

Yukon Fire Marshal's Office

Origin and Cause Report

Incident number: Takhini River Fire XY019

Address: Gravel Pit Access Road, KM 1469 Alaska Highway

GPS Coordinates 60.827000, -135.760367

Date: July 8, 2023

Dispatch Time for Investigation: July 9, 2023, 1630 hrs.

Arrival Time: July 9, 2023, 1715 hrs.





Contents

Initial Summary	4
Definitions.....	4
Participating Fire Investigators	5
Weather Conditions	6
Property Owner	6
Scene Security.....	6
Insurance.....	6
Fire Discovery and Initial Statement of Owner	6
Firefighter Observations	6
Forest Fuel Types	7
Site Location	8
Arrival of Investigator – Deputy Fire Marshal Chris Green.....	8
Examination of the incident.....	9
Examination of potential ignition sources in the area of origin.....	14
Orientation Map	17
Data Collection.....	18
Delta 1 911 Call log.....	18
Email From Wildland Fire Management	20
Experiments on Wildfire Ignition by Exploding Targets	21
Abstract.....	21
Methods and Materials.....	21
Results.....	23
Testing of the ThunderShot product.....	23
Results from the field test conducted on September 22, 2023	28
Information about ThunderShot.....	31
Suggested Hypotheses	36
Admission	36
Summary.....	37

Yukon Fire Marshal's Office



Thunder Shot Information and Purchase	37
Events of July 8	37
Conclusion	38
Point of Origin	38
Causation	38



Initial Summary

On Sunday, July 9, 2023, at approximately 1630 hrs., the Fire Marshal's Office was requested by Yukon Southern Lakes Wildfire Centre to conduct a Fire Investigation at GPS Coordinates 60.827000, -135.760367.

A wildfire had been reported to the Wildland Fire Regional Duty Officer at approximately 1636 hrs. on July 8, 2023. In addition, the call came into the 911 dispatching system (Delta 1) for the volunteer fire departments of Ibex Valley and Hootalinqua.

Definitions

AL Aluminum

Area of Origin A structure, part of a structure, or general geographic location within a fire scene, in which the "point of origin" of a fire or explosion is reasonably believed to be located.

Cellulosic Ethanol A type of biofuel produced from lignocellulose, a structural material that comprises much of the mass of plants and is composed mainly of cellulose, hemicellulose, and lignin.

CL Crew Lead.

Combustion or **burning** A high-temperature exothermic redox chemical reaction between a fuel (the reductant) and an oxidant, usually atmospheric oxygen, that produces oxidized, often gaseous products, in a mixture termed as smoke. Combustion does not always result in fire, because a flame is only visible when substances undergoing combustion vaporize, but when it does, a flame is a characteristic indicator of the reaction. While activation energy must be supplied to initiate combustion (e.g., using a lit match to light a fire), the heat from a flame may provide enough energy to make the reaction self-sustaining.

Cross Over Certain atmospheric conditions can produce severe fire behaviour at the point when the air temperature reading, and the relative humidity reading, read the same (e.g, Temp. 30° C, RH 30%). At this point a condition has been achieved called "CROSS OVER".

DFM Deputy Fire Marshal.

FMO Fire Marshal's Office.

FPS Feet Per Second.

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Hornaby 6.5 Creedmoor The 6.5mm Creedmoor is a medium-power cartridge comparable to the .260 Remington¹ and 6.5×47mm Lapua.² Its energy at 300 yards using 129-grain Hornady SST bullets is listed by an independent reviewer as 1,641 foot-pounds force (2,225 J).

High Velocity Bullet Velocity is classified as low (<1000 fps), medium (1000 to 2000 fps), and high (>2000 fps).

IA Initial Attack Crew.

IFR Initial Fire Report.

Ignition/Incipient Stage of Fire This first stage begins when heat, oxygen and a fuel source combine and have a chemical reaction resulting in fire. This is also known as “ignition” and is usually represented by a small fire which often goes out on its own.

IC/Incident Commander The person responsible for all aspects of an emergency response.

Point of Origin The exact physical location within the area of origin where a heat source and the fuel interact, resulting in a fire or explosion.

RDO Regional Duty Officer.

Thunder Shot A brand of binary explosive targets used for firearms practice and sold in kit form.

Participating Fire Investigators

Chris Green Fire Marshal's Office

Witnesses:

Individual “A” 1867-334-xxxx

Individual “B” 1-867-993-xxxx

911 Witness 1-867-332-xxxx

Note: This was a multi-jurisdictional response to support Wildland Fire Management. Mutual Aid was provided by Ibex Valley Fire Department, Hootalinqua Fire Department, Champagne and Aishihik First Nations and the Special Heavy Operations Team.

¹ “6.5 Creedmoor-A 10 Year Overnight Sensation” tactic.com. 26July 2022.

² ^ “6.5mm Shootout:.260 Remington vs .6.5x47 Lapua vs. 6.5 Creedmoor” demigodllc.com.

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Weather Conditions

On Saturday July 8, 2023, at approximately 1600 hrs., the following weather conditions were observed at the Champagne Weather Station:

- Average Air Temperature: 27.5 °C
- Average Relative Humidity: 15%
- Average Wind Direction: 238° or West-southwest (WSW)
- Average Wind Speed: 22 km/h and gusting at 38 km/h

Property Owner

The property owner adjacent to the gravel pit has been designated as Yukon Government for the address authority.

Scene Security

At the time of the investigation, Wildland Fire Management restricted access only to those working on the incident. The Area of Origin was under the care of Crew Leader [Redacted] who held the call sign Alpha1 during operational periods.

