

A Thesis Presented to
The Faculty of Alfred University

That's Classified!

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In Partial Fulfilment of
the Requirements for
The Alfred University Honors Program

December 13, 2022

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TABLE OF CONTENTS

	Page
Abstract	4
Introduction	5
Explosives	6
A Brief History of Explosives	7
Engineering of Explosives	13
How Engineering Applies to Crime Scene Investigation	15
SABT Survey and Explosive Background Residues Study:	
1. Current Study	18
2. Research Summary	19
1. Procedure	19
2. Methods and Materials	21
2.1 Chemicals	22
2.2 Standards	22
2.3 Materials	22
2.4 Negative Controls	22
2.5 Instrument Method and Conditions	22
2.6 Limits of Detection	23
3. Results and Discussion	24
3.1. Survey Results	24
3.2. Explosive Residue Background Collection Supplies Extraction Results	25
3.2.1.1 Inorganic Results	26
3.2.1.2 Organic Results	27
4. Discussion & Recommendations	29
5. Acknowledgments	30
6. References	31
7. Appendix	33
7.1 Explosives Background Residues Study Survey Questions	33
7.2 Instrument Method and Conditions	38
7.3 Standards/Test Mixes	40
7.4 Materials	42

7.5	Sample Preparation: Abbreviation Table	42
7.6	Explosives Background Residues Study Survey Results	43
7.7	Individual Package Sample Results	53

Abstract

When collecting post-blast explosive residue examinations, it is important to ensure that all samples taken from the scene are taken with residue collection supplies that have been exposed to as little prior contamination as possible. Swabbing and sampling residue collection supplies are exposed to different environments during storage before implementation in the post-blast scene. The goal of this thesis is to provide a reference study on background levels of explosive residues on evidence collection supplies prior to their use in post-blast scenes in order to assist the forensic community and to assist in the interpretation of crime scene data. The ultimate goal is how clean is “clean.”

Introduction

When an explosion goes off, the chemical fingerprint of the explosive components used is left behind. Explosive residues cover the post-blast scene, radiating out from the center point of the initial explosion. Over the years, bomb scene investigators, bomb technicians, and forensic scientists have developed and improved various methods on what method is best to examine a post-blast scene. According to the Federal Bureau of Investigations (FBI), during post-blast investigations there are two main areas of focus: chemistry and hazardous devices (Yeager, n.d.). The unit of the FBI responsible for conducting these examinations is the Explosives Unit (Yeager, n.d.).

Over the course of this past summer, I had the wonderful opportunity of completing an internship with the FBI's Explosives Unit at their Laboratory Division. The Explosives Unit itself is separated into two sections: Explosives Chemistry and Explosives/Hazardous Devices. The explosives chemistry side of the house deals with the analysis of all the chemical components and the analysis of the explosive chemicals themselves. The explosives/hazardous devices side deals with the actual explosive device (Yeager, n.d.). Within the FBI, the very first explosives matter ever conducted in the laboratory occurred in July of 1932 (Federal Bureau of Investigations, 1941). However, the very first unit to conduct bombing investigations within the FBI was the Firearms, Toolmarks, and Explosives Examinations Unit in the 1940s (Federal Bureau of Investigations, 1941). By the mid-1960s, that original unit was subdivided into three smaller units: Firearms/Toolmarks, Firearms/Explosives, and Firearms/Security units (Federal Bureau of Investigations, 1941). It wasn't until the mid-1970s that it became solely the Explosives Unit (Federal Bureau of Investigations, 1941).

During the course of my internship, I was given the opportunity to conduct a research project that integrated knowledge from explosives chemistry, post-blast scene investigations, and hazardous devices. In order to understand the importance of the research I conducted within the criminal justice industry, we first have to understand just what explosives are.

Explosives

Explosives are defined as “any substance or device that can be made to produce a volume of rapidly expanding gas in an extremely brief period” (Johnson, 2022, p. 1). There are three main types of explosives: mechanical, nuclear, and chemical. Mechanical explosions occur due to a build-up of pressure (Johnson, 2022). I like to think of these types of explosions as the “oopsies” that could happen in your kitchen if you are not too careful. Nuclear explosions occur when human beings mess around with particles on the atomic and subatomic level. One of the most historically famous and devastating nuclear explosions was the bombing of Hiroshima and Nagasaki (Johnson, 2022). When explosives are dealt within a criminal and terroristic environment, the type of explosives typically used are chemical in nature.

Chemical explosives are further separated into two types: low explosives, also known as deflagrating explosives, and high explosives, also known as detonating explosives. Low explosives “involve merely fast burning and produce relatively low pressures” (Johnson, 2022, p. 1). Low explosives are subdivided into pyrotechnics and propellants. Pyrotechnics include both fireworks and road flares, and propellants include black powders, Pyrodex, and smokeless powders (Yeager, n.d.). The most common low explosives are black and smokeless powders, well known for their uses in guns and fireworks. High explosives “are characterized by extremely rapid

decomposition and development of high pressure” (Johnson, 2022, p.1). Publicly well-known high explosives include TNT and dynamite. Typically, the majority of modern explosives utilized are high explosives.

High explosives are further subdivided into three categories: primary, secondary, and tertiary explosives. Primary explosives can be detonated from a small stimulus, such as heat, impact, friction, electrostatic discharge, or shock (Yeager, n.d.). Common primary explosives include mercury fulminate, lead azide (or Styphnate), copper acetylides, TATP, and HMTD. Secondary explosives require a larger stimulus than primaries do in order to detonate. Typically, a detonator filled with a primary explosive to create a shock will stimulate the secondary explosive enough (Yeager, n.d.). Common secondary explosives include TNT, PETN, RDX, dynamite, and NG. Tertiary explosives require an even larger stimulus to detonate. They require the energy of a secondary explosive, or a booster, in order to detonate (Yeager, n.d.). Tertiary explosives also include what is known as blasting agents. The most well-known tertiary explosive is ANFO.

A Brief History of Explosives

To understand modern explosives used in criminal and terroristic acts and how examiners investigate them, we first have to understand the history of explosives. The history of explosives is one that is long and drawn out, filled with curiosity, war, and industry. The initial development and discovery of various different types of explosives had nothing to do with terrorism and criminal acts. Throughout the years, various different chemists searched for ways to increase the heat-resistance, impact-sensitivity, and power, yet, decrease overall sensitivity to varying different stimuli for the safety of

use in the mining industry. Historically, the first discovered explosives were low explosives and sensitive high explosives, specifically primary explosives (Field, 2017).

The first explosive invented was black powder, a low explosive that is composed of a mixture of saltpetre (or potassium nitrate), sulfur, and charcoal (carbon) (Johnson, 2022). The first known recipes for black powder were written down as early as 1044 (Field, 2017). Chemically, these recipes contained less nitrate than what is common in black powder today, making the explosive less powerful. There are several conflicting reports on who first invented black powder and when it first originated; however, several sources unanimously agree that it was the Chinese who first developed black powder sometime between the seventh and tenth century during the Imperial era in China, specifically the Tang Dynasty (Field, 2017; Johnson, 2022). At the time, it was primarily used for fireworks and signals, just like in Disney's 1998 *Mulan*.

Early Chinese experimenters, propelled by curiosity, learned that when black powder was confined, it would produce a loud bang like that of a firecracker (Field, 2017). When they packed the powder into bamboo tubes and threw the tube onto a fire, an explosion would occur. This is the earliest known account of the precursors to modern day pipe bombs, which typically utilize black powder as the explosive of choice. This also depicts how low explosives will only deflagrate and produce an explosion when confined. If they are not confined, they will just burn. It was not until around the 10th century that Li Tian, a Chinese inventor, invented the first paper firecrackers (Field, 2017). Around the same time frame, the invention of the fuse allowed for users to be able to light the firecracker and then have enough time to make a quick getaway (Field, 2017). This was a major breakthrough, as it allowed for the beginning of timed charges, advancing the usefulness of explosives for more than just warfare. These early fuses

were composed primarily of either straws or feather quills that were filled with black powder (Field, 2017). Ultimately, these early fuses were not very reliable. It was not until more reliable fuses were developed in the 1800s, as a result of the copious amounts of black powder that were being applied for the mining industry, that fuses were regularly utilized (Field, 2017).

The first recorded event of the use of exploding bombs was when the Song Dynasty fell to Jin invaders from Korea in a battle that occurred in 1126 (Field, 2017). These bombs were composed of bamboo or paper and mostly just produced noise and smoke. It was not until 1150 that black powder recipes had been perfected by the addition of more nitrate that there was a significant increase in the amount of power (Field, 2017). The resulting powder had the ability to burst iron bomb casings. Bomb-making knowledge continued to advance in China, driven by curiosity and the need for more efficient and effective warfare methods.

From the invention of black powder to around the 1500s, the advancements of explosives occurred primarily on two separate sides of the world: one in China and the other in Europe. While the Chinese have been throwing explosive bombs since the early 1100s, the first initial recording of explosive bombs in Europe was not until the mid-1300s (Field, 2017). As an explosive, black powder itself “is relatively insensitive to shock and friction and must be ignited by flame or heat” (Johnson, 2022, p. 4). Historically, since black powder was first invented, it was primarily used as a propellant in guns, which was how it was being used in Europe.

The next major invention in the history of explosives resulted from the curiosity of an alchemist. In 1585, Sebald Schqartzler wrote the formula for making aurum fulminans, or fulminating gold (Field, 2017). This was the very first high explosive to be

discovered. Chemically, fulminating compounds are compounds that explode violently. This term was first used to describe aurum fulminans, exploding compounds of gold, and then used to describe various compounds of silver and mercury (Field, 2017).

The next major high explosive discovered was not until around 200 years after the discovery of fulminating gold. In 1771, Peter Woulfe discovered picric acid (2,4,6-trinitrophenol or TNP) (Field, 2017). This explosive compound was a more stable high explosive in comparison to the fulminating compounds. Initially, picric acid was utilized as a yellow dye. Between the discovery of picric acid and the mid-1800s, numerous scientists continued to experiment with explosive compounds out of curiosity. Several people were injured and some even died while experimenting, but this did not stop the interest. During this time frame, the advancements of explosives were not driven by warfare, but primarily by man's insatiable curiosity.

The next major invention in the history of explosives was the safety fuse. In 1831, William Bickford invented the safety fuse (Johnson, 2022). While this is not actually an explosive compound, this invention heavily contributed to the safe use of explosives. Following the invention of the safety fuse, the next chemical explosive to be discovered was nitroglycerin (or NG), discovered by Ascanio Sobrero in 1846 when he was experimenting with nitrating various sugar compounds (Field, 2017). Largely at the time, nitroglycerin was viewed as more of a laboratory curiosity than an explosive substance with useful detonation purposes. It was not until Immanuel Nobel's and his son Alfred's work between the years of 1859-61 that nitroglycerin had a detonation purpose (Johnson, 2022). In 1865, Nobel invented the "blasting cap, a device for detonating explosives" (Johnson, 2022, p. 7). In combination with Bickford's safety fuse,

there was now a more dependable means for detonating nitroglycerin and other high explosives that soon were to be discovered.

Between Nobel's invention of the blasting cap and his later work, trinitrotoluene (or TNT) was discovered by Julius Wilbrand in 1863 (Field, 2017). Similar to picric acid, TNT was initially used as a dye. At the time of its initial explosive discovery, TNT was not the well-known explosive it is today, with its use throughout the mining industry and throughout pop-culture.

Nobel's curiosity did not stop with the invention of the blasting cap. In 1867, Nobel invented dynamite, one of the most famous modern explosives through its use in children's cartoon shows such as Looney Tunes (Johnson, 2022). The basis of his discovery was that "kieselguhr, a porous siliceous earth, would absorb large quantities of nitroglycerin" (Johnson, 2022, p. 7). The resulting product was much safer to handle and was easier to use than just nitroglycerin alone (Johnson, 2022). Nobel went on to experiment with the ratio of nitroglycerin to "dopes" or the active ingredients such as wood pulp and sodium nitrate that he would add to nitroglycerin to improve the blasting action (Johnson, 2022). Nobel continued to experiment with nitroglycerin, and in 1875, he invented gelatinous dynamites. These explosives had a "high water resistance and greater blasting action power than comparable dynamites" (Johnson, 2022, p. 8). This made them incredibly useful for mining and other manufactural uses, such as blasting oil wells.

The next most important advancement in explosives was the switch of the use of nitroglycerin for ammonium nitrate (Johnson, 2022). The result was a safer and less expensive product. The inventions and discoveries of high explosives continued to pick up from there. From the late 1800s into the 1900s, various different high explosives

were invented out of the curiosity of scientists and the needs of the mining industry. It was not until the mid-1900s that the advancements of explosives revolved around the needs of the military and the need to develop a less sensitive but more powerful explosive that was also cost efficient.

