

Oerlikon Skyshield[®] MOOTW / C-RAM System



**Rheinmetall Air Defence AG -
Innovative technology against modern air
threats**

Protection against RAM Attacks

RAM stands for rockets, artillery and mortar. These widely available weapons are used by asymmetric attackers or terrorist groups. Their intent is to bring the most devastating effects by attacks at vital assets of nations strategic interests. Both material and personal are vulnerable. The opponent side using RAM in asymmetric warfare is highly mobile and very difficult to identify and to distinguish. Its hit and run tactic is most challenging to counter and to defeat. Since asymmetric, unconventional and terrorist attacks are to be expected below the threshold of war, even during peace time, special requirements for operation, command and control of a defence are to be considered.

The Oerlikon Skyshield® MOOTW / C-RAM System is the Rheinmetall Air Defence solution to counter this challenge. It's a re-locatable Ground Based Air Defence (GBAD) system and can protect any civilian or military vital assets from RAM attacks under the spectrum of military operation other than war (MOOTW) or even full scale war scenario. The system provides permanent airspace surveillance, automated detection and tracking of very small targets, the prior warning of areas under threat and the interception and destruction of approaching RAM targets. Together with the Oerlikon Skymaster® Command and Control System MOOTW configuration Skyshield MOOTW / C-RAM is up to the task for such delicate missions.

The system is based on proven Oerlikon Skyshield air defence technology and an Ahead round specially adapted to defeat RAM targets.

System Layout

The basic system configuration consists of two Oerlikon Skyshield® Fire Control Units and four Oerlikon Revolver Gun® C-RAM which are linked to a control node. By netting these units to the control node, a GBAD cluster is built up. From the control node all the engagement operations are coordinated and from there, the link to the site to be protected and optional links to higher echelons can be established. If requested, long range sensors and weapon systems can be integrated as well.

In order to establish a 24 hours/days and 7 days/week operation, the system functions are highly automated. Skyshield MOOTW / C-RAM is managed by a two man crew. Their task is mainly to supervise the automated operation, verify the engaged target and enable the automated fire release.

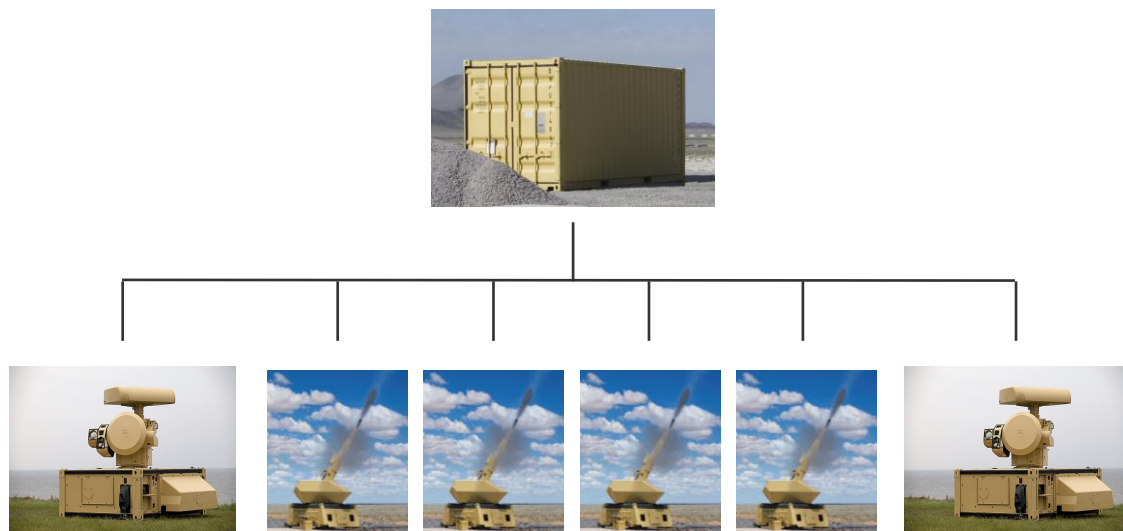


Fig. 1 - Oerlikon Skyshield® MOOTW / C-RAM System Layout

The basic configuration can be used to protect a vital site of about 500 m x 500 m (Fig. 1). For protecting larger sites, the number of sensors and guns can be increased.

