

PASSIVE SECURITY

TECHNICAL GUIDANCE FOR ICRC PREMISES IN THE FIELD

ICRC

REFERENCE

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The main contributors to this publication were James Godbee, who prepared a first draft, Alexandra Patargia, who saw it through to completion, Tim Pitt, who wrote the chapter on strong rooms, and Diego González Sanz, who was involved in finalizing the guidelines.

We would also like to express our gratitude to Shaun Ellis and Mike Pickup from HESCO for their substantial input and to Grégoire Berquin for his illustrations, which contribute greatly to the clarity of this important document.

These guidelines also drew significantly on a number of technical reference works, which are mentioned at the end of the document.

Alexander Humbert, OP_ASSIST_EH, 2016

FOREWORD

For the International Committee of the Red Cross (ICRC), the safety and security of its staff, and by extension the physical security of its premises in the field, is an ongoing concern, especially in conflict areas.

The ICRC seeks to reduce risks as much as possible whilst acknowledging that they cannot be eliminated entirely. The fact that some level of risk is considered inevitable means that everything must be done to minimize it and to mitigate the impact in the event a risk event occurs.

Weapons, tools, tactics, motivations and the political environment can change faster than sites and buildings can be modified. Therefore, all passive security measures that enhance the physical security of an ICRC site must be implemented before the security environment deteriorates. This will reduce the risk of being caught unprepared, such as in a random shooting or shelling or an unexpected attack.

Given the unpredictable environment in which the ICRC works, all delegations are required to establish a certain level of protection against intruders and weapons.

The following guidelines illustrate generally recognized architectural principles and engineering considerations that enhance the physical security of buildings. They are appropriate for the ICRC's needs. They will help mitigate the risk of both personal harm and physical damage in the event of unauthorized intrusion or if fighting takes place near an ICRC site.

We must, of course, remain realistic. Any site in a conflict area can be breached or struck by projectiles and other ammunition, and there are no foolproof measures that guarantee an ICRC facility freedom from harm. Passive security measures are just one part of the equation. Other aspects of security management include identification and notification, security regulations, security guards and evacuation plans.

These guidelines are a living and evolving document that must be periodically reviewed and updated and made available to all staff involved in passive security in the field. Suggested changes or additions are welcome and should be sent to OP_DIR_SCMS along with a detailed explanation.

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1. INTRODUCTION

1.1 Scope

This document provides technical information and guidelines on passive security measures. These measures are intended to mitigate possible adverse consequences in the event of an attack using conventional weapons or unauthorized intrusion. These are appropriate and actionable measures designed to protect against the various risks the ICRC faces in the field.

Mitigating measures put in place by the ICRC take a two-pronged approach to limiting negative consequences for ICRC staff. First, they aim to prevent a security or safety incident from happening. Second, they aim to improve the ICRC's readiness should the risk event materialize. As part of the set of mitigating measures, passive security aims at mitigating the effects of weapons and/or of intrusion into ICRC premises. It includes physically hardening buildings and preparing places for people to be safe. Measures include:

- **a safe area:** for people to seek refuge when threatened by sporadic small arms fire;
- **intrusion mitigation measures:** to protect against criminal intrusion;
- **shelter facility:** for people to seek refuge when threatened by heavy weapons;
- **blast mitigation measures:** to protect against the effects of heavy weapons;
- **violent intrusion mitigation measures:** to protect against violent intrusion; and
- **a strong room:** for people to seek refuge when threatened by violent intrusion.

Passive security measures can help mitigate many of the ICRC's categories of security and safety risks, such as: effects of weapons, criminality & banditry, civil unrest and environmental hazards. These risks can cover a wide spectrum, and there may be some overlap in terms of threats (which are discussed later in this document). The table below groups such threats together and provides an overview of measures that can be used to address them.

	SOURCE OF THREAT					
MEASURES	Small arms fire	Intrusion	Heavy weapons	Shrapnel fragments	Blast	Violent intrusion
Safe area	X			X		
Intrusion mitigation measures		X				X
Shelter facility	X		X	X	X	
Blast mitigation measures	X		X	X	X	
Violent intrusion measures						X
Strong room	X	X	X	X	X	X

Bear in mind that if the risks intensify to the extent that the measures provided in these guidelines no longer apply, the delegation management will have to determine whether ICRC operations should be continued, suspended or relocated.

1.2 Use of this document

The primary users of these guidelines are the WatHab engineers involved in designing and implementing passive security measures for ICRC premises. However, the delegations' management and administrative staff should also be familiar with the contents of this document since they play a role in passive security matters.

This document represents a necessary addition to the ICRC's internal guidance on passive security. It takes an architectural and engineering approach, yet includes appropriate measures recommended in military force protection engineering literature and military handbooks. It is therefore suitable as a technical reference work for anyone involved in developing passive security measures for humanitarian organizations.

A delegation may implement other measures as long as they provide an equivalent level of protection. In such cases, the delegation bears full responsibility for providing adequate technical justification for any deviation from these guidelines.

1.3 Applicability

This document is intended primarily for ICRC field sites. Some protective measures and recommendations are mandatory on all ICRC sites (such as the use of 3M blast film, safe areas, fire-safety measures and earthquake risk mitigation measures), while others only need to be implemented in response to identified risks (these include shelter facilities, strong rooms and blast walls).

This document also provides engineering guidance to be applied when building a new structure or retrofitting existing buildings in order to protect people from the effects of weapons, criminality and banditry.

1.4 Assumptions

These guidelines do not address the deliberate targeting of ICRC staff or facilities. The appropriate response to such a threat would be evacuation and/or relocation. These guidelines mainly address unintentional (and therefore infrequent) risks, along with direct and collateral risks where the ICRC is not necessarily the primary target.

The location, timing, size and nature of incidents the ICRC might face in the field are largely unpredictable, and delegations should conduct a risk assessment (discussed later in this document) to identify potential security and safety risks. The risk assessment will also affect the mitigating measures that should be put in place. These guidelines are based on a specific range of assumed threats and provide a reasonable baseline for the design of passive security measures within ICRC premises.

These guidelines cannot address all possible weapons. The measures proposed only take into account threats from conventional weapons, which are widely available and frequently used. Designing conventional buildings to resist more destructive weapons is complex and frequently impractical.

The countermeasures described in this document are based on protecting against a single strike. The underlying assumption is that the ICRC is not a deliberate target, and the probability that the same location will be struck twice is considered low.

2. METHODOLOGY

2.1 Roles and responsibilities

Security and safety at the ICRC are the shared responsibility of all staff members. Anyone who becomes aware of an inadequate measure or a risk that is not covered by the passive security measures in place must report it to the delegation's management, who will decide on appropriate corrective measures.

For these guidelines to be properly managed, everyone involved in managing passive security must have clearly defined roles and responsibilities and must coordinate closely together.

ICRC's management bears primary responsibility for the security and safety of ICRC staff in the field. It is responsible for providing a risk assessment and for approving the appropriate risk-mitigation measures. In addition, it ensures that passive security measures are consistent with the identified risks and with any other mitigating measures in place.

The Finance & Administration Division is in charge of the ICRC's field sites. It is responsible for developing, implementing and maintaining the risk-mitigation measures relating to ICRC premises, including passive security measures, in line with risk assessments and current standards in the field.

The Water and Habitat Unit, which has technical expertise in the construction field, is responsible for advising on technical aspects and, if required, for developing passive security alternatives in line with the risk assessment. It ensures that all work complies with the relevant technical standards and the recommendations provided in these guidelines.

Other internal resources may be sought out for advice and guidance in the fields of security management, construction practices and weapons technologies. These include **SCMS** and **WEC** at field level and **OP_DIR_SCMS**, **OP_ ASSIST_EH** and **OP_ASSIST_WEC** at headquarters level.

At delegation level, please refer to the SCM Library "ICRC Premises – Roles and Responsibilities" page on the intranet for detailed and updated guidance on this matter:

- *https://intranet.ext.icrc.org/scm_library/mngtsec-safetyrisk/icrc-premises/premises-roles-responsibilities/mngsec-safetyrisk-premises-roles-responsabilities-1.html*

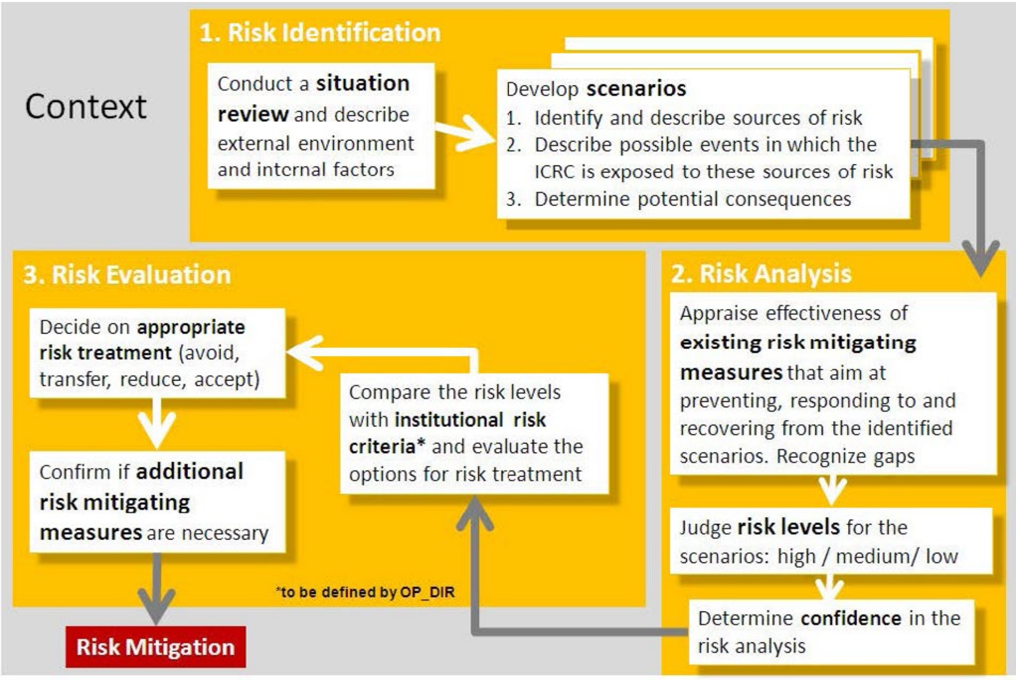
2.2 Risk assessment

The effects of weapons are an inherent risk in armed conflict and other situations of armed violence, while criminality and banditry are inherent risks in most environments in which the ICRC works.

The ICRC considers a risk acceptable if it is justified by the expected humanitarian impact of the planned activity or operation. Such decisions are the responsibility of the field management at all levels and should be taken on a case-by-case basis depending on the risk levels. It is therefore important to note that these guidelines do not set the level at which different risks are acceptable or recommend security measures that purport to provide complete protection from these risks.

Referring to the institutional security and safety risk management (SSRM) framework developed by OP_DIR_SCMS, which uses some of the ISO 31000 terminology, risk assessment consists of determining:

- risk scenarios: combinations of risk events that may result from the exposure of ICRC staff to sources of risk (threats or hazards) with potentially negative consequences on ICRC staff (physical or mental harm);
- risk levels: assessments of the likelihood of the scenarios and their potential impact on ICRC staff, taking into account existing risk-mitigation measures;
- risk treatment: an informed and conscious decision on what to do about the risk after weighing the risk levels against the expected humanitarian impact.



Once the risk-treatment decision is taken, measures aimed at mitigating risks to the lowest feasible level should be designed. The goal is to reach an acceptable residual risk level that can be scored using the methodology described below. Both active and passive security measures need to be designed together and implemented as soon as possible since the construction of passive security measures to mitigate an increasing level of risk usually requires preparation, resources and time. The earlier a rising level of risk is identified the better.

Residual risk = Risk - Passive security measures - Active security measures

In practical terms, sources of risk should first be grouped according to the passive security measures that apply to them. The associated risk should then be evaluated by determining its impact and likelihood (regardless of the planned or existing measures). This determines the risk's position in a risk matrix, as shown below. Active and passive measures should be defined to minimize the residual risk, as shown.

		IMPACT				
		Insignificant	Minor	Significant	Major	Severe
LIKELIHOOD	Almost Certain					
	Likely			mitigated risk		original risk
	Moderate					
	Unlikely			mitigated risk		
	Rare		residual risk			

Please note that when looking for new premises, the risk analysis should also address other factors inherent to the environment (such as earthquake and electrical and fire hazards).

Please refer to the SCM Library "Managing Security and Safety Risks" pages on the intranet for detailed and updated guidance on the institutional approach to risk management:

- https://intranet.ext.icrc.org/scm_library/mngtsec-safetyrisk/organisation-delegation/security-safety-risk-mngt/index.html

Please refer to the SCM Library "Assessing risks related to weapons" and "Assessing risks related to criminality and banditry" pages on the intranet for detailed and updated guidance on hazards related to weapons and criminality:

- https://intranet.ext.icrc.org/scm_library/risk-assesment-treatment/weapons/weapons-risk/index.html
- https://intranet.ext.icrc.org/scm_library/risk-assesment-treatment/criminality/criminal-risk/index.html

2.3 Inspection and evaluation

Passive security measures at delegations should be inspected, reviewed, and upgraded following the risk analysis. This should take place annually, or sooner if there is a change in the existing security environment.

The inspection should include a complete inventory and analysis of the passive security measures in place and an updated assessment of the threats and hazards.

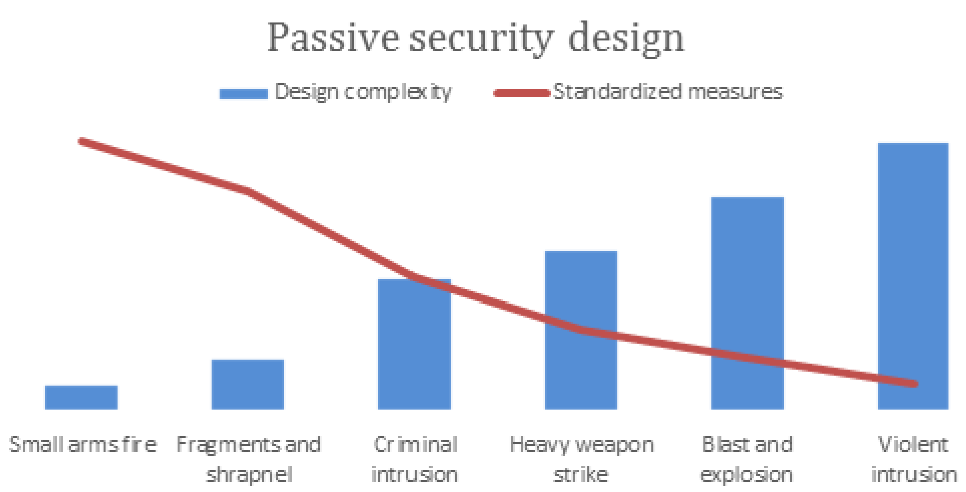
2.4 Design strategy

Designing appropriate passive security measures requires a good understanding of the risks that the ICRC faces, since the aim is to focus resources on the identified risks. Direct threats are generally countered by vertical structures such as walls and fences, whereas indirect threats require compartmentalization or overhead protection.

The more complex the threat is, the greater the need for a coordinated approach to designing appropriate passive security measures. The chart below shows that the scope for standardizing passive security measures varies inversely with the complexity of the threat. In other words, the recommendations set out in these guidelines can be applied when dealing with safe areas, but a more customized approach is required when dealing with strong rooms and violent intrusion.

Security engineering looks at the assets that require protection, the threat to those assets, and the level to which those assets must be protected against the threat (i.e. the protection level). The threat is described in terms of the tactics that aggressors may use in an attack on an asset, along with the weapons, explosives, tools or agents (including chemical, biological, radiological and nuclear) that could be used.

The protection levels effectively define the expected performance of the system of countermeasures.



Design criteria will commonly take into consideration numerous tactics that assets need to be protected against. Because of the complex interrelationship among the countermeasures meant to address different tactics, the design process needs to address the question of integrating the countermeasures in the overall system.

3. FUNDAMENTAL PRINCIPLES

This chapter outlines fundamental principles that must be considered in every situation and context, whether for assessing potential new sites, evaluating the vulnerability of sites already in use or designing a comprehensive passive security system within a delegation.

3.1 Integrated approach

Passive security measures are merely the technical and physical components of a broader security programme. Passive security measures must always be incorporated into, and support, a comprehensive security plan.

Ideally, a potential risk is addressed through communication, identification and acceptance measures. If an intrusion does occur, whether of a criminal or violent nature, physical security measures combined with an active response (detection and alert) may serve to delay or thwart the threat or at least reduce its impact. Disruptive armed entry is by definition intentional and, whatever the motivations, the intruder's action needs to be prevented, delayed or mitigated in order to protect the people present inside. Deception can also be used to misdirect attackers to a non-critical portion of the facility. Making the facility too obviously protected may inadvertently represent an incentive to attack the building. Passive security measures are designed to improve the ability of the facility to withstand attack, to mitigate weapon damage, to provide safe spaces for people and to facilitate their evacuation.

A single protective measure may not adequately address a given threat, but a combination of measures and redundancy should be sufficient. Moreover, passive security measures should always be combined with active safety measures. Because they are linked, the right balance between physical protection measures and procedures contributing to security and safety must be defined early in the design process. Technical solutions often significantly improve the physical protection of an ICRC site. However, the real challenge lies in finding a pragmatic solution that achieves an adequate level of safety and security on a site without impeding access to the site or undermining the ICRC's perception and acceptance in the community.

Complete protection against all potential risks is prohibitively expensive and technically unrealistic. So a balance must be struck between the residual risk and the option of relocation.

3.2 Staff morale

Beyond physical protection, passive security measures may affect people's morale. Measures can have beneficial effects on morale and staff cohesion if people trust the structures and systems provided for their protection. But they can have detrimental effects if people feel trapped by unreliable physical security measures. Considerations of morale must therefore not be overlooked when designing passive security measures and the accompanying procedures.

This can be achieved by putting in place an effective communication system and ensuring that procedures such as security drills and alarms are part of the passive security plan.

It is also important to ensure that no passive security measure poses additional risks or exposes staff to other threats. Security systems on doors and windows must not impede emergency exit. Similarly, access control systems must not create constraints or expose staff to attacks whilst waiting to enter a compound. In all cases, an effort must be made to assess any unintended consequences of passive security measures.

3.3 Location

In armed conflicts or situations of violence, the location of an ICRC facility determines the level of physical security required from a collateral damage perspective. It is therefore advisable to avoid locations too close to potential military targets as far as possible. These can include official buildings, government facilities, high-value targets, media offices and facilities, militants' premises, military premises, strategic fortifications, toxic industrial chemical plants, police stations and high-rise buildings.

If an ICRC facility must nevertheless be located near such potential targets, it may be necessary to clearly distinguish the facility from the surrounding area both visually and physically in order to avoid confusion. It is also customary to notify all parties involved in a conflict of the precise location of ICRC sites.

When selecting new premises, locations that provide effective evacuation routes (e.g. access to main roads or proximity to an airport, port or helipad) should be favoured.

