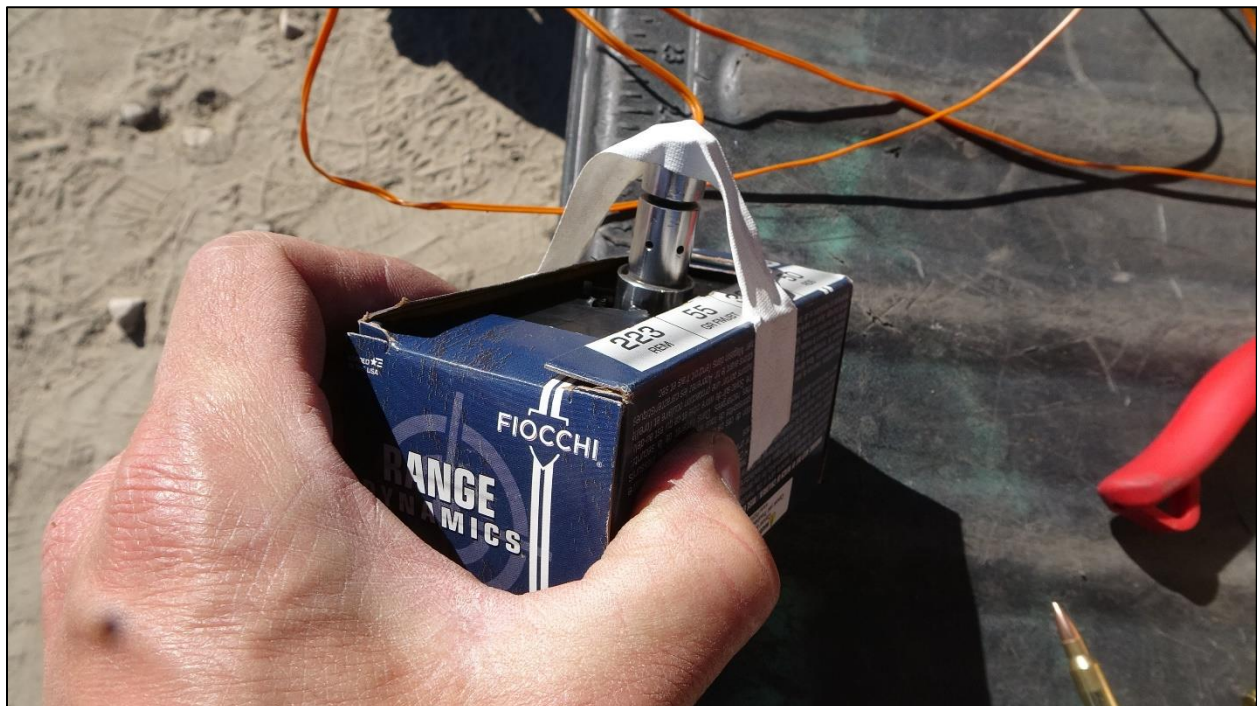


Photo 11: Intermediate Package Prepared with Igniter – FIOCCHI .223



Photo 12: Representative Unconfined Package Test Setup – Fioocchi .223

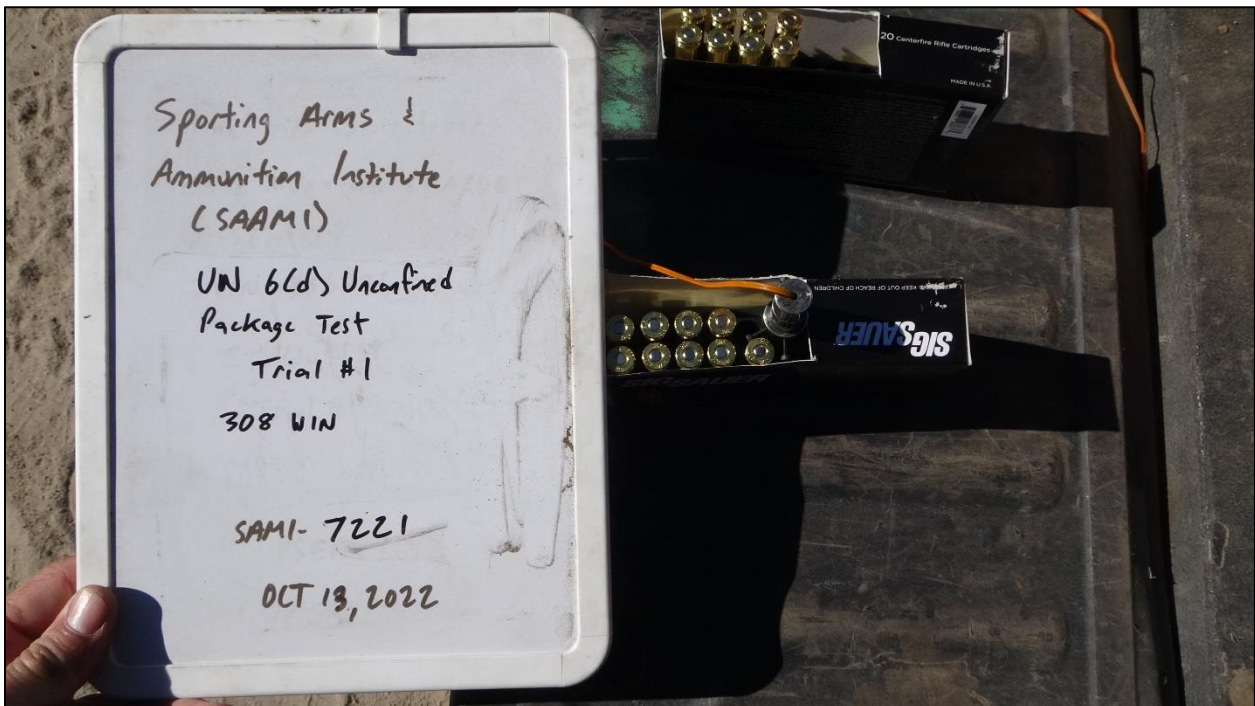


Photo 13: Intermediate Package Prepared with Igniter – Sig Sauer 308 Win



Photo 14: Intermediate Package Prepared with Igniter – Sig Sauer 308 Win



Photo 15: Representative Unconfined Package Test Setup – Sig Sauer 308 Win

4.1.1 UN Series 6 (d) Unconfined Package Test Results

In all trials, after the articles were initiated, there was no damage to the witness plate, there was no propagation from the donor cartridge to any of the acceptor articles, and there was no flash or flame that ignited the adjacent witness paper. However, hazardous projectiles passed completely through the packaging in each trial. Photos 16 – 27 below show the test results.



