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Toxic Free Ammunition - Ballistic Evaluation

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TECHNICAL MEMORANDUM

Submitted by
Canadian Police Research Centre

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NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

SUMMARY

Concern has been expressed within the law enforcement community, as well as by the occupational health and safety profession, on the health risks of using leaded ammunition in indoor ranges.

Reduction in lead (and other heavy metal) vapours produced on the firing line can be realized if one uses ammunition that has lead-free primers and coated bullets. However, for such ammunition to be suitable for training purposes, such ammunition must have ballistic performance and 'feel" that is similar to that of operational ammunition.

Ballistic evaluations were carried out by the RCMP Ordnance Quality Assurance Section on three lines of .38 special and four lines of 9mm ammunition. Comparisons on the ballistic performance of these varieties of non-toxic ammunition were made with conventional leaded ammunition.

The ballistic parameters varied with the type of ammunition, however, the collected data will give police agencies information upon which they can base a decision as to whether any of the ammunition varieties are suitable for their specific training needs.

RÉSUMÉ

Parmi les responsables du maintien de l'ordre et les spécialistes de la santé et de la séurité, on se préoccupe des risques que présente pour la santé l'utilisation de munitions au plomb dans les salles de tir.

II est possible de réduire les émanations de plomb (ou d'autres métaux lourds) si l'on utilise des munitions avec amorce sans plomb et balles laitonnées. Toutefois, pour qu'on puisse les utiliser lors d'exercices, elles doivent avoir un rendement balistique équivalent et donner au tireur la même impression que les munitions opérationnelles.

La Section du contrôle de la qualité de l'armement de la GRC a effecté des évaluations balistiques de trois types de balles spéciales de calibre 38 et de quatre types de balles de calibre 9mm. Le rendement balistique de ces balles non toxiques a été comparé à celui des balles ordinaires au plomb.

Les paramètres balistiques différaient selon le type de munitions. Toutefois, les données recueillies donneront aux forces policières des informations qui leur permettront de décider si ces divers types de munitions peuvent répondre à leurs besoins particuliers en formation.

TOXIC FREE AMMUNITION
INTERIM REPORT

Operational Requirement:

Concern has been expressed within the law enforcement community as well as by the occupational health and safety profession on the health risks of using leaded ammunition in indoor ranges. The basis for the concern is described in following two documents that are appended to this report:

Appendix A: "Lead Exposure Risks *in firing Ranges"* that was prepared by the Rainier Ballistics Corporation, on November 19, 1991

Appendix B: "Occupational Safety and Health Guideline for Inorganic Lead" that was prepared by the U.S. Department of Health and Human Services in 1988

Reduction in lead (and other heavy metal) vapours produced on the firing line can be realized if one uses ammunition with primers that are free of heavy-metals and bullets that are either non-leaded or are plated with copper. However, for such ammunition to be suitable for training purposes, it must have ballistic performance and "feel" that is similar to that of operational ammunition.

Project Objective:

The purpose of this project was to evaluate varieties of "lead-free" ammunition for ballistic performance and to compare the collected parameters with those of traditional leaded ammunition. **Although the term "lead-free" is commonly used, the most desirable ammunition will be that which produces neither lead nor other heavy metal vapours or particulates during the firing process**

Detail:

Ballistic evaluations were carried out by the RCMP Ordnance Quality Assurance Section on four lines of 9mm and on three lines of .38 special ammunition. Each variety of toxic-free ammunition was tested using standard SAAMI protocols for the following parameters:

(1) **energy -** measured in ft.-lb.
(2) **velocity -** measured in ft. per sec.
(3) **precision -** measured as group size (inches) at 25 yards

(4) accuracy - measured as the difference in MPI (Mean Point of Impact) as compared with operational leaded ammunition

Comparisons of the ballistic performance of these varieties of non-toxic ammunition were then made with conventional leaded ammunition.

The noted ballistic parameters were measured on the following commercial products:

9mm:
(1) CCI-Blount **Lawman** Clean-Fire 9mm 124 grain TMJ
(2) CCI-Blount **LFS** Solid 9mm 115 grain Lead Free solid
(3) CCI-Blount **Blazer** 9mm 124 grain TMJ Luger lead-free
(4) SNC Simunition 9mm 85 grain frangible training cartridges

.38 **spl.:**
(5) CCI-Blount **Lawman** Clean-Fire .38 special 148 grain WC
(6) CCI-Blount **Blazer** Lead-Free .38 special +P 158 grain TMJ
(7) SNC Simunition .38 special 90 grain frangible training cartridges

The following commercial ammunition was used as a reference for operational ammunition:

9mm:
(1) **Federal** 9mm Luger 115 grain Jacketed Hollow Point

.38 spl.:
(2) **Winchester .38** special +P 158 grain Hollow Point

Results:

9 mm Ammunition

	Lawman	LFS	Blazer	SNC	Federal
Energy (ft.-lb.)	**304** ±11.35	**290** ±1 3.67	**337** ±7.83	**365** **±7.77**	**418**
Velocity (ft./sec.)	1051 ±8.07	1065 ±1 2.95	1106 ±9.75	1390 ±21.63	1279
Group Size (inches)	5.55 ±3.98	4.10 ±1.10	3.2 ±1.34	4.10 ±1.79	2.06
Mean Point of Impact Difference (inches)	-3.15 ±2.08	-3.30 ±0.65	-2.55 ±0.96	-1.15 ±1.15	0

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.3 special Ammunition

	Lawman	Blazer	SNC	Winchester
Energy (ft.-lb.)	210 ±1 .90	314 ±3.15	363 ±3.35	390
Velocity (ft./sec.)	783 ±23.5	946 ±18.0	1347 ±1 8.9	1055
Group Size (inches)	2.95 It2.39	4.27 ±1.10	3.77 ±2.36	1.93
Mean Point of Impact Difference (inches)	0.85* 0.1 o**	0.95* 0.20**	-2.5* -3.25**	0

* mean point of impact compared with .38 spl. 148 gr. wadcutter
** mean point of impact compared with .38 spl. +P 158 gr. SWCHP

Conclusions and Recommendations:

Details regarding the CCI-Blount ammunition are described in documents provided by the manufacturer which are attached to this report as Appendix C. Details regarding the SNC ammunition are described in documents provided by the manufacturer which are attached to this report as Appendix D. The C.P.R.C. does **not** warrant the accuracy of information contained **in Appendices C and D.**

Reduction in heavy metal vapour and particulate production on the firing line is normally achieved in three ways. First, the lead bullet may be plated or jacketed with another metal (usually copper). If the lead on the bullet is totally encased, a reduction of as much as 80% - 90% of the traditional lead vapour production has been reported. An alternative is to make the bullet with compounds other than lead. This would lead to a similar reduction in lead vapour/particulate production. Second, most of the remaining source of heavy metal vapour/particulate production would be eliminated if you use primers that do not use lead or other heavy metal components.