Insurance

Wildland area with no structural property value.

Fire Discovery and Initial Statement of Owner³

The fire was initially reported through 911 at approximately 1634 hrs. on July 8, 2023 and transferred to Yukon Fire Service Dispatch Delta 1. The Ibex Valley Fire Department was dispatched at 1636 hrs. on July 8, 2023. Details of dispatch can be found in Annex A Delta 1 Log. Wildland Fire Crews were notified of the incident and responded at 1644 hrs. on July 8, 2023.

Firefighter Observations

Wildland Fire Management Crew Leader [Redacted] was responsible for taking me to an area of concern for observation that was thought to be in the area of origin (this occurred on July 9 at approximately 1733 hrs.). He had identified a small spray paint can and iron target in this area as identified in Figure 1.

³ See attached notes for actual initial statement.



Figure 1: This image describes the area of origin that contained a shooting target, spray paint can and various bullet types.

Forest Fuel Types

The suspected area of origin contained an Aspen/Juniper mix and is classified as a low boreal forest type. Surface fuels of this area would be of the Shrub tundra ecosites or vegetation that would fall between the St01 and St08 vegetation.⁴

Shrub tundra ecosites		
Class: Shrub tundra		
St01	Dwarf birch – Labrador tea / Crowberry	102
St02	Dwarf birch – Labrador tea / Muskeg sedge	104
St03	Dwarf birch / Lowbush cranberry / Paperdoll	106
St04	Dwarf birch / Alaska mountain-avens	108
St05	Dwarf birch / Altai fescue	110
St06	Green alder – Alaska spiraea	112
St07	Richardson's willow / Horsetail	114
St08	Diamond-leaved willow – Dwarf birch/ Coltsfoot / Peat moss	116

Figure 2

⁴ MacKenzie, W.H., C.E. Kennedy and N. Flynn. 2022. Ecosystems of the Yukon Arctic Region: a guide to identification. Department of Environment, Fish and Wildlife Branch, Government of Yukon, Whitehorse, Yukon. viii + 236 pp.

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Environment: St01 occurs on (sub)mesic slopes and well-drained flats. Soils are Turbic Cryosols or Brunisols; exposed mineral soil may occur, but generally with low cover. The active layer is usually moderately deep (40 cm or greater). Snow cover is neutral to slight snow accumulating.

Environment: St02 occupies intermediate site conditions between the wetter tussock cotton grass ecosite (Wb01) and drier shrub tundra (St01), often occurring on the upper areas of pediment slopes or on better drained convexities on gradual slopes. The snow cover regime is neutral. Because of the insulating effect of high vegetation cover and fine-textured soils, the active layer is often within 40 cm of the surface. Sites are commonly hummocky and the structure of the ecosite is like that of Wb01 ecosites. Most sites have soils classified as Turbic Cryosols and they primarily occur on acidic substrates.

Site Location

GPS Coordinates 60.827147, -135.760166 as seen in Figure 3.



Figure 3: This image shows the general location of the fire as well as direction of fire growth adjacent to the road to the gravel pit.

Arrival of Investigator – Deputy Fire Marshal Chris Green

Prior to the onsite visit, I met with Wildland Fire Management's Yukon Duty Officer [Redacted], who presented me with photos taken from the first arriving aircraft. These photos, in conjunction with the weather conditions, helped identify an area of origin. This area was large enough to use a longitude and latitude grid search and collect possible ignition sources.



It was initially believed from one of the calls placed to 911 (heard in the 911 recording at timestamp 02:53) that it sounded like a loud boom was heard; that prompted the request of the investigation from Wildland Fire Management. There were no reports of lightning strikes or other natural causes that may have ignited this fire.

I, Chris Green, the investigator, arrived at the staging area to meet the Incident Commander [Redacted] for a safety briefing and orientation to the incident.

Figure 4 was captured by a Samsung Galaxy phone in conjunction with the Google Maps function to get the GPS coordinates.

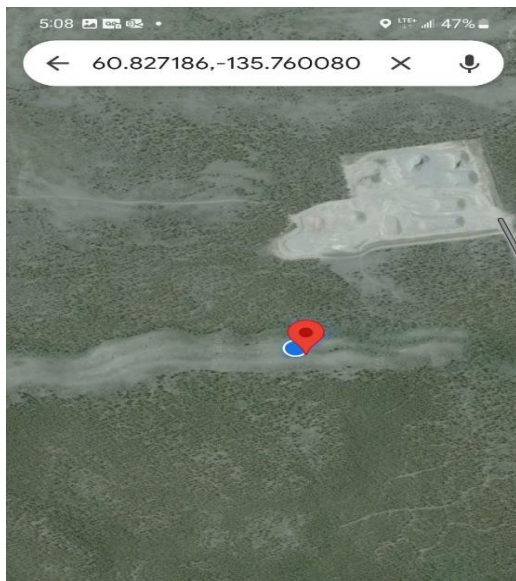


Figure 4: GPS coordinate of area of origin.

Examination of the incident

The incident was investigated using an outward to inward approach toward the area of origin. Found in the outer area, also known as the gravel pit, were items identified in Figures 5-9.



Figure 5: A Single Hornaby 6.5 Creedmoor casing on a nearby highpoint within the gravel pit.



Figure 6: Two .308 Winchester casings on one of the roadways of the gravel pit.



Figure 7: Two distinct types of ammunition casings were found near the entry of the gravel pit. A 300 Win Mag and a type of Russian WW2 Ammo (Mosin Nagent).



