Escondido "Bomb Factory" Response

How the latest technologies and techniques enabled a safe and effective response

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Introduction

In November 2010, responders were faced with potentially the single largest cache of the explosive HMTD in U.S. history at a home in Escondido, California. The sheer volume of unknown material – combined with an extremely challenging environment – provided a unique situation for the many agencies who responded to the call.

Over the course of three weeks, more than 60 local, state and federal agencies assisted in the response. San Diego County Sheriff's Department assumed the role of incident commander, with joint command held by the cities of San Marcos (primary fire command) and the City of Escondido, since all actions taken directly impacted the citizens of Escondido. Ultimately, the coordinated investigation concluded that the property presented a significant hazard to further operations and the public. With the confirmed presence of the explosive HMTD along with precursors to manufacture additional explosives, many of which are hazardous chemicals in their own right, the decision was made to burn the home and all of its contents. The burn occurred on December 9, 2010 with the entire incident spreading over 41 days from start to final cleanup.

Incident Overview

A gardener had been hired to control the vegetation on a rental property located at 1954 Via Scott in Escondido, and to maintain the yard for the property owner. The lot was one of four situated on a four parcel section of unincorporated San Diego County, completely surrounded by the city of Escondido. The property was in a residential neighborhood with an outdoor shopping mall 600 yards away. Shortly after entering the property on Thursday, November 18, 2010, the gardener stepped on a gravel drainage area in the backyard, resulting in an explosion which sent him to the hospital with serious injuries.

The Escondido Fire Department and San Diego County Sherriff's Department were among the first to arrive on scene. Due to the significant amount of suspicious and potentially dangerous chemical substances discovered during the initial assessment phase, the San Diego County Sherriff's Bomb Arson unit and San Diego County Department of Environmental Health (DEH) Hazmat team were dispatched to the expanding incident.

Response Activities

Response was initially focused on the backyard of the home, where the gardener was injured, then moved toward the house. During early assessment, there was a second explosion near the original detonation, under the foot of a trained explosives expert. This secondary detonation occurred despite use of extreme caution, highlighting how dangerous the yard was. It was surmised from residue that the tenant had poured partially manufactured homemade explosives that were considered to be bad batches directly into the drainage areas and yard around the house.

This second detonation was of considerable concern to the responder community because it contradicted conventional knowledge that the explosive HMTD or TATP should have degraded significantly due to exposure to sunlight and soil. Instead, the explosive only partially degraded, or could have been protected from UV light under the gravel, so it was not rendered inert as expected. This prompted an immediate escalation of the severity of the incident. From this point, the yard was treated like a minefield with responders walking in each others' footsteps, and limiting access to mission critical personnel in proper PPE.

Figure 1. *Interior of the home / Kitchen*

Figure 2. *Interior of the home / Living Room*

On scene, responders found large amounts of unknown chemicals in containers ranging from wine and liquor bottles, industrial grade jugs and bags, to laboratory beakers, original chemical containers and mason jars. [See Figures 1, 2.] White powder was also found throughout the home on surfaces and floors, however the thinness of the powder on the floors made it difficult to analyze accurately. The volume and variety of unknown materials – coupled with the known explosives that instigated the investigation—raised tremendous concern for the safety of the responders and the surrounding community. This incident quickly became a joint entry situation

and Unified Command was established.

In the course of the investigation, six large mason jars containing white powder were found in the back yard and more than 14 additional jars inside the house. [See Figure 3.] Based on earlier detonations, it was critical to identify what was contained in the jars, ideally without moving or opening them. Given this goal, the most appropriate technology was Raman spectroscopy. It doesn't require direct contact with a substance, so analysis can be made through sealed containers without disturbing the contents, helping to minimize risk and exposure. It also ensures that evidence can be collected and preserved without inadvertently sending a dangerous substance to a crime lab.

Using Raman spectroscopy, in this case Thermo Scientific FirstDefender RMX, the response team positively identified the white powder in the jars as the homemade explosive HMTD (hexamethylene triperoxide diamine). HMTD is a powerful explosive that is highly unstable and sensitive to shock, friction and heat. The San Diego DEH Hazmat Team worked closely with EOD personnel to follow the recommended safety guidelines and common sense when identifying the potential explosives on scene.

The positive identification of the HMTD in the mason jars helped determine the safest procedures to render safe as much of the premises as possible. Robots were used to move each mason jar into pre-defined locations in the yard which had been prepped with sand bags to create a safe detonation area. Robots were also used to place counter charges and ultimately the jars were individually detonated. The only evidence that remained was the highly detailed spectral information obtained by the Raman systems.

