TRISA WEG

Worldwide Equipment Guide

Volume 2: Airspace and Air Defense Systems

December 2011

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U.S. ARMY TRADOC G-2

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REPLY TO
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MEMORANDUM FOR: Distribution unlimited

SUBJECT: Worldwide Equipment Guide (WEG) Update 2011

1. In today's complicated and uncertain world, it is impossible to predict the exact nature of the next conflict that might involve U.S. joint forces. We must be ready to meet the challenges of any type of conflict, in all kinds of places, and against all kinds of threats. That is the nature of the U.S. Army Contemporary Operational Environment (COE), and its operations within the joint operational environment. Training for the joint environment also requires an expanded scope for the Opposing Force (OPFOR). The U.S. joint warfighters must remain flexible, as must the OPFOR designed as a challenging sparring partner in the training environment.

2. The equipment portrayed represents military systems, variants, and upgrades that U.S. forces might encounter now and in the foreseeable future. It is a living document and is updated. The authors analyze real-world developments and trends to assure that the OPFOR remains relevant.

3. The WEG was developed to support OPFOR portrayal in training simulations (constructive, virtual, and live) and other related activities, and is approved for those uses. The WEG is not a product of the U.S. intelligence community. Published in three volumes, it is the approved document for OPFOR equipment data used in U.S. Army training. Annual WEG updates are posted on the Army Knowledge Online (AKO) website. Therefore it is available for downloading and local distribution (see enclosure 1 for reproducible directions). Distribution restriction is unlimited. This issue replaces all previous issues. TRADOC G2, TRISA would like to thank JFCOM for contributing valuable joint systems data used in the document.

4. For comments or questions regarding this document, contact Tom Redman, BAE Systems contractor, at DSN 552-7925, commercial (913) 684-7925, email: tom.redman@us.army.mil. If he is not available (or for specific issues), contact POCs noted in the chapter introductions

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GARY E. PHILLIPS
TRADOC Intelligence Support Activity

AKO PATH TO OPFOR COE PRODUCTS

To access WEG and other COE training products at our site, use either of these two methods. The AKO direct link is <u>`https://www.us.army.mil/suite/files/21872221`</u>.

Direct link to each volume is as follows:

```
Volume 1 Ground Forces    https://www.us.army.mil/suite/doc/25963538
Volume 2 Air and AD       https://www.us.army.mil/suite/doc/25963539
Volume 3 Naval Littoral   https://www.us.army.mil/suite/doc/25963540
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Or, navigate to the site as follows:

(1) Go to the AKO home page and click on <u>Files</u> (upper right).
(2) Then go to <u>DOD Organizations</u> (left)
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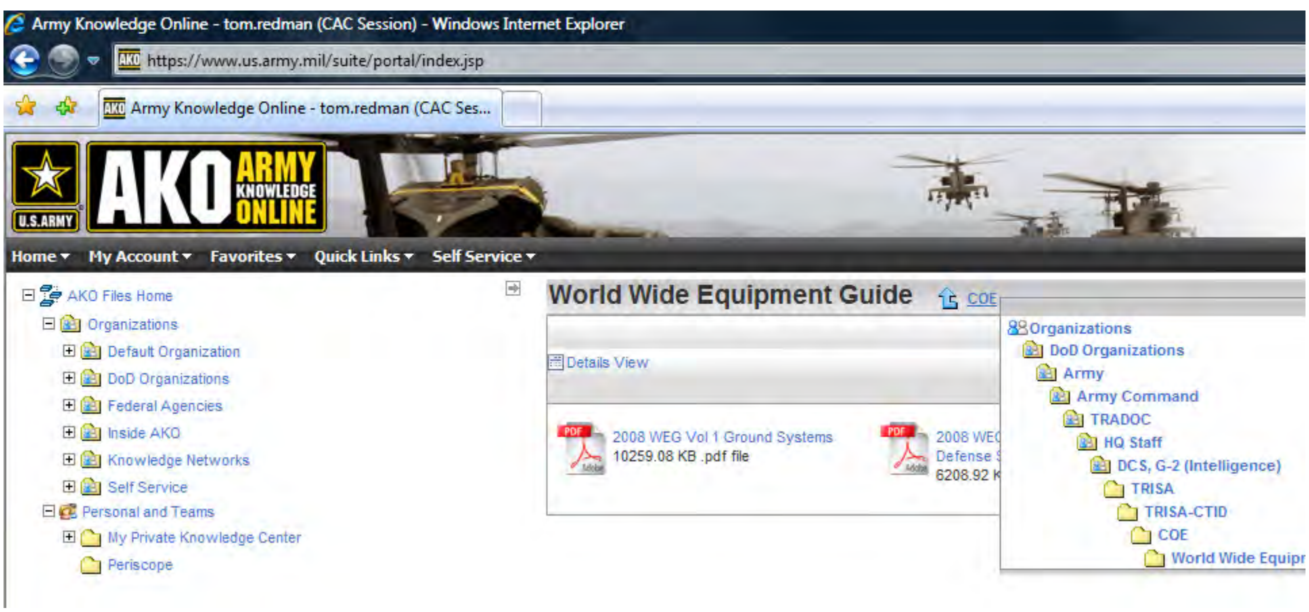

Opposing Force:
Worldwide Equipment Guide
Contents Volume 2

Page

Errata Changes for 2011 Update

Some chapters have significant changes. Changes include specific changes in text and data, photos, equipment name changes, as well as added or deleted pages. For clarity, functional classifications of aircraft and some designators and names for specific models have been adjusted. Please check page numbers, as many have changed. Some illustrations were replaced or added. The following data sheets and narrative sections are added:

System	Page
Zala 421-08	4-6
ASN-207	4-11
Hermes 900	4-17
Lynx Rocket/Missile Launcher, Delilah CM	5-15
Air Defense Systems and Domains	6-6
Air Defense Systems: Key Technology Trends	6-13
Airship Support to Air Defense	6-18
Recent Developments in Very Short Range AD	6-21
Recent Developments in MRAD Systems	6-66

In these times of reduced economic resources for military force improvements, most forces are focusing more on upgrading existing systems, with reduced numbers of new fielded systems. Thus, many older systems are being upgraded to be more effective against even the most modern forces. Therefore, the number of variants for systems described in the WEG continues to expand. Major changes can be found on the following pages:

System	Page
COE Chapter Introduction	1-1
Tier Tables	1-3
Systems Substitution Table	1-6
Air Defense Chapter Introduction	6-1
Theater Missile Chapter Introduction	6-1
Theater Ballistic Missiles	6-2
Cruise Missiles	5-11
Table: Non-Ballistic Land-Attack Systems	5-17

Some system names have been changed to add key upgrade variants which are featured on the data sheets. A red ink edition is available for users who want to know detailed changes to text and data.

Preface

This handbook is one of a series that describes a contemporary Opposing Force (OPFOR) for training U.S. Military commanders, staffs, and units. Together, these handbooks outline an OPFOR than can cover the entire spectrum of military and paramilitary capabilities against which the U.S. Military must train to ensure success in any future conflict.

Applications for this series of handbooks include field training, training simulations, and classroom instruction throughout the U.S. Military. All U.S. Military training venues should use an OPFOR based on these handbooks, except when mission rehearsal or contingency training requires maximum fidelity to a specific country-based threat. Even in the latter case, trainers should use appropriate parts of the OPFOR handbooks to fill information gaps in a manner consistent with what they do know about a specific threat.

Unless this publication states otherwise, masculine nouns or pronouns do not refer exclusively to men.

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Introduction

This Worldwide Equipment Guide (WEG) describes the spectrum of worldwide systems and system trends in the Contemporary Operational Environment (COE). The updated and approved definition for COE is as follows:

> The contemporary operational environment (COE) is the collective set of conditions derived from a composite of actual worldwide conditions that pose realistic challenges for training, leader development and capabilities development for Army forces and their joint, intergovernmental, interagency and multinational partners.

Tier Tables at Chapter 1 provide baseline examples of systems with counterparts in other capability tiers. Other systems are added to offer flexibility for tailoring the force systems mix. Substitution Tables starting at 1-6 offer other system choices versus baseline examples.

The OPFOR in the COE should also include options for portraying "hybrid threat". Hybrid threat is defined as:

…the diverse and dynamic combination of regular forces, irregular forces, terrorist forces, and/or criminal elements, all unified to achieve mutually benefitting effects.

The OPFOR force may use conventional weapons; but regular as well as irregular forces may also employ improvised systems, as described in Volume 1 Chapter 14, and in Volume 2 Chapter 7. Upgrade tables capsulize changes to WEG systems reflecting contemporary upgrade trends. The the WEG is not a product of the intelligence community. It was developed to support OPFOR portrayal in training simulations (constructive, virtual, and live) and activities, and is approved for that use. Systems and technologies in Chapter 10, Emerging Technologies, can be used in simulations reflecting Near-Term and Mid-Term scenarios.

The pages in this WEG are designed use in electronic form or for insertion into loose-leaf notebooks. This guide will be updated as often as necessary, in order to include additional systems, variants, and upgrades that are appropriate for OPFOR use. Please note that a "red ink" edition is available for database developers, noting every change in each edition.

Worldwide OPFOR Equipment

Due to the proliferation of weapons through sales and resale, wartime seizure, and licensed or unlicensed production of major end items, distinctions between equipment as friendly or OPFOR have blurred. Sales of upgrade equipment and kits for weapon systems have further blurred distinctions between old or obsolete systems and modern ones. This WEG describes base models, or fielded upgrades which reflect current capabilities. Many less common variants and upgrades are also addressed. Note the Equipment Upgrades chapter (8) for trends guidance.

How to Use This Guide

The WEG is organized by categories of equipment, in chapters. The format of the equipment pages is basically a listing of parametric data. This permits updating on a standardized basis as data becomes available. For meanings of acronyms and terms, see the Glossary. Please note that, although most terms are the same as U.S. terminology, some reflect non-U.S. concepts and are not comparable or measurable against U.S. standards. For example, if an OPFOR armor penetration figure does not say RHA (rolled homogeneous armor), do not assume that is the standard for the figure. If there are questions, consult the Glossary, or contact us.

System names reflect intelligence community changes in naming methods. Alternative designations include the manufacturer's name, as well as U.S./NATO designators. Note also that the WEG focuses on the complete weapon system (e.g., Ka-50/52 helicopter), versus a component or munition (e.g., Shvkal fire control system or AT-16 ATGM).

Many common technical notes and parameters are used in selected chapters, since the systems contained in those chapters have similar weapon and automotive technologies. Others must use distinct parameters. See Glossary for assistance on parameters.

The authors solicit the assistance of WEG users in finding unclassified information that is not copyright-restricted, and that can be certified for use. Questions and comments should be addressed to the POC below. If he is not available, contact the designated chapter POC.

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Units of Measure

The following symbols and abbreviations are used in this guide.

Unit of Measure	Parameter
(°)	degrees (of slope/gradient, elevation, traverse, etc.)
GHz	gigahertz—frequency (GHz = 1 billion hertz)
hp	horsepower (kWx1.341 = hp)
Hz	hertz—unit of frequency
kg	kilogram(s) (2.2 lb.)
kg/cm^2	kg per square centimeter—pressure
km	kilometer(s)
km/h	km per hour
kt	knot—speed. 1 kt = 1 nautical mile (nm) per hr.
kW	kilowatt(s) (1 kW = 1,000 watts)
liters	liters—liquid measurement (1 gal. = 3.785 liters)
m	meter(s)—if over 1 meter use meters; if under use mm
m^3	cubic meter(s)
m^3/hr	cubic meters per hour—earth moving capacity
m/hr	meters per hour—operating speed (earth moving)
MHz	megahertz—frequency (MHz = 1 million hertz)
mach	mach + *(factor)* —aircraft velocity (average 1062 km/h)
mil	milliradian, radial measure (360° = 6400 mils, 6000 Russian)
min	minute(s)
mm	millimeter(s)
m/s	meters per second—velocity
mt	metric ton(s) (mt = 1,000 kg)
nm	nautical mile = 6076 ft (1.152 miles or 1.86 km)
rd/min	rounds per minute—rate of fire
RHAe	rolled homogeneous armor (equivalent)
shp	shaft horsepower—helicopter engines (kWx1.341 = shp)
µm	micron/micrometer—wavelength for lasers, etc.

Chapter 1
Contemporary Operational Environment OPFOR and Tier Tables

The OPFOR forces and equipment must support the entire spectrum of Contemporary Operational Environment (see Vol 1 Introduction pg vi) in U.S. forces training. The COE OPFOR includes "hybrid threats" (also pg vi), and represents rational and adaptive adversaries for use in training applications and scenarios. The COE time period reflects current training (2011), as well as training extending through the Near Term. This chapter deals with current time frame systems. Lists of equipment on these tables offer convenient baseline examples arranged in capability tiers for use in composing OPFOR equipment arrays for training scenarios. For guidance on systems technology capabilities and trends after 2011, the user might look to Chapter 10, Emerging Technology Trends. Those tables offer capabilities tiers for Near and Mid-Term.

OPFOR equipment is broken into four "tiers" in order to portray systems for adversaries with differing levels of force capabilities for use as representative examples of a rational force developer's systems mix. Equipment is listed in convenient tier tables for use as a tool for trainers to reflect different levels of modernity. Each tier provides an equivalent level of capability for systems across different functional areas. The tier tables are also another tool to identify systems in simulations to reflect different levels of modernity. The key to using the tables is to know the tier capability of the initial organizations to be provided. Tier 2 (default OPFOR level) reflects modern competitive systems fielded in significant numbers for the last 10 to 20 years.

Systems reflect specific capability mixes, which require specific systems data for portrayal in U.S. training simulations (live, virtual, and constructive). The OPFOR force contains a mix of systems in each tier and functional area which realistically vary in fielded age and generation. The tiers are less about age of the system than realistically reflecting capabilities to be mirrored in training. Systems and functional areas are not modernized equally and simultaneously. Forces have systems and material varying 10 to 30 years in age in a functional area. Often military forces emphasize upgrades in one functional area while neglecting upgrades in other functional areas. Force designers may also draw systems from higher or lower echelons with different tiers to supplement organizational assets. Our functional area analysts have tempered depiction of new and expensive systems to a fraction of the OPFOR force. The more common modernization approach for higher tier systems is to upgrade existing systems.

Some systems are used in both lower and higher tiers. Older 4x4 tactical utility vehicles which are 30 to 40 years old still offer effective support capability, and may extend across three tierss. Common use of some OPFOR systems also reduces database maintenance requirements.

Tier 1 systems are new or upgraded robust state-of-the-art systems marketed for sale, with at least limited fielding, and with capabilities and vulnerabilities representative of trends to be addressed in training. But a major military force with state-of-the-art technology may still have a mix of systems across different functional areas at Tier 1 and lower tiers in 2011.

Tier 2 reflects modern competitive systems fielded in significant numbers for the last 10 to 20 years, with limitations or vulnerabilities being diminished by available upgrades. Although forces are equipped for operations in all terrains and can fight day and night, their capability in range and speed for several key systems may be somewhat inferior to U.S. capability.

Tier 3 systems date back generally 30 to 40 years. They have limitations in all three subsystems categories: mobility, survivability and lethality. Systems and force integration are inferior. However, guns, missiles, and munitions can still challenge vulnerabilities of U.S. forces. Niche upgrades can provide synergistic and adaptive increases in force effectiveness.

Tier 4 systems reflect 40 to 50 year-old systems, some of which have been upgraded numerous times. These represent Third World or smaller developed countries' forces and irregular forces. Use of effective strategy, adaptive tactics, niche technologies, and terrain limitations can enable a Tier 4 OPFOR to challenge U.S. force effectiveness in achieving its goals. The tier includes militia, guerrillas, special police, and other forces.

Please note: ***No force in the world has all systems at the most modern tier.*** Even the best force in the world has a mix of state-of-the-art (Tier 1) systems, as well as mature (Tier 2), and somewhat dated (Tier 3) legacy systems. Many of the latter systems have been upgraded to some degree, but may exhibit limitations from their original state of technology. Even modern systems recently purchased may be considerably less than state-of-the-art, due to budget constraints and limited user training and maintenance capabilities. Thus, even new systems may not exhibit Tier 1 or Tier 2 capabilities. As later forces field systems with emerging technologies, legacy systems may be employed to be more suitable, may be upgraded, and continue to be competitive. ***Adversaries with lower tier systems can use adaptive technologies and tactics, or obtain niche technology systems to challenge advantages of a modern force.***

A major emphasis in COE is flexibility in use of forces and in doctrine. This also means OPFOR having flexibility, given rational and justifiable force development methodology, to adapt the systems mix to support doctrine and plans. The tiers provide the baseline list for determining the force mix, based on scenario criteria. The OPFOR compensates for capability limitations by using innovative and adaptive tactics, techniques, and procedures (TTP). Some of these limitations may be caused by the lack of sophisticated equipment or integration capability, or by insufficient numbers. Forces can be tailored in accordance with OPFOR guidance to form tactical groups.

An OPFOR force developer has the option to make selective adjustments such as use of niche technology upgrades such as in tanks, cruise missiles, or rotary-wing aircraft, to offset U.S. advantages (see WEG Chapter 9, Equipment Upgrades). Forces may include systems from outside of the overall force capability level. A Tier 3 force might have a few systems from Tier 1 or 2. The authors will always be ready to assist a developer in selecting niche systems and upgrades for use in OPFOR portrayal. Scenario developers should be able to justify changes and systems selected. With savvy use of TTP and systems, all tiers may offer challenging OPFOR capabilities for training. The Equipment Substitution Matrices (starting at pg 1-6) can help force designers find weapons to substitute, to reflect those best suited for specific training scenarios.

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Volume II: Airspace and Air Defense Systems

	Tier 1	Tier 2	Tier 3	Tier 4
Fixed Wing Aircraft				
Fighter/Interceptor	Su-35	Su-27SM	Mirage III, MiG-23M	J-7/FISHBED
High Altitude Interceptor	MiG-31BS	MiG-25PD	MiG-25	--
Ground Attack	Su-39	Su-25TM	Su-25	Su-17
Multi-Role Aircraft	Su-30MKK	Su-30, Mirage 2000, Tornado IDS	Mirage F1, SU-24	MiG-21M
Bomber Aircraft	Tu-22M3/BACKFIRE-C	Tu-22M3/BACKFIRE-C	Tu-95MS6/BEAR-H	Tu-95S/BEAR-A
Command & Control	IL-76/MAINSTAY	IL-76/MAINSTAY	IL-22/COOT-B	IL-22/COOT-B
Heavy Transport	IL-76	IL-76	IL-18	IL-18
Medium Transport	AN-12	AN-12	AN-12	AN-12
Short Haul Transport	AN-26	AN-26	AN-26	AN-26
RW Aircraft				
Attack Helicopter	AH-1W/Supercobra	Mi-35M2	HIND-F	HIND-D
Multi-role Helicopter	Z-9/WZ-9	Battlefield Lynx	Lynx AH.Mk 1	Mi-2/HOPLITE
Light Helicopter	GAZELLE/SA 342M	GAZELLE/SA 342M	BO-105	MD-500M
Medium Helicopter	Mi-17-V7	Mi-171V/Mi-171Sh	Mi-8(Trans/HIP-E Aslt)	Mi-8T/HIP-C
Transport Helicopter	Mi-26	Mi-26	Mi-6	Mi-6
Other Aircraft				
Wide Area Recon Helicopter	Horizon (Cougar heli)	Horizon (Cougar heli)		
NBC Recon Heli	HIND-G1	HIND-G1	HIND-G1	--
Jamming Helicopter	HIP-J/K	HIP-J/K	HIP-J/K	HIP-J/K
Naval Helicopter	Z-9C	Ka-27/HELIX	Ka-27/HELIX	--
Op-Tactical Recon FW	Su-24MR/FENCER-E	Su-24MR/FENCER-E	IL-20M/COOT	--
EW Intel/Jam FM	Su-24MP/FENCER-E	Su-24MP/FENCER-E	IL-20RT and M/COOT	--
Long Range Recon	Tu-22MR/BACKFIRE	Tu-95MR/BEAR-E	Tu-95MR/BEAR-E	IL-20M/COOT
Long Range EW	Tu-22MP/BACKFIRE	Tu-95KM/BEAR-C	Tu-95KM/BEAR-C	--

Volume II: Airspace and Air Defense Systems (continued)

	Tier 1	**Tier 2**	**Tier 3**	**Tier 4**
Air Defense				
Operational-Strategic Systems				
Long-Range SAM/ABM	Triumf/SA-21, SA-24	SA-20a w/SA-18	SA-5b w/SA-16	SA-5a w/S-60
LR Tracked SAM/ABM	Antey-2500, SA-24	SA-12a/SA-12b	SA-12a/SA-12b	SA-4b w/S-60
LR Wheeled SAM/ABM	Favorit/SA-20b, SA-24	SA-20a w/SA-18	SA-10c w/SA-16	SA-5a w/S-60
Mobile Tracked SAM	Buk-M1-2 (SA-11 FO)	Buk-M1-2(SA-11 FO)	SA-6b w/ZSU-23-4	SA-6a w/ZSU-23-4
Towed Gun/Missile System	Skyguard III/Aspide2000	Skyguard II/Aspide2000	SA-3, S-60 w/radar	SA-3, S-60 w/radar
Tactical Short-Range Systems				
SR Tracked System (Div)	Pantsir S-1-0	SA-15b w/SA-18	SA-6b w/Gepard B2L	SA-6a w/ZSU-23-4
SR Wheeled System (Div)	Crotale-NG w/SA-24	FM-90 w/SA-18	SA-8b w/ZSU-23-4	SA-8a w/ZSU-23-4
SR Gun/Missile System (Bde)	2S6M1	2S6M1	SA-13b w/ZSU-23-4	SA-9 w/ZSU-23-4
Man-portable SAM Launcher	SA-24 (Igla-S)	SA-24 (Igla-S)	SA-16	SA-14, SA-7b
Airborne/Amphibious AA Gun	BTR-ZD Imp (w/-23M1)	BTR-ZD with ZU-23M	BTR-ZD/SA-16	BTR-D/SA-16, ZPU-4
Air Defense/Antitank				
Inf ADAT Vehicle-IFV	BMP-2M Berezhok/SA-24	BMP-2M w/SA-24	AMX-10 w/SA-16	VTT-323 w/SA-14
Inf ADAT Vehicle-APC	BTR-3E1/AT-5B/SA-24	BTR-80A w/SA-24	WZ-551 w/SA-16	BTR-60PB w/SA-14
ADAT Missile/Rocket Lchr	Starstreak II	Starstreak	C-5K	RPG-7V
Air Defense ATGM	9P157-2/AT-15 and AD missile	9P149/Ataka and AD missile	9P149/AT-6	9P148/AT
Anti-Aircraft Guns				
Medium-Heavy Towed Gun	Skyguard III	S-60 with radar/1L15-1	S-60 with radar/1L15-1	KS-19
Medium Towed Gun	Skyguard III	GDF-005 in Skyguard II	GDF-003/Skyguard	Type 65
Light Towed Gun	ZU-23-2M1/SA-24	ZU-23-2M	ZU-23	ZPU-4
Anti-Helicopter Mine	Temp-20	Helkir	MON-200	MON-100

Volume II: Airspace and Air Defense Systems (continued)

	Tier 1	**Tier 2**	**Tier 3**	**Tier 4**
AD Spt (C2/Recon/EW)				
EW/TA Radar Strategic	Protivnik-GE and 96L6E	64N6E and 96L6E	TALL KING-C	SPOON REST
EW/TA Rdr Anti-stealth	Nebo-SVU	Nebo-SVU	Nebo-SV	BOX SPRING
EW/TA Radar Op/Tac	Kasta-2E2/Giraffe-AMB	Kasta-2E2/Giraffe AMB	Giraffe 50	LONG TRACK
Radar/C2 for SHORAD	Sborka PPRU-M1	Sborka-M1/ PPRU-M1	PPRU-1 (DOG EAR)	PU-12
ELINT System	Orion/85V6E	Orion/85V6E	Tamara	Romona
Unmanned Aerial Vehicles				
High Altitude Long Range	Hermes 900	Hermes 450	Tu-143	Tu-141
Med Altitude Long Range	ASN-207	ASN-207	--	--
Tactical	Skylark II	Skylark II	Fox AT2	ASN-104
Vertical Take Off/ Landing	Camcopter S-100	Camcopter S-100	--	--
Vehicle/Man-Portable	Skylite-B	Skylite-A	--	--
Man-Portable	Skylark-IV	Skylark	--	--
Hand-Launch	Zala 421-12	Zala 421-08	Pustelga	--
Artillery Launch	R-90 rocket	R-90 rocket		
Attack UAVs/UCAVs	Hermes 450S	Hermes 450	Mirach-150	--
Theater Missiles				
Medium Range (MRBM)	Shahab-3B	Shahab-3A	Nodong-1	SS-1C/SCUD-B
Short-Range (SRBM)	SS-26 Iskander-M	SS-26 Iskander-E	M-9	SS-1C/SCUD-B
SRBM/Hvy Rkt < 300 km	Lynx w/EXTRA missile	Tochka-U/SS-21 Mod 3	M-7/CSS-8	FROG-7
Cruise Missile	Delilah ground, air, sea	Harpy programmed/piloted	Mirach-150 programmed	--
Anti-ship CM	BrahMos ground, air, sea	Harpy programmed/radar	Exocet	Styx
Anti-radiation	Harpy programmed/ARM	Harpy programmed/ARM	--	--

SYSTEMS SUBSTITUTION TABLE VOLUME 2

This table provides comparative data for users to substitute other systems for those listed in OPFOR guidance documents. Those in italics are Tier 2 baseline systems used in the OPFOR Organization Guide. Systems below are grouped by type in tier order, and can be substituted to fit scenario requirement. Some systems span between the tiers (e.g., 3-4); and systems can be used at more than one tier (e.g., 3-4).

