

Risk assessment for the AK-47

1. Task

This document will consider the risk associated with 5 core hazards inherent to the design of the Avtomat Kalashnikova Model 47 (AK-47) assault rifle, then provide mitigation strategies to reduce the risk to as low as reasonably practicable (ALARP).

2. System

The AK-47 is a fully automatic assault rifle chambered in 7.62x39mm. When the trigger of an AK-47 is actuated, a hammer strikes the firing pin which in turn strikes and punctures the bullet primer, causing thermal decomposition of both the primer composition and then bullet propellant. The gas generated produces enough pressure to drive the bullet through and out of the barrel at high velocity. As the bullet approaches the end of the barrel, the propellant gas enters an inlet above the barrel, forcing a piston head aft of the barrel. This piston is connected to a breech clearing mechanism which pushes back the bolt carrier, leading to ejection of the cartridge casing, followed by reloading of the next round as the pressure is relieved and the piston returns to its initial position. The hammer for the firing pin is also reset by this mechanism.

3. Methodology

3.1 Scope

This risk assessment will be considering the AK-47 under normal operating conditions expected to be experienced during operations and training. These operating conditions are to be defined as: high and low climate, high and low humidities, locations moderate particulate/water ingress is likely, with the former likely being an abrasive particulate. The ammunition is only considered from the point at which it is housed within the magazine and issued to an operator, and consideration ends when it has been unloaded, fired or otherwise cleared from the weapon system.

3.2 Severity definitions

The following definitions for severity of occurrence have been decided upon:

1. Marginal - Negligible harm
2. Minor - Low Triage Recoverable/Public Negligible Harm
3. Severe - High Triage Recoverable/Public Low Triage
4. Critical - Life-altering injury/Public High Triage
5. Catastrophic - Fatality or multiple fatalities/Public Life-altering

3.3 Likelihood definitions

The following definitions for likelihood of occurrence have been decided upon:

1. Improbable - Extremely unlikely (Probability: $O \leq 10^{-6}$)
2. Unlikely - Not expected, but credible (Probability: $10^{-6} < O \leq 10^{-5}$)
3. Occasional - May occur sometimes (Probability: $10^{-5} < O \leq 10^{-4}$)
4. Likely - Will occur several times (Probability: $10^{-4} < O \leq 10^{-3}$)
5. Frequent - Expected to occur repeatedly (Probability: $10^{-3} < O \leq 10^{-2}$)

3.4 Risk classification definitions

- A. High - The risk is considered Intolerable/ Unacceptable. The activity shall not proceed, or the system shall not be used.
- B. Medium/High - The risk can only be considered Tolerable and ALARP if demonstrated that further risk reduction is impracticable.
- C. Medium/Low - The risk is considered Tolerable and ALARP.
- D. Low - The risk is Broadly Acceptable. Additional risk reductions may be introduced only if the benefits justify the cost (time, money, inconvenience).

3.5 Risk Matrix

The following risk matrix has therefore been defined

		Likelihood				
		5	4	3	2	1
Severity	5	A	A	A	A	B
	4	A	A	A	B	C
	3	A	B	B	B	C
	2	C	C	C	D	D
	1	C	D	D	D	D

3.6 Risk appetite

This risk assessment is considering the AK-47's use during relative peacetime where operational usage is limited to training and occasional small-scale operations, resulting in a significantly reduced risk appetite, leading to an overly cautious risk classification matrix. It is highly likely that during wartime the risk appetite would expand as the expectation of high risk becomes more acceptable. It should also be noted that the level of distribution of the weapon system is likely to influence the risk appetite. This is due to the acknowledgement that frequency statistics are blind to the population they apply to; in other words, a 1% occurrence rate is tolerable with 10 people, slightly less with 100, and certainly concerning with a 1,000,000 population, where there would be 10,000 occurrences. As such, while the risk matrix may seem overly cautious, it is in acknowledgement of that fact that the AK-47 is an extremely widely distributed weapon and even low severity occurrences will affect many people in terms of absolute figures.

4. Hazard log

The following is a hazard log containing the 5 core hazards identified, their associated accidents, and causes, see Table 1.