Figure 8: The remains of a container of ThunderShot found in the gravel pit.



Figure 9: Another picture of the container of Thunder Shot found in the gravel pit.

Examination of potential ignition sources in the area of origin

The Incident Commander directed me to make contact on the radio with call Sign Alpha 1. I was escorted by Alpha Team Leader [Redacted] to an area that contained a few of the items that I examined and collected for evidence.

Examination of the area of origin revealed three ignition points on the slope (Area of Origin). These are identified in Figures 10-12.



Figure 10: Iron target was secured to the slope with a single piece of rebar.



Figure 11: Paint can (orange in colour).



Figure 12: Six Bullets were collected from around the target site.

Orientation Map

In an effort to orientate the reader to the items identified at the fire scene, the image below corresponds with the locations. See Figure 13 for reference.



Figure 13: This image displays the location of where bullet casings were found as well as items within the area of origin.

Data Collection

Delta 1 911 Call log

Delta 1 Fire Call #	2023-189
Fire Call date	July 8, 2023
Fire Department(s)	Ibex Hootalinqua Shot
Type of Call	Wildfire
Location of the Incident	Takhini river subdivision
Dispatch time for each department involved	Ibex Tender @ 16:36 Ibex 4x4 @ 16:36 Ibex Portable Hoot Tender @ 16:36 Hoot Pumper @ 16:36 Hoot 4x4 @ 16:36

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	Shot Pumper 18:06
Responding for each apparatus	Ibex Tender @ 16:51 Ibex 4x4 @ 16:56 Hoot Tender @ 16:59 Hoot Pumper @ 17:56 Hoot 4x4 @ 18:37 Shot Pumper @ 18:41
On scene for each apparatus	Ibex Tender @ 17:20 Ibex 4x4 @ 17:20 Hoot Tender @ 17:23 Hoot Pumper @ 18:22 Hoot 4x4 @ 18:59 Shot Pumper @ 19:34
Command Established	@ 16:43
Command Transferred	Not provided
Command Terminated	@ 0:22
Back in Service for each apparatus	Ibex Tender 01:02 Ibex 4x4 @ 0:58 Hoot Tender @ 01:07 Hoot Pumper @ 01:10 Hoot 4x4 @ 01:02 Shot Pumper @ 0:55
Name of initial IC	Not provided
Temperature	29 C
Wind Direction	SW
Wind Speed	28 KPH G 42 KPH
Delta 1 Dispatcher	Not provided
Other Agencies	Wildland

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Email From Wildland Fire Management

Hey Chris,

I will work on getting statements from the IA crews.

Our responders were:

Alpha 1 x 3, [REDACTED] CL

Hotel 1 x 3, [REDACTED] CL

XY 2, [REDACTED]

I have lifted the timeline from our dispatch software.

Supplementation from my RDO notes below:

16:46 – Notify crews reporter said they heard an explosion before the fire started.

16:48 – Hotel 1x3 on scene, reporting black column.

16:50 – Alpha 1x3 in NAV overhead fire.

16:51 – IFR received from Alpha 1

Our staff were mainly focused on suppression, and nothing was reported in the logs regarding the origin of the fire.

I'm sure it would be worthwhile to have a discussion with them yourself if possible.

I am outgoing as RDO today and XY 2 will be taking over. I'll brief him on this subject and allow him to work on a timeline for you to collect statements.

Thanks,

The Yukon logo consists of the word "Yukon" in a bold, sans-serif font, with a stylized sunburst graphic above the letter "o".



[REDACTED]
Emergency Response Officer
Community Services | Wildland Fire Management | C-19
C 867-332-[REDACTED] | Yukon.ca



Experiments on Wildfire Ignition by Exploding Targets

A field study was conducted by the United States Department of Agriculture and released in September of 2019.⁵ The information provided in this section is directly quoted from the study.

Abstract⁶

Tests were conducted using ninety-seven exploding targets (ammonium nitrate and aluminum powder) to examine the effects of product formulation, environment, and shooting on wildfire ignition. Tests in 2015 produced no ignitions in cold and humid weather conditions. Ignitions in 2018 under warm and dry conditions were positively related to the aluminum concentration (expressed as a percentage of the ammonium nitrate mass) and the placement of the target on a straw fuel bed rather than on a 6 in (15 cm) high steel pedestal. High speed videography and peak overpressure measured for each explosion suggested that differences in explosive characteristics were also related to other experimentally controlled variables and could help explain how wildfire ignition results from elements of product usage.

Methods and Materials⁷

The primary hypothesis pursued in this study was that wildfire ignition results from contact of burning Aluminum with wildland vegetation. Aluminum not consumed in the explosion reaction can be ignited and ejected from the blast seat (location on the ground directly beneath the explosive) and forced to contact nearby cellulosic fuels. This was a logical hypothesis given that the temperature of aluminum combustion is much higher than the nominal temperature required for flaming ignition of cellulose. Factors associated with each phase of product usage, including preparation and the AL content, target environment, and shooting, could affect the amount of burning AL in proximity to vegetation and were thus to be controlled and investigated (table 1).

⁵ Finney, Mark A.; Smith, C. Todd; Maynard, Trevor B. 2019. Experiments on wildfire ignition by exploding targets. Res. Pap. RMRS-RP-108. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 29 p.

⁶ Finney et al., 2019.

⁷ Finney et al., 2019.

