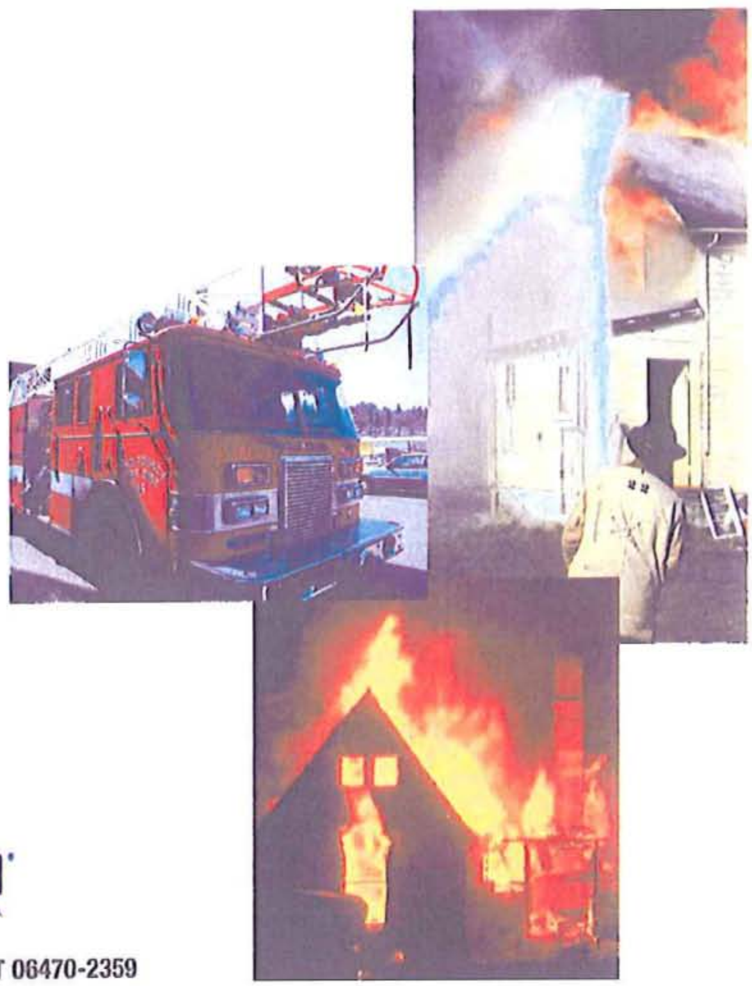
Facts About Sporting Ammunition Fires

By Harry Hampton



SAAMI
Sporting Arms and Ammunition Manufacturers' Institute, Inc.
Since 1926

11 Mile Hill Road • Newtown, CT 06470-2359

THE SPORTSMEN AND HUNTERS OF North America shoot billions of cartridges and shotshells with their firearms annually. To enjoy hunting, marksmanship competition, trap and skeet shooting, and other recreational activities involving lawful use of rifles, shotguns, and handguns, the sportsman-shooter must be able to purchase ammunition of the particular type needed for his gun and the sport that he is pursuing.

To supply his requirements for ammunition, a sizable distribution system is necessary to provide transportation, warehouse storage, and retail stocking of ammunition. Currently there are more than 450 different ammunition items that the shooter can buy, depending on his needs and preferences. This diversity obliges the channels of trade to carry a relatively large supply of ammunition to satisfy their customers' needs.

Is there a fire hazard posed by these large supplies of sporting ammunition in warehouses and retail stores? What, if any, danger do these stocks of ammunition pose to the public and to fire-fighting personnel in the event of a fire in these establishments? Should municipal fire prevention ordinances limit quantities of ammunition that may be stored in a single structure in the interest of public safety?

Experience and tests over the last half-century clearly demonstrate that sporting arms ammunition stocks do not constitute a fire hazard of any great significance. Cartridges are considerably less combustible than many retail items, including dry goods, wooden articles, oil and alkyd-base paints and their thinners, and aerosol preparations. The ignition point of ammunition is much higher than that of these items and most types of ammunition will not even maintain combustion if ignited. To burn them requires help from adjacent combustibles.

But what if the structure containing ammunition burns and the ammunition supplies burn along with it? Are the effects of such a fire similar to the effects of hundreds of shotguns and rifles discharged in all directions as fast as their triggers can be pulled? The answer is an emphatic NO!

