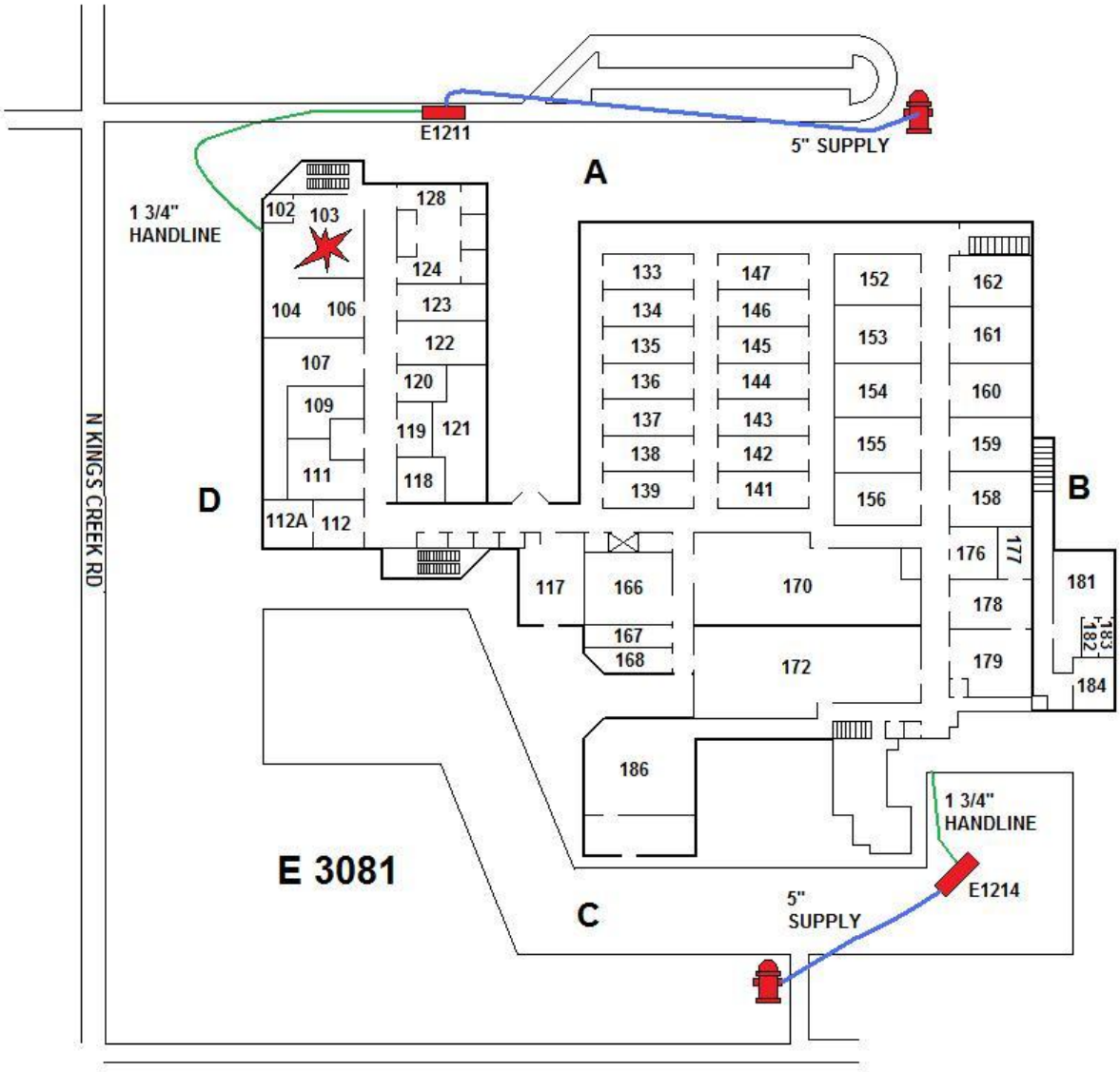
FIRE CAUSE AND ORIGIN REPORT
Fire and Explosion at Building E3081
Edgewood Area, Aberdeen Proving Ground, Maryland