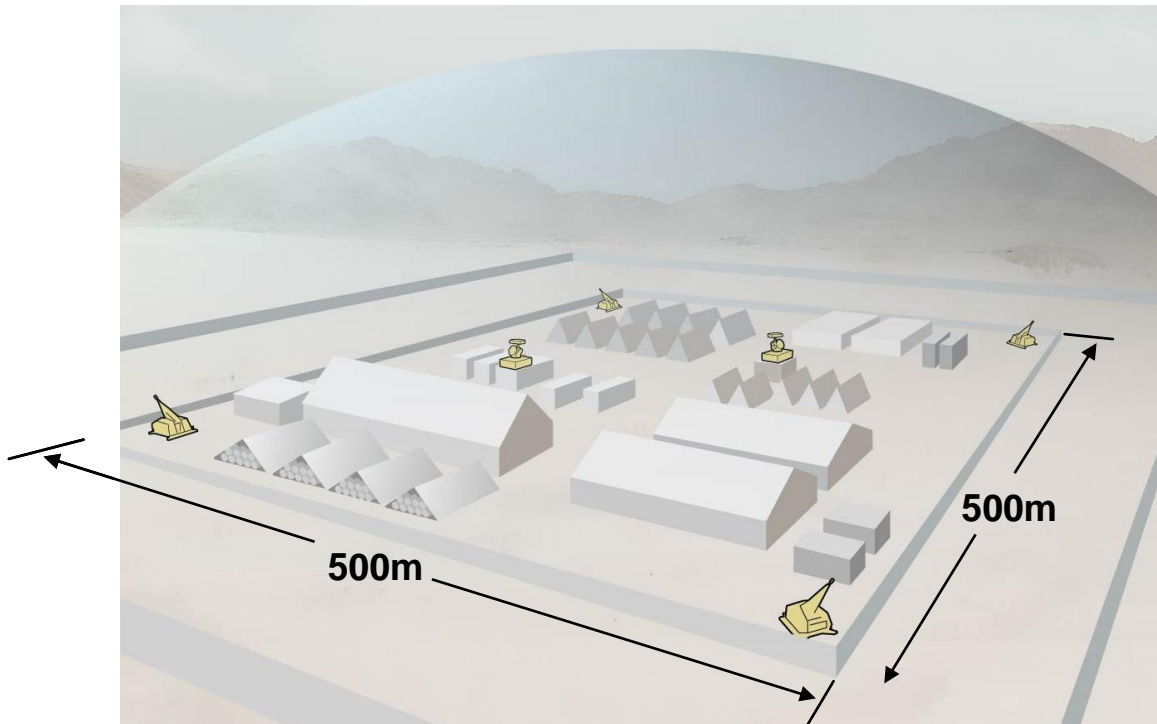


Fig. 1 - Generic Deployment of Skyshield MOOTW / C-RAM

Threat

Skyshield MOOTW / C-RAM is optimized against RAM threats, but it can also be deployed against “Basic Threat” and “Small Target Threat” (see Table below).

“Basic Threat”	Fixed wing aircraft
	Rotary wing aircraft (helicopters)
	Cruise missiles
	Drones, UAV/RPV
“Small Target Threat”	Air-to-Surface Missile (ASM)
	Anti-Radiation Missile (ARM)
	Light Precision-Guided Ammunition (PGM)
“Very Small Target Threat”	Armoured Precision-Guided Ammunition (PGM)
	Rocket, Artillery, Mortar (RAM)
	Radio controlled flying model

Main System Capabilities

The main characteristics of the Skyshield MOOTW / C-RAM System can be summarized as follows:

- Dedicated sensors being optimized for detecting and tracking very small RAM targets at such distances that a timely target engagement can be achieved.
- Exceptional gun performances, in particular in combination with Ahead ammunition. The high firing rate of up to 1000 rounds/min with Ahead ammunition produces a large, high density cloud of heavy metal sub-projectiles around the approaching target causing its destruction or mission abort. The Revolver Gun C-RAM can defeat RAM targets as well as conventional air threats (like aircraft, helicopters or UAVs) and is also highly effective against ground targets.
- Automated control of the sensors and weapons by means of a smart Battle Management System implemented in the Control Node Module minimizes the required amount of personnel and allows a 24h/day, 7 days/week operation.
- Open and standardised interfaces at the Control Node allow integration with higher echelons and neighbouring forces.
- The system is re-locatable and all elements are standardised for transportation by air (transport aircraft or helicopter), trucks or rail road.

The 7 Tasks in RAM Engagement

For a total C-RAM solution the following 7 areas have been identified:

- Prevent
- Detect
- Warn
- Intercept
- Protect
- Attack
- Command and Control

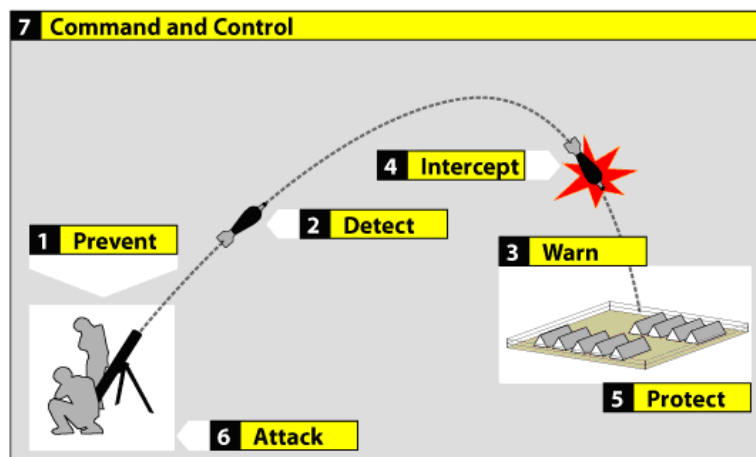


Fig. 3 – Elements of a total C-RAM Solution

The Skyshield MOOTW / C-RAM System serves for most of these areas and at least supports the remaining ones:

- **Prevent:** The Skyshield MOOTW / C-RAM system's high defence power discourages attacks
- **Detect:** The Skyshield MOOTW / C-RAM system detects approaching RAM targets automatically, reliably and in due time
- **Warn:** The Skyshield MOOTW / C-RAM system calculates the point of impact (POI) of the RAM threat. The system integrates existing alarm systems and warns the threatened zone. An analysis of mortar attacks has shown: a reliable alarm in good time – a few seconds advance warning are sufficient – significantly increases the chance of survival
- **Intercept:** The Skyshield MOOTW / C-RAM system counters a wide range of weapons. Automatic fire control optimises the timing and weapons used
- **Protect:** The Skyshield MOOTW / C-RAM system provides a fast deployable protection and reduces the requirement for hardening
- **Attack:** The Skyshield MOOTW / C-RAM system determines the type of weapon employed and its point of origin (POO) thereby making a counterattack viable
- **Command and Control:** The Skymaster Command and Control system assumes all the command tasks necessary for combating RAM targets and can be incorporated in existing command and control systems

System Elements

In its basic configuration the Skyshield MOOTW / C-RAM System consists of:

- one Control Node (20 foot shelter) including the Oerlikon Skymaster® Command and Control System
- two Oerlikon Skyshield® Fire Control Units
- four Oerlikon Revolver Guns® C-RAM
- Oerlikon Ahead® ammunition

Control Node

The operation concept was developed under the condition that a 24 h/day and 7 days/week operation with minimum number of personnel shall be maintained. This led to a technical solution where most engagement functions are fully automated and where the operators can concentrate on the tasks of verifying the target, alarming the site and the decision whether to fire or not. These tasks require dedicated mission operation consoles.

To achieve the required quick reaction time for a successful engagement, the automated functions include automated threat evaluation and weapon assignment. In order to maximize the kill probability, fire release is automated as well in case of engaging RAM targets.

