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AMMUNITION ACCIDENTS - THEIR CAUSES, INVESTIGATION AND PREVENTION

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ABSTRACT

The Presentation covers a brief description of the role of the Directorate including the involvement with ammunition accidents. Several examples are used to show how accidents have occurred worldwide and address Design Faults, Poor Storage Control, Movement of Ammunition, Equipment Failures, Production Faults, In-Service Deterioration, Handling, Tampering and Errors of Drill. Investigation techniques are described using an accident that occurred in the UK involving 81mm Mortar ammunition resulting in three fatalities, as an example. The Presentation concludes with the measures taken in the British Army to prevent the re-occurrence of accidents. A video entitled "The Stupidity Factor" (14 mins) which illustrates the causes of typical ammunition accidents, is also available.

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 PRESENTATION BY LIEUTENANT COLONEL A J MORLEY BSc MSc RAOC
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INTRODUCTION

Thank you for the opportunity to speak at the 24th Department of Defence Explosives Safety seminar.

Before I start talking about the subject of ammunition accidents I would like first of all, to take a few minutes to explain the role of the Director for whom I work.

As Director of Land Service Ammunition he is responsible to the Director General of Ordnance Services for:

Equipment and Supply Management including global stock control and deployment, provision calculations, requisition, monitoring contract processes and progressing orders through production to receipt.

Long Term Equipment Planning for ammunition and explosives.

Sponsoring Ammunition and Explosive Regulations. His staff write and update all ammunition technical regulations.

Training of all ammunition technical personnel, including Explosives Ordnance Disposal Operators.

Explosives Engineering including surveillance, repair, modification, quality assurance, reliability analysis and disposal of munitions.

As Chief Inspector of Explosives for the British Army he is responsible for:

Setting Army Policy and Monitoring Safety Standards for storage, handling, transportation and inspection of ammunition and explosives giving technical advice on the interpretation of current regulations and implementing additional regulations resulting from new legislation. This work is monitored and verified by the Defence Explosives Safety Authority, who in turn liaise closely with the Health and Safety Executive, from whom we heard earlier today.

Proof of Ammunition. Members of his staff carry out Complete Round Proof *ie the proving of ammunition in conditions as close to the service environment as possible. For example the proving of 105mm Howitzer ammunition will be done using a unit of the Royal Artillery firing preselected and conditioned ammunition through their own guns but with monitoring equipment provided by DLSA. The results so obtained allow us to advise on the condition of the stock holdings

Approving New Ammunition Storage and inspecting existing ammunition storage including Royal Army Ordnance Corps ammunition units, and what is more pertinent to the subject of my presentation today:

Ensuring Safe User Drills, methods of repair and proof.

The Technical Investigation of all ammunition incidents including accidents.

Let me now give my credentials. My task within the Directorate is the munition manager for all Land Service Guided Weapons and I am also Head of the UK delegation to the ammunition working party one of whose tasks is the sponsorship of STANAG 2940 the Reporting of Major ammunition malfunctions.

AIM

This brings me nicely on to the subject of ammunition accidents that I wish to talk to you about today. I will spend a little time outlining the causes of accidents; go on to describe how we investigate accidents and finally address the problems of how to prevent accidents - a problem faced by us all.

ACCIDENTS GENERALLY

Accidents are a feature of every day life. We have all, unless we are very lucky, been involved in a road accident, for example. More people are injured in the "Safety" of their own homes each year than in any other location.

Being a Soldier is a hazardous profession! For training to be realistic soldiers are, necessarily, placed in situations which are potentially hazardous. The use of ammunition and explosives, munitions of war designed to kill or maim, places the men at risk. Of course, design features, robust construction and procedures make the use of ammunition at training safe and I shall be discussing that further, but the potential for an individual to be involved in an accident are manifold.

Before I go any further let me stress the point that ammunition is inherently safe but accidents do occur. The first I was involved in was as an Army Cadet at the age of 14 or 15. At the end of an exercise we were left with two of these - a thunderflash - a simulator for making loud bangs to represent grenades, gunfire etc. The instructors with us said "We'll show you how to get rid of these", so they cut them open, poured the contents on a road and put a match into the pile of gun powder. The resultant explosion removed all the skin from the back of his hand. That may I say is not the correct way to dispose of misfired Thunderflashes.

As you can imagine therefore I am a great believer in soldiers not tampering with ammunition.

But now let me give you an idea of the frequency of ammunition accidents, this slide shows the number of ammunition accidents which have occurred in the last seven years. The total column refers to the total number of accidents for a particular year. An accident is an ammunition incident which causes injury, death or damage to equipment or property, hence the apparent disparity between the number of accidents and the numbers injured and killed. There is no discernible trend, although last year was particularly bad in terms of the number of casualties. To put these figures into perspective, the British Army is approximately 300,000 strong, including reservists or part time soldiers. So what are the causes?

CAUSES

Design Faults. If we are to reduce ammunition accidents to a minimum we must design safety into the ammunition our soldiers use. Fortunately, over a long period of time, ammunition design has achieved a very high standard. However, design faults do still come to light after ammunition is brought into service. An example of this is oversized washers on L2 HE Grenades causing partial detonations.