Please refer to the SCM Library "Managing Security & Safety Risks/Premises" page on the intranet for detailed and updated guidance on site and building selection:
- *https://intranet.ext.icrc.org/scm_library/mngtsec-safetyrisk/icrc-premises/index.html*

3.4 Preparation and adaptability

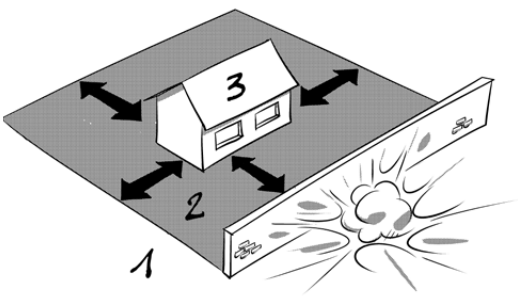
During an ICRC operation, the level and nature of threats can fluctuate gradually or rapidly. Because it takes time to implement passive security measures, they must be in place before the security environment deteriorates, so the ICRC is not caught unprepared in a random shooting or shelling or an unexpected attack.

Passive security measures should be designed in such a way that they can be easily adapted or upgraded, and they need to be periodically reviewed.

3.5 Concentric layers and standoff distance

The physical security of facilities requires concentric and independent layers of protection that provide progressively enhanced levels of security against intrusion. They should also seek to keep explosive events as far away as possible.

The first advantage of this approach is that the facility will not be compromised if one line of protection is breached or damaged. Having numerous lines of protection incorporates redundancy in the security system and strengthens the design. This approach also means that the question of security does not focus entirely on the outer layer of protection, as this could lead to an unattractive, fortress-like appearance. For the security design to be reliable, each layer must provide a uniform level of security along its entire length, since security is only as strong as its weakest point.



The second advantage of this approach is that it naturally creates a standoff distance. This refers to the distance maintained between a protected area and the potential location of an explosive detonation. Increasing this distance is by far the most cost-effective way to protect against the effects of an explosion.

The first layer is the site perimeter, which consists of a perimeter wall with points of entry through gates controlled by security personnel. Visitors and vehicles must be effectively screened at the perimeter without burdening the surrounding roads.

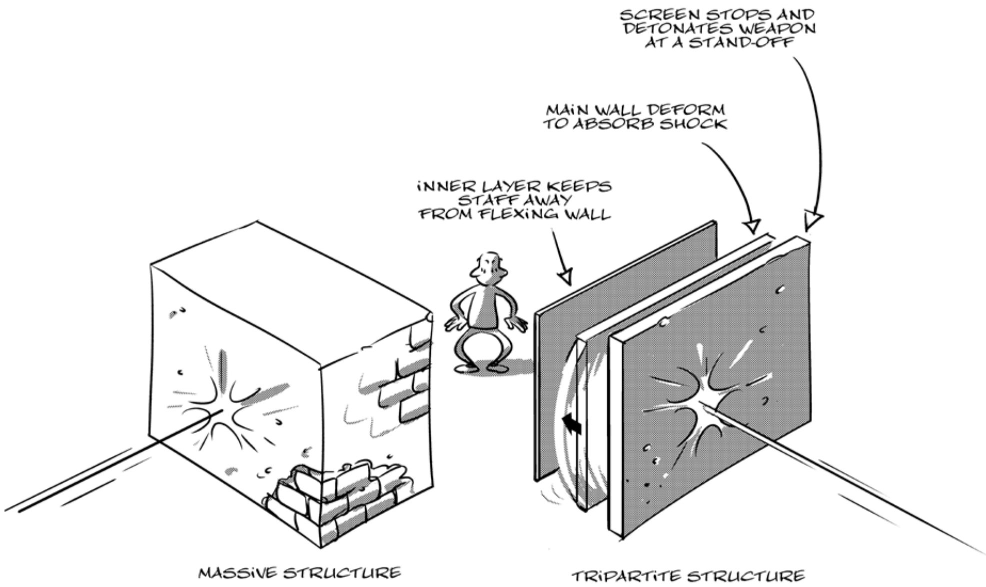
The second layer is the area in the compound between the perimeter wall and the buildings. Mitigation measures against intrusion, blasts and projectiles can be set up in this area.

The third layer is the building envelope, consisting of the walls, roof, doors and other openings. They are protected as a function of identified threats.

3.6 Multi-layered systems

The simplest structures designed to resist the effects of weapons rely on their size and mass alone: they are designed to absorb and dissipate a weapon's effects. But this may require a very thick and heavy structure in order to be effective against even small battlefield weapons. A more efficient technique is to use multi-layered systems, where each layer is optimized to achieve a specific effect.

Disruption and absorption: An outer layer of material can be used to disrupt a projectile and reduce its kinetic energy. This material must either be hard or easily turned into a cone of debris ahead of the projectile, thereby widening the area over which the kinetic energy spreads. An inner layer of ductile material absorbs the energy by deforming. An outer layer of sand backed by a layer of mild steel, for instance, can be effective.



Composite layering: In a multi-layered system, stress is induced into the projectile each time it passes through a layer. The greater the difference in density between layers the greater the induced stress.

Pre-detonation screen: An external pre-detonation screen ensures that explosive weapons detonate no closer than a predetermined standoff distance from the protected building. The main wall behind the pre-detonation screen is meant to absorb the blast energy and contain the fragments. Because the main wall may flex extremely rapidly into the protected space, people in that space should be separated from the main wall with an inner layer. The inner layer can also act as an anti-spall liner.

3.7 Site layout

The site layout directly affects how its physical security is configured and the ICRC's ability to monitor and enforce access control. A compound-style layout with numerous single storey buildings spread around is more difficult to secure than a single building, unless the perimeter is controlled and access points are monitored at all times.

When a site will hold a number of buildings, the individual buildings can be clustered or dispersed. Each of these options offers its own advantages and disadvantages.

With respect to explosive hazards, clustering offers a higher population density and hence invites an attack at the core of the cluster by increasing the chances of casualties and collateral damage. On the other hand, clustering minimizes the amount of perimeter to be shielded and the number of entry points. Dispersing the units reduces the scope for collateral damage. It also maximizes the standoff distance from the perimeter.

With respect to intrusions, clustering offers outsiders a limited view inside buildings and allows enhanced surveillance with a smaller number of posts. Dispersing the units allows greater potential access to each individual building. Also, the number of entry points requiring surveillance is higher, and a relatively smaller area is effectively secured from the threat of intrusion.

3.8 Facility organization

In terms of functional layout, it may be advisable to place non-critical rooms, such as archives and storage, in more exposed areas (e.g. an exposed façade, or on the top floor). This will increase the standoff distance between a risk and the building's occupants.

Potential hazards, such as the car park, fuel tanks and bottled gas, need to be separated from working and living areas of the site or protected from projectiles and blast hazards. The aim is to minimize collateral damage in the event of small arms fire or an explosion.

Please refer to the SCM Library "Risk Assessment and Treatment/Premises Safety" page on the intranet for detailed and updated guidance on managing risks related to flammable liquids, fire and gas:

- *https://intranet.ext.icrc.org/scm_library/risk-assesment-treatment/premises-safety/index.html*

3.9 Building interiors

The arrangement of furniture inside buildings can affect the extent to which occupants are exposed to fragments from weapons or small arms fire. As much as possible, furniture should be positioned to minimize these risks, and seats should not be located near windows or in the likely path of glass fragments (or other projectiles).

4. EFFECTS OF WEAPONS

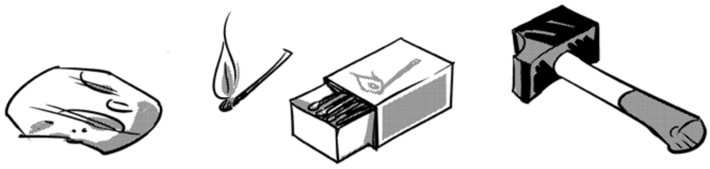
This chapter looks at some characteristics and effects of conventional weapons that the ICRC is likely to encounter in the field. The information provided in this chapter must be used with care, because each type of weapon has its own characteristics, which may vary substantially from one weapon to another, and because the way a weapon is used influences the threat level.

Weapons commonly inflict injury and damage through penetration, fragmentation, blast, flame, thermal pulse and a cratering effect. Because some weapons act in several ways, the full range of threats and associated hazards must be considered when designing passive security measures.

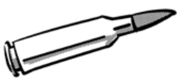
When assessing risk, please refer specific inquiries related to weapons to the local or regional WEC and/or SCMS delegate, who will provide the appropriate advice on weapons hazards and associated effects on buildings and people.

4.1 Improvised weapons

Rioters and thieves can pose a threat without using particularly sophisticated weapons. A burglar may carry a gun or knife, while rioters and ad hoc crowds may turn anything they find into a lethal weapon, for example by setting fire to flammable materials. Delaying strategies give people time to seek shelter, whilst escape strategies provide routes to avoid the threat.

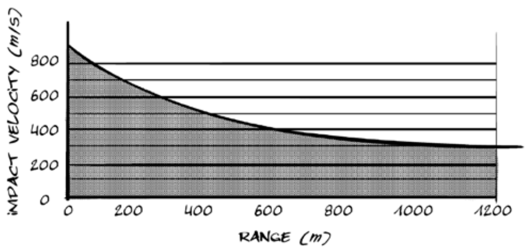


4.2 Small arms

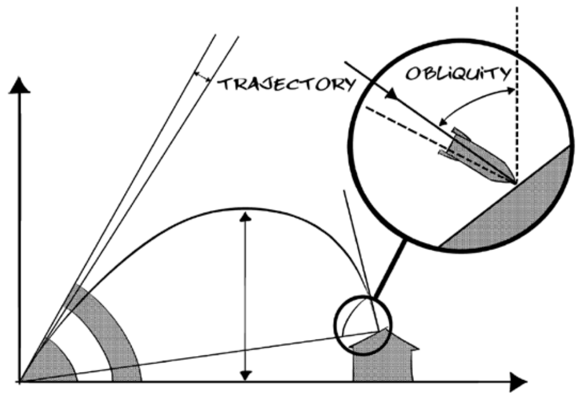


Small arms are characterized by the muzzle velocity and calibre of the bullet fired. These weapons rely on the kinetic energy of the bullets to penetrate and cause damage. Bullets are designed to be aerodynamically stable in flight, they travel farther and penetrate deeper than fragments from a weapon's casing or secondary fragments.

The diagram below shows the velocity of a 7.62 mm*51 NATO bullet over a given range. This information can be used to estimate impact velocity.



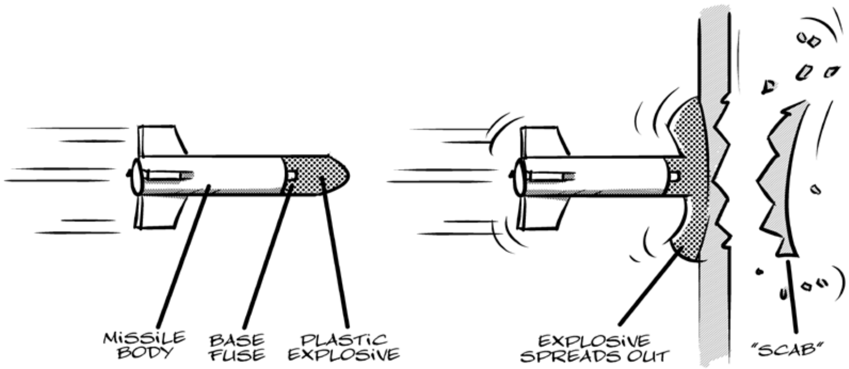
The trajectory of a bullet depends on various factors, such as the firing angle, the initial velocity and friction. However a bullet's trajectory may be affected by obstacles, such as tree branches. This threat should be considered as potentially coming from any direction. The way in which small arms are likely to be used (celebratory fire, assault, random fire from automatic weapons, and sniping) substantially influences the risk it represents in terms of velocity, obliquity, yaw, and so forth.



4.3 Large calibre guns

Large calibre cannons and guns are usually fitted to a vehicle, tank or trailer because they are too large for people to carry around. They pose the same ballistic threat as small arms but at a substantially greater level due to the larger calibre and higher muzzle-velocity characteristics. Such weapons may also fire explosive rounds. The rounds have a soft and blunt nose that allows them to flatten out when they come into contact with a surface and then detonate, causing damage through explosive shock rather than penetration.

Just like a shell blast, the impact of a large calibre projectile causes stress waves to travel through a material. These compression waves may reflect off the back face of the material as a tension wave, causing a scab of material to fly off. To reduce this hazard, two protective layers separated by an air-filled gap are often used. Alternatively, a ductile anti-spall liner, usually of made steel, can be used. Earth-filled barriers are also a good solution, as they may, to a certain extent, prevent the propagation of compression waves and stop tension waves causing scabbing.



4.4 Hand-thrown weapons

Hand-thrown weapons such as grenades, petrol bombs (Molotov cocktails) and inert projectiles can cause serious injury to people. Inert projectiles may cause damage by striking people, while petrol bombs can spray burning fuel and grenades can generate fragmentation.

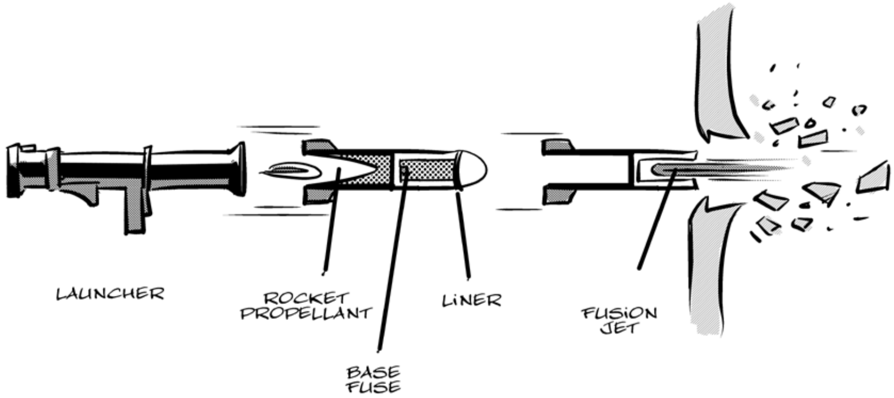
Hand-thrown weapons can be easily concealed and thrown over the perimeter wall of a site. In such instances, the relatively short range of such weapons makes them a threat only to assets close to the perimeter. Strategies that focus on deflecting these weapons and creating distance between people and the explosion point can mitigate their effect.

4.5 Shoulder-launched weapons

Shoulder-launched weapons are characterized by the diameter of the warhead, the type and quantity of explosive and the range of the launcher. Most anti-tank weapons, such as the RPG-7, are designed to be effective against armoured vehicles. They are therefore fitted with a shaped charge warhead capable of penetrating thick materials by forming a molten jet when detonating that does not depend on kinetic energy. Fragmentation of the casing around the warhead and the secondary fragments generated by the explosion also pose a considerable hazard.

Less common weapons, such as the RPO-A, are designed to be effective against buildings. The warhead contains a higher quantity of explosive, which is intended to maximize overpressure and cause damage and injury through the blast effect rather than fragmentation. Such weapons may be fitted with a two-stage warhead to penetrate a wall and a thermobaric explosive to produce heat.

It is difficult to predict the behaviour of shoulder-launched weapons, as this depends mainly on the precise type of warhead. However, a number of measures exist to shield people from penetration, blast and fragmentation, whilst strategies using pre-detonation screens can protect against detonation.



The penetration capacity of an anti-tank weapon, such as an RPG7, is given by the following equation:

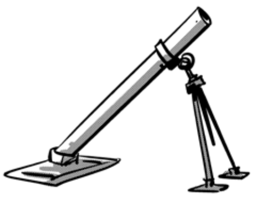
$$T_{material} = 7.79\, D\, M$$

where:
$T_{material}$ = thickness of material (mm)
D= diameter of the warhead (mm)
M= material multiplication factor)

with:
M=2.02 for clay brick masonry
M=2.47 for soil
M=2.97 for wood

Penetration capacity of anti-tank weapon
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

4.6 Heavy weapons



Rockets, artillery and mortars are heavy weapons most commonly encountered in conflict situations. They are characterized by their calibre, range and mobility. They are considered indirect-fire weapon systems since operators of such weapons cannot usually see the target area directly.

The munitions from such weapon systems usually travel at a curved trajectory prior to coming down onto the target, with blast and fragmentation as designed lethality features. The munitions may also penetrate solid materials such as walls, roofs and slabs thanks to their kinetic energy.

Mortars are light and portable weapons used to support infantry troops. The most common sizes are 60 mm calibre with a range of 2 km; 82 mm with a range of up to 6 km; and 120 mm with a similar range but a much more powerful shell.

Artillery is classified as either light or heavy. Light artillery refers to manoeuvrable weapons with a calibre of 76 mm to 105 mm and a range up to 13 km. Heavy artillery includes vehicle-towed weapons with a calibre of 120 mm to 155 mm and a range of up to 40 km.

Most weapons of this kind are designed to detonate on impact. Yet they are equipped with a nose-fuse system that determines the moment of detonation (air burst, impact or delayed), significantly modifying the threat they pose.

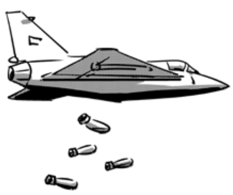
These weapons are not pointed directly at the target. Their aim is estimated, often by map coordinates, and may be adjusted after several strikes. This can cause indiscriminate damage. A number of measures can provide adequate physical protection. In addition, pre-detonation screens offer protection from penetration, blast and fragmentation hazards. The risk can be further reduced through strategies based on keeping a distance from potential targets.

4.7 Improvised explosive devices

Improvised explosive devices (IEDs) are extremely diverse in design, size, firing device, and type of explosive used. Due to the wide range of possible sizes, it is usual to categorize IEDs by their design, how they are delivered (in person, on a vehicle, etc.) and how they are triggered (victim-operated, time delay or command-detonated). Suicide bombs represent a sub-category of the aforementioned types, where the individual delivering the IED detonates it on the spot.

IEDs are designed to inflict the most damage possible on assets and people through the blast and fragmentation. Since the detonation time is unpredictable, strategies that provide for a certain distance and physical separation from explosion points can be effective in protecting people from the blast and fragmentation hazards.

4.8 Aerial-delivered bombs



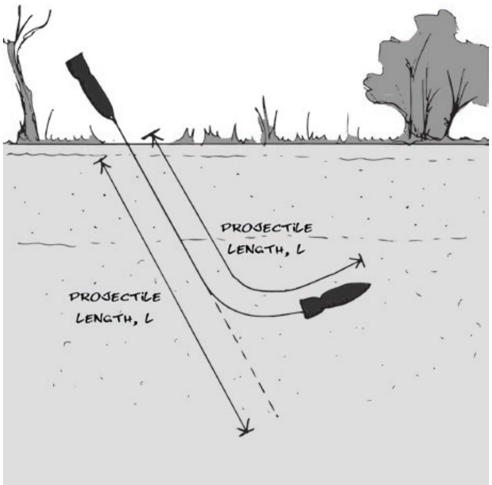
Aerial bombs usually carry considerable quantities of conventional explosives, which are often combined with specialized warheads. They have a high incidence of collateral damage due to the blast wave. This means that the best strategies for the ICRC consist of avoiding areas where aerial bombs are dropped (such as by relocating). It is impractical for the ICRC to implement physical measures that can guarantee full protection from a direct strike by an aerial bomb. These guidelines therefore only address ways of limiting the effects of collateral damage.