Chapter 2
Rotary-Wing Aircraft

This chapter provides the basic characteristics of selected rotary-wing aircraft readily available to the OPFOR. The sampling of systems was selected because of wide proliferation across numerous countries or because of extensive use in training scenarios. ***Rotary-wing aircraft*** covers systems classified as light, attack, multirole, transport, and reconnaissance aircraft. Rotary wing aircraft can be used for a variety of roles, including attack, transport, direct air support, escort, target designation, security, reconnaissance, ambulance, anti-submarine warfare (ASW), IW, airborne C2, search and rescue (SAR), and anti-ship.

Because of the increasingly large numbers of variants of each aircraft, only the most common variants produced in significant numbers were addressed. If older versions of helicopters have been upgraded in significant quantities to the standards of newer variants, older versions may not be addressed. Helicopters can be categorized into capability tiers. Upgrades may designate different configurations of the same aircraft in different tiers. Technology priorities include multirole capability, more lethal weapons with longer range, ability to operate in all terrains, survivability/countermeasures, and sensors for day/night all-weather capability.

Helicopters can be configured for various combat missions (attack, direct air support, escort, target designation, etc.). The best armed combat helicopters are ***attack helicopters***, which may be used for all combat missions (including attack, direct air support, escort, anti-ship, etc), and some non-combat missions (transport, reconnaissance, SAR, etc). ***Helicopter gunships*** (combat configurations of multirole helicopters) can be used for all combat and non-combat missions, but are less suitable for attack missions against well-defended targets. Some of these missions can be executed by armed multirole helicopters.

The weapon systems inherent to the airframe are listed under Armament. They use various weapon mounts, including fuselage or turret nose gun, external mounted pylons (or hardpoints), and cabin weapons, including door guns. Pylons can mount single munitions, launchers or pods, sensor pods, or fuel tanks.

Munitions available to each aircraft are noted, but not all may be employed at the same time. Munition selection is based on mission and flight capability priorities. Munitions include bombs, missiles (ATGMs, air-to-surface missiles/ASMs, air-to-air missiles/AAMs), or rockets (single or in pods), mine pods, and automatic grenade launchers. For helicopter missions, other weapons and more ammunition can be carried in the passenger compartment. The most probable weapon loading options are also given, but assigned mission dictates actual weapon configuration. Tables on aircraft weapons and aircraft-delivered munitions (ADMs) are at pages 2-22 to 2-26.

Many data sheets for joint systems were provided by Mr. Charlie Childress of JFCOM. Questions and comments on data listed in this chapter should be addressed to:

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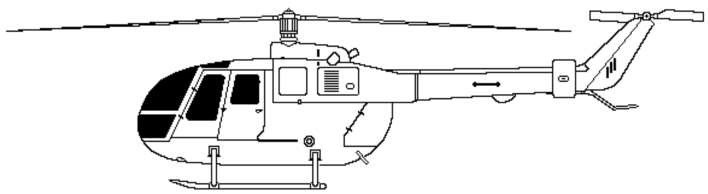
European Light Helicopter BO-105



BO-105AT1 National War College Photo

Weapon & Ammunition Types	Combat Load
Loading Options	
7.62-mm or 12.7-mm MG pods	**2**
2.75-in rocket pods (7 or 12 ea.)	**2**
68-mm SNEB rocket pods (12)	**2**
50-mm SNIA rocket pods (28)	**2**
TOW ATGM (4 ea pod)	**8**
HOT ATGM	**6**
AS-12 ASM pods (2 ea pod)	**4**
Stinger AAM pod (4 ea pod)	**4**
Mission dictates the weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: INA
Date of Introduction: 1972
Proliferation: At least 40 countries
Description: Variants in "( )"
Crew: 1 or 2 (pilots)
Transports 3 troops or 2 litters, or cargo.
Blades:
Main rotor: 4
Tail rotor: 2
Engines: 2x 420-shp Allison 250-C20B turboshaft
Weight (kg):
Maximum Gross: 2,500
Normal Takeoff: 2,000
Empty: 1,301, 1,913 (PAH1)
Speed (km/h):
Maximum (level): 242
Cruise: 205
Ceiling (m):
Service: 3,050
Hover (out of ground effect): 457
Hover (in ground effect): 1,525
Vertical Climb Rate (m/s): 7.5
Fuel (liters):
Internal: 570
Internal Aux Tank: 200 ea. (max 2x)
Range (km):
Normal Load: 555
With Aux Fuel: 961
Dimensions (m):
Length (rotors turning): 11.9
Length (fuselage): 8.8
Width: 2.5 (m):
Height: 3.0
Main Rotor Diameter: 9.8
Tail Rotor Diameter: 1.9

Cargo Compartment Dimensions (m):
Floor Length: 1.9
Width: 1.4
Height: 1.3
Standard Payload (kg):
Internal load: 690
External on sling only: 1,200

Survivability/Countermeasures:
Main and tail rotors electrically deiced. Infrared signature suppressors can be mounted on engine exhausts. Rotor brake.

ARMAMENT
Most Probable Armament:
BO-105P/PAH1: Outriggers carry 6x HOT antitank missiles, or rocket pods.

Antitank Guided Missiles
Name: HOT 3
Missile Weight (kg): 32 (in tube)
Warhead: Tandem shaped Charge (HEAT)
Armor Penetration (mm): 1250
Rate of fire (missiles/min): 3-4, depending on range
Minimum/Maximum Range (m): 75/4,000

Other Missile Types: HOT 2 multi-purpose (HEAT and Frag warheads)

AVIONICS/SENSOR/OPTICS
The **BO-105P** has a roof-mounted direct-view, daylight-only sight to allow firing of HOT ATGMs. Options exist to fit a thermal imaging system for night operations, and a laser designator.

Night/Weather Capabilities:
Available avionics include weather radar, Doppler and GPS navigation, and an auto-pilot. It is capable of operation in day, night, and with instruments under adverse meteorological conditions.

VARIANTS
The BO 105 was developed initially by Messerschmitt-Bolkow-Blohm in Germany.

BO-105CB: The standard civilian production variant.

BO-105CBS: VIP version with a slightly longer fuselage to accommodate 6 passengers, some used in a SAR role.

BO-105P: German military variant

BO-105 PAH-1: Standard antitank version

BO-105AT1: Variant with 6 x HOT ATGMs

BO-105LS: Upgraded to 2x 550-shp Allison 250-C28 turboshaft engines for extended capabilities in high altitudes and temperatures. Produced only in Canada.

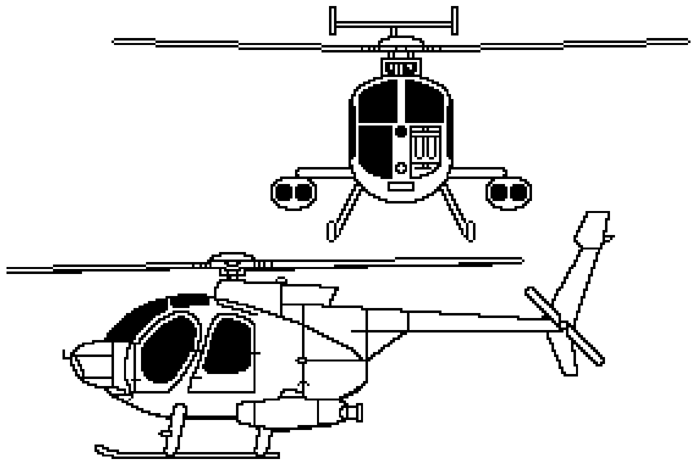
BO-105M VBH: Standard reconnaissance (light observation) version.

Others are built in Chile, the Philippines, Indonesia (**NBO-105**), and Spain.

BO-105/ATH: Spanish CASA assembled variant rigidly mounts 1x Rh 202 20-mm cannon under the fuselage.

NOTES
External stores are mounted on weapons "outriggers" or racks on each side of the fuselage. Each rack has one hardpoint. This helicopter is produced by the Eurocopter Company. It was formed as a joint venture between Aerospatiale of France, and Daimler-Benz Aerospace of Germany. Other missions include: direct air support, antitank, reconnaissance, search and rescue, and transport. Clamshell doors at rear of cabin area open to access cargo area. Cargo floor has tie-down rings throughout.

United States Light Helicopter MD-500MD/Defender



Weapon & Ammunition Types	Combat Load
Loading Options	**2000**
M134 7.62-mm 6x barrel, mini-gun twin pods	
.50 cal MG pods	2
M260 2.75-in Hydra 70 rocket pods (7 or 12 each)	2
M75 40-mm grenade launchers	2
MK19 40-mm grenade launcher	2
TOW missiles (2 each pod)	4
Hellfire ATGM	
Stinger AAM	
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Hughes model 369, Cayuse, Loach
Date of Introduction: 1977 (MD-500 MD)
Proliferation: At least 22 countries
Description: Variants in "( )"
Crew: 1 or 2 (pilots)
Transports 2 or 3 troops or cargo internally, or 6 on external platforms in lieu of weapons.
Blades:
- Main rotor: 4 or 5 (see VARIANTS)
- Tail rotor: 2 or 4 (see VARIANTS)

Engines: (see VARIANTS)
Weight (kg):
- Maximum Gross: 1,361 (500), 1,610 (530)
- Normal Takeoff: 1,090
- Empty: 896

Speed (km/h):
- Maximum (level): 241 (500), 282 (530)
- Cruise: 221 (500), 250 (530)

Ceiling (m):
- Service: 4,635 (500), 4,875 (530)
- Hover (out of ground effect): 1,830 (500), 3,660 (530)
- Hover (in ground effect): 2,590 (500), 4,360 (530)

Vertical Climb Rate (m/s): 8.4 (500), 10.5 (530)
Fuel (liters):
- Internal: 240
- Internal Aux Tank: 80

Range (km): 485 (500), 430 (530) normal load
Dimensions (m):
- Length (rotors turning): 9.4 (500), 9.8 (530)
- Length (fuselage): 7.6 (500), 7.3 (530)
- Width: 1.9
- Height: 2.6 (500), 3.4 (530 over mast sight)

Dimensions continued (m):
- Main Rotor Diameter: 8.0 (500), 8.3 (530)
- Tail Rotor Diameter: 1.4

Cargo Compartment Dimensions (m):
- Floor Length: 2.4
- Width: 1.3
- Height: 1.5

Standard Payload (kg):
- Internal load: INA
- External load: 550

Survivability/Countermeasures:
Some models have radar warning receivers.
Chaff and flare systems available.
Infrared signature suppressors can be mounted on engine exhausts.

ARMAMENT
MD-500MD/Scout Defender: Version with Most probable armament: Fitted with guns, rockets, grenade launchers, or combination on 2 x fuselage hardpoints. For general use recommend 12.7-mm MG and a twin TOW ATGM pod.

MD-500MD/TOW Defender: Twin TOW missile pods on 2x hardpoints; mounts missile sight in lower-left front windshield.

Antitank Guided Missiles
Name: TOW 2
- Alternative Designations: BGM-71D
- Missile Weight (kg): 28.1 (in tube)
- Warhead Type: Tandem Shaped Charge
- Armor Penetration (mm): 900 est
- Maximum Range (m): 3,750
- Rate of fire (/min): 3-4, based on range
- Probability of Hit (%): 90

Other Missile Types: TOW, ITOW, TOW 2A

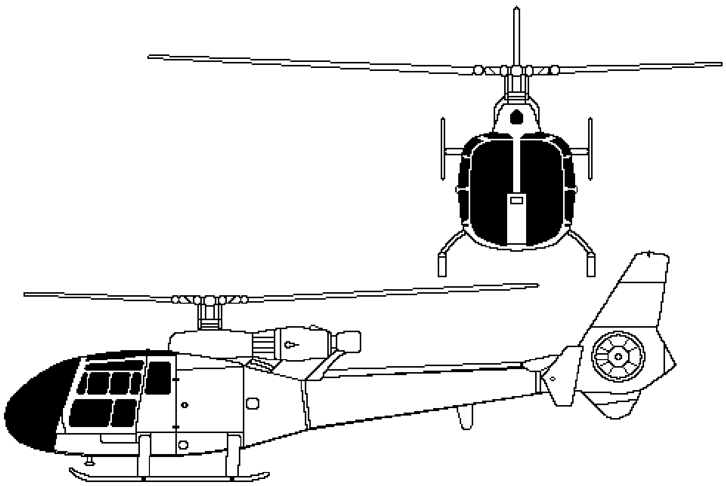
AVIONICS/SENSOR/OPTICS
The MD-500MD allows for mounting a stabilized direct-view optical sight in the windshield. Options exist to fit a mast-mounted, multiple field of view optical sight, target tracker, laser range finder, thermal imager, 16x FLIR for night navigation and targeting, and autopilot.

Night/Weather Capabilities:
Optional avionics include GPS, ILS and full instrument weather conditions packages.
The more advanced variants are fully capable of performing missions under any conditions.

VARIANTS
MD-500D: Civilian version. North Korea acquired 80+ aircraft and converted them into gunships. The **NK MD-500D Gunship** has rockets and 7.62-mm MGs, or ATGMs.
Hughes 500M: Military export OH-6, in mid-1970s with upgrade 278-shp Allison 250-C18 turboshaft engine, and "V" tail.
MD-500MD/Scout and TOW Defender: Improved military version of the model 500M with 5 main rotor blades, 375-shp Allison 250-C20B turboshaft engine, and T-tail.
MD-500E/MD-500MG/Defender II: Has more elongated streamlined nose, optional 4x blade tail rotor for reduced acoustic signature. Possible mast-mount sight.
MD-530MG/Defender aka **-500MD/MMS TOW:** Has a mast-mount sight, and incorporates upgrades of previous variants.
OH-6A/Cayuse: Light observation variant in mid-1960s for US Army. It was fitted with 1x 253-shp turboshaft, 4 bladed main rotor, and offset "V" tail. Options include M134 7.62-mm mini-gun or M129 40-mm auto-grenade launcher.
OH-6A/MD-530F Super Cayuse/Lifter: Upgraded engine (to a 425-shp), and avionics in 1988 for US Army.
MH-6B: Army Special Ops variant "Little Bird", carries 6 for insertion/extraction.
AH-6C "Little Bird" armed variant.
AH-6J: "Little Bird" Attack variant with M134,.50-cal mini-gun, MK19 AGL, HELLFIRE ATGM or 2.75 in rockets, etc.

NOTES
External stores are mounted on weapons racks on each side of the fuselage. Each rack has one hardpoint. Other missions include: direct air support, reconnaissance, security and escort.

French Light Helicopter SA-341/342 Gazelle



Weapon & Armament Types	Combat Load
7.62-mm Mini-TAT MG or	
20-mm GIAT M.621 cannon or	**100**
2x 7.62-mm AA-52 FN MG pods	**1,000**
Other Loading Options	
2.75-in rocket pods (7 ea.)	2
68-mm SNEB rocket pods (12 ea)	2
57-mm rocket pods (18 ea.)	2
HOT ATGM	**4-6**
AT-3 SAGGER ATGM	4
AS-12 ASM	**4 or 2**
SA-7 GRAIL AAM	2
MISTRAL AAM	2
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Variants
Date of Introduction: 1961 SA-341, 1973 SA-342
Proliferation: At least 23 countries
Description: Variants in "( )"
Crew: 1 or 2 (pilots)
Transports 3 troops or 1 litter, or cargo.
Blades:
  Main rotor: 3
  Tail rotor: 13 (fenestron in tail)
Engines: 1x 590-shp Turbomeca Astazou IIIB turboshaft
Weight (kg):
  Maximum Gross: 1,800 (SA 341), 1,900 (SA 342K), 2,000 (SA 342L/M)
  Normal Takeoff: 1,800
  Empty: 998
Speed (km/h):
  Maximum (level): 310
  Cruise: 270
Ceiling (m):
  Service: 4,100 (SA 341), 5,000 (SA 342)
  Hover (out of ground effect): 2,000 (SA 341), 2,370 (SA 342)
  Hover (in ground effect): 2,850 (SA 341), 3,040 (SA 342)
Vertical Climb Rate (m/s): 12.2
Fuel (liters):
  Internal: 445
  Internal Aux Tank: 90
  Additional Internal Aux Tank: 200
Range (km) Normal Load: 670 (SA 341), 735 (SA 342)
Dimensions (m):
  Length (rotors turning): 11.9
  Length (fuselage): 9.5
  Width: 2.0
  Height: 3.1
  Main Rotor Diameter: 10.5
  Tail Rotor Diameter: 0.7
Cargo Compartment Dimensions (m):
  Floor Length: 2.2
  Width: 1.3
  Height: 1.2
Standard Payload (kg):
  Internal load: 750
  External on sling only: 700

Survivability/Countermeasures:
IR signature suppressor on engine exhaust.

ARMAMENT
Most Probable Armament:
SA 341H: Can carry 4x AT-3 ATGMs, and 2x SA-7, or 128-mm or 57-mm rockets, and 7.62-mm machinegun in cabin.
SA 342L: Export light attack variant with either rocket pods or machineguns.
SA 342K: Armed antitank version with 4-6x HOT ATGMs and 7.62-mm MG.
SA 342M: Armed version with 4 x HOT ATGMs, 2x Mistral AAM, 7.62-mm MG.

Antitank Guided Missiles
Name: HOT 3
  Missile Weight (kg): 32 (in tube)
  Warhead: Tandem shaped Charge
  Armor Penetration (mm CE): 1250
  Maximum Range (m): 75/4,000
  Rate of fire (missiles/min): 3-4, depending on range

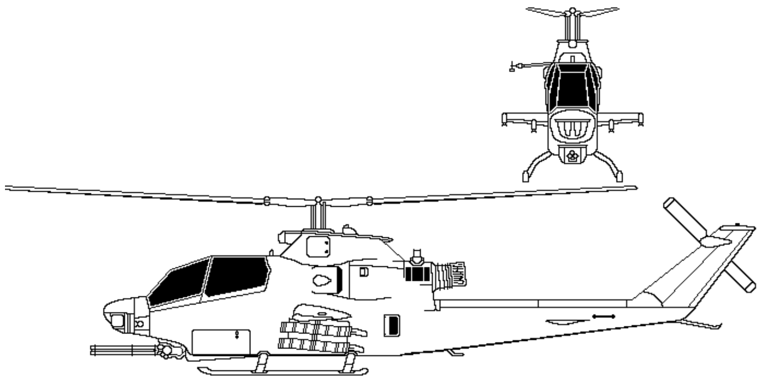
AVIONICS/SENSOR/OPTICS
The SA 342M has a roof-mounted Viviane stabilized direct view/infrared/laser sight to allow night firing of HOT ATGMs

Night/Weather Capabilities:
The aircraft is NVG compatible; and by its instruments, avionics, autopilot, and nav computer, is capable of flight in day, night, and instrument meteorological conditions.

VARIANTS
SA 341 Gazelle: Developed by Aerospatiale in France. Others were built in the UK by Westland, and in Yugoslavia.
SA 341B/C/D/E: Production versions for British military. Used in communications and training and roles.
SA 341F: Production version for French Army. A GIAT M.621 20-mm cannon is installed on right side of some aircraft. Rate of fire is either 300 or 740 rpm. Upgraded engine to Astazou IIIC.
SA 341H: Export variant.
SA 342K: Armed SA 341F with upgraded 870-shp Astazou XIVH engine, mostly exported to the Middle East.
SA 342L: Export light attack variant with Astazou XIVM engine.
SA 342M: Improved ground attack variant for French Army, with 4-6 HOT ATGMs, possibly fitted with Mistral air- to-air missiles. Similar to SA 342L, but with improved instrument panel, engine exhaust baffles to reduce IR signature, navigational systems, Doppler radar, and other night flying equipment. Fitted with Viviane FCS with thermal sight for night attack. This the OPFOR Tier 1 baseline light helicopter.

NOTES
Missions include: direct air support, anti-helicopter, reconnaissance, escort, security, transport, and training. External stores are mounted on weapons "outriggers" or racks on each side of the fuselage. Each rack has one hardpoint. The bench seat in the cabin area can be folded down to leave a completely open cargo area. Cargo floor has tie down rings throughout.

United States Attack Helicopter AH-1F/Cobra



Weapon & Ammunition Types	Combat Load
20-mm 3x barrel Gatling gun	**750**
Other Loading Options	
TOW missiles (4 ea pod)	**0-8**
2.75-in Hydra 70 rocket pods (19 each)	**2-4**
7.62-mm 6x barrel rotary MG pods	**0-2**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM

Alternative Designations: Hueycobra, Bell 209, AH-1S - upgrades to standard
Date of Introduction: 1979
Proliferation: At least 11 countries
Description:
Crew: 2 (pilots in tandem seats)
Blades:
- Main rotor: 2
- Tail rotor: 2

Engines: 1x 1,800-shp AlliedSignal T-53-L-703 turboshaft
Weight (kg):
- Maximum Gross: 4,535
- Normal Takeoff: 4,524
- Empty: 2,993

Speed (km/h):
- Maximum (level): 315
- Cruise: 227

Max "G" Force: INA
Ceiling (m), Service: 3,720
- Hover (out of ground effect): INA
- Hover (in ground effect): 3,720

Vertical Climb Rate (m/s): 8.5
Internal Fuel (liters): 991
Range (km):
- Normal Load: 610
- With Aux Fuel: N/A

Dimensions (m):
- Length (rotors turning): 16.3
- Length (fuselage): 13.6
- Width (including wing): 3.2
- Height: 4.1
- Main Rotor Diameter: 13.4
- Tail Rotor Diameter: 2.6

Cargo Compartment Dimensions: Nil
Standard Payload (kg): 1,544

Survivability/Countermeasures:
Infrared signature suppressors on engine exhaust. Radar warning receivers, IFF, infrared jammer, chaff and flares. Armored cockpit.