After the invention of nitroglycerin, the next high explosive to be invented was the compound tetryl, or 2,4,6-trinitrophenylmethyl-nitramine. Tetryl was invented in 1877 by Wilhelm Michler and Carl Meyer (Field, 2017). Typically, tetryl is used in blasting caps as a primary explosive; however, it is also good as a booster (Field, 2017).

In 1891, one of the most explosive compounds known was created by Bernhard Christian Gottfried Tollens and P. Wigand (Field, 2017). Pentaerythritol or PETN is typically used as an ingredient in primer cord, also known as primacord or detcord, which is just a plastic tube full of PETN (Field, 2017). PETN was utilized by both the shoe and the underwear bomber as the main explosive charge in their suicide bombings. Luckily, both bombers were unsuccessful in their attempts.

Just before the turn of the century, Richard Wolffenstein discovered triacetone triperoxide (or TATP) in 1895 (Field, 2017). TATP is a fan-favourite for self-taught bombers as it is incredibly easy to make from common household products; however, it does have a terribly nasty habit of blowing up in your face if you are not careful. It is incredibly shocking just how easy it is to cook up multiple different types of improvised explosives with just common everyday household products.

The turn of the 19th century began the era of the expansion of military explosives. In 1898, cyclotrimethylenetrinitramine or RDX was patented by Georg Friedrich Henning (Field, 2017). RDX stands for Research Department eXplosive but also goes by the code names cyclonite, hexogen, and T4. RDX comes in a mixed variety of forms and

is utilized vastly in military explosives. The most well-known variety of RDX by the public is C-4 through its use in the military and pop-culture.

The beginning of the most revolutionary change in the explosive industry began in 1955 with the development of ammonium-nitrate-fuel oil mixtures (ANFO), as well as ammonium nitrate-base water gels (Johnson, 2022). At the same time, there was an increased need for safer explosives in the military, leading to a class of compounds that were specifically designed to be difficult to detonate. The first in this class of explosives was triaminotrinitrobenzene (TATB) (Field, 2017). By the end of the 20th century, the primary focus for the advancement in explosive technology production centered around the development of new methods for making explosives that was more cost-effective, safe, and simpler; however, there was still an underlying curiosity of if we could make it bigger, because as you know, bigger “always” means better. This led to more theoretical ideas of explosives that have yet to be made into existence.

Engineering of Explosives

As far as the engineering of explosives, there is a huge difference in military grade explosives and improvised explosives made by the “mad-bombers” in their kitchens. The majority of modern criminal acts that involve explosives deal with IEDs or improvised explosive devices (The National Academies, n.d.). The term IED did not come into common usage until 2003, during the Iraq War. These “homemade” bombs typically consist of “an initiator, switch, main charge, power source, and a container” (The National Academies, n.d., p. 1). The make of the bomb depends on the bomber’s knowledge and accessibility to resources. Each piece of a homemade bomb can easily be made from common household items, such as cleaning products and electrical supplies. It is fairly common for bombers to utilize Christmas lights or syringes for make-shift

blasting caps. In addition to the “normal” pieces of a bomb, the IEDs may be surrounded by enhancements such as nails or other metal fragments to increase the number of shrapnel that are to be propelled by the blast (The National Academies, n.d.). The more damage they can cause, the better.

The majority of chemical charges utilized in IEDs are improvised explosives cooked up in the bomber’s very own kitchen. The use of improvised high explosives has increased in usage since the 1900s, as more high explosives emerged and new methods of explosive production were discovered. Take for example Richard Reid, the shoe bomber. Reid utilized PETN, a secondary high explosive, detonated by TATP, a primary high explosive, for his improvised incendiary device (Yeager, n.d.). Both of these high explosives can be very easily produced through common household products in someone’s kitchen and cleaning supplies closet.

When low explosives are utilized as the primary charge, enough pressure needs to build in order for an explosion to occur. The resulting explosion produces lethal fragmentation. Take for example the Boston Marathon bombings that occurred in April of 2013 (Yeager, n.d.). During this case, two separate pressure cooker bombs were used. Each pressure cooker was filled with nails and ball bearings glued down to the inside of the cooker for extra shrapnel (Yeager, n.d.). In addition, the main charge utilized was black powder. Typically, pressure cooker bombs consist of a pressure cooker, as their name implies, that has been inserted with explosive material, such as black powder. Attached into the cover of the cooker is a blasting cap for the initiation of detonation (Yeager, n.d.).

All in all, the make of the bomb all depends on what the bomber has access to. A little bit of a high explosive can go a long way, as long as you have access and the

knowledge to produce said explosive. In contrast, greater quantities of low explosives and a containment device are required to have the same effect as high explosives; however, low explosives, such as black and smokeless powders, are readily available to the general public in the form of fireworks, gunpowder, and handy dandy Amazon. Amazon also has made it incredibly helpful for our friendly neighborhood bomber being that governmental agencies have limited access to track sketchy purchases (Yeager, n.d.).

Statistically speaking, this correlates to the fact that low explosives are more likely to be utilized in IED devices because it requires less knowledge for building, is more cost effective, and more efficiently available. Nevertheless, over the years, bomb-makers have become incredibly crafty with making bombs. They have found loopholes on how to purchase the products they require and have found ways to spread information via the web and social media; however, if someone tried to walk out of Home Depot with a short pipe and two end caps, that would certainly raise some red flags.

How Explosives Engineering Applies to Crime Scene Investigation

Every year, the United States Bomb Data Center releases an Explosives Incident Report. The report includes the “total number of explosives related incidents reported in the Bomb Arson Tracking System [for each year] and includes explosions and bombings, recoveries, suspicious packages, bomb threats, hoaxes, and explosives thefts/losses” (United States Bomb Data Center, 2019, p. 3). In 2019, there were a total of 14,490 explosives related incidents, and of those, 715 were explosions and 251 were bombings (United States Bomb Data Center, 2019). In comparison to the 2018 statistics, there was a 13% decrease in bombing incidents that were reported (United States Bomb Data

Center, 2019). The following chart from the 2019 Explosives Incident Report gives a brief glance at the statistics on explosive main charges from 2015-2019:

Explosion – Main Charges						
Material Subtype Description	2015	2016	2017	2018	2019	Total
Ammonium Nitrate/Prills	10	4	6	1	0	21
Expanding Gas (Overpressure Device)	10	4	6	1	0	29
Improvised/Homemade Explosives (HME) – Explosive Compounds	1	5	3	1	8	18
Improvised/Homemade Explosives (HME) – Fuel Oxidizer Mixture	46	53	47	43	14	203
Ignitable Gas	10	8	7	11	8	44
Ignitable Liquid	3	7	4	4	9	27
Ignitable Solid	0	0	0	0	1	1
Other (Not identified)	11	6	7	7	5	36
Commercial Explosives - Ammunition	0	0	0	2	3	5
Commercial Explosives – Binary	9	9	2	3	7	30
Commercial Explosives – Det Cord	0	0	0	0	2	2
Commercial Explosives – Propellant	35	53	22	23	13	146
Commercial Explosives – Pyrotechnics/Fireworks	115	126	70	59	66	436
Military Explosives – Propellants	0	0	0	0	1	1
Unknown or N/A	0	0	43	69	80	192

Table 1 – Explosion – Main Charges Statistics for 2015-2019 (United States Bomb Data Center, 2019)

From this report, there appears to be a trend of decreasing bombing incidents. It will be interesting to see the report that appears for 2020, as that was the year that the COVID pandemic started. These statistics depict the fact that overall, the main charge utilized by most explosion incidents in the United States is commercial grade pyrotechnic, or firework explosives, with a close second being the homemade explosives fuel oxidizer mixture. This correlates with the fact that low explosives such as black powder are more widely available to the public in the forms of gunpowder and fireworks and that the production of high explosives requires more knowledge.

When examining a post-blast scene in a criminal investigation, it is entirely up to the bomb technician and post-blast scene investigators to determine the chemical composition of the explosive used and the construction/type of device utilized. While examining a post-blast scene, forensic investigators and bomb technicians separate the

investigation into two separate sides: chemistry and explosives/hazardous devices. All of the pieces of shrapnel and debris from the bomb are collected by the bomb technicians, labelled, placed into separate evidence bags in order to decrease the chances of cross-contamination of evidence, and shipped to a forensics laboratory for further examination (Technical Working Group for Bombing Scene Investigation, 2000). It is then the bomb technician's job to reconstruct the hazardous device utilized. This includes locating the specific materials used by the bomber and where they could have possibly obtained them from. The resulting fragments of an IED device can hint at whether the explosive utilized was low or high. Typically, when larger fragments are found, a low explosive was used. When smaller fragments are found, a high explosive was used. When a containment device is utilized, a low explosive was used. Low explosives require enough pressure to build up inside of a device in order to detonate or else the explosive will just burn. Before the hazardous device can be reconstructed, the fragments found are swabbed for traces of explosive residues, which are then examined by explosive chemists. The surrounding post-blast scene is also swabbed for traces of explosive residues (Technical Working Group for Bombing Scene Investigation, 2000).

Back in the laboratory, the explosive chemists examine the swabs for trace levels of inorganic and organic explosive compounds, which was what I did during my internship. See Procedure beginning on page 19 for a more in-depth explanation on the extraction procedure utilized to examine trace levels of explosive residues. These collection and analysis procedures are crucial in crime scene investigations, as they are often used as evidence in court.

In court, there is almost always a question of whether or not the physical evidence that has been examined is reliable or not, particularly whether or not the

evidence has been contaminated in anyway. When dealing with explosive residues, the primary question of contamination centers around “clean” evidence collection supplies. Are the supplies used “clean” prior to use, or could there be potential background noise that could mislead data. In court, this fact could be called up, leading to questioning surrounding the explosive residue analysis results and the resulting physical evidence being dismissed or invalidated (*Residue Swabbing*, n.d.; Technical Working Group for Bombing Scene Investigation, 2000).

As a result of this potential fact, multiple studies have been conducted centering around potential sources of contamination that could potentially alter data. Until this research project, there has not been any data centered around “clean” evidence collection supplies and if these supplies could be potentially contaminated.

Current Study

When collecting post-blast explosives residues, it is important to ensure that evidence collection supplies have been exposed to as little prior contamination as possible. The collection of explosives residue occurs at the post-blast scene through various swabbing techniques. Typically, two technicians conduct the residue swabbing. The collector swabs for residue, while the assistant carries supplies, containers, and holds the clean swabs. The technicians conduct the swabbing in non-contaminated PPE (disposable gloves, Tyvek suits, and boot covers). Control swabs are utilized prior to residue collection. The control swab is swabbed over both the collector’s and assistant’s PPE (gloved hands, front torso, and sleeves of Tyvek suit). The control swabs are taken to account for what chemicals are naturally present in the environment and if there are any sources of contamination on the technicians conducting the residue collection (*Residue Swabbing*, n.d.).

Previous research conducted on the background levels of explosives has established that certain ions are ubiquitous in some environments, potentially interfering with the interpretation of crime scene data (Cullum et al., 2004; Crowson et al., 1996; Lahoda et al., 2008; Walker et al., 2001). The use of a control swab at the crime scene is supposed to account for any background noise that may interfere with interpretation of data. Previous studies have also shown that contamination risk comes mainly from the samples themselves during examination (Pawlowski et al., 2017).

Swabbing and sampling residue collection supplies are exposed to different environments during storage before implementation in a post-blast scene. The goal of this research project is to provide a reference study on background levels of explosive residues on evidence collection supplies prior to their use in post-blast scenes in order to assist the forensic community and to assist in the interpretation of crime scene data.

The data in this study was acquired with the assistance of Special Agent Bomb Technicians (SABTs) throughout the FBI. SABTs in various field offices across the United States were surveyed. Several SABTs were asked to collect evidence collection supplies in 13 different locations. The supplies were then analyzed in the FBI's Laboratory Division Explosives Unit for the presence of trace levels of inorganic and organic explosive compounds, which may interfere in explosives analysis and interpretation of results. The following provides the results of this research.

RESEARCH SUMMARY

Procedure

Prior to the analysis of the samples received in all thirteen packages, a survey was conducted focusing on the storage and acquirement of explosives residue sampling supplies. The survey was initially drafted during the second week of the internship

(week of June 13-17, 2022). See appendix 7.1 on page 33 for the figures containing all of the Explosives Background Residues Study Survey Questions as they were seen by the SABTs being surveyed. The survey was sent out to all of the SABTs in the country at the end of week 5 (week of July 4-8, 2022). While waiting for the survey results to be completed, a residue analysis was conducted on “clean” evidence collection supplies, looking for any sources of contamination. By the end of week 3 (week of June 20-24, 2022), an email was sent out requesting for several of the SABTs across the country to send in evidence collection supplies. They were specifically asked for: 2 cotton balls, 1 forceps/tweezer, 2 glass/plastic vials used to store cotton balls, 2 disposable scoops, 2 zip top bags (1 small, 1 medium), 1 paint can used for soil samples, and whatever else they commonly use to swab, collect, or store explosive post-blast/residue samples or soil samples. By the beginning of week 4 (June 27-July 1, 2022), the SABTs began to send supplies to the FBI Laboratory in Quantico. Unfortunately, all of the packages were opened by the Evidence Management Unit (EMU), meaning contamination could have occurred during this time prior to extraction. The last package was received during week 6 (July 11-15, 2022).