The ballistic parameters of the sample toxic-free ammunition were different, however, the data will give police agencies information upon which they can base a decision as to whether any of the varieties are suitable for their specific training needs. The energy parameter would give an indication of the relative recoil of the weapon when using the

ammunition. The velocity of the projectile itself is not critical for training ammunition. The precision and accuracy are important, however, each user agency must decide how much deviation from reference operational ammunition is acceptable for training ammunition.

The second and remaining portion of this project will examine the lead or other heavy metal (primarily Barium and Antimony) vapour and particulate production during the firing process. This portion of the study will be conducted by scientists at the National Research Council.

For additional information on varieties of “lead-free” ammunition tested in this project, please contact:

(1) Blount Inc.
2299 Snake River Ave.,
P.O. Box 856,
Lewiston, ID, USA 83501
Attention: Mr. Tom Saleen, International Sales Manager
Phone: 208-746-2351

(2) Simunition Technologies Inc., or
366 Bruyere Street,
Ottawa, Ontario KI N 5E7
Phone: 613-232-2927
Fax: 613-789-0227
(Distributor)

R. Nicholls Distributors Inc.
2475 De La Province
Longueuil (Quebec) J4G IG3
Phone: 514-442-9215
Fax: 514-442-9581
(Distributor)

SNC Industrial Technologies Inc.
5 Montée Des Arsenaux
Le Gardeur (Quebec) J5Z 2P4
Attention: Mr. Alain Berube
Phone: 514-582-6287
(Manufacturer)

APPENDIX A

LEAD EXPOSURE RISKS IN FIRING RANGES

An Overview for Range Owners and Range Managers

Following a series of many academic studies and a steadily growing number of accounts in the press, the Occupational Safety and Health Administration and affiliated state agencies have been increasing their efforts toward identifying occupations where risks of lead exposure exist and toward reducing the exposures once identified. Lead exposure in firing ranges is one of the areas that is receiving increasing attention from those agencies.

In addition to the concerns every range owner or master has about the levels of lead exposure of range employees and shooters, range owners and masters must also now deal with occupational safety and health agencies that are increasingly resorting to immediately citing ranges that have lead leveis in excess of regulatory standards. The occupational safety and health agencies are taking the view that range owners and managers should now be awark of the risks inherent in their operations. Given the growing concerns about the effects of lead exposure on adults and the regulatory agencies' increasingly tough stance, it is more important than ever for ranges to ensure that they are in full compliance.

Effects of Overexposure to Lead

Lead, when either ingested or inhaled in unsafe amounts, can cause numerous health problems.

- The nervous system, bone marrow and kidneys are known to be especially sensitive to lead exposure.
- In more severe cases, commonly occurring symptoms include abdominal pain and nausea, loss of appetite, pain in muscles and joints, tremors and nervous system disorders.

Lead Exposure Findings at Firing Ranges

The lead vapor created in firing a handgun has several principal sources: the action of hot propellent gases (reaching 2000°F) against the lead base of the bullet, the friction of the bullet against the barrel and the combustion of lead in priming compounds. Numerous studies have shown that shooters, range workers and others in the shooting area at ranges frequently have elevated blood lead levels caused both by inhaling lead vapor and by inadeqate personal hygiene prior to smoking and/or eating.

- One study carried out by the United States government in the 1970's found that at nine indoor firing ranges examined, the average airborne lead concentration was almost 54 times the current OSHA limit.
- Subsequent studies have reported such findings as an average ten-fold increase in blood lead levels among a class of 17 law enforcement cadets during three months of training at an indoor range.

- Other studies of indoor ranges have found numerous cases throughout the United States of elevated blood lead levels and symptoms of lead poisoning.

Several recent studies, focussed on exposure in outdoor firing ranges, have – to **the** surprise of some – also found high lead exposure levels.

- One study in 1989 found that blood lead levels among a class of police cadets in Richmond, Virginia tripled during their five-day training period using conventional lead bullets at an outdoor range.
- Another recent study found that a group of seven Los Angeles Police Department shooting instructors at an uncovered outdoor shooting range all had elevated blood lead levels and nearly 30% of the group had lead levels above OSHA's maximum.

Possible Solutions

Although studies have demonstrated that improved ventilation systems and careful personal hygiene before smoking or eating can help reduce the risks of overexposure to lead, most research has been focussed on solving the lead exposure problem at its source through modified ammunition.

- One study, published in 1990 and titled ***Reducing Exposure to Airborne Lead in a Covered, Outdoor Firing Range by Using Totally Copper-Jacketed Bullets*** found that using such ammunition reduced airborne lead levels by more than 95% in the area of the range where the shooters were located when compared to lead levels present when lead ammunition was used.
- Other studies have shown similar results from eliminating lead bullets.

Every range, whether indoor or outdoor, should carefully evaluate the potential for unsafe lead exposure levels and should take steps to solve any potential sources of problems.

- If any doubts exist concerning lead exposure levels, lead levels should be tested.
- A variety of organizations are capable of conducting tests including universities' departments of industrial hygiene as well as OSHA, which is required by law to conduct risk evaluations when requested.
- OSHA consultations are confidential and violations cannot be referred to OSHA's enforcement division.

Prepared by Rainier Ballistics Corporation
November 19, 1991

APPENDIX B

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR INORGANIC LEAD

INTRODUCTION

"Inorgamc lead" is defined as lead oxides. metallic lead. and lead salts (including organic salts such as lead soaps but excluding lead arsenate). This guideline summarizes pertinent information about inoraganic lead for workers. employers. and occupational safety and health professionals who may need such information to conduct effective occupational safety and hcahhprogmms.Recommcndatonsmaybcsupcm&dtynnv dcvclopmcnts in thcsc fields: therefore. readers am advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- Formula: Pb
- Synonyms: C.I. pigment metal 4. C.I. 77575. KS-4 lead flake. lead S2
- Identifiers: CAS 7439-92-l; RTECS OF7525000: DOT 1794
- Appearance and odor: Bluish-white silvery or gray odorless solid

CHEMICAL AND PHYSICAL PROPERTIES

- Phpicaldata

1. Molecular weight 207.19
2. Boiling point (at 760 mmHg): 1.740°C (3.164°F)
3. Specific gravity (water = 1): 11.34
4. Melting point: 327.5°C (621.5 °F)
5. Insoluble in water

- Reactivity

1. Incompatibilitios: Lead reacts vigorously with oxidizing chemicals such as sodium or potassium may cause fires or explosions.
2. Hazardous~products:Toxic fumes (c?..lad oxide) may be released in a fire involving inorganic lead.

- -

1. Extinguishant: Dry sand. dry dolornite or dry graphic
2. Caution:&adiscombtxiblcinpcmdcrformwbataposai to heat or flame

- Warning properties

Evaluation of warning properties for respirator selection: Based on lack of information on odor threshold and eye irritation levels. inorganic lead should betreated as a chemical with poor warning properties.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) pcrmissiblc exposure limit (PEL) for inorganic lead is 50 micrograms of lcad per cubic meter of air z as a time-weighted average (TWA) conccnrtation over an I-hour workshift. If a worker is exposed to lead for more than 8 hours in any workday. the PEL. as a TWA for that day. shall be reduced according to the following formula: maximum pcrmissible limit (in pg/rn') = 400 divided by hours worked in the day. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) is 100 $\mu g/m^3$ as a TWA for up to a IO-hour workshift. 40-hr. work week The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLW') is 0.15 mg/m^3 (150 $\mu g/m^3$) as a TWA for a normal I-hour workday and a 40-hour workweek (Table I).