EXECUTIVE SUMMARY

On 30 April 2011 at approximately 1506, an explosion occurred in Lab 103 located in building E3081 in the Edgewood area of the Aberdeen Proving Ground (APG). The explosion was accompanied by a pressure release that cause substantial human injuries (lethal), property damage, and a thermal release which propagated a fire in the lab that was controlled and extinguished by APG Fire and Emergency Services Division (F&ESD) personnel. At the time of the event, one person was present in the lab; Dr. Nanaj Bhamara (victim) who was a chemist under contract to the Medical Research Institute for Chemical Defense (MRICD) working on an organic chemical synthesis process. The explosion produced injuries to the victim that were incompatible with life including severe thoracic and abdominal injuries, burns, and severe upper extremity injuries. Several concurrent investigations have begun and continue to take place, and some of the organizations assisting with these investigations are APG F&ESD, Maryland State Fire Marshall's Office, Army Criminal Investigation Division, Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), Federal Bureau of Investigation (FBI), and an appointed Army Accident Review Board. The following report contains detailed information regarding the event and has been prepared utilizing reasonable and appropriate investigative processes and techniques.

FACILITY

The building is a mixed-use facility located on North Kings Creek Road which houses both administrative and laboratory operations. The building contains 66,902 square feet of administrative offices, agent laboratories, chemical laboratories, animal care areas, receiving areas, and service areas. The facility has two levels; one entered from ground level and the remaining areas accessed from downward leading stairwells and elevators to a lower floor. The lower level may also be accessed from grade on the charlie and delta sides of the building. The facility is also separated where as all agent operations take place in the "BB Area" in the northern end of the building. At the time of the incident, no agent operations were on-going; and all agents were secured. The facility does have rooms and areas maintained under negative internal pressure for the chemical agent operation. These systems were functioning at the time of the event and did not contribute to the cause or progress of the event. The building has no fixed fire suppression system but does contain a supervised reporting fire alarm system. This system can be activated by a series of hallway smoke detectors or manual pull stations located throughout the structure. The fire alarm was in service at the time of the event, and a fire alarm was received at the Edgewood area dispatch center from King Fisher transmitter 916, zone one which indicates a general fire alarm for the first or second floor area. The alarm was due to the activation of a lobby pull station by an occupant in the building at the time of the event. No smoke detectors activated during the event, and a follow-up test of these devices will be discussed in this report. A site plan depicting the footprint, fire equipment placement and the sub grade 100 level for the facility is shown on the page 2.


E1211
5" SUPPLY
A
1 3/4"
HANDLINE
102
103
128
124
123
122
120
119
121
118
104
106
107
109
111
112A
112
D
133
134
135
136
137
138
139
147
146
145
144
143
142
141
152
153
154
155
156
162
161
160
159
158
B
176
177
181
178
183
182
179
184
117
166
167
168
170
172
186
N KINGS CREEK RD
E 3081
C
1 3/4"
HANDLINE
E1214
5"
SUPPLY

EVENT AND INITIAL RESPONSE ACTIVITIES

On the day of the event, the Edgewood Area F&ESD station was staffed with the minimum required personnel. Those personnel consisted of one Battalion Chief (Incident Commander), two Captains (Lead Firefighters), six Firefighters (2 of which were driver operators), one switchboard operator, and two Paramedics. Some personnel were located at building E5180 (Fire Station) at the time of the event, and others were participating in physical fitness training at Hoyle Gym. The Edgewood dispatcher received a call over extension 436-4451, an administrative line from Dawn at the Edgewood Area Security guard desk at 15:07:21 reporting she had received a call from a subject at E3081 advising she had heard a boom in the basement and smelled smoke. The Security Desk Officer then advised the caller to activate the fire alarm system and evacuate the building.

At this point, the Edgewood Fire Dispatcher received a King Fisher alarm from transmitter 916, Zone 1 indicating a fire alarm at building E3081 in the first or second floor office areas. Units were dispatched to that location and advised to use "CP 10." Pre-established Command Posts (CP)s are utilized during responses to chemical agent facilities until a determination can be made if any chemical operations are active. At the request of Command (Battalion Chief Hinch), the Edgewood dispatcher confirmed utilizing the after-hour chemical operations log that no agent work was being conducted in the facility. At this time, command directed units to report directly to the building to investigate. Command 1202 arrived and established the CP on North Kings Creek Road at the entrance of the parking lot to E3081. Engine 1211 was directed to enter from the alpha side and Engine 1214 was directed to enter from the charlie side. Suppression units arrived and began operations to locate the incident. Prior to entering the facility, the crew was advised by personnel who had evacuated the area on the alpha side that one subject was unaccounted for and was possibly working in the basement lab area. Crews (1211) entering the alpha (front) side made their way through the main entrance door with self-contained breathing apparatus (SCBA), an apartment pack, thermal imaging camera, chemical meters, and radiological monitors. The second Engine (1214) was directed to the charlie (rear) side of the building and advised to enter from that area. The crew from 1214 advanced a 1 ¾" hose line into the rear of the building in the area of the loading dock and proceeded with forcible entry tools, monitoring equipment, and SCBA and began a search of the lower floor. They encountered smoke in the hallways and also reported visible smoke in the 'BB Wing" area. As the crew from 1211 entered, they proceeded down the main hallway on the south side of the building to a stairwell which leads down to the lower lab area. They also encountered visible smoke in the hallways and reported that information to command. Upon arrival, Command requested an additional engine company from the Aberdeen Area F&ESD station.