Storage. In a disciplined organisation, the application of stringent procedures and regulations, should ensure that ammunition storage accidents do not happen. However, accidents in storage do occur.

Faisalabad, Pakistan. As recently as 10 Apr 88 a complete ammunition depot was destroyed. No firm details are available but it is believed to have started with a HD 1.1 event followed by other major explosions and fires. There were an estimated 100 casualties including many fatalities.

Brazil. 12 tons of PETN in store caught fire. Fortunately most of it burnt away before the residue detonated. Traversing restricted propagation.

Inkomo, Zimbabwe - Aug 81. A fire led to a series of HD 1.1 events via propagation. The complete depot was lost, but, as it happened on a rest day there were no casualties.

Severomorsk, Russia - May 83. During a seven month period in 1983-84 six ammunition storage locations in Russia suffered explosive events. The most serious of these was at Severomorsk Naval base on the Kola Peninsula. Three separate storage areas were involved and the result severely affected the operational readiness of the most powerful Russian fleet.

What were the causes of these accidents - or what caused some of them to reach such dramatic scales? Almost certainly inadequate safety distances between buildings and sites was one factor. This may have been the result of inadequate regulations or the incorrect application of regulations.

Movement. Transporting ammunition and explosives is potentially more hazardous than storing it as there is more opportunity for things to go wrong. Trucks may crash, set on fire, trains may be de-railed, ammunition can be dropped during intermodal transfers:

USSR --1988. A freight train carrying commercial explosives exploded near a station causing heavy casualties and severe damage.

Ambazac, France - May 86. A lorry carrying 19 tons of Dynamite exploded. A fire took hold and spread to the load causing mass detonation. Fortunately the driver took the vehicle off the main road and evacuated the area. There were no casualties, but over 100 houses were damaged.

Equipment Failures. A 76 mm gun on a tracked recce vehicle (Scorpion) had a faulty safety system which caused accidental firing. Our 9 mm sub-machine gun breach mechanism wore so badly that the sears, which held the breach block to the rear enabling single round firing, failed causing the full discharge of the magazine.

Production Faults. Shell 175mm Gun HE - at high angles of elevation loaded shell were falling back onto the propelling charges - resulting in a breech explosion which destroyed the M107 Gun. This was due to the driving band being incorrectly profiled. These examples necessitated 100% rework of affected stocks.

In-Service Deterioration. Round 84mm Inf HEAT, Carl Gustav - level of stabiliser in the igniter had degraded with age - similar propellant stored in bulk by civilian industry had ignited spontaneously.

Handling. I have spoken about how faults can be built into ammunition but we can all accept that this is a fairly rare occurrence. I have illustrated how accidents, some of great magnitude, can occur during storage and transportation. But these are rare events because both storage, and to a lesser extent transportation, can be carefully controlled. The real potential for accidents is realised when ammunition is brought into use by the soldier at training. In this case the ammunition is exposed, used for the purpose for which it was designed (generally to kill) and often used in a hostile environment where the user is under stress.

Tampering. There is also another effect caused by the soldier handling "real" ammunition that of arousing curiosity - and that is what I would like to talk to you about next. Soldiers are blessed (or cursed) with great curiosity. They like to know how things work. For most this thirst for knowledge is satisfied by instruction and reading books and manuals. For a few, however, that is not enough. They need to look for themselves and try to take things to pieces. This leads to one of the causes of accidents caused during handling - Tampering!

Tampering is the cause of relatively few accidents. In an average 12 month period, of, say, 200 reportable ammunition accidents - 5 can be expected to result from tampering. However, it is likely that at least one person will have been injured on each occasion.

Errors of Drill. Errors of Drill account for between 10-20% of all ammunition accidents and cause a significant number of casualties - 20 in an average year. Examples of errors of drill are firing ball small arms ammunition through a rifle fitted with a blank firing attachment, firing the 84mm recoilless weapon system with someone in the rearward danger area, and double feeding an 81mm Mortar tube after a misfire. All these accidents have happened and I shall be telling you more about the lattermost in a moment. What leads to errors of drill? Inadequate training, working under stress and difficult conditions, tiredness during long exercises. Sometimes it can be the result of incorrect procedures and drills in training pamphlets but this is rarely the case.

Negligent Discharge (ND). It is surprising how many people fire weapons, particularly personal weapons, accidentally. More ammunition accidents are caused by soldiers negligently discharging their weapons than by any other single cause. Something like 30-40% of reportable ammunition accidents are caused by negligent discharges and contribute significantly to the annual casualty list, an average of 17 in any year. Again, what are the causes? Negligent discharges usually occur because people do not unload their weapons properly and at the correct place. This may be because of tiredness, stress or poor procedures.

But there is one underlying trend in most ammunition accidents which occur because of handling errors - a lack of supervision.

INVESTIGATION

Having discussed the causes of ammunition accidents, and I am not saying that my list is exhaustive, I am now going to consider their investigation. To do this I am going to use a real case history, an accident involving a mortar section firing under field conditions at Otterburn Training Area, UK on 18 Mar 82.