Tabie I.-Occupational exposure limits for inorganic lead

	Exposure units tqimJ
OSHA PEL TWA	50
NIOSH REL TWA	100*
ACGIH l'IX@' TWA	150

- Air level to be maintained such that worker blood lead remains <60 $\mu g/$ 100g.

HEALTH HAZARD INFORMATION

- Ruutesdapo6In

Inorganic lad may cause adverse health effects following exposure via inhalation or ingestion.

U.S. DEPARTMENT Of HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational safety and Health
Division of Standards Development and Technology Transfer

- Summary of toxicology

I. Effects on animals In rats or **mice.** chronic oral administration or subcutaneous **or intraperitoneal injection of** lead **subacetate.** lead **acetate. or lead** phosphate produced cancer of the kidneys. **Intravenous or intrapertoneal injection of lead nitrate. lead acetate. or lead chloride to pregnant mice. rats. or hamsters caused** increased fetal mortality and mal formations of the posterior extremities and urogenital and intestinal tracts in the offspring.

2. Effects on humans: Inhalation or ingestion **of** inorganic **lead has caused** peripheral neuropathy with paralysis **of the muscles of the wrists and ankles.** encephalopathy. anemia (due to **decreased red blood cell life and** impaired hcme synthesis). proximal kidney **tubule damage. decreased kidney function. and chronic** kidney disease. Lead can accumulate in the soft tissues and bones. with the highest accumulation in the liver and kidneys. and elimination is slow. Lead can **penetrate the placental barrier. resulting in neurologic disorders in infants**

- **Signs and symptoms of exposure**

1. Short-term (acute): Exposure **to inorganic lead *can cause*** decreased appetite. insomnia. headacbe. muscle and joint pain. colic. and consttpation.

2. Long-term ***(chronic): Exposure*** **to inorganic lead can cause weakness.** weight loss. nausea. vomiting. constipation blue or blue-black dot-like pigmentation on the gums ("lead line"). severe headache and abdominal cramps, delirium, convulsions, and coma.

RECOMMENDED MEDICAL PRACTICES

- **Medical surveillance program**

Workers with **potential exposures to chemical hazzards should be** monitored in a systematic program of medical surveillance **intended to prevent or control occupational injury and disease. The program should include education of employers and workers** about ***work-related hazards.*** placement of workers in jobs that do not jeopardize their safety and health. earliest possible **detection of adverse health effects and referral of workers for diagnostic confirnation and treatment. The occurrence of disease (a** "sentinel health event". SHE) or **other work-related adverse health effects** should prompt immediate evaluation **of primary preventitive measures (e.g., industrial hygiene monitoring. engineering controls. and personal protective equipment).** A medical surveillance program is intended to supplement, not replace. such measures

A medical surveillance program should include systematic collection and epiderntol0gic analysis af relevant environmental **and biologic monitoring. medical screening** morbidity. and mortality data. This analysis may provide information about **the relatedness of adverse health effects and occupational exposurc that cannot be discerned from results in individual workers. Sensitivity. specificity and** predictive values **of biologic** monrtonng and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the **dissemination of summary data to those who need to know.** including **employers. occupational health professionals. potentially exposed workers. and regulatory and public** health agencies.

- Preplacement medical evaluation

Prior to placing a worker in a job with **a potential for** exposure to **inorganic lead. the physician should** evaluate and document the **worker's baseline** health status with thorough medical environmental. and occupational histories. a physical examination. **and physiologic and laboratory tests appropnate for the anticipated occupational risks. These should** concentrate on the **function and integrity of the kidneys and the** hematopoietic (blood cell forming). nervous. gastrointestinal and reproductive systems.

A **preplacement medical evaluation is recommended** in order to detect and assess preexisting **or** concurrent conditions which may be aggravated or result in increased risk when **a worker is exposed to inorganic lead at or below the** NIOSH REL.

The examining physician **should consider the probable** frequency. **intensity, and** dutation of exposure. as well as the nature and degree of the condition. in placing **such a worker** Such conditions. which should not be regarded as absolute contraindicattons to job placement. **include preexisting neuromuscular disease. *In* addition to the** medical interview and physical examination. the physician should **consider obtaining additional baseline electrophysidogic and clectromyognphic studtes and an assessment of fertility using standardized methods and evaluation criteria. The physician** should also **obtain baseline values for the complete blood count including the** reticulocyte **count and for those tests which** characterize **prior internal exposure (e.g.. blood lead level) and the effects of prior exposures (e.g. ctythrocytc zinc protoporphyrtn and dclta-aminokrvulinic acid dehydtqenasc).**

- **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and Physical examenations should be performed at regular intervals. Additional examinations may be necessary should **a worker develop symptoms that**

examinations and **appropriate** medical screening and/or biologic **monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physioiogtc function of the kidneys and the hematopoietic (blood cell forming). nervous. gatointestinal and reproductive systems as compared to the baseline status of the individual worker or to expeclcd values for a suitable reference population The following tests should be usedand interpreted according to standardized epidemiologic procedures and** evaluation criteria: a **complete blood count with reticulocyte count and those tests which characterize prior internal exposure (e.g., blood lead level) and the effects of exposures (e.g.. erythrocyte** zinc protoporphyrin **and delta-aminolevulinic acid dehydrogenase).**

- **MaBc8ipcxtiaS recomended at the time of job transfor or termination**

The medical. environmental. and occupational history interviews. the physical examination and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes. **in the worker's healt status should be** compared to hthose expected **for a suitable reference population Because** occupational exposure **to inorganic lead may cause adverse reproductive effects and diseases of prolonged induction-**

latency. the need for medical surveillance may extend well beyond termination of employment.

• Sentinel health events

I. Acute SHE's include: Acute renal failure.

3. Delayed-onset or reprodutive SHE's include: Inflammatory and toxic neuropathy and chronic renal failure.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to inorganic lead should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions. it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• Method

Sampling and analysis may be performed by collecting inorganic lead with celiulosc membrane filters followed by acid digestion and analysis by atomic absorption. A detailed sampling and analytical method for inorganic lead may be found in the *NIOSH Manual of Analytical Methods* (method number 7082).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data. consulting with the manufacturer. and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC. gloves. face shields (I-inch minimum) and other appropriate protective clothing necessary to prevent skin contact with inorganic lead.

Workers should be provided with and required to use dust-proof safety goggles where inorganic lead may come in contact with the eyes.

SANITATION

Clothing which is contaminated with inorganic lead should be removed immediately and placed in closed containers for storage until it can be discarded or until provision is made for the removal of inorganic lead from the clothing. If the clothing is to be laundered òr cleaned the person performing the operation should be informed of inorganic lead's hazardous properties.

Change and shower moms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated With inorganic lead should be promptly washed with soap and water.