Before opening each package received from the SABTs, two cotton ball swabs were used to swab the outside of the package three times. One cotton ball was then extracted via acetone and the other extracted via water. The acetone extracted sample was rinsed with approximately >3 mL of HPLC grade acetone (Fisher Scientific) in a tripour beaker. The extract was then filtered with a Millipore nylon filter and run on EU-GC/ECD-3 system for screening analysis. If potential explosives were observed, the samples were then run on either the EU-LTQ-3 or EU-TSQ-2 for confirmation. If potential explosives were observed after the confirmation analysis on the LTQ or TSQ,

the samples were then run on the Orbitrap for verification due to the fact that it has a lower limit of detection (~1 ppb). At the moment, none of these samples have been run on the Orbitrap due to time limits and instrument downtime. The water extracted sample was rinsed with 3-4 mL of 18.2 MΩ deionized water in a tripour beaker. The extract was then filtered with a Millipore nylon filter and run on the Anions Carbonate system (EU-Anions-7) for screening analysis. If potential ions of interest were observed, the samples were then run on the Anions Hydroxide system (EU-Anions-8).

After the package was opened and an inventory of the samples received was taken, the samples were then extracted. If two of one type of sample was received, one sample was rinsed with approximately >3 mL of HPLC grade acetone (Fisher Scientific) and the other sample was extracted with 3-4 mL of 18.2 MΩ deionized water. If more than two samples of the same type were received, only two of the samples were randomly selected and extracted for time. If only one sample was received of that type, the sample was first rinsed with approximately <3 mL of HPLC grade acetone (Fisher Scientific) and then rinsed with 3-4 mL of 18.2 MΩ deionized water. Each extract was then filtered with a Millipore nylon filter. The samples were then analyzed following the organic and inorganic analyses described above. This process was repeated for all thirteen packages received by the SABTs.

Each instrument used throughout this project had its own specific method that was run with the sequence (see appendix section 7.2 on page 38). The extraction procedure utilized throughout the research is based off of the SOP residue extraction (*Explosive Residue Analysis SOP*, n.d.).

Methods and Materials

Chemicals:

18.2 MΩ deionized water was used for all water extractions of inorganic ions, negative control H₂O, and H₂O blanks. HPLC grade acetone (Fisher Scientific) was used for all acetone extractions of organic explosives, negative control acetone, and acetone blanks.

Standards:

Verified standards for each instrument were used throughout the analysis as the knowns/basis for confirming presence of explosive residues. See appendix 7.3 on page 40 for the list of all components found in each test mix [Anions TM (374a), ECD TM (375b), LTQ TM (383a), and TSQ TM (360b)] utilized throughout the analysis, including the compound, manufacturer, lot number, and compound in the test mix.

Materials:

All materials utilized for extraction purposes were provided for by the Explosives Unit. See appendix 7.4 on page 42 for complete list of materials and their manufacturers used throughout the extractions of the samples received.

Negative Controls:

All negative controls for acetone extraction samples were prepared by adding HPLC grade acetone (Fisher Scientific) into a tripour beaker and filtering with a Millipore nylon filter. All negative controls for water extraction samples were prepared by adding 18.2 MΩ deionized (DI) water into a tripour beaker and filtering with a Millipore nylon filter.

Instrument method and conditions:

The instruments used, were the GC/ECD, IC-Anions (carbonate and hydroxide), LTQ, and TSQ. GC/ECD stands for gas chromatography coupled with an electron

capture detector. IC stands for ion chromatography. LTQ stands for linear ion trap mass spectrometer. Lastly, TSQ stands for triple quadrupole MS/MS system with GC. MS/MS stands for tandem mass spectrometry and GC stands for gas chromatography. All of the method parameters and conditions for each specific instrument utilized can be found in the appendix, Table 7.2 on page 38.

Limits of detection:

The instrumentation used throughout this project had the following limits of detection.

GC-ECD-3 Limit of Detection (US10724029)	
GC-ECD Test Mix Explosive	LOD Detection
EGDN	250 PPB
DMDNB	25 PPB
4-NT	750 PPB
NG	75 PPB
2,4-DBT	75 PPB
TNT	100 PPB
PETN	75 PPB
RDX	75 PPB
Tetryl	75 PPB
HMX	1 PPM

Table 2 – Limits of detection for GC-ECD-3 used for all acetone sample's screening analysis

LTQ-3 Limit of Detection (LTQ20973)	
LTQ Test Mix Explosive	LOD Concentration
HMX	75 PPB
RDX	250 PPB
Tetryl	1 PPM
NG	250 PPB
PETN	100 PPB

Table 3 – Limits of detection for LTQ-3 used for all acetone sample's confirmation analysis

There was no limit of detection for either of the IC-Anions systems used. There was a LOD for the Anions-3 hydroxide system that was a good baseline for what the LOD would be for EU-Anions-8 hydroxide system.

Anions-3 Limit of Detection (11061462)	
IC Carbonate Test Mix Anions	LOD Detection
Chloride	25 PPB
Nitrite	50 PPB
Chlorate	75 PPB
Nitrate	75 PPB
Sulfate	25 PPB
Thiocyanate	75 PPB
Perchlorate	75 PPB

Table 4 – Limits of detection for Anions-3

Results and Discussion

Survey Results:

The explosive background residues study survey was sent out to 234 participants across all 56 field offices. Of the 234 surveys sent, 23% were completed and returned. This is a low response rate for survey data and may be due to fact that SABTs receive a large number of incoming emails and their large workload. Figure 7 below depicts the location of the 23 SABTs across the country who responded to the survey. Several of the SABTs who responded also commented on the inconsistency of kits/storage practices, wanted standardized kits, and asked for guidance/resources.

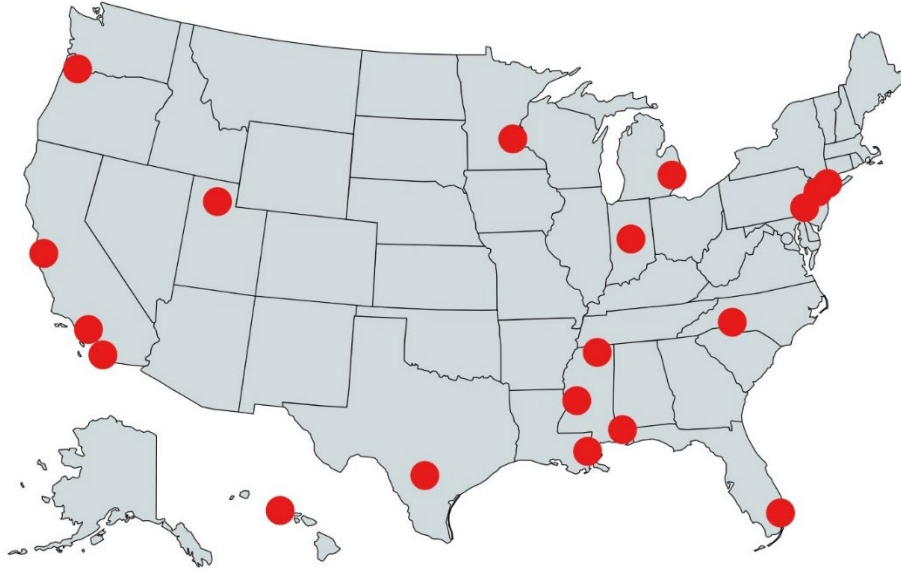


Figure 1 – SBT Survey Response Map

See appendix section 7.6 on page 43 for the results from the Explosives Background Residues Study Survey.

Explosives Residue Background Collection Supplies Extraction Results:

Thirteen SBTs responded to the email requesting evidence collection supplies. The request included minimal information on the study being conducted so as not to sway the types of items sent in or how they were handled. Between weeks 4 and 6, 13 packages were sent to the FBI Laboratory in Quantico for residue analysis. Figure 2 below depicts the location of each field office where a package was sent in from. In total, 284 samples were sent among the 13 packages received. Table 5 below depicts the package label (PKG-#), the location, the type and number of samples received for each package.

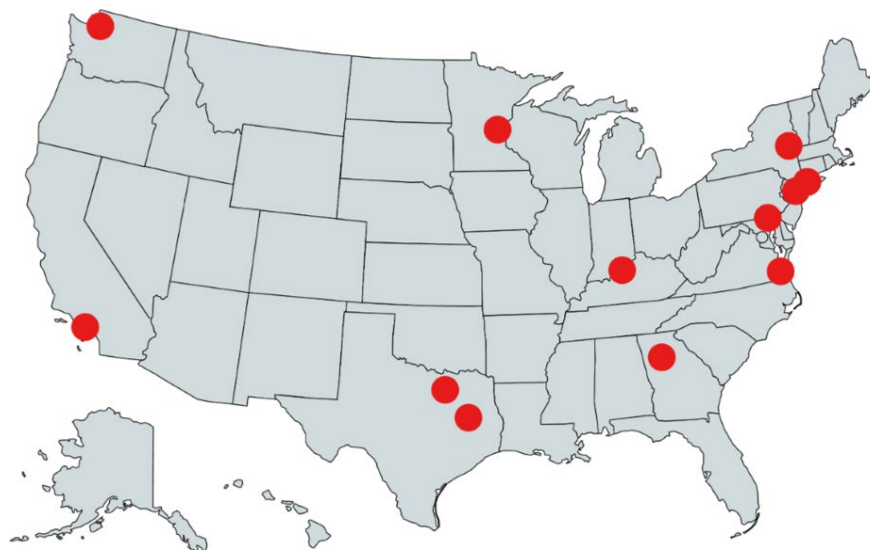


Figure 2 – SABT Package Location Map

Package Number	Location	Cotton Balls	Forceps/Tweezers	Glass/Plastic Vials	Disposable Scoops	Zip top Bag	Paint Cans	Other	Total
PKG-I	HO	4	1	2	2	2	2	5	18
PKG-II	SE	2	2	2	2	2	2	5	17
PKG-III	LS	2	1	1	1	1	1	7	14
PKG-IV	NF	0	2	0	2	2	0	2	8
PKG-V	LA	1	2	2	2	2	0	2	11
PKG-VI	AL	7	4	0	0	2	2	7	22
PKG-VII	AT	0	2	2	2	6	0	20	32
PKG-VIII	NK	6	3	15	27	19	0	39	109
PKG-IX	LA	2	1	2	2	2	1	0	10
PKG-X	NY	2	1	0	4	2	1	2	12
PKG-XI	MP	2	2	1	2	2	1	0	10
PKG-XII	DL	0	0	1	1	0	0	10	12
PKG-XIII	BA	0	0	0	0	3	0	6	9
Total	-	28	21	28	47	45	10	105	284

Table 5 – Package number, location, and type of samples received from SABTs

See appendix 7.7 on page 53 for individual package results for the organic and inorganic analysis.

Inorganic results:

Location	# Samples analyzed	# Potential Ions of Interest	# Confirmed Ions of Interest
HO (PKG-I)	13	1	0
SE (PKG-II)	11	0	0
LS (PKG-III)	9	0	0
NF (PKG-IV)	6	0	0
LA (PKG-V)	8	0	0
AL (PKG-VI)	15	7	2

AT (PKG-VII)	17	1	0
NK (PKG-VIII)	14	3	0
LA (PKG-IX)	8	0	0
NY (PKG-X)	9	0	0
MP (PKG-XI)	8	3	0
DL (PKG-XII)	7	1	0
BA (PKG-XIII)	9	3	1
Total	134	18	3

Table 6 – Overall inorganic explosive analysis results

Each sample was examined for several ions of interest. The ions of interest were elevated levels of nitrate and the presence of chlorate and/or perchlorate. The initial screening analysis presented a total of 18 potential ions of interest: 15 were possible chlorate ions and 3 were possible elevated levels of nitrate ions. The confirmation analysis presented that only 3 of the 18 potential ions of interest were confirmed as nitrate ions. None of the samples have confirmed chlorate ions. The confirmed ions of interest were nitrate in samples BG-2 and BG-4 from PKG-VI and BG-6 from PKG-XIII. BG-2 sample was a blue examiner glove, potentially a Technitrile glove from BlueThunder. BG-4 and BG-5 were black examiner gloves, most likely Microflex black nitrile gloves. Based off of previous research done within the Explosives Unit, nitrate is a common background ion on various different types of nitrile examiner gloves. Therefore, the elevated levels of nitrate found in these three samples do not indicate traces of explosive residue and are likely naturally occurring on that type of background material. The previous research conducted was the Cleanroom Glove Extraction Project by JenaMarie Baldaino and Gloves and Tweezer Study by Joseph Stein.