As the crew from 1211 entered the lower level, they could see deteriorating conditions at the far end of the lower level hallway and proceeded to that area. They located a fire in Lab Room 103 and made entry into that location by pushing the unlocked door open. The crew utilized a pressurized water (PW) extinguisher and a dry chemical (ABC) extinguisher from the facility to extinguish the fire in the lab. At this time, the interior crew requested a 1 ¾" hand line to be deployed to the delta (right) side door for further firefighting operations. This was completed by the driver operator of Engine 1211.

After opening the door to the lab, a victim (Dr. Nanaj Bhamara) was located on the floor behind the door. He was immediately removed by the crew which exited with him into the main hallway and started to remove him up a stairwell that was in close proximity to the lab entrance. After removing him from the lab to an area with better visibility it was quickly determined he had sustained injuries that were incompatible with life. (b) (6) assessed the victim and found him to be not breathing and without a pulse. It was obvious he had suffered severe chest trauma, severe abdominal injured (major evisceration), severe upper extremity injuries (loss of left hand and loss of a portion of right hand), severe facial burns and a left upper leg injury. At this time, the victim was not moved any further and remained in the hallway for the duration of the firefighting operations.

The fire was reported to be extinguished at 15:34:17 hours, and a check for further extension of the fire was completed. The fire and explosion damage was contained to Lab 103 and Lab 105, and some smoke did spread to other areas of the facility and will require some clean-up effort.

The initial fire damage is estimated at $40,000 including the structure and contents.

During entry and firefighting operations, it was noted that this was a chemistry lab and had door signage and placards depicting radiological and biological hazards in the area. Command was notified of this and requested contact be made with someone from the Medical Research Institute of Chemical Defense (MRICD) who had knowledge of the operations taking place within this lab. Interior crews reported that the Haz Cad had a low toxicity reading and the APDNR14 indicated 130 micro curies in the area. Since the fire was extinguished, it was determined not to remove the victim at this time. The decision was made to exit fire personnel from the area until a better assessment of the potential hazards could be made and a more comprehensive Incident Action Plan could be developed. This was accomplished, and crews exited the facility and completed rehabilitation.

Supplemental entry plans were developed after consultation with MRICD personnel that arrived on the scene that included Mr. (b) (6) who assisted with the (adiological hazard assessment, Mr. (b) (6) from MRICD security, and Deputy Commander (b) (6) . Discussions were also conducted over the phone with (b) (6) a chemist from the organization responsible for the lab, and Mr. (b) (6) a student and technician in the lab. It was determined that numerous chemicals and other hazards were present in the lab including some radiological and biological material located in room 102.

Prior to exiting the area, firefighting crews noted that there was some type of experiment still active in the lab fume hood. There was no information provided at this point in time by anyone who had knowledge of the operation and lab activities as to what could have caused such a violent reaction.

Supplemental personnel and hazardous material response equipment were requested from the Aberdeen Area as well as call back of off-duty personnel. Fill-in companies were requested from off- post volunteer companies for both the Aberdeen and Edgewood Areas.

It was determined that the best course of action was to re-enter the lab with some other monitoring devices (PID), radiation detection devices, and multi-gas meters to determine, if possible, what hazards may be present. A decision was also made to photograph the area during the entry.