The storage. preparation. dispensing, or consumption of foal or beverages. the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials. or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle inorganic lead should wash their faces. hands. and forearms thoroughly with soap and water before earing. smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to inorganic lead may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.-Operations and methods of control for inorganic lead

Operations	Controls
During primary (ore) and secondary (scrap) smelting of lead; during the manufacture of storage batteries; during typecasting and remelting of type metal in pnnting	Process enclosure. local exhaust ventilation. dust control. personal protective equipment
During soldering in the fabrication of metal articles	Process enclosure. local exhaust ventilation. personal protective equipment
During melting and pouting of lead and alloys containing lead; during welding. burning, and cutting of metal structures containing lead or painted with lead conraining surface coatings	Local exhaust ventilation. personal protective equipment
During the use of lead in the manufacture of surface coatings. including paints and varnishes; during the manufacture of ceramics and glass	Local exhaust ventilation. personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from *further exposure send* for medical assistance. and initiate emergency procedures

● Eycapoavr

Where there is any possibility Of a worker's eyes being exposed to inorganic lead. an eye-wash fountain should be provided within the immediate work area for emergency use.

If inorganic lead gets into the eyes. flush them immediately with large amounts of water for 15 minutes. lifting the lower and upper lids occasionally. Get medical attention as soon as possiblc. Contact lenses should not be worn when working with this compound.

where there is any possibility of a worker's body being exposed to inorganic lead. facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If inorganic lead gets on the skin, wash it immediately with soap and water. **If inorganic** lead penetrates the clothing. remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

- R0scUe

If a worker has been incapacitated, move the affected ***worker*** from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the Facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has ban completed.

If inorganic lead is spilled or leaked the following steps should be ***taken:***

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing inorganic` lead. absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing inorganic lead may be absorbed in vermiculite. dry sand. earth. or a similar ma&-al and placed in an appropriate container.
5. If in solid form. inorganic lead may be collected and placed in an appropriate container.
6 Inorganic lead may be collected by vacuuming with an appropriate system.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency. Department of Transportation. and/or state and local regulations shall be followed to assure that removal transport. and disposal are in accordance with aisting regulation

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least **preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).**

In addition to respirator selection. a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory **protection** program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator. the regular training of personnel, fit testing, periodic environmental monitoring. maintenance. inspection. and cleaning. The implementation of an adequate respiratory protection program. including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA. formerly Mining Enforcement and Safety Administration) and by :JIOSH should be used. Remember! Air-purifying **respirators will not** protect from oxygen-deficient **atmospheres.**

For each level of respirator protection. only those respirators that have the minimum required protection factor and meet ***other*** use restrictions are **listed All** respirators that have higher protection factors may also be used.

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Table 3.-Respiratory protection for inorganic lead

Condition	Minimum respiratory protection* †
Concentration:	
Less than or equal to 0.5 mg/m³	Any supplied air respirator
	Any air-purifying respirator with a high-efficiency particulate filter
	Any self-contained breathing apparatus
Less than or equal to 1.25 mg/m³	Any powered air-purifying respirator with a high-efficiency particulate filter
	Any supplied-air respirator operated in a continuous flow mode
Less than or equal to 2.5 mg/m³	Any air-purifying full facepiece respirator with a high-efficiency particulate filter
	Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter
	Any self-contained breathing apparatus with a full facepiece
	Any supplied-air respirator with a full facepiece
	Any supplied-air respirator with a tight-fitting facepiece and operated in a continuous flow mode
Less than or equal to 50 mg/m³	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode
Less than or equal to 100 mg/m³	Any supplied-air respirator with a full facepiece and operated in a pressuredemand or other positive pressure mode
Planned or emergency entry into environments containing unknown concentrations or levels above 100 mg/m³	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator with a high-cfflciency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

• Only NIOSHIMSHA-approved equipment should be used.

† The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 100 µg/m³ (TWA).

APPENDIX C

BLOUNT
Sporting Equipment Division
Lewiston, ID 83501

CCI® Blazer@ CLEAN-FIRE™ Centerfire Ammunition
9mm luger, 38 Special +P and 45 Auto

TECHNICAL SPECIFICATIONS

9mm Luger – part number 3460 (50 per box; 1000 per core)

Bullet: 124 grain UNI-COR™ Totally Metal Jacketed" (TMJ) round nose; jacket material – pure copper; lead core completely encased by jacket; core – 3% antimony/lead alloy; nominal diameter – 0.3555". Ballistic coefficient 0.118.

Cartridge Case: high-strength aluminum alloy, heat-treated; internal shoulder acts as bullet stop to prevent bullet set-back during cycling in marginal firearms; Berdan-type primer pocket with integral anvil and twin flash holes. Cartridge case has a clear anodized protective coating for low friction during feeding and corrosion resistance.

Primer: CCI 55OBCF lead-free primer; cup thickness 0.020"; primer mix contains no lead, barium or antimony compounds. Non-metallic initiator; non-corrosive. Berdan system was chosen because it allows one less moving part compared to Boxer priming system, resulting in better efficiency and sensitivity. Twin offset flash holes allow direct flame path from primer to propellant charge.

Propellant: non-canister flake-type powder; double base. Weight of charge is determined at time of loading by pressure and velocity testing of loaded ammunition. Non-canister powders (available only to ammunition manufacturers) are routinely calibrated for each powder lot after receipt of the product from the vendor.

Pressure: Maximum product average – 37,400 psi*; maximum predicted high individual – 43,300 c.u.p.; determined in standard industry pressure/velocity barrel.

Velocity: mean instrumental at 15 feet – 1145 ± 75 feet per second from SAAMI P/V test barrel. Velocity in actual service pistols may vary depending on dimensional variations of chamber and bore from make to make.**

. pounds per square inch

**** SAAMI – Sporting Arms and Ammunition Manufacturers institute**

BLOUNT
Sporting Equipment Division
Lewiston, ID 83501

38 Special +P – part number 3475 (50 per box: 1000 per case)

Bullet: 158 grain UNI-COR™ Totally Metal Jacketed™ flat point; jacket material - pure copper; lead core completely encased by jacket; core – 3% antimony/lead alloy; nominal diameter – 0.3570". Ballistic coefficient 0.173.

Cartridae Case: high-strength aluminum alloy, heat-treated; Berdon-type primer pocket with integral anvil and twin flash holes. Cartridge case has a clear anodized protective coating for corrosion resistance and reduced friction during extraction.

Primer: CCI 500BCF lead-free primer; cup thickness 0.017"; primer mix contains no lead, barium or antimony compounds. Non-metallic initiator; non-corrosive. See comments under 9mm Luger specifications.

Propellant: non-canister flake-type powder; double base. See comments under 9mm luger specifications.

Pressure: Maximum product average – 22,500 psi; maximum predicted high individual – 26,000 psi; determined in standard industry pressure/velocity barrel.

Velocity mean instrumental at 15 feet ± – 1050 75 feet per second from SAAMI P/V test barrel. Velocity in actual service revolvers may vary depending on dimensional variotions of chamber, barrel/cylinder gap and bore from make to make.