Organic Results:

Location	# Samples analyzed	# Potential Explosives	# Confirmed Explosive
HO (PKG-I)	13	0	0
SE (PKG-II)	11	0	0
LS (PKG-III)	9	0	0
NF (PKG-IV)	6	0	0

LA (PKG-V)	8	0	0
AL (PKG-VI)	15	3	0
AT (PKG-VII)	17	0	0
NK (PKG-VIII)	14	0	0
LA (PKG-IX)	8	0	0
NY (PKG-X)	9	0	0
MP (PKG-XI)	8	1	1
DL (PKG-XII)	7	2	0
BA (PKG-XIII)	9	8	1
Total	134	14	2

Table 7 – Overall organic explosive analysis results

Each sample was examined for multiple different explosives. The explosives that were being looked for in the samples were: EGDN, DMDNB, NG, R-Salt, 2,4-DNT, ETN, TNT, PETN, RDX, Tetryl, and HMX. The initial screening analysis presented a total of 14 potential explosives: 3 were possible TNT, 3 were possible RDX, 1 was possible PETN, 1 was possible NG, 5 were possible Tetryl, and 1 was possible R-Salt. The confirmation analysis presented that only 2 of the 14 potential explosive residues were confirmed. The confirmed explosive residues were PETN on sample CB-45 (PKG-XI) and RDX on sample TD-9 (PKG-XIII).

The confirmation and random sampling analysis on the LTQ did present 4 potential explosive residues found due to the lower limit of detection. These have yet to be further confirmed and would need to be additionally confirmed on the Orbitrap, which has an even lower limit of detection.

Sample CB-3 (PKG-1) was part of the screening analysis. The initial results from the GC/ECD presented no traces of explosive residue and results from the LTQ presented possible RDX and Tetryl traces. Sample PB-28 (PKG-XIII) presented possible Tetryl traces during the initial analysis on the GC/ECD. During the LTQ confirmation analysis, presence of Tetryl was negative and there was possible RDX traces. Sample TD-9 (PKG-XIII) presented possible RDX and Tetryl traces during the initial analysis. During the

confirmation analysis, the presence of RDX was confirmed and the presence of Teteryl was negative. Instead, possible PETN was observed. Overall, there were only two confirmed positive samples of explosive residue.

Discussion & Recommendations

In this project, 234 SABTs were sent a survey (23 responded) and 284 evidence collection supply samples were received from 13 SABTs across the U.S. 268 of the samples received were analyzed for explosives residue. The results yielded that nitrate, chloride, and sulfate were ubiquitous ions present in nearly all samples. The ions of interest, such as chlorate and perchlorate, were not confirmed on any of the samples. For organic explosives, the results yielded that the chances of finding contamination of high explosive residues in “clean” residue sampling supplies is extremely rare. Only two of the samples sent had confirmed levels of explosives. Similar results were recorded in another study conducted on the background levels of explosives in the environment (Lahoda et al., 2008).

These results demonstrate that it is possible for “clean” explosive residue sampling supplies to be contaminated prior to use, although it is extremely rare, at a very minute amount, and would be accounted for in the control swabs.

As mentioned previously, several of the SABTs who responded to the survey commented on the inconsistency of kits/storage practices, wanting standardized kits, and asked for guidance/resources. I would recommend composing several handouts on these issues into a shared folder that is then shared among all of the SABTs in the 56 field offices. The handouts would include recommendations of specific supplies for swab kits, of storage practices, and examples of the Explosives Unit’s standardized kit for guidance. Standardizing storage practices and swab kits would increase the strength of

the physical evidence's testimony in court. The folder should be updated and maintained by the Explosives Unit. The Explosives Unit already has documents containing information on swab kit contents for examples of what information should be shared (Federal Bureau of Investigations Explosives Unit, 2016; *Residue Collection Swab Kit Contents*, n.d.).

I would also recommend that similar surveys of "clean" swab materials should be conducted with samples being collected from several SABTs from all 56 field offices. While this would be time consuming, it would help to give a better understanding of where the minute levels of explosive residues could be coming from prior to use. In addition to expanding the area of sampling, each package received should contain the same type of residue swab material from each SABT surveyed for consistency. In addition to that, each sample received should be run on both IC-Anion and IC-Cation systems for the inorganic analysis, as well as GC/ECD, LTQ, and Orbitrap for the organic analysis. Due to time, no samples were run on the IC-Cation system and Orbitrap and not every sample was run on the LTQ system in this research.

Acknowledgments

Thank you again to all the SABTs who sent in items for this project. As a thank you, an explosive residue swab kit pre-made by the Explosives Unit in Quantico was sent to each of those SABTs.

Thank you for all the SABTs who completed the survey. Your help was very much appreciated.

References

- Cullum, McGavigan, C., Uttley, C., Stroud, M., & Warren, D. (2004). *A Second Survey of High Explosives Traces in Public Places*. Journal of Forensic Sciences, 49(4), 1–7. <https://doi.org/10.1520/JFS2003237>
- Crowson, Cullum, H., Hiley, R., & Lowe, A. (1996). *A Survey of High Explosives Traces in Public Places*. Journal of Forensic Sciences, 41(6), 980–989. <https://doi.org/10.1520/JFS14035J>
- Federal Bureau of Investigations Explosives Unit. (n.d.). *Federal Laboratory EU Explosive Residue Analysis SOP*. Department of Justice.
- Federal Bureau of Investigations Explosives Unit. (n.d.). *FBI Laboratory EU Explosives Residue Swabbing – Quick Reference Guide*. Department of Justice.
- Federal Bureau of Investigations Explosives Unit. (n.d.). *FBI SALT Directory*. Department of Justice.
- Federal Bureau of Investigations Explosives Unit. (2016). *Medium Combination Swab Kit Contents*. Department of Justice.
- Federal Bureau of Investigations Explosives Unit. (n.d.). *Residue Collection Swab Kit Contents*. Department of Justice.
- Federal Bureau of Investigations. (1941, April). *The Explosive Unit History*. Department of Justice.
- Field, S. Q. (2017). *Boom! The Chemistry and History of Explosives*. Chicago: Chicago Review Press.
- Johnson, N. G. (2022, August 12). *Explosive: chemical product*. Retrieved from Encyclopedia Britannica: <https://britannica.com/technology/explosive>
- Lahoda, Collin, O. L., Mathis, J. A., LeClair, H. E., Wise, S. H., & McCord, B. R. (2008). *A Survey of Background Levels of Explosives and Related Compounds in the Environment*. Journal of Forensic Sciences, 53(4), 802–806. <https://doi.org/10.1111/j.1556-4029.2008.00743.x>
- Mauricio, Abritta, V. R. M., de Lacerda Aquino, R., Ambrósio, J. C. L., Logrado, L. P. L., & Weber, I. T. (2020). *Evaluation of interferers in sampling materials used in explosive residue analysis by ion chromatography*. Forensic Science International, 307, 109908–109908. <https://doi.org/10.1016/j.forsciint.2019.109908>

- The National Academies. (n.d.) *IED Attack: Improvised Explosive Devices*. Department of Homeland Security.
https://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf
- Oxley, Smith, J., Resende, E., Pearce, E., & Chamberlain, T. (2003). *Trends in Explosive Contamination*. *Journal of Forensic Sciences*, 48(2), 1–9.
<https://doi.org/10.1520/JFS2002158>
- Pawlowski, Matyjasek, L., Cieslak, K., & Karpinska, M. (2017). *Contamination with explosives in analytical laboratory procedure*. *Forensic Science International*, 281, 13–17. <https://doi.org/10.1016/j.forsciint.2017.10.018>
- Technical Working Group for Bombing Scene Investigation. (2000, June). *A Guide for Explosion and Bombing Scene Investigation*. Department of Justice.
<https://www.ojp.gov/pdffiles1/nij/181869.pdf>
- United States Bomb Data Center. (2018). *2018 Explosives Incident Report (EIR)*. Bureau of Alcohol, Tobacco, Firearms, and Explosives.
<https://www.atf.gov/file/136971/download>
- United States Bomb Data Center. (2019). *2019 Explosives Incident Report (EIR)*. Bureau of Alcohol, Tobacco, Firearms, and Explosives.
<https://www.atf.gov/file/143481/download>
- Walker, Cullum, H., & Hiley, R. (2001). *An Environmental Survey Relating to Improvised and Emulsion/Gel Explosives*. *Journal of Forensic Sciences*, 46(2), 254–267. <https://doi.org/10.1520/JFS14958J>
- Yeager, K. (n.d.) *Improvised Explosives in Terrorism*. FBI Laboratory Explosives Unit.

Appendix

7.1 Explosives Background Residues Study Survey Questions

Explosive Background Residues Study

1. How many years have you been an SABT? *

Enter your answer

2. Have you attended the Post Blast Investigator's School? *

☐ Yes

☐ No

☐ Other

3. For your explosives residue sampling supplies (e.g., cotton swabs, forceps, vials, bags, paint cans, etc.) and PPE (e.g., gloves, Tyvek suits), do you have a clean, explosives residue-free clean room to store the supplies prior to use? *

☐ Yes, SABT space

☐ Yes, ERT space

☐ Yes, shared office space

☐ No

☐ Other

4. How often do you clean or decontaminate this room? *

Enter your answer

Figure 7.1.1 – Explosive Background Residues Study Survey Questions 1-4

5. How are your residue collection supplies and PPE stored in the clean room? *

- ☐ In original store-bought containers
- ☐ In heat sealed bags
- ☐ In pre-assembled kits
- ☐ Other

6. Do you assemble your own kits or use purchased kits? *

- ☐ Assemble own kits as needed
- ☐ Purchased kit (e.g., OOV, Lynn Peavey)
- ☐ Other

7. Do you store the kits in your S&BT response vehicle so they are readily available? *

- ☐ Yes
- ☐ No
- ☐ Other

8. If stored in a vehicle, how do you protect them against explosives contamination? *

- ☐ Stored in heat sealed bags
- ☐ Stored in a plastic container
- ☐ Other

Figure 7.1.2 – Explosive Background Residues Study Survey Questions 5-8

9. Where do you acquire your cotton balls? *

☐ ERT

☐ SABT purchase

☐ Other

10. How do you store them in a post-blast kit prior to use? *

☐ Stored in original bulk bag

☐ Subdivided into groups in smaller bags/containers

☐ Placed into individual vials

☐ Other

11. Where do you acquire your gloves? *

☐ ERT

☐ SABT purchase

☐ Office supply room

☐ Other

12. How do you store them in a post-blast kit prior to use? *

☐ Stored in original box

☐ Subdivided into small groups in smaller bags

☐ Subdivided into pairs in smaller bags

☐ Other

Figure 7.1.3 – Explosive Background Residues Study Survey Questions 9-12

13. When collecting post-blast residue samples, after donning a Tyvek suit, do you change gloves or place a second pair over the first? *

- ☐ Change gloves
- ☐ Second pair over the first
- ☐ I have not collected post-blast residue
- ☐ Other

14. While collecting post-blast residue samples, how often do you change gloves while swabbing for residue? *

- ☐ Change after collecting control swabs
- ☐ Change after ever control and surface swab
- ☐ I do not change gloves
- ☐ Other

15. Do you use forceps or tweezers to hold the cotton ball while swabbing for post-blast residues? *

- ☐ Forceps, disposable
- ☐ Tweezers, disposable
- ☐ Tweezers, reusable
- ☐ Hold cotton ball in gloved hand
- ☐ Other

16. Where do you acquire you forceps? *

- ☐ ERT
- ☐ SABT purchase
- ☐ Other

Figure 7.1.4 – Explosive Background Residues Study Survey Questions 13-16

17. Do you use new forceps/tweezers after collecting each swab? *

☐ Yes

☐ No

☐ Other

18. If reusing forceps/tweezers, what do you use to decontaminate/clean them? *

☐ Water

☐ IPA wipes

☐ Other

19. Have you ever not had residue collection supplies available when needed? *

☐ Yes, I have worked scenes with no supplies

☐ No, I have always had the proper supplies available

☐ Other

20. If yes, what did you do to collect residue swabs? *

☐ Used makeshift items (e.g., napkins, plastic bags)

☐ Purchased at stores in area

☐ Other

21. Have you ever ran out of supplies at a post-blast/residue collection scene? *

☐ Yes

☐ No

☐ Other

Figure 7.1.5 – Explosive Background Residues Study Survey Questions 17-21

22. If yes, what do you do? *

☐ Call ERT to use their supplies

☐ Call another SABT to use their supplies

☐ Purchased at stores in area

☐ Other

23. Do you reuse unused parts of residue kits or boxes of gloves for other scenes? *

☐ Yes

☐ No

☐ Other

24. If no, what do you do with the items? *

☐ Disposed of

☐ Used for training

☐ Other

25. If yes, what type of scenes are they used? *

☐ Residue/post-blast scenes

☐ Bulk collection scenes

☐ General evidence collection

☐ Other

26. Do you have any additional comments regarding storage or preparation of post-blast swabbing supplies? *

Enter your answer

Figure 7.1.6 – Explosive Background Residues Study Survey Questions 21-26

7.2 Instrument Method and Conditions

GC-ECD-3 Operating Conditions	
Oven	Agilent 7890A
Wash Vials	Acetone
Split mode injection	5:1 ratio
Inlet temp	225 °C
Oven temp	50 °C to 250 °C