The second entry took place, and it was noted that there were numerous chemicals stored in the area. There were both flammable and acid cabinets in the area, and there were refrigerators which stored other materials used for processes in the lab. There was no evidence of any further reactions taking place, and the area appeared stable. Atmospheric monitoring indicted neither the presence of any flammable gases nor the presence of any volatile organic compounds, and the oxygen concentration in the area was normal. It was determined that there was no obvious damage to the flammable liquid or acid storage cabinets as well as no damage to either refrigerator in room 103 or 105. The door to room 102, where the biological material and radiological material were stored, was intact and undamaged. Therefore, no further concern existed of any biological or radiological hazard.

A request was made by Chief 12 (E. Budnick) that the Garrison Emergency Operations Center (EOC) be activated due to the scope and magnitude of the event. This was accomplished over time, and the EOC was utilized as a conduit for information and activities during the incident.

It was further determined that a substantial inspection and investigation of the affected area would be required and that this would occur over an extended period of time. Command requested response from the Criminal Investigation Division, and assistance was provided on the scene by the Directorate of Emergency Services (DES) Police Operations Division and the Edgewood Area Security Guards.

Chief Budnick requested Inspector (b) (6) to the scene to assist in the initial fire origin and cause investigation. Upon entering the building for a first look, it was determined by Chief Budnick that assistance would be needed for the investigation; and a request was made to the Maryland State Fire Marshall's Office to provide that assistance.

Fire Investigator (b) (6) who has post-blast investigative experience reported to the scene and assisted with the initial investigation. Details regarding the investigation will be included in another section of this report. The Criminal Investigation Division was the responsible entity in reference to the death and completed a field investigation related to the fatality. They processed the scene, conducted witness interviews, and made arrangement with the Office of the Maryland State Medical Examiner to respond, remove the body, and transport the victim to the morgue for an autopsy. A field forensic investigator from that office responded to the scene, documented the situation and called for transport of the decedent. The deceased was placed in a body bag and moved to a location outside the facility. After midnight, a transport unit from the morgue arrived and removed the deceased. This concluded operations on that day, and a schedule was developed for a meeting at 0900 on the 2 May 11 with all interested parties to plan future activities at the site. Some of these issues will also be discussed in other sections of this report.