During operations on the second day, DEH Hazmat worked with the EOD teams and took additional steps to neutralize any HMTD that might remain in the gravel area or in and around traffic areas. DEH was advised by several leading explosives experts to create a five percent sodium hydroxide solution to spray on the ground to degrade any remaining HMTD. This was done twice on November 19 and 20 in an attempt to stabilize or destroy any materials that had not been degraded by the weather.

Figure 3. *One of the six mason jars determined to contain HMTD.*

Alternative Response Actions

Raman spectroscopy is the only identification technique which allows identification through sealed containers. Without Raman spectroscopy, the response team would have had two choices to deal with the mason jars:

Open the containers to sample.

To use alternate analysis techniques, the jars would need to be opened, putting the responder at risk of exposure. By unscrewing the lid, there's the potential to detonate these friction-sensitive substances that could have been in the threads.

Destroy the containers without knowing the contents.

Destroying suspicious containers is not an uncommon approach, though it does present risk to the responder as the containers are transported to a safe location. By destroying containers without identification, evidence is also destroyed, which could have an impact on prosecution. In Escondido, the jars were eventually destroyed, but only after the HMTD had been positively identified and the results permanently captured for evidentiary support if needed.

Given the risk of detonation and the desire to capture the identification for evidence, Raman spectroscopy was deemed the safest, most-effective response tool.

Technology Overview

Like all tools in the toolbox, Raman spectroscopy has specific strengths that make it particularly useful in many scenarios. As an optical technique, it allows non-contact sampling through sealed containers. Raman spectroscopy is also highly precise and selective, providing reliable results that can be acted upon with confidence.

The EOD responders were provided *"just in time"* training by the hazmat team in the use of the instrument. They then took appropriate precautions to ensure that the instrument was used safely, including use of two key safety features. The first was the flexible sampling probe. This probe allowed the device to be positioned for analysis without having a responder hold the unit, and allowed analysis of substances in hard to reach locations. The second feature was a scan delay which allowed the responder to initiate the analysis then leave the area before the scan began. These features allowed the EOD technician to retreat to a safe distance while the instrument performed its analysis. Both of these safety features were key to ensuring the safety of the response personnel.

Manufacturer Support

As noted, Raman spectroscopy is a highly accurate and precise technology, and the mason jar contents were clearly identified as HMTD. [See Figure 5.] Given the scope of the incident and the severity of the actions that would be taken based on the analysis results, the responders used every resource at their disposal to ensure they had the best in-

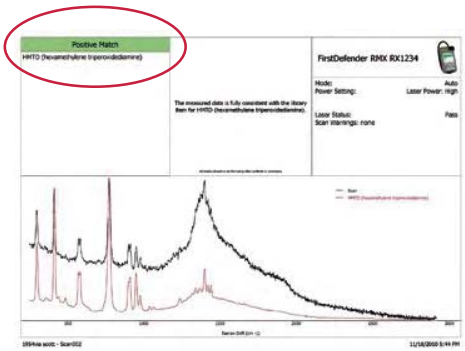

Figure 5. *Analysis result with a positive identification of HMTD.*

formation on which to act. This incident had the potential to impact not only the responders, but also the surrounding community. Following positive field identification, the response team also worked with the manufacturer, Thermo Fisher Scientific, using the company's reachback service and speaking directly with the product specialist to secure additional levels of confirmation to verify the materials as HMTD while preserving the chain of custody of the evidence and to support the subsequent prosecution. The support ultimately assisted in the eventual decision to burn the home.

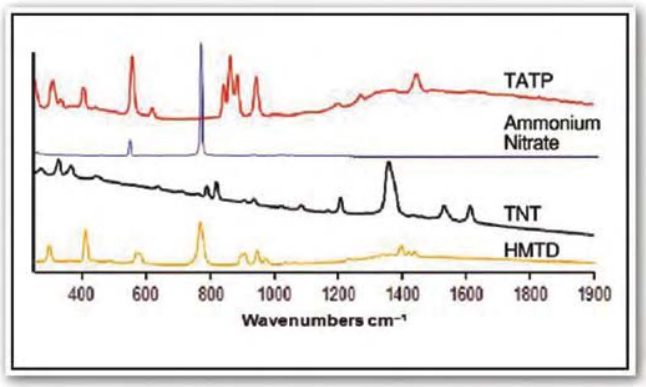

Figure 6. *Unique Raman spectra of TATP, Ammonium Nitrate, TNT and HMTD.*

Automatic Data Capture

When a Raman instrument's laser interrogates a sample of interest, data is captured in the form of spectra. This spectra is a molecular fingerprint of the sample of interest and can be compared to a known library. No two chemicals have the same fingerprint because no two chemicals have the same chemical structure. [See Figure 6.]