Otterburn is one of our main training areas; it is bleak, rough, undulating, moorland terrain. The unit was on a one week mortar live firing practice and had already had three days successful training. During that time they had had three misfires but had not reported them through the ammunition incident reporting chain as required by regulations. This was a significant error as you will see.

At 1102 hrs on the fourth day - Thursday - an explosion occurred at No 2 Mortar position causing serious casualties. Three soldiers were killed and two others seriously injured.

Immediate action included tasking the Civil Police (because death had occurred), the Special Investigations Branch of the Military Police and the Ammunition Technical Officer (ATO) one of DLSA's technical staff deployed throughout the UK. A Sergeant Ammunition Technician was immediately tasked by Range Control to attend. He arrived at 1127 hrs, asked that nothing be touched or removed, including the bodies, and checked the area for any ammunition which could be in a dangerous state. Having satisfied himself that the area was safe he sought assistance from his Company Headquarters and then organised a meticulous search of the area. Every fragment found was marked with white tape but was not moved. A grid search pattern was established and the location of each fragment accurately plotted. Witnesses were identified and held ready for questioning.

By the time the ATO Company Commander arrived at 1315 hrs police photographers had recorded the scene and witnesses were being questioned by both civil and military police.

The ammunition on site which had been prepared for firing was inspected by the ATOs, repackaged and the technical details recorded. These details were passed to DLSA and a worldwide ban imposed pending the outcome of the investigation. Witnesses were interviewed by the ATO to provide background information to the incident. The light was failing by this time so the area was left under guard, and in depth questioning of witnesses was carried out by the ATO off-site. At this stage everything indicated that correct procedures had been followed.

Further interviews were carried out and included all personnel involved in the accident. The Otterburn Range Armourer stated that the weapons had been correctly maintained and that they were serviceable. The weapon's log books confirmed that they had been subjected to a recent inspection and found to be serviceable.

The following day a more intensive search was carried out, every fragment was plotted and labelled before collection and removal to the ATOs HQ for further investigation. But ammunition damaged in the explosion was destroyed at a nearby site.

As a result of an initial inspection of the fragments the suspicion was that, a second bomb had been involved, so an extended search of the area was carried out to 600 m from the explosion site but no further mortar bomb fragments were found, however two pieces of the mortar barrel were. The remains of the weapon were inspected by the District Armourer who could not attribute the accident to the weapon.

This led the team into a more detailed inspection of the fragments which showed that the lower section of the mortar barrel had been reduced to very small fragments consistent with a detonation in that area. The upper part of the barrel was bulged which would be consistent with an obstruction (2nd - bomb) in the barrel deflecting the effects of an explosion outwards. This was confirmed by the discovery of fragments of a second tail unit at the scene. There was now significant evidence to support a two bomb theory and it was concluded that:

Bomb 1 Misfired.

A double feed occurred.

Bomb 2 functioned normally when the primary cartridge hit the forward contours of the bomb 1 fuze.

Hot propellant gases/pressure caused bomb 1 fuze magazine/gain to function.

The accident was the result of an error of drill.

The investigation of any accident includes, as a standard procedure:

Inspection of site.

Questioning of witnesses.

Inspection of weapons and equipment.

Taking account of the environment.

Investigation of procedures used and if necessary:

The use of experts/scientists.

Manufacturers input.

A report giving details of the accident and where possible giving the cause of the accident.

Every accident is the subject of a Board of Inquiry at which the cause is, if possible, identified and recommendations are made to prevent future accidents.

PREVENTION

This brings me to the final part of my presentation and that is how do we prevent accidents?

Design. The first task is to ensure that ammunition is designed and manufactured correctly. This should be possible because it is carried out in slow time under controlled conditions.

We must respond rapidly to ammunition accidents, investigate thoroughly and implement resultant recommendations.

Ammunition involved in an accident must be suspended from use. Our system of imposing ammunition bans must be comprehensive and rapid. This is both a national and NATO requirement STANAG 2940 requires that any major ammunition malfunction which occurs involving ammunition listed in the interoperability catalogue must be reported to all member nations as quickly as possible and follow up reports published as appropriate.

Movement and Storage Regulations must be correct, and must be enforced.

User drills and procedures must be carefully developed and tested to reduce risks to a minimum).

Allied to this, training must be thorough, realistic and properly supervised. It is the lack of proper supervision that is the common thread running through most ammunition accidents.

Finally, publicity is one way in which we try to bring peoples attention to accidents and their consequences. DLSA issues periodic accident reports and we have recently produced an updated training film called "The Stupidity Factor" which is shown to soldiers during training. There is something of the stupidity factor in us all; we do things without thinking, sometimes we become distracted when we should be concentrating. But we hope it does not result in an ammunition accident which can cause this.

CONCLUSION

Gentlemen, that concludes my presentation. Accidents involving ammunition will continue to happen because of its very nature, and because of human nature. Our task is to ensure that accidents are kept to a minimum so that our soldiers can work and train in safety.

QUESTIONS