UNITED STATES AIR FORCE
GROUND ACCIDENT INVESTIGATION BOARD REPORT

TYPE OF ACCIDENT: ON-DUTY FATALITY
LOCATION: JOINT BASE BALAD, IRAQ
DATE OF ACCIDENT: 15 SEPTEMBER 2010

BOARD PRESIDENT: COLONEL JOHN H. FRANZ, USAF
Conducted IAW Air Force Instruction 51-507

United States Air Force Ground Accident Investigation Board Report
On-Duty Fatality
Joint Base Balad, Iraq
15 September 2010

EXECUTIVE SUMMARY

On the morning of 15 September 2010, six members of the 332d Air Expeditionary Wing's Explosive Ordnance Disposal (EOD) flight performed controlled detonations of unserviceable ordnance on the EOD range at Joint Base Balad (JBB), Iraq. The unserviceable ordnance included various munitions as well as M1028 cartridges that were divided among six planned positions at the detonation area. A group of nineteen non-EOD military members were allowed to observe the detonations as casual observers. Six of the nineteen observers volunteered to initiate the detonations from a concrete structure on the range approximately 769 feet from the detonation area. EOD members positioned these six volunteers under the structure where they had direct line of sight visibility to the detonation area. The other thirteen observers took positions around the concrete structure; most where they could directly view the blasts. The type and amount of ordnance detonated on 15 September required all individuals within 2,092 feet from the detonations to have both frontal and overhead protection from the explosions. The EOD team chief conducted a safety briefing to both the EOD members and all of the observers covering the safety procedures for the controlled detonations. The Range Safety Officer (RSO) then positioned himself in front of the six volunteers and directed the first volunteer to initiate the first detonation at approximately 0941 hours local time. A few seconds after the first explosion, the RSO directed the second volunteer to initiate the second detonation.

At approximately 0942 hours local time, fragmentation from the second controlled detonation struck two of the six volunteers selected to initiate the detonations. A large fragment of a M1028 cartridge base plate struck an active-duty Air Force Senior Airman in the chest then exited his left side and struck an active-duty Army Staff Sergeant in the right forearm and left groin area. The Air Force member is assigned to 332d Expeditionary Operations Support Squadron, 332d Air Expeditionary Wing, at JBB, Iraq. The Army member is assigned to the 334th Quartermaster Battalion supporting Task Force 6-30 at JBB, Iraq. No other individuals, equipment or facilities were injured or damaged.

EOD members and observers immediately provided basic life-support and limb-saving techniques to help the two injured military volunteers. At approximately 0945 hours local time, Air Force and Army Emergency Responders arrived on scene and took over providing first aid. The 332d Expeditionary Medical Group's Chief of Aerospace Medicine arrived on scene and pronounced the active-duty Air Force Senior Airman dead at 1009 hours local time. The Army Staff Sergeant was transported by ambulance to the JBB hospital at approximately 1015 hours local time. A short time later, Air Force Mortuary Affairs transported the Air Force Senior Airman to the JBB mortuary.

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COMMONLY USED ACRONYMS & ABBREVIATIONS

ACC	Air Combat Command
ADWSR	Additional Duty Weapons Safety Representative
AE	Ammunitions and Explosives
AETC	Air Education and Training Command
AEW	Air Expeditionary Wing
AFB	Air Force Base
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFMC	Air Force Materiel Command
AFSC	Air Force Specialty Code
AMC	Air Mobility Command
ASHS	Assessment System Hazard Survey
C-4	Composition 4
CE	Civil Engineering
CFETP	Career Field Education and Training Plan
CMSgt	Chief Master Sergeant
CoBRA	Combat Battlefield Ready Airmen
ECES	Expeditionary Civil Engineer Squadron
EMSG	Expeditionary Mission Support Group
EOD	Explosive Ordnance Disposal
GAIB	Ground Accident Investigation Board
HFDR	Hazardous Fragmentation Distance Range
HMX	High-velocity Military Explosive
IAW	In Accordance With
IDF	Indirect Fire
IED	Improvised Explosive Device
JBB	Joint Base Balad
L	Local Time
Lt Col	Lieutenant Colonel
MAJCOM	Major Command
MDIS	M23 Demolition Initiation System
MFDR	Maximum Fragmentation Distance Range
MSgt	Master Sergeant
NEW	Net Explosive Weight
OI	Operating Instruction
PACAF	Pacific Air Forces
QDR	Quantity Distance Range
RDX	Cyclotrimethylenetrinitramine
RSO	Range Safety Officer
S/N	Serial Number
SNCO	Senior Non-Commissioned Officer
SOP	Standard Operating Procedure
SPC	Specialist
SrA	Senior Airman
SSgt	Staff Sergeant (Air Force)
SSG	Staff Sergeant (Army)
T.O.	Technical Order
TSgt	Technical Sergeant
USAF	United States Air Force
USAFCENT	U.S. Air Forces Central
USAFE	U.S. Air Forces Europe
USCENTCOM	United States Central Command
Z	Zulu or Greenwich Meridian Time (GMT)
3E8X1	Explosive Ordnance Disposal Specialty Code

The above list was compiled from the Summary of Facts, the Index of Tabs, and witness testimony (Tab V).

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SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

1.1. Authority

On 21 September 2010, Lieutenant General Janet C. Wolfenbarger, Vice Commander, Air Force Materiel Command (AFMC), appointed Colonel (Col) John H. Franz to conduct a ground accident investigation of the 15 September 2010 explosive ordnance disposal (EOD) mishap which occurred at Joint Base Balad (JBB), Iraq. The investigation took place at JBB, from 13 October 2010 through 11 November 2010. Technical advisors were Captain (Capt) Todd M. Sparks (Legal Advisor), Capt Eric D. Powell (Medical Advisor), Master Sergeant (MSgt) Lewis M. McDonald (EOD Advisor), and Technical Sergeant (TSgt) Brian D. Meeker (Recorder). (Tabs X-3 – 8)

1.2. Purpose

This ground accident investigation was convened under Air Force Instruction (AFI) 51-507, *Ground Accident Investigations*. The purpose of the investigation is to inquire into the facts surrounding the ground accident, to prepare a publicly releasable report, and to gather and preserve all available evidence for use in claims, litigation, disciplinary actions, administrative proceedings, and for other purposes.

2. ACCIDENT SUMMARY

On the morning of 15 September 2010, six members of the 332d Air Expeditionary Wing's Explosive Ordnance Disposal (EOD) flight performed controlled detonations of unserviceable ordnance on the EOD range at JBB, Iraq. MSgt Garet A. Vannes (EOD Member #1) was the EOD Team Chief that day. He was accompanied by TSgt Gregory P. Divito (EOD Member #2) and TSgt Matthew J. Hefti (EOD Member #3) who served as the Range Safety Officer (RSO). Also participating in the operation were three junior enlisted EOD members who included Senior Airman (SrA) Brant A. Lundberg (EOD Member #5), Airman First Class (A1C) Max J. Kuespert (EOD Member #6), and A1C Justin D. Smith (EOD Member #7). Staff Sergeant (SSgt) Adam K. Janssen (EOD Member #4) did not attend the operation as he was performing operations desk sergeant duties at the EOD Flight operations office at the time. (Tab V-18.11) Nineteen non-EOD military members voluntarily participated as "casual observers" to witness the event. (Tabs O-30, O-37) The allowance of casual observers on the JBB EOD range during controlled detonations is a well-established program and approved in the EOD Flight Operating Instruction 32-3002, as well as the EOD range site plan. (Tabs O-5, O-9, O-13, O-43, O-47) The casual observers witnessed the EOD members constructing the ordnance placements with explosive

Composition-4 (C-4) charges prior to being directed to a concrete shelter approximately 769 feet away from the detonation area. (Tab Y-16) At this location, there is a concrete structure that, although not designed to provide protection against effects of explosions, is an EOD designated safe area. (Tab Y-5) Six of the casual observers volunteered to initiate the demolition charges. This activity consisted of pulling a mechanical cord when directed by the EOD RSO. These volunteers were positioned in direct line-of-sight of the detonation area and were instructed to kneel to allow other observers behind them to also witness the detonations. (Tabs V-1.12, V-2.14, V-2.20, V-3.7, V-12.4 – 5, V-13.7, V-13.12, Y-3, Y-4) Some of the EOD personnel were also in direct line-of-sight of the ordnance detonations with one member in front of the observers. (Tabs V-2.15 – 17, V-16.11 – 14) After three consecutive "fire in the hole" calls performed by an observer, the RSO directed the first detonation and then a few seconds later directed the second detonation. (Tabs V-2.6, V-12.4, V-13.11, V-16.19) Immediately after the second detonation, a large fragment of a M1028 cartridge base plate struck United States Air Force SrA James A. Hansen in the chest, exited his left side and then struck a United States Army Staff Sergeant (SSG) in the right forearm and left groin area. (Tabs V-1.9, V-16.5) SrA Hansen died almost immediately after being struck. (Tab V-24.7) The Army SSG sustained life-threatening wounds that required tourniquets to both his arm and leg. (Tabs V-1.9, V-2.18, V-16.5) The rear wall of the designated safe area was damaged minimally by a metal fragment from one of the two detonations. (Tab S-32)

No other individuals, equipment or property were injured or damaged in this mishap.