5. WEAPON HAZARDS

This chapter outlines some physical hazards of conventional weapons that the ICRC is likely to encounter in the field. It also suggests a number of protective measures from a theoretical perspective.

5.1 Penetration hazard

Any projectile has the potential to penetrate materials, mostly thanks to their kinetic energy. This penetration capacity can be predicted with a combination of ballistic equations (internal, flight and terminal ballistics) and physical properties such its nature, quality, moisture content and thickness.



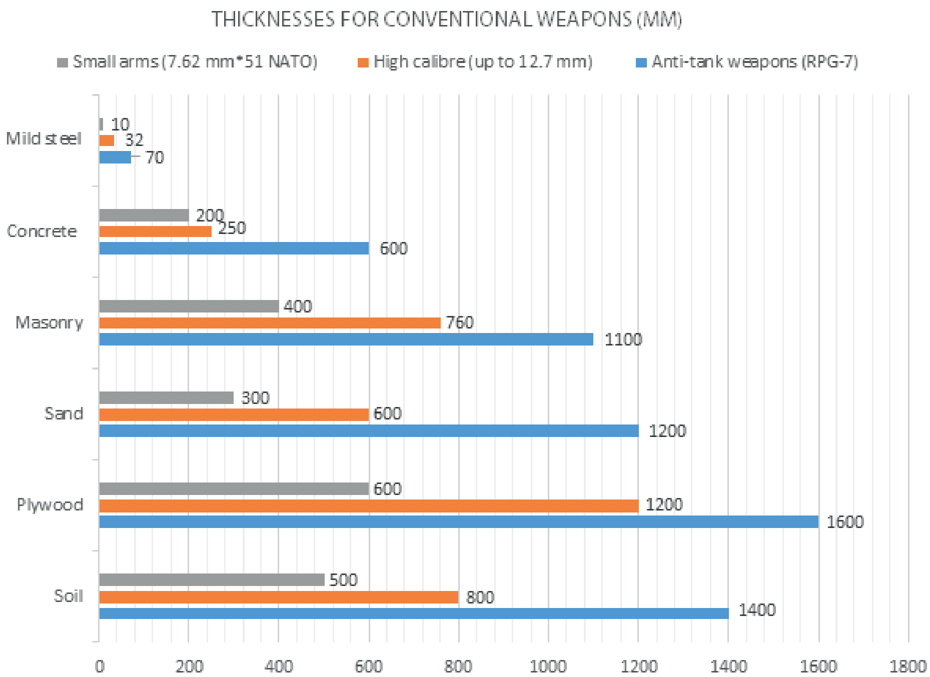
The nature of a protective material significantly influences the stresses generated on the projectile and therefore determines the material's response after impact, which can include perforation (the projectile passing through the material), penetration (the projectile entering but not passing through the material), deflection, ricochet or break-up.

For non-homogenous materials (e.g. sand or soil), the moisture content significantly affects their protective capacity. This results in uneven stresses, which cause the projectile to deflect and reduce its penetration capacity.

A very high impact velocity may cause the projectile to break up when striking a hard material (e.g. concrete or sand). Because the projectile will present a wider cross section as it strikes, it will penetrate less. This accounts for discrepancies between theory and tests. It also means that the optimum penetration velocity is 500 m/s rather than the muzzle velocity of small arms rounds.

If the protective material is composed of several layers, ideally with an air gap between them, the changes in material density can reduce the projectile's penetration capacity.

The table below provides an overview of the required thickness for construction materials so that they can withstand direct hits from certain types of conventional weapons (small arms and infantry weapons).



These figures were either calculated with ballistic equations or based on test results. The figures provided can be used to determine if a wall made of a given material will be perforated or not. They can also be used to retrofit existing walls that do not provide the necessary ballistic resistance. These are simply reference figures; it may be unrealistic to use some of the materials in the thicknesses indicated.

Conservatively, the projectile's velocity at impact can be estimated as the muzzle velocity (i.e. 830 m/s for a 7.62 mm x 51 NATO). However, when calculating the appropriate thickness of roof material for overhead protection, the impact velocity can be estimated at 100 m/s. A projectile fired vertically in the air (i.e. celebratory fire) will drop down from a velocity of zero and accelerate until it reaches its maximum velocity, which is limited by air friction (the greater the velocity, the higher the force of friction).

5.2 Fragmentation hazard

As a weapon explodes, the material surrounding it breaks up and is propelled outward as fragmentation. Primary fragments are those formed from the weapon casing itself. They are generally very small, weigh less than 1g and often travel initially at several times the speed of sound. However, some fragments may weigh more, as indicated in the table below for some selected weapons:

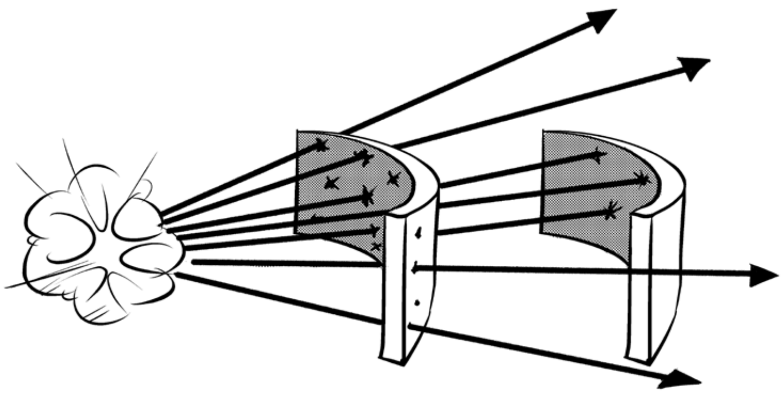
Weapon	Max fragment weight	Initial velocity
Mortar 60 mm (US M49)	2.38 g	1470 m/s
Mortar 81 mm (US M362A1)	1.93 g	1930 m/s
Artillery 105 mm (US M1)	13.12 g	1240 m/s
Artillery 155 mm (US M107)	64.35 g	1030 m/s
Rocket 140 mm (RUSSIA M14OF)	34.30 g	1200 m/s
Rocket 240 mm (RUSSIA 9)	14.74 g	2110 m/s

$$v = v_0 e^{-0.04 \frac{D_f}{m^{\frac{1}{3}}}}$$

where:
v = striking velocity
v_0 = initial velocity
D_f = distance travelled by fragment (m)
m = projectile mass (g)

Variation of fragment velocity with distance
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons. November 1986

These fragments have far more kinetic energy than most small arms rounds and will spread over a concentrated area. These two factors increase their penetration capacity. However, unlike small arms rounds, they are not aerodynamically stable and so they quickly slow down. Their velocity can be calculated with the above equation. Larger fragments travel at a lower speed but their greater mass makes them harder to stop with a protective layer.



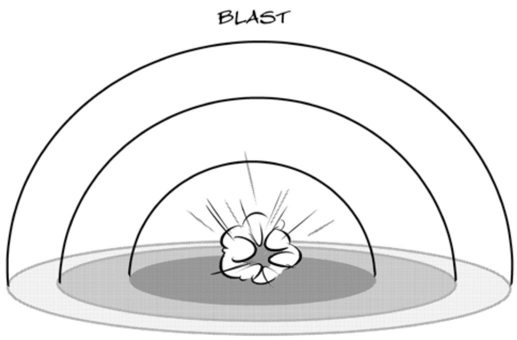
DOUBLING THE RANGE (STAND-OFF) MORE THAN DOUBLES PROTECTION

In terms of range, if there are no obstacles, fragments resulting from the explosion of a 10 kg TNT equivalent bomb can travel as far as 500 meters, and fragments resulting from the explosion of a 25 kg TNT equivalent bomb can travel as far as 600 meters.

Fragment density is related to the surface area of the expanding gas bubble of an explosion. It is thus inversely proportional to the range squared. Therefore, at close range, simply doubling the distance from the site of an explosion more than halves the fragment hazard.

Secondary fragments are those items of debris picked up by the blast wave and thrown outward. They are generally much slower but often far heavier. Secondary fragments, particularly glass, may cause most injuries.

5.3 Blast hazard



When an explosive detonates, it produces a pressure shock wave that, like a sound wave, moves outward quickly and can reach around corners and over walls, reflect off surfaces and remain focussed in enclosed spaces. Any material in contact with the explosive can be shattered by the extremely high stresses produced.

If the explosive is surrounded by air, a blast wave will be produced. The resulting pressure bubble will usually dissipate rapidly over distance, however; confining the explosion will enhance its effect. If the explosive is surrounded by earth, the shock wave will spread differently: it will cause a ground shock and may produce a crater.

The pressure behind the blast wave is related to the volume of space occupied by the expanding bubble of hot gas generated by the explosion. It is thus inversely proportional to the cube of the distance (range) from the seat of the explosion. The most cost-effective way of protecting facilities and people from explosives is to maintain distance from the seat of an explosion.

There is no ideal standoff distance. The appropriate distance is determined by the type of explosive likely to be used, the type of construction, and the desired level of protection. In terms of range, if there are no obstacles, a blast resulting from the explosion of a 10 kg TNT equivalent bomb can severely damage unreinforced buildings at a distance of up to 40 meters. A blast from a 25 kg TNT equivalent bomb can severely damage unreinforced buildings at a distance of up to 50 meters.

Because most open sites offer significant open space for standoff, conventional construction with minor modifications may provide an acceptable level of blast protection. Sufficient standoff may not be feasible on a typical urban site where space is tight and some rooms may be adjacent to public areas. In such cases, alternative protective measures include a perimeter wall, blast walls, obstacles to extend the standoff, structural hardening, building envelope enhancement and operational procedures such as increased surveillance. It may also be necessary to accept some degree of risk.

5.4 Flame and thermal pulse hazard

All explosions are accompanied by a fireball and thermal pulse, the reach of which can be estimated using the equation below. For most conventional weapons, the damage from flame and thermal pulse is much less significant than that caused by blast and fragmentation. However, some thermobaric weapons are expressly designed to cause injury by flame or thermal pulse.

$$D = 3.3\, m^{0.341}$$

where:
D = diameter of the fireball
m = mass of the explosive based on TNT (kg)

Diameter of a fireball
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects

6. CONSTRUCTION PRACTICES

The ballistic and blast resistance provided by a material is determined by its composition, cohesion, quality, moisture content and thickness. This chapter assesses the ability of certain construction practices and materials to provide protection from blast and penetration hazards.

6.1 Sandbag wall

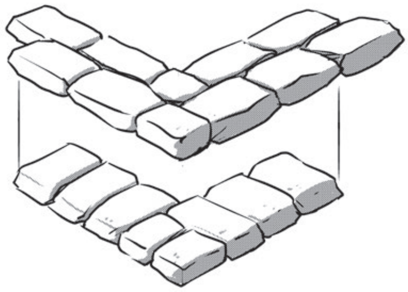
Sandbags are effective in erecting blast walls, reinforcing safe areas, building shelters and shielding windows.

Clean and dry sand (maximum diameter: 4 mm) should be used to fill the bags. It provides better protection than an equal volume of wet sand or soil.

Sandbag walls are easily damaged and deteriorate quickly over time unless specific precautions are taken to protect them from adverse weather conditions. They can be covered by tarpaulins, for example, or the jute sacks can be soaked in a 1/10 cement-water liquid mortar mix before being filled.

Here are some recommendations for building a sandbag wall that will be both effective and stable:
- There is a 1:10 slope on both sides.
- The sacks are filled to 3/4 of their capacity.
- The sacks are firmly tamped down when placed.
- The sacks are laid in alternate directions layer by layer.
- Strands of barbed wire are placed between the layers to stabilize the wall, thus acting as both mortar and reinforcement.
- Joints are staggered in adjacent courses.
- The sandbags are laid so that neither the necks nor the seams are on the outer face of the wall.
- The unfilled end of each bag is tucked as it is laid.

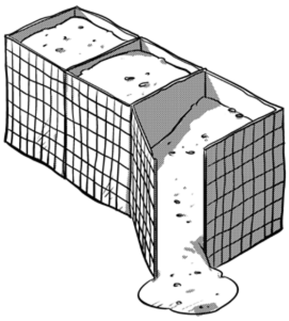
Most importantly, shape and make sure each bag is compact as it is laid. This is done by beating it with a board or shovel.



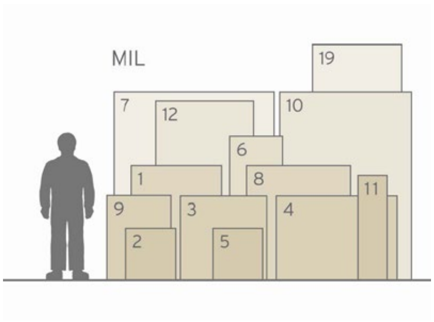
To make the blast wall and shelter facilities last longer and to protect them against rain, mix cement with the filler material (dry earth or sand gravel) in the following ratio: 1 part cement to 10 parts dry earth, or 1 part cement to 6 parts sand gravel. The mixture sets as the bag absorbs moisture. Alternatively, filled bags may be dipped in a cement-water slurry. When necessary, use planks of wood to hold the bags firmly in place.

Constructing the corners is particularly important. If not done properly the whole construction will be weakened. The rule is to make sure that joints in adjacent layers are staggered, as shown.

6.2 Hesco® bastion gabions



Robust, stable and fairly durable, walls made of Hesco Bastion gabions are versatile and highly effective thanks to the various formats in which they come (from MIL1 to MIL12). Each unit, which is made of resilient geotextile fabric in order to ensure durability and physical integrity, is filled with locally source material and is reinforced with a metal grid structure.



Capping the exposed fill with plants, cement screed or tarpaulins will enhance the stability, performance and durability of a blast wall of composed of Hesco gabions.

The manufacturer supplies a comprehensive construction guide for engineers in several languages. It can be found at OP_ASSIST_EH, in the WatHab Reference Manual and at OP_DIR_SCMS ("Construction Guide for Engineers" Version 2, 2011). Further information can also be found on the Hesco website: http://www.hesco.com

6.3 Improvised walls

A variety of other materials may be used to construct blast walls offering ballistic protection against projectiles and fragments. Because the protection comes from a combination of the physical integrity of the wall and the high mass of the fill material, any blast wall that incorporates these elements will provide blast and fragment protection. Improvised materials include:

- earth berms, particularly when held in place by retaining walls or geotextile matting;
- drums, crates, or boxes filled with soil or sand;
- tyres, preferably bolted or wired together, and filled with earth or sand; and
- corrugated iron or geotextile sheeting and mesh, held in place with star pickets or wooden stakes windlassed together, then filled with earth or sand.

In addition to being locally sourced, such improvised methods offer the advantage of not always looking like conventional blast walls. This may help avoid an overt perception issue.

6.4 Sand and soil

The protection provided by earth-filled barriers and sandbags is significantly affected by the characteristics and moisture content of the infill material. For better ballistic protection, infill materials should be dry; a higher moisture content significantly decreases resistance to penetration.

Generally, the ideal fill is a well-graded sand and gravel mix. This offers a high degree of blast and ballistic protection with a low incidence of secondary fragmentation, even from large close-in explosions. Sand and natural sandy soil are an ideal fill to contain the energy of an in-contact explosion with no incidence of secondary fragmentation, even if the protective structure bursts. Fine materials such as clay, silt and organic substances tend to clump, causing gaps in the structure and reducing stability due to varying moisture levels within the fill material. These materials may nevertheless be considered for operational reasons and logistical difficulties. But the structures will need to be thicker to achieve the desired level of protection, since they are less stable and require more maintenance.

As a projectile or fragment passes through sand or soil, the stresses at the tip will be uneven and reduce the projectile's ability to penetrate. This material will actually alter the path of the projectile. Small arms rounds are particularly prone to this, and in many cases the optimum impact velocity for penetration is around 500 m/s, which is less than the muzzle velocity.

The thickness of soil necessary to prevent small arms projectiles or fragments from perforating (i.e. completely penetrating the structure and emerging with null velocity) is given by the following equation:

$$T_{soil} = 16.45 m^{1/3} K_p log_{10}\left(1 + \frac{5}{10^5} v^2\right)$$

where:
T_{soil} = thickness of soil (mm)
m = fragment mass
K_p = soil perforation constant
v = fragment velocity at impact (m/s)

with:
K_p = 5.29 for sandy soil
K_p = 10.6 for clay soil

Soil thickness to prevent fragment perforation
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

This equation provides a safe calculation for most applications. If the soil thickness is less than that given by the above equation, the fragment will pass through the material with a residual velocity, which can be predicted using the following equation. That residual velocity could then be applied to a subsequent layer of protective material.

$$v_r = v\left(1 - \frac{t_{soil}}{T_{soil}}\right)^{0.555}$$

where:
v_r = residual velocity after perforation (m/s)
t_{soil} = thickness of soil (mm)
T_{soil} = thickness of soil to prevent perforation (mm)
v = fragment velocity at impact (m/s)

Fragment residual velocity after passing though soil
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

Sand and soil weigh approximately 1,200 kg/m^3 to 2,000 kg/m^3 depending on the material and moisture content. The impact of this weight on the structure must be taken into account when designing passive security measures.

6.5 Aggregates

Aggregates, such as crushed rock and stones, may leave gaps in the protection. Gravel can also pose a secondary hazard if a large close-in explosion causes the gabions to burst.

6.6 Steel

Steel plates offer good protection against ballistic and fragment penetration. The level of protection provided depends largely on its hardness. This is measured by the Brinell Hardness Number (BHN), which ranges from 110 to 160 for conventional mild steel plates (e.g. Grade S235 or S275, which refers to the shear yield strength).

The steel in corrugated iron roofing sheets and in the sandwich panels of prefabricated containers is too thin to provide effective ballistic protection. To achieve the desired level of protection, roofs could be reinforced with steel plates or sandbags, provided the structure can withstand the additional weight.

Consideration must also be given to the weight of steel (7850 kg/m^3) when affixing steel plates to walls and especially roofs. For example, a 4 mm thick steel plate weighs approximately 30 kg/m^2.

The thickness of a steel plate necessary to prevent small arms projectiles or fragments from perforating (i.e. completely penetrating the structure and emerging with null velocity) is given by the following equations:

$$T_{steel} = d * \left(\frac{v \left(\frac{m}{1000}\right)^{0.5} cos^{0.8}\,\alpha}{1.125\, d^{1.5}\, log_{10}\, BHN} \right)^{1.25}$$

where:
T_{steel} = thickness of mild steel (mm)
d = projectile diameter (mm)
v = projectile velocity at impact (m/s)
m = projectile mass (g)
α = angle of obliquity (degrees)
BHN = Brinell Hardness Number

with:
BHN=140 for mild steel

Steel thickness to prevent projectile perforation
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

$$T_{steel} = \frac{1.65 m^{0.33} v^{1.22}}{1000}$$

where:
T_{steel} = thickness of mild steel (mm)
v = projectile velocity at impact (m/s)
m = fragment mass (g)

Steel thickness to prevent fragment perforation
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

These equations provide safe calculations for most applications. But if the thickness of the steel plate is less than that given by the equations above, the projectile or fragment will pass through the material with a residual velocity, which can be predicted using the following equations. That residual velocity could then be applied to a subsequent layer of protective material.

$$v_r = \sqrt{v^2 - \left(\frac{1.125 * \left(\frac{t_s}{d}\right)^{0.8} d^{1.5}\, log_{10}\, BHN}{\left(\frac{m}{1000}\right)^{0.5} cos^{0.8}\,\alpha} \right)^2}$$

where:
v_r = residual velocity (m/s)
t_s = thickness of steel plate (mm)
T_{steel} = thickness of steel to prevent perforation (mm)
m = projectile mass
v = projectile velocity at impact (m/s)
d = projectile diameter (mm)
BHN = Brinell Hardness Number

Projectile residual velocity after passing through a steel plate
Ref:. UFC 4-023-07, Design to resist direct fire weapons effects.

$$v_r = \frac{\sqrt{v^2 - \left(\frac{t_s}{m^{1/3}}\right)^{1.64}}}{\left(1 + 0.173 \frac{t_s}{m^{1/3}}\right)}$$

where:
v_r = residual velocity (m/s)
t_s = thickness of steel plate (mm)
m = fragment mass (g)
v = fragment velocity at impact (m/s)

Fragment residual velocity after passing through a steel plate
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

6.7 Wood

Wood is a non-homogeneous material that reduces the effects of a blast but offers little ballistic and fragment protection. Very thick wood would be required to achieve the desired level of protection.