Ammunition fired in the open, not enclosed in a gun's chamber, discharges with such inefficiency that the projectile will not even penetrate an ordinary fiberboard shipping container panel at very close range. When not strongly and tightly confined, smokeless propellant powders burn relatively slowly and do not explode as we know they do when fired in a gun. Pressure within a cartridge case must build up to several thousand pounds per square inch to cause the cartridge to discharge as it does in a gun. Unless it is tightly confined, as in a gun chamber, no ammunition shell case will withstand the growing pressure of gases generated by burning propellant powder without bursting before the bullet or shot is expelled with violence or velocity.

Newspaper accounts of fires in hardware and sporting goods stores often tell of "whizzing" bullets or ammunition flying from the store windows, spraying the area with a devastating barrage. Yet miraculously, no one is ever seriously wounded or killed by the spray of bullets and shot. The fact is that bullets and shot are not projected at velocities higher than you could throw them by hand. The whizzing sounds that are reported are, for the most part, primer cups being popped from shells. Because they are of relatively low mass, they have very little energy, short range, and practically no penetrating power.

In 1974, the City of Chicago contemplated a fire protection ordinance to limit severely the stores of sporting ammunition permitted in commercial establishments. Local wholesale and retail outlets challenged the proposal, and the Court asked the Fire Prevention Bureau to determine what degree of hazard is involved in a structural fire involving ammunition. The Sporting Arms and Ammunition Manufacturers' Institute (SAAMI) volunteered to help the Chicago Fire Prevention Bureau obtain factual data to present to the Court.

SAAMI technical experts met with Chicago Fire Prevention Bureau engineers and a test program was developed. A location for the tests was selected on abandoned powder mill, property of the Olin Corporation's Winchester-Western Ammunition Works near East Alton, Illinois. The test program agreed upon is summarized as follows:

1. Burn a frame structure containing packed sporting ammunition and observe the effects of the burning ammunition on the overall intensity of the fire and judge as to hazards to personnel and adjacent property.
2. Burn packed ammunition in an open area to assess missile hazard.
3. Burn packed sporting ammunition in a fire-resistant structure that provides close confinement and determine if build-tip of heat and pressure in the close confinement increases the rate and intensity of burning, or possibly causes mass explosion.
4. Subject packed ammunition to severe shock to determine if any cartridges in the packages will fire; in the event they do fire, do they cause other cartridges in the container to fire?

Ammunition for the experiments was supplied by the four ammunition manufacturers who are members of SAAMI. A total of 111 cases of sporting ammunition containing 145,500 rounds representing most of the popular types and brands of shotgun shells, rimfire cartridges, centerfire pistol or revolver cartridges, and centerfire rifle cartridges were consumed in the series of experiments. This ammunition contained approximately 272 pounds of smokeless propellant powder and 9.2 pounds of priming compositions.

The experimental program, conducted October 2, 1974, was witnessed by Chicago Fire Prevention Bureau personnel and fire chiefs from several other cities, representatives from SAAMI and each of the member companies participating, as well as from the NFPA and the local press.

Ammunition in a Burning Structure

An abandoned manufacturing building scheduled for demolition was used in this experiment. It was a solidly-built frame structure, 20-feet-by-24-feet, 1 1/2 stories high on a concrete pad, of wood sheathing with tar paper exterior, and a steeply pitched asphalt shingle roof. There were fourteen 3-foot-by-6-foot wooden sash glass windows and a 15 foot ceiling. The ammunition listed below was stacked inside the building near the left-rear corner, on a wooden platform.

24 cases shotshells	12,000 rounds
12 cases centerfire rifle cartridges	12,000 rounds
4 cases centerfire pistol or revolver cartridges	8,000 rounds
7 cases 22 rimfire cartridges	35,000 rounds
47 cases	TOTAL: 67,000 rounds

A large quantity of scrap lumber and fiberboard packing materials was piled adjacent to and under this ammunition. Fuel oil was poured over some of the scrap lumber. Fire was initiated by an electric squib in a small sack of black powder placed in a small pile of smokeless powder near the oil-soaked wood.

Sounds of ammunition "popping" began approximately one minute after ignition, and the "popcorn popping" effect lasted for 20 minutes, at which time the building was almost completely consumed. Olin Fire Protection Department personnel extinguished the blaze at that time. They had been spraying the adjacent trees behind the building from a distance of approximately 35 feet to prevent spread of the fire to the timbered area.

Fire-fighting personnel were as close to the building as the heat would allow during the height of the fire, while the ammunition was popping. They could have extinguished the fire with water from hoses at the scene, if they had so desired. No missile problems were encountered. They wore standard fire-fighter's rubberized coats and knee-high rubber boots, and their faces were protected by plastic face shields that extended from their helmets.