3. BACKGROUND

3.1. Units

The various military units relevant to the mishap and their relationship to each other are as follows. The EOD Flight is a flight within the 332d Expeditionary Civil Engineer Squadron (332 ECES). The 332 ECES is a squadron within the 332d Expeditionary Mission Support Group (332 EMSG). The 332 EMSG is part of the 332d Air Expeditionary Wing (332 AEW), which is, in turn, a wing within 9th Air Force (9 AF). 9 AF is a Numbered Air Force within U.S. Air Forces Central (USAFCENT).

a. U.S. Air Forces Central

USAFCENT, headquartered at Shaw Air Force Base, South Carolina, is the Air Force component of United States Central Command (USCENTCOM). (Tab EE-3)

b. 9th Air Force

9 AF, also located at Shaw Air Force Base, South Carolina, is the headquarters for USAFCENT and serves as the air component for a 25-nation area within the USCENTCOM area of responsibility. (Tabs EE-3, EE-9)

c. 332d Air Expeditionary Wing

The 332 AEW is a deployed combat wing supporting the United States Forces-Iraq transition from combat to stability operations. The 332 AEW is headquartered approximately 40 miles north of Baghdad, Iraq, at JBB and employs airpower throughout the Iraqi theater. It is based

jointly with the U.S. Army's 103rd Sustainment Command (Expeditionary) which is responsible for operation of the largest Army logistics center in Iraq. The 332 AEW consists of five distinct groups, one of which is the 332d EMSG. (Tabs EE-5 – 6)

d. 332d Expeditionary Mission Support Group

The 332 EMSG provides the life-support infrastructure for JBB, overseeing the expeditionary communications, services, civil engineering, personnel accountability, cargo and personnel handling and supply operations. The 332 EMSG consists of four squadrons, one of which is the 332 ECES. (Tabs EE-7 – 8)

e. 332d Expeditionary Civil Engineer Squadron

The 332 ECES is responsible for all facilities and infrastructure, ensuring continuous air- and ground-combat capabilities for Coalition forces at JBB. Additionally, the 332 ECES provides training and emergency management oversight for all JBB tenants through its readiness and emergency management, fire department, and EOD flights. (Tab EE-7)

f. Explosive Ordnance Disposal Flight

The EOD Flight performs, supervises and manages EOD operations to protect people, resources and the environment from the effects of hazardous explosive ordnance and improvised explosive devices (IEDs), including weapons of mass destruction (WMD). The EOD Flight detects, identifies, renders safe, recovers, and disposes of conventional, incendiary, chemical, biological and nuclear ordnance delivered or placed by enemy forces and U.S. and allied ordnance made dangerous by accident or other circumstance. It renders safe and disposes of criminal/terrorist IEDs. (Tab AA-70)

3.2. Mission

The primary mission on 15 September 2010 was to perform a controlled demolition operation at the JBB EOD range in order to dispose of unserviceable ordnance. (Tabs AA-42, CC-3) Providing non-EOD military observers an opportunity to participate in and observe the disposal was a secondary objective. (Tabs O-5, O-9, O-13, O-43, O-47) The mission was in accordance with the duties assigned to 332 EOD Flight and in accordance with the 332 ECES/EOD Flight Operating Instruction (FOI) 32-3002, *EOD Disposal Range and Emergency Disposal Operations*, dated 31 March 2010. (Tab O-4)

3.3. Planning

On Monday, 13 September 2010, the Army Ammunition Supply Point at JBB requested the EOD Flight to assess and dispose of 35 damaged 120 millimeter (mm) M1028 Anti-Personnel (APERS), tank-fired, cartridges. (Tab CC-4) The 120 mm M1028 APERS cartridge is fired from the main cannon of the M1A1/M1A2 Abrams Battle Tank and is similar in both form and function to a large shotgun shell with an antipersonnel projectile (canister) containing hundreds of 10mm tungsten balls. The EOD members retrieved the cartridges that same day. (Tab CC-4)

On Tuesday, 14 September 2010, EOD members tested alternative demolition techniques to dispose of the M1028 cartridges utilizing detonating cord (detcord) in lieu of C-4 explosives.

(Tab V-18.16) Detcord is a thin flexible tube with an explosive core commonly used for demolition purposes. These tests were conducted in order to conserve the limited supply of C-4. (Tab V-18.16) All tests were completed at the EOD range. (Tab V-18.16) Prior to all demolition operations, the tungsten balls were removed from the cartridges. (Tabs Y-3, Y-4) Having researched the ordnance, the EOD members learned that the cartridge casings were composed of a combustible material connected to a steel base. (Tabs V-18.24 – 25, AA-59 – 60) The propellant in the cartridge is a "low" explosive, meaning that under normal functioning conditions it will "deflagrate" rather than detonate as "high" explosives. (Tab AA-60, AA-122 – 124) Deflagration is a dynamic reaction similar to, but lesser than, an explosion or detonation. (Tab AA-106) The propellants in cartridges are intended to deflagrate in a confined space such as the breach of the M1 tank's 120 mm cannon barrel. (Tabs V-18.16, AA-60, AA-106) However, the EOD members applied the detcord techniques to the cartridge in an open space at the EOD range. (Tab V-18.16) Applied detcord techniques revealed these procedures were insufficient to destroy the M1028 cartridges, merely causing the casing to burn and scatter unconsumed propellant. (Tab V-18.16, V-18.25) Research had shown that the casing was consumable and designed to disintegrate when exposed to a sufficient explosive charge. (Tab V-18.25)

On 15 September, three safety briefings were conducted for the benefit of the observers. (Tab V-14.2) All observers attended at least one of the briefings. (Tabs V-2.10, V-16.14) Further relevant planning and preparation guidance is outlined in the EOD FOI 32-3002. However, available evidence is insufficient to determine what other procedures were used to prepare for the mission or to what extent individuals involved in the accident participated in such planning or preparation.

4. SEQUENCE OF EVENTS

On the morning of the mishap, Wednesday, 15 September 2010, observers composed of Navy personnel, soldiers from the Army's 334th Quartermaster Battalion, and Airmen from the 332 AEW arrived at the EOD Flight facilities between 0745 hours and 0800 hours local time. (Tabs V-1.4, V-12.3) EOD personnel routinely permitted observers to participate in demolitions subject to the guidance contained in their local operating instructions. (Tabs O-5, O-9, O-13, V-2.7)

Upon arrival, the casual observers were provided their initial safety briefing and signed a log listing observers; then they followed the EOD members' vehicles to the EOD disposal range. (Tabs O-28, V-1.4, V-13.2, V-18.11) The victim received permission from the Non-Commissioned Officer in Charge of Airfield Management Operations to attend while on call that day. (Tab V-15.5) He drove out to the site in an Airfield Operations vehicle, carrying his radio in the event he was needed elsewhere. (Tabs V-11.4, V-15.3)

Upon arrival at the range, all personnel received a second safety briefing from EOD, and then were divided into small groups. (Tabs V-12.3, V-13.3, V-47.1) Some EOD members were already on site previous to the observers' arrival and had separated the charges and ordnance between six different detonation sites on the EOD range. (Tabs V-12.3, V-13.3) These detonation sites varied between 90 to 180 feet apart. (Figure 1 below)

Figure 1: Diagram of EOD Range Structure and Detonation Area

Approximately three observers and one EOD member assembled at each of the six locations on the range and began carefully arranging ordnance and placing C-4 under direct supervision of EOD members. (Tabs O-13, V-13.5, V-26.2, V-47.2) At each of the six detonation sites, an EOD member explained basic principles of ordnance disposal and safety. (Tabs V-13.5, V-47.3) Four of the six detonation sites were located in shallow pits in the ground while two were on level ground. (Tabs Y-3, Y-4, Y-25 – 28)

