

Risk Assessment and ALARP Justification for Firing AK-47 in Urban Environments: Mitigation
Strategies and Operational Considerations.

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Abstract

This report presents a comprehensive risk assessment and ALARP (As Low As Reasonably Practicable) justification for firing an AK-47 in a hot, humid, and dusty urban environment. The assessment identifies potential hazards associated with the use of this firearm under challenging conditions, evaluates their severity and probability, and proposes effective control measures to mitigate these risks.

Key hazards include exposure to toxic substances, heat burns, heat exhaustion, accidental discharge from weapon drops, noise-induced hearing damage, vibration-related injuries, and the impacts of adverse weather conditions. The report details control measures such as the use of PPE (Personal Protective Equipment), including gloves, masks, ear protection, and ergonomic supports, as well as comprehensive training programs focused on safe handling techniques and situational awareness.

The urban environment significantly influences the ALARP justification, emphasising the necessity for training and PPE due to the uncontrollable factors present. These include the presence of bystanders, high heat levels, and unpredictable weather conditions, which complicate risk mitigation efforts. In an ideal scenario, firing would occur in a controlled environment with adequate protection for all present, but operational realities often preclude such conditions.

The report concludes that maintaining ALARP status in this context requires continuous monitoring, regular updates to risk assessments, and the incorporation of new safety technologies as they become practical and cost-effective. This approach ensures that the risks are managed to the lowest practicable level, prioritising the safety and effectiveness of AK-47 operations in adverse urban environments.

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1. Risk Assessment

1.1. Introduction

This risk assessment focuses on the scenario of firing an AK-47 in a hot, humid, and dusty urban environment. The assessment aims to identify the potential hazards associated with the use of this firearm under challenging environmental conditions and to propose effective control measures to mitigate these risks.

1.2. Scope

The scope of this assessment includes the operation, handling, and maintenance of the AK-47 in conditions characterised by high temperatures, high humidity, and significant amounts of dust in an urban environment. The assessment will consider the potential risks to both the operator and any bystanders in the vicinity. The evaluation covers the entire process from preparation and firing to post-operation maintenance, ensuring a comprehensive understanding of the hazards involved and the necessary precautions.

1.3. Objectives

The primary objectives of this risk assessment are to:

1. Identify the specific hazards associated with firing an AK-47 in a hot, humid, and dusty urban environment.
2. Evaluate the severity and probability of each identified hazard, providing a pre-control risk estimate.

3. Propose and detail appropriate control measures and mitigations to address each hazard.
4. Re-assess the severity and probability of the hazards after the implementation of controls, providing a post-control risk estimate.
5. Ensure that the risks are reduced to a level that is ALARP.
6. Clearly communicate the risks and mitigations to relevant stakeholders, ensuring that all measures are understood and can be effectively implemented.

By achieving these objectives, the assessment aims to enhance the safety and effectiveness of operating an AK-47 in adverse environmental conditions, minimising the risks to both the operator and bystanders.

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Identified Hazard	Persons at Risk	Causes	Cause Description	Severity	Probability	Existing Risk Level	Controls	Severity (Post-Control)	Probability (Post-Control)	Final Risk Level
Toxicity	Operator, Bystander	Exposure to lead and other toxic substances	Prolonged exposure to propellant residue and lead within rounds can cause respiratory issues	4	3	12	Use of gloves and masks to reduce direct contact and inhalation. Ensure proper ventilation in enclosed spaces. Reduce exposure in confined areas. Regularly clean rifle to reduce propellant residues	3	2	6
Contact – Heat-burn, Skin Sensitisation	Operator	Heat from weapon parts	Contact with hot surfaces of the weapon, such as the barrel and receiver after prolonged firing can cause burns or skin sensitisation	4	3	12	Use of heat resistant glove to prevent direct contact. Reduce exposed for regular body-weapon contact points. Ensure cooling periods after extended use and training on safe handling techniques to avoid touching hot parts	4	2	8
Heat - Environment	Operator	High ambient temperature	Prolonged exposure to high temperatures can lead to heat exhaustion or heat stroke, affecting personal performance	3	5	15	Regular breaks in shaded or air-conditioned areas, adequate hydration with water. Wearing appropriate clothing, and monitoring for signs of heat stress (recognition training).	3	2	6
Drop	Operator, bystanders	Dropping the weapon	Dropping the weapon can cause accidental discharge,	4	3	12	Use of shoulder straps or slings to secure the weapon, training on proper	4	2	8