After extinguishing the fire, the witnesses searched the surrounding area for missiles. They found some cartridge shells as far as 135 feet from the fire. During the fire it was evident that smoking primer cups and cartridge shells were individually being thrown from the fire in an arcing trajectory. There was no audible evidence of ammunition exploding en masse during the fire. The din of the "popping" was quite loud from a distance of approximately 100 feet, where most of the observers stood. Relatively few projectiles (bullets) were observed or found at distances of more than 40 or 50 feet from the fire's site.

Open Burning of Ammunition to Assess Missile Effects

This experiment was conducted to determine the extent of missile projection and the penetration effects from a fire involving sporting ammunition.

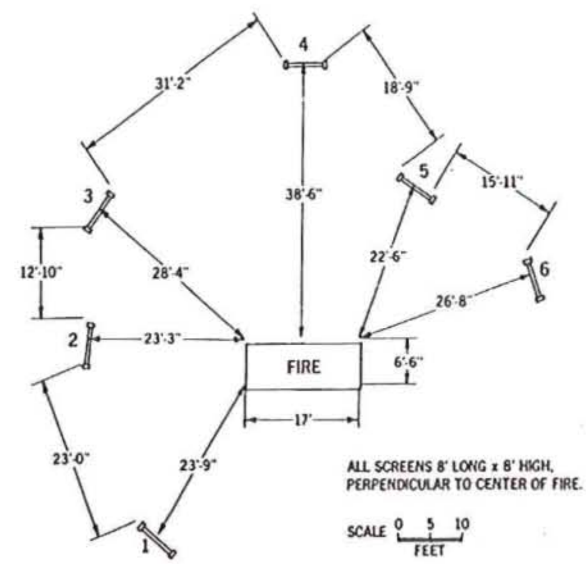
Cased ammunition was stacked on wooden pallets supported about three feet above ground level by concrete blocks. A large amount of oil-soaked scrap lumber was placed under and around the pallets to provide a hot fire. The area was flat and open, encircled on about half its perimeter by a wooded embankment 20 yards or more from the fire. The following stores of ammunition were consumed in this test:

22 cases shotshells	11,000 rounds
11 cases centerfire rifle cartridges	11,000 rounds
3 cases centerfire pistol or revolver cartridges	6,000 rounds
6 cases 22 rimfire cartridges	30,000 rounds
42 cases	TOTAL: 58,000 rounds

To assess missile effects from the fire, six witness screens were deployed at various distances, facing the fire in a semicircular arrangement. Eight-foot-square frames of two-by-fours were covered on one side by tent canvas (15.7 oz/yd.) with the backs covered by 3/4 inch Cellotex® insulation board. The canvas simulated protective outer clothing ordinarily worn by fire service personnel. The insulation board was used to show by depth of penetration of the missiles the relative velocity or wounding power of projected missiles that might puncture the canvas.

After ignition by the same procedure used in the building-burning experiment, the fire proceeded rapidly and burned for 23 minutes, after which the smoldering remains were extinguished by Olin Fire Protection

Figure 1



Department personnel. Cartridges started popping one minute after ignition and popped steadily until the fire was extinguished. The popping created considerable din during the apex of the fire. Some observers standing about 150 feet away reported that a few missiles dropped in their vicinity, and at least one observer standing about 75 to 100 feet from the blaze said that he was hit harmlessly by a missile.

The witness screens were located at distances from the fire that varied from 22$^1/_2$ feet to 38$^1/_2$ feet, as shown in Figure 1.

After the fire subsided, the observers examined the witness screens. A more thorough assessment was made a few days later; the results are tabulated in Table 1.

Nearly all punctures of the canvas were made by primer cups. A few punctures were caused by small flying shards from ruptured cases of metallic cartridges. One "spitzer"-type small caliber bullet pierced the canvas and was "trapped" in the fabric. No other bullets penetrated the canvas or the Cellotex® boards. Penetration depths recorded in the boards and observation of the canvas punctures lead observers to the conclusion that no serious wounds would have been sustained by fire-fighting personnel struck by missiles from a fire involving sporting ammunition at distances beyond 50 feet, if standard protective garments and face masks were worn. This observation is substantiated by the experience of sporting-ammunition manufacturers over the past half-century and more. It reflects precisely the industry's knowledge concerning fires involving military stores of small arms ammunition.

Table 1

Screen #1 23' 9" from fire center
Punctures in canvas upper half — 4
lower half — 6
Depth of penetration in Cellotex® Max. $^3/_{32}$"
Min. $^1/_{16}$"

Screen #2 23' 3" from fire center
Punctures in canvas upper half — 6
lower half — 14
Depth of penetration in Cellotex® Max. $^3/_{32}$"
Min. $^1/_{16}$"
Two large rifle primer cups and one small pistol primer cup stuck in the insulation board to a depth of $^1/_8$".