Though observers assisted, EOD members ensured the ordnance and explosive charges were arranged to their satisfaction, rearranging and adjusting the items as necessary. (Tabs V-26.2, V-35.2) The first two detonations that day were three times the maximum permissible explosive limit on the JBB EOD range. (Tabs O-29, O-90, Y-3, Y-4, CC-3) Per the Explosive Site Plan

(ESP) CENTAF-Balad-07-S146 the maximum permissible limit is fifty (50) pounds net explosive weight (NEW) per detonation on the JBB EOD range. (Tabs O-5 – 6)

At approximately 0845 hours local time the Commanding Officer, Senior Non-Commissioned Officer, and First Sergeant of the 332 ECES arrived at the detonation site with the intent to celebrate an EOD member's birthday by performing "birthday push-ups" as a form of building esprit de corps. (Tabs V-2.3 – 4, V-3.3, V-16.3) After performing these push-ups with the EOD Flight and observers, preparation of the six controlled detonation sites resumed. Afterwards, observers were allowed to walk around, photograph and view the different sites under EOD supervision. (Tabs V-1.10, V-2.4, V-13.3)

At one point, the 332 ECES Commanding Officer and Senior Non-Commissioned Officer noticed some ordnance prepared for demolition was on level ground and asked an EOD member about it. (Tabs R-22 – 26, V-2.4, V-3.9) These ordnances were prepared for the first and second detonations. This configuration was noteworthy to the Commanding Officer because he did not remember seeing this type of ordnance before and had not seen ordnance placed on flat terrain during previous demolition operations he attended. (Tab V-2.4) The EOD member indicated to the Commanding Officer this configuration was safe by explaining that they had researched the specific ordnance and found that they were composed of "consumable casings" which meant they would "go up with the burst." (Tabs V-2.4 – 12, AA-59 – 60) It was further explained that the ordnance was "directional in nature" and "low" and that the arrangement of the C-4 "would push down and disintegrate" the ordnance "as it pushed them down and out, and that it was standard procedure." (Tabs R-6, R-22 – 26, V-3.9, V-16.16, AA-60, AA-106, AA-114 – 117)

The metal bases of the M1028 cartridges prepared for the first and second detonations were oriented towards the general direction of personnel participating in the operation. (Tabs O-29, R-3 – 6, V-2.11, Y-12 – 15, Y-18, Y-25 – 28, CC-3)

At 0909 hours local time, the EOD team radioed in to the Air Traffic Control Tower (Tower) and other relevant base agencies the notification that a detonation would take place in 30 minutes. (Tab O-28) Observers were directed to the designated safe area while the EOD members placed the blasting caps in the explosive charges. (Tabs V-2.5, V-12.3) Blasting caps come pre-connected to one end of a "shock tube" which is wound around a spool. The other end of the shock tube is pre-connected to the initiation system. (Tab Y-29) When the initiation system is activated, it triggers a reaction that travels down the shock tube to the blasting cap which in turn detonates the explosive charge. (Tabs AA-45 – 50) The EOD members unwound the shock tube from the spool and proceeded to the designated safe area. (Tabs V-2.13, V-16.17)

The EOD members brought the end of shock tube connected to the detonation initiators to an area just under the overhang of the designated safe area in the open space between the concrete wall and the arched shelter. (Tabs V-2.14, V-12.4 – 5, Y-3, Y-4, Y-8) Personnel in this location were in a direct line-of-sight to the demolition set-ups. (Tabs V-12.6, Y-3, Y-4) They were also within the maximum fragmentation range distance and did not have frontal protection against the effects of the explosions (see section 5.2). (Tabs Y-17, Y-18, Y-21, CC-3)

Figure 2: Placement of shock tube and initiators

Figure 3: Close up view of shock tube and detonation initiator

While the observers waited in the designated safe area, EOD members asked for volunteers. (Tabs V-1.11, V-2.14, V-13.3, V-13.7) Six observers, including the injured Army SSG and the victim, raised their hands and were selected to initiate the detonations. (Tabs V-1.11, V-13.7) The observers were then instructed on how to properly perform the task. (Tabs V-2.13, V-13.7) After the instruction, the observer volunteers knelt behind the initiation systems connected to the ends of the shock tubes. (Tabs V-1.11, V-13.7) Other observers stood immediately behind them. (Tabs V-2.17, V-12.4) This configuration of personnel was the pattern used by EOD members in the past when detonating non-robust munitions, such as flares (see section 5.3). (Tabs V-16.11, V-20.7 – 8, V-22.9, Y-22 – 24, CC-4)

At 0932 hours local time, the EOD team radioed the tower with the 10-minute prior notification for pending detonation. (Tab O-28) At this time, the senior EOD technician in the flight provided a third and final safety briefing to the observers. (Tabs V-1.8, V-2.13 – 14, V-32.1) The observers listened attentively as he explained that at their present location they were "far enough away" from the detonations and that EOD had never had any problems in the past. (Tabs V-2.11, V-12.6) The senior EOD technician further explained that the observers should be quiet during the detonations, listening for the distinctive sound of fragmentation. (Tabs V-2.6, V-12.6, V-13.3, V-16.14) He emphasized that if anyone heard those sounds, or the command to "take cover" from any EOD member, they were to immediately take cover and get as low to the ground as possible, similar to procedures taken during enemy indirect fire (mortar) attacks. (Tabs V-2.10, V-12.6, V-16.15)

At 0935 hours local time, the EOD team radioed in the 5-minute notification to the Tower. (Tab O-28) At 0942 hours local time, the EOD team radioed in the 1-minute notification to the Tower. (Tab O-28) One of the observers was then directed by an EOD member to give the warning that explosive detonation was imminent, yelling "Fire in the hole" three times. (Tabs V-2.6, V-12.4, V-13.11) Next, EOD Member #3, standing in front of the observers, gave the directive to fire in sequence. (Tab V-16.19) He executed this with a "Fire One" command. (Tab V-16.19) The first observer initiated his system and detonated the first demolition set-up without

incident. (Tab O-28) Within seconds, EOD Member #3 gave a "Fire Two" command, and the second observer initiated his system and detonated the second demolition set-up. (Tab V-16.19)

Figure 4: Observer photo immediately after second detonation (No casualties appear in this photograph)

Almost immediately, EOD technicians and observers heard the Army SSG's shouts of distress and noted the shrapnel injuries to his arm and leg. (Tabs V-2.6, V-3.4, V-12.4, V-13.3, V-16.5) Several individuals then saw the victim fall backwards to the ground and noted the significant shrapnel injury to his chest. (Tabs V-1.9, V-13.3, V-16.19, V-26.3, V-27.2, V-35.3) An EOD member called in the emergency while other EOD members and observers immediately provided aid to both the Army SSG and the victim, implementing the basic life support and limb-saving techniques taught by the military to help injured personnel survive in medical emergencies until professional medical help is available. (Tabs V-13.3, V-14.4, V-16.5, V-34.2, V-35.3) Although it was quickly evident that the victim had expired immediately after injury, aggressive efforts to aid him continued. (Tabs V-2.18, V-13.3, V-16.20, V-26.3 – 4, V-46.3, V-48.4)

JBB Fire Department was notified of the incident and responded immediately; they also dispatched emergency responders to the scene. (Tab O-35) The Fire Department arrived first at the scene and assisted in the first aid for both the Army SSG and the victim. (Tab V-25.2)

It was clear to Fire Department personnel the victim had passed. (Tabs V-37.1, V-46.3) At approximately 0945 hours local time, "Bulldog Medics," JBB Hospital's Air Force Emergency Responders, and "Guardian Medics," JBB Hospital Army Emergency Responders, arrived on scene and relieved the observers, EOD members and Fire Department members providing first aid. (Tabs O-35, V-24.6, V-39.1) The 332d Expeditionary Medical Group's Chief of Aerospace Medicine arrived with the Bulldog Medics and pronounced the victim dead at 1009 hours local time. (Tab V-24.6) The victim was respectfully covered by a Fire Department member while the Army SSG was stabilized and transported by ambulance to JBB Hospital. (Tabs O-35, V-2.19, V-24.6, V-36.1, V-37.2, V-38.2) At 1016 hours local time, the Fire Department terminated the Emergency Response and contacted Mortuary Affairs who transported the victim to the hospital. (Tabs O-35, V-25.2, W-2)

5. ORDNANCE DEMOLITION OPERATIONS

5.1. Explosive Effects

Any detonation produces several explosive effects that generate potential hazards to personnel and material. This section outlines the specific explosive effects associated with the dangers of fragmentation.