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			damage to the weapon, or injury to nearby persons from the impact.				handling and carrying techniques, and maintaining awareness of surroundings to prevent slips or trips			
Noise	Operator, Bystanders	Loud noise from firing	The loud noise from firing can cause immediate hearing damage or long-term hearing loss /tinnitus with repeated exposure.	3	5	15	Use of earplugs or ear defenders rated for high decibel protection, use of suppressors where permissible, and regular hearing tests to monitor any damage.	3	2	6
Vibration	Operator	Firing the weapon	Continuous exposure to vibrations from firing can cause hand-arm vibration syndrome (HAVS) and other musculoskeletal issues.	3	3	9	Use of padded gloves to dampen vibrations, limit duration of continuous firing sessions, and incorporate regular breaks to reduce exposure, monitor HAVS levels.	2	2	4
Repetitive Action/Force	Operator	Extended periods of firing	Repeated actions such as firing and reloading can cause muscle strain, joint issues, and fatigue.	3	3	9	Training on ergonomic firing techniques, use of supportive gear such as braces or straps, and scheduling regular breaks to reduce repetitive strain.	3	2	6
Weather	Operator	Hot, humid and dusty conditions	Adverse weather can exacerbate other hazards, affecting visibility, grip, and overall performance.	3	4	12	Wear weather-appropriate clothing, ensure proper hydration, implement dust suppression methods, and	2	2	4

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							provide shaded or cooled rest areas.			
Contact – Falling objects	Operator, bystander	Debris from structures	Falling debris from damaged or unstable structures in the urban environment can cause injuries.	4	3	12	Identify and avoid unsafe structures, wear protective helmets, and establish clear safety zones where debris risk is minimised.	2	2	4
Contact – Stationary Objects	Operator	Collision with structures	Navigating through urban environments with numerous obstacles can result in collisions and injuries.	3	3	9	Provide awareness training, maintain clear and well-lit pathways, and use protective gear to mitigate injury risk.	2	2	4
Contact – Falling, Tripping	Operator	Uneven or slippery surfaces	Hot and humid conditions can make surfaces slippery, increasing the risk of falls. Uneven terrain can also cause tripping.	3	3	9	Ensure use of footwear with good traction, regularly inspect and maintain walking surfaces, and provide training on navigating hazardous areas safely.	3	2	6
Contact – moving parts	Operator	Moving parts of the weapon	Contact with moving parts, such as the bolt and ejection port, can cause pinch injuries.	3	3	9	Provide proper handling training, use protective gloves, and implement safety guards or barriers where possible.	2	2	4
Contact - Ejected Parts and Fragments	Operator, Bystanders	Shell casings and debris from firing	Ejected shell casings and fragments can cause eye injuries or burns if they make contact with skin.	3	3	9	Use of protective eyewear, maintain safe distances between operators, and ensure proper ejection path clear of bystanders.	2	2	4

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Entrapment - Parts of the Body	Operator	Moving parts of the weapon	Extremities or other body parts can get caught in moving parts during operation or maintenance.	3	4	12	Provide thorough training on safe operation and maintenance, use protective gloves, and design weapon with safety features to prevent entrapment.	2	2	4
Entrapment - Clothing	Operator	Loose clothing caught in weapon parts	Loose or baggy clothing can get caught in moving parts, leading to entrapment and injury.	3	4	12	Enforce wearing of appropriate, close-fitting clothing, provide training on safe clothing practices, and consider design modifications to reduce entrapment risks.	2	2	4
Manual Handling - Excessive Weight	Operator	Lifting and carrying the weapon and ammunition	Carrying heavy weapons and ammunition can cause back and muscle strain, especially over long periods	3	3	9	Provide training on proper lifting techniques, use ergonomic supports and limit the weight carried by individual operators.	3	2	6
Ergonomics - Posture and Position	Operator	Poor firing posture	Incorrect posture during firing can lead to musculoskeletal problems over time.	3	3	9	Provide ergonomic training, encourage use of proper posture, and consider ergonomic modifications to weapon design where feasible.	3	2	6
Human factors – Human error	Operator	Improper handling or misuse of the weapon	Human error, such as incorrect handling or operational mistakes, can lead to accidental discharge or malfunction.	4	3	12	Implement comprehensive training programs, enforce strict adherence to safety protocols, and regularly review and update training	4	2	8