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Table 1—List of experimental factors associated with preparation, environment, and shooting that possibly affect wildfire ignition. Each factor was considered or involved in testing.⁸

No.	Factor	Phase	Possible effect on wildfire ignition	Tested
1	Completeness of mixing of ammonium nitrate-aluminum components	Preparation	Incomplete mixing increases burning aluminum ejected into vegetation	Yes
2	Aluminum concentration	Preparation	Higher concentrations increase aluminum contact with vegetation	Yes
3	Target weight	Preparation	Larger targets may be more difficult to mix or react, meaning increased chance of ignition	Partial
4	Aluminum particle size	Preparation	Larger aluminum particles may be more likely to burn longer	No
5	Ammonium nitrate condition (moisture, particle properties such as sizes and density)	Preparation	Ammonium nitrate properties and moisture may affect reaction efficiency	No
6	Moisture content of vegetation	Environment	Dry dead vegetation is more likely to ignite	Partial
7	Target placement on vegetation vs. hard surface	Environment	Ignition is more likely with explosion contacting vegetation	Yes
8	Bullet placement on target	Shooting	Oblique or peripheral impact would decrease propagation of explosion through mixture, ejecting burning aluminum into vegetation	Partial

Note: The product utilized in this testing was Tannerite and not Thunder Shot that was utilized in the XY019 Gravel Pit Fire.

⁸ Finney et al., 2019.



Results⁹

Tests were conducted on ninety-seven targets. Ignitions of the straw bales were observed in 22 of 51 tests in 2018 but none in 2015. Weather conditions and, thus, fuel moisture were very different: warm and dry in 2018 versus cold and humid in 2015. Ignition was determined by inspecting the straw bales and blast zone immediately after the explosion. Both smoldering and flaming ignitions were classified as successful ignition. Smoldering ignitions were observed in four tests. Ignition probability was modeled by logistic regression from 2018 data and found to be strongly predicted by the characteristics of material used as the target's base (the metal pedestal vs. placing the product directly on the straw bale) as well as the AL concentration. Tannerite was less likely to cause ignition than targets with higher AL concentration because the AL was a relatively low 1.6 percent of the AN weight. Completeness of target mixing was not statistically significant in the model at the $p = 0.05$ level, meaning that ignition likelihood from partially mixed targets and well-mixed targets was not distinguishable from chance.

Testing of the ThunderShot product

Date: Friday, September 22, 2023.

What: A field test was conducted with three 1lb containers of ThunderShot.

Participants: Deputy Fire Marshal Colin O'Neill and Deputy Fire Marshal Chris Green.

Firearm type: 30-06 Marlin and 180 grain bullet that would travel at approximately 2500 FPS at 100 meters.

Camera: GoPro Hero 7 and Galaxy S22 phones.

Weather conditions: Light rain and clouds with wind blowing to the south at 6km/h. Temperature at 1323 hrs. was 6°C.

The following three images were from the first test. A 1lb container of ThunderShot was placed on the gravel with a small bundle of fine fuels placed on top and around the container. These fine fuels were collected from the original XY019 fire site on July 9, 2023.¹⁰

⁹ Finney et al., 2019.

¹⁰ Note: The fine fuels used in this experiment had a significant drying period (July 8 to September 22, 2023).

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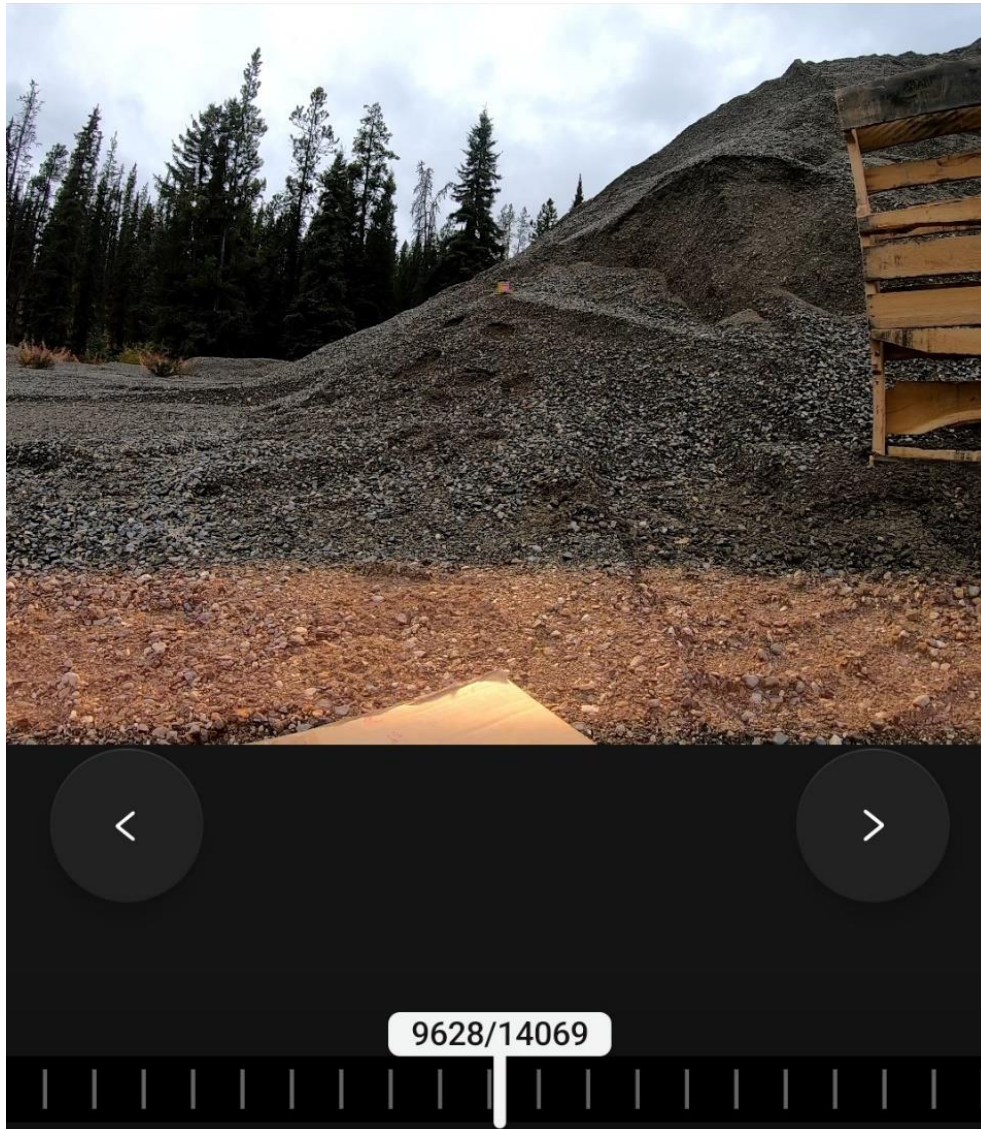