Fragments from a detonation are categorized as either "primary" or "secondary" depending on their origin. A "primary" fragment results from the shattering of a container in direct contact with the explosives. These fragments are usually small and can travel long distances from an explosion, initially at a velocity of thousands of feet per second. A "secondary" fragment results from debris in close proximity to the explosion. These fragments are routinely larger in size, but do not travel as far as primary fragments. (Tabs AA-11, AA-23)

EOD personnel use Quantity Distance Range (QDR) calculations for potential explosions in order to determine the safe distances and protection levels required for personnel and property. These calculations, for fragmentation in particular, are proportional to the properties of the largest single munition (amount and type of explosives plus metal content) in a detonation. (Tabs AA-12, AA-25 – 28) QDRs specifically for fragmentation are referred to as the Hazardous Fragmentation Distance Range (HFDR) and the Maximum Fragmentation Distance Range (MFDR). (Tabs AA-25 – 32)

The HFDR is the minimum withdrawal distance for protection from potential fragmentation. This is the distance where primary fragment concentration is no more than one per 600 square-foot area and equates to a one percent probability of a person being struck by a hazardous fragment when standing in the open. EOD publications require all personnel to have adequate frontal and overhead protection against the explosive effects at this distance. (Tabs AA-34 – 35)

The minimum withdrawal distance for personnel to stand in the open without frontal and overhead protection is known as the MFDR. The MFDR is the range that primary and secondary fragments from a detonation are not expected to travel beyond. The standard minimum MFDR is 1,250 feet. (Tabs AA-28 – 30, AA-32 – 34)

Certain components of ordnance, such as baseplates, can generate "rogue" non-case fragments. According to Air Force Manual (AFMAN) 91-201, paragraph 12.74.3.2.2.1, "Rogue" fragments can travel to distances far beyond the MFDR. (Tabs AA-14, AA-22) Mitigation techniques are usually used for these types of ordnance. For example, munitions should be oriented so suspension lugs, strongbacks, and baseplates are facing away from areas to be protected. (Tab AA-14) Additionally, munitions can be detonated in a pit, trench or earth depression to control fragmentation effects. (Tabs AA-29, AA-52 – 53)

5.2. Reconstruction of 15 September Controlled Detonation

The Ground Accident Investigation Board (GAIB) researched documents, testimony, and pictures to determine the placements of ordnance and demolition explosives on the day of the mishap. (Tabs O-29, R-22 – 26, V-2.11, V-3.9, Y-3, Y-4, Y-12, Y-13, Y-14, Y-15, Y-25 – 28, CC-3 – 4) Each of the first two detonations consisted of eight M1028 cartridges and thirty blocks of C-4 demolition explosives.

The GAIB calculated the QDR for the first and second detonation, using the EOD Tactical Decision Aid (version 1.4.3). (Tabs Y-17, Y-21, CC-3 – 4) The NEW was estimated to be 178.98 pounds, which produced an HFDR of 497.51 feet and an MFDR of 2,092.48 feet. (Tabs Y-17, Y-21, CC-3 – 4)

The GAIB plotted the calculated fragmentation distances on a map of the EOD range for a visual representation. The designated safe area from which personnel viewed the detonations was outside of the HFDR (depicted by the red "ring" at 497.51 feet from the detonations in the graphic below) but within the MFDR (depicted by the yellow "ring" at 2,092.48 feet from the detonations) and the EOD range boundaries (depicted by the green "ring" at 2,500 feet from the detonations). (Tab Y-17) Actual fragments from the detonations were plotted on the JBB EOD range by base personnel after the mishap. (Tabs O-33, O-34, O-40, O-41) These fragments were easily distinguished by their distinctive "bluing" effect and the lack of any environmental rusting. The locations of these actual fragments are overlaid on the map as well (depicted by numbers next to small yellow "+'s") and were consistent with the predictive fragmentation calculations. (Tabs Y-17, Y-21, CC-3 – 4) The EOD members and casual observers were approximately 769 feet from the detonations. They were within both the minimum 1,250 foot distance and the calculated MFDR. When individuals are within the MFDR or within the 1,250 foot distance, they are required to use both frontal and overhead protection. (Tabs AA-28 – 30, AA-34 – 35)

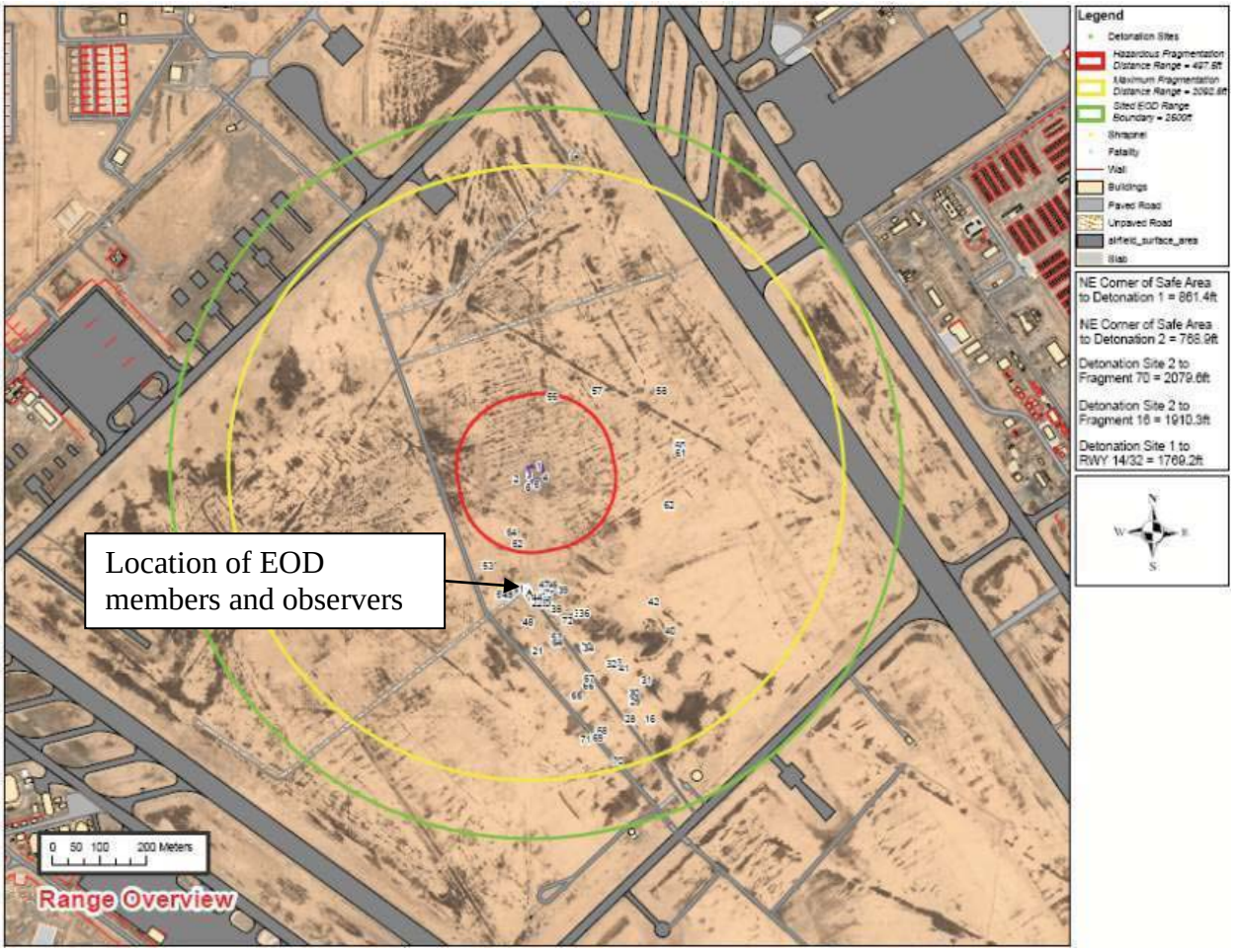

Figure 5: Range Overview

The general orientation of the ordnance set-ups prior to the detonations was determined through analysis conducted during a site visit using terrain association in conjunction with available photographs, maps, and a compass. (Tabs CC-3 – 4) The metal case bases of the cartridges were "oriented north/south" toward the general direction of personnel participating in the operation on 15 September 2010. (Tabs O-29, R-22 – 26, V-2.11, V-3.9, Y-12 – 15, Y-18, Y-25 – 28, CC-3 – 4) The plotted fragmentation pattern is consistent with this orientation. In addition, the cartridges prepared for the first and second demolitions were on the surface of the ground instead of a depression at the detonation area. The photographs below show the ordnance and munitions for the first and second detonations as they appeared before EOD members and observers departed the blast area.