Evidence Collection

Once the yard was rendered safe, the responders shifted attention to the inside of the residence. The tenant was apparently a capable garage chemist, so there were concerns that he could be manufacturing other dangerous materials. Of particular concern was a prior purchase of castor beans that could be used to make the deadly biotoxin Ricin.

Following standard operating procedures, the property was repeatedly evaluated for biological and radiological threats. High volume air samplers were deployed multiple times and the resulting extracts tested using PCR to determine if select biological agents may have been present. None were found. Responders wore equipment for testing gamma and neutron radiation during every entry into the premises.

Continuing to follow standard operating procedure, air quality and other environmental conditions were assessed using everything available in the DEH Hazmat inventory. This multiple technology approach was a critical element in the response process. DEH used everything from pH Paper, wet chemistry kits, Combustible Gas Indicators, Photo Ionization Detectors and thermal imaging cameras, as well as monitoring for potential radiological and chemical weapons such as nerve and blister compounds with SAW and CAD technology.

The house presented a significant challenge due to a large accumulation of personal items bordering on the definition of a hoarder. The accumulation was so extensive that robots were unusable inside the residence and it was difficult to determine which items presented hazards – explosive, chemical or otherwise. For example, intermixed with non-threat items such as marshmallows and coffee filters were chemical precursors, homemade hand grenades and homemade functional blasting caps. As noted, there were large amounts of unknown chemicals in a range of containers. Based on the mason jar contents, there were concerns that the white powder throughout the home on floors could be HMTD. Electronics, cables, and computer equipment added to the disarray, making it extremely difficult to distinguish between dangerous items and benign materials.

Throughout the assessment, responders relied on FirstDefender® RMX to identify as many of the unknown chemicals as possible. This included unknown substances exposed on floors and countertops as well as those inside sealed containers. This process ensured that the responders could collect evidence without endangering themselves or inadvertently sending a dangerous substance to a crime lab.

Many of the white powders that were not identified by the onboard library as explosive compounds were sent to the manufacturer for further review. This included items identified in the field as hexamine, citric acid and sodium bisulfate. Given the variety of powders found on scene – many of which were explosive -- it was critical that these samples were confirmed non-energetic by a PhD chemist prior to removal and transportation.

Decision to Burn

On November 22, the joint entry teams decided that is was too dangerous to continue clearing the house. There was simply too much risk to the responders based on the conditions inside of the house and the volume of explosives discovered up to this point. Misleading information from the tenant, and the overriding concern the team would never be able to assure all the hazards were removed, led to this decision.

Through discussions with a wide range of responding agencies across the country throughout the three week response, it was determined that destroying the house through a controlled burn was the best option to ensure responder and community safety. The use of thermal destruction to eliminate chemicals and explosives is a familiar process that is addressed in EOD and hazmat training classes. However, burning an entire residence is seldom performed and presented a unique situation due to proximity to the other residences and Interstate 15.

Dozens of agencies were consulted multiple times to ensure that this was the most appropriate way to neutralize the risk. The decision was complicated by the inaccuracies of the plume modeling programs the responders needed to rely on. The concerns of what would be in the smoke were ever present. The ultimate decision to burn was held by Unified Command staff.

On November 30, the county declared a state of emergency just prior to a town hall meeting attended by more than 250 citizens, held to discuss the decisions and how responders arrived at this course of action. This town hall meeting was vital in gaining concurrence from the neighbors and community that the destruction of the residence was required. All the testing and openness gained that vital support. Later that evening the State of California made a similar state of emergency declaration which opened up the availability of State assets.

Preparing for the Burn

It would be more than two weeks from the decision to burn the property to the actual burn. With public safety as the primary concern, the responding agencies thoroughly evaluated the best protocols to employ. Evidence collection, while putting the responders at great risk, was also an important function. Evidence removed from the property included hand grenades in various stages of construction and tools for making explosives. Many explosive precursors and finished explosives such as PETN were deemed too dangerous to move and were left in the home.

Chemicals that could be safety removed from the property were removed to minimize the potential offsite consequences associated with the thermal destruction process. For example, acids, such as Sulfuric, Nitric and Hydrochloric, were removed wherever safely possible as they could potentially aerosolize instead of being destroyed by heat. The more chemicals that could be removed from the residence, the smaller the offsite consequence plume would become. Some of these could not be safely moved and remained in the home for thermal destruction.