Figure 14: The image portrays the exact placement of the container.

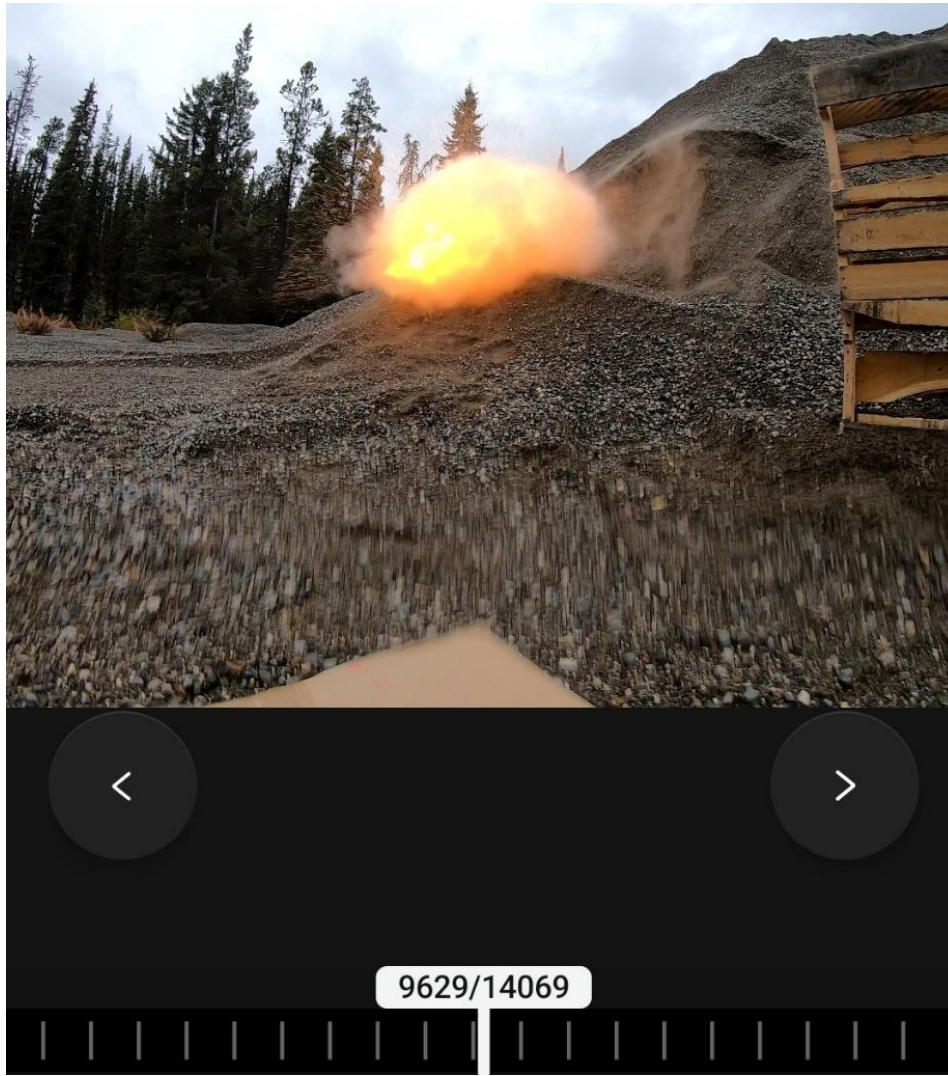


Figure 15: This is an image of the initial contact with the bullet and the container. The yellow is barely visible to the human eye.