Figure 6: Photo of Detonation 1 Set-Up

Figure 7: Photo of Detonation 2 Set-Up

In summary, the evidence shows that the metal fragments did not travel farther than the predicted MFDR and primarily traveled in the direction they were oriented. The frontal protection available by the designated safe area on the JBB EOD range is sufficient to protect against the dangers associated with such fragments. (Tabs Y-7, AA-30)

5.3. Past Demolition History

The EOD Flight members were all experienced and had conducted several detonations on the JBB EOD range prior to the mishap. On 14 July 2010, one member of the current EOD Flight participated in a demolition operation conducted by the EOD personnel they replaced at JBB. (Tabs CC-3 – 4) The EOD flight conducted 14 routine disposal operations during the period of 21 July 2010 to 15 September 2010. All but the last consisted of flares and similarly less robust ordnance. (Tabs CC-3 – 4) Associated operational sequence, patterns for viewing detonations and general procedures set by previous rotations were consistent with how the current EOD Flight ran these detonations. (Tab V-16.8) The EOD Flight and observers routinely observed these detonations with no frontal protection and without incident. (Tabs V-2.17, V-16.11, V-20.7 – 8, V-21.7 – 8, V-22.9, Y-22 – 24, CC-4)

All witness testimony confirmed a visible culture of professionalism and safety focus before, during and after the mishap. (Tabs V-2.11, V-14.5, V-16.3 – 5) This was apparent on all previous demolition operations as well. (Tabs V-20.8, V-22.7, V-23.5) There was no evidence to suggest any of the EOD members anticipated a fatal hazard on the day of the mishap.

5.4. Roles and Responsibilities

EOD operations, by their nature, are hazardous and require highly skilled personnel to apply good judgment, common sense, ingenuity, sound techniques and EOD principles. The 332 EOD FOI 32-3002 specifically spells out supervisory duties when conducting operations on the JBB EOD range. (Tabs O-5, O-6) Specific roles and responsibilities include:

a. The Flight Commander and Superintendent: The Flight Commander and Superintendent will oversee compliance with the OI. (Tab O-5)

b. The Range Safety Officer: The RSO will be a qualified 7-level EOD technician, responsible for overall safety of the disposal operation. (Tab O-5)

c. The EOD Team Chief: The EOD Team Chief will provide the RSO a list of items and NEW per detonation. (Tab O-6)

d. Personnel: Personnel will utilize maximum available cover during all high explosive detonations. (Tab O-12)

5.5. Procedure

AFMAN 91-201 (Explosive Safety Standards) paragraph 12.74.4., Technical Order (T.O.) 60A-1-1-4 (Protection of Personnel and Property), and the 332 ECES EOD FOI 32-3002 all require the maximum protection to personnel from the potential dangers from ammunition and explosives. (Tabs O-12, AA-15, AA-28, AA-34 – 35) On the day of the mishap, several personnel—both EOD technicians and casual observers—were in direct line-of-sight of the detonations. (Tabs V-1.12, V-2.20, V-3.7, V-12.4 – 5, V-13.12, V-14.8, Y-5, Y-6) The photograph below shows that several observers did not have either frontal or overhead protection during the detonations.

Figure 8: Photo by observer from west side of structure

EOD Disposal Procedures outlined in T.O. 60A-1-1-31 states that a pit, trench, earth depression, and tamping are normally required when control of fragmentation is a factor. (Tabs AA-52 – 53) In addition, Attachment 2 (Safety Briefing) of the local OI states to place explosives that present a projectile hazard into the bottom of the blast craters. (Tab O-13) During this accident, the M1028 cartridges were detonated on the surface of the ground. (Tabs Y-3 – 4)

Allowing detonation on the surface increases the probability of potential fragmentation hazards. (Tabs AA-52 – 53) Trenches to minimize potential fragmentation hazards to personnel and material have not been constructed anytime since U.S. forces arrived at JBB. This is especially relevant considering the exemptions of the JBB EOD sited range, the distances from the detonation site to critical materials (runways, bldgs, etc), and previous identified fragmentation hazards. (Tab O-83)

The M1028 cartridges' baseplates were oriented toward the area at which personnel were located during the detonations on the day of the mishap. (Tabs O-29, V-2.11, V-3.9, Y-12 – 15, Y-18, Y-25 – 28, CC-3) AFMAN 91-201, paragraph 12.74.3.2.2.1, states "Care must be taken to orient munition tail plate sections away from personnel locations or to minimize or eliminate the hazard …prior to detonation." (Tab AA-14)

During the mishap, the demolition setups were three times the maximum limit of fifty (50) pounds NEW per detonation. (Tabs O-5, O-29, O-90, Y-3, Y-4, Y-21, CC-3) The EOD Team Chief and RSO are responsible for checking the NEW per detonation. (Tabs O-5 – 6) Exceeding the total NEW increased each detonation's blast overpressure distances but had little impact on the fragmentation created by the explosion. (Tabs AA-25 – 27)

6. RANGE, FACILITIES, EXPLOSIVES, AND EMERGENCY EQUIPMENT

6.1. JBB EOD Range

An area has been established, sited, and approved by several levels of appropriate authority by both the Air Force Safety Center (AFSC) and the USAFCENT Commander in order for EOD to conduct demolition operations in accordance with their duties and ensure mission success. (Tabs O-43 – 86) This area is identified as the EOD range and is located between the two main runways on JBB, Iraq. (Tab Y-16) The sited location was selected based on its low impact, minimal number of Explosives Safety Standard violations and exposure to personnel and assets, as well as zero risk to inhabited buildings, public traffic routes, or populated recreational areas. (Tabs O-46, O-57 – 70) This location is the only area of the base that is free of any type of inhabited building. (Tab O-64) The EOD range generates a 2,500-feet explosives clear zone. (Tabs O-52, Y-14) This separation distance is based on the relationship to explosive operations. Within the clear zone there are exposures that are classified as violations to Explosives Safety Standards. (Tabs O-43 – 50, O-66) Control and compensatory measures are outlined in the EOD range site plan and local operating instructions, to mitigate associated hazards. (Tabs O-4 – 9, O-43 – 50, O-66) One notable compensatory measure is to limit any detonation to 50 pounds NEW or less. (Tab O-5) A detailed risk assessment was conducted, weighing factors such as exposures, likelihood of mishaps, consequences, etc. (Tabs O-46, O-57 – 70) The overall risk assessment associated with explosive ordnance disposal operations was determined to be "Low." (Tabs O-46, O-57, O-61, O-62) The USAFCENT Commander weighed, exhausted all options, and ultimately accepted the risks associated with the EOD Range Site Plan. (Tabs O-46 – 51) Final approval of the EOD Range Explosives Site Plan was granted in August 2008, by the Weapons Safety Division Chief from Headquarters, AFSC. (Tab O-43)

6.2. Local EOD Designated Safe Area on the JBB EOD Range

There is a structure located on the EOD range, which is used for personnel protection from the effects of explosions, such as blast overpressure and fragmentation hazards. This structure consists of an arched concrete shelter located on a concrete pad with additional walls on the opposing open ends of this arched shelter. Walls are constructed of heavily reinforced concrete, 47 inches thick. This structure was built prior to U.S. forces residing in JBB. While not oriented optimally (walls not perpendicular to detonation sites) and not specifically designed to provide frontal and overhead protection against effects of the explosions, the local EOD designated safe area does provide protection from the explosive effects of detonations to personnel positioned entirely behind and underneath the walls and roof. (Tabs Y-5 – 7, Y-17, AA-4, AA-15, AA-29 – 30) However, the angle of the structure allows for individuals located in certain sections (northeast side) to be in direct line-of-sight to the detonation site with no frontal protection.