The mission control consoles are optimised for performing tasks that cannot be delegated to the computer. These include:

- Periodical sensor set-up optimization

- Visual target verification (as safety means)
- Sensor reset in case of false target acquisition
- Alarm of the defended asset in case of a dangerous RAM attack (shall be done manually in order to minimize false alarms)
- Decision whether to fire or not

The Control Node (CN) provides the following main capabilities:

- Situational Awareness
 - LAP Compilation
 - Monitoring of Skyshield sensor unit and C-RAM gun activities
 - Target Identification (IFF and Airspace Control Means)
 - Threat Evaluation
 - Display of Situational Awareness
 - Evaluation of the potential collateral damage in case of fire release
- Engagement Control
 - Weapon Control Order
 - Weapon Assignment
 - Friend Protection
- Alarm Function
 - Alarm the site to be protected in case of a dangerous RAM attack
- Crew Protection
 - Protect operation crew by use of a 20 feet protected shelter



Fig. 4 - Example of Control Node Shelter and the consoles architecture

Oerlikon Skyshield® Fire Control Unit C-RAM

The Skyshield Fire Control Unit C-RAM is based on the modern Skyshield technology and its proven sub-systems (Radar, Electro Optics, Man Machine Interface). It has a search radar coverage of up to 70 degrees in elevation and can detect very small, fast and steep attacking air targets such as rockets and mortar shells. A track-while-scan function and powerful Electronic Counter Counter Measures have been implemented. Its prediction algorithms and the multiple ballistic allow the firing of conventional HEI (or other types) or Oerlikon Ahead® ammunition.

The Sensor Unit consists of the major components:

- Platform
- Tracker mount and drives
- Radar
 - Search Radar
 - Tracking Radar
- IFF (option)
- Electro-Optical group
 - TV-camera
 - IR-camera (Thermal Imager)
 - Video Tracker Module
 - Laser Range Finder, low eye hazard
 - Distance Measuring Device (DMD) for determining the distance between the Sensor Unit and the weapons; eye safe, invisible IR beam
- Data Processing Group
- Power Supply Unit.



Fig. 5 - Oerlikon Skyshield® Fire Control Unit C-RAM

Oerlikon Revolver Gun® C-RAM

The Revolver Gun C-RAM is a single-barrel, low weight, high performance 35 mm gun with the following features:

- Ahead ammunition and full-calibre, homologated 35 mm ammunition capability
- High firing rate of 1'000 rounds/min
- Easy to transport
- Unmanned operation
- Automatic tilt compensation

It has the following characteristics and performance:

- Calibre 35 mm
- Rate of fire 1000 rounds/min
- Ammunition storage 252 rounds
- 4km engagement range against air and ground targets
- 1 – 1.5 km engagement range against RAM targets
- Improved accuracy for engagement against RAM targets
- Increased hit probability against small and fast targets due to Ahead technology
- Gas-operated revolver cannon
- Revolver drum with 4 cartridge chambers
- Mechanical ignition
- Automatic cocking device



Fig. 6 – Oerlikon Revolver Gun® C-RAM

The 35 mm revolver cannon is a gas operated cannon with a mechanical ignition. It is charged with a remote controlled hydraulic cocking device.

The main components of the 35 mm revolver cannon are:

- Cannon housing with revolver drum
- 35 mm cannon barrel
- Muzzle velocity measuring and Ahead programming base
- Ammunition feeder
- Electromechanical trigger device.
- Fibre optic sensor unit

The muzzle velocity measurement and Ahead fuse time programming are accomplished with the 3-coil muzzle base. The three coils are positioned concentrically to the barrel axis and do not come into physical contact with the rounds fired.



Fig. 7 – 35 mm Revolver Cannon with muzzle velocity measuring and Ahead programming base

Oerlikon Ahead® Ammunition Technology

The Skyshield MOOTW / C-RAM System sensors are optimized for detecting and tracking very small targets with short reaction times and high accuracy.

Such threats are being engaged by using the Ahead ammunition.

The Ahead ammunition carries a payload of subprojectiles, which have to be ejected at a pre-determined distance in front of the target, with the objective of achieving an optimal subprojectile density for maximum effectiveness. The optimal ejection distance from the target depends on the type of target and the interception range of the target.