ARMAMENT

The chin-mounted turret accepts Gatling-type guns ranging from 7.62-mm to 30-mm. Some aircraft have been modified to accept Stinger missiles (air-to-air Stinger or ATAS).

Most Probable Armament:
AH-1F: M197 3x barrel 20-mm Gatling gun in chin turret. Also on under-wing hardpoints, 8x BGM-71D TOW 2 antitank missiles, and 2x70-mm/ 2.75-in FFAR rocket pods.

20-mm 3x barrel Gatling gun, M197:
Range: (practical) 1,500 m
Elevation: 21° up to 50° down
Traverse: 220º
Ammo Type: AP, HE
Rate of Fire: burst 16±4, continuous 730±50

Antitank Guided Missiles
Name: TOW 2
- Alternative Designations: BGM-71D
- Warhead Type: Tandem Shaped Charge
- Armor Penetration (mm CE): 900+ est
- Rate of fire (/min): 3-4, based on range
- Maximum Range (m): 3,750

Other Missile Types: TOW, ITOW, TOW 2A

AVIONICS/SENSOR/OPTICS

The TOW missile targeting system uses a telescopic sight unit (traverse 110º, elevation –60º/+30º), a laser augmented tracking capability, thermal sights and FLIR to allow for acquisition, launch, and tracking of all types of TOW missiles in all weather conditions. It also uses a digital ballistic computer, a HUD, Doppler nav, and a low speed air data sensor on the starboard side for firing, and has in-flight boresighting.

Israeli upgrades includes an integrated FLIR, GPS, laser rangefinder, automatic boresighting, and ability to fire both TOW II and Hellfire.

Night/Weather Capabilities:
The AH-1 is fully capable of performing its attack mission in all weather conditions.

VARIANTS

AH-1F: Current standard Cobra. Also referred to as the "Modernized Cobra". Incorporated all past upgrades. Most older Cobra variants are still in operation, and have been upgraded to the AH-1F standard.

AH-1G: Initial production model in 1966. Most probable armament was 2x 7.62-mm mini-guns, and underwing hardpoints for a mix of weapons and munitions. Also produced in Romania and Japan under license from Bell Textron in the U.S.

AH-1S: 1960s-produced aircraft upgraded in late 1980s to AH-1F weapons standard and improved engine.

AH-1P: A set of AH-1S aircraft fitted with composite rotors, flat plate glass cockpits, and NVG capabilities.

AH-1E: Selected AH-1S upgraded with Enhanced Cobra Armament System using universal turret, 20-mm gun, automatic compensation for off-axis gun firing, TOW ATGM, and weapon management system.

AH-1J: Initial USMC **Seacobra** with twin engine. fielded in 1970s.

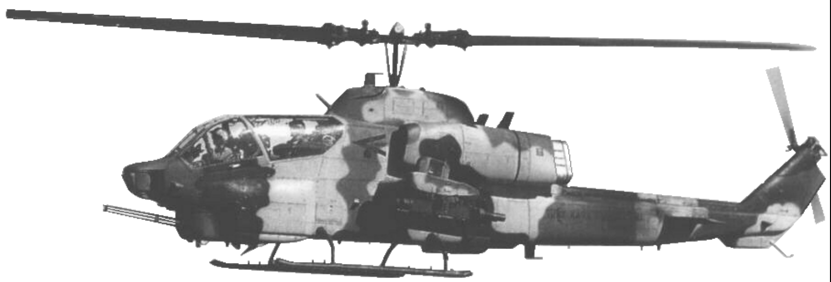
AH-1T/Improved Seacobra added TOW ATGM, and increased hp engine.

AH-1W/Supercobra: Most are variants of AH1-J and AH-T. See data sheet next page.

NOTES

Additional missions include direct air support, security, escort, and air to air combat. External stores are mounted on underwing external stores points. Each wing has two hardpoints for a total of four stations. The gun must be centered before firing underwing stores. The armored cockpit can withstand small arms fire. Composite blades and tailboom can withstand damage from 23-mm cannon and small arms fire.

United States Attack Helicopter AH-1W/Supercobra



Weapon & Ammunition Types	Combat Load
20-mm 3x barrel Gatling gun	**750**
Other Loading Options	
Hellfire missiles (4 each pod)	**0-8**
TOW missiles (4 each pod)	**0-8**
2.75-in Hydra 70 rocket pods (19 each)	**2-4**
AIM-9L/Sidewinder	**2**
External fuel tanks (liters)	**291/378**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Bell 209
Date of Introduction: By 1986
Proliferation: At least 3 countries
Description:
Crew: 2 (pilots in tandem seats)
Blades:
Main rotor: 2
Tail rotor: 2
Engines: 2 x 1,775-shp General Electric T-700-GE-401 turboshaft
Weight (kg):
Maximum Gross: 6,700
Normal Takeoff: 6,700
Empty: 4,670
Speed (km/h):
Maximum (level): 350
Cruise: 270
Max "G" Force: +2.5 to -0.5 g
Ceiling (m):
Service: 5,703
Hover (out of ground effect): 915
Hover (in ground effect): 4,270
Vertical Climb Rate (m/s): 4.0
Internal Fuel (liters): 1,150
Range (km): 590 Normal LoadAux Fuel N/A
Dimensions (m):
Length (rotors turning): 17.7
Length (fuselage): 14.7
Width (including wing): 3.3
Height: 4.2
Main Rotor Diameter: 14.7
Tail Rotor Diameter: 3.0
Standard Payload (kg): 1,740

Survivability/Countermeasures:
Armored cockpit can withstand small arms fire, composite blades, tailboom, and fuel tanks withstand 23-mm cannon its. Infrared signature suppressors on engine exhaust. Radar/laser warning receivers, IFF, infrared jammer, missile launch warner, chaff, flares, and rotor brake.

ARMAMENT
M197, 3x barrel 20-mm Gatling gun in chin turret. On 4 underwing hardpoints, it can mount 8 x TOW or Hellfire ATGMs (or four each), and 2 x 2.75-in FFAR rocket pods. AIM-9L/ Sidewinder provide air-to-air capability. Not all may be used at one time. Mission dictates weapon configuration.

Most Probable Armament:
AH-1W: A representative mix when targeting armor formations is eight Hellfire missiles, two 2.75-in rocket pods, and 750x 20-mm rounds. Gun is centered before firing underwing stores.

20-mm 3x barrel Gatling gun, M197:
Range: (practical) 1,500 m
Elevation: 21° up to 50° down
Traverse: 220º
Ammo Type: AP, HE
Rate of Fire: Burst 16±4, continuous 730±50

Antitank Guided Missiles
Name: TOW 2
Warhead Type: Tandem Shaped Charge
Armor Penetration (mm CE): 900+ est
Maximum Range (m): 3,750
Rate of fire (missiles/min): 3-4 based on range

Name: HELLFIRE II
Warhead Type: Tandem Shaped Charge
Armor Penetration (mm CE): 1,000+
Maximum Range (m): 8,000+
Rate of fire (missiles/min): 2-3

Other Missile Types: TOW, ITOW, TOW 2A HELLFIRE

AVIONICS/SENSOR/OPTICS
The missile targeting system uses a telescopic sight unit (traverse 110º, elevation –60º/+30º) with two magnifications/fields of view, a laser augmented tracking capability, TV, video recorder, thermal sights, FLIR, Doppler navigation, and a digital ballistic computer for acquisition, launch, and tracking of ATGMs in all weather conditions. Helmet-mounted display integrates NVGs with laser target designator (LTD) missile targeting and gun turret. This system allows aircraft to self-designate targets.
NOTE: The LTD enables the AH-1W to designate targets for SAL-H artillery and mortar rounds, other ATGM launchers, and SAL-H aircraft bombs.

Night/Weather Capabilities:
AH-1 is fully capable of performing attack and armed escort missions in all weather conditions from land- or sea-based launch platforms.

VARIANTS
AH-1J: Initial USMC twin engine AH-1 variant fielded in the early 1970s.

AH-1T: AH-1 variant with upgraded engines and powertrain for improved performance. This minimally expanded rotor system and overall dimensions of the AH-1J.

Most older AH-1J Seacobra and AH-1Ts are still in operation, having been upgraded to the AH-1W standard.

AH-1RO: Talks are ongoing between Romania IAR industries and Bell Textron. Construction of a variant, possibly called "Dracula", may occur in the near future.

AH-1Z/AH-1(4B)W: Four-bladed variant called the "King Cobra" or "Viper", with better flight performance. It contains an integrated digital tandem cockpit and digital map display. Improved FCS includes helmet-mount sight system.

NOTES
Additional missions include: direct air support, escort, target designation, security, reconnaissance, air to air combat, and anti-ship. This aircraft costs approximately $10.7 million, inexpensive compared to other modern attack helicopters; but its performance is similar. Thus many nations consider this aircraft as a good candidate for fielding in attack helicopter squadrons. This the OPFOR Tier 1 representative helicopter system.

Russian Attack Helicopter Ka-50/HOKUM and Ka-52/HOKUM-B

Ka-50/HOKUM National War College Photos

Weapon & Ammunition Types	Combat Load
1x 2A42 30-mm cannon	**460 rds**
Frag-HE	230
APFSDS-T	230
Other Loading Options	
AT-16/Vikhr-M ATGM pod (6) or Hermes-A ASM pod (6 each)	**2-4 or 2**
80-mm rocket pods (20 each)	**2**
Twin 23-mm gun pods	**940 rds**
500-kg bombs (rarely used)	**4**
AA-18S (SA-18S) AAM	**2**
AA-11/ARCHER AAM	**2**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Black Shark, Werewolf , HOKUM-A
Date of Introduction: Limited fielding by 1995. Ka-52 fielding starts in 2011.
Proliferation: 2 countries
Description:
Crew: 1 (2 in Ka-52)
Blades:
Main rotor: 6 (2 heads, 3 blades each)
Tail rotor: None
Engines: 2x 2,200-shp Klimov TV3-117VMA turboshaft
Weight (kg):
Maximum Gross: 10,800
Normal Takeoff: 9,800
Empty: 7,692
Speed (km/h):
Maximum (level): 310, 390 diving
Cruise: 270
Sideward: 100+, Rearward: 100+
Turn Rate: unlimited
Max "G" Force: +3 to +3.5 g
Ceiling (m):
Service: 5,500
Hover (out of ground effect): 4,000
Hover (in ground effect): 5,500
Vertical Climb Rate (m/s): 10
Fuel (liters):
Internal: INA
External Fuel Tank: 500 ea. (max 4 x)
Range (km):
Maximum Load: 500
Normal Load: 1,000
With Aux Fuel: 1,100
Dimensions (m):
Length (rotors turning): 16
Length (fuselage): 15.0
Width (including wing): 7.34
Height (gear extended): 4.93
Height (gear retracted): 4
Main Rotor Diameter: 14.5 Cargo
Compartment Dimensions: Negligible
Standard Payload:
External weapons load: 2,500 kg on 4 under-wing hardpoints.

Survivability/Countermeasures:
Main rotors and engines electrically deiced. Infrared signature suppressors can mount on engine exhausts. Pastel/L-150 radar warning receiver, laser warning receiver, IFF, chaff and flares. Armored cockpit. Self-sealing fuel tanks. Pilot ejection system.

ARMAMENT
Most Probable Armament:
HOKUM A/B/N: Fuselage-mounted 30-mm cannon on right side, 40 x 80-mm rockets, 12 x Vikhr-M ATGMs, 2 x AA-18S AAMs (ATGM pod can launch AA-18S AAMs).

Guided Missiles
Name: AT-16/Vikhr-M antitank missile
Guidance: Laser-beam rider, prox on/off
Warhead: Tandem shpd Chge (HEAT)
Armor Penetration (mm): 1,200
Rate of fire (missiles/min): 2-3 per range
Range (m): 1,000- 10,000
Other Missile Types: AT-16 HE, Ataka 9M120-1 HEAT, HE (below)

AVIONICS/SENSOR/OPTICS
The Shkval FCS uses low-light level TV/ FLIR sights, a laser range-finder (10 km), air data sensor, and digital data link which interface with an FC computer, autopilot, helmet sighting system and HUD for target location, acquisition, designation, and firing.

Night/Weather Capabilities:
This aircraft's avionics package ensures full day/night, all weather capability. If it is to be employed at night in an attack role, it must be fitted with a night targeting pod. Pod includes FLIR and a millimeter wave radar. Ka-50N and Ka-52 can perform attack missions in day and night, and all weather conditions.

French companies Thomson-CSF, and Sextant Avionique offer nav/attack systems, which can be fitted to export variants.

VARIANTS
Ka-50A/HOKUM A: Original Hokum. Due to poor performance, it will not be fielded.

Ka-50N/HOKUM N: Night attack variant fitted with a nose-mounted FLIR from Thomson-CSF. The cockpit is fitted with an additional TV display, and is NVG compatible. These replace the Saturn pod on HOKUM-A. ATGM pods hold 6 AT-16/Vikhr missiles.

Later, dual-seat versions were developed. Dual-seat arrangement can significantly improve effectiveness of a combat aircraft, because it frees up the pilot for precision flying, and provides a weapons officer who can give full attention to the combat mission.

Ka-52/Alligator/HOKUM-B: It is a tandem, dual-seat cockpit variant of Ka-50, with 85% of its parts in commonality. Although performance is slightly inferior to Ka-50 in

Russian Attack Helicopter Ka-50/HOKUM and Ka-52/HOKUM-B continued _______

Ka-52/HOKUM-B

some areas (Max g 3.0, 3,600 m hover ceiling), it out-performs its predecessor in other areas (such as 310 km/h max speed), and has an equal service ceiling and range. An upgrade to the more powerful VK-2500 engine has begun.

Ka-52 can be used as an air and ground attack. The fire control system employs a mast-mounted FH-01/Arbalet millimeter wave radar covering the front quadrant. The fire control system has a chin-mounted TV, FLIR, and laser in the UOMZ DOES stabilized ball mounted behind the cockpit. Also included is a Prichal laser range-finder/laser target designator (LTD), with a range of 18+ km. It can acquire, auto-track, and engage moving targets at a range of 15 km. Stationary targets can be engaged to 18+ km.

The Ka-52 can launch AT-16/Vikhr ATGMs, with LBR guidance. However, there have been issues with that missile. A version of AT-9/Ataka, 9M120-1 now has added LBR guidance to its RF; so it could be used on the Ka-52, and supplement or replace Vikhr missile loads.

Another option to replace or supplement Vikhr is Hermes-A. The aircraft has been displayed with 2 pods (12 multi-role missiles), and has been successfully tested. It is a 2-stage supersonic missile with a 170-mm booster stage, and 130-mm sustainer. The aircraft can use its own LTD for guidance, or launch but defer to a remote LTD (man-portable, vehicle mounted, or UAV-mounted) for terminal phase, and shift to its next target. These multi-mode guided ASMs have a range of 18 (15-20) km, and a 28-kg HE warhead large enough to kill any Armored vehicle, and a wide variety of other air or ground targets

Name: Hermes-A multi-role missile
Missile Weight (kg): 32 (in tube)
Guidance: Inertial/ MMW radar ACLOS
or SAL-H with auto-tracker lock-on
Warhead: HE, 28 kg
Armor Penetration (mm): 1,30 0+
Rate of fire (missiles/min): 2
Range (m): 18,000 maximum

A 40-km version of Hermes has been tested and is due in the Near Term. A 100-km version (with a 210 mm booster, for 4 missiles per pylon) is featured at the KBP Tula site, and will be an option. Future versions will have an IR or radar-homing option.

The Ka-52 adds workstation equipment for air battle management. It has 2 identical workstations with aircraft controls for mission hand-off. Russian forces have demonstrated operations with Ka-52s controlling flights of Ka-50N helicopters. It can also be used as a trainer for the Ka-50N.

Ka-50-2/Erdogan: Russian/Israeli cooperative effort competing For the Turkey helicopter contract. The variant has Israeli avionics and a tandem dual seat cockpit similar to the Apache.

NOTES
Additional missions include: direct air support, escort, target designation, security, reconnaissance, air to air combat, and anti-ship.

Russian Attack Helicopter Mi-24/35 HIND

Weapon & Ammunition Types	Combat Load
Fuselage/nose mount gun/MG	**1**
7.62/12.7-mm door MG	**1**
Other Loading Options	
AT-2/-6/-9 ATGMs (See below)	**2**
80-mm S-8 rocket pods (20 ea.)	**2-4**
57-mm S-5 rocket pods (32 ea.)	
122-mm S-13 rocket pods (5 ea.)	
240-mm S-24 rocket pods (1 ea)	
	4
250-kg bombs, including FAE	**2**
500-kg bombs, including FAE	
	2-4
Gun/MG/AGL pods (See below)	**2-4**
AA-8/R-90 or AA-18 AAM	**2-4**
KMGU or K-29 Mine pods	
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Mi-25 or Mi-35 for exports (See Variants).
Date of Introduction: 1976 (HIND D)
Proliferation: At least 34 countries

Description:
Crew: 2 (pilots in tandem cockpits)
Transports: 8 combat troops/4 litters
Blades:
  Main rotor: 5
  Tail rotor: 3
Engines: 2x 2,200-shp Klimov TV3-117VMA turboshaft
Weight (kg):
  Maximum Gross: 11,500
  Normal Takeoff: 11,100
  Empty: 8,500
Speed (km/h):
  Maximum (level): 335
  Cruise: 295
Max "G" Force: 1.75 g
Ceiling (m):
  Service: 4,500
  Hover (out of ground effect): 1,500
  Hover (in ground effect): 2,200
Vertical Climb Rate (m/s): 15
Fuel (liters):
  Internal: 1,840
  Internal Aux Tank (in cabin): 1,227
  External Fuel Tank: 500 ea. x 2
Range (km):
  Normal Load: 450
  With Aux Fuel: 950
Dimensions (m):
  Length (rotors turning): 21.6
  Length (fuselage): 17.5
  Width (including wing): 6.5
  Height (gear extended): 6.5
  Main Rotor Diameter: 17.3
  Tail Rotor Diameter: 3.9
Cargo Compartment Dimensions (m):
  Floor Length: 2.5
  Width: 1.5
  Height: 1.2
  External weapons load: 1,500 kg
    (no weapons): 2,500 kg

Protection/Survivability/Countermeasures:
Armored cockpit and titanium rotor head defeat 20-mm rds. Overpressure system is used for NBC environment. Infrared signature suppressors on engine exhausts. Radar warning receivers, IFF. Infrared jammer, rotor brake. Armored cockpit. ASO-4 Chaff/flare dispenser. Auxiliary power unit for autonomous operation. Main and tail rotors are electrically deiced.

ARMAMENT
Mi-24 has a fuselage or turret nose gun, and at least one door machinegun. It also has 6 pylons (hardpoints), on which it can mount bombs, missiles (ATGMs, ASMs, AAMs), rockets, and gun or grenade or mine pods.

Mission dictates weapon configuration. Available munitions are shown above; not all may be employed at one time. As ammunition/payload weight is expended, more passengers can fit aboard the aircraft.

Fuselage-Mounted Guns/Machineguns
Guns vary widely with different variants (see below). Some are fixed, providing accurate fires along the flight path. Nose turret guns offer more responsive fires against targets to sides, but may lack accuracy, range and ammo capacity of fixed guns. The gun is assisted by rear and side mount guns and arms operated by passengers. Onboard combat troops can fire personal weapons through cabin windows. For gunship missions, usually the only troop is a door gunner, thus permitting more ammo in the cabin. Also, to complement main gun fires, crews can add gun pods.

Guided Missiles
Name: AT-6b or AT-9/Ataka-M (pg 2-24)
  Guidance: Radio-guided
  Warhead: Tandem shpd Chge (HEAT)
  Armor Penetration (mm): 1,100, 800+ERA
  Rate of fire (missiles/min): 3-4
  Range (m): 400-7,000 (6,000 AT-9)
  Other Missile Types: AT-6/Ataka HE, 9A2200 anti-helicopter w/prox fuze

Most Probable Armament:
HIND D: Nose turret-mounted 4-barrel 12.7-mm gatling type minigun, 1,470 rds, 4 pods of 57-mm rockets, and 4 x AT-2C/SWATTER ATGMs.

HIND E: Nose turret-mounted 4-barrel 12.7-mm gatling type minigun, 40 x 80-mm rockets, and 8 x AT-6C/SPIRAL ATGMs.
HIND F: GSh-30K gun on fuselage, 40 x 80-mm rockets, 8 x AT-6C ATGMs, and 2x AA-18 AAMs.

Mi-35M2: Nose turret 23-mm twin gun 470 rds, 40 x 80-mm (or 10 x 122-mm) rockets, 8 AT-6c (or 8 AT-9), and 2 AA-18S/Igla-S AAMs. For tank destroyer role, exchange rocket pods for 8 more ATGMs.

AVIONICS/SENSOR/OPTICS
The ATGM targeting system uses a low-level light TV, a laser target designator, PKV gunsight for pilot, air data sensor, and a missile guidance transmitter. Some versions and specific forces have upgraded FCS.

Russian Attack Helicopter Mi-24/35 HIND continued

VARIANTS

Mi-24A/HIND A/B/C: The original **-A** helicopter had side-by-side seats, single-barrel 12.7-mm MG, 57-mm rocket pods, and AT-2a/b/SWATTER-A/B ATGMs. The export HIND A launched AT-3/SAGGER ATGMs. All of these missiles were manually controlled (MCLOS). The **HIND B** never entered production. **HIND C** was a trainer, without a gun pod. Nearly all of the older HIND A, B and C variants have been upgraded or modified to the HIND D or E standard.

Mi-24D/HIND D: This represents an OPFOR Tier 4 helicopter capability. This gunship has a more powerful engine and improved fire control system. Other upgrades include a 4-barrel 12.7-mm Gatling type gun. Rocket pods can be mounted on the inner 4 pylons, and AT-2c/SWATTER-C ATGMs can be mounted on wing pylons. These SACLOS missiles offer superior range and operational precision over earlier versions. There are NVGs and II sights, which permit night flying but virtually no night engagement capability, except in illuninated areas.
Mi-25: Export version.

Mi-24V/HIND E: The most proliferated version. This variant represents OPFOR Tier 3 helicopter capability. It has the 4-barrel mini-gun and up to 8 AT-6/Shturm-V series ATGMs (most recent is AT-6C). It can also launch Ataka/AT-9 series ATGMs. With its heads-up-display (HUD) fire control system, the aircraft can also launch AA-8 AAMs. **Mi-35** is an export version of HIND E. **Mi-35O** night attack upgrade with an Agema FLIR ball.

Mi-24P/HIND F: This gunship variant has A 30-mm twin gun affixed to right side. ATGMs are the AT-6 and AT-9 series.
Mi-35P is an export version of the HIND F.

Mi-24PS: Ministry of Internal Affairs version, with wingtip ATGM launchers, sensor ball with FLIR night sights and loud speakers.

Mi-24R/HIND G-1: Mi-24V variant for NBC sampling. It has mechanisms for soil and air samples, filter air, and place marker flares.

Mi-24K/HIND G-2: Photo-reconnaissance and artillery fire direction variant. It has a camera in the cabin, gun, and rocket pods, but no targeting system. Upgrades to the Mi-35M standard are the **Mi-24VK-1** and **Mi-24PK-2.**

Mi-24PN/Mi-35PN: Russian upgrade of Mi-24P/35P with Zarevo FLIR FCS.

Mi-24VP is a Russian response to lack of satisfaction with the 30-mm gun. This variant replaces the gun with a twin 23-mm nose turret gun and 470-mm rounds. It has been fielded in limited numbers.