Figure 9: View of Structure from Direction of Detonations

Figure 10: Side View of Structure

6.3. Ordnance

The unserviceable explosive items to be disposed of by detonation consisted of M1028 and 120mm U.S. Cartridges (Tab AA-59). There were eight of these cartridges prepared for each of the first two detonations. (Tabs O-29, O-90, Y-1 – 2) Each cartridge consists of a combustible case, made from nitrocellulose and cellulose (wood pulp kraft), plus a metal case base. The metal base plate is visible upon inspection of the M1028 cartridge. Hazardous components for each cartridge consist of nitrocellulose and nitroglycerin based propellant (15.95 lbs) and an igniter tube with 26 grams of black powder. (Tabs O-93, AA-59 – 60)

6.4. Demolition Explosives

All demolition explosives used in the operation were serviceable. Explosives used for demolition purposes consisted of the following:

a. Military M112 blocks: Thirty blocks were prepared for each of the first two detonations. (Tabs O-90, Y-3 – 4) Each block consists of 1.25 pounds of Composition C-4. (Tabs AA-42 – 43) Composition C-4 consists of RDX (Cyclotrimethylenetrinitramine) and plasticizing oils. (Tabs AA-113, AA-120)

b. M23: Used to initiate standard military explosives and demolition charges and were utilized for the operation on 15 September 2010. (Tabs Y-10, Y-29, AA-47 – 48) It is a single in-line initiation system consisting of a spool, 1,000 feet of plastic shock tube and a pre-attached M81 igniter. (Tabs Y-27, AA-47 – 48)

c. M81 igniter: Consists of a small plastic tube with a pull ring, a safety (cotter) pin and a screw cap that connects and secures the shock tube to this mechanism. (Tab AA-50) It is a pull-type percussion igniter which initiates the shock tube. (Tab AA-50) When the pull ring is pulled to the rear, the striker is cocked and released, driving into and initiating the primer. (Tab AA-50) The primer, in turn, ignites the explosive powder within the shock tube. (Tab AA-50)

d. Shock Tube: This is comprised of plastic tubing (1,000 feet) that contains a dusting of explosive consisting of 90 percent High-velocity Military Explosive (HMX) and 10 percent aluminum powder. (Tabs AA-48 – 49) Its function is to transfer a small initiating impulse to the end of the attached blasting cap. (Tabs AA-48 – 49)

e. Blasting Cap: This is an aluminum tube or detonator with approximately 0.03 ounces of explosives in the tip. (Tabs AA-41, AA-46 – 47) Its purpose is to produce a detonation shock wave strong enough to initiate military explosives. (Tabs AA-41, AA-46 – 47)

6.5. Emergency Equipment

All equipment associated with, required and necessary in the event of an emergency was identified as on-hand, serviceable and functioning the date of the mishap. (Tab O-6) Required equipment consisted of the following:

a. First Aid Kit and Combat Life Saver Bag: Both were readily available, briefed to all participants, and utilized immediately after the mishap to provide appropriate medical response. (Tab O-6)

b. Fire Extinguishers: Required serviceable extinguishers were on-hand the day of the mishap; however, their purpose was not called for, because there was no fire to extinguish. (Tab O-6)

c. Demolition gear: Appropriate demolition gear (crimpers and knives) were on-hand and serviceable for the purpose of demolition set-ups. (Tabs O-6, AA-51)

6.6. Communication Equipment

Two Land Mobile Radios were on-hand and functioning throughout the operation on the day of the accident. (Tab O-6) Communication equipment is necessary for appropriate notifications throughout the operation and in the event of an emergency.

7. ENVIRONMENTAL CONDITIONS

There was nothing notable regarding the topography or weather of the JBB EOD range on the day of the mishap.

8. PERSONNEL QUALIFICATIONS

8.1. Mandatory Training Tasks

Disposal of unserviceable, excess, or dangerous ordnance is one of the numerous General EOD Duties and Responsibilities. Similar to other career fields, EOD has a Career Field Education and Training Plan (CFETP). (Tab AA-69) Within this training plan there is mandatory initial training/certification tasks for personnel to accomplish based on their skill level. Personnel must obtain and maintain knowledge, qualifications and certifications within the assigned EOD specialty. (Tabs AA-70 – 72) Upon completing each task, members acknowledge and document task qualification. (Tabs AA-73 – 87) Documenting each task means the individual can perform the task without assistance and meets the local requirements for accuracy, timeliness and correct use of procedures. Documenting a task qualification serves as an official certification of proficiency, certifying that the individual is accountable for task performance in accordance with (IAW) the governing instructions. (Tabs AA-67 – 68) All minimum mandatory training tasks must be accomplished and documented prior to deployment. (Tab AA-64) The following mandatory initial training tasks from the CFETP are relevant to the mishap on 15 September 2010:

a. Perform Disposal Techniques (by) Detonation (Technical reference 60A-1-1-31), to include non-electric demolition systems

b. Determine/Demonstrate Munitions Safety Precautions (Technical reference 60A-1-1-22)

c. Protection of Personnel and Property (Technical reference 60A-1-1-4) Specifically, "Determine Hazard Distances and Estimate Collateral Damage"

d. Identify Projectiles and Observe Safety Precautions (Technical reference 60D-series publications)

There are recurring training requirements for all of these tasks in order to maintain knowledge, qualifications, and certifications. (Tab G-3)

8.2. Individual Personnel Qualifications

A thorough review of training records and related documents was accomplished to assess training currency, experience level, and overall qualifications of the Air Force EOD personnel involved in the mishap. (Tabs G-3 – 246, T-1 – 7) The following are notes on each EOD individual:

a. EOD Member #1 has 18 years of EOD experience. He is an EOD Craftsman and currently holds the Superintendent duty position for the EOD flight. Training documentation of related EOD tasks was complete and transcribed from previous records IAW prescribed procedures. He was very qualified to perform related EOD duties and known to be a professional senior non-commissioned officer (SNCO). (Tabs G-219 – 246, T-1)

b. EOD Member #2 has a total of 12 years of EOD experience and is currently an EOD Craftsman. Training documentation of related EOD tasks was complete and transcribed from previous records IAW prescribed procedures in 2004. He was qualified to perform related EOD duties and known to be professional. (Tabs G-3 – 32, T-2)

c. EOD Member #3 has a total of 8 years of EOD experience and is currently an EOD Craftsman. He recently earned a promotion to Technical Sergeant in July 2010. Training documentation of related EOD tasks was completed and documented IAW prescribed procedures. He was qualified to perform related EOD duties and known to be professional. (Tabs G-33 – 80, T-3)

d. EOD Member #4 has a total of 6 years of EOD experience. He is currently an EOD Craftsman and completed skill level training requirements as of December 2009. Training documentation of related EOD tasks was completed IAW prescribed procedures. He was qualified to perform related EOD duties. (Tabs G-81 – 138, T-4)

e. EOD Member #5 has nearly 2 years of EOD experience and is currently an EOD Journeyman. Training documentation of related EOD tasks were completed IAW prescribed procedures. He was qualified to perform related EOD duties. There were remarks in his training record in January 2010 referencing how training documentation lacked proper attention due to his supervisor being deployed. This issue was sufficiently addressed and corrected with the appropriate courses of action. (Tabs G-156 – 191, T-5)

f. EOD Member #6 has nearly 2 years of EOD experience and is currently an EOD Journeyman. Training documentation of related EOD tasks were completed IAW prescribed procedures. He was qualified to perform related EOD duties. (Tabs G-139 – 155, T-6)

g. EOD Member #7 has nearly 2 years of EOD experience and is currently an EOD Apprentice. He has completed EOD Journeyman training requirements but lacks time in grade or experience to be qualified at that level. The training documentation of his related EOD tasks was complete. He was qualified to perform his related EOD duties; however, thorough review of his training record revealed that numerous tasks were started and completed within the same day or just two days later. One hundred and sixty-nine tasks were started on 4 January 2010 with eighty-nine of these tasks completed that same day and sixty tasks completed on 6 January 2010. The other twenty training tasks were signed off on later dates. Task knowledge and performance of these tasks require a high degree of proficiency for qualification standards IAW governing directives. A trainee would not be able to adequately comprehend such training requirements within a few days. This documentation is not consistent with sound training progression and there was no explanation identified within his training record to account for these dates. (Tabs G-192 – 218, T-7)

9. MEDICAL FACTORS

9.1. Health Prior to Mishap

Based on witness statements and a review of medical records, at the time of the mishap, all members of the EOD Flight were in good health. (Tab W-5) No medical issues were identified which could have impaired their ability to perform their duties or to conduct the controlled demolition operation. (Tab W-5) No medical records were reviewed for uninjured casual observers.