Screen #3 28' 4" from fire center
Punctures in canvas upper half — 47
lower half — 25
Depth of penetration in Cellotex® Max. $^3/_{32}$"
Min. $^1/_{16}$"
One shot shell primer cup stuck in the Cellotex® which had penetrated to a depth of $^3/_{32}$".

Screen #4 38' 6" from fire center
Punctures in canvas upper half — 6
lower half — 4
Depth of penetration in Cellotex® Max. $^3/_{32}$"
Min. $^1/_{32}$"

Screen #5 22' 6" from fire center
Punctures in canvas upper half — 11
lower half — 7
Depth of penetration in Cellotex® Max. $^5/_{32}$"
Min. $^1/_{32}$"
One shot shell primer cup and one small rifle primer cup stuck in the Cellotex® to a depth of $^5/_{32}$".

Screen #6 26' 8" from fire center
Punctures in canvas upper half — 35
lower half — 17
Depth of penetration in Cellotex® Max. $^1/_4$"
Min. $^1/_{16}$"
Two shot shell primer cups and one large rifle primer cup stuck in Cellotex® to depth of $^3/_{32}$". One sliver of metal penetrated $^1/_4$".

Burning Ammunition in Close Confinement

To simulate an ammunition fire in relatively close confinement, as might be encountered in a small basement storage room, a cubical concrete block structure six feet square and five feet high was constructed. A heavy steelmesh grille was supported by concrete blocks about two feet off the concrete floor. Cased ammunition was stacked on the grille. Oil-soaked scrap lumber beneath the grille provided a hot ignition fire.

Quarter-inch-thick flat boiler plates were placed over the top of the structure. One missing concrete block at the bottom-center of the structure provided necessary air draft to support combustion The leakage around the edges of the boiler plate "lid" provided the only exit for the products-of-combustion. The ammunition of various types and brands consumed in this test is listed below.

20 cases shotshells	10,000 rounds
3 cases centerfire rifle cartridges	3,000 rounds
3 cases centerfire pistol or revolver cartridges	6,000 rounds
3 cases 22 rimfire cartridges	15,000 rounds
29 cases	TOTAL: 34,000 rounds

Ignition was provided by the method used on the frame building. Cartridges started "popping" three minutes after ignition and continued a steady popping for 36 minutes. Dense gray smoke curled out of the structure, and "puffs" or minor gas explosions were observed, resulting from the ignition of accumulations of combustible gases above the fire in the relatively tight structure. The combustible gases were probably produced because insufficient air was provided to support complete oxidation of the combustibles. The heat of this fire was intense enough to cause the steel grille to collapse, and several small cracks developed in the mortar joints between some of the concrete blocks. Some missiles were projected from the fire through the opening at the bottom of the structure. A few of these were projected approximately 100 feet from the structure. There was no evidence of mass propagation of the ammunition in this fire.

Experiments of Severe Shock to Packed Ammunition

These experiments were conducted to determine the capabilities of packed ammunition to sustain severe shock without cartridges firing, and to determine if one shell firing in a container will "propagate" or cause others in the container to fire, which might cause mass explosion of the contents. Three types of experiments were conducted to investigate these phenomena: drop tests, rifle bullet impact tests, and firing a cartridge by remote control while it is in normal position within a container.

One case of 500 12-gauge shotshells, one case of 5,000 22-caliber long rifle rimfire cartridges, and one case of 1,000 30-30 centerfire rifle shells were raised in a derrick's clamshell to 30 feet above a concrete pad and dropped. The impact on the concrete caused the containers to break open and some of the contents to scatter, but no cartridges fired.

A much more severe experiment to determine the possibility of mass propagation was conducted by shooting highpower rifle bullets into cases of ammunition. One case each of 1,000 30-06 centerfire rifle cartridges, 500 12-gauge shotshells, and 5,000 22 long rifle rimfire cartridges were used in these experiments. 308 Winchester 150-grain soft point ammunition was fired from a rifle into each case at a range of 35 yards.

The case of rifle cartridges was struck twice, once on case-end center and again on case-end off-center. A puff of smoke was emitted from the case on each shot; on the second shot, a top flap of the case was jarred open. The bullet exits at opposite ends of the case produced a tear. Observers opening this case found that considerable damage was done to the, cartridges by the two expanding bullets, and that several cartridges within the shipping container had indeed fired, but there was no evidence of propagation — i.e., the discharge of one cartridge did not cause any of the adjacent rounds to fire.