45 Auto — part number 3480 (50 per box; 1000 per case)

Bullet: 230 grain C O R TM Totally Metal Jacketed (TMJ) round nose; jacket material – pure copper; lead core completely encased by jacket; core – 3% antimony/lead alloy; nominal diameter – 0.4512". Ballistic coefficient 0.153.

Cartridge Case: high-strength aluminum alloy, heat-treated; internal shoulder acts as bullet stop to prevent bullet set-back during cycling in marginal firearms; Berdan-type primer pocket with integral anvil and twin flash holes. Cartridge case has a clear anodized protective coating for low friction during feeding and corrosion resistance.

Primer: CCI 300BCF lead-free primer; cup thickness 0.0185"; primer mix contains no lead, barium or antimony compounds. Non-metallic initiator; non-corrosive. See comments under 9mm luger specifications.

Propellant: non-canister flake-type powder; double base. See comments under 9mm Luger specifications.

Pressure: Maximum product average – 22,000 psi; maximum predicted high individual – 25,400 psi; determined in standard industry pressure/velocity barrel.

Velocity: mean instrumental at 15 feet – 845 + 75 feet per second from SAAMI P/V test barrel. Velocity in actual service pistols may vary depending on dimensional variations of chamber and bore from make to make.

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General Notes on Lead-Free Ammunition

The requirements to improve air quality in indoor firing ranges has resulted in the development of cleaner ammunition for use in these environments. U.S. government testing in the 1970's showed that the majority of airborne lead is the result of powder gases vaporizing lead from the base of a lead bullet, or a jacketed bullet with lead exposed at the base. This accounts for approximately 80 percent of the airborne lead emitted. The remaining 20 percent of the emissions comes from conventional lead styphnate primers. Lead styphnate is the primary explosive initiator in standard primers.

Encasing the bullet base and sides with jacket material virtually eliminates the bullet's contribution to airborne lead at the firing point. However, the lead emission from the primer is still of concern. The lead residues from primers are more finely divided than the lead residue from the bullet, and can remain suspended in the atmosphere longer than bullet residues. The primer's contribution to airborne lead can be eliminated by developing primers with non-metallic initiators.

All current ammunition using lead-free primers contains lead in the bullet core. Although research in this area continues, there is currently no other material for bullet cores which allows the bullet weight to be kept at or near service levels for realistic training. Therefore ventilation of the backstop/trap area is still required. lighter bullet materials such as brass or aluminum are rigid and can damage range backstops, and produce insufficient momentum to function the actions of semi-automatic firearms. lead-free priming and protected bullet bases combine to virtually eliminate airborne lead at the firina point, where most lead exposure to personnel occurs.

In addition to health concerns over the presence of excessive amounts of lead in the air, European countries have identified barium as a indoor range hazard in traditional primer mixes. This metal is present in styphnate primers in the form of barium nitrate, which is the oxidizer in the compound. European police and military agencies now specify that ammunition for indoor use must be both lead-free and barium-free. One make of lead-free primers imported

into the U.S. still contains barium nitrate as an oxidizer. CCI lead-free primers contain no lead, barium or other harmful heavy metal compounds.

Non-metallic (lead-free) primer initiators are, by their chemical characteristics, slightly less sensitive than the traditional initiator, lead styphnate. Therefore the metal parts configuration must be optimized to permit reliable function in a wide variety of firearms. This is the major reason that CCI chose to retain the Berdan priming system of standard Blazer when developing Blazer CLEAN-FIRE ammunition. Lead-free primers are not recommended for firearms with non-factory spring kits or excessive headspace, as these firearms may show a high misfire rate. All lead-free primed ammunition, regardless of make, should be fired in factory-original firearms in good condition.

CCI LF52 and MLF52 CLEAN-FIRE priming compounds for small arms primers utilize proprietary ingredients and are protected by U.S. patents 4608,102 and 4,963,201 as well as certain pending foreign patents.

CLEAN-FIRE primer performance, including energies and temperatures are similar to conventional primers. Exhaust from CLEAN-FIRE primers consists of

Carbon Monoxide
Carbon Dioxide
Water (H_2O) as steam
Nitrogen
Strontium Oxide

Primer exhaust comprises only a small part of the the exhaust from a cartridge, the greater part being from the carbon oxides, nitrogen and steam from the propellant charge. See the attached chart for a comparison of the ratio of solid ta gaseous materials in CCI CLEAN-FIRE primer exhaust compared to conventional styphnate primers.

Carbon monoxide in ammunition exhaust is produced primarily by the propellant charge. Choice of propellant will have a greater bearing on CO amounts than the primer. CCI CLEAN-FIRE primers do not produce sulphur dioxide, nitrogen dioxide, nitrous oxide or hydrogen cyanide in the exhaust.

UNI-COR™ Totally Metal Jacketed bullet used in conjunction with CLEAN-FIRE primers result in a cartridge that produces no harmful airborne contaminants at the firing point. Independent testing has demonstrated 100x reductions in airborne lead levels at the firing point with CCI Blazer CLEAN-FIRE 9mm ammunition. The small amounts of lead detected in these tests (less than 0.01 mg/m^3) are attributed to residual lead in the test firearms from previous firing with conventional styphnate-primed cartridges, and to pre-existing amounts of lead in the range.

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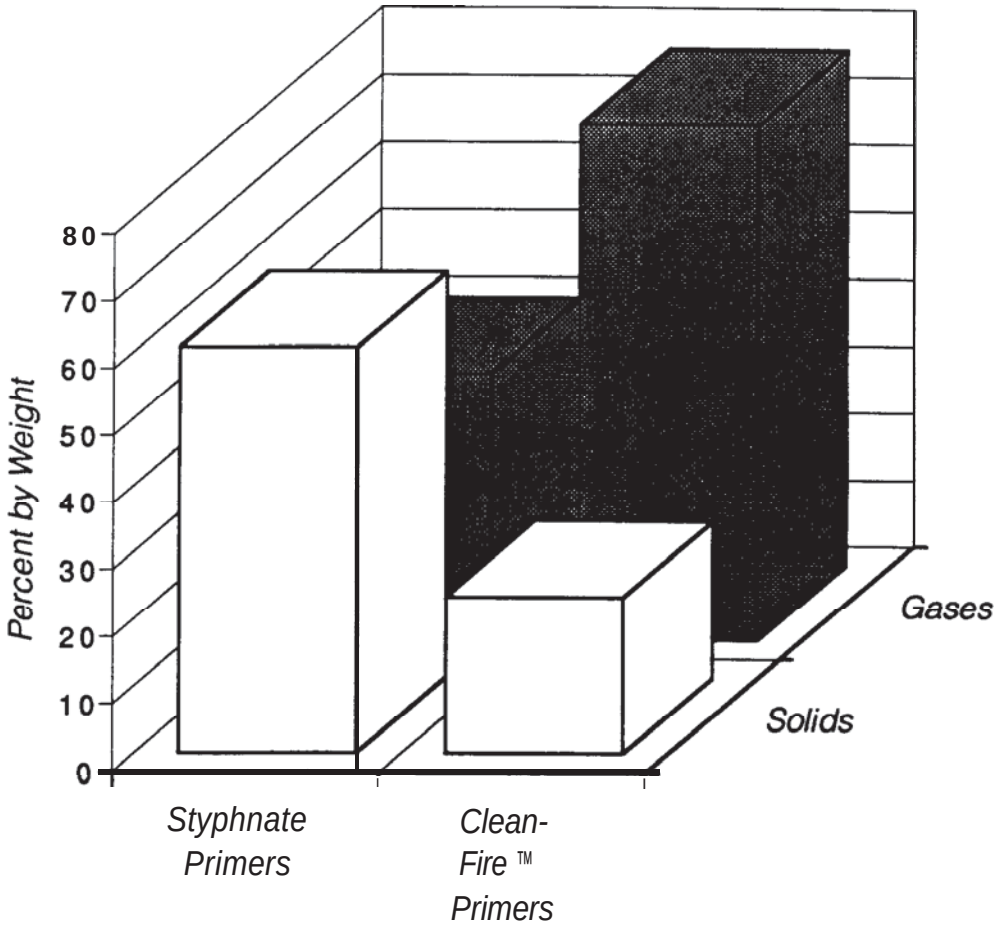
Sporting Equipment Division
Lewiston, ID 83501