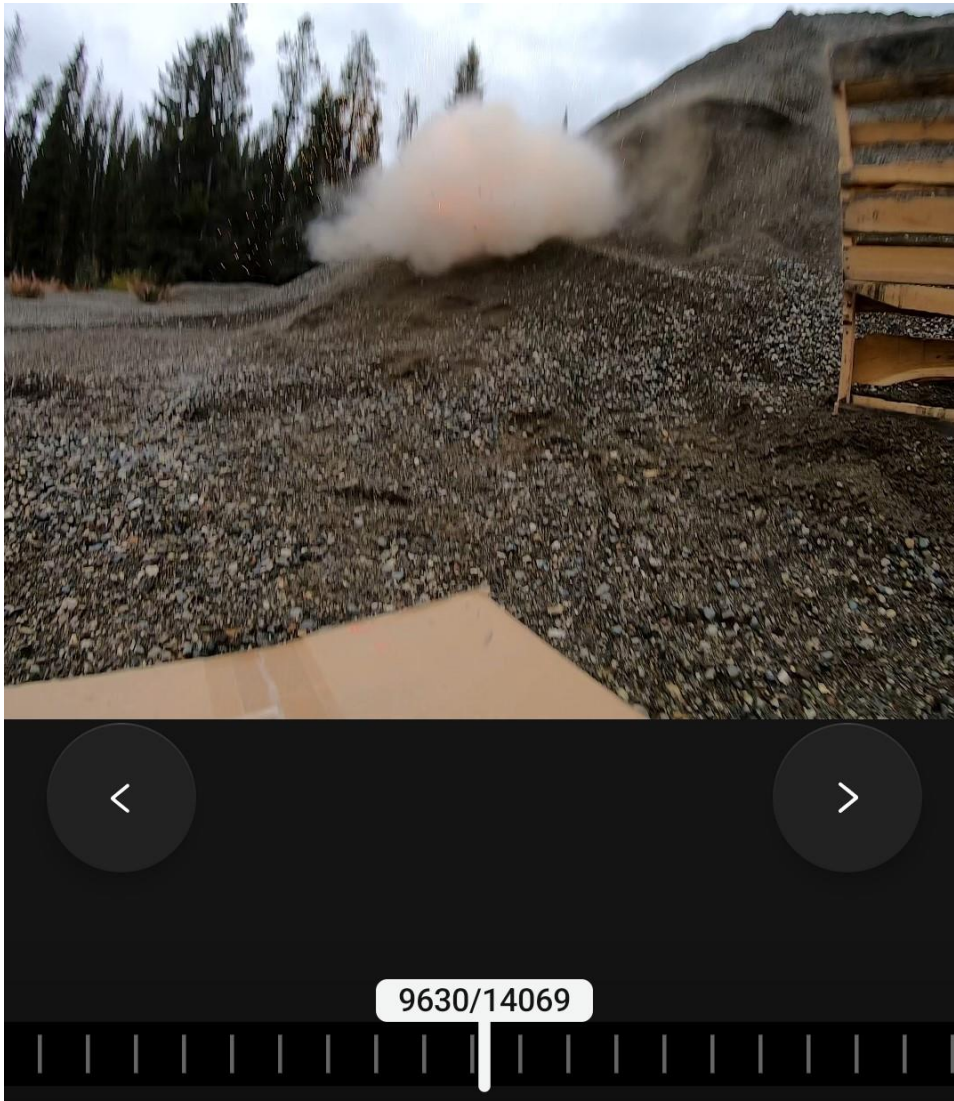


Figure 16: This image is the aftermath of the event. The camera was knocked over in the blast. The only remaining evidence of the container, its contents and the fine fuels was a small piece of labeling from the container.

The following three images were from the second test. A 1lb container of ThunderShot was placed on the gravel. This time no fine fuels were present.