Mi-24VM/Mi-35M: The program integrates a suite of compatible upgrades. It has main and tail rotors from Mi-28, and a new engine and transmission, with improved capability for nap-of-the-earth (NOE) flight. It includes: hardpoints reduced to 4, hover rise to 3,000 m, fiberglass rotor blades, fixed landing gear, scissors tail rotor, new nav, and stabilized all-weather FLIR ball FCS. Export Mi-24VP with FLIR sights is **Mi-35M1** (NFI). Mi-35-PM is a Mi-35P upgraded to -M standard. Indian **Mi-35**s are upgrading to -M standard.

Mi-24VK-1 and **Mi-24PK-2**: upgrades for earlier helicopters to the Mi-35M standard.

The **Mi-35M2,** is latest export version, and the most robust version of the Mi-24/35 HIND helicopter. This variant represents OPFOR Tier 2 helicopter capability. It has new 2,400-shp VK-2500 engines. Ceiling is increased to 5,700 m (4,000 hover). The French based FCS pod has a Chlio FLIR night sight. Armanment is: twin barrel 23-mm nose turret gun, 12.7-mm NSV MG (at the cargo door), 16 x AT-6c (or AT-9) ATGMs, and 2 rocket pods. Other options include AA-8, AA-11, or AA-18S AAMs. A 30-mm nose gun is available.
For tank destroyer role, exchange rocket pods for pods with 8 more ATGMs.

Other Country Upgrades:
Mi-35D: Export private venture upgrade with weapons systems from the Ka-50/Hokum helicopter. Changes include the Shkval FCS, Saturn FLIR, and up to 16 AT-16/Vikhr ATGMs. For AAM, the AA-18 would be replaced with AA-18S (SA-18S/Igla-Super).

Tamam Mi-24 HMSOP/ Mission 24: Israeli upgrade program. It includes a TV FCS with FLIR, autotracker, and GPS. Contrary to other HINDs, The pilot sits in front, with the gunner in the rear. ATGM is the NLOS Spike-ER. The launcher can also launch Skylite UAVs, then hand them off to ground controllers.

Mi-24 Mk III: South African upgrade.
It has a 20-mm Gatling-type gun, and ZT-35/ Ingwe ATGM. The Ukrainian **Super HIND Mk II** would be similar, with Mokopa.

Former WP countries V4 (Poland, Slovakia, Cz, Hungary) have agreed to cooperate on upgrades. The Polish plan includes a 3-barrel 20-mm Gating gun and Spike-ER ATGM.

NOTES
Additional missions include: direct air support, escort, target designation, security, reconnaissance, air to air combat, and anti-ship. Optional upgrades include the Mi-28's AT-9/Ataka 8-missile launcher (16 total), or Israeli Spike-LR ATGM launcher. A new upgrade is addition of a laser target designator in the FCS, which can guide semi-active laser-homing bombs, and laser-guided 57/80/122-mm rockets from pods.

Russian Attack Helicopter Mi-28N/HAVOC

National War College Photos

Most Common Armament:	Combat Load:
1x 2A42 30-mm cannon	**250 rds**
Other Loading Options: AT-6c or AT-9/Ataka pods (4 ea pod)	**2-4**
S-8 80-mm rocket pod (20 ea) or S-13 122-mm rocket pod (5 ea) Preferred type S-8Cor laser-guided	**2-4**
AS-12/KEGLER ASM	**2**
23-mm gun pods (250 rds)	**2**
250/500-kg bombs	**2-4**
AA-18S (SA-18S) AAM pod (2-4 ea)	**2**
KMGU scatterable mine pod	**2-4**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: N/A
Date of Introduction: N/A
Proliferation: This aircraft is fielded in very limited numbers in one country**.** Russian fielding increase is due in 2011.
Description:
Crew: 2 pilots in tandem cockpits
Blades:
Main rotor: 5
Tail rotor: 4 (in “X” configuration)
Engines: 2x 2,200-shp Klimov TV3-117VMA turboshaft
Weight (kg):
Max Gross: 11,500
Normal Takeoff: 10,400
Empty: 7,000
Speed (km/h):
Max (level): 300
Cruise: 260
Sideward: 100, Rearward: 100
Turn rate: 60^0 /second
Max “G” Force: -.5 to +3.7 g
Ceiling (m):
Service: 6,000
Hover (out of ground effect): 3,600
Hover (in ground effect): INA
Vertical Climb Rate (m/s): INA
Fuel: (liters)
Internal: 1,900
Internal Aux Tank: N/A
External Fuel Tank: INA
Range: (km)
Max Load: INA
Normal Load: 475
With Aux Fuel: 1,100
Dimensions: (m)
Length (rotors turning): 21.2
Length (fuselage): 16.8
Width (including wing): 4.9
Height: 4.7
Main Rotor Diameter: 17.2
Tail Rotor Diameter: 3.8
Cargo Compartment Dimensions: Negligible
Standard Payload: 3,640 kg on 4 underwing stores points.

Survivability/Countermeasures:
Armored cockpit frame is made of titanium, steel, and ceramic. It can withstand hits of 20-mm shells at a minimum. The cockpit glass is bulletproof to 12.7-mm rounds, and resistant to fragmentation from 20-mm shells. The HAVOC has a high altitude ejection system that jettisons wings and cockpit doors when the crew jumps to safety with parachutes. It has a “technical compartment” accommodating two persons, to evacuate the crew from downed aircraft. Main rotors and engines are electrically deiced. Self-sealing fuel tanks. Infrared signature suppressors mounted on engine exhausts. Radar warning receivers, pressurized cockpit, IFF, chaff, decoys, flares.

ARMAMENT

ATGMs:
See pg 2-24.

Most Probable Armament:
Mi-28A/N: Chin turret-mounted 2A42 30-mm auto-cannon, 40 x 80-mm (or 10 x 122-mm) unguided or semi-active laser-homing rockets, 14 x AT-6c/Kokon-M ATGMs, and 2 x AA-18S. Note. The ATGM pods can launch other ATGMs and selected AAMs.

SENSOR/OPTICS
The HAVOC has optical magnification, a HUD, 2 FLIR sights, targeting radar, and a laser designator for target engagement. A helmet sighting system turns the cannon in the direction the pilot is looking. Rotor blade-tip pitot tubes give speed/drift data for targeting at low airspeed. For night/weather capabilities, see below.

VARIANTS
Mi-28A is the original version, and is primarily a daylight only aircraft.

Mi-28N: The Mi-28N has avionics upgrades. Use of night-vision goggles gives day/night, all-weather mission capability. The “Night version” (**Mi-28NE** for export) features an integrated rotor-hub radar for targeting and navigation, autopilot, an inertial nav system, thermal night sight, and low-light level TV helmet targeting system for target engagement. It is probable that changes for the Mi-28M (below) will be applied to Mi-28N, and in fact, to all Mi-28s.

Mi-28M: Next upgrade version currently in development. It includes 2x 2,400-shp Klimov VK-2500 (TV3-117SB3) turboshaft engines, improved transmission, and more efficient rotor blades. These compensate for added avionics weight, and increases in armament basic load. The aircraft’s upgraded avionics offer better coordination of group combat actions through datalinks. A likely ATGM change will be to the Krizantema/AT-15, with 6,000-m range and 1,500+ mm penetration. A version of AT-9/Ataka, 9M120-1 now has RF and laser beam rider guidance as on Krizantema. Thus Ataka can be used to supplement AT-15missile loads.

NOTES
Additional missions include: direct air support, escort, target designation, security, reconnaissance, air to air combat, and anti-ship. Although this aircraft is routinely compared to the U.S. AH-64 Apache, it is much larger and less maneuverable than its U.S. counterpart.

British Medium Multirole Helicopter Lynx

National War College Photo

Weapon & Ammunition Types	Combat Load
Loading Options	
20-mm Gatling gun	**2**
2x 7.62-mm AA-52 FN MG pods	**2**
12.7-mm machinegun pod	**2**
20-mm GIAT Mini-gun pods	**2**
HOT/TOW/HELLFIRE ATGMs (4 each pod, up to 8 in cabin)	**8-16**
2x AAM pod	**2**
Sea Skua/AS-12 ASM	**2**
2x 68-mm or 2.75-in rocket pods (18 or 19 each)	**36 or 38**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: AH. Mk-1, 7, 9
Date of Introduction: 1977
Proliferation: At least 11 countries
Description: Variants in "( )"
Crew: 2 (pilots)
Transports: 9 troops, 6 litters or cargo.
Blades:
Main rotor: 4
Tail rotor: 4
Engines: 2x 900-shp Rolls Royce Gem 42-1 turboshaft, 2x 1,260 LHTEC CTS800-4N turboshaft (Mk 9)
Weight (kg):
Max Gross: 4,535, 5,126 (Mk 9)
Normal Takeoff: 2,658, 3,496 (Mk 9)
Empty: 2,578
Speed (km/h):
Max (level): 289
Cruise: 259, 285 (Mk 9)
Sideward: 130, Rearward: INA
Max "G" Force: +2.3 to -0.5
Ceiling (m):
Service: INA
Hover (out of ground effect): 3,230, 5,126
Hover (in ground effect): 3,660
Vertical Climb Rate (m/s): 7
Fuel (liters):
Internal: 985
Aux fuel : 696
Range (km):
Normal Load: 630
With Aux Fuel: 1,342
Dimensions (m):
Length (rotors turning): 15.2
Length (fuselage): 13.2
Width: 3.8, 3.0 (Mk 9)
Height: 3.7
Main Rotor Diameter: 12.8
Tail Rotor Diameter: 2.2, 2.4 (Mk 9) Cargo
Compartment Dimensions (m):
Floor Length: 2.1
Width: 1.8
Height: 1.4
Standard Payload (kg):
Internal load: 907
External on sling only: 1,360, 2,000 (Mk 9)

Survivability/Countermeasures:
Engine exhaust suppressors, infrared jammer, and flare/chaff dispensers are available. Rotor brake and self-sealing fuel tanks are used.

ARMAMENT
The Lynx employed by ground forces can be equipped with two 20-mm cannons mounted externally to permit 7.62-mm machineguns to be fired from the cabin. Two fuselage pylons allow for external stores.

Most Probable Armament
Armed versions have side-mounted 20-mm gun and 8x Hellfire ATGMs. An additional load of 8 missiles can be carried in the cabin.

AVIONICS/SENSOR/OPTICS
Army variants equipped for TOW missiles have a roof-mounted sight (over the left-hand pilot's seat) with IR and thermal capabilities for firing. Optional equipment allows for target magnification, LLLTV, cameras, and IR searchlight. Safire or other FLIR for night capability.

Night/Weather Capabilities:
The aircraft is NVG compatible, and through instruments, avionics, autopilot, and doppler navigation system, is capable of operations day and night, and is instrumented for adverse meteorological conditions.

VARIANTS
Developed under a partnership between predominantly Westland of the United Kingdom, and Aerospatiale of France. Listed below are primary and most proliferated variants used by ground forces. Many others exist in small numbers for ground and naval forces.

Lynx AH. Mk 1: The basic army multirole and gunship version. This aircraft has skid-type landing gear. Most have been converted to **Mk 7** format.

Lynx AH. Mk 7: Also known as **AH 1**. Upgraded British army version, some with improved main rotor blades. Reverse-direction tail rotor to reduce noise signatures and improve performance. Aircraft has skid-type landing gear.

Lynx AH. Mk 9: aka **Super Lynx** or **Light Battlefield Helicopter**. Implemented tricycle-type landing gear, improved rotor blades, and upgraded engines to increase performance. Mostly used in tactical transport role, with no ATGM launch capability.

Battlefield Lynx: Export version of Lynx AH. Mk 9 that can be armed with ATGMs. See **Most Probable Armament** (left).

NOTES
This aircraft was designed to be both a transport and an attack aircraft. Missions include: direct air support, antihelicopter, reconnaissance, escort, security, transport, and training.

Each fuselage side has one pylon allowing for a single gun pod or missile rack. Lynx is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) with its engine load sharing system. If an engine fails, the other's output increases.

Russian Medium Multirole Helicopter Mi-2/HOPLITE

Weapon & Ammunition Types	Combat Load
1x 23-mm automatic cannon 1x 7.62-mm or 12.7-mm MG	
Other Loading Options:	
AT-3c/SAGGER ATGM (mounted on wing pods)	**8** 4
57-mm rocket pods (16 each)	**2**
Twin or single fixed 7.62-mm or 12.7-mm MG	**Based on mix**
External fuel tanks (liters)	**238**
AA-7b (SA-7b) missile	**4**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: INA
Date of Introduction: 1965
Proliferation: Widespread
Description:
Crew: 1 (pilot)
Transports 6-8 troops
Blades:
Main rotor: 3
Tail rotor: 2
Engines: 2x 400-shp PZL GTD-350 (series III and IV) turboshaft
Weight (kg):
Maximum Gross: 3,700
Normal Takeoff: 3,550
Empty: 2,372
Speed (km/h):
Maximum (level): 220
Cruise: 194
Ceiling (m):
Service: 4,000
Hover (out of ground effect): 1,000
Hover (in ground effect): 2,000
Vertical Climb Rate (m/s): 4.5
Fuel (liters):
Internal: 600
External Fuel Tank: 238 ea.
Range (km):
Maximum Load: 170
Internal Fuel Load: 440
With Aux Fuel: 790
Dimensions (m):
Length (rotors turning): 17.4
Length (fuselage): 11.9
Width: 3.2
Height: 3.7
Main Rotor Diameter: 14.6
Tail Rotor Diameter: 2.7
Standard Payload:
Transports 700 kg internal cargo or 800 kg external load on 4x external hardpoints.

Survivability/Countermeasures:
Main and tail rotor blades electrically deiced.

ARMAMENT
23-mm Automatic Cannon, NS-23KM:
Range: (practical) 2,500 m
Elevation/Traverse: None (rigidly-mounted)
Ammo type: HEFI, HEI, APT, APE, CC
Rate of Fire (rpm): (practical) 550

7.62-mm or Pintle-mounted Machinegun:
(may be mounted in left-side cabin door)
Range: (practical) 1,000 m
Ammo type: HEFI, HEI, APT, APE, CC
Rate of Fire (rpm): (practical) 250

OR

12.7-mm or Pintle-mounted Machinegun:
(may be mounted in left-side cabin door)
Range: (practical) 1,500 m
Ammo type: API, API-T, IT, HEI
Rate of Fire (rpm): (practical) 100

AVIONICS/SENSOR/OPTICS
The cannon is pilot sighted, and fire is adjusted by controlling attitude of the aircraft.

Night/Weather Capabilities:
The Mi-2 is primarily a daylight only aircraft.

VARIANTS
Mi-2B: Upgrade with improved navigation and electrical system s

Mi-2R: Ambulance version that carries 4x litter patients.

Mi-2T: Transport version that carries 8 personnel.

Mi-2URN: Armed reconnaissance variant, employs 57-mm unguided rockets, and mounts a gun sight in the cockpit for aiming all weapons.

Mi-2URP: The antitank variant. Carries 4x AT-3C Sagger ATGMs (pg 2-24) on external weapons racks, and 4x additional missiles in the cargo compartment.

Mi-2US: The gunship variant, employs an airframe modification that mounts a 23-mm NS-23KM cannon to the portside fuselage. It also employs 2x 7.62-mm gun pods on external racks, and 2x 7.62-mm pintle-mounted machineguns in the cabin.

PZL Swidnik: A Polish-produced variant under license from Russia. It features minor design changes, but same performance, characteristics, and missions. Polish MOD officials will upgrade the gunship version with a new ATGM. Likely choice is between the Israeli 6 km FOG-M Spike-ER missile, and the 4 km HOT-3. The 4-missile launcher will also have a thermal night sight.

NOTES
External stores are mounted on weapons racks on each side of the fuselage. Each rack has two hardpoints for a total of four stations. Additional missions include; direct air support, reconnaissance, transport, medevac, airborne command post, smoke generating, minelaying, and training. The cabin door is hinged rather than sliding, which may limit operations. There is no armor protection for the cockpit or cabin. Ammo storage is in the aircraft cabin, so combat load varies by mission. Some Mi-2USs currently employ fuselage-mounted weapon racks rather than the 23-mm fuselage-mounted cannon, which is removed. Some variants however, still employ the cannon.

Chinese Medium Multi-role Helicopter Z-9/Haitun and WZ-9 Gunship


Naval Z-9C


Z-9G Launching missile

Weapon & Ammunition Types	Combat Load
23-mm Type 23-3 gun Fixed (WZ-9)	**200**
HEI-T and API-T	100@
Other Loading Options	
12.7-mm twin machinegun pod	**2**
23-mm gun pod	**2**
90-mm rocket pods (7 ea) or 57-mm rocket pods (16 each)	**2**
Red Arrow-8F ATGM (2 or 4/pod)	**4-8**
TY-90/FN-5 AAM (MANPADS)	**2**
A244/Mk-46 Mod 1Torpedo	**1**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: See Variants
Date of Introduction: 1994
Proliferation: At least 3 countries
Description:
Crew: 1 for Z-9, 2 for WZ-9
Transports: 9-12 troops, 4-8 litters or cargo
Blades:
Main rotor: 4
Tail rotor: 13 Z-9A, 11 Z-9B/WZ-9
Engines: 2 x turboshaft, 1,480 hp
Weight (kg):
Max Takeoff: 4,100
Empty: 2,050
Speed (km/h):
Max (level): 315
Cruise: 280
Max "G" Force: INA
Ceiling (m):
Service: 4,500 Z-9A, 6,000 Z-9B/WZ-9
Hover (out of ground effect):1,020 Z-9A
1,600 Z-9B
Hover (in ground effect): 1,950 Z-9A
2,600 Z-9B
Vertical Climb Rate (m/s): 246
Fuel (liters):
Internal: 1,140
Aux fuel : 180
Range (km):
Normal Load: 860
With Aux Fuel: 1,000
Dimensions (m):
Length (rotors turning): 13.7
Length (fuselage): 12.1 without rotors
Width: 1.9
Height: 4.06 to top of fenestron
Main Rotor Diameter: 12.0
Tail Rotor Diameter: 1.1 in fenestron

Compartment Dimensions (m):
Floor Length: 2.2
Width: 1.9
Height: 1.2
Standard Payload (kg):
Internal load: INA
External on sling only: 1,600
Max 2,038

Survivability/Countermeasures:
Light armor panels. All composite rotors and fenestron, and composite body structure reduce signature. Nomex honeycomb in structure. Limited countermeasure capability.

ARMAMENT
Two fixed 23-mm guns or 12.7-mm MGs. Two pylons permit mounting up to 8 ATGMs, or 4 plus 2 rocket pods.

Most Probable Armament
Combat versions (WZ-9 and Z-9G) have Twin 23-mm gun, four Red Arrow-8F ATGMs, 2x 7-round 90-mm rocket pods, and 2 TY-90 IR-homing AAMs.

Rockets and Missiles
Name: Red Arrow-8F
Type: ATGM
Warhead: Tandem Shaped Charge
Armor Penetration (mm CE): 1,100
Min/Max Range (m): 100/4,000
Rate of fire (missiles/min): 3-4, depending on range

Name: Type 90-1
Type: Air-to-surface rocket
Warhead: Frage-HE
Max Range (m): 7,000

AVIONICS/SENSOR/OPTICS
WZ-9 has a day/night all-weather capability with gyro-stabilized TV/IRST FLIR chin pod gunsight, and SFIM autopilot. Transponder and weather radar are optional. Datalink for naval observation supports over-the-horizon attack.

Night/Weather Capabilities:
The aircraft is NVG compatible, and through instruments, avionics, autopilot, and doppler navigation system, is capable of operations day and night, and is instrumented for adverse meteorological conditions.

VARIANTS
License-produced variant of the Eurospatiale SA 365N-1/Dauphin, which has been sold to more than 50 countries.

Z-9A: Military production version with some upgrades, such as Arriel 1C2 engine, upgrade instrument panel, and 150-kg payload increase. **Z-9A 100** is almost all indigenously produced.

Z-9B: Current production version for multi-role use, based on Dauphin 2 design. Changes include 11-blade tail rotor.

Z-9C: Naval version for ASW and SSM, with Sinatra HS-12 dipping sonar and torpedo. It has a datalink to support targeting for YJ-82 SSM. An expected near-term upgrade is the C-701 TV guided air-to-surface missile.

WZ-9: Light attack version of Z-9B (see ARMAMENT, left). Poss aka **Z-9W**. Export version is **Z-9G.**

Z-9Z: Reconnaissance prototype.

NOTES
Despite statements from some sources, WZ-9 is too lightly protected to be an "attack helicopter". The Z-9 was designed to be adaptable for a variety of roles, including transport, direct air support, escort, security, reconnaissance, ambulance, anti-submarine warfare, IW, airborne C2, search and rescue, anti-ship, and anti-submarine warfare. Each fuselage side has one pylon allowing for a single pod or missile rack. An expected upgrade for WZ-9/Z-9G is the Red Arrow 9 laser-beam rider/MMW guided ATGM, with 1,200 mm penetration and 5 km range.

European Multirole Helicopter AS-532/Cougar


National War College Photo

Weapon & Ammunition Types	Combat Load
7.65-mm MG	2
Other Loading Options	
20-mm twin gun pods	2
68-mm rocket pods (22 each)	2
2.75-in rocket pods (19 each)	2
External fuel tanks (liters)	600
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: AS 332 Super Puma, SA 330 Puma
Date of Introduction: 1981
Proliferation: At least 38 countries
Description: Variants in "( )"
Crew: 2 (pilots)
Transports: 20-29 troops or 6-12 litters (variant dependant), or cargo
Blades:
  Main rotor: 4
  Tail rotor: 5, 4 (U2/A2)
Engines: 2x 1,877-shp Turbomeca Makila 1A1 turboshaft
Weight (kg):
  Maximum Gross: 9,000 (Mk I), 9,750 (Mk II)
  Normal Takeoff: 8,600 (Mk I), 9,300 (Mk II)
  Empty: 4,330 (UC/AC), 4,460 (UL/AL), 4,760 (U2/A2)
Speed (km/h):
  Maximum (level): 275 (Mk I), 325 (Mk II)
  Cruise: 270
Ceiling (m):
  Service: 4,100
  Hover (out of ground effect): 1,650 (Mk I) 1,900 (Mk II)
  Hover (in ground effect): 2,800 (Mk I), 2,540 (Mk II)
Vertical Climb Rate (m/s): 7
Fuel (liters):
  Internal: 1,497 (UC/AC), 2,000 (UL/AL), 2,020 (U2/A2)
  Internal Aux Tank: 475 ea. (4x Mk I, 5x Mk II)
Range (km):
  Normal Load: 620 (UC/AC), 840 (UL/AL), 800 (U2/A2)
  With Aux Fuel: 1,017 (UC/AC), 1, 245 (UL/AL), 1,176 (U2/A2)

Dimensions (m):
  Length (rotors turning): 18.7-19.5 (U2/A2)
  Length (fuselage): 15.5 (UC/AC), 16.3 (UL/AL), 16.8 (U2/A2)
  Width: 3.6-3.8 (U2/A2)
  Height: 4.6
  Main Rotor Diameter: 15.6-16.2 (U2/A2)
  Tail Rotor Diameter: 3.1-3.2 (U2/A2)
Cargo Compartment Dimensions (m):
  Floor Length: 6.5 (AC/UC), 6.8 (UL/AL), 7.9 (U2/A2)
  Width: 1.8
  Height: 1.5
Standard Payload (kg):
  Internal load: 3,000
  External on sling only: 4,500

Survivability/Countermeasures:
Main and tail rotor blades electrically deiced. A radar warning receiver is standard, while a laser warning receiver, missile launch detector, missile approach detector, infrared jammer, decoy launcher, and flare/chaff dispensers are optionally available.