							based on incidents and feedback.			
Human factors – fatigue	Operator	Extended periods of operation	Fatigue can impair judgment and reaction times, increasing the risk of accidents.	3	4	12	Schedule regular breaks, manage work/rest cycles to prevent fatigue, and monitor operators for signs of fatigue to intervene promptly.	2	2	4
Human Factors - Training	Operator	Inadequate training on weapon handling	Lack of comprehensive training can lead to mishandling of the weapon and increase the risk of accidents.	3	4	12	Conduct regular, thorough training sessions, provide refresher courses, and ensure all operators demonstrate competence before handling the weapon independently.	2	2	4

Figure 1 – AK-47 Hot, Humid, Dusty, urban environment risk assesment

Note - In certain cases, the severity of a risk can be reduced with PPE (Personal Protective Equipment) [1]. For example, in the case of entrapment, wearing gloves can protect appendages and reduce the severity of injuries, such as cuts or abrasions, by providing a barrier between the skin and the hazardous parts. However, while PPE can mitigate the impact of an injury, it does not reduce the probability of the hazard occurring. To effectively lower the risk level, proper training and operational procedures are crucial in preventing incidents from happening in the first place.

Risk Assessment Matrix							
Risk Matrix							
Severity	Multiple fatalities >5	5	5	10	15	20	25
	Fatalities <5	4	4	8	12	16	20
	Severe life-threatening injuries requiring immediate hospitalisation	3	3	6	9	12	15
	Serious non-life-threatening injuries requiring medical treatment	2	2	4	6	8	10
	Minor injuries requiring first aid treatment	1	1	2	3	4	5
Probability			1	2	3	4	5
			Remote	Unlikely	Occasional	Likely	Frequent

Assessment to evaluate the suitability of control measures.		
Key	Risk = Severity x Frequency	
	12 - 25 Intolerable	The risk is too high, the activity should cease until control measures are improved.
	4 - 10 Tolerable if ALARP	The level of protection from the activity is only acceptable when the risks are ALARP
	1 - 4 Broadly Acceptable	The level of protection for the activity is considered acceptable

Figure 2 – Risk Matrix

2. ALARP Justification – Noise

2.1. What is ALARP?

ALARP (As Low as Reasonably Practicable), This principle is central to risk management. It involves assessing a risk and balancing it against the time, effort, and cost required to mitigate it [2]. ALARP sets the expected standard for controlling workplace risks, ensuring they are managed to a level that is both practical and reasonable [3].

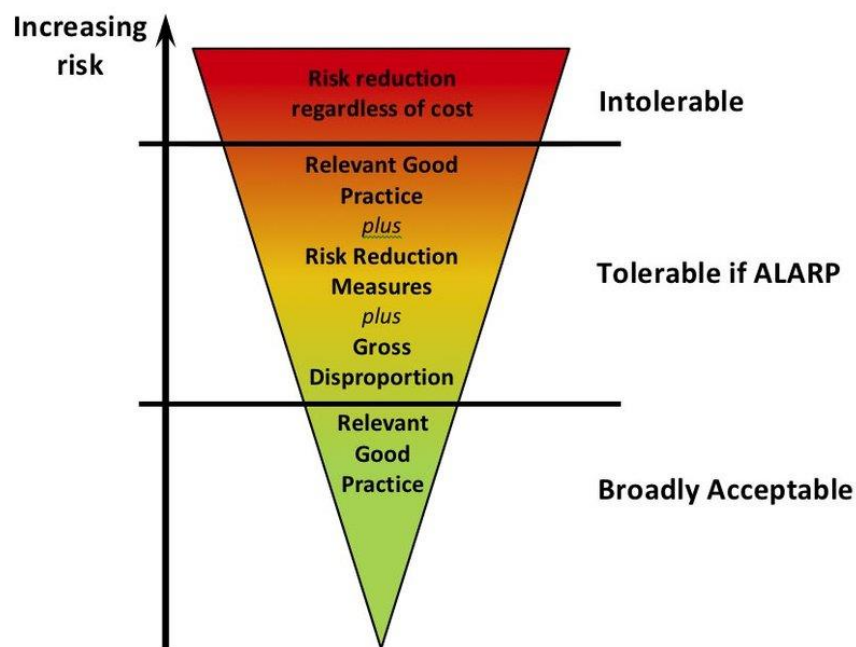


Figure 3 – Exponential Risk triangle [4]

2.2. Why is ALARP Important in Health and Safety?

The ALARP principle embodies the legal duty to take all reasonably practical steps to manage and reduce health and safety risks. Employers must demonstrate that they have taken all feasible steps to achieve this [5].