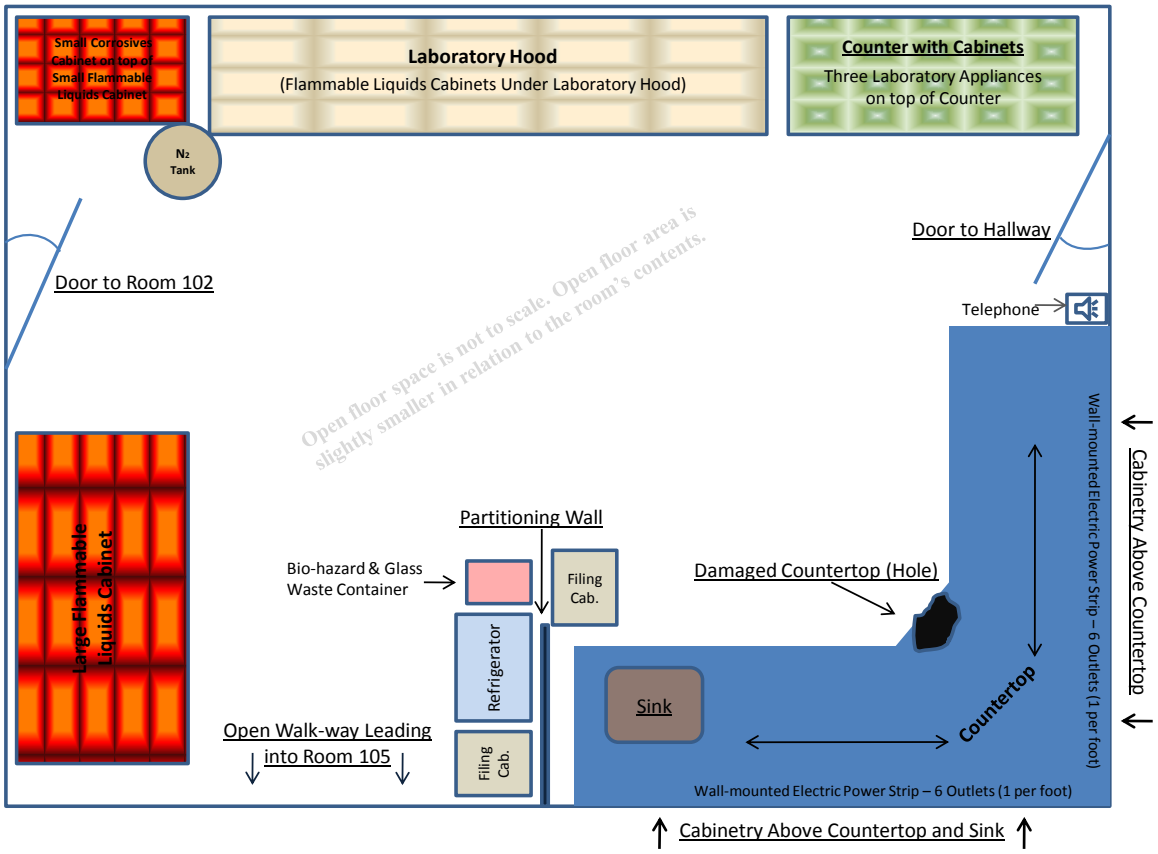
ORIGIN AND CAUSE DETERMINATIONS

After the relative safety of the area was determined by interviews with subject-matter experts and further hazardous material monitoring efforts, Fire Chief Edward Budnick and Inspector (b) (6) (b) (6) completed an initial look at the area. After this initial assessment, it was determined that there was substantial damage; and that some of the damage and injuries to the victim were consistent with a blast or overpressure. At this time, notification was made to the Maryland State Fire Marshall's Office; and a request was made for an investigator that had post-blast investigative experience. Investigator (b) (6) contacted Chief Budnick via cell phone and advised he would respond to the scene to assist. This is a typical process used by the APG F&ESD when an investigation of origin and cause is necessary. Prior to the arrival of Investigator (b) (6), the scene was secured; and access was limited into the area. Material and equipment in the lab was left undisturbed at this point. Photographs were taken of the area to document the damage and other points of interest.

Upon arrival of Investigator (b) (6), a systematic investigation was started. The exterior of the structure presented as normal with no obvious exterior damage. An exterior door on the delta side of the facility was open with a charged 1 ¾" hose line extending into the lab from that location. A discussion with firefighting personnel indicated that this door was slightly ajar upon arrival and required no forcible entry to gain access. It was noted that there was no blast damage or fire damage to that door. It was determined that this means of ingress would be used for further entries as it was remote from the area of most damage and allowed for easy entry into the area. Upon entering the lab area, it was determined that there were several room numbers assigned to this particular space. Room 102 is a room separated by a locked door way which is, in essence, a room located in Lab 103. This room contained secured storage for a radiological source as well as biological materials utilized for testing. The door to this area was secured; and there was no fire, smoke or blast damage either to the door or to the inside of this space. It was determined that this area had no play or role in the event. Lab room 105 is contiguous with Lab room 103. Lab room 105 contained mostly storage, personnel desks, workspace, lab machines and testing devices. Smoke staining was present on the ceiling and upper portion (top 1 foot) of some of Lab room 105. There was no evidence of direct flame contact or burning in Lab 105; however, there was evidence of broken glass in an area of Lab room 105 which shared a wall with Lab room 103. The shared wall contained a metal, glass-front storage cabinet housing lab glassware that was found with the doors open. Some of its contents were strewn on the desk below and broken. It was determined that nothing located in Lab room 105 had anything to do with the initiation of the event. Both Lab rooms 103 and 105 have doors that open directly into a main internal corridor in the sub level of the building. There was some smoke staining on the ceiling of this hallway as well as in the stairwell leading up from the sub level near the exit door from Lab room 103. Above both Lab rooms 103 and 105, a substantial interstitial space was present; and smoke travel was noted through that space leading into other areas of the facility, most notably into the hallway and stairwell area on the alpha end of the building. It is believed that due to the smoke travel in this interstitial space, the hallway smoke detectors did not activate during the event. A further discussion on follow-up testing of those detection devices will be presented later in this report. The two hallway exit doors showed no signs of structural damage.

They were unlocked, entered by firefighting crews, opened easily, and appeared to be closed during the initial event. There was some indication that the hallway egress door from Lab room 103 may have attempted to be opened after the event by the victim. This conclusion was drawn due to blood staining and smearing on the door which appeared to be consistent with an attempt being made to open the door or at least an attempt to locate the door. After a general and systematic review of visual indicators, flame spread patterns, and damage location and intensity, a determination was made that the initial event occurred on a countertop located in Lab room 103. The basic layout for Lab room 103 is included below.