ARMAMENT
The Mk I variants may employ 2x 7.65-mm machine guns on pintle-mounts in the cabin doors when employed in a transport role.

Most Probable Armament
The armed versions have side-mounted 20-mm machineguns and/or axial pods fitted with 68-mm rocket launchers.

AVIONICS/SENSOR/OPTICS
Night/Weather Capabilities:
The aircraft is NVG compatible, and through its instruments, avionics, full autopilot, and nav computer, is capable of operation in day, night, and instrument meteorological conditions.

VARIANTS
SA 330 Puma: Developed in the late 1960s by Aerospatiale in France. Others were built in the UK, Indonesia, and Romania.

AS 332 Super Puma: Differs from the SA 330 Puma through an improved rotor system, upgraded engines, stretched fuselage, and a modified nose shape.

The **Cougar** name was adopted for all military variants. In 1990, all Super Puma designations were changed from AS 332 to AS 532 to distinguish between civil and military variants. The "5" denotes military, "A" is armed, "C" is armed-antitank, and "U" is utility. The second letter represents the level of "upgrading".

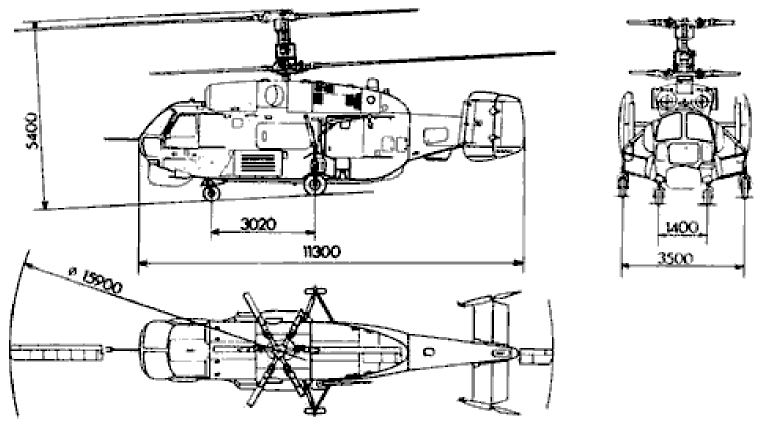
AS-532 Cougar UC/AC Mk I: The basic version with a short fuselage to carry 20 troops.

AS-532 Cougar UL/AL Mk I: This version has an extended fuselage, which allows it to carry 25 troops and more fuel. It is also capable of carrying an external load of 4,500 kg.

AS-532 Cougar U2/A2 Mk II: This 1992 version is the longest variant of the Cougar line. It has an improved Spheriflex rotor system with only 4x tail rotor blades, and 2x 2,100-shp Turbomeca Makila 1A2 turboshaft engines that allow an increased cargo carrying capability. It can transport 29 troops or 12 litters, or an external load of 5,000 kg. Primarily used for combat search and rescue, and as an armed version. It may be armed additionally with a 20-mm cannon or pintle-mounted .50 caliber machine guns.

NOTES
This helicopter is produced by the Eurocopter company. It was formed as a joint venture between Aerospatiale of France, and Daimler-Benz Aerospace of Germany. Additional missions include: VIP transport, electronic warfare, and anti-submarine warfare.

Russian Patrol/Anti-Submarine Warfare Helicopter Ka-27/HELIX



Weapon & Ammunition Types	Combat Load
Other Loading Options	
7.62 mm machine gun	**1**
PLAB 250-120 bombs (rarely used)	**2**
AT-1MV 400 mm Torpedoes	**2**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations:
Date of Introduction: 1980
Proliferation: At least 6 countries
Description: Variants in "( )"
Crew: 2 (pilot, navigator) + 1-3 sensor operators
Transports: Main cabin holds ASW gear or up to 16 passengers
Blades:
- Main rotor: 6 (2heads, 3 blades each)
- Tail rotor: None

Engines: 2 x 2,200 shp Isotov TV3-117KM turboshaft
Weight (kg):
- Maximum Takeoff: 11,000
- Normal Takeoff: 10,700
- Empty: 6,400

Speed (km/h):
- Maximum (level): 250
- Cruise: 230

Ceiling (m):
- Service: 6,000
- Hover: 3,500

Vertical Climb Rate (m/s): 12.5
Fuel (liters):
- Internal: 4,720

Range (km):
- With Max Fuel: 800

Dimensions (m):
- Length (rotors turning): 31.8
- Length (fuselage): 11.3
- Width: 5.65
- Height: 5.4

Main Rotor Diameter: 15.9
Cabin Dimensions (m):
- Length: 4.52
- Width: 1.3
- Height: 1.32

Standard Payload (kg):
- Internal load: 4,000
- External load: 5,000

Survivability/Countermeasures:
Lower fuselage sealed for flotation. Leading-edge electro-thermal de-icing.
IFF, RWRs, Infrared jammer, chaff and flare dispensers, and color coded identification flares.

ARMAMENT
Most Probable Armament: Torpedoes

AVIONICS/SENSOR/OPTICS
Auto-hovering, automatic flight control system, 360 degree search radar, directional ESM, Doppler, dipping sonar, magnetic anomaly detector (MAD), sonobuoys stored internally
.
Night/Weather Capabilities:
Designed to operate day and night in adverse weather.

VARIANTS
Ka-27PL Helix-A: ASW version.

Ka-27PS Helix-D: SAR version. Fitted with 300 kg rescue hoist. Hooks under fuselage for loads up to 5,000 kg.

Ka-28: Export version of Helix-A. Max takeoff weight increased to 12,000 kg. Max fuel and range also increased.

Ka-29TB Helix-B: Armored assault troop version operated from amphibious landing ships or aircraft carriers. Armed with single four-barrel 7.62 mm machine gun, can also fit a 30 mm Type 2A42 cannon. Four stores pylons for 80 mm rocket pods, 57 mm rocket pods, 23 mm gun pods, incendiary tanks, or anti-tank missiles.

Ka-31 AEW: Airborne early warning version of Ka-29 fitted with rotating radar antenna underneath the aircraft.

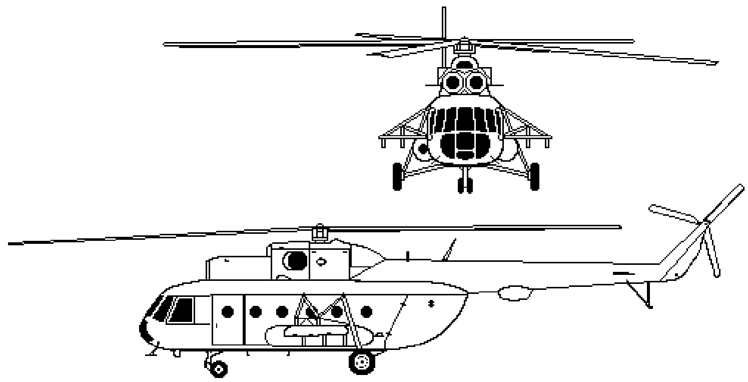
Ka-32A2: Paramilitary transport version used by police. Pintle mounted guns in window, hydraulic hoist, loudspeakers, and searchlights. Can carry 11 passengers.

Ka-32A7: Armed version of Ka-27PS. 13-passenger capacity. Two GSh-3L 23mm cannons, B-8V-20 rocket pods, two AS-20 Kayak anti-ship missiles or AS-10 Karen air-to-air missiles.

Ka-32 Attack Variant National War College

NOTES
The Helix is primarily a naval helicopter, for missions such as ship-based anti-submarine warfare, direct air support, transport, rescue, EW, anti-ship, and air-to-air. The Helix has the distinctive contra-rotating main rotor system favored by the Kamov bureau. The contra-rotating design eliminates the need for a tail rotor.

Russian Multirole Helicopter Mi-8/HIP-C and Variants



Weapon & Ammunition Types	Combat Load
1x 12.7-mm MG or 2x 7.62-mm MG (1 aft)	**700**
Other Loading Options	
AT-2C for HIP-E	**4-8**
AT-3 ATGMs for HIP-F	**6**
80-mm rocket pods (20 each)	**2**
57-mm pods (16 each): HIP-C	**4**
HIP-E/F	**6**
250-kg bombs (rarely used)	**4**
500-kg bombs (rarely used)	**2**
VSM-1 or K-29 mine dispenser	**2-6**
12.7-mm MG pod	**2**
Twin 23-mm gun pods	**2**
VSM-1 (4 x K-29 mine pods)	**1**
Mission dictates weapons configuration. Not all will be employed at the same time.	

SYSTEM
Alternative Designations: Rana in India
Date of Introduction: 1967
Proliferation: At least 54 countries
Description:
Crew: 3 (2x pilots, 1x flight engineer)
Transports: 24-26 troops (HIP-C, HIP-E)
Blades:
Main rotor: 5
Tail rotor: 3 right side, left on upgrades
Engines: 2x 1,700-shp Isotov TV2-117A turboshaft. Upgrades use Mi-17 engines.
Weight (kg):
Maximum Gross: 12,000
Normal Takeoff: 11,100
Empty: 6,990
Speed (km/h):
Maximum (level): 250
Cruise: 240
Ceiling (m):
Service: 4,500
Hover (out of ground effect): 850
Hover (in ground effect): 1,760
Vertical Climb Rate (m/s): 9
Fuel (liters): 1,870 total, 3,700 max
Internal: 445
Internal Aux Tank: 915 ea., up to 2
Auxiliary Cabin Tank: 915 ea, 1 or 2
Range (km):
Maximum Load: INA
Normal Load: 690
With Aux Fuel: 950
Dimensions (m):
Length (rotors turning): 25.4
Length (fuselage): 18.2
Width: 2.5
Height: 5.6
Main Rotor Diameter: 21.3
Tail Rotor Diameter: 3.9
Height: 1.8
Cargo Compartment Dimensions (m):
Floor Length: 5.3
Width: 2.3
Height: 1.8
Standard Payload:
HIP C: 24-26 troops or 3,000 kg internal or external loads on 4x hardpoints.
HIP E: troops or 4,000 kg internal or 3,000 kg external on 6x hardpoints

Survivability/Countermeasures:
Can be fitted with armor. Main and tail rotor blades electrically deiced. Infrared jammer, chaff and flares. Armor on some variants

ARMAMENT
HIP C has four external hardpoints. HIP E , -F have six; other variants have none. Weapons include fuselage/nose MGs, rockets, ATGMs, bombs, mines, and AAMs. Only a selected mix of munitions will fit. Mission dictates weapon configuration. Troops can fire their personal weapons from pintles and windows and doors. Assault versions may have fewer onboard troops to carry more ammunition.

The K-29 dispenser can hold POM-2S or PTM-3 mines.

AVIONICS/SENSOR/OPTICS
Night/Weather Capabilities:
The Mi-8 is equipped with instruments and avionics allowing operation in day, night, and is instrumented for bad weather conditions.

VARIANTS
The original civilian version produced at Kazan is called Mi-8. A civilian version produced at Ulan-Ude is called Mi-8T.

Mi-8T/HIP C: Initial fielded version for medium assault/transport, with 4 external hard points and noted engines and rotor.

Probable assault armament mix is 7.62-mm MGs, 4x 57-mm or 2x 80-mm rocket pods.

Mi-8PS: Military VIP transport variant of civilian HIP-C deluxe **Mi-8 Salon**.

Mi-8TVK/HIP E: Assault or transport heli. Assault probable armament with 6x hard points: 12.7-mm nose turret MG, 4x AT-2 type ATGMs, and 2 x rocket pods or bombs.

Mi-8TV/HIP-F export version uses AT-3 type ATGMs.

Mi-8SMV/HIP J: Airborne electronic countermeasures (ECM) platform. R-949 jammer, and up to 32 dispensable jammers.

Mi-8PPA/HIP K: Airborne IW comms intercept/jam platform characterized by 6x "X"-shaped antennas on the aft fuselage.

Mi-8VP/HIP D: Comes in two variants. **Mi-8VPK** is an airborne communications platform with rectangular comms canisters mounted on weapons racks. **Mi-8VzPU** is an airborne reserve command post.

Mi-9/HIP G: Airborne command relay post characterized by antennas, and Doppler radar on tailboom.

Mi-14/HAZE: Naval HIP upgrade variant.

Mi-17/Mi-171/HIP H: Upgrade helicopters produced after 1977, with more powerful engines, left-side tail rotor, and a five blade rotor. See separate **Mi-17** entry, next page.

Many Mi- 8 helicopters have been upgraded to the Mi-17/HIP-H standard.

NOTES
More than 12,000 HIP helicopters have been produced. Missions include direct air support, transport, reconnaissance, EW, medevac, search and rescue, smoke generating, and minelaying. There are dozens of variants and a more than a dozen upgrades and upgrade packages. Interior seats are removable for cargo carrying. Rescue hoist can lift 150 kg. Cargo sling system capacity is 3,000 kg. The Mi-8 is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) because of an engine load sharing system.

Russian Multirole Helicopter Mi-17/HIP-H and Mi-171Sh Gunship


Mi-171Sh export (Mi-8AMTSh for Russian forces)

Weapon & Ammunition Types	Combat Load
Same as Mi-8/HIP except:	
2x 7.62-mm MG (1 fore, 1 aft)	**700**
Mi-171Sh Max Loads	
AT-6c/AT-9Ataka ATGM pod (4 per pod)	**2**
80-mm rocket pods (20 each)	**4**
SA-18S/ Igla-S AAM (SAM)	**4**
250-kg bombs	**4**
500-kg bombs	**2**
VSM-1 (4 x K-29 mine pods)	**1**
23-mm gun pods (250 rds/pod)	**2**

SYSTEM
Alternative Designations: Mi-8M for home use, Mi-17 for export. With Mil Plant design and Kazan, Ulan-Ude plant products, varied mission designs and upgrades, nomenclatures vary. Export nomenclatures vary from Russian military-use products.
Date of Introduction: 1977**,** 1981 as Mi-17
Proliferation: At least 23 countries, with more than 5,000 in service worldwide.

Description:
Crew: 3 (2x pilots, 1x flight engineer)
Transports: up to 26, 36 troops military seating, or 12 casualties
Blades: Main rotor 5, tail rotor 3 left on side
Engines: 2x 2,200-shp Isotov TV3-117VM turboshaft. For other engines, see Variants.
Weight (kg):
- Maximum Gross: 13,000
- Normal Takeoff: 11,100
- Empty: 7,100-7,370 (variant dependant)

Speed (km/h):
- Maximum (level): 300
- Cruise: 230

Ceiling (m): (variant dependant)
- Service: 6,000
- Hover (out of ground effect): 1,760
- Hover (in ground effect): 1,900-3,980

Vertical Climb Rate (m/s): 9
Fuel (liters): 1,870 total, 3,700 max
- Internal: 445
- External Fuel Tanks: 745 left, 680 right
- Auxiliary Cabin Tank: 915 ea, 1 or 2

Range (km):
- Normal Load: up to 580, 675 Mi-17-V5
- With Aux Fuel: 1,065

Dimensions (m): See Mi-8/HIP-C above
Cargo Compartment Dimensions (m):
- Width: 2.3, Height: 5.5 Others see Mi-8

Standard Payload (kg):
- Internal load: 4,000
- External sling: 4,000 (5,000 Mi-17-V5)

Survivability/Countermeasures:
Armor plating (military versions), main and tail rotor blades electrically deiced. Infrared jammer, chaff and flares, exhaust diffusers. Missile warners include LIP. Shear-cutters. Like Mi-8 it has single-engine flight ability.

AVIONICS/SENSOR/OPTICS
Night/Weather Capabilities:
The Mi-17 is equipped with instruments, GPS nav, avionics, doppler radar, autopilot for operation in day and night, map display screen, and instruments for meteorological conditions.

ARMAMENT
Assault versions have six (sometimes four) external hardpoints. Weapons options include fuselage/nose MGs, rockets, ATGMs, bombs, mines, AAMs, and ASMs. Only a selected mix will fit, dictated by mission. Troops can fire personal weapons with pads at windows, plus doors. Assault versions may have fewer onboard troops to carry more ammunition.

Most Probable Armament:
HIP H: Fitted with 1x 12.7mm MG or AG-17 30-mm AGL, aft 7.62-mm machinegun, 4x AT-2C/SWATTER and 40x 80-mm rockets.

VARIANTS
Mi-17/HIP-H: Original production HIP-H had 2x 1,950-shp Isotov TV3-117MT engines from Mi-14/HAZE, a new main rotor, and left-side tail rotor (distinguishing it from HIP-C). The reconfigured cab has rear clamshell doors. Many early HIP models are modified to the Mi-17 standard. Counterpart export and Russian-use variant weapons, sensors, and other features may differ to fit requirements.

Mi-17T/Mi-8M: Military **v**ariant added crew armor plating. The assault version has 1x 12.7mm MG or 30-mm AG-17 AGL, aft 7.62-mm MG, and 40x 80-mm rockets.
Mi-17P: Descendent of the HIP K airborne jamming platform characterized by large rectangular antennas along aft fuselage.
Mi-17PG: Variant with H/I-band pulse and continuous wave jamming system.
Mi-17PI: Variant with D-band jammer, able to jam up to 8 sources simultaneously.

Mi-8MT: Early "Hot and high" upgrade, with 2x 2,070-shp Klimov TV3-117VMA engines for greater rate of climb, higher hover ceiling
Mi-19: Airborne CP on Mi-17 chassis.
Mi-19R: Abn rocket artillery regiment CP.

Many common versions now use 2,200-shp engines as noted at left. Kazan makes the **Mi-17-1V** export/**Mi-8MTV** multi-role, the **Mi-17-V5/Mi-8MTV-5** multi-role (with APU and increased sling load), and **Mi-172** passenger version. Ulan-Ude produces the **Mi-171 e**xport/**Mi-8AMT** multi-role, and the **Mi-171Sh** combat helicopter.
Mi-171A is a civilian version.

Mi-17N/Mi-8MTO/Mi-8N: Upgrade night assault variant tested in Chechnya,with FLIR sights. It led to the helicopter noted below.

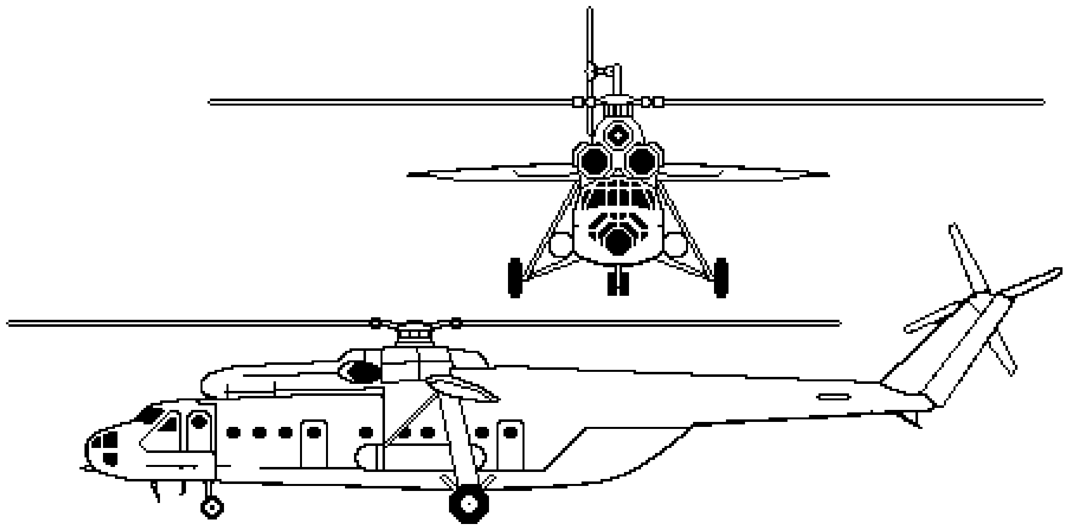
Mi-171-Sh/Mi-8AMTSh Terminator (Rus): Better armored 2001 gunship, with upgrades, e.g., 2x 2,200-shp engines. The FCS includes Raduga-Sh ATGM day sight from Mi-35M, FLIR night sight. Most probable armament: 2 x 7.62-mm MGs, 8x AT-6c/AT-9 ATGMs, and 40 x 80-mm rockets. Frangible rod AT-9 missiles can be used for air-to-air combat. Also, AA-18S/SA-18S AAMs (SAMs) can be used. The ATGM pod can also launch AAMs. IR warner and flares. For export, they can fit other sensors and/or munitions.

Newest variant is the **Mi-17-V7** multi-role from Kazan, with VK-2500 engines rated at 2,500 shp. It can operate at high altitude, and offers 14,000 max take-off weight, 5,000 kg internal payload, and 6,000 kg max external sling load. Gunship has a laser designator for semi-active laser-homing munitions (bombs, 80/ 122-mm rockets or ATGMs).

Israeli **Peak-17** gunship upgrade for India has FLIR/CCD day/night FCS, either Spike-ER (8 km) or LAHAT ATGM (13 km, below), and can launch Skylite UAVs.

NOTES
Mission dictates weapons configuration. Not all will be employed at the same time.

Russian Transport Helicopter Mi-6/HOOK



SYSTEM

Alternative Designations: INA
Date of Introduction: 1961
Proliferation: At least 15 countries

Description:
Crew: 5 (2x pilots, 1x navigator, 1x flight engineer, 1x radio operator)
Blades:
  Main rotor: 5
  Tail rotor: 4
Engines: 2x 5,500-shp Soloviev D-25V (TV-2BM) turboshaft
Weight (kg):
  Max Gross: 42,500-46,800
  Normal Takeoff: 40,500
  Empty: 27,240
Speed (km/h):
  Max (level): 300
  Cruise: 250
Ceiling (m):
  Service: 4,500
Fuel (liters):
  Internal: 6,315
  Internal Aux Tank: INA
  External Fuel Tank: 3,490
Range (km):
  Max Load: 620
  With Aux Fuel: 1,000 km
Dimensions (m):
  Length (rotors turning): 41.7
  Length (fuselage): 33.2
  Width (including wing): 15.3
  Height: 9.9
  Main Rotor Diameter: 35.0
  Tail Rotor Diameter: 6.3
Cargo Compartment Dimensions (m):
  Floor Length: 12
  Width: 2.65
  Height: Variable from 2.0 to 2.5
Standard Payload:
  Internal: 12,000 kg with rolling takeoff
  External: 8,000 kg at hover
  Transports over 65 troops, or 41 litters, or 1x BRDM-2 scout car, or 1x BMD, or 1x GAZ truck, or 1x 7,500 liter POL truck or 12,000 liters in soft bladders.

Survivability/Countermeasures:
Main rotor blades electrically deiced.
Tail rotor blades have internal anti-icing fluid.

ARMAMENT

Some aircraft used for tactical missions have a 12.7 mm machinegun in the nose.

AVIONICS/SENSOR/OPTICS

Night/Weather Capabilities:
The avionics and navigational package, and a fully functioning autopilot allow for day/night all-weather operation.

VARIANTS

Mi-6A/-6T/HOOK A: Basic civil and military transport version.

Mi-6VKP/HOOK B: Airborne command post variant.

Mi-6VUS/HOOK C: Developed airborne command post. Also known as **Mi-22**.

Mi-6AYaSh/HOOK D: Airborne command post with possible side-looking airborne radar fairing.

Mi-6S: Medevac variant.

Mi-6TZ: Tanker variant.

NOTES
Removable stub wings, when installed, are fixed at a 15° incidence relative to the longitudinal axis. They provide 20% of the total lift in forward flight. Aircraft production ended in 1981. Aircraft has hydraulically actuated rear clamshell doors and ramp, provisions for internal cargo tie-down rings, an 800 kg capacity internal winch system in cargo compartment, floor capacity is 2,000 kg/m^2, and a central hatch in the cabin floor for sling loads.