Table 1: Hazard log for AK-47 as a service weapon

Serial	Hazard	Hazard Description	Accidents	Causes/ threats
H1	Ejected hot casings	Ejection of ammunition casing by the weapon's breech clearing mechanism leaves hot metal casings about the rifle's location.	Burns Barrel wear Clothing damage Fire Impact from casing to sensitive body part	Standard firing of the weapon Excessive firing of the weapon Poor planning of firing position Lack of awareness High temperature operating conditions
H2	Misfire	The sudden or complete failure of the system's ammunition to ignite after the trigger is pulled and the firing pin strikes the primer.	Fatality/Personnel shot Barrel wear Explosion Unintended fire	Firing pin wear Ammunition fault Poor maintenance Operating temperatures exceeded Excess particulate ingress Extended use
H3	Noise Exposure	The weapon produces a considerably high-volume report when fired. Exposure to this could temporarily or permanently harm the inner ear.	Temporary or permanent hearing loss.	Ammunition produces Loud Noise Cumulative Exposure Confined Environment (Space/Room)
H4	Unintended fire	The potential for the weapon to fire without an operator's intention.	Non-fatal gunshot wound Fatal gunshot wound Temporary hearing loss	Slip/Trip/Fall Thermal Cook off Firing mechanism malfunction Limp-wristing semi-automatic fire Negligent discharge
H5	Breech explosion	Mechanical compromise of the weapon breech resulting in ejection of gas and/or fragmentation.	Blast Injuries- Fragmentation, blast Noise of explosion	Overpressure Ammunition Barrel obstruction (e.g. squib load, incorrect calibre) Weapon wear Manufacturing fault

5. Causes

5.1 *Ejected hot casings*

During the thermal decomposition of the primer and propellant, some amount of heat is transferred to the cartridge casing prior to ejection. Depending on the heat of the ejected cartridge, accidents can occur ranging from minor burns to major burns, to potential secondary accidents caused by initiation an energetic or flammable material by the casing.

Standard firing of the weapon will result in relatively hot cartridge casings which can cause mild to moderate burns with prolonged skin contact. Excessively frequent firing will raise the barrel temperature faster than it can be cooled by the environment causing round casings to reach high temperatures, resulting in moderate to severe burns depending on skin contact time and location. Operating in hot environments exacerbates this risk through both a higher baseline temperature and reduced efficacy of environmental cooling. At a sufficiently high temperatures, casings would be capable of initiating sensitive energetic compounds and potentially igniting very dry foliage. Poor positioning with the weapon, and a lack of awareness by the operator would lead to an increased incidence of all the aforementioned scenarios.

5.2 *Misfire*

Misfiring describes the case in which the weapon trigger is actuated but a round is not fired.

Typically, misfires are mechanical in nature and often occur due to poor maintenance. The firing pin must be sharp and strong enough to pierce the primer cap and cause ignition, which can easily be inhibited by wear and tear of the pin. Furthermore, poor cleaning of the barrel, particulate ingress and corrosion can cause lead to obstruction of the barrel, preventing full ejection of the bullet. Incorrect ammunition calibre similarly can lead to blockages, as does barrel expansion due to excessively high operating temperatures, particularly under extended use.

5.3 *Noise exposure*

The pressure necessary to propel the bullet out of the barrel inherently produces a wave of sound which can damage the sensitive parts of the inner ear.

Just a single report from the weapon could be capable of causing damage depending on proximity, but continuous fire is highly likely to cause at least temporary, if not permanent hearing damage. Additional damage is likely to be accrued by firing in a confined space due to reflection of sound waves off the walls, ceiling and floor.

5.4 *Unintended fire*

The AK-47 is designed to only fire when the trigger is actuated. Unintended fire however can occur via two main means.

Primarily unintended fire would occur via negligent or accidental discharge of the weapon by the operator. Often this is due to finger placement near the trigger while moving, which will tend to result in discharge after/during tripping or falling. Misapplication (namely lack thereof) of the weapon safety switch followed by attempted actuation of the trigger will result in negligent discharge. If there is a mechanical fault in the safety and automatic firing assembly, unintended discharge may also occur. Limp-wristed handling of the weapon during fire can also result in accidental discharge as the trigger is actuated during return from recoil. If the barrel or casing of a chambered round reaches sufficient temperature, the round may also auto-initiate, in what is called a "cook-off", resulting in unintended fire. The opaque magazines

also do not easily indicate how many rounds remain to be firing, meaning an operator could unintentionally fire thinking the magazine was empty.

5.5 Breech explosion

The pressure generated by decomposition of the propellant and primer overcomes the mechanical stress resistance of some component of the barrel or breech, causing ejection of hot gas and likely fragmentation.

Typically, in good condition with the correct ammunition, this will not occur as the weapon components are designed strong enough to resist such pressures. However, if the ammunition is too energetic, more pressure may be produced than is tolerable, causing an explosion. Similarly, if the breech/barrel is damaged or compromised due to excessive heat from firing, it may not be able to withstand the pressure. If the ammunition used is too low in power, it may not produce a full ejection of the round, resulting in a barrel obstruction. Likewise, any other barrel obstruction from incorrect calibre, barrel expansion, or droop is likely to cause a breech explosion during the subsequent firing when the next bullet is unable to leave the barrel, preventing the relief of pressure, thus over pressurising the system, at which point some component will likely fail catastrophically and relieve the pressure in the direction of the operator.