Oven Program	50 °C for 1.5 min then 25 °C/min to 250 °C for 0.5 min
Column	Agilent DB-5MSAgilent DB-5MS
Run Time	10 min
Injection Volume	1 uL
Detector temp	275 °C
Gas flow	25 mL/min
Software	Chemstation
Method	C:\Chem32\1\METHODS\EXSPLIT.M

Table 7.2.1 – Details of GC/ECD operating conditions

TSQ Operating Conditions	
Method Type	Acquisition – General
Instrument Type	TSQ 8000 Evo
MS Transfer Line Temp	260 °C
Ion Source Temp	185 °C
Split mode injection	15.0 mL/min
Initial temp	60.0 °C
Oven temp	60 °C to 260 °C
Injection Volume	1 uL
Ionization Mode	CI
CI Gas Type	Methane
CI Gas flow	2 mL/min
Software	Thermo Xcalibur
Method	C:\Xcalibur\methods\Expl NICI

Table 7.2.2 – Details of TSQ operating conditions

LTQ Operating Conditions	
Oven Model	CTO-20AC
Autosampler Model	SIL-20AC/HT
Instrument Type	Thermo Scientific LTQ XL
Pump A	3.125 mM ammonium nitrate in DI H ₂ O
Pump A Model	LC-20AD
Pump B	methanol
Pump B Model	LC-20AD
Pump C	Wash solvent column flush (75% methanol 25% DI H ₂ O)
Pump C Model	LC-20AD
Pumping Mode	Binary Flow
Total Flow	0.3000 mL/min
Pressure Range (Pump A/B)	0 – 4000 psi
Pressure Range (Pump C)	0 – 4000 psi
Run Time	10 min
Software	Thermo Xcalibur
Method	C:\Xcalibur\methods\EXP

Table 7.2.3 – Details of LTQ operating conditions

EU-Anions-7 Operating Conditions	
Instrument Type	IC-CARBONATE
Eluent	18.2 MΩ deionized water
Program	Isocratic (10 mM)
Injection Volume	25 uL
Operating Temperature	30 °C
Method	ANIONS-CARBONATE
Processing Method	Anions-Carbonate Processing Method
Run Time	16 min
Retention Time	5%
Software	Chromeleon

Table 7.2.4 – Details of IC-Anions carbonate operating conditions

EU-Anions-8 Operating Conditions	
Instrument Type	IC-HYDROXIDE
Eluent	18.2 MΩ deionized water
Program	Gradient (20-80 mM)
Injection Volume	25 uL
Operating Temperature	30 °C
Method	Anions-KOH
Processing Method	Anions KOH Processing Method
Run Time	25 min
Retention Time	3%
Software	Chromeleon

Table 7.2.5 – Details of IC-Anions hydroxide operating conditions

7.3 Standards/Test Mixes

Inorganic test mix used was initially prepared 06/17/2020 (JB).

374a Anions TM 20 ppm IN 18.2 MΩ DI H₂O	
Compound	Manufacturer, Lot#
Calcium L-Threonate	TCI, 3HT4O
Chloride	SpeX, 12-153AS
Nitrite	SpeX, 12-13AS
Chlorate	SpeX, 12-86AS
Sulfate	Spex, 10-139AS
Oxalate IC Standard	Sigma Aldrich, BCCB7816
Thiosulfate	Fluka, LRAA1584
Thiocyanate	SpeX, 13-30AS
Perchlorate	SpeX, 13-31-AS

Table 7.3.1 – 374a Anions TM 20 ppm

Verified: 06/10/2022 (JB)

Organic test mix used for GC/ECD instrument was initially prepared 06/29/2021
(RWP).

375b ECD TM 10 ppm in Acetone, Fisher, Lot 170940	
Compound	Manufacturer, Lot#
EGDN (324)	Cerilliant, FN042913-02
DMDNB (321)	Spex, EN160510005
NG (273)	Cerilliant, FN052108-01
R-Salt (344)	AccuStandard, 217081429
2,4-DNT (100)	Cerilliant, FN042111-03
ETN (112b)	Synthesized In-House, 091614a
TNT (315)	Cerilliant, ER08131501
PETN (320)	Cerilliant, FN04201502
RDX (88)	Cerilliant, ER071910-01
Tetryl (319)	Cerilliant, ER081012-01
HMX (89)	Cerilliant, ER051210-01

Table 7.3.2 – 375b ECD TM 10 ppm

Verified: 06/29/2021 (RWP)

Organic test mix used for LTQ instrument was initially prepared 07/29/2022 (JB).

383a LTQ TM 10 ppm in Acetone, Fisher, Lot 175460	
Compound	Manufacturer, Lot#
HMX	Cerilliant, ER051210-01
RDX	Cerilliant, ER071910-01
Tetryl	Cerilliant, ER112310-02
NG	Cerilliant, FN07091503
PETN	Cerilliant, FN04201502

Table 7.3.3 – 383a LTQ TM 10 ppm

Verified: 07/29/2022 (JB)

Organic test mix used for TSQ instrument was initially prepared 03/05/2018 (JB).

360b TSQ TM 10 ppm in Acetone, Fisher, Lot 170940	
Compound	Manufacturer, Lot#
EGDN	Restek, A0127817
4-NT	AccuStandard, 215081096
2,6-DNT	Cerilliant, ER121908-03
2,4-DNT	Cerilliant, FN042111-03
TNT	Cerilliant, ER08131501
1,3-DNN	Aldrich, 05117EA

1,5-DNN	Aldrich, 06203EN
1,8-DNN	Aldrich, 06019PR

Table 7.3.4 – 360b TSQ TM 10 ppm

Verified: 03/05/2018 (JB)

7.4 Materials

Tyvek Lab Coat – Medium from Uline

Microflex CE4-313 Class 10 nitrile Clean Room Gloves, Powder Free; Size Small from criticaltool.com

Fisherbrand Tri-cornered Polypropylene Beakers:100 mL and 250 mL from Fisher Scientific

Nalgene Polypropylene Scissor-type Forceps from Fisher Scientific

DR Instruments Operating Scissors with Sharp/Sharp Points from Fisher Scientific

BD Disposable syringes with Luer-lok tips: No. 309657; Volume: 3mL from Fisher Scientific

Millex-GN 0.2 um, nylon, 33mm, non-sterile from EMD Millipore

Fisherbrand 5 3/4" Disposable Pasteur Pipets, Borosilicate Glass, Non-sterile from Thermo Fisher

2mL, Clear Glass I-D, 12x32mm, Flat Base, Target Snap-It 11mm Crimp/Snap vial from Thermo Fisher

250uL, Clear Glass, 12x32mm, Fused Insert, Target Snap-It 11mm Crimp/Snap Vial from Thermo Fisher

Dionex AS-AP Autosampler Vial Kits from Thermo Fisher

Polypropylene 12x32mm Snap Neck Vial with Cap and Preslit PTFE/Silicone Septa, 700 uL Volume from Waters

Seal, AI Crimp, 11 mm, PTFE/Sil., Silver, High Purity GC Septa from Sun-SRI

Analytical Sales & Services Crimp Cap with Pre-Slit, 20034SL-CASE from Fisher Scientific

Fisherbrand disposable borosilicate glass tubes with plain end: O.D. x L: 16 x 100mm from Fisher Scientific

Fisherbrand Nonsterile Plastic Culture Tubes from Fisher Scientific

Fisherbrand TainerTop Safety Closures, 16mm from Fisher Scientific

Dispo (plastic pipets) from Fisher Scientific

Fisherbrand Nonsterile Cotton Balls, Medium from Fisher Scientific

7.5 Sample Preparation: Abbreviation Table

Item name abbreviation key

Abbreviation	Name
PKG	Package
PKG-I	Package one
PKG-II	Package two
PKG-III	Package three
PKG-IV	Package four

PKG-V	Package five
PKG-VI	Package six
PKG-VII	Package seven
PKG-VIII	Package eight
PKG-IX	Package nine
PKG-X	Package ten
PKG-XI	Package eleven
PKG-XII	Package twelve
PKG-XIII	Package thirteen
NC	Negative control
Ace	Acetone
H ₂ O	Water
CB	Cotton ball
PC	Paint can
PB	Plastic bag
GV	Glass vial
SP	Disposable spatula
PP	Plastic pipette
TD	Tongue depressor
TW	tweezer
EB	Evidence bag
GJ	Glass jaw
CS	Cotton swab
BG	Black or blue gloves
PTA	Polyester-tipped applicators
SY	Syringe
SC	Disposable scoop
PV	Plastic vial
PT	Plastic tube
DS	Dirt stake
TP	Transfer pipette
SS	Sterile swab
RD	Recovery device
LP	Large plastic pipette
TTD	Tiny tongue depressor
NAP	Non-adherent pad
SL	Disposable scalpel

Table 7.5.1 – Abbreviation key for sample names

7.6 Explosives Background Residues Study Survey Results

7.6.1 Question 1 Results:

Respondent Number	Number of Years as an SBT
1	12
2	6
3	15
4	9
5	7
6	14
7	8
8	7

9	10
10	14
11	15
12	3
13	4
14	9
15	12
16	6
17	13
18	2
19	3
20	8
21	2
22	10
23	3
Lowest	2 yrs
Highest	15 yrs
Average	8.35 yrs

Table 7.6.1 – How many years have you been an SBT?

7.6.2 Question 2 Results:

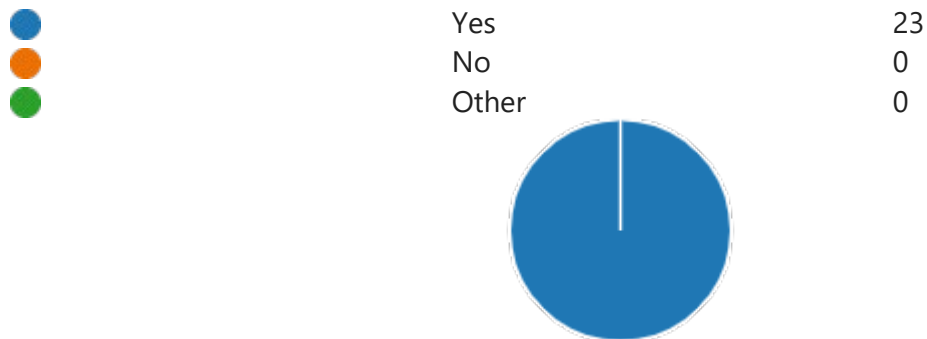


Figure 7.6.1 – Have you attended the Post-Blast Investigator's School?

7.6.3 Question 3 Results:

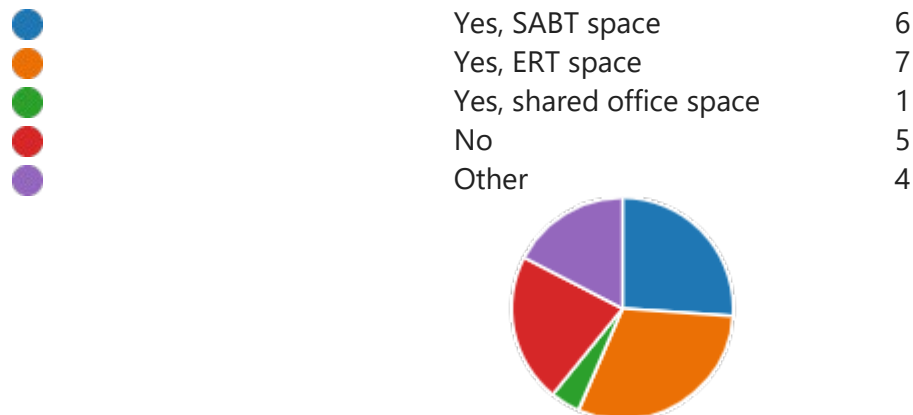


Figure 7.6.2 – For your explosives residue sampling supplies and PPE, do you have a clean, explosives residue-free clean room to store the supplies prior to use?

7.6.4 Question 4 Results:

Respondent Number	Response
1	Never
2	Not often
3	Never
4	n/a
5	Never
6	Don't have one
7	Never
8	n/a
9	None
10	Unknown
11	Fairly new SABB room
12	n/a
13	Never
14	Don't
15	ERT's responsibility
16	ERT's responsibility
17	Clean as needed, not decontaminated
18	SABB space also houses explosives
19	Vehicle cleaned ~monthly, not decontaminated
20	At least once a month
21	Never
22	n/a
23	Weekly

Table 7.6.2 – How often do you clean/decontaminate this room?