Russian Transport Helicopter Mi-26/HALO

SYSTEM

Alternative Designations: INA
Date of Introduction: 1983
Proliferation: At least 5 countries

Description:
Crew: 5 (2x pilots, 1x navigator, 1x flight engineer, 1x loadmaster)
Blades:
- Main rotor: 8
- Tail rotor: 5

Engines: 2x 11,400-shp Lotarev D-136 turboshaft
Weight (kg):
- Maximum Gross: 56,000
- Normal Takeoff: 49,500
- Empty: 28,240

Speed (km/h):
- Maximum (level): 295
- Cruise: 255

Ceiling (m):
- Service: 4,500
- Hover (out of ground effect): 1,800
- Hover (in ground effect): 4,500

Vertical Climb Rate: INA
Fuel (liters):
- Internal: 11,900

Range (km):
- Maximum Load: 800
- Normal Load: INA
- With Aux Fuel: 1200 km

Dimensions (m):
- Length (rotors turning): 40
- Length (fuselage): 33.5
- Width: 8.2
- Height: 8.1
- Main Rotor Diameter: 32
- Tail Rotor Diameter: 7.6

Cargo Compartment Dimensions (m):
- Floor Length: 12
- Width: 3.3
- Height: variable from 2.9 to 3.2

Standard Payload:
- Internal or external load: 20,000 kg
- Transports over 80 troops, 60 litters, or 2x BRDM-2 scout cars, or 2x BMDs, or 1x BMP or, 1x BTR-60/70/80 or, 1x MT-LB.

Survivability/Countermeasures:
Main and tail rotor blades electrically deiced.
Infrared signature suppressors on engines.
Infrared jammers and decoys; flares.
Self-sealing fuel tanks.

ARMAMENT

None

AVIONICS/SENSOR/OPTICS

Night/Weather Capabilities:
The avionics and navigational package, a Doppler weather radar, and a fully functioning autopilot allow for day/night all-weather operation.

VARIANTS

Mi-26MS: Medical evacuation version.

Mi-26T: Freight transport.

Mi-26TZ: Fuel tanker with an additional 14,040 liters of fuel in 4x internal tanks and 1,040 liters of lubricants, pumped through 4x 60-meter long refueling nozzles for refueling aircraft, and 10x 20-meter long hoses for refueling ground vehicles. Fuel transfer rate is 300 liters/minute for aviation fuel, and 75-150 liters/minute for diesel fuel. The refueling system can easily be removed to allow the aircraft to perform transport missions.

NOTES
The HALO A has no armament. The load and lift capabilities of the aircraft are comparable to the U.S. C-130 Hercules transport aircraft. The length of the landing gear struts can be hydraulically adjusted to facilitate loading through the rear doors. The tailskid is retractable to allow unrestricted approach to the rear clamshell doors and loading ramp. The cargo compartment has two electric winches (each with 2,500 kg capacity) on overhead rails can move loads along the length of the cabin. The cabin floor has rollers and tie-down rings throughout. The HALO has a closed-circuit television system to observe positioning over a sling load, and load operations. The Mi-26 is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) because of an engine load sharing system. If one engine fails, the other engine's output is automatically increased to allow continued flight.

French Heliborne Battlefield Surveillance Radar System Horizon

SYSTEM
Alternative Designations: Helicoptere d'Observation Radar et d'Investigation sur Zone
Date of Introduction: 1994
Proliferation: At least 1 country
Description:
Crew: 4
Platform: Mounted on AS-532UL/Cougar helicopter (pg 2-15)
Combat Weight (mt): 11.5
Antenna size (m): 3.5 x 5

Radio: INA

RADAR
Antenna:
Mount: Vertical post mount pointing downward from left rear.
Radar stows under helicopter tail on take-off and landings, then lowers hydraulically during operation.
Antenna Type: Doppler, with MTI
Mode: Search
Scan Method: Antenna rotates horizontally for azimuth scan. Radar rotates 10°/sec, for a low pulse repetition frequency (PRF). Electronic for elevation.

Transmitter:
Transmitter Type: Traveling Wave Tube fully coherent, agile frequency and adaptive burst mode.
Frequency band: I/J
RF maximum (GHz): 12.0
Power (kw): 50
Mode: Doppler MTI radar

Receiver and Processing Requirements:
Aircraft has onboard processing system. The processor is designed for a low false alarm rate. Ground station is mounted in a 7-mt truck. Each ground station holds 2 workstations. System receives 60° and 90° sector scans, independent of aircraft flight dynamics. Real-time digital data link can be integrated into French RITA communications net. Each moving target is automatically detected, located, analyzed, and classified. System can operate separately or as part of an intelligence network.

Protection and Electronic Counter-countermeasures:
Radar snapshot mode reduces vulnerability to anti-radiation missiles.
Very low sidelobes reduce ECM effects.
The aircraft carries flares and decoys.

VARIANTS
System derived from the **Orchidee** system used in Desert Storm. Orchidee was compatible with the British Astor and US JSTARS systems.

PERFORMANCE
Surveillance range (km): 200 / 150 in rain clutter
Surveillance rate: 20,000 km^2 every 10 sec
Target location accuracy (m): 40
Datalink range: 120 km, Agatha data link
Surveillance targets: Wheeled or tracked vehicles, moving or hovering rotary wing aircraft, slow-flying FW aircraft, watercraft.
Target speed (km/hr): 4-400, including nap-of-the-earth (NOE)
Flight speed (km/hr): 130
Surveillance altitude (m): 2,000-4,000
Endurance (hrs): 4

NOTES
The system was designed to operate under army control at division level. HORIZON set consists of 2 aircraft, one ground station, navigation equipment, and Agatha data link.

ROTARY WING AIRCRAFT WEAPONS AND AIRCRAFT-DELIVERED MUNITIONS (ADM)

A wide variety of weapons and munitions can be employed on rotary-wing aircraft for use against aerial, ground, and waterborne targets. Weapons can be generally categorized as guns, launchers, and dispensers. Munitions are primarily rounds, rockets, missiles, bombs, grenades, mines, and torpedoes (see the tables below). However, new technologies continue to emerge, and are expanding the ability of aircraft to deliver lethality and execute other missions for and against military forces. Technology trends for more lethal air attack include abilities to: launch reconnaissance UAVs to support their missions in roles such as target selection and designation, launch attack UAVs, and add new weapons and munitions for long-range precision attack. The following weapons and munitions apply to RW systems in this chapter. Fixed-wing aircraft can use these munitions and a variety of heavier ones.

Guns

Mount/Gun Name	Producing Country	Caliber or mm/Type	Barrels (if 2+)	Mount, Fixed or Turret/ Pod (Fixed)	# of Rounds/ Rds per Min	Munition Types (Other Than Ball-T, API-T, HEI-T)	Munition Range (m)/ Lethality (penetration-mm)
AA-52	France	7.62 MG *1	1	Pod	500+/900		1,200 heavy barrel
M134	U.S.	7.62 Miini-gun	6	M27or Mini-TAT turret, M18 pod	1500/2,000, 4,000		1,500 m
PKM	Russia	7.62 MG		Cabin, rear	Varies/250practical		1,000/ 8 at 500 m
PKT	Russia	7.62 MG		Nose fixed, rear, pod	3,800/250 practical		2,000/ 8 at 500 m
AN/M2	U.S./Others	.50-cal MG	1	Door pintle, or fixed, pod	/750-850	APFSDS-T, SLAP	1,800
NSV-T	Russia	12.7 MG	1	Door pintle or fixed, pod	/800	Incendiary, Duplex-T *2	2,000/20 at 500, 13.2 at 1,000
YakB-12.7	Russia	12.7 Gatling	4	USPU-24 chin turret GUV-8700 pod	1,470/4,500 750/4,500	Incendiary, Duplex-T *2	2,000
M197	U.S.	20 Gatling	3	Nose turret	/750		1,500
M 621	France	20 Cannon	1	THL-20 turret, pod, right side fixed *3	100+/650	APDS	1,500-2,000 m
9A669 GUV **9A624** **9A622**	Russia	 23 Cannon 7.62 Mini-gun	 2 4	Pod with 3 guns, the 23-mm, and 2 x 7.62 mini-guns	 750/300 or 3,400 2200/	 Frangible, APFSDS-T	 2,500+/16 at 1,000 m for Frangible 2,000/ 8 at 500 m
GSh-23L **Type 23-3**	Russia China	23 Cannon	2	USPU-24 chin turret NPPU-24 right side *3 UPK-23-250 pod fixed *3	470/3,400 470/4,300 250/300 or 3,400	Frangible, APFSDS-T	
NS-23KM	Russia	23 Cannon	2	Right side fixed	550 practical	Frangible, Frag-HE, CC*4 APFSDS-T	2,500/19 @ 1000 m API-T
2A42	Russia	30 Cannon	1	NPPU-280 chin turret	460/250/200 or 600	Frangible, Frag-HE, CC*4 APFSDS-T	4,000/45 at 2,000 m for APFSDS-T
GSh-30K	Russia	30 Cannon	2	Right side fixed	250/varies to 2,600	Frangible, Frag-HE, CC*4 APFSDS-T	4,000/45 at 2,000 m for APFSDS-T

*1 Early versions of AA-52 were in 7.5 x 54 mm.
*2 Duplex round has 2 cartridges, to double fire saturation in the beaten zone.
*3 Gun (on fuselage or in a pod) has a fixed base mount, but can flex in elevation. An example is the UPK-23-250 flexible gun pod, which can depress guns to 30 degrees.
*4 CC is a 30mm canister round with 28 sub-projectiles for use against soft targets and personnel with increased fire saturation in the beaten zone.

Aerial Rockets

Name	Producing Country	Caliber (mm)	Guidance No/Yes	Pod Name (# per pod)	Munition Nomenclature	Lethal Munition Type	Munition Range (m)/ Lethality (penetration-mm)	Comments
SNIA	France	50	No	/28				
S-5	Russia Others	57	No/SAL-H	UB-9 UB-16-57 UB-32	S-5K, KO, KP, KPB S-5, S-5M, S-5OM S-5Cor	HEAT-Frag, Frag-HE Frag-HE HEAT SAL-H	2,000/200 4,000 4,500 7,000/200	SAL-H: Semi-active Laser-Homing, on aircraft equipped with a laser target designator.
SNEB	France	68	No/SAL-H	Heli TDA 68-12C/12 Heli TDA 68-22C/22	Type 253 Type 26P Type 24, 26	HEAT-MP Frag-HE APERS	1,600/INA 1,600	There are reports of SAL-H capability - see above
S-8	Russia Others	80	No/SAL-H	B-8V7/7 B-8V20A/20 B-8M1/20	S-8KOM S-8T S-8DM S-8BM S-8ASM S-8Cor	HEAT-Frag Tandem HEAT Frag HE APHE Flechette HEAT SAL-H	4,000/400 antitank 4,000/600+ antitank 4,000/HE fuel-air 2,200/2 m concrete + HE INA 8,000/ 400	SAL-H see above. Other assets, such as aircraft or ground forces with LTD can laze rockets to target. S-8PM with jammer
Hydra-70/ 2.75 inch rkt	U.S. Others	70	No	M260/7, M261/19	M151 and M229 M261 M255A1	HE HE-MPSM Flechette	8.8/M151 10-lb Warhead, M229 17-lb 7,000/9 DP submunitions	MPSM is multipurpose, programmable time fuze. SAL-H in R&D.
S-13	Russia Others	122	No/SAL-H	B-13R/5 B-13L/5	S-13 S-13-OF S-13DF S-13T S-13Cor	HEAT Frag-HE HE thermobaric APHE HEAT SAL-H	4,000/3 m soil, 1 m concrete +HE 3,000/Frag-HE 6,000/equal to 40 kg of TNT 4,000/6 m soil, 1 m concrete + HE 9,000/700	SAL-H see above
S-24B	Russia	240	No/SAL-H Inertial	/1	V-24APD RV-24 S-24BMZ	Frag-HE PD fuze Frag-HE prox fuze Frag-HE	2,000/23.5 kg warhead	SAL-H option see above Fuze conversion kit with fins
S-25	Russia	340	No/SAL-H	O-25/1	S-25-OFME S-25L S-25LD	Frag-HE prox fuze HE SAL-H HE SAL-H	2-4,000/190 kg warhead 7,000/150 kg HE warhead 10,000/150 kg HE, 8 m CEP	SAL-H see above S-25LD can also use TV or IR-homing
Type 90-1	China	90	No	/7	Type 90-1	Frag-HE	7,000	Chinese

* Aerial rockets are also referred to as air-to-surface rockets (ASRs), or as fin-folding aerial rockets (FFARs).

Antitank Guided Missiles (ATGMs)

Name	Producing Country	Rate of Fire (#/min, based on range)	Guidance	#/Pod	Munition Nomenclature (If different)	Munition Type	Munition Range (m)/ Penetration (mm)	Comments
AT-2c	Russia	3-4	RF SACLOS	2		HEAT, HE	4,000/650	
AT-3c and AT-3e	Russia Others	2-3	Wire SACLOS	1 or 3	AT-3c, AT-3E	HEAT (comments), HE	3,000/520, 800 AT-3e	AT-3e has Tandem HEAT. Other Countries make copies/variants.
AT-6/Shturm-V	Russia	3-4	RF SACLOS	4 *1,2		HEAT, HE	5,000/650	
AT-6b/Shturm-V1	Russia	3-4	RF SACLOS	4 *1,2		Tandem HEAT, HE	6,000/1,000	
AT-6c/Shturm-V2	Russia	3-4	RF SACLOS	4 *1,2		Tandem HEAT, HE	7,000/1,000	
AT-9/Ataka	Russia	3-4	RF SACLOS	4 *1,2		Tandem HEAT, HE, AA frangible rod	6,000/1,100	Expected upgrades include 8-km range, IR/radar homing. See *1.
Krizantema/AT-15	Russia	4-6	RF ACLOS/LBR	4		Tandem HEAT	6,000/1,250+ERA (1,500+)	2 simultaneous, separate targets
AT-16/Vikhr-M	Russia	2-3	Laser-beam rider	8 *2, 3		Tandem HEAT/HE *2	10,000 /1,200 *3	Proximity fuze on/off per target.
Hellfire	U.S./UK	2-3	SAL-H *5	4 *3	Hellfire, Hellfire II	Tandem HEAT + HE *2	Hellfire II 8000/1300+ equiv	
Hermes-A	Russia	2-2	Inertial/RF/SAL-H *5	6		Tandem HEAT + HE *2	18,000/1300+ equiv	28 kg warhead, 40 km version due
HOT	Europe	3-4	Wire SACLOS	2, 3, 4	HOT-2, HOT-3	Tandem HEAT	HOT 3 4000/1250+	
LAHAT	Israel	2-4 *4	SAL-H *5	4		Tandem HEAT	13,000/1,000+ Dive attack	
Mokopa	South Africa	2-4 *4	SAL-H *5			Tandem HEAT	10,000/1,350+	Variant of Hellfire
Red Arrow-8F	China	3-4	Wire SACLOS	2 or 4		Tandem HEAT	4,000/1,100	
Spike-ER	Israel	2-3	Fiber-Optic *5 and IIR homing	2 or 4		Tandem HEAT	8,000/1,000+ Dive attack	AKA: NTD, Dandy. ER stands for Extended Range
TOW/BGM-71	U.S./Others	3-4	Wire SACLOS	2 or 4	TOW-2	Tandem HEAT	TOW 2 3750/900+	2-missile pod on MD-500. Other countries make copies/variants.

*1. AT-6 and variants, and AT-9 and variants, are interchangeable in launchers for each other.
*2. Launcher pods can also launch AA-16, AA-18, or AA-18S air-to-air missiles, decreasing the number of ATGMs in the pod for a given mission.
*3. AT-16 and Hellfire II have combined HEAT and HE warheads for multi-role use. The AT-16 also has proximity fuse that can be engaged in-flight for aircraft and materiel targets.
*4. With semi-active laser homing (SAL-H) guidance, launcher craft can hand off missile control to another designator, and launch other missiles without delays from missile flight time.
*5. Guidance modes such as SAL-H and fiber-optic can be categorized as non-line-of-sight, whereby the launcher craft can be outside of view of the target, and can avoid return fires.
6. For additional information on antitank and anti-armor missiles, see Vol 1 Chapter 6.

Air-to-Air Missiles (AAMs)

Name	Producing Country	Also SAM or ATGM *1	Guidance	Pod Name (# per pod)	Munition Type	Munition Range (km)/Warhead (kg)	Comments
AA-2C or D/ATOLL/R-13M	Russia		IR-homing	/1, 2	Frag-HE	8/7.4	AIM-9L upgrade phasing out
AA-8/APHID/R-60M	Russia		IR-homing	/1	HE Continuous rod prox	8 low altitude/3.5	Upgrade missile with DU rod
AA-11/ARCHER/R-73 RMD1	Russia		IR-homing	/1	HE Continuous rod prox	30/7.4	
AA-11/ARCHER/R-73 RMD2	Russia		IR-homing	/1	HE Continuous rod prox	40/7.4	
SA-7b/Strela-2M	Russia/Others	MANPADS SAM	IR-homing	/1	Frag-HE	5/1.15	
SA-14/Strela-3	Russia/Others	MANPADS SAM	IR-homing	/1, 2, 4	Frag-HE	6/1.0	
SA-16/Igla-1	Russia/Others	MANPADS SAM	IR-homing	/1, 2, 4	Frag-HE	5.2+/1.27	
SA-18/Igla	Russia/Others	MANPADS SAM	IR-homing	/1, 2, 4	Frag-HE	6/1.27	
SA-18S/Igla-S	Russia	MANPADS SAM	IR-homing	/1, 2, 4	Continuous rod, prox fuze	6+/2.5	Aka: Igla-Super
AIM-9L/Sidewinder	U.S./Others	Veh/towed SAM	IR-homing		Frag-HE	17.7/9.5	
AT-6c and AT-9/Ataka	Russia	Veh ATGM	RFSACLOS	/4, 8 *1 *2	Tandem HEAT	7/7.4, 6/7.4 Ataka	Penetration 1,000-1,100 mm
Ataka 9A2200 Missile	Russia	Veh ATGM	RFSACLOS	4, 8 *1 *2	Continuous rod, prox fuze	6/	Also fit AT-6 launchers
AT-16/Vikhr-M	Russia	RW ATGM	Laser-beam rider	/8 *1 *2	HEAT/HE with prox on/off	10,000 /INA	Penetration 1,300+ mm
Mistral 2	France	Veh/pedestal SAM	IR-homing	ATAM/1, 2	Frag-HE, prox	6/3	On Gazelle
Spike-ER	Israel	Veh/man-port ATGM	FOG_M, IIR-homing	/4 *1 *2	Tandem HEAT	8.0/INA	Penetration 1,000+ mm
Starstreak	UK	AD/AT or multi-role	Laser-beam rider	ATAS/4 *1	3 x Sabots with Frag-HE	7/.9 kg per submissile	3 x high-velocity submissiles
Stinger	U.S./Others	Veh/MANPADS SAM	IR-homing	ATAS/4, 2	HE	4.5+/1.0	
TY-90/Yitian	China	Veh-launch SAM	IR-homing	/2, 1	HE, frangible rod	6/3	Too large for MANPADS use

*1. All ATGMs can be used to engage helicopters hovering or flying low and slow, esp. nap-of-the-earth mode (35 km/hr or less). These ATGMs can engage RW aircraft at all times.
2. ATGM launcher can substitute 1 or more SAMs.

Air-to-Surface Missiles (ASMs)

Name	Producing Country	Mission	Guidance	#/Pod	Warhead Type	Munition Range (km)/ Penetration (mm)	Comments
AS-10/KAREN/Kh-25ML **Kh-25-MR** **Kh-25-MT** **Kh-25MTP**	Russia	Tactical Tactical, AT Tactical, AT Tactical, AT	SAL-H RF-Guided TV-Guided Thermal-Guided	1	Frag-HE/90 kg Frag-HE/90 kg Frag-HE/90 kg Frag-HE/90 kg	20/ 10/ 20/ 20/	
AS-12/KEGLER/Kh-25MP	Russia	Anti-radar	Passive-homing	1	90 kg	40/	
AS-12/AS.12	France	Tactical, AT, Anti-ship	Wire SACLOS	2	SAPHE, 28 kg	7/	
AS-17/KRYPTON/Kh-31P	Russia	Anti-radar	Passive homing	1	90 kg	100/	
AS-17/KRYPTON/Kh-31A	Russia	Anti-ship	Active radar	1	90 kg	50/	
C-701	China	Anti-ship, land attack	TV, IR-homing	4	SAPHE, 29 kg	20/	MMW-homing tested
Hermes-A	Russia	Tactical, AT	Inertial/RF/SAL-H	6-8	Frag-HE, 28 kg	40/1300+	100 km version due
Sea Skua	UK	Anti-ship	Semi-active Radar	1	SAPHE, 28 kg	25/	
Guided Rockets see pg 2-23	Russia		SAL-H				

* Systems designed for use with laser guidance are generally called missiles. However, some rockets can be adapted with SAL-H modifications for near-ASM range and precision.

Bombs[1]							
Name	**Weight (kg)**	**Guidance (if any)**	**Type**	**Nomenclature Specific Bomb**	**Warhead or Submunition/# if more than 1/Nomenclature/Type**	**Munition Range (m)/ Lethality (penetration-mm)**	**Comments**
GBU-100	120		ASW Depth Bomb		HE 100 kg		
SZV	94	Underwater Acoustic	ASW Depth Bomb		HEAT 19 kg	600 m in depth	Steers on glide fins
FAB-100	117		General Purpose	M80	HE 39 kg		
OFAB-100	100		Blast-Frag		Frag-HE 60 kg		
FAB-250	250		General Purpose	M79	HE 105 kg	30 radius	
OFAB-250	250		Blast-Frag		Frag-HE 210 kg		
RBK-250 Glide bomb (Dispenser)	273		Cluster Cluster	RBK-250-275AO- RBK-250AD-1	150 AO-1sch bomblets /60 AO-2.5 RT AP bomblets /30 PTAB-2.5KO HEAT bomblets Chemical bomblets	4,800 m^2 destructive area	Like MK-118
ZAB-250	250		Incendiary		200 kg Napalm		
KhB-250			Chemical		200 kg Sarin, VX, mustard, etc		
FAB-500/M62	500		General Purpose		HE 450 kg		
OFAB-500	515		General Purpose		Frag-HE 155 kg		
OFZAB-500	500		General Purpose		Frag-HE Incendiary 250 kg		
ODAB-500PM	520		Fuel-Air Explosive		193 kg		
KAB-500Kr	560	TV guided	Precision Attack		Concrete-piercing 380 kg, 200 kg chg	1500 m^2 destructive area	
KAB-500L	534	SAL-H	Precision Attack		HE 400 kg with 195 kg of charge	1500 m^2 destructive area	
RBK-500U Glide bomb (Dispenser)	504 500 520 427 334 525 525 525 500 467		Cluster	RBK-500AO OAB-2.5RT PTAB PTAB-1M ShOAB-0.5 BETAB-500ShP OFAB ZAB PPM SPBE-D	108/ AO-2.5 APAM ICM/bomblets 126/ 5RTM APAM 352/ PTAB HEAT bomblets 60/ PTAB-2.5KO HEAT bomblets 268/ PTAB-1M HEAT bomblets 565/ 0.5 ShOAB-0.5 AP bomblets 10/ BETAB-M concrete piercing bomblets 10/ OFAB APAM bomblets 168/ ZAB incendiary bomblets 48/ PPM mines 15 IR sensor-fuzed 14.5 kg bomblets Chemical bomblets	6,400 m^2 destructive area 210 m^2 destructive area 210 mm penetration top-atk 300 m x 400 m/210 mm top atk 300 m x 400 m Runway penetrators EFP top-attack[2]	Improvement over the RBK-500
ZAB-500	500		Incendiary		480 kg Napalm		

1. Only Russian RW aircraft in this chapter employ bombs. Thus, all bombs listed are Russian.
2. EFP - Explosively-formed penetrator

Other ordnance includes submunition and mine dispensers, minelayer ramps, automatic grenade launchers, anti-ship torpedoes, anti-submarine mines, and torpedoes. Selected RW aircraft can launch UAVs; therefore a near-term capability will be ability to launch attack UAVs or UCAVs and guide them to engage targets.