6. Controls

6.1 Ejected hot casings

- C1: Mandatory eye protection when operating the weapon system
- C2: Introduction of correct firing position with regard to casings and potential ignition sources or sensitive body parts into Standard Operating Procedures (SOPs)
- C3: Awareness training for hot brass, including handling instructions, clothing management to prevent entrapment
- C4: Heat sinking material on outer layer of barrel for more effective heat transfer away from ammunition
- C5: Training and SOP inclusion of appropriate fire rate and barrel temperature management

6.2 Misfire

- C4: Heat sinking material on outer layer of barrel for more effective heat transfer away from ammunition
- C5: Training and SOP inclusion of appropriate fire-rate and barrel temperature management
- C6: Mandatory cleaning and maintenance training and inclusion of regular maintenance in SOPs
- C7: Formal misfire drill training and regular practise included in SOPs
- C8: Introduction of mandatory post-incident log to inform investigation process in determining cause

6.3 Noise exposure

- C5: Training and SOP inclusion of appropriate fire-rate and barrel temperature management
- C9: Mandatory hearing protection

- C10: Introduction of noise hazard barriers around training areas to prevent collateral exposure
- C11: Health surveillance via regular hearing test regimen
- C12: Muzzle suppressor will reduce the volume of the report

6.4 Unintended fire

- C4: Heat sinking material on outer layer of barrel for more effective heat transfer away from ammunition
- C5: Training and SOP inclusion of appropriate fire-rate and barrel temperature management
- C8: Introduction of mandatory post-incident log to inform investigation process in determining cause
- C13: Mandatory training for correct finger placement, safety drills and weapons handling in all fire modes and movements
- C14: Inclusion of trigger assembly inspection in cleaning and maintenance instructions and training
- C16: Magazine transparency for round count visibility

6.5 Breech explosion

- C1: Mandatory eye protection when operating the weapon system
- C4: Heat sinking material on outer layer of barrel for more effective heat transfer away from ammunition
- C5: Training and SOP inclusion of appropriate fire-rate and barrel temperature management
- C8: Introduction of mandatory post-incident log to inform investigation process in determining cause
- C16: Incorporation of ammunition recognition in training to prevent incorrect ammunition usage
- C17: Intermediary pressure relief valve which triggers higher than 7.62mm typical pressure, but lower than the yield stress of the weakest component.
- C18: Kevlar collar to prevent fatal shrapnel

7. Pre- and post-mitigation risk classification

Table 2: Pre- and post-mitigation risk classification and ALARP status

Serial	Pre-mitigation			Post-mitigation			ALARP?
	Severity	Likelihood	Class	Severity	Likelihood	Class	
H1	4	5	A	1	3	C	Yes
H2	5	2	A	5	2	C	Yes
H3	5	2	A	2	2	D	Yes
H4	4	5	A	4	2	C	Yes
H5	5	3	A	4	1	C	Yes

8. ALARP Statement on Hazard 4 - Unintended Fire

Prior to the applied controls, the risk classification of H4 was considered A: Intolerable/ Unacceptable, and as such, not allowed to be operated. In order to reduce this classification several controls were considered targeting both the severity of the hazard and the likelihood of its occurrence.

The following controls were considered to provide appropriate benefit vs cost and practicality:

8.1 *C4: Heat sinking material on outer layer of barrel for more effective heat transfer away from ammunition*

Heat induced initiation of a round is one of the few principal causes that can be confronted with an engineering control. In many other domains, overheating of components has been solved via various means, including air cooling, liquid cooling and compression heat pumping. Heat sinking however is fundamental to all of these; a heat sink allows extremely efficient cooling by providing a thermal interface with complete surface area coverage composed of a more thermally conductive material, allowing heat to move rapidly from the heat-exposed material to another which can then be shaped in such a way to integrate with other heat dispersing mechanisms.

Common materials for heat sinking include copper, aluminium and graphite. Copper is an excellent heat sink with high conductivity, but suffers from its high density, which would risk making the AK-47 too heavy to handle, and would also lead to an increase in cost due to the value of copper. Graphite offers far superior heat dissipation and is incredibly light, however it's cost far exceeds almost any other material in consideration and has durability issues as well. Aluminium strikes a medium as it maintains excellent conductivity while being light and cheap.

This does introduce a secondary hazard of a higher temperature surface on the weapon, but this is less severe of an outcome than an unintended discharge.

This leads to a significant reduction in the frequency of this causal mechanism.

8.2 *C5: Training and SOP inclusion of appropriate fire-rate and barrel temperature management*

A further temperature control stems from the training and policy inclusion of temperature management within the weapon system. If users are trained to fire in semi-automatic at a reasonable fire-rate and rotate weapons/operators when barrel temperature starts to become unmanageable, this would significantly reduce the probability of a round cook-off. The weakness inherent in this control is that it requires personnel to calmly adhere to policy in a potential combat environment, which is significant ask. In the context of training however this is an appropriate and effective control.