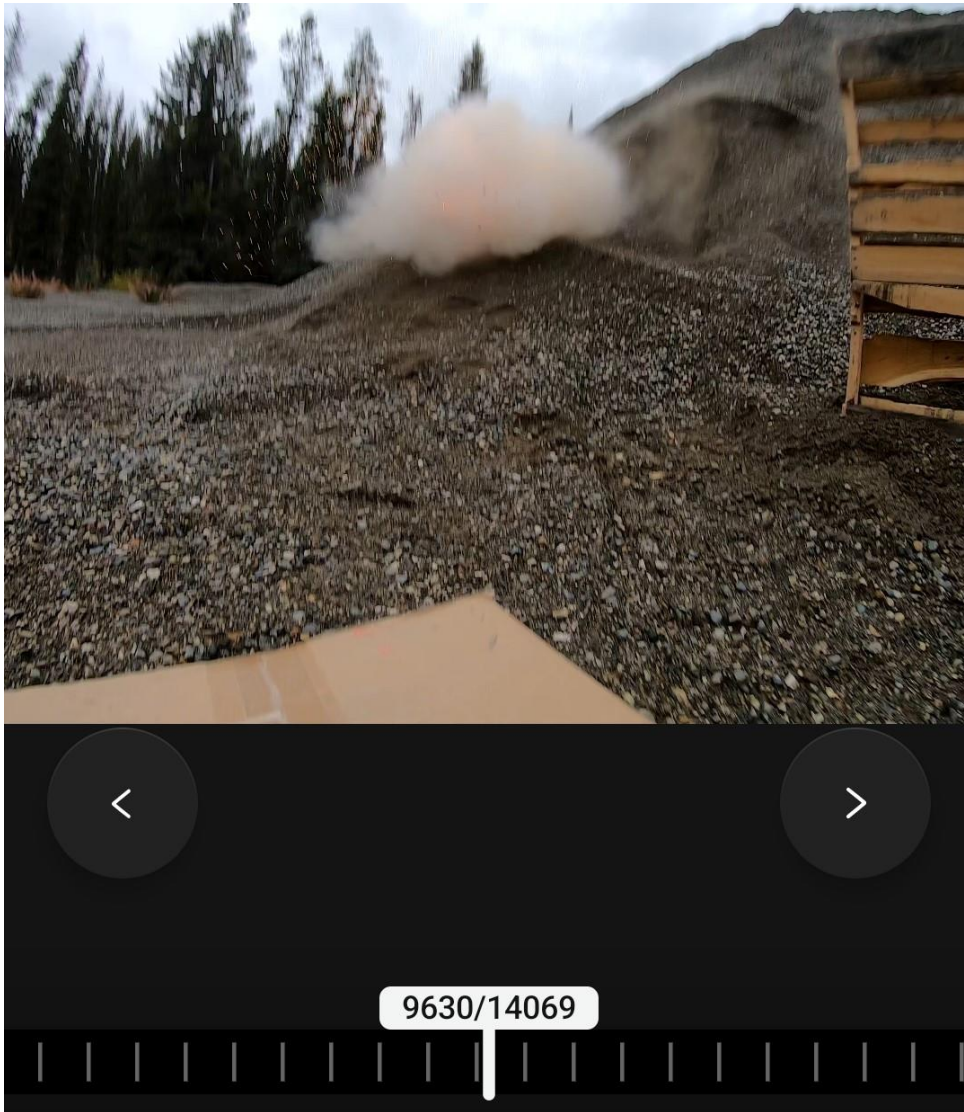


Figure 17: This is an image of the initial contact with the bullet and the container. There is no bright yellow colour observed as in Figure 18.

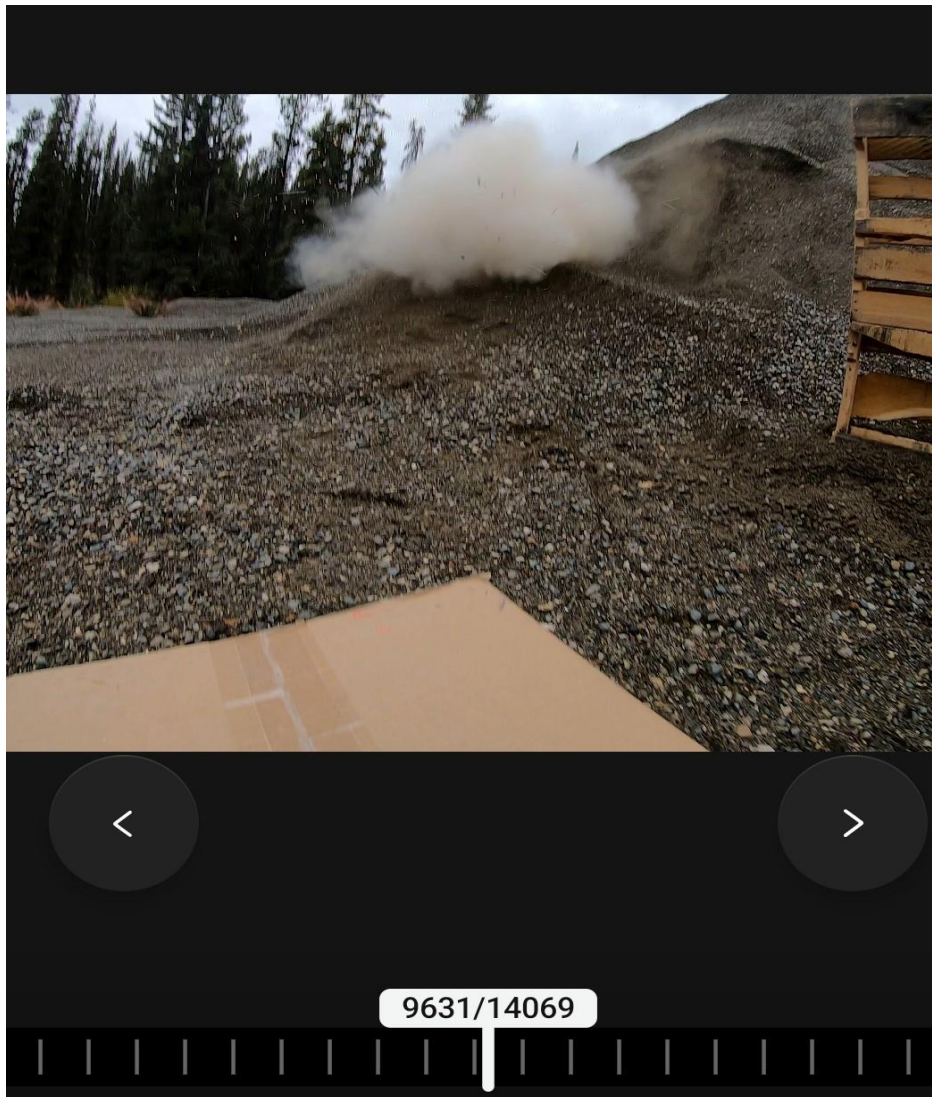


Figure 18: This image is the aftermath of the event. The camera was knocked over in the blast. The only remaining evidence of the container and its contents were again one piece of labeling material.

The third test was inconclusive as the bullet impacted the container on the cover and emptied the contents on the gravel.

Results from the field test conducted on September 22, 2023

The first test conducted showed significant ignition of the ThunderShot product. Little to no trace of the container, its contents and fine fuels remained after the first test. This indicated that the initial ignition of this product was sufficient to rapidly ignite and remove all remaining fuels in and around the target. Figures 22 and 23 below show the remains of the target contents after ignition.

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Figure 19: This picture shows the remains of the target contents. A small amount of fine stone was dispersed in the detonation.



Figure 20: A small piece of yellow labelling is visible in this image.

The second test conducted showed significant ignition of the ThunderShot product. Little to no trace of the container and its contents remained after the first test. This indicated that the initial ignition of this product was sufficient to rapidly ignite and remove all remaining fuels in and around the target.



Figure 21: This image shows a small piece of labelling from the second detonation.