ALARP requires a careful evaluation of the trade-offs between the risk reduction achieved and the resources expended. This ensures that safety measures are not excessively costly or time-consuming relative to the benefit they provide in reducing risk.

Following established guidelines and approved codes of practice is essential. Adhering to these provides a presumption of compliance with ALARP standards. When specific measures are not taken, it is crucial to document the reasons why, providing a record that justifies the decision based on what was reasonably practicable [6].

The ALARP principle promotes ongoing evaluation and enhancement of safety measures. As new technologies and methods emerge, they may offer more efficient ways to reduce risks further, and these should be considered as they become practical and affordable [7].

Implementing the ALARP principle ensures a safer working environment. This is vital for preventing workplace injuries and illnesses, enhancing employee morale, and maintaining productivity.

Beyond occupational health and safety, ALARP applies to public safety in various sectors. Reducing public risks to ALARP levels helps maintain trust and prevent accidents that could impact the broader community.

In essence, the ALARP principle ensures that risk reduction efforts are practical, balanced, and justified. By mandating that risks are reduced to levels that are ALARP it ensures that the sacrifices in time, effort, and cost are not grossly disproportionate to the benefits gained from reducing those risks [8].

2.3. Hazard Analysis

Noise from Firing an AK-47

Firing an AK-47 generates significant noise levels, typically around 159 dB at the shooter's ear [9]. Such intense noise can cause immediate hearing damage and lead to long-term auditory issues like hearing loss or tinnitus. The hazard is compounded in a hot, humid, and dusty urban environment due to several factors (outlined in 2.3.1.).

2.3.1. Factors Contributing to the Hazard:

Intensity of Noise:

The intensity of noise produced by firing an AK-47 is a critical factor contributing to the hazard. The weapon generates peak noise levels up to 159 dB at the shooter's ear, which is significantly higher than the safe limit of 140 dB. This level can cause instantaneous and irreversible hearing damage. Even short-term exposure to such high noise levels without proper protection can be hazardous. In operational settings where multiple rounds are fired, the cumulative exposure can significantly amplify the risk [9].

Extended Exposure to High Noise Levels:

While peak noise levels are inherently dangerous, the duration and frequency of exposure also play a vital role. Extended exposure to noise levels exceeding 87 dB without adequate hearing protection is particularly harmful. This threshold is critical because, at levels above 87 dB, prolonged exposure can lead to chronic hearing conditions such as noise-induced hearing loss (NIHL) and tinnitus. Continuous firing sessions, training drills, and combat scenarios can expose operators to sustained high noise levels, compounding the risk of long-term auditory damage [10].

Environmental Amplification:

Urban environments present unique challenges that can exacerbate the impact of noise from firing an AK-47. Buildings, walls, and other structures in urban areas can reflect and amplify sound waves, increasing the effective noise exposure for both the shooter and nearby individuals. This reflection can create hotspots where the noise level is significantly higher than it would be in an open field.

Additionally, narrow streets and alleys can funnel and concentrate sound, leading to more intense noise exposure. These environmental factors can make it difficult to predict and control noise levels, thereby increasing the hazard [11].

Lack of Proper Hearing Protection:

Proper hearing protection is essential in mitigating the risk of noise-induced hearing damage. However, standard hearing protection devices may not provide

adequate attenuation for the high noise levels produced by an AK-47. Without specialised, high-attenuation devices, operators remain at risk. Additionally, hearing protection can become uncomfortable in a hot, humid, and dusty environment, leading to reduced compliance. Dust can also interfere with the seal of earplugs or HPD (overhead) (Hearing Protection Device), diminishing their effectiveness. Ensuring that hearing protection is both comfortable and compatible with other gear is necessary to maintain consistent use [12].

2.3.2. Impact:

Immediate Hearing Damage:

- Exposure to noise levels above 140 dB can cause instant, irreversible hearing damage [13].
- The peak noise level from an AK-47 shot is well above this threshold, posing a high risk of immediate harm to unprotected ears [9].