One of the biggest challenges in burn preparation was the lack of plume modeling software to determine a viable model for destruction. Air modeling was attempted starting on the first day of the response, November 18, to determine potential evacuation distances in the event that the home caught fire inadvertently during the investigation. It was determined early in the response that if a fire started it would not be fought and over one half mile of Escondido would need to be evacuated with no notice, as opposed to destroying the structure in a planned controlled burn.

There were numerous challenges presented by this type of event based on current modeling programs:

- Current programs typically only model an instantaneous release.
- They do not account for synergistic or potentiation effects caused by the intermingling of the chemicals during a fire.
- The chemical compounds are modeled but not their thermal degradation byproducts, unless the chemist enters those byproducts into the equation manually.
- Finally, there were no modeling programs available that could take into account the thermal lift potential of these chemicals at 1800 to 2500 degrees F.

Due to the variety and quantity of hazards in the house, a complex, customized model was developed to eliminate caches of chemicals. Models were run multiple times per day and by agencies across the country including, but not limited to, the Federal Environmental Protection Agency (EPA) and the 9th National Guard Weapons of Mass Destruction Civil Support Team (CST) in Southern California. In particular, the tireless efforts of Sergeant First Class Scott Yates of the 9th CST were critical in development of the final plume model and evacuation plan.

The property was prepared for destruction with maximum effort to contain the flames and prevent damage to the surrounding residential properties, and to set up an air monitoring perimeter. It was critical that the temperature remained high enough in all areas around the property to ensure thermal destruction of any potentially undiscovered explosive materials.

On December 9, the home was engulfed in flames in a controlled and choreographed burn that destroyed the explosives and wastes from the inside out. Test data obtained showed that products of decomposition went laterally no more than 75 feet, with all smoke going vertically 2,600 feet and dispersing.

Final Lessons Learned

This incident provided a tremendous challenge to the responders tasked with assessment and mitigation. The sheer volume of hazardous materials and complexity of response provide several lessons learned for responders faced with comparable scenarios moving forward. We anticipate this will become a textbook case for many years to come.

Multi-Agency Collaboration. No response occurs in a vacuum. Given the complexity of this response, it was even more critical to involve the appropriate agencies early and often. Numerous experts were consulted to provide timely and relevant information as the response progressed. This incident utilized the joint efforts of San Diego County Sheriff, City of San Diego Fire, and Federal (FBI and ATF) EOD teams in consort with the Joint Hazardous Incident Response Team (Hazmat). Knowing how and where to acquire these resources before an incident is important.

Know your Instruments. Understanding the capabilities and limitations

of your equipment is extremely important. When it comes to mission-critical decisions, responders must have the confidence that their instruments will operate as intended. Thorough testing and evaluation prior to purchase help distinguish between true capabilities and empty manufacturer claims. Ongoing training and exercises increase proficiency and ensure responders know how to select the right tool for the job.

In this case, DEH and several other responding agencies were very familiar with the FirstDefender RMX and how it complemented other tools in the toolbox. They were able to take full advantage of its capabilities to ensure that they operated safely and reliably to determine the best course of action.

As with any technology or piece of equipment, it's important to understand strengths and limitations, and how equipment fits into the overall technology toolbox. In this case, the responders relied on the FirstDefender RMX to identify unknown chemicals due to the non-contact sampling through sealed containers and accurate, reliable results. They understood the underlying Raman technology and knew the appropriate response protocols and precautions to ensure responder and community safety.

In the Escondido response, they used the flexible probe with scan delay for samples in containers, allowing the responders to analyze the contents without added risk of handling or friction risk by unscrewing the lids. They were also able to leave the hazard zone before initiating analysis when desired. Since the responders knew energetic materials were present, they lowered the laser power to minimize ignition risk and knew to never scan dark substances. They also used small sample sizes where possible for exposed samples.

In addition to manufacturer's recommendations, a responder should also follow their organization's standard procedures for the handling of unknown substances.

Know your experts. By time an incident occurs, responders must already have relationships in place with the experts who can contribute to the overall response. This was critical in several ways in Escondido. As noted, the plume modeling was extremely challenging, and required extensive custom programming and consultation by several key people and organizations starting on day one to ensure the safest possible resolution. This was much more successful due to existing relationships and a collaborative approach by all parties.

Responders must also know their instrumentation experts, in many cases, the manufacturers themselves. While some responders see manufacturers strictly as vendors, the relationship should not end at an equipment purchase. The relationship can be a critical asset, serving as an extension to the response team with specific technology and application expertise. In this case, the DEH has had a long relationship with Thermo Scientific representatives, spanning more than 10 years. The ability to call a representative during an emergency response and be confident in their expertise and support is invaluable.

To learn more about the Escondido "bomb factory" or use of FirstDefender RMX, please contact the authors:

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