The ability of wood to resist penetration is substantially influenced by the wood's density and hardness, as measured by the Janka hardness test. For example, dry conventional plywood has a density of 480 kg/m3 and a Janka hardness of 3400N (i.e. 340 kg) as expressed in the metric system.

The thickness of wood necessary to prevent small arms projectiles or fragments from perforating (i.e. completely penetrating the structure and emerging with null velocity) is given by the following equations:

$$T_{wood} = 2.57 * 10^5 \left(\frac{v^{0.4113} m^{1.4897}}{\rho \left(\frac{\pi d^2}{4}\right)^{1.3596} H^{0.5414}} \right)$$

where:
T_{wood} = thickness of wood (mm)
ρ = wood density (kg/m³)
H = Janka hardness (kN)
d = projectile diameter (mm)
v = projectile velocity at impact (m/s)
m= projectile mass (g)

with:
ρ= 480 kg/ m³ for fir plywood
H= 3.4 kN for fir plywood

Wood thickness to prevent projectile perforation
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

$$T_{wood} = \frac{10242 v^{0.41} m^{0.59}}{\rho H^{0.54}}$$

where:
T_{wood} = thickness of wood (mm)
ρ = wood density (kg/m³)
H = Janka hardness (kN)
v = fragment velocity at impact (m/s)
m = fragment mass (g)

with:
ρ=480 kg/ m³ for fir plywood
H=3.4 kN for fir plywood

Wood thickness to prevent fragment perforation
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

These equations provide safe calculations for most applications. If the thickness of the wood is less than that given in the equations above, the projectile will pass through the material with a residual velocity, which can be predicted using the following equations. That residual velocity could then be applied to a subsequent layer of protective material.

$$v_r = v * \left[1 - \left(\frac{t_w}{T_{wood}}\right)^{0.5735}\right]$$

where:
v_r = projectile velocity after perforation (m/s)
t_w = thickness of wood plank (mm)
T_{wood} = thickness of wood to prevent perforation (mm)
v = projectile velocity at impact (m/s)

Projectile residual velocity after passing through a wood plank
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

$$v_r = v * \left[1 - \left(\frac{t_w}{T_{wood}}\right)^{0.5735}\right]$$

where:
v_r = fragment velocity after perforation (m/s)
t_w = thickness of wood plank (mm)
T_{wood} = thickness of wood to prevent perforation (mm)
v = fragment velocity at impact (m/s)

Fragment residual velocity after passing through a wood plank
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

Wood, and in particular plywood, is therefore not recommended for blast and ballistic protection. However, it can serve as an effective pre-detonation screen or anti-spall liner, and it can be used to prevent being spotted by snipers or to build containers to be filled with sand.

6.8 Concrete and masonry

Concrete is a very hard material that generally provides the highest level of blast and ballistic protection. Masonry, whether made of clay bricks, stones or concrete masonry unit (CMU) blocks, is good at resisting penetration by primary fragments and bullets. However, stone and CMU blocks can pose a considerable secondary fragment hazard.

The compressive strength, and by extension the quality, of the masonry is a significant factor in its ability to resist penetration. Approximate compressive strength ranges are shown in the table below, which gives conservative values assuming a medium to low quality of material and workmanship:

Material	Assumed compressive strength	Comments
Solid clay brick	1MPa - 3MPa	Handmade sun dried bricks
	3MPa - 6MPa	Factory made burnt bricks
CMU blocks	3MPa - 6MPa	CMU blocks must be fully grouted
Stone	10MPa - 50MPa	Limestone, sandstone, buhrstone
	50MPa - 80MPa	Granite, slate, marble
Concrete	15MPa - 20MPa	Reinforcement ratio is not significant

The thickness of masonry necessary to prevent small arms projectiles or fragments from perforating (i.e. completely penetrating the structure and emerging with null velocity) is given by the following equations:

$$T_{masonry} = d\left(1.239\left(\frac{P_m}{d}\right) + 1.132\right)$$

where:

$$P_m = \frac{56.6\left(\frac{m}{d^3}\right)^{0.075} \bar{N} m v^{1.8}}{d^2\sqrt{f_c}}\left(\frac{d}{c}\right)^{0.15} f_{age} + d$$

where:
$T_{masonry}$ = thickness of masonry (mm)
P_m = penetration into masonry (mm)
N = nose performance coefficient
f_c = compression strength (MPa)
c = maximum gravel size (mm)
f_{age} = age factor
d = projectile diameter (mm)
m = fragment mass (g)

with:
N = 1.26 for small arms fire AK47 type
f_c = 4MPa (masonry) to 20Mpa (concrete)
c = 4mm (masonry) to 20mm (concrete)
f_{age} = 1.01 for materials aged >6 months

Masonry thickness to prevent projectile perforation
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

$$T_{masonry} = 0.976 X m^{0.033} + 0.302 m^{0.33}$$

where:

$$X = \frac{0.274 m^{0.4} v^{1.8}}{1000 f'^{0.5}_c} + 6.541 m^{0.33}$$

where:
$T_{masonry}$ = thickness of masonry (mm)
X = penetration into masonry (mm)
f_c = compression strength (MPa)
m = fragment mass (g)

with:
f_c = 4MPa (masonry) to 20Mpa (concrete)

Masonry thickness to prevent fragment perforation
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

These equations provide safe calculations for most applications. If the thickness of the masonry is less than that given by the equations above, the projectile will pass through the material with a residual velocity, which can be predicted using the following equations. That residual velocity could then be applied to a subsequent layer of protective material.

$$v_r = v\left(1 - \frac{t_m}{T_{masonry}}\right)^{0.733}$$

where:
v_r = projectile velocity after perforation (m/s)
t_m = thickness of masonry wall (mm)
$T_{masonry}$ = thickness of masonry to prevent perforation (mm)
v = projectile velocity at impact (m/s)

Projectile residual velocity after passing through a masonry wall
Ref.: UFC 4-023-07, Design to resist direct fire weapons effects.

$$v_r = v\left(1 - \frac{t_m}{T_{masonry}}\right)^{0.555}$$

where:
v_r = fragment velocity after perforation (m/s)
t_m = thickness of masonry wall (mm)
$T_{masonry}$ = thickness of masonry to prevent perforation (mm)
v = fragment velocity at impact (m/s)

Fragment residual velocity after passing through a masonry wall
Ref.: TM 5-855-1, Fundamentals of protective design for conventional weapons.

Compressive stress waves caused by an impact can reflect off the back face of a concrete or masonry wall as a tension wave, causing a scab of material to fly off. To reduce this hazard, notably for overhead protection, a ductile anti-spall liner, usually made of steel, can be used.

Concrete blast walls, such as pre-cast T-walls, are not recommended by OP_DIR_SCMS, as they may raise perception problems.

6.9 Commercial products

In addition to conventional building materials there are a number of commercial ballistic protective products, including ceramic, aramid and polycarbonate ballistic sheets or plates. These products are relatively lightweight and can be plastered or painted to look like ordinary internal walls. These products have not yet been assessed or endorsed by OP_DIR_SCMS because of their cost and lack of on-site availability. They should not be considered an option from the start or used without first consulting OP_ASSIST_WEC.

Whilst expensive, such products may be suitable in special situations where structural or perception issues prevent the use of standard construction materials to meet the required ballistic protection.

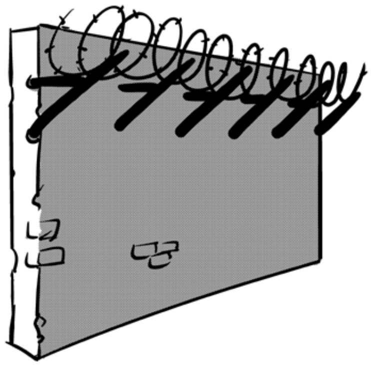
7. INTRUSION MITIGATION MEASURES

Intrusion mitigation measures are safety preparedness measures aimed at increasing the time and effort needed to break into ICRC premises. These measures should have a significant physical and deterrent effect, yet their appearance should not compromise the perception of the ICRC by the public.

7.1 Risk event

Intrusion mitigation measures are designed to prevent forced or clandestine entry with criminal intent (but not necessarily the intent to harm or kill).

7.2 Perimeter line



The perimeter line is the first layer of protection against intrusion. Passive security measures at this level typically comprise the perimeter walls and fences, which may be enhanced with barbed wire, a non-lethal electric fence and/or access control.

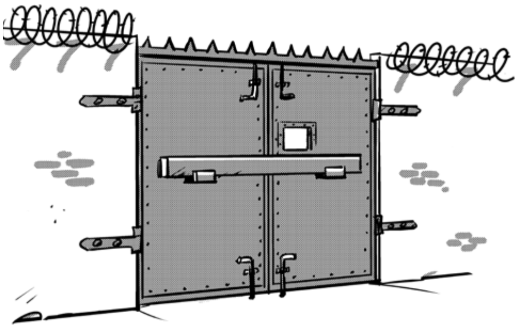
Perimeter wall: the perimeter wall identifies an ICRC site, delineates the site boundary and provides protection from intrusion if all openings (drains and culverts) are secured with iron bars:

- A 300 cm high wall hinders intrusion and prevents observation of the site from outside. Walls made of masonry should be designed so as to not be climbable.
- A 250 cm high fence may be considered in rapid deployment or temporary situations. A fence of this height may be opaque or covered to prevent observation but will offer no protection from other threats.

Barbed/Razor wire: The effectiveness of fences and walls can be enhanced with barbed wire or razor wire (450-730 mm coil diameter) laid along the entire perimeter and attached to the wall every 60 cm. It can be attached to the top of the wall or, to avoid perception problems, on the inside of the wall. In some situations, non-lethal electric fences may provide the necessary protection.

Trees and vegetation: Remove or cut vegetation alongside the perimeter wall that could be used to gain access to the site, particularly overhanging trees. If that is not possible, cover them with barbed wire or razor wire.

Gates and doors: Gates and doors giving access to the compound should be as small as possible and only as large as necessary. Unguarded gates and doors should be securely locked and/or bolted and inspected regularly. Moreover, entrance gates and doors should be:



- flush with the wall; where this is not possible, metal spikes on the upper edge can prevent an intruder from scaling the gate;
- made of reinforced steel, have a strong frame, and have solid hinges that are mounted on the inside and protected by plates or bolts;
- equipped with numerous locking systems: strong lock plates, mortise locks with solid cylinders, and cross bars and sliding bolts; and
- equipped with a way of viewing people approaching the entrance, such as a peep hole covered by a metal plate, a large overhead mirror or a video monitoring system.

Access control is an essential aspect of any security system, and it applies equally to residences, offices and other types of ICRC sites. It consists of identifying people before authorizing them to enter, whilst all other people are kept outside or in a designated waiting area until access is approved. A log should be kept to record and monitor all such movements. Access control applies to vehicles as well. Unauthorized non-ICRC vehicles should always be parked outside ICRC premises or in a designated non-secure parking area separate from the rest of the compound.

7.3 Site compound

Passive security measures to be applied between the perimeter and the outer walls of the buildings involve lighting, compound organization and maintenance.

Compound organization and maintenance: Bushes, trees, and undergrowth that could provide cover, especially close to buildings, footpaths, or driveways, should be removed or trimmed. This will give guards clear lines of observation and prevent intruders from hiding. In addition, such things as dustbins, water tanks and outdoor furniture should be stored neatly in an enclosed area. This will make it easier to identify unusual or suspicious objects.

Visibility and site lighting: At night-time, the compound should be adequately lit, eliminating any shadowy areas. This will allow guards to perform their duty and deter intruders.

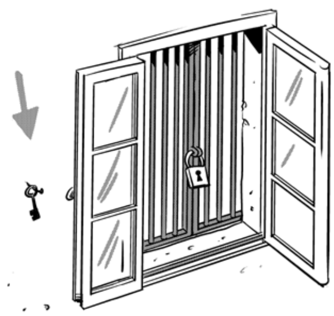
7.4 Building

Intrusion mitigation measures to be applied to the outside and inside of buildings consist of "hardening" the premises, as follows:

Entrance doors: Entrance doors and door frames should be made of steel, if possible, or solid wood and be of good quality. Where an existing door cannot be strengthened or where security has to be further enhanced, a secondary metal door, metal grill or metal roller shutter should be installed. Doors can also be equipped with:
- multiple locking systems: strong lock plates, mortise locks with solid cylinders, and cross bars or sliding bolts with padlocks;
- solid and securely fixed striking plates;
- strong frames deeply anchored in the wall;
- solid hinges mounted on the inside and protected by plates or bolts; and
- peep holes covered by a swinging steel plate.

Internal doors: Internal doors are frequently composed of two thin pieces of wooden veneer separated by cardboard spacers. This type of door provides little in the way of security. It is better to install solid-core doors or even metal doors. Internal doorframes, hinges, and locks should also be upgraded where necessary. This allows occupants to close and secure separate areas within the building.

Windows: Window frames should be made of good quality steel or solid timber frame. Windows should also be protected by metal grill bars or steel shutters. These measures must be compatible with fire safety measures, and it must always be possible to open from the inside in an emergency. In addition, windows should have curtains to prevent people outside from seeing the inside of the room in the evening when the lights are turned on.



Openings: Air conditioners and other service port openings should be covered with exterior mounted metal grill boxes. The grill boxes should be mounted with heavy duty bolts rather than screws, and should require tools to be removed.

7.5 Electronic security devices

Electronic security devices can provide additional alert capabilities and enhance site surveillance when applied appropriately within a clearly defined security concept. But they are only effective if they are correctly installed and operated. A specialist should therefore be called on to design, install and maintain electronic surveillance and alarm systems and to train staff in operating them.

Alarm systems can be used to detect any forced, unauthorized or attempted entry into a building or onto a site. They can be triggered either manually (panic button) or automatically (magnetic-contact or volumetric devices).

Video surveillance systems such as closed circuit television (CCTV) may be used for monitoring purposes. They can considerably enhance security by the early detection of suspicious circumstances.

Please refer to the SCM Library "Protecting buildings against intrusion" page on the intranet for detailed and updated guidance on this matter:

- *https://intranet.ext.icrc.org/scm_library/risk-assesment-treatment/criminality/prot-intrusion/index.html*

8. SAFE AREA

Identifying and setting up safe areas is part of the safety preparedness of a delegation and a requirement for every ICRC site (OP_DIR 01E452).

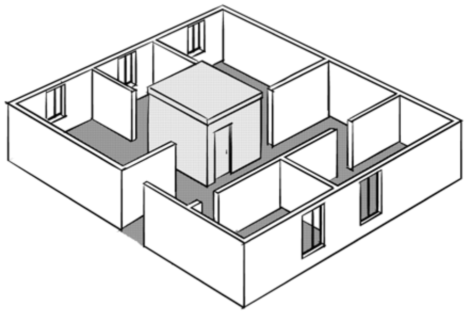
All ICRC sites (i.e. delegations, sub-delegations, offices, warehouses, workshops and residences) must therefore establish safe areas and put in place any other protective measures deemed necessary in view of ballistic risks.

8.1 Risk event

A safe area is a place of refuge that protects occupants from stray bullets caused by sporadic small arms fire (e.g. rifle fire) and/or fragments from mortars and grenades (e.g. rocket-propelled grenades or hand grenades).

A safe area does not provide protection from sustained and targeted small arms fire, direct hits by mortars or grenades or violent intrusion.

8.2 Identification of a safe area



Everyone who may need to use a safe area must know where it is. When a safe area is established, the following factors should be taken into consideration:

- It should be located in an existing structure, and there should ideally be one in every building. This eliminates the need for people to cross exposed areas to reach safety.
- It should be located away from any of the building's external walls. This means there will be at least two walls between the potential danger zone and people in the safe area.
- The ballistic resistance properties of the existing walls and roof must be adequate.
- There must be no doors, windows or any other openings that lead directly outside the building.

In most buildings, corridors and bathrooms are potential safe areas. These rooms usually require few additional measures and adaptations. Bathrooms have the added advantage of a water supply and toilet.

In the unlikely event an area that meets the guidelines described above cannot be found, then the building's walls, roof and openings must be reinforced with additional protective measures in order to meet the ballistic requirements.

If no safe area can be set up in an existing structure, such as in field camps or field hospitals, a stand-alone structure to serve this purpose will have to be built in the compound.

Depending on the situation, consideration should also be given to the following concerns when identifying and setting up a safe area:

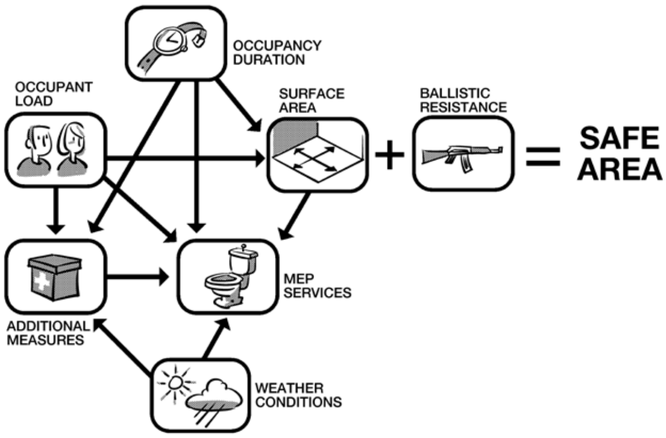
- The safe area should be adaptable, in case the identified threat increases in intensity or changes.
- It should be durable, if it is exposed to severe weather conditions.
- It should be able to withstand natural disasters, if located in a risk-prone area (floods, earthquakes, etc.).
- It should not be located near toxic chemical installations.

- Evacuation and escape routes should be available.
- Other local practices should be taken into account (other organizations, civil protection, etc.).
- Preventive and corrective maintenance should be carried out regularly.

8.3 Architectural specifications

Establishing a safe area must be guided by the fact that it is meant to serve as a space where a number of people will seek protection – possibly for an extended period of time – from stray fire caused by sporadic small arms and/or fragments from mortars and grenades. The following design parameters and the way they influence each other should be taken into consideration.

In broad terms, the figure below illustrates the design parameters that should be considered when preparing a shelter and how they influence each other.