The case of shotshells was hit three times on the case-end and on the side, a puff of smoke resulting on each impact. A corner of the case was torn off by the exit of one of the expanding bullets on the opposite end. Again, damage to the contents was extreme, caused by the expanding bullets' shock waves of energy. Several rounds within the case did fire, but again, there was no evidence of propagation.

The case of 22 long rifle rimfire cartridges was hit at the case-end centrally and again on the bottom. The exit of the bullets from the opposite side of the case produced a hole in the container about two inches square. Puffs of smoke were emitted on each impact. Inspection of the contents revealed considerable damage to the contents and several cartridges fired. There was no evidence of propagation.

A test criterion has been established for packed sporting ammunition by the United Nations Committee on Transport of Dangerous Goods. In order that the product may be classified as "safety explosives" and be transported without restriction as to quantity, it must meet a test whereby the firing of a single cartridge located centrally within the sealed shipping container results in total confinement of any explosion occurring within the container. The codes of this international body apply to international shipment of dangerous goods.

This test was performed on a case of shotshells, using electric ignition to fire shells located near the center of a regular case containing 500 rounds. Primers were specially prepared with a small hole in the center of the crown of each primer cup through which the priming charge was exposed. Shotshells were loaded with these special primers. Electric squibs were taped to each shell head so that on firing, the flash would impinge on the exposed priming mixture. This in turn fired the propellant powder in each shell.

Two shells so prepared were placed in a box of 25 shells in the normal position, with a regular shell between the two. The wires to the squibs were led out of the box through punctured holes in the inner case wall and through the top flaps of the case. The box was in the bottom layer, placed so that the test shells would be centrally located in the case. Nineteen more boxes of regular ammunition were packed and sealed to simulate a factorypacked container (case) of shotshell ammunition ready for shipment.

When the electrically ignited squibs fired, there was a muffled report, and a puff of white smoke was observed. The case remained intact and was not punctured by explosion or debris from the firing. Examination of the contents showed that both shotshells had fired as they would be expected to fire without confinement in a gun chamber. No other shells had been caused to discharge by the two squib-ignited shells. Thus, the test would have qualified the commodity as "safety explosives" under the United Nations code.

Comments and Conclusions

1. This series of experiments confirmed the assertion that mass detonation of sporting ammunition in a fire is extremely unlikely, an assertion substantiated by all previous experience of the sporting ammunition industry. This characteristic results from the dilution effect of inert portions of sporting ammunition cartridges that separate the propellant and ignition charges into small increments, coupled with the fact that smokeless propellants burn relatively slowly and inefficiently at the low pressure levels generated before shell case failures occur. Even under extreme conditions of heat and confinement created in the close confinement burning test, there was no indication of either mass detonation or explosion.
2. Ammunition fires are noisy, generating the amplified sound of "popping corn." Confronted by such sound levels, fire protection personnel understandably could be unnerved if they were not accurately informed of the nature of the fire being fought.
3. Missile hazard is minimal even at relatively short distances from a fire involving sporting ammunition. The missiles of highest velocity are the primer cups which, because of their poor aerodynamic shape and light weight, lose velocity rapidly. At very close distances they could cause superficial flesh wounds. The heavier bullets, shot charges, and shell cases are not ejected from an ammunition fire at velocities sufficient to cause them to penetrate canvas screens within 25 feet of a fire.

It is obvious, however, that the face and exposed portions of the body must be protected. This protection is usually provided by face masks and protective clothing normally worn by fire protection personnel.

This article was prepared by the staff of the Sporting Arms and Ammunition Manufacturers' Institute based on the tests described, the present state of knowledge and experience, and observations in the industry that span four decades. It is being published in the interests of safety, but is not intended to be comprehensive or to modify or supersede safety suggestions, standards, or regulations made by competent authorities, public or private. The Institute expressly disclaims any warranty, obligation or liability whatsoever in connection with the information contained herein or its use.

It should be noted that the tests described in this article involved factory-loaded ammunition, manufactured by members of the Institute and packed in containers approved by the Department of Transportation. In none of the tests were separate stores of ammunition components such as primers, smokeless powder, and black powder present. Likewise, there were no stocks of other flammable or hazardous commodities ordinarily sold by hardware and sporting goods distributors, such as propane tanks, paints, solvents, thinners, and products in aerosol cans.

Chapter 11 of NFPA 495-1996, *Explosive Materials Code*, details recommendations that should be followed precisely for storage and handling of small arms ammunition, small arms primers, and propellant powders. As a matter of normal operating procedure, fire protection units are advised to acquaint themselves with the storage and sales facilities of distributors and retailers of these commodities.