Long-term Hearing Loss or Tinnitus:

- Prolonged or repeated exposure to high noise levels can result in permanent hearing loss or chronic conditions like tinnitus. Prolonged exposure to noise levels above 87 dB without adequate hearing protection is particularly harmful [10].

Reduced Operational Effectiveness:

- Hearing loss can impair an operator's ability to communicate effectively, recognise important auditory cues, and maintain situational awareness.

Increased Risk to Bystanders:

- High noise levels can affect not only the operator but also nearby personnel and civilians.
- In an urban environment, the risk extends to bystanders who may not have adequate hearing protection.

2.3.3. Supporting Data from Study:

A study on noise control from rifle shooting provided detailed measurements of noise levels generated by an AK-47 in an open shooting field. The findings are crucial in understanding the magnitude of the noise hazard and devising effective controls [9]. Key data points include:

Sound Pressure Levels (SPL):

- For a single shooter at 1 meter, the SPL was 102 dB.
- For a group of 20 individuals at 1 meter, the SPL was 110.4 dB.
- At 50 meters, the SPL for a single shooter was 67.3 dB. For a group, it was 92.3 dB.

Peak Sound Pressure Levels (PSPL):

- For a single shooter at 1 meter, the PSPL was 130.3 dB.
- For a group of 20 individuals at 1 meter, the PSPL was 132.8 dB.
- At 50 meters, the PSPL for a single shooter was 64.1 dB, and for a group, it was 87.7 dB.

Frequency Analysis:

- The highest sound pressure level was at a frequency of 500 Hz. At 1 meter, the SPL at this frequency was 98.5 dB for a single shooter and 108 dB for a group. At 50 meters, it was 64.1 dB for a single shooter and 87.7 dB for a group.

The study concluded that both shooters and personnel in the field were exposed to unacceptably high noise levels, recommending the use of dual hearing protection (Over ear and earplugs) and increasing the distance between individuals and the sound source to mitigate the risk of hearing damage [9].

2.4. Discounted Controls and Reasoning**2.4.1. Active Noise-Cancelling Helmets**

Advanced helmets with built-in active noise-cancelling technology offer a sophisticated means to reduce noise exposure. These helmets use electronic systems to actively counteract external noise, potentially providing superior hearing protection compared to traditional earplugs or HPD (overhead).

Currently, active noise-cancelling helmets are expensive and not widely available. Their high cost makes them impractical for widespread use, especially in resource-constrained settings. Furthermore, their complexity and the need for regular maintenance and battery replacements make them less suitable for the challenging conditions in a hot, humid, and dusty urban environment. The implementation of these helmets would be grossly disproportionate in terms of cost and practicality compared to the benefits they offer. The fact the Hearing protection cannot be worn separately to the helmet presents a risk in itself, needing the helmet to be removed to hear in non-firing scenarios.

Cost-Benefit Analysis:

- **Cost:** High (initial purchase, maintenance, and batteries).
- **Benefit:** Potential significant reduction in noise exposure; enhanced hearing protection.
- **Conclusion:** The high costs and maintenance needs outweigh the benefits, making them impractical for this application.

2.4.2. Acoustic Barriers

Portable acoustic barriers can be deployed to shield operators and bystanders from the noise generated by firing an AK-47. These barriers work by

absorbing and deflecting sound waves, thus reducing the overall noise exposure in the vicinity.

Acoustic barriers, while effective in reducing noise, are impractical in dynamic urban environments where mobility is essential. The setup and dismantling of these barriers would be time-consuming and logistically challenging, particularly in fast-paced or unpredictable scenarios. Additionally, the barriers could obstruct movement and hinder operational efficiency. Given these drawbacks, the use of acoustic barriers is not a viable solution in the context of urban combat or training exercises [14].

Cost-Benefit Analysis:

- **Cost:** Medium (purchase, transportation, and setup).
- **Benefit:** Localised reduction in noise levels.
- **Conclusion:** The logistical challenges and impact on mobility outweigh the noise reduction benefits, making this control impractical.

2.4.3. Elimination of Usage of the AK-47 Platform

Eliminating the use of the AK-47 and replacing it with a different firearm platform that generates less noise could theoretically reduce noise exposure. This control measure involves phasing out the AK-47 in favour of a newer, quieter alternative.