7.6.5 Question 5 Results:

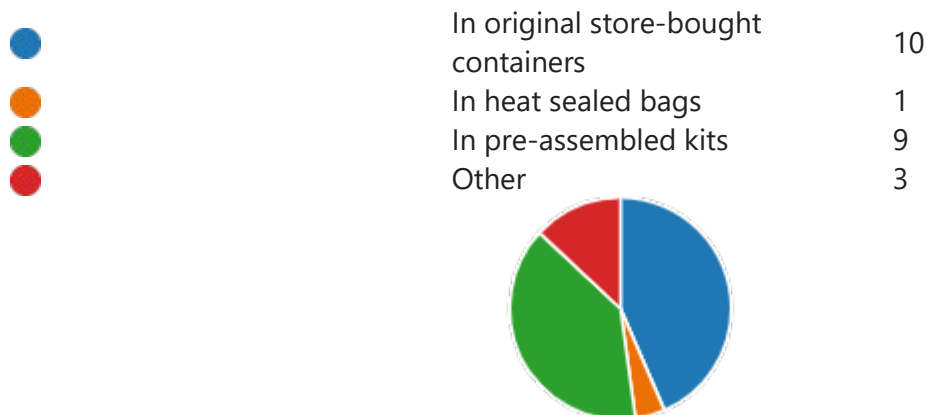


Figure 7.6.3 – How are your residue collection supplies and PPE stored in clean room?

7.6.6 Question 6 Results:

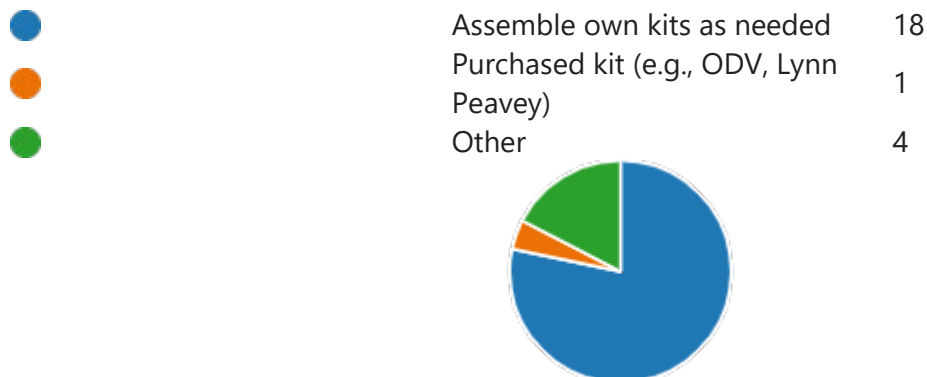


Figure 7.6.4 – Do you assemble your own kits or use purchase kits?

7.6.7 Question 7 Results:

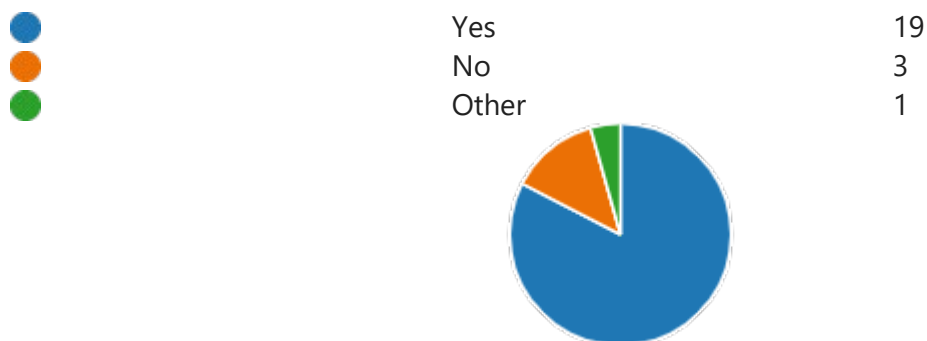


Figure 7.6.5 – Do you store the kits in your SBT response vehicle so they are readily available?

7.6.8 Question 8 Results:

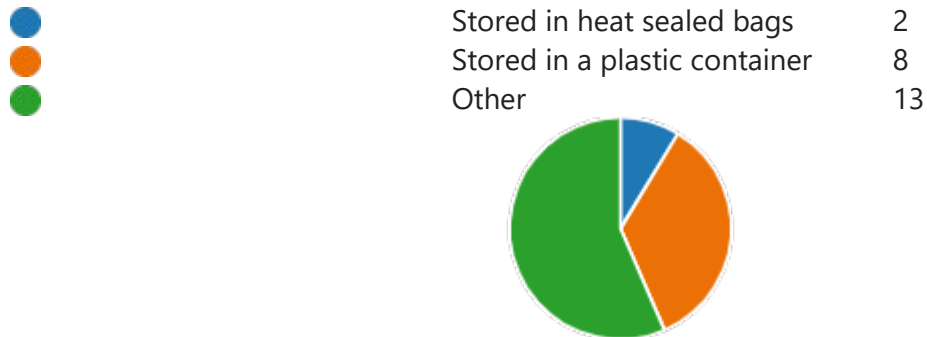


Figure 7.6.6 – If stored in a vehicle, how do you protect them against explosives contamination?

7.6.9 Question 9 Results:

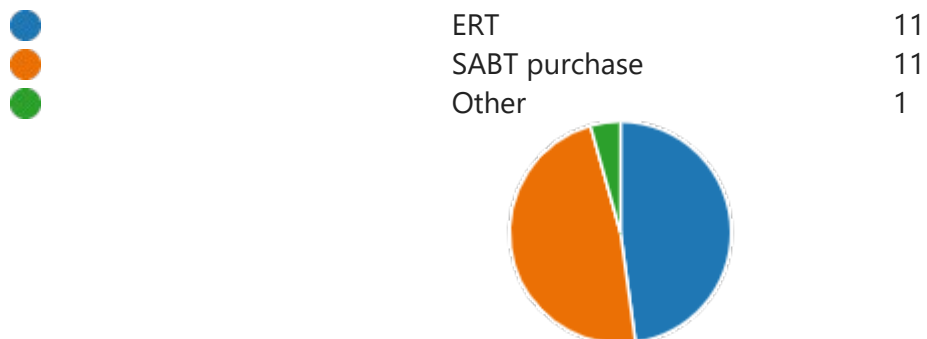


Figure 7.6.7 – Where do you acquire your cotton balls?

7.6.10 Question 10 Results:

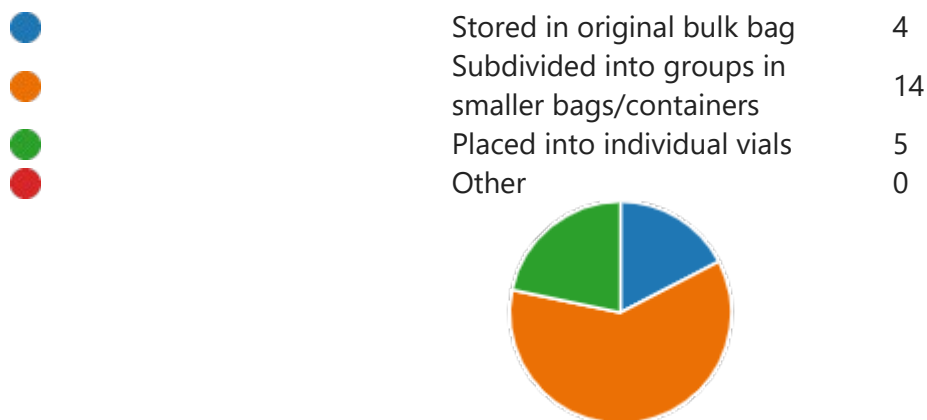


Figure 7.6.8 – How do you store them in a post-blast kit prior to use?

7.6.11 Question 11 Results:

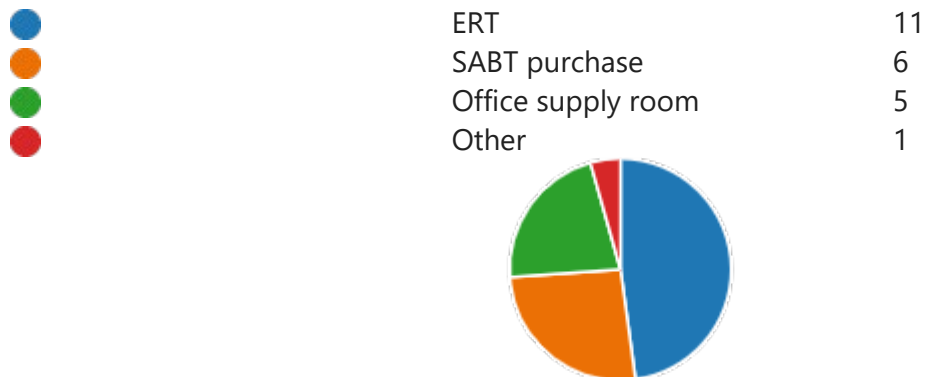


Figure 7.6.9 – Where do you acquire your gloves?

7.6.12 Question 12 Results:

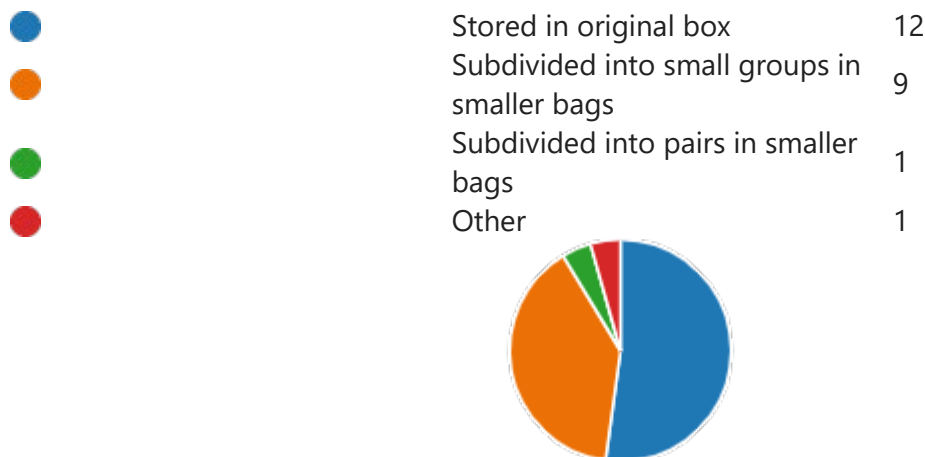


Figure 7.6.10 – How do you store them in a post-blast kit prior to use?

7.6.13 Question 13 Results:



Figure 7.6.11 – When collecting post-blast residue samples, after donning a Tyvek suit, do you change gloves or place a second pair over the first?

7.6.14 Question 14 Results:

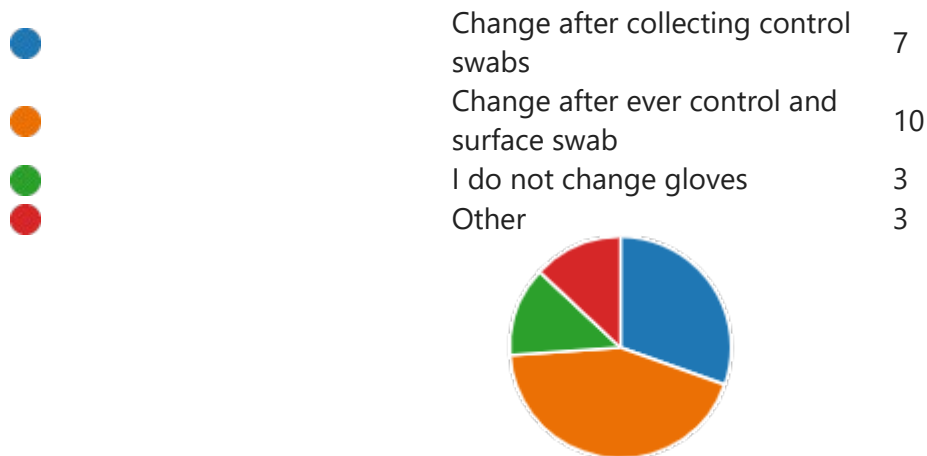


Figure 7.6.12 – While collecting post-blast residue samples, how often do you change gloves while swabbing for residue?