The desired ejection point is achieved by means of a fuze with a programmable timer. The fire control system calculates a fuze time corresponding to the required target interception

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conditions, based on an assumed muzzle velocity. The actual muzzle velocity of each round is measured by a device on the end of the gun barrel. The calculated fuze time is corrected to correspond to the measured muzzle velocity. This value is programmed into the Ahead round in real time by an inductive coil placed just in front of the muzzle velocity measuring device.

A salvo of Ahead ammunition creates a cloud of high-energy spin-stabilised subprojectiles directed towards the target with devastating terminal effects which have been demonstrated several times against a variety of target types, including RAM targets.

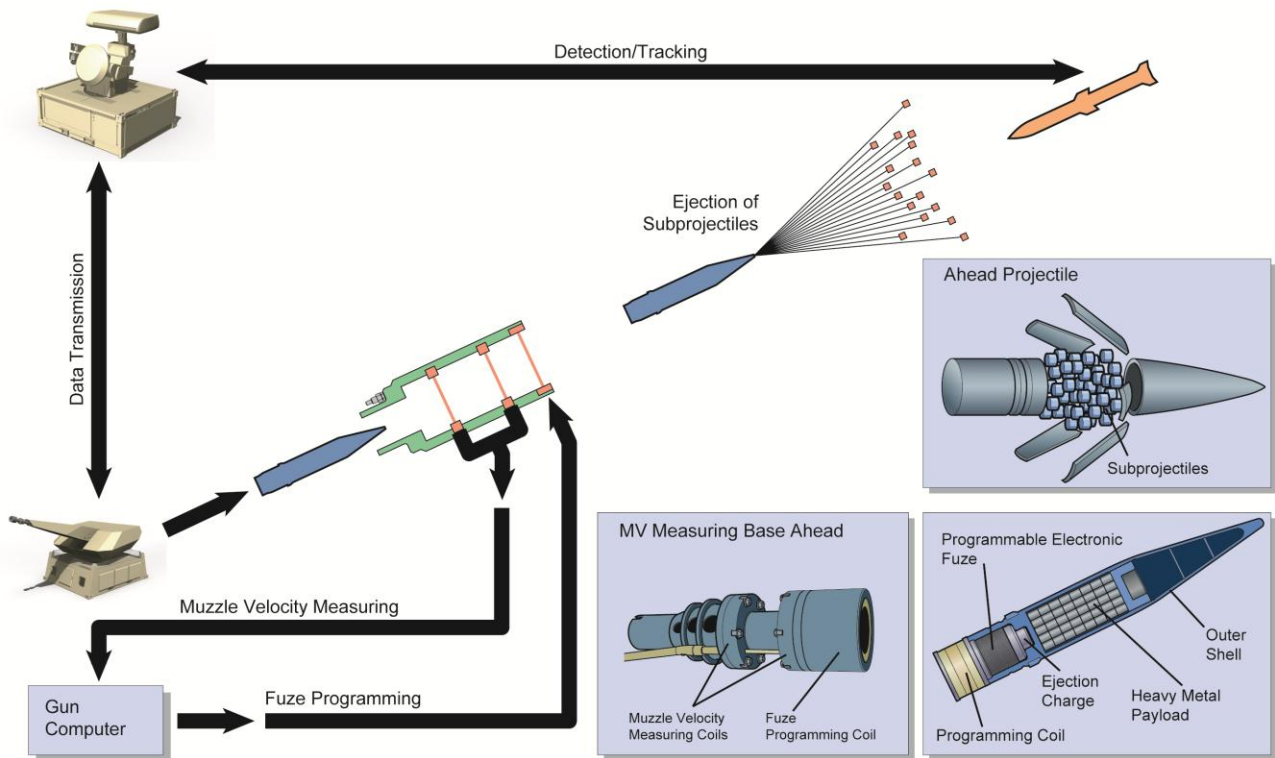


Fig. 8 – Oerlikon Ahead® Ammunition Technology Principle