In environments where the AK-47 is heavily used, such as many military and paramilitary operations, eliminating its use is not practicable. The cost of procuring new firearm platforms and training personnel to use them would be prohibitively high. Moreover, the AK-47 is favoured for its reliability, especially in harsh conditions, and suitable alternatives may not be readily available or may not offer the same level of performance. Therefore, replacing the AK-47 with a different platform is not a feasible option given the current operational and financial constraints [15].

Cost-Benefit Analysis:

- **Cost:** High (procurement of new firearms, training, and logistics).
- **Benefit:** Potential noise reduction and modern features.
- **Conclusion:** The high financial burden and operational disruption outweigh the potential benefits, making this option unfeasible.

2.5. Future ALARP Status Maintenance

Maintaining ALARP over time is crucial because workplace conditions, technologies, and regulations continually evolve. Relying solely on the factors and controls initially implemented can lead to outdated risk management practices. Continuous evaluation and adaptation ensure that risks remain effectively controlled and that safety measures evolve with advancements and changing conditions [16].

2.5.1. Monitoring Plan:

Regularly review and update the availability and condition of earplugs and HPD (overhead): Conduct frequent inspections to ensure that all hearing protection devices are in good condition and are readily available to all operators and bystanders. Implement strict protocols for the use and maintenance of these devices, ensuring they are worn correctly and consistently during all operations involving the firing of the AK-47 [17].

Ensure compliance with hearing protection protocols during all operations: Establish and enforce training programs to educate all personnel on the importance of using hearing protection. Conduct random checks to ensure adherence to these protocols and address any non-compliance immediately.

2.5.2. Technological Advancements:

Stay updated on developments in hearing protection technologies: Monitor advancements in hearing protection, including more affordable active noise-cancelling solutions and other innovative technologies. Evaluate the practicality, cost-effectiveness, and potential benefits of these new technologies as they become available [18].

Assess the viability of new technologies as they become practical and cost-effective: Perform cost-benefit analyses on emerging hearing protection

solutions to determine their suitability for implementation. Consider adopting new technologies that offer improved protection and are economically feasible for widespread use.

Re-review discounted controls: As technology evolves, previously discounted controls such as active noise-cancelling helmets and acoustic barriers should be reassessed. For example, active noise-cancelling helmets may become cheaper, more readily available, and have a wider variety of options as the market develops and competition increases. Similarly, acoustic barriers might become more portable and effective, providing a wider guarding range and easier setup. Regularly revisiting these controls ensures that new advancements are not overlooked and that risk mitigation strategies remain optimal [3].

2.5.3. Review Process:

Conduct periodic reviews of the risk assessment and control measures:

Regularly revisit the risk assessment to ensure it reflects current practices, conditions, and technological advancements. Assess the effectiveness of existing control measures and identify areas for improvement. Standard practice for these reviews is Circa 3 months, to include random spot checks when necessary to confirm usage and effectiveness of current implementations and possible changes [19].

Implement improvements as necessary, considering feedback from operators and advances in technology: Use feedback from personnel to inform updates to risk management strategies. Incorporate new technologies and best practices to enhance the effectiveness of hearing protection and overall risk mitigation. Establish a continuous improvement cycle to keep risk levels as low as reasonably practicable [3].

3. Conclusion

This risk assessment and ALARP justification highlight the significant influence of the urban environment on the risks associated with firing an AK-47. The challenging conditions of high heat, humidity, and dust, combined with the unpredictability of urban settings, necessitate a focus on training and the use of PPE to mitigate risks effectively.

In urban environments, many factors remain beyond direct control. Bystanders are often present around the operator, and environmental conditions such as dust and high temperatures are inherently variable and challenging to manage. The urban landscape, with its reflective surfaces and confined spaces, exacerbates noise hazards, while the presence of structures and uneven terrain increases the risk of collisions and falls.

Ideally, firing an AK-47 should occur in a controlled, enclosed space where the operator and any nearby individuals are adequately protected with appropriate PPE. However, operational environments rarely allow for such ideal conditions. Consequently, the ALARP principle in

this context emphasises rigorous training and the consistent use of PPE to manage risks to the lowest practicable level.

By ensuring that operators are well trained in safe handling techniques and that they consistently use provided PPE, we can mitigate the risks associated with firing an AK-47 in adverse urban conditions. Regular reviews and updates of risk assessments, along with monitoring technological advancements in hearing protection and other safety measures, will help maintain ALARP status over time. This proactive approach ensures that the safety of operators and bystanders remains a priority, even in challenging and uncontrollable urban environments.

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