7.6.15 Question 15 Results:

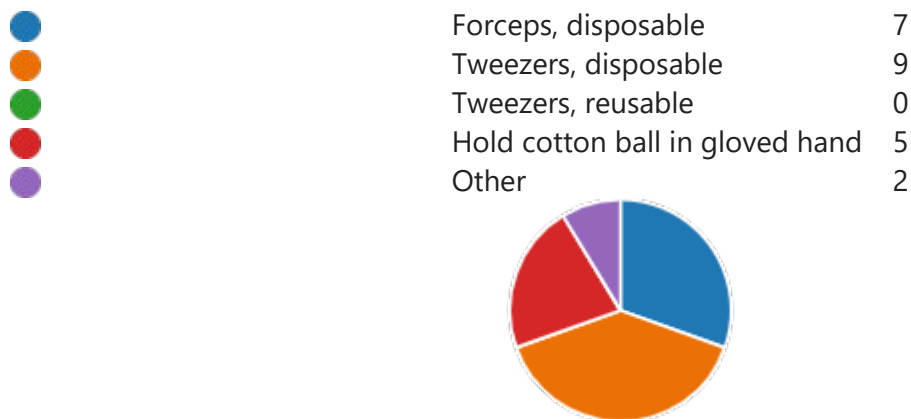


Figure 7.6.13 – Do you use forceps or tweezers to hold the cotton ball while swabbing for post-blast residue?

7.6.16 Question 16 Results:

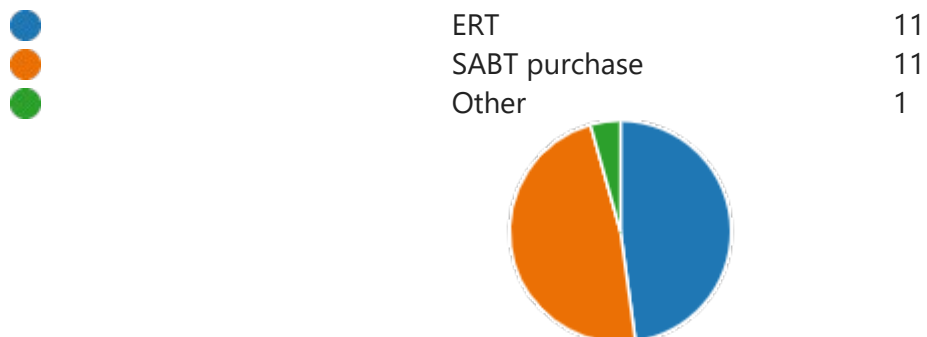


Figure 7.6.14 – Where do you acquire your forceps?

7.6.17 Question 17 Results:

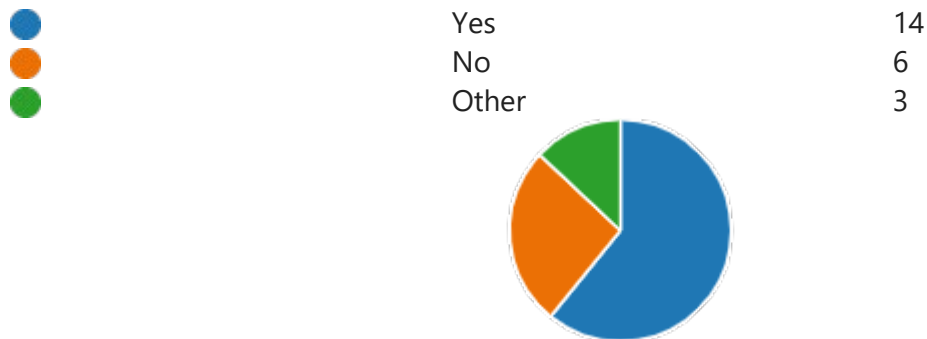


Figure 7.6.15 – Do you use new forceps/tweezers after collecting each swab?

7.6.18 Question 18 Results:

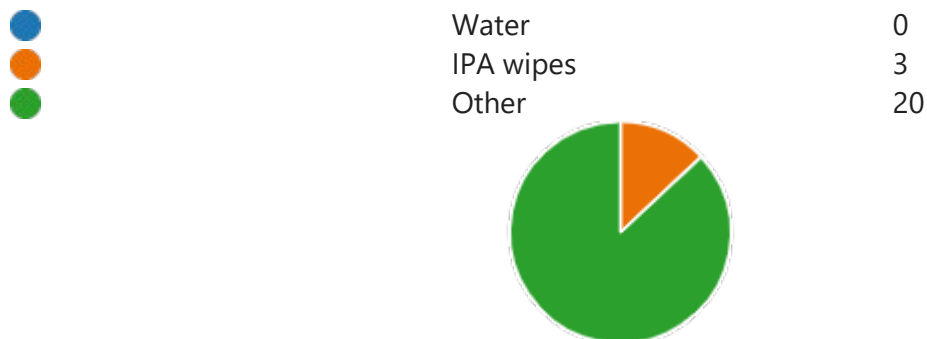


Figure 7.6.16 – If reusing forceps/tweezers, what do you use to decontaminate/clean them?

7.6.19 Question 19 Results:

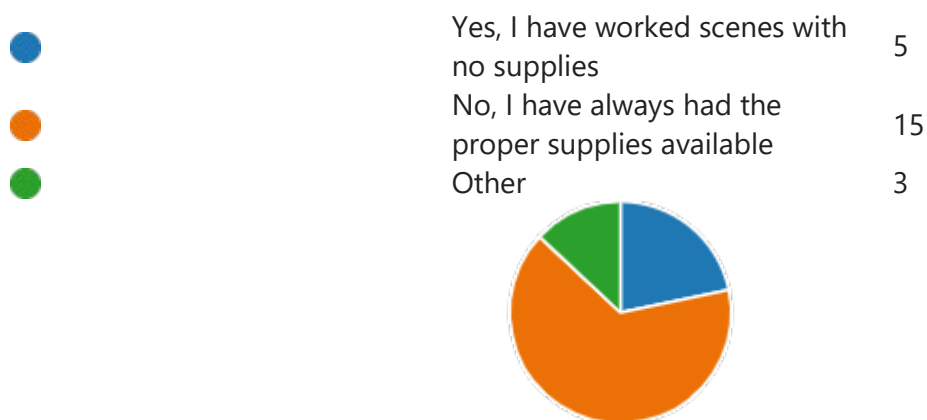


Figure 7.6.17 – Have you ever not had residue collection supplies available when needed?

7.6.20 Question 20 Results:



Figure 7.6.18 – If yes, what did you do to collect residue swabs?

7.6.21 Question 21 Results:

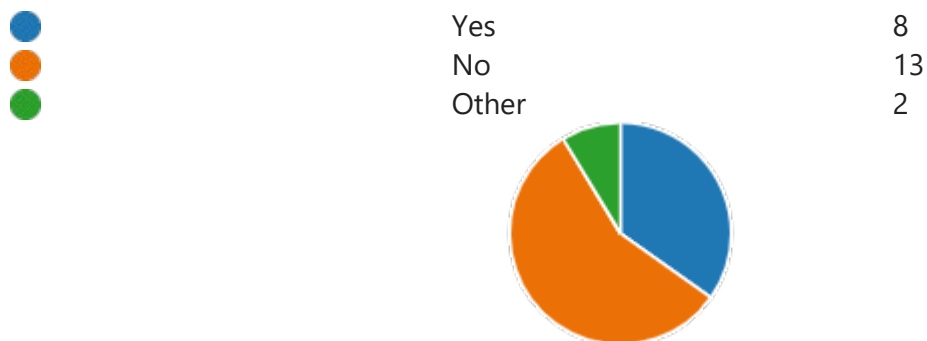


Figure 7.6.19 – Have you ever ran out of supplies at a post-blast/residue collection scene?

7.6.22 Question 22 Results:

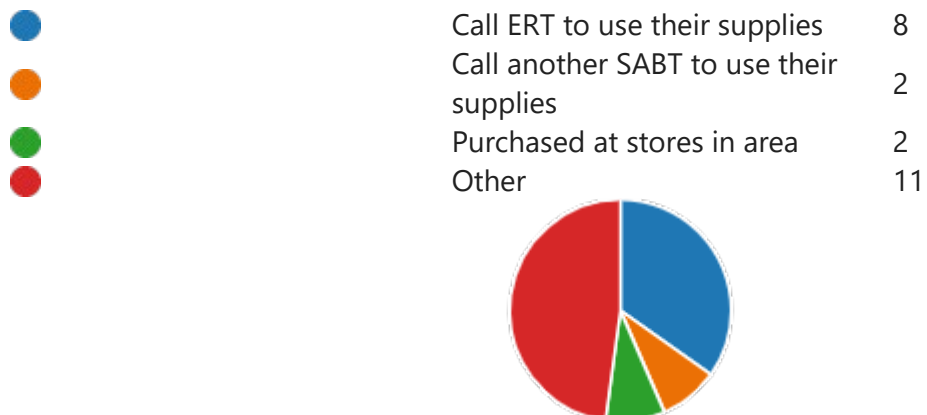


Figure 7.6.20 – If yes, what do you do?

7.6.23 Question 23 Results:

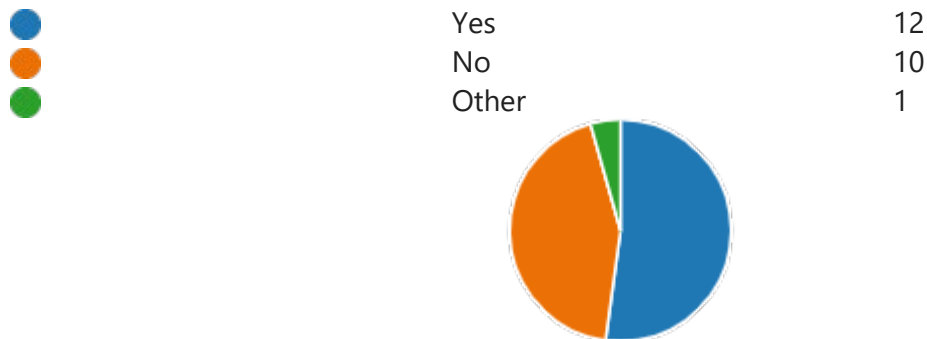


Figure 7.6.21 – Do you reuse unused parts of residue kits or boxes of gloves for other scenes?

7.6.24 Question 24 Results:

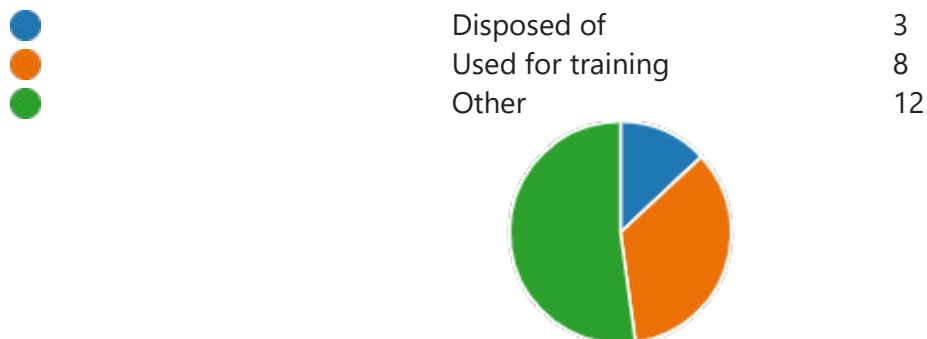


Figure 7.6.22 – If no, what do you do with the items?

7.6.25 Question 25 Results:

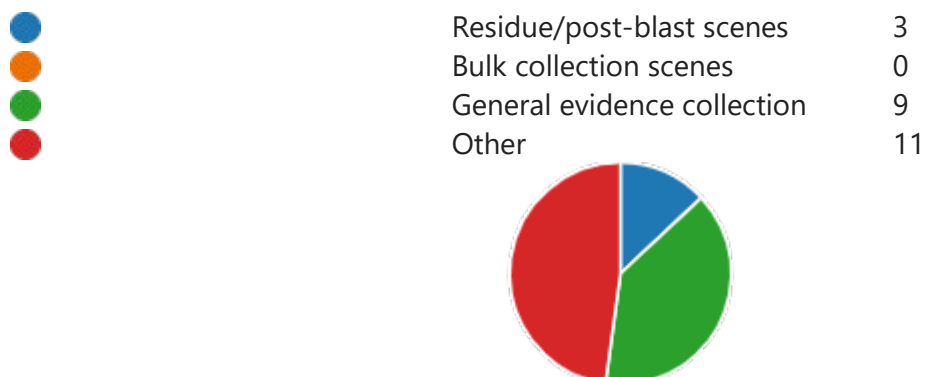


Figure 7.6.23 – If yes, what type of scenes are they used?

7.6.26 Question 26 Results:

Respondent Number	Response
1	No
2	No
3	n/a
4	Good luck with your research!
5	n/a

6	No
7	None
8	n/a
9	n/a
10	n/a
11	ERT provides swab supplies for domestic and large overseas response. We only maintain swab kits for small overseas response
12	n/a
13	Regular supply dumps from the EU would be nice
14	I reuse uncontaminated supplies. I never put collected evidence anywhere near my evidence collection kit. If there is any question about an item being contaminated, I dispose of it
15	n/a
16	No
17	No consistency to making up kits, storage, etc. Kits always on a to do list but get down whenever a possibility arises
18	n/a
19	There should be a standardized, portable, pre-packaged kit that is issued to every SABT to be stored in the SABT response vehicle and opened only for an actual post-blast investigation
20	The swab kits are very new here and I purchase the 2 oz glass vials, forceps, and cotton balls from Amazon
21	I would LOVE guidance and resources for where to find items and what should be used
22	n/a
23	n/a

Table 7.6.3 – Do you have any additional comments?