CLEAN-FIRE primers will not produce any of the following metals or their oxides in the exhaust:

Lead	**Barium**	**Antimony**
Zinc	**Cadmium**	**Chromium**

CLEAN-FIRE priming composition has been formulated to duplicate conventional lead styphnate compositions with similar performance, but with acceptable exhaust products harmless to health and the environment.

Exhaust Composition - CCI Clean-Fire™ primers v. Conventional Styphnate Primers



BLOUNT
Spotting Equipment Division
Lewiston, ID 83501

Speer® Lawman® CLEAN-FIRE™ Centerfire Ammunition
9mm luger (9x19mm)

TECHNICAL SPECIFICATIONS

9mm Luger – part number 3824 (50 per box; 1000 per case)

Bullet: 124 grain (8 g) UNI-COR™ Totally Metal Jacketed™ (TMJ) round nose; jacket material – pure copper; lead core completely encased by jacket; core – 3% antimony/lead alloy; nominal diameter – 0.3555" (9.03mm). Ballistic coefficient 0.118.

Cartridae Case: Standard Boxer-primed brass case; alloy-commercial cartridge brass; 70 percent copper, 30 percent zinc.

Primer: CCI SOOCF lead-free Boxer-type primer; cup thickness 0.017" (0.43mm); cup is nickel plated; primer mix contains no lead, barium or antimony compounds.

Propellant: non-canister flake-type powder; double base. Weight of charge is determined at time of loading by pressure and velocity testing of loaded ammunition. Non-canister powders (available only to ammunition manufacturers) are calibrated after receipt of the product from the vendor.

Pressure: Maximum average pressure: 35,000 psi*; determined in standard industry pressure/velocity barrel.

Velocity: mean instrumental at 15 feet – 1145 ± 75 feet per second (350 ± 23 m/sec) from SAAMI P/V test barrel. Velocity in actual service pistols may vary depending on dimensional variations of chamber and bore from make to make.**

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General Notes on Lead-Free Ammunition

The requirements to improve air quality in indoor firing ranges has resulted in the development of cleaner ammunition for use in these environments. U.S. government testing in the 1970's showed that the majority of airborne lead is the result of powder gases vaporizing lead

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• pounds per square inch

**** SAAMI – Sporting Arms and Ammunition Manufacturers Institute**

from the base of a lead bullet, or a jacketed bullet with lead exposed at the base. This accounts for approximately 80 percent of the airborne lead emitted. The remaining 20 percent of the emissions comes from conventional lead styphnate primers. Lead styphnate is the primary explosive initiator in standard primers.

Encasing the bullet base and sides with jacket material virtually eliminates the bullet's contribution to airborne lead at the firing point. However, the lead emission from the primer is still of concern. The lead residues from primers are more finely divided than the lead residue from the bullet, and can remain suspended in the atmosphere longer than bullet residues. The primer's contribution to airborne lead can be eliminated by developing primers with non-metallic initiators.

All current ammunition using lead-free primers contains lead in the bullet core. Although research in this area continues, there is currently no other material for bullet cares which allows the bullet weight to be kept at or near service levels for realistic training. Therefore ventilation of the backstop/trap area is still required. Lighter bullet materials such as brass or aluminum are rigid and can damage range backstops, and produce insufficient momentum to function the actions of semi-automatic firearms. Lead-free priming and protected bullet bases combine to virtually eliminate airborne lead at the firina point, where most lead exposure to personnel occurs.

In addition to health concerns over the presence of excessive amounts of lead in the air, European countries have identified barium as a indoor range hazard in traditional primer mixes. This metal is present in styphnate primers in the form of barium nitrate, which is the oxidizer in the compound. European police and military agencies now specify that ammunition for indoor use must be both lead-free and barium-free. One make of lead-free primers still contains barium nitrate os on oxidizer. CCI lead-free primers contain no lead, barium or other harmful heavy metal compounds.

Non-metallic (lead-free) primer initiators are, by their chemical characteristics, slightly less sensitive than the traditional initiator, lead styphnate. Therefore the metal parts configuration must be optimized to permit reliable function in a wide variety of firearms. Lead-free primers are not recommended for firearms with non-factory spring kits or excessive headspace, as these firearms may show a high misfire rate. All lead-free primed ammunition, regardless of make, should be fired in factory-original firearms in good condition.

CCI LF52 and MLF52 CLEAN-FIRE priming compounds for small orms primers utilize proprietary ingredients and are protected by U.S. patents 4,608,102 and 4,963,201 as well as certain pending foreign patents.

CLEAN-FIRE primer performance, including energies and temperatures are similar to conventional primers. Exhaust from CLEAN-FIRE primers consists of

Carbon Monoxide	Nitrogen
Carbon Dioxide	Strontium Oxide
Water (H20) as steam	

Primer exhaust comprises only a small part of the the exhaust from a cartridge, the greater part being from the carbon oxides, nitrogen and steam from the propellant charge.

Carbon monoxide in ammunition exhaust is produced primarily by the propellant charge. Choice of propellant will have a greater bearing on CO amounts than the primer. CCI CLEAN-FIRE primers do not produce sulphur dioxide, nitrogen dioxide, nitrous oxide or hydrogen cyanide in the exhaust.

Speer UNI-COR™ Totally Metal Jacketed bullet used in conjunction with CLEAN-FIRE primers result in a cartridge that produces no harmful airborne contaminants at the firing point. Independent testing has demonstrated 100x reductions in airborne lead levels at the firing point with Speer CLEAN-FIRE 9mm ammunition. The small amounts of lead detected in these tests (less than 0.01 mg/m^3) are attributed to residual lead in the test firearms from previous firing with conventional styphnate-primed cartridges, and to pre-existing amounts of lead in the range.