Floor Plan for E3081 Room 103 (approximate dimension = 20' x 30')



After determining the basic area of origin for the incident, investigators started a systematic removal and inspection of debris and other material located in proximity to the location. It was also determined that it would be beneficial to contact the ATF and the FBI to assist in the investigation in an effort to rule on any criminal intent. The Criminal Investigation Division of the DES assisted in the civilian death investigation as well as origin and cause investigation. Lab room 103 presented with physical evidence that indicated an explosion followed by an intense fire.

There was visual discoloration of the ceiling area as well as fire damage to an area of the lab countertop, the wall and cabinet above the sink area, and material that was stored adjacent to the lab countertop. In regard to the victim's blast-like injuries, a location of that blast was determined. It was on the lab countertop in the center outer edge where the counter is pieced together as a 90% unit. There was an operation ongoing in the lab fume hood, but there was no evidence or reason to believe there was any connection with that operation and the event.

For the purpose of clarity, the incident will be discussed as two separate sequential events. The first event was the explosion/detonation and the second event was the fire.

EXPLOSION: During the initial investigation that occurred on the 30 April 2011 as well as several subsequent site visits, the exact determination as to the materials that caused the explosion as well as the process involved in using those materials was not determined. However, in the course of other developing investigations, a most probable scenario was developed in relation to the known activities in the lab, the physical evidence in the lab, and interviews with personnel most familiar with the victim's activities and operations being conducted prior to the event. Material was also obtained and is being evaluated by the ATF Washington Lab. The initial reaction/explosion caused an overpressure situation in the area of a magnitude great enough to cause severe damage to the victim's torso, as well as upper and lower extremities. This overpressure situation forced displacement of ceiling tiles above the event, and broke heavy panel glass located in the lab storage cabinets above the lab countertop. Additionally, it forced open a lab cabinet attached to a shared wall breaking both the door glass and some of the glass wear in the cabinet. A distinct blast pattern radiated out 360 degrees from the area of origin in Lab room 103, and the exterior exit door in Lab room 105 was forced ajar.

After an exhaustive investigation and follow-up related to the processes and procedures being conducted in the lab, the following determination was made regarding the explosion.

Dr. Bhamara was a synthetic organic chemist working under contract for MRICD. At the time of the event, he was working on several projects, one of them being a synthesis process attempting to develop a molecule that would assist in some medical treatment related to organophosphate poisoning. This process required the stirring of materials in controlled situations to obtain the end product. The process used a starting material (2-amino-5-nitro-benzoic acid) as well as the addition of other products at certain times during the reaction. As the reaction was conducted, the solution would be filtered apparently under the assumption that starting material could be collected to be used in other reactions. This reaction began on a relatively small scale with the use of 100 or so milligrams of starting material. On the Monday prior to the event, a decision was made to scale up the reaction and to utilize 200 grams of starting material in some 10 liters of liquid. The initial yields of dry material in the small reactions were very limited. However, there may have been as much as 30 to 40 grams of material filtered from the larger reaction. It is the belief of the investigators that Dr. Bhamara had experienced no issues with the small scale operations, and probably felt he had filtered a benign substance from this large scale reaction. This reaction was known to chemically produce diazonium salts (2-diazonium-5-nitrobenzoic acid salt) specifically which are extremely unstable and energetic in nature.

After the filtering process, the material was placed in a vacuum oven to dry and apparently left there until Dr. Bhamara returned to the lab at 1430 on Saturday, 30 April 2011. It was determined that the event occurred at just after 1500 hours as confirmed by the first sound of an explosion heard by other occupants of the facility and the approximate time line of the initial emergency calls and response. Evidence indicated that the victim had removed the dried material from the oven and was performing some operation with it on the lab counter top. It appears most likely that he was scrapping it out of or through a porcelain funnel possibly into another container when the detonation occurred. For the most part, the detonation vaporized the container or containers and created a hole in the lab countertop. Both fragments of the lab countertop as well as small chips of what was possibly the porcelain funnel were collected and provided to the ATF lab for further assessment. The small chips were removed from the backsplash area of the lab counter adjacent to the area of the detonation. Other areas of concern in the lab were inspected and reviewed such as acid and flammable liquid storage cabinets, an explosive proof refrigerator, hazardous waste accumulation site, and a chemical storage refrigerator. None of these items displayed any indications that they were involved in the detonation or fire which followed.