7.7 Individual Package Sample Results

PKG-I				
Sample Name	GC/ECD Results	LTX Results	TSQ Results	Orbi-Trap Results
CB-1	Negative	-	-	-
PC-1	Negative	-	-	-
PC-2	Negative	-	-	-
PB-1	Negative	-	-	-
PB-2	Negative	-	-	-

GV-1	Negative	-	-	-
SP-1	Negative	-	-	-
PP-1	Negative	-	-	-
TD-1	Negative	-	-	-
TD-2	Negative	-	-	-
CB-3	Negative	Possible RDX; Possible Tetryl	-	
CB-5	Negative	-	-	-
TW-1	Negative	-	-	-

Table 7.7.1 – PKG-I Organic Explosives Analysis Results

PKG-I		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-2	Negative	-
PC-1	Negative	-
PC-2	Negative	-
PB-1	Negative	-
PB-2	Negative	-
GV-2	Negative	-
SP-2	Negative	-
PP-2	Negative	-
TD-1	Negative	-
TD-3	Possible Chlorate	Negative
CB-4	Negative	-
CB-6	Negative	-
TW-1	Negative	-

Table 7.7.2 – PKG-I Inorganic Explosives Analysis Results

PKG-II				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results
CB-7	Negative	-	-	-
PC-3	Negative	-	-	-
PB-3	Negative	-	-	-
PB-4	Negative	-	-	-
EB-1	Negative	-	-	-
SP-3	Negative	-	-	-
TD-4	Negative	-	-	-
TW-2	Negative	-	-	-
GV-3	Negative	-	-	-
GJ-1	Negative	-	-	-
CB-9	Negative	Negative	-	

Table 7.7.3 – PKG-II Organic Explosives Analysis Results

PKG-II		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-8	Negative	-
PC-4	Negative	-
PB-3	Negative	-
PB-4	Negative	-
EB-1	Negative	-
SP-4	Negative	-
TD-5	Negative	-
TW-3	Negative	-
GV-4	Negative	-
GJ-2	Negative	-
CB-10	Negative	-

Table 7.7.4 – PKG-II Inorganic Explosives Analysis Results

PKG-III				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results
CB-11	Negative	-	-	-
EB-2	Negative	-	-	-
PC-5	Negative	-	-	-
TW-4	Negative	-	-	-
CS-1	Negative	-	-	-
CB-13	Negative	Negative	-	-
GV-5	Negative	-	-	-
GJ-3	Negative	-	-	-
SP-5	Negative	-	-	-

Table 7.7.5 – PKG-III Organic Explosives Analysis Results

PKG-III		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-12	Negative	-
EB-3	Negative	-
PC-5	Negative	-
TW-4	Negative	-
CS-2	Negative	-
CB-14	Negative	-
GV-5	Negative	-
GJ-3	Negative	-
SP-5	Negative	-

Table 7.7.6 – PKG-III Inorganic Explosives Analysis Results

PKG-IV				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results

CB-15	Negative	-	-	-
PB-5	Negative	-	-	-
PB-6	Negative	-	-	-
TW-5	Negative	Negative	-	-
PP-3	Negative	-	-	-
SP-6	Negative	-	-	-

Table 7.7.7 – PKG-IV Organic Explosives Analysis Results

PKG-IV		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-16	Negative	-
PB-5	Negative	-
PB-6	Negative	-
TW-6	Negative	-
PP-4	Negative	-
SP-7	Negative	-

Table 7.7.8 – PKG-IV Inorganic Explosives Analysis Results

PKG-V				
Sample Name	GC/ECD Results	LTD Results	TSQ Results	Orbi-Trap Results
CB-17	Negative	-	-	-
PB-7	Negative	-	-	-
PB-8	Negative	-	-	-
TD-6	Negative	-	-	-
TW-7	Negative	-	-	-
SP-8	Negative	-	-	-
GV-6	Negative	-	-	-
CB-19	Negative	Negative	-	-

Table 7.7.9 – PKG-V Organic Explosives Analysis Results

PKG-V		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-18	Negative	-
PB-7	Negative	-
PB-8	Negative	-
TD-7	Negative	-
TW-8	Negative	-
SP-9	Negative	-
GV-7	Negative	-
CB-19	Negative	-

Table 7.7.10 – PKG-V Inorganic Explosives Analysis Results

PKG-VI

Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results
CB-20	Negative	-	-	-
PB-9	Negative	-	-	-
PB-10	Negative	-	-	-
BG-1	Possible TNT	-	Negative	
BG-3	Negative	-	-	-
PC-6	Possible RDX	Negative	-	
PC-7	Possible RDX	Negative	-	
GJ-4	Negative	-	-	-
GJ-6	Negative	-	-	-
TW-9	Negative	-	-	-
TW-11	Negative	-	-	-
CB-22	Negative	Negative	-	
CB-24	Negative	-	-	-
CB-26	Negative	-	-	-
CB-28	Negative	-	-	-

Table 7.7.11 – PKG-VI Organic Explosives Analysis Results

PKG-VI		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-21	Possible Chlorate	Negative
PB-9	Negative	-
PB-10	Negative	-
BG-2	Possible Chlorate and Nitrate	Confirmed Nitrate
BG-4	Possible Chlorate and Nitrate	Confirmed Nitrate
PC-6	Negative	-
PC-7	Negative	-
GJ-5	Possible Chlorate	Negative
GJ-6	Possible Chlorate	Negative
TW-10	Negative	-
TW-12	Negative	-
CB-23	Negative	-
CB-25	Negative	-
CB-27	Negative	-
CB-28	Negative	-

Table 7.7.12 – PKG-VI Inorganic Explosives Analysis Results

PKG-VII				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results
CB-29	Negative	-	-	-
PB-11	Negative	-	-	-
PB-13	Negative	-	-	-

PB-15	Negative	-	-	-
PTA-1	Negative	-	-	-
PTA-3	Negative	-	-	-
SY-1	Negative	-	-	-
SC-1	Negative	-	-	-
TW-13	Negative	Negative	-	-
PV-1	Negative	-	-	-
PT-1	Negative	-	-	-
DS-1	Negative	-	-	-
TP-1	Negative	-	-	-
PP-5	Negative	-	-	-
CS-3	Negative	-	-	-
SS-1	Negative	-	-	-
RD-1	Negative	-	-	-

Table 7.7.13 – PKG-VII Organic Explosives Analysis Results

PKG-VII		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-30	Possible Chlorate	Negative
PB-12	Negative	-
PB-14	Negative	-
PB-16	Negative	-
PTA-2	Negative	-
PTA-3	Negative	-
SY-2	Negative	-
SC-2	Negative	-
TW-14	Negative	-
PV-2	Negative	-
PT-2	Negative	-
DS-2	Negative	-
TP-2	Negative	-
PP-6	Negative	-
CS-4	Negative	-
SS-2	Negative	-
RD-2	Negative	-

Table 7.7.14 – PKG-VII Inorganic Explosives Analysis Results

PKG-VIII				
Sample Name	GC/ECD Results	LTV Results	TSQ Results	Orbi-Trap Results
CB-31	Negative	-	-	-
SP-10	Negative	-	-	-
PB-17	Negative	-	-	-

TW-15	Negative	-	-	-
GJ-7	Negative	-	-	-
CB-33	Negative	Negative	-	-
PB-19	Negative	-	-	-
GV-8	Negative	-	-	-
LP-1	Negative	-	-	-
PP-7	Negative	-	-	-
TD-8	Negative	-	-	-
SC-3	Negative	-	-	-
SC-5	Negative	-	-	-
TTD-1	Negative	-	-	-

Table 7.7.15 – PKG-VIII Organic Explosives Analysis Results

PKG-VIII		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-32	Negative	-
SP-11	Negative	-
PB-18	Negative	-
TW-16	Negative	-
GJ-7	Negative	-
CB-34	Possible Chlorate	Negative
PB-19	Negative	-
GV-9	Negative	-
LP-2	Possible Chlorate	Negative
PP-8	Possible Chlorate	Negative
TD-8	Negative	-
SC-4	Negative	-
SC-6	Negative	-
TTD-2	Negative	-

Table 7.7.16 – PKG-VIII Inorganic Explosives Analysis Results

PKG-IX				
Sample Name	GC/ECD Results	LTD Results	TSQ Results	Orbi-Trap Results
CB-35	Negative	-	-	-
PC-8	Negative	-	-	-
PB-20	Negative	-	-	-
PB-21	Negative	-	-	-
SP-12	Negative	-	-	-
TW-17	Negative	-	-	-
GV-10	Negative	-	-	-
CB-37	Negative	Negative	-	-

Table 7.7.17 – PKG-IX Organic Explosives Analysis Results

PKG-IX		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-36	Negative	-
PC-8	Negative	-
PB-20	Negative	-
PB-21	Negative	-
SP-13	Negative	-
TW-17	Negative	-
GV-11	Negative	-
CB-38	Negative	-

Table 7.7.18 – PKG-IX Inorganic Explosives Analysis Results

PKG-X				
Sample Name	GC/ECD Results	LTV Results	TSQ Results	Orbi-Trap Results
CB-39	Negative	-	-	-
PC-9	Negative	-	-	-
SC-7	Negative	-	-	-
PB-22	Negative	-	-	-
PB-23	Negative	-	-	-
TW-18	Negative	-	-	-
SP-14	Negative	-	-	-
CB-41	Negative	Negative	-	-
GJ-8	Negative	-	-	-

Table 7.7.19 – PKG-X Organic Explosives Analysis Results

PKG-X		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-40	Negative	-
PC-9	Negative	-
SC-8	Negative	-
PB-22	Negative	-
PB-23	Negative	-
TW-18	Negative	-
SP-15	Negative	-
CB-42	Negative	-
GJ-9	Negative	-

Table 7.7.20 – PKG-X Inorganic Explosives Analysis Results

PKG-XI				
Sample Name	GC/ECD Results	LTV Results	TSQ Results	Orbi-Trap Results
CB-43	Negative	-	-	-
PC-10	Negative	-	-	-
PB-24	Negative	-	-	-

PB-25	Negative	-	-	-
TW-19	Negative	Negative	-	
SP-16	Negative	-	-	-
CB-45	Possible PETN	Confirmed PETN	-	
GV-12	Negative	-	-	-

Table 7.7.21 – PKG-XI Organic Explosives Analysis Results

PKG-XI		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-44	Negative	-
PC-10	Possible Chlorate	
PB-24	Negative	-
PB-25	Negative	-
TW-20	Negative	-
SP-17	Negative	-
CB-46	Possible Chlorate and Nitrate	Confirmed Nitrate
GV-13	Negative	-

Table 7.7.22 – PKG-XI Inorganic Explosives Analysis Results

PKG-XII				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results
CB-47	Negative	-	-	-
CS-5	Negative	Negative	-	
PTA-3	Negative	-	-	-
NAP-1	Negative	-	-	-
PV-3	Possible NG	Negative	-	
SP-18	Possible TNT	-	Negative	
LP-3	Negative	-	-	-

Table 7.7.23 – PKG-XII Organic Explosives Analysis Results

PKG-XII		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-48	Negative	-
CS-6	Negative	-
PTA-4	Negative	-
NAP-2	Possible Chlorate	Negative
PV-3	Negative	-
SP-18	Negative	-
LP-3	Negative	-

Table 7.7.24 – PKG-XII Inorganic Explosives Analysis Results

PKG-XIII				
Sample Name	GC/ECD Results	LTQ Results	TSQ Results	Orbi-Trap Results

CB-49	Possible Tetryl	Negative	-	
BG-5	Possible TNT	-	Negative	
PB-26	Negative	-	-	-
PB-27	Possible R-Salt	Negative	-	
PB-28	Possible Tetryl	Negative; Possible RDX	-	
TD-9	Possible RDX and Tetryl	Confirmed RDX; Possible PETN	-	
SL-1	Possible Tetryl	Negative	-	
TTD-3	Negative	-	-	-
GV-14	Possible Tetryl	Negative	-	

Table 7.7.25 – PKG-XIII Organic Explosives Analysis Results

PKG-XIII		
Sample Name	IC-Anions Carbonate Results	IC-Anions Hydroxide Results
CB-50	Possible Chlorate	Negative
BG-6	Possible Chlorate	Negative
PB-26	Negative	-
PB-27	Negative	-
PB-28	Negative	-
TD-10	Possible Chlorate	Negative
SL-1	Negative	-
TTD-3	Negative	-
GV-15	Negative	-

Table 7.7.26 – PKG-XIII Inorganic Explosives Analysis Results