Chapter 3
Fixed-Wing Aircraft

This chapter provides the basic characteristics of selected fixed-wing aircraft readily available to COE OPFOR across the spectrum of joint operations. This sampling of systems was selected because of wide proliferation across numerous countries or because of already extensive use in training scenarios. Additional data sheets addressing other widely proliferated aircraft will be sent with further supplements to this guide.

Because of the increasingly large numbers of variants of each aircraft, only the most common variants produced in significant numbers were addressed. If older versions of airplanes have been upgraded in significant quantities to the standards of newer variants, the older versions were not addressed.

Fixed-Wing Aircraft generally covers the systems that will affect the planning and actions of the ground maneuver force, aircraft commonly employed by the OPFOR when in close proximity to enemy ground forces, as well as strategic aircraft. This chapter classifies aircraft as fighter/interceptor, strike, ground-attack, multi-role, bombers, special-role, and transport aircraft. Multi-role aircraft are able to support missions across each of the categories. This chapter encompasses many aircraft which may have a dual civil/military application. It does not include, however, aircraft designed and used primarily for civil aviation.

The munitions available to each aircraft are mentioned, but not all may be employed at the same time. The weapon systems inherent to the airframe are listed under armament. The most probable weapon loading options are also given, but assigned mission dictates actual weapon configuration. Therefore, any combination of the available munitions may be encountered.

A wide variety of upgrade programs are underway. The FW aircraft variants noted are only a small representation of those available. For instance, application of GPS and commercial GPS map display units permits even the oldest aircraft to have precision location. Night vision systems coupled with the high level of night illumination existing in most areas of the world permit night use of older aircraft. Even though some weapons require linked effective night sights, many weapons, such as bombs (including sensor-fuzed), standoff GPS programmed cruise missiles, and munitions using remote guidance (such as semi-active laser-homing munitions guided by laser target designators) permit older aircraft to launch the munitions and rely on others to guide them to target. Other aerial systems can substitute for FW aircraft to execute what were FW missions. These include rotary-wing aircraft, unmanned aerial vehicles (including attack UAVs and UCAVs), improvised systems such as airships, and cruise missiles.

Many data sheets for joint systems were provided by Mr. Charlie Childress of JFCOM.
Questions and comments on data listed in this chapter should be addressed to:

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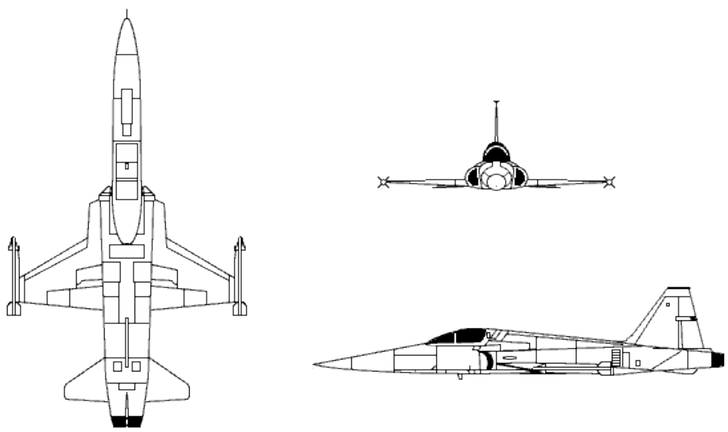
Fighter Aircraft F-5 Freedom Fighter/Tiger



Weapon & Ammunition Types	Combat Load
2 x M239A2 20-mm	**280 ea**
Other Loading Options	
AAMs: AIM-9 Sidewinders on wingtip launchers	**2**
5 pylons (4 underwing, 1 fuselage)	
Max weapons: (kg)	
F-5A	**2,812**
F-5E	**3,175**
BOMBS:	
900 kg	**1**
227 kg	**9**
AGM-65	**1**
submunitions dispensers	
rocket pods	
GPU-5 30-mm gun pods	**3**
568-L or 1,041-L drop tanks	**3**

SYSTEM
Alternative Designations: F-5A initial
Date of Introduction: 1964
Proliferation: At least 30 countries

Description:
Crew: 1 (pilot) / 2 (F-5B/F)
Appearance:
Wings: Small, thin mounted low on the fuselage well aft of the cockpit
Engines: Two turbojets are buried side-by-side in the aft fuselage
Fuselage: Long pointed nose that slopes up to the canopy, behind the canopy, a thick dorsal spine slopes down to the tail
Tail: Double-taper fin has to-section inset rudder. Cropped delta tail planes are mounted at the bottom of the fuselage in line with the fin
Engines: 2 x 2,720 lbs thrust General Electric J85-GE-13 turbojets 4,080 lbs thrust with afterburner (F-5A)
2 x 5,000 lbs thrust General Electric J85-21A turbojets w/afterburner (F-5E)
Weight (kg):
Empty: 3,667/4,410 (A/E)
Max Takeoff: 9,333/11,214 (A/E)
Speed (km/h):
Maximum (at altitude): 1,489/1,733 (A/E)
Cruise: 904
Max "G" Force (g):
Ceiling (m): 15,789
Vertical Climb Rate (m/s): 146/175 (A/E)
Fuel (liters):
Internal: 2,207/2,555 (A/E)
Range (km):
Ferry: 2,519/2,861 (A/E)

Dimensions (m):
Length: 14.4/14.6 (A/E)
Wingspan: 7.7/8.1 (A/E)
Height: 4.1
Standard Payload (kg):
External: 2,812 (A), 3,175 (E)
Hardpoints: 1 centerline and 4 wing pylons

Survivability/Countermeasures:
Fitted with ejection seat, F-5Es have Martin-Baker Mk10 ejection seats.
Some have ECM systems, advanced RWR, chaff and flare dispensers.

ARMAMENT
2 x M239A2 20-mm cannon

AVIONICS/SENSOR/OPTICS
The F-5A has an austere avionics fit including a radar gun sight. The F-5E is equipped with a pulse Doppler radar, communications and navigation equipment, lead-computing optical sight, central air data computer, an attitude and heading reference system, and FLIR.

Night/Weather Capabilities:
Designed to be a day air-to-air Fighter.

VARIANTS
F-5B Freedom Fighter: Two-seat version. First export production variant flew in May 1964.

CF-5A/D: Canadian-built variant. Powered by 4,300 lbs thrust J85-CAN-15 turbojets. CF-5As are single seat fighters, and CF-5Ds are two-seaters.

NF-5A/D: Canadair built aircraft for Netherlands with modified wing including leading-edge maneuvering slats and larger drop tanks.

Norwegian F-5A/B Upgrade: Performed on 30 aircraft (17 A, 13 B). As were fitted with ALE-40 chaff/flare dispensers. Bs received ALR-46 RWR, ALE-38 chaff/flare dispensers, new radio, TACAN, IFF, and LIS-600D altitude and heading reference system (AHRS).

F-5E Tiger II: Second generation F-5 fighter version that replaced F-5A/B in production.

F-5F: Two-seat trainer retains one cannon with 140 rounds, weapons pylons, tip rails; can be fitted with AVQ-27 laser target designator.

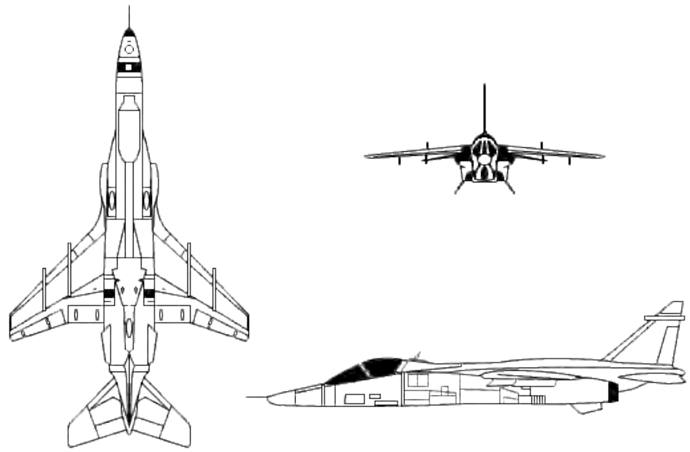
Chegoong-Ho (Air Master): South Korean name for F-5Es and F-5Fs assembled by Korean Air.

Chung Cheng: Taiwanese name given to F-5Es and F-5Fs assembled by AIDC in Taiwan.

RF-5E Tigereye: Photo-reconnaissance version with modified nose that accepts a variety of camera-carrying pallets and mounting an oblique frame camera.

NOTES
The F-5 is a lightweight, easy-to-fly, simple-to-maintain, and relatively cheap supersonic fighter. It was originally offered as a candidate for the U.S. lightweight fighter, but found virtually all its market overseas.

British/French Light Attack Aircraft Jaguar



Weapon & Ammunition Types	Combat Load
Two 30 mm Aden or DEFA 533 guns	**150 ea**
Other Loading Options	
Bombs:	
400 kg or 445 kg	**8**
227 kg or 250 kg	**11**
113 kg or 125 kg	**15**
Rocket pods	**4-6**
Munitions dispensers	**4-6**
ECM pods	**4**
Fuel drop tanks	**3**
ATLIS laser designating pod (French)	**1**
Missiles	
AIM-9 Sidewinder/Matra/Magic R550	**2**
AS30L AGM	**2**

SYSTEM
Alternative Designations:
Date of Introduction: 1969
Proliferation: 6 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Short-span, swept shoulder-mounted
Engines: Two turbofans in rear fuselage
Fuselage: Long and sleek with long, pointed, chiseled nose, widened at air intakes
Tail: Delta vertical fin has a swept leading edge and an inset rudder. Small ventral fins mounted in line with the vertical fin's leading edge
Engines: 2 x 8,040 lbs thrust Rolls-Royce Turbomeca Adour Mk 104/804 turbofan with afterburner
Weight (kg):
Maximum Gross: 15,700
Normal Takeoff: 10,954
Empty: 7,000
Speed (km/h):
Maximum (at altitude): 1,699, Mach 1.6
Maximum (sea level): 1,350, Mach 1.1
Landing Speed: 213
Max "G" Force (g): +8.6 g
Ceiling (m): 14,000
Vertical Climb Rate (m/s): 72
Fuel (liters):
Internal: 4,200
External: 3,600
Range (km):
Combat Radius (km):
Internal Fuel: 537 - 852
External Fuel: 917 - 1,408
Dimensions (m):
Length: 16.9
Wingspan: 8.7
Height: 4.9
Standard Payload (kg):
External: 4,500 – 4,763
Hardpoints: 5 (1 fuselage, 2 each wing)

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seats, night vision goggles, and bulletproof windscreen.
Comprehensive ECM suite

ARMAMENT
Two 30 mm Aden or DEFA 533 guns

AVIONICS/SENSOR/OPTICS
DARIN (display attack and ranging inertial navigation) nav/attack system, ADF, radar altimeter, and HUDWAC (head-up display and weapon aiming computer)

Night/Weather Capabilities:
Day/VFR medium and low-level ground attack/ reconnaissance aircraft. The night vision goggles program will allow limited night capability.

VARIANTS
Jaguar S/Jaguar GR1: Single-seat attack version designated GR1 in British service. First equipped with Adour Mk 102 engines developing 7,305 lbs thrust with afterburner.

Jaguar A: French aircraft with twin-gyro platform and Doppler navigation, weapon-aiming computer, missile fire control for anti-radar missile, fire control sighting unit, and laser ranger and designator pod.

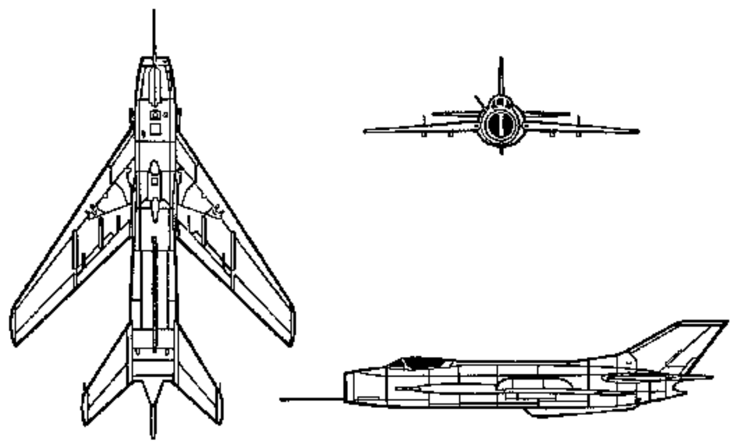
Jaguar T2/JaguarE: Twin-seat combat-capable trainer version: 35 aircraft designated T2 in British service and E in France and other nations.

Jaguar International: Export variant, often with more extensive avionics fits than British or French aircraft.

Shamsher: Jaguar International variant selected by India over the Mirage F1 and the Saab AJ37 Viggen as the deep penetration strike aircraft (DSPA).

NOTES
Produced to meet a joint Anglo-French requirement in 1965 for a dual-role advanced/operational trainer and tactical support aircraft, the Jaguar has been transformed into a potent fighter-bomber. The RAF originally intended to use the aircraft purely as an advanced trainer, but this was later changed to the offensive support role on cost grounds

Chinese Fighter Aircraft J-6 (Jian-6)/F-6



Weapons	Combat Load
30 mm guns	
Six underwing hardpoints	
Outboard Stations	
250 kg Bombs, or	**2**
400-L drop tanks, or	**2**
760-L drop tanks, or	**2**
CAA-1B AAM	**2**
Inboard Stations	
8 x 57-mm rockets, or	**4**
16 x 57-mm rockets, or	**4**
7 x 90-mm rockets, or	**4**
Gun pods, or	**4**
Practice bombs	**4**

SYSTEM
Alternative Designations: see variants
Date of Introduction: 1962
Proliferation: 10 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Sharply swept, mounted at mid-fuselage.
Engines: Two small turbojets are fitted side-by-side in the aft fuselage.
Fuselage: Relatively long and slender, swelling aft for the engines with engine nose intake that has a central splitter plate.
Tail: The sharply swept fin has a small dorsal fillet and nearly full height rudder.
Engines: 2x 5,732 lbs thrust Shenyang Wopen-6 turbojets (7,165 lbs thrust with afterburner)
Weight (kg):
Takeoff:
Clean: 7,545
Typical: 8,965 with 2 AAMs and 760-L drop tanks
Max: 10,000
Empty: 5,760
Speed (km/h):
Maximum Clean:
(at 11,000 m): 1,540, Mach 1.45
(at low level): 1,340, Mach 1.09
Cruise: 950
Max "G" Force (g): +8 g

Ceiling (m): 19,870
Vertical Climb Rate (m/s): 152+
Fuel (liters):
Internal: 2,170
External: 800 or 1,520 (2 drop tanks)
Range (km):
Normal: 1,390
With 2 x 760 L drop tanks: 2,200
Dimensions (m):
Length: 12.6 fuselage, 14.9 with nose probe
Wingspan: 9.2
Height: 3.9)

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seats. Cockpit is pressurized, heated and air-conditioned. Fluid anti-icing system for windscreen.
Tail warning system.

ARMAMENT
Three 30-mm automatic cannons, one in each wing root and one in the nose. Six underwing hardpoints.

AVIONICS/SENSOR/OPTICS
Avionics are very simple and include a small airborne interception radar, VHF transceiver, blind-flying equipment, radio compass, and radio altimeter.

Night/Weather Capabilities:
Day only all-weather capable.

VARIANTS
J-6: Equivalent of the MiG-19S/SF daytime fighter with 3 x 30 mm guns, one at each wing root and one on the fuselage.

J-6A: Equivalent of the MiG-19PF all-weather fighter. Armed with standard J-6 guns and rockets.

J-6B: Equivalent of the MiG-19PM all-weather fighter. Armed with the AA-1 ALKALI radar homing missiles, no guns.

J-6C: Similar to the J-6, but with brake chute housed in bullet-faring at the base of tailfin. Same guns as the J-6A. Export variant with Martin-Baker ejection seats and AIM-9 Sidewinder missiles.

J-6XIN: Similar to J-6A, but with nose-mounted interception radar. Same guns as the J-6A.

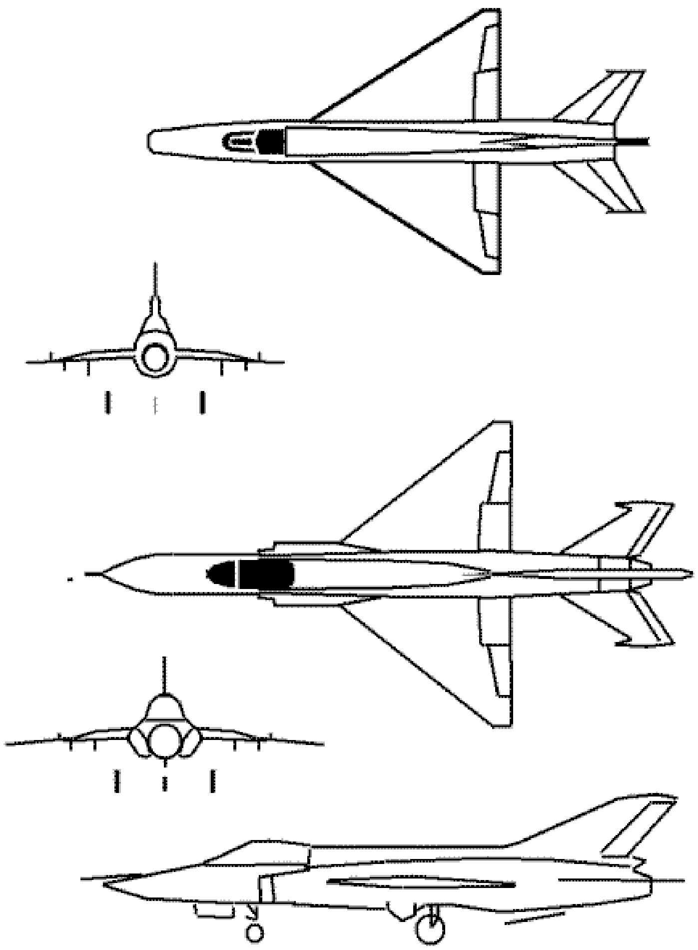
JJ-6: Trainer version with tandem two-seat cockpit. Export versions are FT-6. Armed with only the fuselage gun.

JZ-6: A tactical photo-reconnaissance version, armed with wing root guns only.

F-6: Export versions.

NOTES
The F-6 (Jian-6 Fighter aircraft) is the Chinese version of the MiG-19, which was still in production in China in the mid-1990s.

Chinese Fighter Aircraft J-7 (Jian-7)/FISHBED



Weapon & Ammunition Types	Combat Load
F-7M	
One 23mm type 23-3 twin barrel	
5 External Stations	
AAM:	
PL-5B	**2/4**
Rockets:	
12 round 57mm	**4**
7 round 90 mm	**4**
Bombs:	
100 kg	**10**
250 kg	**4**
500 kg	**2**
Fuel Tanks:	
500-L	**3**
800-L	**1**
J-7III	
Two 30mm type 30-1 cannons	**60 each**
4 wing hardpoints	
AAM:	
PL-2/2A/5B/7	**2**
Matra Magic	**2**
Rockets:	
18 round 57mm	**4**
7 round 90 mm	**4**
Bombs:	
50 kg/150 kg	**4**
250 kg/500 kg	**2**
Fuel Tanks:	
500-L	**2**

SYSTEM
Alternative Designations: F-7B, F-7M
Date of Introduction: 1965
Proliferation: At least 11 countries

Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: Mid-mount, Delta, Clipped tips
Engines: One turbofan in fuselage
Fuselage: Circular with dorsal spine
Tail: Swept-tail with large vertical surfaces and ventral fin
Engines: 1x 9,700 lbs thrust Wopen-7B turbofan, 13,500 lbs thrust w afterburner
Weight (kg):
Empty: 5.145 (F-7B); 5,275 (F-7M)
Max takeoff: 7,372 (F-7B); 7,531 (F-7M)
Speed (km/h):
Max: 2,175 Mach 2.05
Landing Speed: 310-330

Ceiling (m): 18,800
Vertical Climb Rate (m/s): 150 (F-7B): 180 (F-7M)
Fuel (liters):
Internal: 2,385
Range (km):
Low Alt: 370
F-7B with 2 Pl-2 AAM:
Internal fuel: 1,200
1 800-L drop tank: 1,490
F-7M with 2 PL-7 AAM:
3 500-L drop tanks: 1,740
Dimensions (m):
Length: 14.9
Wingspan: 7.2
Height: 4.1
Standard Payload (kg): 1,800
2 under wing hardpoints

Survivability/Countermeasures:
Zero/130-850 km/h ejection seat, newer models equipped with ECM jammer.

ARMAMENT
Two 30-mm type 30-1 cannons with 60 rounds each in farings under front fuselage
or
One 23-mm type 23-3 twin-barrel gun in ventral pack.

AVIONICS/SENSOR/OPTICS:
Skyranger or Super Skyranger radar, Heads-Up-Display and Weapons Aiming Computer, and ECM pod

Night/Weather Capabilities:
Early model had limited night/weather capability. J-7 III is all-weather capable.

Chinese Fighter Aircraft J-7 (Jian-7)/FISHBED continued

VARIANTS

J-7 I/F-7: Initial production version, similar to MiG-21F Fishbed-C. The 12,677-lbst Wopen 7 engine is said to be more reliable than the Tumansky R-11 from which it was derived. Export models are designated F-7.
30-mm cannon,

J-7 II/F-7B: Uprated engine, redesigned inlet center-body, installation of second 30-mm cannon, centerline drop tank hardpoint. Entered production in early 1980s.

JJ-7/FJ-7: Tandem two-seat trainer version developed well after the single seat fighters. First flight on July 5,1985.

F-7M Airguard: Current production version and export version: recognition feature is relocation of the pitot tube from below the nose intake to above it. Fitted with Marconi Skyranger radar; GEC Avionics heads-up-display and weapons aiming computer; Inboard wing pylons for PL-2/2A/5B/7 or Matra Magic AAM, rocket pods or bombs up to 500 kg; additional outboard pylons with plumbing for 500-L drop tanks or 50/150 kg bombs or rocket pods.

F-7P Skybolt: Similar to the F-7M with some Pakistani equipment: Cannon is two Norinco 30 mm cannons with 60 rounds each. Usually carries a 720-L centerline drop tank.

F-7MP: Latest variant of F-7P built by Pakistan. Has uprated Collin avionics (VOR/ILS receiver, ADF and digital DME).