9.2. Post-Mishap Health

No EOD Flight members were injured during or after the mishap. However, the victim, an observer, was fatally injured. (Tabs R-30 – 31, V-16.20, V-24.5) Another casual observer, an Army SSG, received severe life-threatening injuries. (Tabs V-1.5, V-13.3, V-16.5, V-24.5) The Army SSG's condition was stabilized at JBB's Hospital, followed by further treatment and rehabilitation at a military medical facility in the United States. (Tabs V-1, V-24)

According to the victim's autopsy report and witness statements, the trajectory of the shrapnel produced by the detonation caused an impact entrance wound through the victim's front upper left side of his chest continuing along a path that exited the lower left rear side of his rib cage. (Tabs R-7 – 8, V-16.19, V-24.6, Y-11) The shrapnel continued on a trajectory to cause major injuries to the Army SSG's right arm and left leg. (Tabs R-8, R-17, V-1.17, V-16.20, V-24.5) Several service members were able to stabilize the Army SSG observer's injuries and hemorrhaging until emergency responders arrived to provide medical care and transport. (Tabs R-8, R-20, R-30, V-1.17, V-2.5, V-13.3, V-16.6) Although several service members administered Self–Aid Buddy Care (SABC) and Combat Life Support (CLS) to the victim, they were unable to stabilize his condition. (Tabs V-16.20, V-24.6) At 1009 hours local time, the victim was pronounced dead by the on-scene Emergency Physician. (Tab V-24.5) Furthermore, several witnesses reported the victim died almost immediately from his wounds. (Tabs R-14, V-24.6)

9.3. Toxicology

Shortly after the mishap, EOD Flight members submitted blood and urine samples. Blood was tested for ethanol. Urine samples were tested for amphetamines, barbiturates, benzodiazepines, cannebinoids, cocaine, opiates, and phencyclidine. Toxicology reports for all members were negative.

The victim's post-mortem toxicology was negative for all tested substances, including ethanol, amphetamines, barbiturates, benzodiazepines, cannebinoids, cocaine, opiates, and phencyclidine.

9.4. Lifestyle

Review of medical records and witness statements did not reveal any significant or unusual habits, behaviors, or stressors related to the mishap. (Tabs R-33, V-3.9, V-16.16, W-2)

9.5. Crew Rest and Crew Duty Time

According to AFI 32-3001, *Explosives Ordnance Disposal (EOD) Program*, and local EOD FOIs, there are no requirements for "crew rest" for EOD personnel or casual observers. (Tab AA-11) There is no evidence of fatigue or any other associated factors.

10. OPERATIONS AND SUPERVISION

10.1. Operations

The EOD Flight members had been together at JBB for approximately 60 days on the day of the mishap. (Tabs T-1 – 7, CC-3) The flight was composed of mostly experienced members (four 7-level "Craftsmen," two 5-level "Journeymen" and one 3-level "Apprentice;" one additional

member had been forward deployed to Afghanistan and no longer at JBB) and had attended Combat Battlefield Ready Airmen (CoBRA) training prior to deploying. (Tabs T-1 – 7, V-2.25, AA-64) The operations tempo of the EOD flight was fairly robust when compared to home station detonations, but was less than other deployed units. (Tab DD-63) Over the 9 weeks the team had been together, they had completed 14 controlled detonations on the JBB EOD range, which was not an unusual operational tempo. (Tab CC-3)

10.2. Supervision/Oversight

Personnel in the EOD Career field are the only individuals specially trained in explosive ordnance disposal. (Tab AA-5) Normally, Weapons Safety individuals only spot inspect compliance with locally established procedures during training demolition (5 pounds NEW or less) at a home station base. At deployed locations it is routine for Weapons Safety personnel to only review basic EOD documents that cover procedures for only the deployed location. This practice is in compliance with AFMAN 91-201, paragraph 1.1.2 guidance *"Expose the minimum number of people to the minimum amount of AE for the minimum amount of time consistent with safe and efficient operations."* (Tab AA-10) The EOD Flights are sent to a CoBRA class prior to deployment to review procedures and training required for their deployment. (Tabs V-2.25, AA-64) Once the EOD flight arrives at their deployed location, it is the sole responsibility of the senior EOD member to ensure all operational procedures are accomplished per Air Force direction. (Tab O-5)

The GAIB reviewed accessible inspections of the EOD Flight over the past 12 months, and EOD was not a prime focus area of any of these inspections. (Tab DD-3 – 15, DD-17, DD-43 – 63, DD-65 – 68) Standard oversight of EOD flights overseas only assess facilities and related documentation, and do not assess actual procedures used during weapons disposals. (Tabs AA-94 – 97, DD-3 – 17, DD-43 – 62) Weapons Safety did not inspect any EOD training detonations or other procedures at JBB. (Tabs V-17.6 – 8, AA-94 – 97, DD-13 – 15, DD-43 – 63) Several individuals in the 332d Civil Engineer Squadron chain of command, as well as 332 AEW Weapons Safety, did attend selected controlled detonations as casual observers, but were not trained enough to recognize any safety violations. (Tabs V-17.10, AA-94) Other reviews included: AFCENT Staff Assistance Visit (SAV) for Civil Engineering; a Risk Assessment Visit (RAV); the 332 AEW Annual Safety Program Assessment & Facility Inspection; the 332 AEW Weapons Safety Spot Inspections; and the Civil Engineering Squadron Commander's Review Log. (Tabs DD-3 – 15, DD-43 – 63, DD-65 – 68) The records and evidence do not show any independent oversight or operational supervision of the actual EOD procedures used at JBB.

11. HUMAN FACTORS ANALYSIS

The board evaluated human factors relevant to the mishap using the analysis and classification system model established by the Department of Defense (DoD) Human Factors Analysis and Classification System (HFACS) guide, implemented by Air Force Pamphlet (AFPAM) 91-204, *USAF Safety Investigations and Reports,* dated 24 September 2008. (Tab AA-99) A human factor is any environmental, technological, physiological, psychological, psychosocial, or psycho-behavioral factor a human being experiences that contributes to or influences his

performance during a task. The DoD has created a framework to analyze and classify human factors and human error in mishap investigations.
The framework is divided into four main categories: Acts, Preconditions, Supervision, and Organizational Influences. Each category is further subdivided into related human factor subcategories. The main categories allow for a complete analysis of all levels of human error and how they may interact together to contribute to a mishap. This framework allows for evaluation from the unsafe acts that directly are related to the mishap through the indirect preconditions, supervision, or organizational influences that may have led to the mishap. The potentially relevant factors to this mishap are discussed below.

11.1. Supervision – De Facto Policy

De Facto Policy is a factor when unwritten or "unofficial" policy perceived and followed by the individual, which has not been formally established by the properly constituted authority, leads to an unsafe situation. (Tab AA-104) Interviews and photos from previous EOD range operations demonstrate that EOD Flight members repeatedly placed themselves and others outside of the designated safe area during demolition of flares and similarly less robust ordnance. (Tabs V-2.17, V-16.6, V-20.4 – 5, V-21.7 – 8, V-22.9, Y-20 – 22, CC-3) This routine was not supported by local guidance. (Tab O-12) However, it became a standard pattern of operation that was followed during EOD demolition operations.

11.2. Negative Transfer

Negative Transfer is a factor when the individual reverts to a highly learned behavior used in a previous system or situation and that response is inappropriate or degrades mission performance. (Tab AA-102) The De Facto Policy of positioning themselves and observers outside of the designated safe area during demolition operations was a learned behavior, reinforced over the course of 14 operations (see section 5.3). (Tabs V-2.17, V-16.6, V-20.4 – 5, V-21.7 – 8, V-22.9, Y-20 – 22, CC-4) This learned behavior was then transferred from demolitions involving less robust ordnance to a demolition involving more robust ordnance.