FIRE: Subsequent to the explosion, a fire occurred in Lab room 103. The thermal release of the detonation provided enough heat to ignite Class A and B combustible materials located in close proximity to the actual detonation. The victim also presented with charring and soot on his unprotected facial areas as well as some smoke staining and flame impingement scorching areas of his clothing; however, it did not appear that his clothing caught fire. Combustible materials located in the area of the explosion consisted of cardboard boxes, plastic containers of methanol and ethanol, absorbent pads on the lab countertop, and particle board shelves stored adjacent to the sink. The fire propagated across the countertop and into these materials and was rather intense at some point. The fire became oxygen deficient prior to entry of the firefighting crews evidenced by the lack of open burning in the lab.

One area of investigative interest was a string of countertop electrical receptacles that showed some evidence of arching at the last receptacle in line. The receptacle did have a lab device plugged into it. The breaker supplying power to it was tripped, and it was located adjacent to the area of most severe fire damage. The power strip was disassembled and photographs were provided to an ATF electrical engineer at the suggestion of State Fire Investigator Selvage. After reviewing the photographs and further visual inspections, it was determined that the arching was a result of flame contact with the wiring and housing, and the circuit breaker tripped due to the short. There was likely power on to the device plugged in at the time; however, it is believed that the damage to that area resulted from the fire and was not related to the cause of the fire nor did it have anything to do with the initial explosion. Fire and smoke damage for the most part was contained to the area of origin with smoke spread occurring through the interstitial space above the lab and out into the hallway continuing to spread throughout the structure. The only activation of the fire alarm system was from a manual pull station in the lobby which was activated by another occupant of the facility. There was no fire suppression located in the facility or in Lab room 103. The fire and smoke damage was estimated at $40,000.

FIRE SAFETY ISSUES: The facility was protected by a reporting automatic and manual fire alarm system; however, no automatic fire suppression system was present in the building. The manual system consisted of manual pull stations located throughout the facility, and system smoke detectors located in the hallways and in some duct work. It appeared as if means of egress met code requirements throughout the facility as well as in Lab room 103 and Lab room 105. There were two exits out of Lab room 103 and Lab room 105 which lead directly to an interior hallway which then exited out at grade level to the rear of the building and up the stairwell to the front of the building. There was an exterior door that led directly to the outside of the building at grade level located towards the back of Lab room 105. All exit doors appeared to be intact and functioning properly; however, the rear door in Lab room 105 was partially blocked by a refrigerator. The lack of a suppression system did not impact the ability to survive the initial explosion; however, it did lead to a more intense fire in the lab. In an effort to insure the smoke detection devices were operating properly, a follow-up test was conducted on 6 May 2011. It was determined that the system was operational, and all detectors and audible devices functioned with the only issue being smoke detectors in the elevator lobbies not operating as designed. This issue did not contribute to the incident. Evacuation procedures were posted in the area, and an assumption was made that personnel were aware of how to exit the area if need be. The victim was incapacitated immediately and was unable to remove himself from the area.

PREVIOUS FIRE INSPECTIONS: The two most recent fire inspections took place on 4 May 2010 and 21 March 2011 with a review of those inspections indicating several issues noted. Issues included a blocked exit door in the BB Area of the building, exit lights not illuminated in a hallway downstairs, and some material being stored in a stairwell. The blocked door was corrected during the May 2010 inspection, and the other issues appeared to be corrected at the time of the event. No other deficiencies were noted, and none of the previous issues contributed to the cause or severity of this event.

ENVIRONMENTAL CONDITIONS: The afternoon was a typical late April day, clear and warm; and no environmental factors played a role in the event.

AGENCIES INVOLVED:

Aberdeen Proving Ground Directorate of Emergency Services
Aberdeen Proving Ground Emergency Operations Center (Supporting Functions)
Aberdeen Proving Ground Criminal Investigation Division
Medical Research Institute for Chemical Defense
Maryland State Fire Marshall's Office
Bureau of Alcohol, Tobacco, Firearms, and Explosives
Federal Bureau of Investigations
Office of the State Medical Examiner
Aberdeen and Joppa Magnolia Volunteer Fire Departments

ENCLOSURES:

1) Edgewood Event Chronology of 30 Apr 11
2) Aberdeen Event Chronology of 30 Apr 11
3) Aberdeen Proving Ground Fire Department Fire Alarm System Device Test at Building E3081 dated 6 May 2011