CLEAN-FIRE primers will not produce any of the following metals or their oxides in the exhaust:

Lead	Barium	Antimony
Zinc	Cadmium	Chromium

CLEAN-FIRE priming composition has been formulated to duplicate conventional lead styphnote compositions with similar performance, but with acceptable exhaust products harmless to health and the environment.

APPENDIX D

9mm Lead-free Frangible

Material and component specifications:

Projectile: molded nylon loaded with copper powder

Projectile weight: 83 grains

Cartridge case: standard service case

Propellant: SS109

Primer: standard service primer or Fiocchi lead-free primer

Shelf life and storage: 5 years

Performance specifications:

Ballistics:

Port pressure (21° C): 26,000 - 28,000 CUP

Velocity (15m): 14,000-14,500 feet per second

Accuracy: meets SAAMI and **NATO** specifications up to 50 meters

Maximum range: 1,000 meters (computer analysis)

Minimum effective range: 50 meters

Trajectory match: will match ball round trajectory up to 50m

Frangibility: will not penetrate l/4" thick soft steel at point-blank range (back stop of l/4" armoured steel plate recommended)

Splash back: maximum splash back of 6" firing at 90"

Ricochet (Impact at 10 m): projectile will disintegrate at a 15° angle on 1/4" armored steel

Weapon functioning:

	Beretta 92F	Browing HP	SIG Saur	H&K MP5	Glock 17	H&K P7
Temperatures: +21° +40° -20° Feed & Cycle	100%	100%	100%	100%	100%	100%
Accuracy	as ball	as ball	as ball	as ball	as ball	as ball

9mm Pre-fragmented Munitions

Material and component specifications:

Projectile: Primary (disintegrating) projectile: plastic envelope with tungsten powder
Secondary projectile: plastic

Projectile weight: 90 grains

Cartridge case: standard service case

Propellant: SS109

Primer: standard service primer or Fiocchi lead-free primer

Shelf life and storage: as ball

Performance specifications:

Ballistics:

Port pressure (21° C): 14,000 CUP

Velocity (3m): 1230-1340 feet per second

Trajectory match: will match ball round trajectory up to 50 meters

Penetration: will not penetrate 3/4" plywood at 7 meter range

Ricochet (impact at 10 m): no ricochet

Weapon functioning:

	SIG P226	Beretta 92F	Glock 17	MP5
Temperature: +21° Feed & Cycle	100%	100%	100%	199%
Accuracy at 7m	2.37"	2.32"	2.66"	1.77"

.38 Lead-free Frangible

Material and component specifications:

Projectile: molded nylon loaded with copper powder
Projectile weight: 95 gr
Cartridge case: standard service case
Propellant: SS109
Primer: standard service primer or Fiocchi lead-free primer
Shelf life and storage: 5 years

Performance specifications:

Ballistics:

Port pressure (21" C): 14,000 CUP
Velocity (15m): 14,000-l 4,500 feet per second
Accuracy: meets SAAMI and NATO specifications up to 50 meters
Maximum range: 1,000 meters (computer analysis)
Minimum effective range: 50 meters
Trajectory match: will match ball round trajectory up to 50 meters
Frangibility: will not penetrate l/4" thick mild steel at point-blank range (back stop of l/4" armored steel plate recommended)
Splash back: maximum splash back of 6" firing at 90°
Ricochet (impact at 10 m): projectile will disintegrate at a 15° angle on 1/4" armored steel plate.

Weapon functioning:

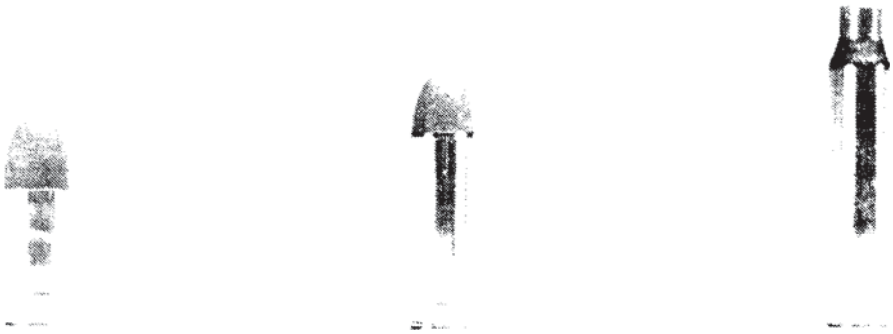
	Colt
Temperatures: +21° + 40" -20° **Feed & Cycle**	100%
Accuracy	**as ball**

SIMUNITION

TECHNOLOGIES

New – L.F.A. – “lead Free Ammunition”

(frangible)



Constructed of a revolutionary new polymer bullet and loaded with lead-free primers — no lead pollution whatsoever

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Features and Benefits

- same mean point of impact as service ammunition to combat ranges (50 m pistol. 150 m rifle)
- reduced danger of ricochet
- similar recoil as service ammunition
- reduced maximum range — approximately one-third of service ammunition
- breaks up on impact against 1/4 inch steel sheet
- no splashback
- feeds and fires in all types of weapons. including full-autos (no modification required)
- leaves only non-toxic residue

Simunition Technologies Inc., 366 Bruyere Street. Ottawa. Canada KIN SE7

tel: (613) **232-2927 fax: (613) 232-0580**

New – L.F.A. – "lead Free Ammunition"
(frangible)

Specifications

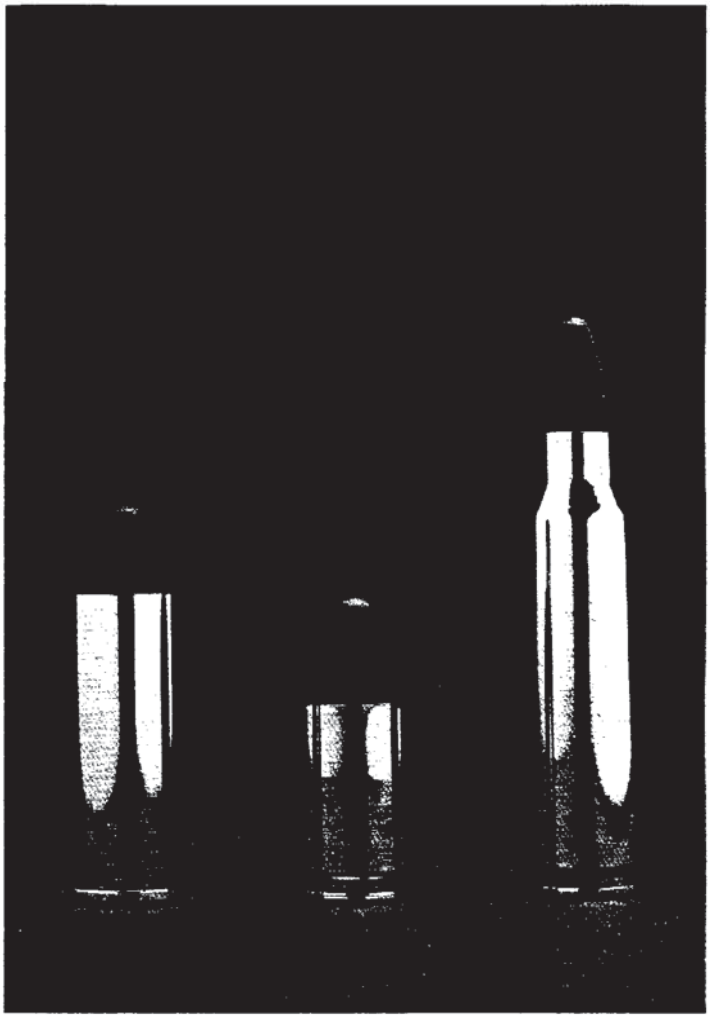
	Muzzle *Velocity*	*Bullet Weight*	*MPI*
9mm	1375 fps	85 grains	same as ball to 25 m
5.56 mm	4000 fps	**37** grains	same as ball to 150 m
38 sp	**950** fps	**80** grains	1" high at 25 m