Occupant load: The occupant load of a safe area depends on the requirements set out by the security contingency plan. It could potentially be only for essential staff. This is based on the assumption that if the security situation had deteriorated to the point where a safe area is needed, non-essential staff would have already been evacuated. However, there are also situations where this would clearly not be the case. The occupant load for any safe area should be determined by the risk assessment. The total number of people who may use a safe area must be accurately estimated and regularly revised as necessary.

Occupancy duration: A safe area should not be occupied for more than 12 hours.

Surface area: A minimum net floor area of 1.2 m^2 per person should be provided for.

Mechanical electrical and plumbing (MEP) services: As a general consideration, stand-alone services should have priority. In other words, it should be possible to operate services and communication equipment independently of the normal grids or systems.

A site may choose to use existing installations or consider additional measures when few or no MEP services are provided in the safe area. Either way, the following minimum requirements apply:

- <u>Drinking water:</u> Two litres per occupant must be provided and available at all times.
- <u>Toilets:</u> A small space in the room giving occupants some privacy should be set up; this can be done very simply with a curtain and a bucket. It is comforting and will discourage people from leaving the room in case of a personal emergency.
- <u>Temperature:</u> One blanket per occupant should be provided in cold climates in case the heating system (electrical heater or wood stove with appropriate exhaust) fails or does not exist. In hot

climates, the thermal inertia of the walls and ceiling of the safe area should be sufficient to maintain a reasonable temperature inside.

- Ventilation: Safe areas, as enclosed spaces occupied by a certain number of people, must provide for natural ventilation. In most cases, this is possible through the infiltration of outdoor air. If not, considering a buoyancy-driven ventilation airflow of two-thirds of the volume of the room per hour, the net cross-sectional area of the air inlet(s) and outlet(s) should be around:
  - 1/1000 of the net floor area (NFA) in cold climates (t°<20°C)
  - 1/500 of the net floor area (NFA) in hot climates (t°>20°C)

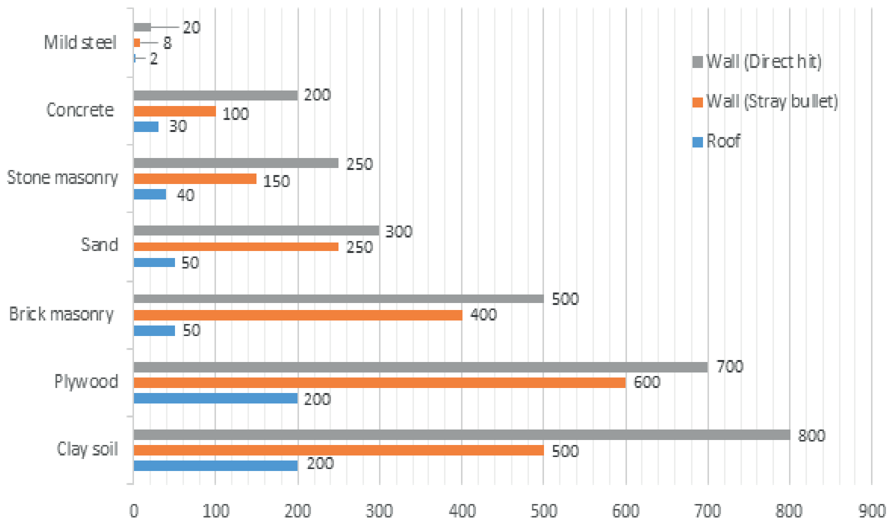
Additional preparedness measures: Although safe areas are meant for occasional and temporary protection, additional supplies for emergency situations and back-up purposes may be necessary. These could include torches, first aid kits, a fire extinguisher, alternative means of communication, fans and mattresses.

8.4 Ballistic resistance

The envelope, or shell, of a safe area is the physical separator(s) between the danger zone and the protected zone. It comprises the vertical elements (i.e. walls, doors and windows) and overhead elements (i.e. roof, slab, or ceiling).

The ballistic protection provided by the envelope of a safe area is given by a combination of its composition, cohesion, quality, moisture content and thickness, as discussed in Chapter 6 (Construction Practices). The figure below shows how thick wall and roof materials should be in order to protect against sporadic small arms fire and blast fragments.

WALL AND ROOF NOMINAL THICKNESSES FOR CONVENTIONAL WEAPONS (7.62x51 mm NATO rifle)



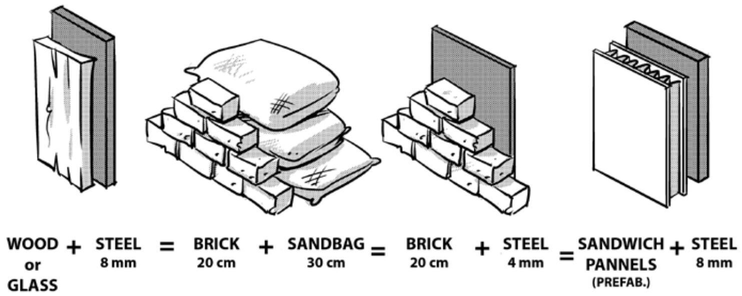
Material thickness in mm for the protection of a safe area

It is recommended that two walls (vertical elements) be provided between the safe area and the threat. Hence, two brick walls that are 20 cm thick meet the requirements.

The ballistic resistance required overhead is lower because projectiles fired into the air follow an arc or curve and will strike a roof indirectly and at a considerably reduced velocity. Sufficient protection can be achieved with thinner materials than that needed for walls.

8.5 Enhancing ballistic resistance

Where the envelope of the identified safe area is deemed to provide insufficient protection, the walls and/or roof should be reinforced by additional layers of material. The respective thickness of each layer should be combined proportionally in order to match the desired protection level. For example, a 20 cm brick wall could be enhanced with a 4 mm steel plate to provide protection equivalent to a 40 cm brick wall.

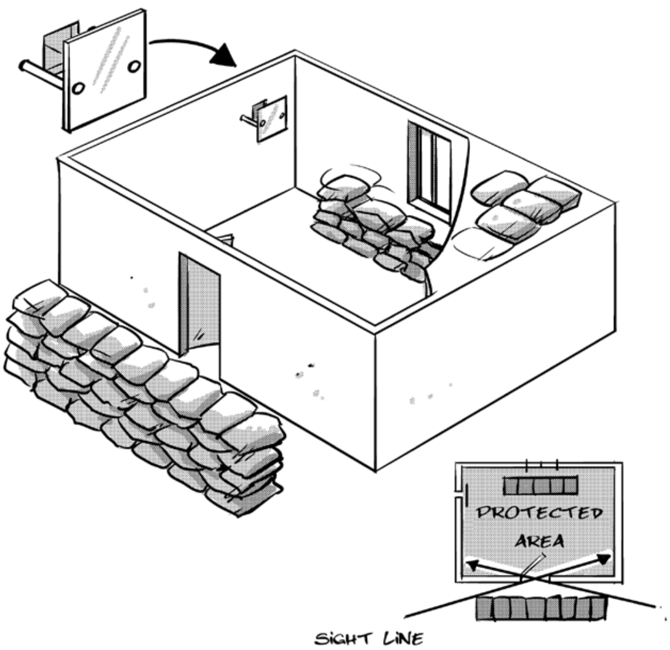


Another advantage of multi-layered protection is that it increases the opportunity to induce stress in the projectile, therefore reducing its penetration capacity. The greater the difference in density between layers, the greater the induced stress.

8.6 Openings

Any opening in the envelope of a safe area such as windows, doors and ventilation grills may compromise the ballistic resistance of the safe area. Each opening should therefore be assessed and any vulnerability addressed appropriately. A protective system is only as strong as its weakest point, and measures should be taken to make such openings more secure in order to protect against stray bullets. The following measures may be appropriate:

- Windows can be covered with steel shutters or even blocked with sandbags.
- Doors can be reinforced with steel plates or an entrance chicane.
- Ventilation inlets and outlets can be protected with steel plates.



9. SHELTER FACILITY

A shelter facility is a safety preparedness measure that is necessary when sustained military operations are likely to occur. Everyone meant to use shelter facilities should know where they are, and care should be taken not to raise perception-related issues.

9.1 Risk event

A shelter facility is a place of refuge that provides protection from direct hits from small arms fire and indirect hits from heavy weapons, such as mortars, artillery and rocket-propelled grenades.

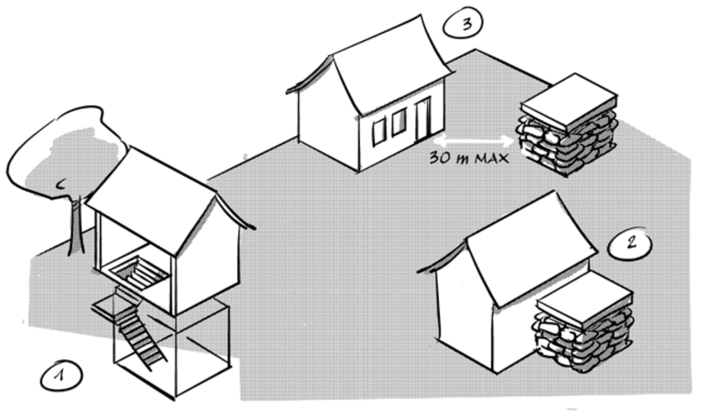
It also provides some protection from a single direct hit from heavy weapons in the event of indiscriminate shelling in the vicinity.

A shelter facility does not provide protection from sustained attacks or from violent intruders who wish to harm or kill staff.

9.2 Identification of shelter facilities

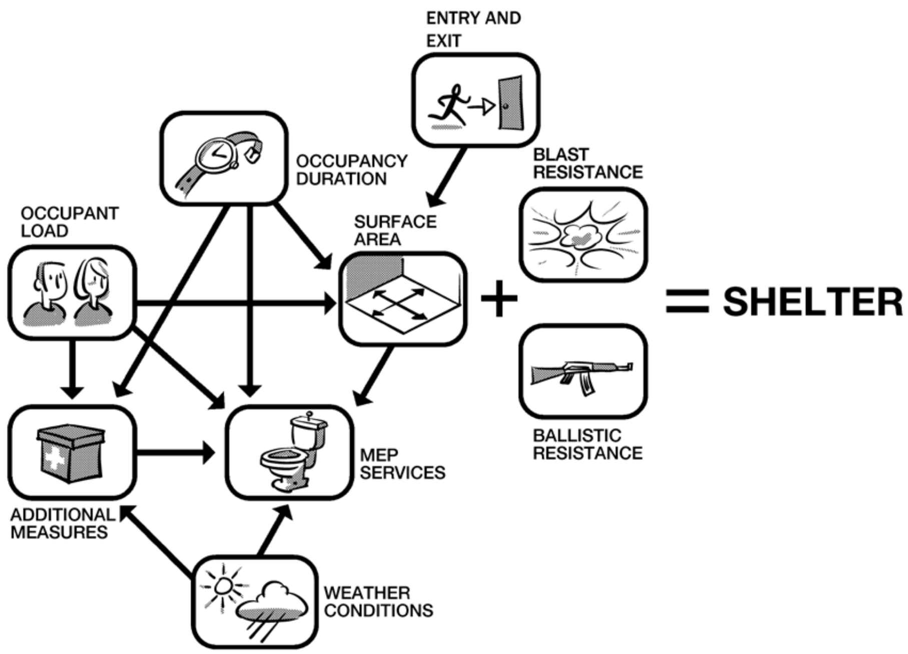
A shelter facility must be readily accessible, and staff should not have to cross exposed areas to reach safety. If routes to shelter facilities are overly exposed, they may require additional protection in the form of blast walls. The following concerns should be taken into account when establishing a shelter facility:

- Wherever practicable, a shelter facility should be established inside an existing building at the delegation, either inside a secure basement or a hardened ground floor area. If a suitable area inside the premises cannot be found, then it will be necessary to build one as a stand-alone structure in the compound, preferably adjacent to existing buildings.
- In large delegations, where many people may need to be sheltered, it is advisable to build several smaller shelter facilities in order to reduce vulnerability. There should be sufficient shelters spaced around the compound at a maximum distance of 30 meters from where people work and live so that they can get inside quickly.



9.3 Architectural specifications

Establishing a shelter facility must be guided by the fact that it is meant to serve as a space where a number of people will seek protection – possibly for an extended period of time – from direct hits from small arms fire and indirect hits from heavy weapons, such as mortars, artillery and rocket-propelled grenades.

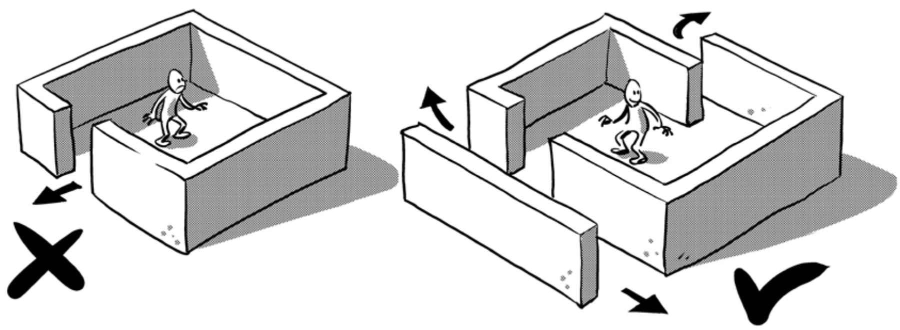


Occupant load: The occupant load of a shelter facility depends on the requirements set out by the security contingency plan. It could potentially be only for essential staff. This is based on the assumption that if the security situation had deteriorated to the point where a shelter facility is needed, non-essential staff would have already been evacuated. However, there are also situations where this would clearly not be the case. The occupant load for any shelter facility should be determined by the risk assessment. The total number of people who may use a shelter facility must be accurately estimated and regularly revised as necessary.

Occupancy duration: A shelter facility should not be occupied for more than 12 hours.

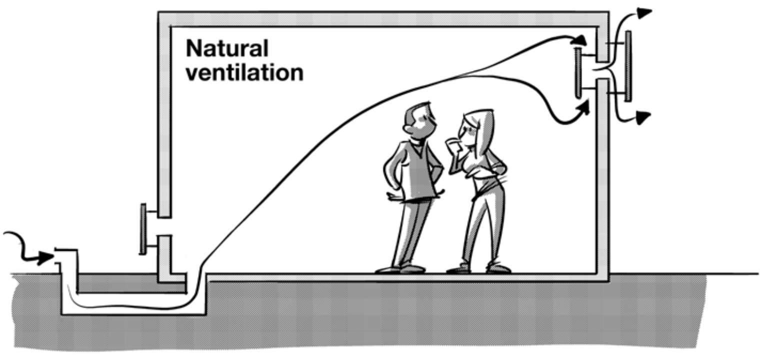
Surface area: A minimum net floor area of 1.2 m^2 per person should be allocated. If people may need to seek shelter for prolonged or overnight periods, 1.8 m^2 per person should be provided. A shelter should be as small as possible and only as large as necessary, since the larger it is the more vulnerable it becomes.

Entry/exit points: Shelters should have two entry/exit points in case one becomes blocked. These points should be offset and protected by blast walls so that they do not represent a weak point.



Mechanical electrical and plumbing (MEP) services: As a general consideration, stand-alone services should have priority. In other words, it should be possible to operate services and communication equipment independently of the normal grids or systems. A site may choose to use existing installations, build ad-hoc installations

- Drinking water: Two litres per occupant must be provided.
- Toilets: A small space in the room giving occupants some privacy should be set up; this can be done very simply with a curtain and a bucket. It is comforting and will discourage people from leaving the room in case of a personal emergency.
- Temperature: One blanket per occupant should be provided in cold climates in case the heating system fails or does not exist. In hot climates, the thermal inertia of the walls and ceiling of the safe area should be sufficient to maintain a reasonable temperature inside. If not, a cooling system may be considered, particularly in hot and humid climates.
- Ventilation: Shelters, as enclosed spaces occupied by a certain number of people, must provide for natural ventilation. In some cases, this is possible through the infiltration of outdoor air. If not, considering a buoyancy-driven ventilation airflow of two-thirds of the volume of the room per hour, the net cross-sectional area of the air inlet(s) and outlet(s) should be around:
  - 1/1000 of the net floor area (NFA) in cold climates (t°<20°C)
  - 1/500 of the net floor area (NFA) in hot climates (t°>20°C)
- Care should be taken when designing ventilation systems for shelters, because air inlets and outlets may represent a weak point through which a blast wave could enter the shelter. Ideally, the ventilation



system should be concealed in such a way that air inlets and outlets are difficult to identify and access.

Additional preparedness measures: Although shelters are meant for occasional and temporary protection, additional supplies for emergency situations and back-up purposes may be necessary. These could include communication equipment, batteries, a dedicated generator, picks and shovels, buckets, torches, a first-aid kit, fire extinguishers, playing cards, air blowers, fans, and ICRC flags and dossards.

9.4 Engineering specifications

A shelter facility should provide all-round protection from simultaneous blast and ballistic threats. This can be achieved with a thick earthen envelope or reinforced concrete walls and roof, relying on the mass of such a barrier to contain the energy of an explosion.

In order to provide suitable protection against blast and shrapnel, the construction of a shelter facility often requires specialist construction materials and techniques. One of the easiest and quickest ways to erect a stand-alone shelter is to use sandbag walls or Hesco blast walls (as developed in Chapter 6, Construction Practices). They are capable of withstanding explosions thanks to their mass. If they fail, there is a limited risk of collapse and secondary fragmentation.

Overhead protection may be achieved either through a thick and robust single protective layer or through a thin roof fitted with a pre-detonation screen.

- Single protective layers are heavy and transfer the shock pulse of an explosion directly into their supports. The thicker the layer the more it absorbs this pulse, which is then less likely to breach the supporting layer containing the soil.

- Roofing fitted with a pre-detonation screen,[1] as shown below, is effective because it increases the standoff distance between the projectile's detonation point and the shelter's walls or roof. This idea is to build a lightweight screen at least 50 cm above the shelter's roofing. Such screens are commercially available, or can be built from a lightweight frame and heavy gauge mesh (>3 mm), corrugated iron or plywood sheets (18 mm). It is important to ensure the pre-detonation panels cannot be lifted up by the wind.

Pre-detonation screen (example from HAB2 Hesco kit) Hesco.com / HESCO

The table below summarizes the required thickness of the infill materials to ensure the shelter's structural integrity and provide protection against one (and only one) in-contact detonation and near-miss explosions of some selected weapons that could breach the wall.