11.3. Caution/Warning – Ignored

"Caution/Warning – Ignored" is a factor when a caution or warning is perceived and understood by the individual but is ignored by the individual, leading to an unsafe situation. (Tab AA-101) According to Air Force T.O. 60A-1-1-42, a warning is defined as, "An operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury to, or death of, personnel, or long term health hazards." (Tab AA-56) The EOD Flight members at the mishap possessed the knowledge and understanding of the relevant regulations to be aware of the "Warning" contained within T.O. 60A-1-1-4 (see section 8). This "Warning" reads:

> "WARNINGS. (Safety Supplement 1) Ensure that all personnel located within intentional/anticipated detonation quantity distance ranges are afforded adequate frontal and overhead protection against explosion effects; hearing protection devices are recommended as required. Within these ranges, personnel remaining in the open may incur injury or death from being struck by a hazardous fragment(s). Risks associated with explosion effects increase for distances closer than the maximum fragmentation ranges." (Tab AA-35)

On the day of the mishap, the EOD Flight ignored the "*Warning*" by placing EOD Flight members and casual observers in the line of sight of the detonations. (Tabs V-1.12, V-2.20, V-3.7, V-12.4 – 5, V-13.12, V-14.8, Y-5, Y-6, AA-35) Negative Transfer created a precondition for EOD Flight members to ignore the cautions and warnings of technical orders.

11.4. Procedural Error

Procedural Error is a factor when a procedure is accomplished in the wrong sequence or using the wrong technique or when the wrong control or switch is used. This subcategory also captures errors in navigation, calculation or operation of automated systems. (Tab AA-100) AFMAN 91-201, paragraph 12.74.3.2.2.1, states "Care must be taken to orient munition tail plate sections away from personnel locations or to minimize or eliminate the hazard …prior to detonation." (Tab AA-14) During this mishap, the M1028 cartridges' baseplates were oriented toward the area at which personnel were located during the detonations. (Tabs O-33 – 34, V-2.11, V-3.9, Y-10 – 13, Y-16, Y-23 – 26, CC-3) Also, EOD Disposal Procedures outlined in T.O. 60A-1-1-31 states that a pit, trench, earth depression, and tamping are normally required when control of fragmentation is a factor. (Tab AA-53) In addition, Attachment 2 (Safety Briefing) of the local OI states to place explosives that present a projectile hazard into the bottom of the blast craters. (Tab O-2) During this mishap, the M1028 cartridges were detonated on the surface of the ground. (Tabs Y-1 – 2)

11.5. Leadership/Supervision/Oversight Inadequate

Leadership/Supervision/Oversight Inadequate is a factor when the availability, competency, quality or timeliness of leadership, supervision or oversight does not meet task demands and creates an unsafe situation. Inappropriate supervisory pressures are also captured under this code. (Tab AA-103) Senior EOD Flight members in a deployed environment are responsible for ensuring all operational procedures are accomplished per AF instructions. (Tabs O-5, AA-5, AA-38) In addition, several individuals in the 332d Civil Engineer Squadron chain of command attended the detonations on several occasions, but were not trained enough to recognize any safety violations. (Tabs V-2.7, V-2.20, V-3.5, V-3.15) Furthermore, per the evidence reviewed, Weapons Safety, AFCENT CE SAV, an AFCENT RAV, 332 AEW Annual Safety Program Assessment & Facility Inspection and a 332 AEW Weapons Safety Spot Inspection did not provide pertinent oversight of controlled detonation operations. (Tabs DD-3 – 68)

11.6. Other Human Factors Considered

The GAIB found no relevant evidence of EOD Flight *fatigue, pressing, proficiency, discipline enforcement, complacency, authorized unnecessary hazard, procedural guidance/publications* or *personnel resources.*

12. GOVERNING DIRECTIVES AND PUBLICATIONS.

12.1. Primary Operations Directives and Publications.

1. 332 ECES/EOD Flight Operating Instruction (FOI) 32-3002, *EOD Disposal Range and Emergency Disposal Operations*, dated 31 Mar 10
2. DoD 6055.09-STD, *DoD Ammunition and Explosives Safety Standards*, dated 29 Feb 08
3. Air Force Manual 91-201, *Explosives Safety Standards*, dated 17 Nov 08
4. Technical Order 60A-1-1-4, *Protection of Personnel and Property*, dated 17 Dec 03
5. Message 141645Z MAR 07, *Safety Supplement to Technical Order 60A-1-1-4 (SS-1)*, dated 14 Mar 07
6. Technical Order 60A-1-1-22, *General EOD Safety Precautions*, dated 30 Jul 07
7. Technical Order 60A-1-1-31, *General Information on EOD Disposal Procedures*, dated 24 Oct 08
8. Technical Order 60A-1-1-42, *Joint-Service Explosive Ordnance Disposal Manual System*, dated 15 Mar 07
9. Technical Order 60D-2-2-235, *U.S. Cartridge, 120-mm, APERS, Canister, M1028*, dated 16 Mar 07
10. EOD Tactical Decision Aid (version 1.4.3)
11. Air Force Instruction 32-3001, *Explosive Ordnance Disposal (EOD) Program*, dated 10 Oct 07
12. Air Force Instruction 36-2618, *The Enlisted Force Structure*, dated 27 Feb 09
13. Air Force Instruction 36-2201, *Air Force Training Program*, dated 15 Sep 10
14. Air Force Specialty Code 3E8X1 CFETP, Career Field Education and Training Plan, dated 5 Aug 10
15. Joint Publication 1-02, *DoD Dictionary of Military and Associated Terms*, as amended through Apr 10
16. Technical Order 00-5-1, *Air Force Technical Order System*, dated 15 Aug 09
17. Air Force Instruction 91-202, *The US Air Force Mishap Prevention Program*, dated 18 Feb 10

12.2. Known or Suspected Deviations from Directives or Publications.

Deviation from the governing directives and publications are explained in the Procedural Error section (see section 11.4).

13. ADDITIONAL AREAS OF CONCERN

13.1. Misleading/Inadequate Guidance

There is guidance that could be misleading regarding important safety distances. DoD 6055.9-STD; *DoD Ammunition and Explosives Safety Standards*, is the source document for the Air Force's T.O. 60A-1-1-4 and AFMAN 91-201. AFMAN 91-201 is the Air Force's implementation of DoD 6055.9-STD for all explosive activities. The Air Force T.O. 60A-1-1-4 specifically incorporates the EOD safety standards established by the Department of Defense Explosive Safety Board, DoD 6055.9-STD. Noteworthy discrepancies within these publications that could lead to an unsafe situation are:

a. Regarding the detonation of fragmenting explosives on areas used for intentional detonations, both T.O. 60A-1-1-4 and DoD 6055.9-STD dictate that all personnel (essential and non-essential) exposed in the open, be at the greater distance of either the calculated MFDR or the calculated blast overpressure distance range. In addition, both documents also require a minimum distance of 1,250 feet. (Tabs AA-4, AA-28, AA-34) AFMAN 91-201 follows the same guidance with exception of the minimum distance. The minimum distance, provided in paragraph 12.74.3.2, is 200 feet vs. the 1,250 feet stated in DoD 6055.9-STD. (Tab AA-13)

b. Regarding the detonation of non-fragmenting explosives on areas used for intentional detonations, DoD 6055.9-STD dictates that all personnel exposed in the open, be at the greater distance of either the calculated blast overpressure distance range or the minimum distance of 1,250 feet. (Tab AA-4) AFMAN 91-201 follows the same guidance with exception of the minimum distance. The minimum distance, provided in paragraph 12.74.3.1, is 200 feet vs. the 1,250 feet stated in DoD 6055.9-STD. (Tab AA-13)

c. There are several terms used in AFMAN 91-201 and DoD 6055.9-STD that must be completely understood in order to assess Ammunition and Explosives (AE), and thus calculate fragmentation hazards correctly. Some of these terms include "non-fragmenting" "fragmenting" "non-robust" "robust" and "extremely heavy case" munitions. (Tabs AA-7 – 8, AA-17 – 19) An experienced EOD member should have the skills to distinguish between these terms; however, the definitions are not uniform within these publications. (Tabs AA-2 – 4)

13.2. Training Discrepancies in EOD Flight Members' Records

Training discrepancies appear in two of the junior EOD flight members' records. The notes in one of the records indicated the supervisor had been deployed during a significant portion of the individual's training. The other record showed 169 training tasks were initiated on one day with 89 of the 169 tasks (88%) signed off the same day; and another 60 of the 169 training tasks (36%) signed off two days later. The remaining 20 training tasks were completed and signed off on later dates. Task knowledge and performance of these tasks require a high degree of proficiency for qualification standards IAW governing directives. A trainee would not be able to adequately comprehend such training requirements within a few days. Home station training is critical to ensuring deployed EOD members are ready for the missions experienced during deployments overseas, and requires adequate time with both the trainee and the trainer.

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