Photo 16: HSV - Fiocchi .223 - Trial 1 (Representative for all Trials)

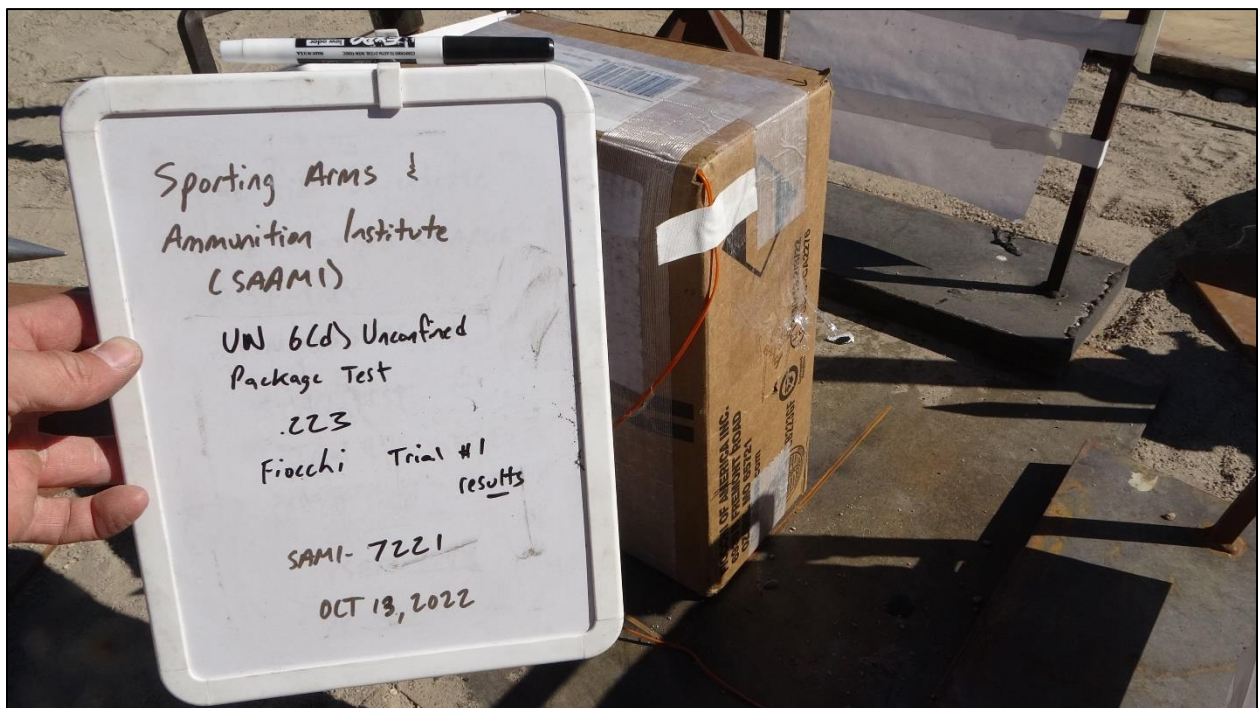


Photo 17: Unconfined Package Test Results - Fiocchi .223 - Trial 1



Photo 18: Unconfined Package Test Results – Fiocchi .223 – Trial 1



Photo 19: Unconfined Package Test Results – Fiocchi .223 – Trial 2



Photo 20: Unconfined Package Test Results – FIOCCHI .223 – Trial 2



Photo 21: Unconfined Package Test Results – FIOCCHI .223 – Trial 3



Photo 22: HSV – Sig Sauer .308 – Trial 1 (Representative for all Trials)



Photo 23: Unconfined Package Test Results – Sig Sauer .308 – Trial 1



Photo 24: Unconfined Package Test Results – Sig Sauer .308 – Trial 1



Photo 25: Unconfined Package Test Results – Sig Sauer .308 – Trial 2



Photo 26: Unconfined Package Test Results – Sig Sauer .308 – Trial 2



Photo 27: Unconfined Package Test Results – Sig Sauer .308 – Trial 3