Identified threat	Wall with good infill	Wall with poor infill	Single layer roof	Roof with pre-detonation screen	Roof combination
Small arms	60 cm	60cm	30 cm	30 cm	/
Grenades	60 cm	60 cm	50 cm	30 cm	/
RPG7	120 cm	150 cm	90 cm	45 cm	/
Mortars (<120mm)	100 cm	100 cm	60 cm	45 cm	10 cm sand on 10 mm steel plate
Artillery (<155mm)	200 cm	200 cm	100 cm	45 cm	60 cm sand on 10 mm steel plate

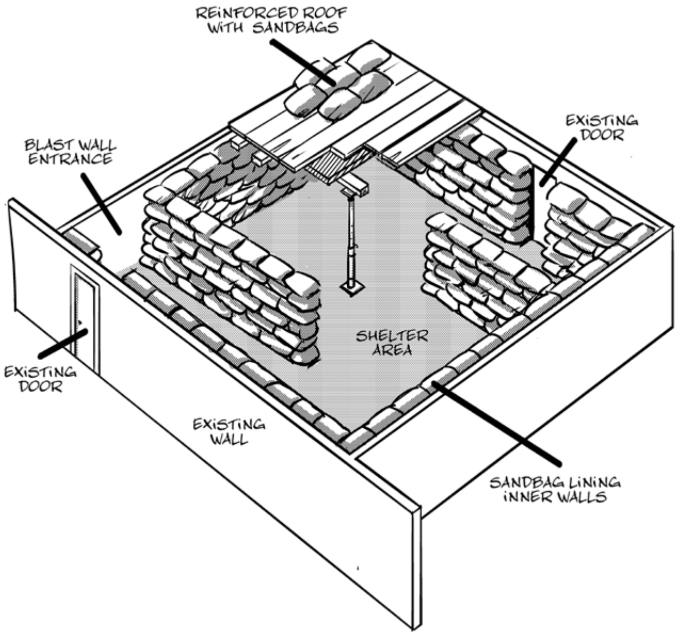
Some materials should not be used to build or protect the shelter. In addition to not providing the required protection, they will actually reduce the level of protection by becoming secondary projectiles.

1 On weapons equipped with point detonation impact fuzes, proximity (Doppler radar) fuzes and shaped charge designs (high explosive anti-tank), i. e. the vast majority of weapons, a pre-detonation screen will mitigate the designed lethality and effect on the target. On kinetic weapons and on those with a delay fuze design, a screen will have only a limited or no impact.

Material	Reason for inadequacy
Masonry	Bricks and CMU blocks are considered brittle materials that may generate highly hazardous flying debris in the event of an explosion. Therefore, any room that is turned into a shelter facility should have its masonry walls layered with earth-filled barriers or sandbags outside or steel plates inside.
Steel	Although steel plates provide ballistic protection as described in the safe area specifications, this material does not provide any protection from explosions.
Wood	Wooden planks and even small tree trunks can be invaluable in building a shelter. They may be used to strengthen blast walls, support a shelter roof or create a pre-detonation screen. However, they provide no direct protection from blasts, and may generate hazardous flying debris.
Glass	Glass provides no protection at all from ballistic and blast threats, even when fitted with a 3M film, which does no more than mitigate the risk. Shelter facilities should therefore have no windows.

9.5 Enhancing existing structures

A shelter facility located inside an existing building offers a number of advantages. It minimizes perception issues and negates the need for staff to cross exposed areas outside in order to reach the shelter facility. This type of shelter facility also benefits from a pre-detonation screen and a standoff distance thanks to the walls and slabs of the building in which the shelter is located.



Even if a building becomes severely damaged to the point of collapsing, the shelter inside must remain intact. In other words, the structure of a shelter must be able to withstand the additional load caused by the building's collapse.

The envelope of the shelter area, whether located on the ground floor or in the basement of an existing building, must be assessed by a civil engineer to determine what reinforcement and adaptations are required:

- The shelter's envelope should be layered with sandbags or earth-filled barriers in order to meet the required level of protection.
- The roof slab may require structural reinforcement, depending on the load of material layered on top of it.

- Falsework can add structural reinforcement. This type of reinforcement should provide structural redundancy, increase the load capacity of the overhead slab and bolster the structure in case the building above collapses.
- The overhead slab should be evaluated to determine if a protective plate is needed as a spall liner to prevent brittle material inside the shelter from fragmenting.

9.6 Shelter kits

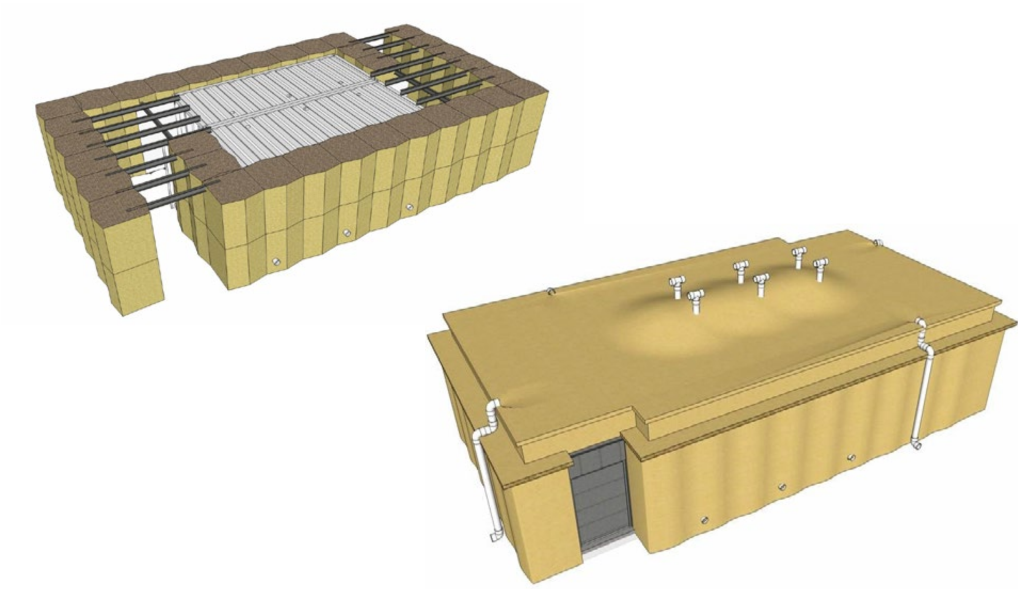
Commercial solutions for shelters can be used as long as they have been tested for blast and ballistic protection. HESCO® supplies complete kits (see below). These kits, including the roof, are specifically designed to provide all-round blast and fragment protection from direct and indirect fire weapons. For further details, refer to the attachments and check for updates on the company's website: http://www.hesco.com/.

Shelter kit	Protection afforded	Fill qty	Shipping weight	Cost (CHF)	Illustration
Hesco 20 ft bunker kit 10 people	155 mm artillery shell from airburst to direct contact	154 m^3	N/A	11,000	
Hesco 40 ft bunker kit 20 people	155 mm artillery shell from airburst to direct contact	221 m^3	N/A	19,000	
Hesco HAB1 32 people	Up to 120 mm mortars from airburst to direct contact	80 m^3	4,730 kg	28,000	
Hesco HAB2 35 people	Up to 120 mm mortars from airburst to direct contact	145 m^3	5,480 kg	44,000	
Hesco LWBR (roof only)	Up to 120 mm mortars from airburst to direct contact	10 m^3	1,750 kg	11,000	

In the Kandahar sub-delegation, for example, shelter facilities were built inside 20 ft containers and reinforced with HESCO® concertina units. Walls were constructed using reinforced HESCO MIL1 modules, which provided a wall with a thickness of 1.06 m. MIL5 modules were used for the roof, providing 0.61 m of overhead cover. The walls were offset 20 cm from the container for deflection purposes in case of an explosion close by. This concept was inspired by the 20 ft bunker kit from HESCO® described above. This type of shelter facility was intended to provide protection from heavy weapons, such as mortars (up to 120 mm).

Although shipping containers are not necessary when constructing bunkers, they do provide enhanced protection because they act as a spall liner. If properly ventilated, the container protects the occupants highly effectively.

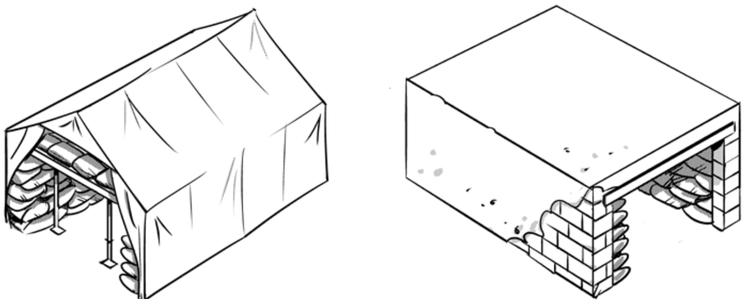
Because shipping containers are not designed to support heavy loads, some sort of internal structural reinforcement may be necessary, using stringers to transfer the loads.



Shelter in shipping containers protected by HESCO® earth-filled barrier units Hesco.com / HESCO

9.7 Camouflage

Shelters constructed as stand-alone units or adjacent to an existing delegation building may require some sort of camouflage or concealment measures. This will make them less apparent and reduce perception-related concerns. This can be done by applying locally sourced plaster on the envelope of the shelter or by erecting a Rubb-Hall tent over it.



10. BLAST MITIGATION MEASURES

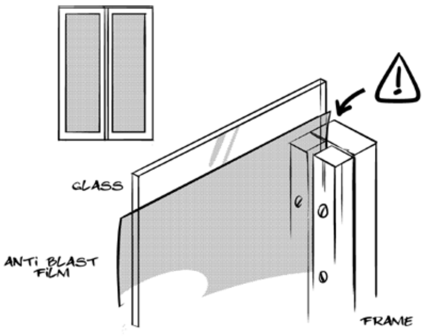
10.1 Risk event

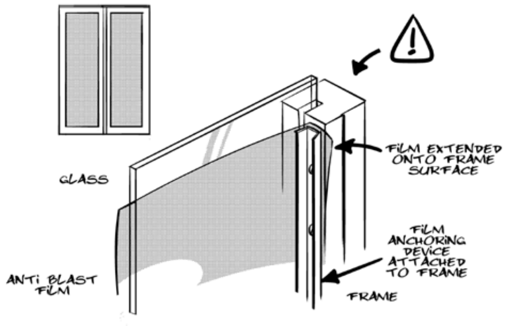
Blast mitigation measures offer protection from blast and fragmentation hazards of heavy conventional weapons such as grenades, RPGs, mortars, artillery, rockets and bombs. This also includes protection against small arms fire.

Blast mitigation measures are intended to protect people and critical infrastructure when sustained military operations are likely to occur. In this context, passive security measures must offer a compromise between physical security and visual perception.

10.2 Anti-blast glass films

The application of an anti-blast polyester film on the inside of windows and glass panels in all residences and offices is part of a delegation's safety preparedness. It is a compulsory measure for each ICRC site and applies even if glass panels are laminated. The aim is to protect people from flying shards of glass caused by a blast or earthquake.





Glass fragments may actually cause more injury to people than the explosion itself. Thick curtains will block glass fragments resulting from an explosion and the consequent blast effect, but the curtains would have to be closed to be effective. Plastic adhesive film designed to hold broken glass together represents a constant and convenient way to minimize bodily injury.

The ICRC uses a film made by 3M called ULTRA S600 (thickness: 150 microns). It does not compromise visibility because it is completely transparent. It must cover the frame section or be anchored to the frame to prevent the glass panel from being blown into the room by a blast wave.

If anti-blast film is not easily available, or if this type of film cannot be used, the following alternatives are possible in emergency situations:

- The glass panels can be completely covered with adhesive tape (e.g. ICRC or standard grey packing tape).
- Heavy and long net curtains can be installed, and they must be left closed to catch glass shards.
- The inside of the window can be covered with mosquito netting.
- 3 mm metal plates or thick wooden shutters can be used (although this is not thick enough to protect against ballistic projectiles).
- The inside of the window can be covered with thick wooden planks, sandbags or piled up bricks.

If a glass panel or window frame is likely to be blown into the room, a series of catch bars or cables firmly anchored in the wall can block them. However, these measures may prevent the windows from being opened for ventilation or escape purposes.

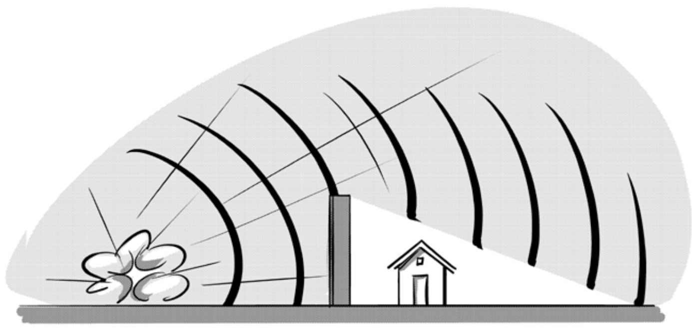
10.3 Blast and fragmentation walls

Any robust wall will reduce the effects of blast and fragmentation up to a point. Blast walls are specifically designed to absorb and deflect the pressure, impulse and fragmentation caused by a close-in explosion. Fragmentation walls are designed to serve as a shield against fragments without causing secondary fragmentation hazards. Blast and fragmentation walls are also effective in enhancing protection against small arms fire, although the penetration capacity of small arms projectiles is considerably greater than that of fragments.

When used as part of a comprehensive passive security safety preparedness program, blast walls have a number of uses. These include:

- reinforcing the protective envelope and entrances to safe areas, shelter facilities and strong rooms;
- providing protected routes to shelter facilities, thus limiting the risk exposure to staff;
- providing enhanced protection to exposed facades of premises by shielding windows and doors leading to the outside (as shown in the illustration below);
- protecting essential or critical equipment (communication facilities, vehicles, water reservoirs and generators);
- compartmentalizing and protecting dangerous items (fuel or flammable gas storage facilities);
- breaking up large open spaces, such as car parks and warehouse facilities, so as to limit the damage caused by blast and shrapnel; and
- providing standoff and protection from areas with an identified blast risk, such as grenade or bomb attacks at the entrance to a large compound.

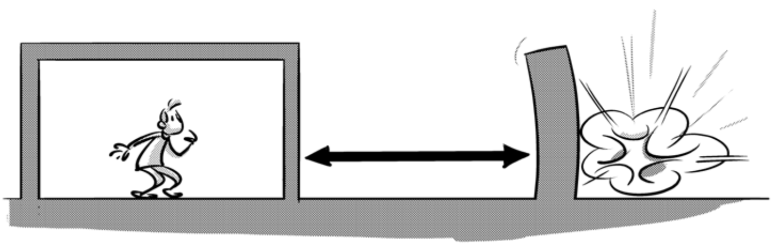
Blast walls reflect much of the pressure, creating a shadow of reduced pressure on their shielded side for a distance of up to three to six times their height. An effective blast wall will therefore be close to, higher and wider than the asset that it is meant to protect (see the illustration).



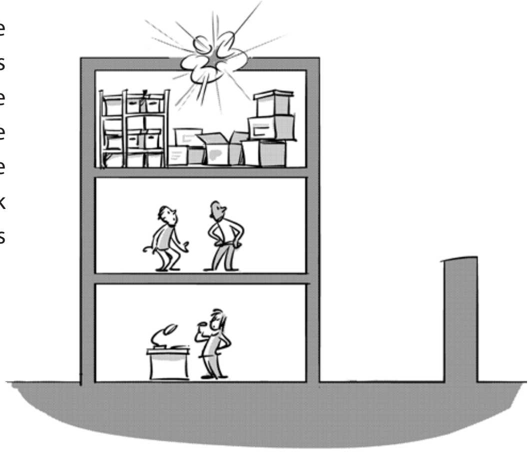
10.4 Maximize standoff

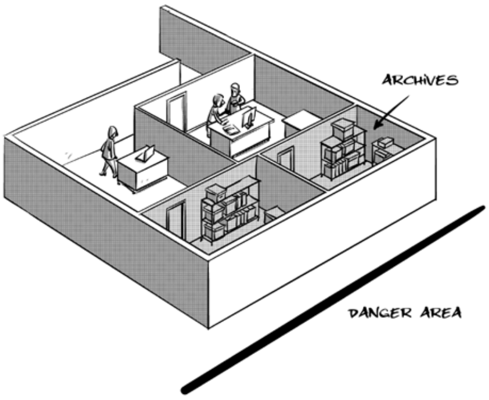
The best way to mitigate the effects of any explosion is to keep it as far away from any vulnerable assets as possible. This distance, called the standoff distance, includes three important components.

Horizontal standoff: This is created by using active or passive measures to keep the weapon away from the target. A perimeter wall or airlock system may keep an explosive threat away; a screen may detonate a mortar round far away from its intended target.



Vertical standoff: In multi-storey structures, the top floor may be used as a sacrificial layer. It is accepted that bombs or mortars may strike the roof of the structure and detonate. However, the lethal effects of the blast and fragments will be confined to this unoccupied top floor. Some work may be required to ensure that the weapon's effects remain limited to that single storey.





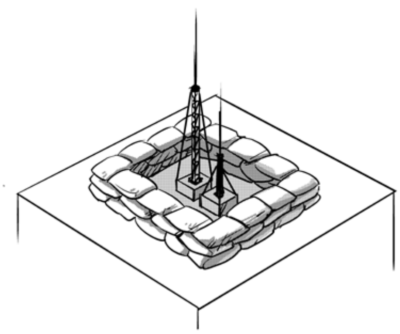
Sacrificial rooms: Storage, archives and other low occupancy rooms may be considered appropriate shields and a way of enhancing the standoff distance if they are located along the most exposed facades of a building. High occupancy rooms can therefore be located in more sheltered areas within the premises.

10.5 Dispersion and compartmentalization

The techniques of dispersion and compartmentalization seek to minimize secondary hazards by reducing the number of assets that may be damaged or destroyed in an attack, particularly from indirect fire. These two measures may be used separately, but they are often combined.

Dispersion: Increasing the distance between assets is a simple technique that aims to reduce risk by increasing standoff. However, the greater the dispersion among assets, the greater the area requiring security.

Compartmentalization: Discrete compartments may be formed around groups of assets using protective structures, usually blast or fragmentation walls. Their purpose is to ensure that the damaging effects of an attack are contained within the compartment attacked. This technique inherently accepts the loss of assets within the compartment.



10.6 Essential equipment protection

Sandbags may prove to be useful in constructing small blast walls to protect critical equipment such as emergency generators and communications equipment (including antenna assemblies). They may also be used to protect hazardous materials such as fuel and gas. Sandbags can easily be concealed by installing a low wooden skirt or a similar type of cover, in order to reduce perception issues.

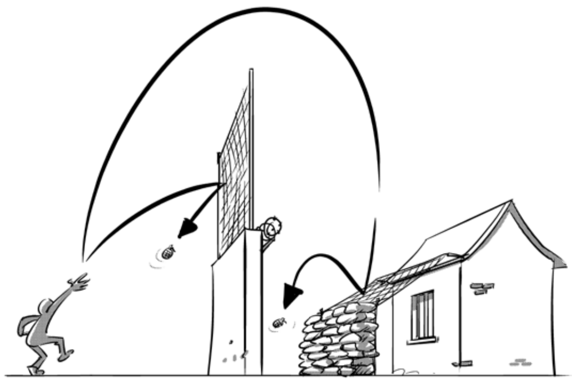
10.7 Blast wall specifications

Blast and fragmentation walls must be positioned either close to the detonation point of an explosion or next to the asset to be protected to be effective. This is because blast waves are similar to sound waves in terms of propagation, and because flying fragments follow a ballistic trajectory.

Please refer to the table in Chapter 9 (Shelter Facility) for information on the required thickness of a blast wall (filled with sand or soil) to provide effective protection from blast, penetration and fragmentation hazards. A wall thickness of 1 m should be sufficient in most situations.

10.8 Anti-lob fence

Hand-thrown weapons can be stopped by a high screen or deflected away from the exposed façade of premises as shown below. This creates a standoff distance between buildings with occupants and the seat of an explosion.