Prices (U.S. Dollars)

	(per thousand)	<1,000	1,000 - 50,000	Over 50,000
9mm	**New** Brass	$ 250	$240	$230
	Once Fired	$220	$ 210	$ 190
5.56 **mm**	New Brass	S 260	$250	$240
	Once Fired	$ 230	$220	$210
38 **SP**	New Brass	$ 240	$230	$220
	Once Fired	$210	$200	$ 190

Packaged in SO rnd dump boxes. Prices do not include freight or applicable local taxes. Prices are F.O.B. our NY warehouse.

SMALL CALIBRE TRAINING AMMUNITION
LEAD FREE FRANGIBLE CARTRIDGES



GreenShield™ Training Ammunition is specially designed to reduce safety hazards in training by eliminating exposure to lead through the use of a lead free primer and polymer projectile. Ricochet and splash-back are also reduced **since the projectile shatters into a fine powder, even at very oblique angles, upon contact with standard backstop materials designed to wtthstand impact from service ammunition.**

GreenShield™ Training Ammunition matches service ammunition accuracy and maximum range is reduced by approximately 30%.

COMPONENTS	.38 SPECIAL .357 MAGNUM	9 X 19mm NATO	5.56 X 45mm NATO
Projectile mass	6.2 grams (95 grains)	5.5 grams (85 grains)	2.3 grams (36 grains)
Projectile material	Copper-polymer compound	Copper-polymer compound	Copper-polymer compound
Cartridge case	Copper alloy 260	Copper alloy 260	Copper alloy 260
Primer	Lead free, boxer style, non-corrosive	Lead free, boxer style, non-corrosive	Lead free, boxer style, non-corrosive
Propellant	Single or double-base smokeless powder	Single or double-base smokeless powder	Single or double-base smokeless powder
BALLISTIC DATA (fixed test barrel)			
Chamber Pressure at 21°C (70°F)	100 - 120 MPa (14,500 - 17,500 psi)	200 - 240 MPa (29,000 - 35,000 psi)	310 - 340 MPa (45,000 - 49,000 psi)
Velocity at 21°C (70°F)	420 - 450 m/s at 5 m (1.380 - 1.480 ft/s at 16 ft)	440 - 472 m/s at 5 m (1,450 - 1,550 ft/s at 16 ft)	950 - 1,030 m/s at 24 m (3,100 - 3,350 ft/s at 80 ft)
Accuracy	7.5 cm (3 in) extreme spread at 25 m (80 ft) as per SAAMI standard testing procedure	• 7.5 cm (3 in) extreme spread at 25 m (80 ft) as per SAAMI standard testing procedure • 3.75 cm (1.5 in) mean radius at 25 m (80 ft) as per NATO standard testing procedure	• 3.75 cm (1.5 in) mean radius at 50 m (160 ft) as per NATO standard testing procedure • Meets NATO specification for ball ammunition up to 100 m (320 ft) indoors

COMPONENTS	.38 SPECIAL .357 MAGNUM	9 X 19mm NATO	5.56 X 45mm NATO
Maximum range (computer analysis)	1 .000 m **(3,280** ft)	1.000 m **(3,280 ft)**	**2.255 m (7.400 ft)**
Trajectory match	Same mean point of impact as ball round up to 25 m (80 ft)	Same mean point of impact as ball round up to 25 m (80 ft)	Same mean point of impact as ball round up to 50 m (160 ft)
TERMINAL EFFECTS			
Frangibility	Does not perforate 6.4 mm (1/4 in) thick mild steel plate at point blank range	Does not perforate 6.4 mm (1/4 in) thick mild steel plate at point blank range	Does not perforate 6.4 mm (1/4 in) thick armoured steel plate at point blank range
Ricochet	**None** Projectile desintegrates on 6.4 mm (1/4 in) armoured steel at 15° obliquity firing at 10 m (33 ft)	**None** Projectile desintegrates on 6.4 mm (114 in) armoured steel at 15° obliquity firing at 10 m (33 ft)	None Projectile desintegrates on 6.4 mm (1/4 in) armoured steel at 15° obliquity firing at 10 m (33 ft)
Maximum splash back	**60 cm (24** in) firing perpendicularly to the plate	60 cm (24 in) firing perpendicularly to the plate	60 cm (24 in) firing perpendicularly to the plate
USE			
General	For most .38 special and .357 magnum revolvers without any modification or ancillary device	For most 9 mm pistols and sub-machine guns without any modification or ancillary device	For use in gas operated weapons without any modification or ancillary device
Handling	The same handling and safety precautions should be exercised as with service ammunition	The same handling and safety precautions should be exercised as with service ammunition	The same handling and safety precautions should be exercised as with service ammunition
Operational temperature range	0 to 40°C (32 to 105°F)	**10** to 40°C (50 to 105°F)	0 to 40°C (32 to 105°F)
Firing mode	Not applicable	Single shot, burst, full automatic	Single shot, burst, full automatic (See note 1)
Weapons	The ammunition functions the following weapons: .38 **SPECIAL CALISRE:** **Smith & Wesson Model 10 (7 in)** **Smith & Wesson Model 14 (2 & 4 in)** **Smith & Wesson Model 64 (3 in)** **Ruger Model SP-101 short barrel,** Stainless Taurus Model 82 .357 MAGNUM CALIBRE: Smith & Wesson Model 13 (4 in) Ruger Model GP-100, Colt King Cobra, Taurus Model 65	The ammunition functions the following weapons: Beretta 92F Browning Hi-Power Sig Sauer P226 Glock 17 Heckler & Koch - MP5- A2, A3 Heckler & Koch - MP5- A4, A5	The ammunition functions the following weapons: Colt Ml 6Al El Colt M16A2 Colt Commando (Ml 6)
MISCELLANEOUS			
Recommended storage	**Cool and dry environment**	**Cool and dry environment**	**Cool and dry environment**
Noise and Recoil	**Comparable to service rounds**	**Comparable to service rounds**	**Comparable to service rounds**

Note 1 As thermo setting polymer's mechanical properties vary with temperature, do not keep the projectile chambered more than 30 seconds before firing to avoid possible projectile break-up. with a hot barrel.
Dimensions and weights are nominal

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