Information about ThunderShot

The ThunderShot product is readily available for purchase at local vendors within Yukon. There are no restrictions on the amount of this product an individual can buy. On the day that the testing containers were purchased, I was asked to show a Firearms Acquisition License and bought three 1lb containers of ThunderShot but could have bought a substantial amount. Detailed information about the product has been released in a Non-Disclosure to the Fire Marshal's Office.

Figures 22 – 26 show the information available on the container as well as the container found at the XY019 fire.



Figure 22: This image was taken at Hougens Sport Lodge on September 13, 2023 and displays the product carried by the distributor. 1Lb of high-performance exploding target.



Figure 23: Warning information on product use. It should be noted that the manufacturer indicated that this product shouldn't be used in areas under a fire restriction or fire ban. There were no restrictions in place at the time this product was used.



Figure 24: Mixing instructions of product.



Figure 25: Aluminum powder (grey pouch) and ammonium nitrate powder (white sphere shaped).



Figure 26: This picture displays the remains of a target found in the gravel pit. This was indicated at timestamp 03:58 in the Admission Statement where a jug of Tannerite was said to be set up in the gravel pit.

Suggested Hypotheses

Hypothesis # 1: A high-power rifle was fired from an elevated platform and in the direction of a fixed target against a slope (estimated at 30 degrees). Within a few feet from the orange iron target, a small spray paint can was found. The rounds connected with the metal plate and created a spark into the surrounding fuels.

Although plausible, this theory was not evaluated due to the admission received.

Hypothesis # 2: A spray paint can that was found in the area of origin was impacted with a high caliber bullet that triggered a sustained combustion long enough to ignite the fine surface fuels.

This theory was ruled out upon closer examination of the spray paint can. There was an outward explosion from the spray paint can that meant a buildup of pressure caused a failure in the vessel resulting in an explosion. This most likely occurred during exposure to high temperatures of the nearby burning fuels of the wildfire.

Admission

After receiving the requested 911 recording I was able to pinpoint someone that had put themselves in the gravel pit at the incipient stage of the fire.



I requested a meeting with Individual "A" who was identified in the 911 recording.

I arranged for Individual "A" to meet me at the Fire Marshal's Office to go over the 911 call.

The night of the meeting, I was greeted with Individual "A" and Individual "B".

It was confirmed in this meeting that the individuals admitted to the accidental ignition of the XY019 wildfire.

Summary

Thunder Shot Information and Purchase

Thunder Shot is a brand of binary explosive targets used for firearms practice and sold in kit form. The majority of exploding targets are comprised of the same compounds, aluminum powder (catalyst) and ammonium nitrate (oxidizer). The combination is stable when subjected to forces **less severe** than a high-velocity bullet impact. A hammer blow, the product being dropped, or impact from a low-velocity bullet or shotgun blast would not initiate a reaction. It is also designed to be non-flammable¹¹ (the reaction cannot be triggered by a burning fuse or electricity), although its explosion can ignite flammable material.

A buyer can purchase Thunder Shot. The purchaser must hold a valid Firearms License or Pyrotechnician certificate by law.

Note: In the Admission, Tannerite was given as the name of the product used. However, Tannerite is a different brand and is not the brand Individual "A" and Individual "B" were using. The brand utilized by both individuals was Thunder Shot.

Events of July 8

In the late afternoon hours of July 8, 2023 Individual "A" and Individual "B" did some target shooting, with Thunder Shot used in two locations: the Gravel Pit area and on a slope where the fire first ignited (the area of origin).

The individuals were shooting at various targets for approximately three hours throughout the course of the afternoon. Somewhere between the hours of 1600 hrs. and 1636 hrs. Individual "A" fired a final bullet at a 1lb jug of Thunder Shot, located on the slope (point of origin).

The final rifle shot connected with the target and exploded in a different capacity than seen at other times used by the shooter. It was at that time a fire was witnessed by Individual "A" who ran towards the slope to try and extinguish the fire.

¹¹ Thunder Shot brand targets explode when shot by a high-velocity bullet.

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Weather conditions, fine fuels, moisture content and target placement enhanced the fire's ability to ignite and spread rapidly in a southern direction. With a given distance between the shooter and the point of origin at 400m, it was determined it would have been difficult for the shooter to extinguish the initial fire, despite their best efforts.

After an attempt to make it to the fire, it was apparent to Individual "A" and Individual "B" that they would not be able to extinguish it and they left the gravel pit and called 911 at approximately 1636 hrs. on July 8, 2023.

I (Chris Green) recovered the recording from the 911 dispatch center (Delta 1) and was able to identify the caller (Individual "B"). I followed up with this information and requested Individual "B" to attend the Fire Marshal's Office and provide a Statement for the investigation.

Conclusion

Individual "A" and Individual "B" admitted that they had started the fire by accident. At the time of the interview, they showed genuine concern for what occurred and provided critical information regarding the investigation.

My finding did not uncover unlawful activities that would warrant other agencies' support and/or involvement.

- The firearm used was a Christensen Arms Ridgeline non-restricted.
- Shooting location was not within 1km of a home.
- Targets were positioned in an area for safe shooting.
- Shooting lane had a clear line of sight to target.

Point of Origin

The point of origin of this fire was a 1lb container of Thunder Shot placed on the slope in the area of origin that ignited the fine fuels and led to the XY019 wildfire.

Causation

The cause of this fire was **human caused** and ruled **accidental** in nature.

Chris Green
Deputy Fire Marshal
Email: chris.green@yukon.ca
Phone: 1-867-334-5725

Report published December 19, 2023