10.9 Minimize secondary hazards

Inherently hazardous items should be kept away from exposed or vulnerable areas to minimize secondary hazards and indirect explosions and weapons fire:

- Flammable or explosive storage facilities such as fuel tanks should be located away from buildings where people work and live. They may also be located inside a dedicated shelter.
- Gas bottles must be kept away from exposed areas or protected from bullets and fragments with blast walls.
- Heavy overhead architectural features should be avoided or removed.
- Loose gravel surfaces should be avoided in non-secured areas as they may generate secondary fragments.

11. VIOLENT INTRUSION MITIGATION MEASURES

Violent intrusion mitigation measures are safety preparedness measures intended to provide staff with the time they need to escape or seek refuge when threatened by violent intruders.

Violent intrusion is, by definition, intentional, and the ICRC would be a deliberate target in such a situation. It is important to note that violent intrusion mitigation measures are not among the passive security mechanisms recommended by OP_DIR_SCMS. Before considering such measures, other passive security measures, such as staff evacuation or relocation, should be fully investigated.

11.1 Risk event

Violent intrusion mitigation measures provide protection against intruders who wish to harm, kill or abduct staff. These measures may apply, for example, when an ICRC site is threatened by rioting crowds or exposed to the risk of complex attacks including small arms and/or improvised explosive devices.

11.2 Access control

Robust access control is an essential aspect of any security system. All non-ICRC people are kept outside or in a designated waiting area until access is approved. A log should be kept to record and monitor all such movements. Access control applies to vehicles as well. Non-ICRC vehicles should always be parked outside ICRC premises or in a designated non-secure parking area separate from the rest of the compound.

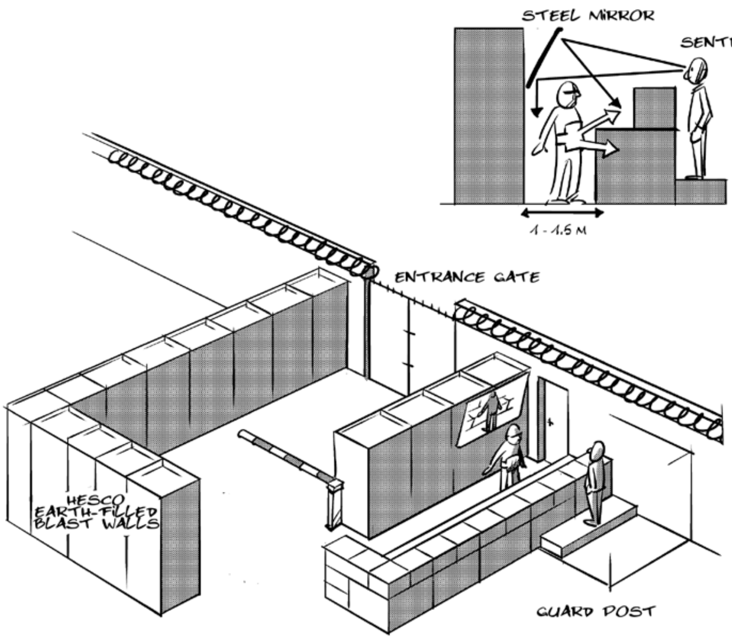
A comprehensive access control plan should include a variety of passive security measures, such as:
- a secure or hardened guard post from which guards can easily and safely identify all persons approaching an entrance;
- bollards or barriers to slow and channel vehicles or pedestrians approaching an entrance;
- bollards, barriers, or tyre spikes, to prevent a vehicle from ramming a gate or entrance;
- secure search or parking facilities, which may include blast walls to isolate non-secure areas from secure areas; and
- secure zones within a compound, separating staff from visitors and preventing open access to large compounds.

Guards and guard posts: By virtue of their role in perimeter security, guards are inherently vulnerable during the initial stages of any direct attack. Passive security measures for guards, which are mean to protect them while on duty, include:
- secure guard posts that protect the guards without obstructing their lines of sight;
- lighting that allows guards to quickly identify approaching people;
- blast walls or bollards that create standoff from explosive devices in the event of an attack; and
- blast walls and cover providing guards with a protected means of escape in the event of a direct attack.

A system that enables a guard to observe beyond the perimeter whilst remaining safe must also be devised. Ideally, such a system would allow a guard to detect and identify approaching vehicles and people without allowing the approaching vehicles and people to either observe or attack the guard. Options for such a system include:

- CCTV cameras with monitors inside the guardhouse;
- a viewing portal with a grill to prevent weapon muzzles or grenades being forced through and a steel shutter to secure the portal when not in use; and
- a mirror mounted over an entranceway, angled to allow the guard to observe outside the door or gate.

Airlock system: In high risk environments, where a direct attack using a vehicle is an identified risk, a vehicle airlock system may be required in order to maintain an appropriate standoff distance between a potential explosion and the premises. An airlock system allows only one vehicle to enter a secure identification and search bay at a time.



11.3 Compound access

Entrances are often a weak point in any perimeter. Subsequently, and wherever practicable, they should be reinforced so as to meet a similar protection standard as walls and fences. Entrances should also be kept to a minimum, consistent with operational and emergency requirements.

Entrance gates: Vehicle access and pedestrian access should ideally be kept separate. Any unmanned gates or doors should be securely locked and/or bolted and inspected regularly. An entrance gate should be:

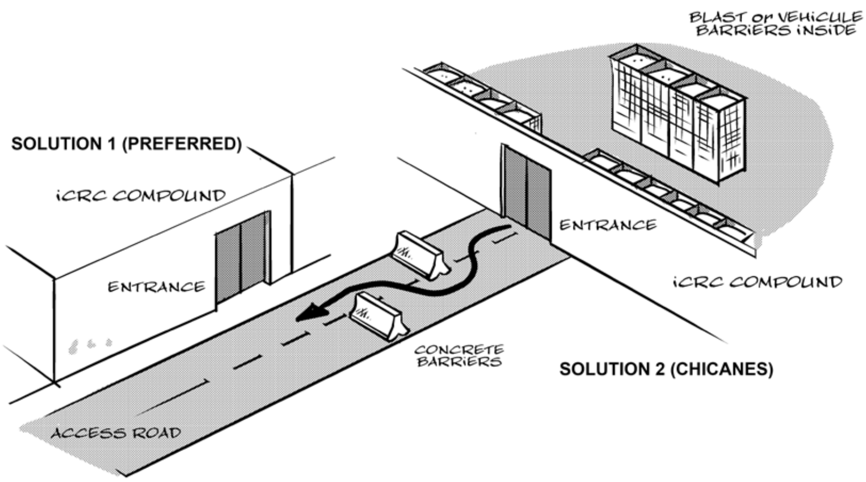
- completely flush with the wall, or, where this is not possible, metal spikes on the upper edge can prevent an intruder from scaling the gate;
- made of reinforced steel and have a strong frame, hinges and locks to prevent easy removal or battering;
- equipped with a way of seeing people approaching the entrance, such as CCTV, a peep hole covered by a metal plate or a large overhead mirror; and
- equipped with several horizontal and vertical locking bolts to effectively secure the gate.

Vehicle approach: given the size and the potential speed and momentum of a vehicle, passive security measures for vehicle access points require special consideration:

- Wherever practicable, the entrance to an ICRC compound should be sited parallel rather than perpendicular to an access road. This reduces the run-up distance to the entrance, limiting the speed at which an attacking vehicle can approach it.
- A chicane made of bollards or barriers to slow and channel vehicles approaching an entrance could be built. Such barriers are particularly useful if there is a long run-up distance to the entrance. These barriers can be formed of commercial concrete barriers, concrete-filled steel barrels or drums, locally made concrete barriers, HESCO®-style earth-filled barriers or other improvised materials of appropriate

strength and mass. A two-meter thick blast wall will quickly stop a medium-sized truck travelling at a speed of 50km/h.

- Blast or vehicle barriers could be built inside an access gate, using commercial concrete barriers, concrete-filled steel barrels or drums, locally made concrete barriers, HESCO®-style earth-filled barriers, or other improvised materials of appropriate strength and mass. Such barriers serve the dual purpose of halting any vehicle that rams an access gate and containing or deflecting a blast detonated at an access point. Placing these barriers inside a gate also reduces the external visibility of passive security measures.

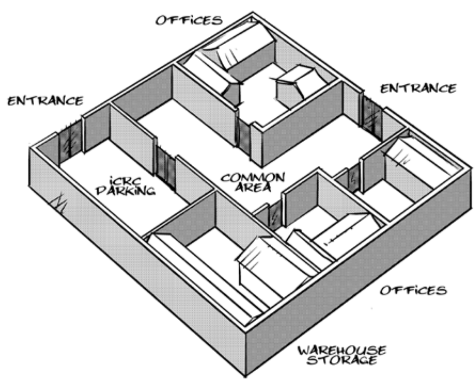


11.4 Delaying an attack

Any measures that delay an attack will give people more time to seek safety or, in the event of violent intrusion with the intent to harm, to escape.

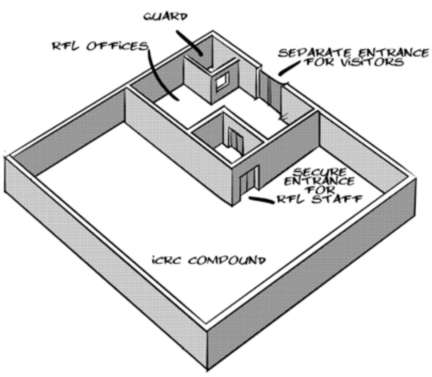
Labyrinth system:

In particularly large compounds or where there are a number of adjoining compounds, a labyrinth system can be created by separating the compound into smaller ones with walls, fences and doors that channel internal access. An intruder who manages to breach the perimeter will still face restricted movement within the compound. This increases the likelihood of detecting the intruder and gives staff time to seek safety if required.



Isolated areas:

When large numbers of non-ICRC visitors are present in specific areas, it may be possible to isolate or quarantine them. For example, a separate entrance point can be set up for people seeking information from the Restoring Family Links (RFL) office. The RFL staff can also have their own secure access between the secure area and the non-secure area.



11.5 Escape routes

Escape routes should be set up to allow staff to leave the compound and reach neighbouring properties. These include emergency exits, which staff can open from the inside but which are locked from the outside.

11.6 Electronic security devices

Electronic security devices can provide additional alert capabilities and enhance site surveillance when applied appropriately within a clearly defined security concept. But they are only effective if they are correctly installed and operated. A specialist should therefore be called on to design, install and maintain electronic surveillance and alarm systems and to train staff in operating them.

Alarm systems can be used to detect any forced, unauthorized or attempted entry into a building or onto a site. They can be triggered either manually (panic button) or automatically (magnetic-contact or volumetric devices).

Video surveillance systems such as CCTV may be used for monitoring purposes. They can considerably enhance security by the early detection of suspicious circumstances on or around an ICRC site.

Please refer to the SCM Library "Protecting buildings against intrusion" page on the intranet for detailed and updated guidance on this matter:

- *https://intranet.ext.icrc.org/scm_library/risk-assesment-treatment/criminality/prot-intrusion/index.html*

12. STRONG ROOM

A strong room is a safety preparedness measure in the event of violent intrusion with the intent to kidnap or harm staff.

It is important to note that strong rooms are not among the passive security mechanisms recommended by OP_DIR_SCMS. Before contemplating such measures, other passive security measures, such as staff evacuation or relocation, should be fully investigated.

12.1 Risk event

A strong room is a refuge that protects staff from intruders who wish to kidnap or harm them. The function of a strong room is to prevent intruders from gaining direct access to staff. The objective of a strong room is to delay intruders long enough for local law enforcement or military agencies to intervene.

The design of a strong room may include the protective features of safe areas and shelter facilities.

12.2 Identification

A strong room should be readily accessible, and staff should not have to cross exposed areas to reach it. Routes to strong rooms may therefore require additional protection and screens if they are overly exposed.

As mentioned above, the objective of a strong room is to prevent direct access to the staff by intruders. One of the most effective ways of achieving this is if the intruders cannot find the staff. This is the thinking behind hidden rooms, which will be discussed in more detail below. Hence, the location of strong rooms should not be widely publicized, and the presence of strong rooms should not be easily identifiable by visitors to ICRC premises.

In larger premises, the ICRC's preferred strategy is to use several small strong rooms spread over a number of locations throughout the compound. This makes it easy for staff to rapidly access a strong room.

12.3 Risk assessment

In order to provide adequate protection against an attack, strong rooms need to be designed with some key aspects of the threat posed against it in mind:

- **The intruders' intentions:** Did the intruders enter the premises simply to steal materials (valuables, vehicles, etc.), and it is simply necessary to avoid direct contact with them while they carry this out? Or did the intruders enter the premises specifically to kidnap or harm ICRC staff? In this latter case, how determined are the intruders?
- **The tools available to the intruders:** Did the intruders come equipped with specific tools, or will they just use what they find? If they brought their own tools, how sophisticated are they? For house robberies, for example, intruders may want to remain undetected and will only use simple, quiet tools such as bolt cutters. If it is an open invasion of a compound, the intruders may not hesitate to use noisy equipment such as hammers and pickaxes. To what extent are weapons controlled in the country? If there is minimal control, or the country is in conflict, it will be relatively easy for intruders to have access to weapons and simple explosives. The tools that they will use is also closely linked to their intentions. The more determined, targeted and planned the attack, the higher the likelihood that more sophisticated tools will be used.
- **Duration of the intrusion:** The strong room needs to protect staff long enough for law enforcement or military agencies to intervene or for the intruders to leave the premises. Assistance can be expected

within a few minutes in some locations, while in others the response may take up to 30 minutes. In certain – particularly conflict – situations, there may be no possibility of outside assistance. The strong room may need to protect staff long enough for the intruders to get bored and give up. In this last situation, it is clear that the length of the intrusion will be linked to the intruders' intentions.

Before a strong room can be designed, an in-depth risk assessment must therefore be undertaken. At the very least, it must specifically examine the three key issues cited above.

In these guidelines, we consider three levels of threat (low, medium and high) and provide corresponding advice on designing strong rooms. However, as already stated, the design of a strong room depends on the specific threat that it is supposed to protect against. The design must therefore be based on the results of an exhaustive risk assessment.

12.4 Limitation

As discussed in the previous section, an ICRC strong room may be required to protect against a wide range of threats. This means that there is also a wide range of designs, depending on each individual situation. It is therefore impossible for these guidelines to provide one specific strong-room design applicable in all situations. Instead, they offer some general advice and recommendations, and they set certain thresholds beyond which specialist advice must be sought.

The most severe threat levels potentially include the intentional use of explosives by individuals determined to target ICRC staff. These threat levels go beyond the competence of the ICRC (WatHab, WEC and SCMS), either in the field or at HQ.

It is worth reiterating the point made in the previous section: before a strong room can be designed, an in-depth risk assessment must be conducted. The construction of a strong room must not be approved without a risk assessment.

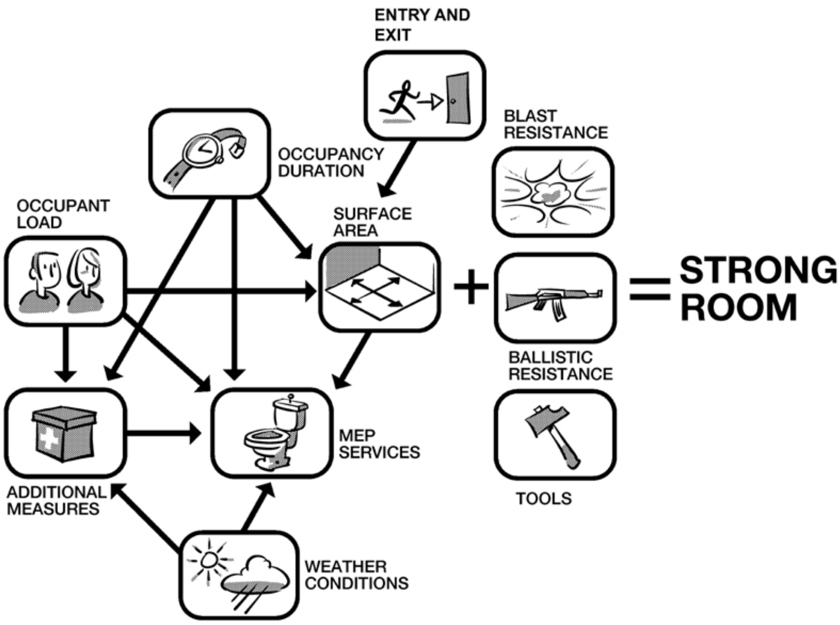
12.5 Architectural specifications

In broad terms, the figure below illustrates the design parameters that should be considered when preparing a strong room and how they influence each other.

Occupant load: The occupant load of a strong room depends on the requirements set out by the security contingency plan. It could potentially be only for essential staff. This is based on the assumption that if the security situation had deteriorated to the point where a strong room is needed, non-essential staff would have already been evacuated. However, there are also situations where this would clearly not be the case. The occupant load for any safe area should be determined by the risk assessment. The total number of people who may use a strong room must be accurately estimated and regularly revised as necessary.

Occupancy duration: The occupancy duration of a strong room should be defined in accordance with the risk assessment, since it is linked to the rescuers' response time.

Surface area: A minimum net floor area of 1.2 m^2 per person should be allocated. If possible, 1.8 m^2 per person should be provided. A strong room should be as small as possible and only as large as necessary, since the larger it is the more vulnerable it becomes.



Entry/exit points: Strong rooms should have only one entry/exit point, as this represents a potential weak point. More than one entry/exit point could be considered, however, in situations where this could add value (such as providing an alternative escape route).

Mechanical electrical and plumbing (MEP) services: As a general consideration, stand-alone services should have priority. In other words, it should be possible to operate services and communication equipment independently of the normal grids or systems. A site may choose to use existing installations, build ad-hoc installations or consider additional measures when few or no MEP services are provided in the strong room. Either way, the following minimum requirements apply:

- Drinking water: Two litres per occupant must be provided.
- Toilets: A small space in the room giving occupants some privacy should be set up; this can be done very simply with a curtain and a bucket.
- Temperature: One blanket per occupant should be provided in cold climates. In hot climates, the thermal inertia of the walls and ceiling of the strong room should be sufficient to maintain a reasonable temperature inside. The presence of an air conditioner could reveal the existence of the strong room. An air conditioner and its ducts also represent a potential weak point in the strong room.
- Ventilation: Particular care should be taken when designing ventilation systems for strong rooms. If not properly designed, ventilation vents could reveal the location of a strong room. They also represent a potential weak point. A badly designed ventilation vent can provide an easy route for a determined attacker to drop a grenade into the strong room. Ventilation systems should ideally be concealed and exit far away from the strong rooms. They should include bends and mesh screens as necessary to prevent objects being dropped into the strong room.

Additional preparedness measures: Although shelters are meant for occasional and temporary protection, additional supplies for emergency situations and back-up purposes may be necessary. These could include communication equipment, batteries, a dedicated generator, picks and shovels, buckets, torches, a first-aid kit, fire extinguishers, playing cards, air blowers and fans.