8.3 *C7: Introduction of mandatory post-incident log to inform investigation process in determining cause*

Fault analysis is a crucial part of future preventative action, especially in the context of mechanical and energetic weapon systems. This control on its face does not necessarily help in any individual event, except perhaps allowing for the isolation of a faulty weapon, however the long-term effects would be quite potent. Additionally, this control does not have a stockpile-wide cost associated with it, as most engineering controls would, granting it significant benefit against cost. The Haddon Cave report on the 2006 Nimrod Crash [1] highlighted the

importance of fault finding and tracking as a key weakness in the RAF at the time, as many faults in the Nimrod were widespread and preventative measures could have been taken if pattern analysis had taken place.

8.4 C12: Mandatory training for correct finger placement, safety drills and weapons handling in all fire modes and movements

Adequately drilled training for correct and safe handling of the AK-47 has the potential to instil core habits which prioritise safety first and lead to a significant reduction in accidental discharges, in the context of slips, trips, and falls. Strictly instilling safe handling practices also results in a greater respect for the due care each operator must take when handling a weapon and will likely reduce the probability of negligent discharges. Furthermore, correct handling will see fewer barrels pointed at allied personnel, especially their vital organs, reducing the severity of future incidents.

Once again, this is a policy and training control and has the inherent weakness of some operators not conforming, and the possibility of an accidental discharge while falling is still a credible possibility, even if less likely.

8.5 C13: Inclusion of trigger assembly inspection in cleaning and maintenance instructions and training

Faulty trigger assemblies are often caused by poor maintenance but can also be the result of natural wear and tear during operation. By regularly inspecting the trigger assembly of their own weapons, operators will be able to get ahead of potential unintended discharges by identifying faults, weaknesses and abnormalities, and isolating the weapon until repair or replacement. While there is similarly an inherent weakness in a training control, regular practise will instil a culture of weapon maintenance and fault reporting which will likely be retained post training and aid in maintaining other policy controls, thus reducing the frequency of accidental discharges.

8.6 C14: Magazine transparency for round count visibility

While the probability of an accidental discharge due to miscount of ammunition is quite low, having visibility of the number of rounds available within a magazine is still a very valuable control and will also reduce the likelihood of any other accidents involving mistaking live magazines for training, empty or gas simulated magazines.

8.7 Discarded controls

Several controls were considered for implementation but were discarded due to redundancy, impracticality and/or grossly disproportion cost to benefit.

A fully integrated liquid cooling system for the barrel and breech was considered as it would allow for very rapid dispersal of heat without exposing an operator to high temperature surfaces on the outside of the weapon. However, the reality is that such a system is grossly disproportionate in cost compared to its additional benefit and would make the weapon system more susceptible to faults, harder to handle, and increase mass transit costs due to weight increases, not to mention the increased load on maintenance personnel.

Tracking and restricting the fire rate is possible through various means and was considered in two forms. The first involved a digital integration into the trigger assembly which would allow for tracking of fire-rate and barrel temperature and limit the operator to semi-auto or potentially

force the weapon onto safety. The second involved modification of the AK-47's automatic fire assembly, reducing it to 2 fire modes: semi-automatic and safety. Both of these modifications would be exorbitantly costly for stockpile wide effect, and more importantly, expose the operator to immense risk by limiting the weapon capability in exchange for a slightly lower probability of an already unlikely cook-off incident. Subsequently this notion was discarded.

An alternate control was explored of nature of a multi-step safety process to prevent accidental actuation of the safety lever. While this could drastically reduce the likelihood of many accidental discharges, this implementation would have been extremely costly and would have zero effect if the operators simply chose not to safety, which is what already occurs in many incidents. Additionally, this would have exposed operators in combat situations to immense undue risk as they must take more time to un-safety their weapon before firing, potentially while under fire themselves.

In addition to C14, it was considered that a transparent or translucent material could be used to allow operators to see if a round was chambered without interacting with the weapon in any way. This control was quickly discarded as it offered minimal benefit but incurred immense cost due to the extreme material properties required for such a feature, and the ensuing weapon integration which would require complete disassembly of every weapon in the stockpile.

8.8 Conclusion

The controls that have been implemented have lowered the probability of an unintended fire incident sufficiently that, even if the severity is largely the same (although somewhat mitigated by correct handling), the risk classification is considered tolerable and as low as reasonably practicable within the scope of this risk assessment.

References

- [1] C. Haddon-Cave, "The Nimrod Review," Oct. 2009. Accessed: July 17, 2026. [Online]. Available:
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