12.6 Hidden strong room

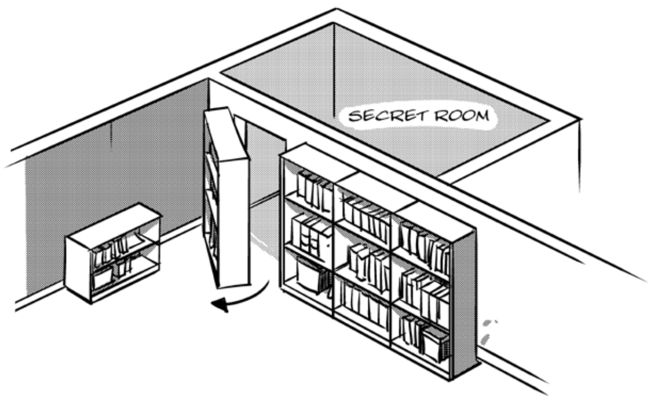
As mentioned earlier in these guidelines, one of the most effective protection mechanisms against intruders who wish to kidnap or harm staff is if the intruders cannot find anyone. This ties into both the escape strategy and the concept of strong rooms. If the intruders do not know where the staff are hiding, they will not know which room to attack and it will take them valuable time to identify the correct location. Under no circumstances should the presence and location of strong rooms be widely known outside of ICRC staff.

The ICRC's preferred strategy is thus for all strong rooms to be hidden or disguised as much as possible. Measures to conceal a strong room can range from simple to complex, as illustrated by some examples:

- The door to a strong room needs to be reinforced (as discussed in detail a bit later in this section). However, a strong-looking metal door gives the impression that there is something important behind it. The door to a strong room should look like any other door, which could be as simple as painting them all the same. A wood panel could also be fixed to a strong room door to make it look like an ordinary wooden door. It may seem like good idea to have a peep-hole in a strong room door (in order to see who is outside) but the presence of a peep-hole implies that there is someone on the other side of the door. If no other doors in the building have a peep-hole, this can quite quickly reveal the location of the strong room.
- The entrance to a strong room could also be concealed as something different – for example a set of shelves. Once the door is closed, it looks like a set of shelves rather than a door.
- A number of small strong rooms are easier to hide than one large one. Strong rooms intended to accommodate only a few people for a short period of time can be hidden very creatively, such as inside wardrobes.

As mentioned earlier, the presence of ventilation and air conditioners makes it more difficult to hide a strong room. Whilst creating a hidden room is a valuable approach, it is not prudent to rely solely on this strategy. The ICRC's preferred approach is to create rooms that are both strong and hidden.

It is recommended, wherever possible, to build strong rooms inside existing buildings, as this makes it easier to hide or disguise them.



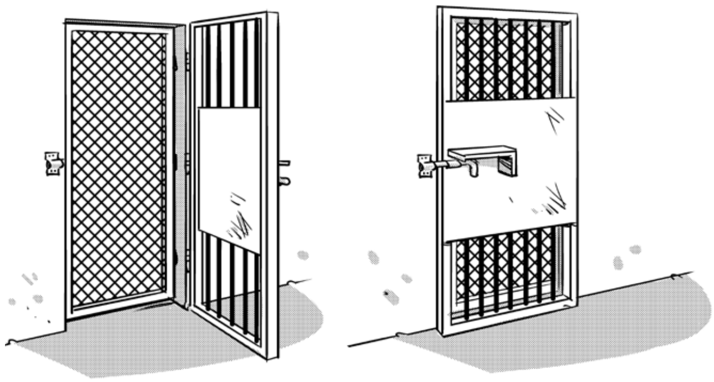
12.7 Low risk level

A low threat level could correspond to a situation in which intruders would like to target staff, but this may not be their main intention. The intruders are probably not equipped with sophisticated equipment, and/or external assistance can be expected to arrive quickly. A typical example is a robbery of a residence, a situation in which the intruders must not have easy access to staff. The intruders will be able to steal valuables (the intruders' primary objective) but will not be able to harm the residents. For a low threat level, common sense can guide the design of a strong room, bearing in mind the following guidance:

Tools: For low threat levels, the intruders are unlikely to have access to sophisticated equipment. In the case of a robbery, the intruders will want to remain undetected as long as possible and will thus tend to use equipment that does not make much noise. Bolt cutters and hacksaws may be used, but hammers are unlikely. The intruders are also very unlikely to use cutting torches, disc cutters or explosives.

Time: A very effective protective strategy is to reduce the time that intruders have before outside assistance arrives. The installation of panic buttons and rapid response guard units is widely used in Nairobi, for example. This approach greatly reduces the time that intruders have to gain entry into the strong room. For low threat levels, the strong room may only have to resist entry for a relatively short period of time, such as five to ten minutes. Either outside assistance will arrive quickly, or the intruders will rapidly become frustrated and concentrate on easier tasks, such as stealing valuables.

Secure entrance: A secure entrance is a vital component of any strong room. For low threat levels, the entrance must be strong enough to resist human force and simple tools such as bolt cutters. A steel door (either solid or grill) is probably the simplest option, but it should be installed in a good quality, strong door frame. A common approach in Nairobi is to install a steel door at the top of the stairs, effectively turning the first floor into a Strong room. If a grill door is used, care should be taken to ensure that the intruders cannot easily reach the lock with bolt cutters, as illustrated in the following image:



Walls: For common wall materials such as brick, cement block or concrete, no additional measures should be needed to protect against low level threats. The intruders will not want to make much noise and are unlikely to use sledge hammers or pickaxes. Plywood walls are not suitable, however, as they are very easy to penetrate.

Floor and ceiling: For low threat levels, it is considered unlikely that intruders would try to gain access to the strong room via the floor or ceiling. Most normal construction techniques would prevent easy access by either of these routes. However, if the strong room has a false ceiling, careful consideration should be given to how easy it would be to gain access to the ceiling space.

12.8 Medium risk level

A medium threat level corresponds to a situation where intruders intend to target staff and have access to a wide range of relatively unsophisticated equipment. A possible medium threat level scenario could be when an angry crowd spontaneously decides to attack an ICRC compound. More effort must be put into designing a strong room capable of responding to medium threat levels than low threat levels. As already mentioned numerous times, a thorough risk assessment should be the starting point for determining the characteristics of the strong room.

It is strongly advised that all levels within the WatHab team (engineer, coordinator and head of sector) be aware of the plans to establish a strong room and involved in its design.

Tools: For medium threat levels, one can expect a wide range of relatively unsophisticated tools to be used in the attempt to gain access to the strong room. In a medium threat level situation, it is unlikely that the intruders will be concerned about making noise. Depending on where the ICRC site is located, it may be prudent to assume that, in medium threat scenarios, intruders will have access to unlimited hand tools (e.g. bolt cutters, saws, pry bars, sledge hammers and pickaxes) and small arms (e.g. pistols, shotguns, rifles and automatic weapons). It is unlikely in medium threat scenarios that intruders will use cutting tools, heavy weapons (such as a heavy machine gun) or explosives.

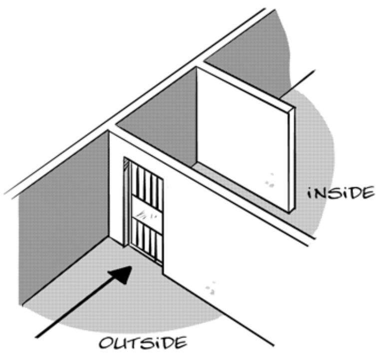
Time: The time that a strong room needs to withstand attack can vary significantly from one ICRC site to the next. The length of time before outside assistance arrives could well be a factor in determining whether a given situation corresponds to a medium or high threat level. The timeline will depend on the nature of the threat, however it is probably reasonable to assume that the strong room will need to resist a determined attack for at least 15 to 30 minutes.

Secure entrance: This is a key issue to be considered, as the entrance is potentially one of the weakest points of a strong room. Given the combination of tools that could be used by intruders, it is important to bear in mind that the door will need to resist both physical and ballistic attack.

Door construction: In a medium threat level situation, intruders are unlikely to be worried about making noise and will attack the entrance with all the tools at their disposal. The door itself will need to resist repeated and determined blows from a large sledge hammer and hence needs to be solid and reinforced to prevent buckling. The door also needs to resist being punctured, for example by pickaxes. Doors made from steel, or wood reinforced with steel, are the most appropriate solution. It is possible that the intruders will have access to small arms, and the door itself must be able to withstand these weapons. The ballistic resistance of relatively thin wood (such as a door) is low. In order to resist small arms fire of up to 7.62 mm (i.e. 7.62 mm x 51 NATO), a door with a 7 mm thick sheet of mild steel on each face represents a good option.

Door orientation: The reference documents dealing with strong rooms present opposing opinions as to which way the entrance door should open. Some reference documents note that the door should open (swing) outward, as it will naturally resist physical impact better. The impact of a sledge hammer on an outward opening door will tend to force the door further into its own frame. The intruders would need to break the frame in order to force the door. However, with an outward opening door it is more difficult to protect the hinges (and possibly the locking system), making them more vulnerable to attack with pry bars. Other reference documents recommend inward opening doors. For the ICRC, either option is acceptable (depending on which works best in a given situation). However, preference is generally given to inward opening doors, which are more effective in protecting the hinges against physical and ballistic attack. The addition of anti-pry strips (see below) can further enhance this protection.

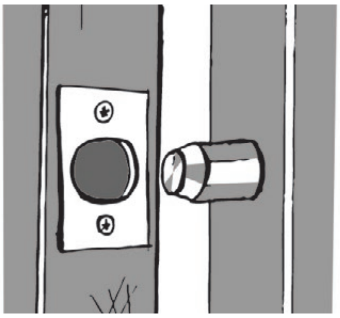
Whether the door opens inward or outward, further consideration needs to be given to the layout of the entrance to the strong room. Although the door will be designed to resist the expected attack, the consequences of a potential minor failure of the door should be minimized. For example, if a small hole can be punched in the door, this aperture could enable the intruders to fire a weapon directly into the strong room. This risk can easily be mitigated by a well-organized entry layout that obstructs the path from the door. For example, the entrance door could be at an angle to the strong room, or a secondary wall (built from ballistic-resistance materials) could be built directly in front of the entrance door.



Door hinges: Good quality, heavy duty hinges should be used for the entrance door. The door will be heavy, and the hinges used should take this into account. With normal hinges, it is relatively easy to lift a door straight off the hinges. Attention should be paid to the hinge details in order to avoid this risk. Special security hinges are available that incorporate a dowel-pin system that provides additional resistance against the door being lifted off its hinges. These dowel-pins can either be incorporated in the hinges themselves or elsewhere in the door.

In terms of ballistic attack, the main recommendation is to keep the hinges hidden and protected, as an exposed hinge could potentially be destroyed by small arms fire. An inward opening door will help hide the hinges, and the door itself will provide protection. The addition of an anti-pry strip to the door frame (see below) made from a heavy steel plate will also provide considerable ballistic protection to the door hinges.

Door locking system: Clearly the entrance door needs to be well secured. Although there will be some differences between the locking systems for inward and outward opening doors, the overall approach will be the same. The locking system should be entirely on the inside face of the door, with no part of it accessible from the outside. As such there will be no need for a key, and the locking system can rely on bars and bolts. The locking system should be designed to resist the expected forces (such as human power and sledgehammers) and should secure the door at numerous points. A multi-point locking system could be used.



However, the locking system could be even simpler – just using bars to prevent the door from being opened. The locking bars should be substantial and ideally there should be more than one. They should be used in conjunction with substantial bolts locking the top and bottom of the door.

Door frame: The door frame also needs to be high in quality and heavy duty and should be made from steel. The door frame must be very securely attached to the adjacent walls. Walls will be discussed in more detail in the next section, but in terms of the door frame, it is preferable that the wall around the door be constructed from reinforced concrete. The door frame should be properly attached (e.g. welded) to the reinforcement, before the concrete is cast. The door frame must provide a close fit with the door in order to minimize gaps that could be exploited with pry tools.

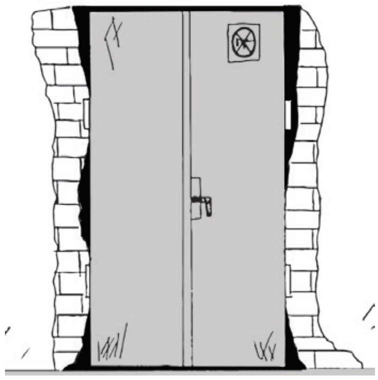
One of the major advantages of using an inward opening door is the protection of the hinges provided by the door frame. However, this can be further enhanced by adding anti-pry strips to the door frame. Strips of steel plate, at least 4 mm thick, should be welded to the outside of the door frame on both vertical faces. The strips should overlap with the door frame by at least 25 mm and project into the doorway by 20 mm. In this way, when the door is closed the gap between the door and the frame is completely inaccessible.

Because the door frame is exposed, it is vulnerable to ballistic attack. The addition of anti-pry strips will provide some additional protection to the door frame. However, the best approach is to use a heavy duty steel door frame strongly connected to the reinforced concrete walls. This is basically the same approach used to resist physical attack.

Proprietary security door and frame system: There are a number of companies that specialize in making door and frame systems for use in strong rooms. They are designed to resist various levels of attack (e.g. tools used and resistance time). If there is a concern about the quality of door that could be manufactured locally, OP_ASSIST_EH should be consulted about the option of purchasing a proprietary security door and frame system.

Walls: A strong entrance door will be of no use if the strong room walls are weak, as an intelligent and determined intruder will attempt all means to gain entry. As seen in the illustration below, the intruders were unable to enter the strong room, but they would have been able to fire directly into it.

However, the construction of the walls must be carefully considered, as intruders may attempt to gain entry into the strong room directly through them. Walls made from cement block or brick offer a reasonable level of ballistic protection but can be breached very quickly using simple hand tools such as



sledgehammers. For medium severity threats, only one type of wall construction is recommended: reinforced concrete or concrete masonry units (cement hollow block) that have been reinforced and grouted (i.e. horizontal and vertical reinforcement and all voids filled with cement grout), in accordance with the US Military Handbook, Design Guidelines for Physical Security of Facilities, Section 5.5.3.1.

The same reference text includes design charts that indicate the time needed to penetrate walls of different thicknesses depending upon the severity of the threat and the tools used. For a medium severity threat, typically reinforced concrete walls (i.e. 10 mm diameter bars spaced 150 mm apart in both directions) of different thicknesses provide the following resistance in terms of time required to penetrate:

- 150 mm thick reinforced concrete wall: 7.5 minutes
- 200 mm thick reinforced concrete wall: 12 minutes

However, there is a subtle but important difference here. In this reference text the definition of a medium severity threat is an attack using hand tools and battery powered tools (e.g. drills and cutters). The ICRC definition of a medium threat level includes hand tools only. Hence penetration times should be higher.

This reference text also states that the following wall construction methods represent a barrier that is impractical to attack only using hand tools and that is capable of resisting ballistic attack by small arms:

- reinforced concrete, 200 mm thick
- reinforced and grouted CMU, 200 mm thick

Composite walls: Composite walls that incorporate numerous layers and, possibly, different materials can be an effective means of achieving the targeted physical and ballistic resistance levels. This approach can also potentially be very effective in retrofitting an existing room in order to upgrade it to a strong room. The general approach is simple: additional layers of material (with appropriate characteristics and thickness) are added to the existing wall construction. Normally it is most practical to add these supplementary layers to the inside of the walls. The resistance of each individual layer is added together in order to obtain the overall resistance.

For example, an existing 100 mm thick reinforced concrete wall could be augmented with an additional 100 mm thick reinforced concrete wall to obtain the required level of protection against physical attack. If additional ballistic protection is needed, a steel plate or bullet resistant fiberglass could be attached to the inside of the wall.

Floor: The most effective way for a floor to resist attack is to make sure that it is not accessible. This is one of the main reasons why it is strongly recommended that the strong room be located where the floor is in direct contact with the ground, i.e. on the ground floor or in the basement. In a medium threat scenario, it is considered highly unlikely that the intruders will have the time or motivation to dig a tunnel in order to attack the floor of a strong room. In situations where a strong room is not in contact with the ground, the floor has to be designed to protect against potential attack.

Physically attacking a floor is more difficult than attacking a wall or ceiling, since the attack has to be upwards. Hence penetration resistance times are longer. According to the reference text, the resistance time of a 150 mm reinforced concrete floor slab is 13 minutes.

For ballistic attacks, it is just as easy to attack a floor slab from below as it is to attack a wall. Hence, the ballistic resistance of exposed floor slabs must be at least the same as that for walls. It is not possible to construct floor slabs from CMU or masonry. So in order to resist ballistic attack by small arms fire up to 7.62 mm (7.63x51 mm NATO), the minimum requirement is 100 mm thick reinforced concrete.

As described in the section on walls, it is also possible to increase floor slab resistance through the use of additional composite layers. As for walls, it is strongly recommended that OP_ASSIST_EH be consulted before any project designed to use composite floor construction is begun.

Ceiling: The ceiling also clearly needs to be capable of resisting attack. There is anecdotal evidence that at least one ICRC security incident involved an attack on the ceiling of a strong room by small arms fire.

A downward attack, either physical or ballistic, on a strong room ceiling is as easy as attacking the walls. Hence the ceiling must have at least the same resistance capacity as the walls: 200 mm thick reinforced concrete.

This represents a significant load to be supported by the roof slab itself and by the walls. As for the walls and floor, a composite approach could be used. Here again, OP_ASSIST_EH should be consulted before any project involving composite ceiling construction is begun.

In terms of physical attack, the time needed for intruders to gain access to the strong room via the ceiling could be significantly increased if they do not have easy access to it. For example, if a strong room is on the top floor of a building, the walls in the roof space should extend up to the external roof. Intruders would then need to break through these walls to gain access to the ceiling of the strong room. For strong rooms with another room above, consideration should be given to restricting access to this room, such as with a locked strong door. The intruders would then need to break through this door to gain access to the room above the strong room.

12.9 High threat level

A high threat level corresponds to a situation in which the intruders' primary intention is to target staff with the help of sophisticated equipment. It is probably unlikely that the intruders will come equipped with cutting torches or disc cutters. However, it is important to be attentive to the equipment they may find on site. For example, an ICRC compound that includes a vehicle workshop may inadvertently provide access to cutting equipment. Given the situations in which the ICRC works, it is thought to be more likely that intruders will be equipped with explosives, in the form of hand grenades and rocket-propelled grenades.

12.10 Shelter facilities as strong rooms

As discussed in an earlier chapter, shelter facilities can provide a good level of protection against ballistic attack. As such, it may seem simple to upgrade them to strong rooms.

Such an upgrade is possible, but it is not necessarily as simple as it would first appear. It is important that a strong room be capable of resisting both physical and ballistic attack (whereas a shelter facility only resists blast and ballistic effects). For example, Hesco gabions represent an effective ballistic wall construction, but they can be vulnerable to a sustained physical attack. The gabions can be cut and the soil or sand removed relatively quickly. Firmly attaching the entrance door to the walls of a shelter facility can also be a challenge.

OP_ASSIST_EH should be consulted before a project designed to convert a shelter facility into a strong room is begun.

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MISSION

The International Committee of the Red Cross (ICRC) is an impartial, neutral and independent organization whose exclusively humanitarian mission is to protect the lives and dignity of victims of armed conflict and other situations of violence and to provide them with assistance. The ICRC also endeavours to prevent suffering by promoting and strengthening humanitarian law and universal humanitarian principles. Established in 1863, the ICRC is at the origin of the Geneva Conventions and the International Red Cross and Red Crescent Movement. It directs and coordinates the international activities conducted by the Movement in armed conflicts and other situations of violence.

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