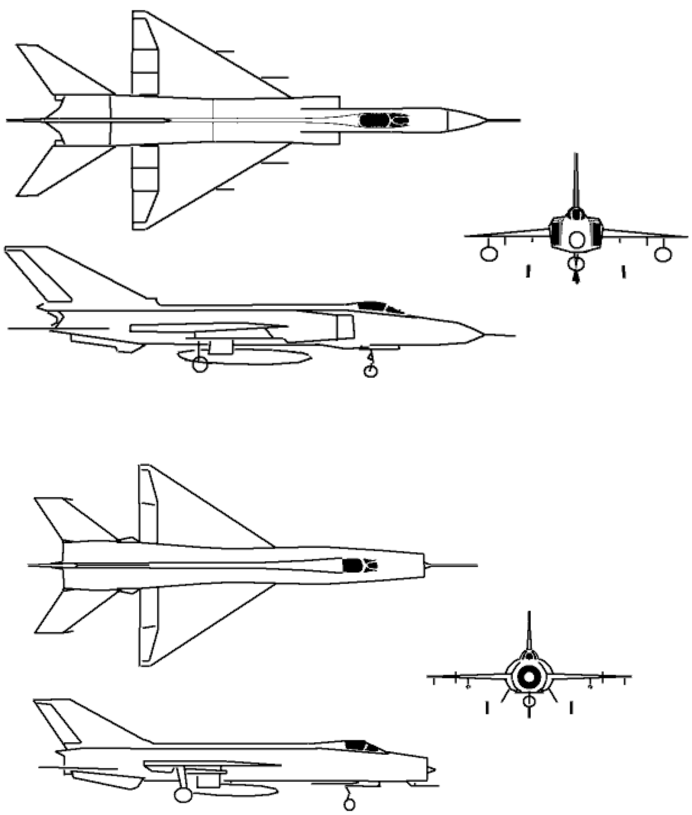
Super Sabre /Super-7: Grumman Aerospace proposal for redesigning the F-7M. Effort disbanded after the violent suppression of Chinese demonstrators in Tiananmen Square.

J-7 III: All-weather version. Uprated 14,550 lbs thrust Wopen 13 turbofan engine, with enlarged nose intake; larger nose radome; increased internal fuel; and single 23 mm cannon in belly pod.

NOTES

The Soviets licensed the manufacture of the MiG-21F and its engine to China in 1961, and assembly of the first J-7 using Chinese-made components began early1964. The J-7 aircraft was the most widely produced Chinese fighter, replacing older J-6 fighters, the Chinese version of the MiG-19. In 1995 it was projected that J-7 production would continue for at least another decade, resulting in a total inventory of nearly 1000 aircraft by 2005, but the PLAAF inventory has remained at about 500 aircraft, suggesting that production was either suspended or terminated.

Chinese Fighter Aircraft J-8/FINBACK



Weapon & Ammunition Types	Combat Load
1x 23-mm Type 23-3 twin barrel cannon	**200**
Other Loading Options	
PL-2B IR AAMs and/or	**6**
PL-7 medium range semi-active homing AAMs and/or	**6**
Quingan HF-16B 57 mm Unguided rockets and/or	**6**
90 mm AS rockets and/or	**6**
Bombs and/or	**6**
Auxiliary Fuel Tanks (Centerline and outboard wing stations only)	**3**

SYSTEM
Alternative Designations: F-8
Date of Introduction: 1980
Proliferation: Maybe Iran

Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: Sharply set delta wing
Engines: Side by side Wopen turbojets
Fuselage: Slender with nose engine air intake (J-8-I), solid conical nose (J-8-II)
Tail: Swept with full-height rudder
Engines: 2x 14,815 lbs thrust Wopen 13A-II turbojets with afterburner
Weight (kg):
Max Gross: 17,800
Normal Takeoff: 14,300
Empty: 9,820
Speed (km/h):
Max (at altitude): 2,340
Max (sea level): 1,300
Limit "G" Force (g): +4.83
Ceiling (m): 20,000
Vertical Climb Rate (m/s): 200
Fuel (liters):
Internal: 5,400
External: 1,760 (3 external tanks
Range (km): 2,200
Combat Radius: 800
Takeoff Run/Landing Roll (m):
670/1,000 (w/afterburner and drag chute)
Dimensions (m):
Length: 21.6
Wingspan: 9.4
Height: 5.4
Standard Payload (kg):
External: 7
Hardpoints: 6 under wing, 1 centerline

Survivability/Countermeasures:
Pressurized cockpit with ejection seat, Radar warning receiver, chaff and flares.

ARMAMENT
1 23-mm Type 23-3 twin-barrel cannon in under fuselage gun pack, and
1 under fuselage hardpoint, and
6 under wing hardpoints for external fuel, bombs, rockets, or PL-2B or PL-7 air-to-air missiles.

AVIONICS/SENSOR/OPTICS
VHF/UHF and HF/SSB radios; 'Odd Rods' type IFF: Monopulse nose-radar; Gyro gun sight and gun camera.

Night/Weather Capabilities:
All-weather dual role (high-altitude and ground attack).

VARIANTS
This aircraft is an adaptation of the Soviet MiG-21 FISHBED

J-8/F-8-I FINBACK-A: Initial production version with WP-7P engines and nose air intakes. J-8 is designation for aircraft in Chinese service; F-8/F-8M denotes export version. More than 100 J-8/F-8-Is were produced

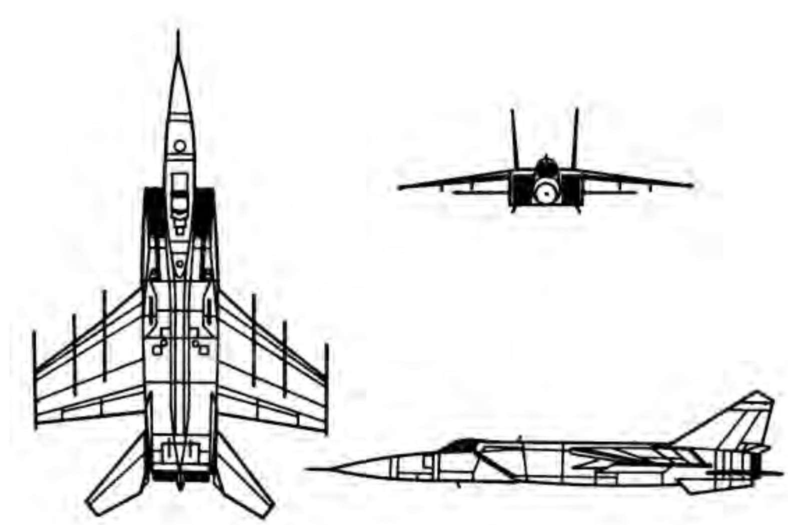
Chinese Fighter Aircraft J-8/FINBACK continued

J-8-II FINBACK-B: Radar type is an unidentified monopulse radar, but may be the Leihua Type 317A in a solid nose housing. Seven pylons for increased weapons inventory and new side air intakes. Other characteristics similar to F-8-II.	**F-8-II FINBACK-B:** Improved version with new 14,815 Wopen-13A engines, wing root intakes, and all-flying horizontal stabilizers, folding ventral fin, 80%-composite material vertical fin and improved avionics.	**F-8 ILM FINBACK-B:** Designation for Russian modified F-8-IIs. Includes: Russian AA-12 and AA-10 missiles, a heads-up-display, global positioning system receiver, multi-function cockpit displays and integrated electronic countermeasures. Also Russian Phazotron Zhuk 8 II multi-function pulse Doppler fire-control radar.

NOTES

The best that can be said for the J-8 is that once upgraded it will be no more than an advanced obsolete aircraft, comparable in configuration and aerodynamic performance to the SU-15/FLAGON. The J-8 and J-8-II aircraft are trouble-prone aircraft with a poor weapon suite and an inefficient engine. At best, the J-8-II can be compared with an early model (1960s) US F-4 Phantom. In fact, after twenty-six years the J-8-II is still in the development stage, has resulted in only about 100 fighters deployed, and meets none of the requirements of the PLAN.

Russian Interceptor Aircraft MiG-25/FOXBAT-B



Weapons	Combat Load
Air-to-Air Missiles	
AA-6 ACRID	**4**
AA-7 APEX	**4**
AA-6 ACRID and	**2**
AA-8 APHID/AA-11 ARCHER	**4**
AA-7 APEX and	**2**
AA-8 APHID/AA-11 ARCHER	**4**

SYSTEM
Alternative Designations: Mig-25 RB FOXBAT-B/ MiG-25PD FOXBAT-E
Date of Introduction: 1967
Proliferation: At least 10 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Shoulder-mounted, swept-back, and tapered with square tips
Engines: Buried side by side in aft fuselage
Fuselage: Long and slender with solid, pointed nose. Flats are mid- to low mounted on fuselage, swept-back and tapered with angular tips.
Tail: Two sweptback, and tapered vertical fins with angular tips
Engines: 2x 19,400 lbs thrust Soyuz/ Tumansky R-15BD-300 turbojet (24,692 lbs thrust with afterburner)
Weight (kg):
Maximum Gross: 41,200 R series 36,720 P series
Clean Takeoff: 35,060 (R)
Empty: 20,000 (P)
Speed (km/h):
Maximum (at altitude): 3,000/3,390(R/P)
Maximum (sea level): 1,200/1,050(R/P)
Cruise: 2,500/3,000(R/P)
Takeoff/Landing Speed: 360/290(P)
Max "G" Force (g): +4.5(P)

Ceiling (m):
Service (clean): 23,000/20,700 (R/P)
With External Stores: 20,700 (R)
Vertical Climb Rate (m/s): 208 (P)
Fuel (liters):
Internal: 17,470
External: 5,300
Range (km):
Maximum with Max Internal fuel:
Supersonic: 1,635/1,250 (R/P)
Subsonic: 1,865/1,730 (R/P)
With 5,300-litre Fuel Tank:
Supersonic: 2,130 (R)
Subsonic: 2,400 (R)
Takeoff Run/Landing Roll (m): 1,250/800 (P)
Dimensions (m):
Length: 21.6/23.8 (R/P)
Wingspan: 13.4/14.0 (R/P)
Height (gear extended): 6.0/6.1 (R/P)
Standard Payload (kg):
External: 2,000 – 5,000
Hardpoints: (R) 10 (4-wing, 6-fuselage) (P) 4

Survivability/Countermeasures:
Pressurized cockpit with zero/130 – 1,250 km hour ejection seats, decoys, radar jammer, radar and missile warning receivers.

ARMAMENT
No Gun. Air-to-air missiles on four under-wing attachments.

AVIONICS/SENSOR/OPTICS
Fire control radar in the nose (search range 100 km, tracking range 75 km); navigation radar; infrared search and track sensor pod under front fuselage, INS updated by Doppler.

Night/Weather Capabilities:

VARIANTS
MiG-25 FOXBAT-A: Standard interceptor Version. Withdrawn from service in Russia in the 1990s.

MiG-25R FOXBAT-B: Reconnaissance version.

MiG-25RB FOXBAT-B: Reconnaissance-bomber version built in 1970.

MiG-25U FOXBAT-C: Two-seat trainer version.

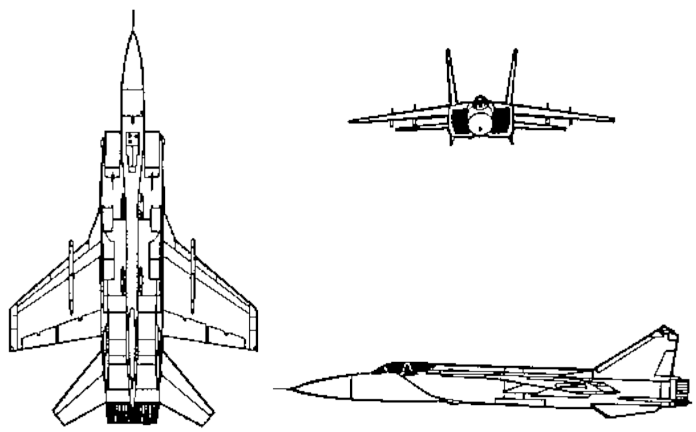
MiG-25RBK FOXBAT-D: Reconnaissance-bomber version with SLAR.

MiG-25P/PD FOXBAT-E: Interceptor with improved radar that has limited look-down/shoot-down capability, IR sensor under the nose, and upgraded engine.

MiG-25BM FOXBAT-F: Fighter/attack version with AS-11 Kilter ant-radar missiles and free-fall bombs to attack ground based air defense from high altitudes.

NOTES
The Foxbat is a high-performance, high-altitude interceptor. This fast but unmaneuverable interceptor has been deployed as a high altitude reconnaissance platform. Those remaining in Russian service are all reconnaissance versions. The interceptors phased out in 1994. Interceptor versions remain in service with other nations.

Russian Interceptor Aircraft MiG-31/FOXHOUND



Weapon & Ammunition Types	Combat Load
GSh-23-6 23mm Gatling-type cannon	**260**
Other Loading Options	**8**
Fuselage: AA-9 AMOS AAM	**4**
Wing: AA-6 ACRID AAM or	**2**
AA-8 APHID AAM	**4**
Multirole versions	**8**
AA-10 ALAMO	
AA-11 ARCHER	
AA-12 ADDER	

SYSTEM
Alternative Designations:
Date of Introduction:
Proliferation: Maybe China

Description:
Crew: 2 (pilot, weapons operator)
Appearance:
Wings: Shoulder-mounted, moderate-swept with squared tips
Engines: Two turbofans
Fuselage: Rectangular from intakes to exhausts with a long, pointed nose
Tail: Tail fins are back-tapered with angular tips and canted outward. Low-mounted flats are swept-back and tapered
Engines: 2 x 20,944 lbs thrust Aviadvigatel D-30F-6 turbofan, 34,172 lbs thrust with afterburner
Weight (kg):
Maximum Gross: 46,200
Normal Takeoff: 41,000
Empty: 21,820
Speed (km/h):
Maximum (at altitude): 2,500
Maximum (sea level): 1,500
Maximum Attack Speed: 3,000
Cruise: 1,010
Max "G" Force (g): +5 g
Ceiling (m): 24,400
Vertical Climb Rate (m/s): 42
Fuel (liters):
Internal: 20,250
External: 5,000
Range (km):
Ferry: 3,300 without refueling
Combat Radius (km):
2,200 with 4 x AA-9 Amos, 2 x drop tanks, 1 in-flight refuel at Mach 0.85.
1,400 with 4 x AA-9 Amos, 2 x drop tanks at Mach 0.85.
1,200 with 4 x AA-9 Amos, no drop tanks at Mach 0.85.
720 with 4 x AA-9 Amos, no drop tanks at Mach 2.35.
Duration: (hr)
3.6 (internal and drop tanks only)
6 -7 (drop tanks and in-flight refueling)
Takeoff Run/Landing Roll (m): 1,200/800
Dimensions (m):
Length: 20.6
Wingspan: 13.5
Height: 6.2
Standard Payload: 8 pylons

Survivability/Countermeasures:
Pilot and weapons system operator in tandem under individual rearward hinged canopies.
Active infrared and electronic countermeasures, radar warning receiver, wingtip ECM/ECCM pod.

ARMAMENT
1 GSh-23-6 23mm Gatling-type cannon in starboard wing root

AVIONICS/SENSOR/OPTICS
N-007/S-800 Zaslon (Flash Dance) electronically scanned phased array look-down shoot-down fire control radar. Long range nav system. Infrared search/track system.

Night/Weather Capabilities:
The MiG-31 can intercept air targets in VFR and IFR weather conditions, day and night and in continuous and discontinuous field of control and guidance commands, regardless of target defensive maneuvers and ECM.

VARIANTS
The MiG-31 FOXHOUND is a substantially improved derivative of the MiG-25 FOXBAT.

MiG-31 FOXHOUND-A interceptor: Original production version.

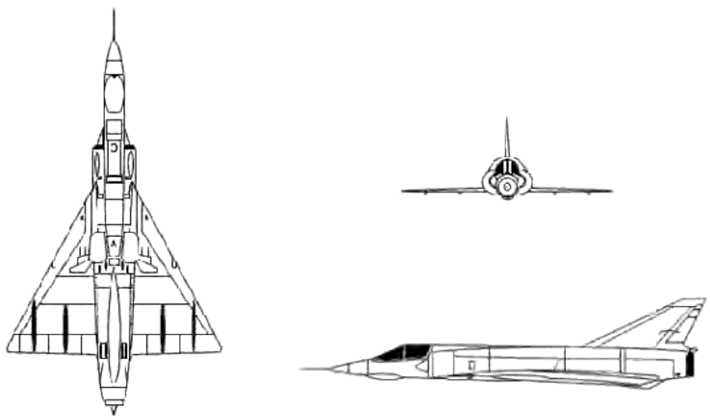
MiG-31B/BS/E FOXHOUND-A interceptor:
The MiG-31B has Flash Dance A radar and improved AA-9 Amos AAMs, in-flight refueling probe, and new navigation system.
MiG-31BS: Similar to the MiG-31B, with radar enhancement and A-723 navigation.
MiG-31E: Export variant of MiG-31B aimed at China, India, and Iran. None were sold.

MiG-31BM/FE FOXHOUND-A multirole fighter: Mid-life upgrade for interceptors. Fitted with ASMs, upgraded radar and AA-11 and AA-12 AAMs. MiG-31FE is export variant.

MiG-31M FOXHOUND-B multirole fighter: Upgraded long range navigation system and improved phased array radar.

NOTES
The MiG-31 is an all-weather, two-seat interceptor with advanced digital avionics. It was the first Soviet fighter to have a true look-down, shoot-down capability.

French Fighter Aircraft Mirage III/5/50



Weapon & Ammunition Types	Combat Load
30-mm cannon	**125**
Other Loading Options	
AAMs:	
Matra Magic 550	**2**
AIM-9 Sidewinder	**2**
Bombs:	
125 kg /250 kg	**12**
440 kg	**6**
Durandal anti-runway	**10**
Rocket Pods:	
68-mm or 100-mm	**2**
2 x 30-mm Cannon Pods	**250 ea**

SYSTEM
Alternative Designations:
Date of Introduction: 1959
Proliferation: At least 15 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Low-mounted delta wings with pointed tips
Engines: One turbojet inside fuselage
Fuselage: Long, slender, and tubular with a pointed nose and bubble cockpit
Tail: Large, swept-back square tip with a tapered fin and no tail flats
Engines: 6,200 lbs thrust SNECMA Atar 9C turbojet with afterburner (Mirage III/5) 7,200 lbs thrust SNECMA Atar 9K50 turbojet, afterburner (Mirage 50)
Weight (kg):
Max Takeoff: 13,500
Empty: 7,050
Speed (km/h):
Max (at altitude): 2,350, Mach 2.2
Max (sea level): 1,390, Mach 1.1
Ceiling (m): 17,000, 17,000, 18,000 (III/5/50)
Vertical Climb Rate (m/s): 84
Fuel (liters):
Internal: 3,330
External: 1,700, 1,200, 1,700 (III/5/50)

Range (km):
Cruise: 1,670, 1,930, 2,133 (III/5/50)
Ferry: 4,000
Takeoff Run/Landing Roll (m): 700-1,600/700
Dimensions (m):
Length: 15.0, 15.6, 15.6 (III/5/50)
Wingspan: 8.3
Height (gear extended): 4.3
Standard Payload (kg): 4,000

Survivability/Countermeasures:
Martin-Baker zero/267 km/h ejection seat, separate cockpit and avionics air conditioning systems, radar warning receiver,

ARMAMENT
Two 30-mm DEFA 552, 553, 552A cannon (III/5/50)

AVIONICS/SENSOR/OPTICS
Intercept or ground mapping radar, fire-control radar in the nose, navigation computer and automatic gun sight.

Night/Weather Capabilities:
All-weather, day and night capable. (III/5)
Clear-weather day fighter. (50)

VARIANTS
Mirage IIIA: High altitude interceptor and strike aircraft fitted with rocket motor for take-off.

Mirage IIIB: Two-seat trainer version of IIIA with strike capability retained. No internal cannon.

Mirage IIIC: Major production variant of IIIA. Fitted with Atar 9B3 engine, Cyrano II intercept and ground-mapping radar.

Mirage IIID: Two-seat trainer/strike aircraft. No internal cannon.

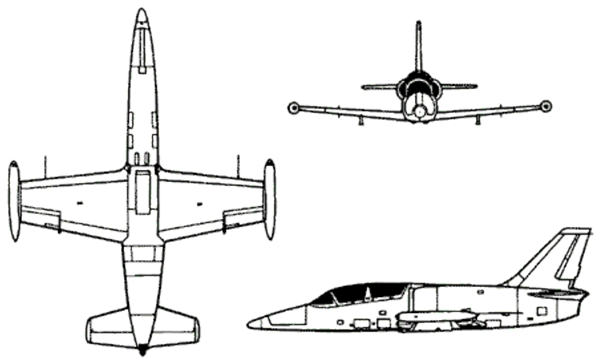
Mirage IIIE: Major production variant. Fitted with Atar 9C engine, Cyranio IIbis radar, and extra avionics bay.

Mirage IIIEA/EO: Australian license-built aircraft. (52 attack and 48 interceptor aircraft)

Mirage 5: Ground attack variant originally developed for the Israeli Air Force. Fitted with two extra fuselage stores stations, fire control radar deleted or replaced by ranging radar. Performance identical to Mirage III except for longer range on internal fuel; some fitted with Cyrano or Agave radar.

NOTES
One of the most successful aircraft produced for export to be produced outside of the United States and the former Soviet Union. The Mirage III/5/50 has proven to be a competent ground attack aircraft despite its original development as a high altitude interceptor. The Mirage 5 and 50 are similar to the III, but fitted with simplified avionics and have exclusively been export variants.

Czech Republic Trainer/Light Ground Attack Aircraft L39 Albatros



Weapon & Ammunition Types	Combat Load
23-mm twin barrel GSh-23 cannon	**150**
Other Loading Options	
Rocket Pods or	**4**
Rocket Pods and 350 L drop tanks or	**2 ea**
IR Missiles and 350 L drop tanks or	**2 ea**
227 kg bombs or	**4**
454 kg bombs or	**2**
113 kg bombs or	**6**
dispensers and 350 L drop tanks	**2 ea**
350 L drop tank and Photo Recon Pod	**1 ea**

SYSTEM
Alternative Designations:
Date of Introduction: 1974
Proliferation: 22 countries

Description:
Crew: 2 (pilot, copilot)
Appearance:
Wings: Low, slightly swept
Engines: Single turbofan in fuselage
Fuselage: Long, slender, pointed nose
Tail: Tall, swept vertical with inset rudder
Engines: 3,792 lbs thrust Ivanchenko AI-25TL turbofan
Weight (kg):
Max Takeoff: 4,700
Clean Takeoff: 4,525
Empty: 3,455
Speed (km/h):
Maximum (at altitude): 750
Maximum (sea level): 700
Max "G" Force (g): +8/-4 g
Ceiling (m): 11,500
Vertical Climb Rate (m/s): 22
Fuel (liters):
Internal: 1,255
External: 8,40

Range (km):
With Max Fuel: 1,750
Takeoff Run/Landing Roll (m): 530/650
Dimensions (m):
Length: 12.2
Wingspan: 9.5
Height: 4.8
Standard Payload (kg):
External: 1,500
Hardpoints: 5 (1 fuselage, 4 under wing)

Survivability/Countermeasures:
Zero/150 km/hr ejection seats and pressurized, heated, and air conditioned cockpit.

ARMAMENT
23-mm GSh-23 twin barreled cannon:

AVIONICS/SENSOR/OPTICS
Weapon delivery and navigation system with HUD and video camera in front cockpit and monitor in rear cockpit. Gun/rocket/missile firing and weapon release controls in front cockpit only.

Night/Weather Capabilities:
Limited night, limited weather capability.

VARIANTS
L39C: Basic flight trainer.

L39V: Similar to the L39C, but with single seat cockpit and modified to act as target tow aircraft.

L39ZO: Armed version of L39C, adding four underwing hardpoints for a variety of ground attack stores.

L39ZA: Similar to L39ZO, but with under fuselage gun pod and reinforced landing gear. Used for ground attack and reconnaissance missions.

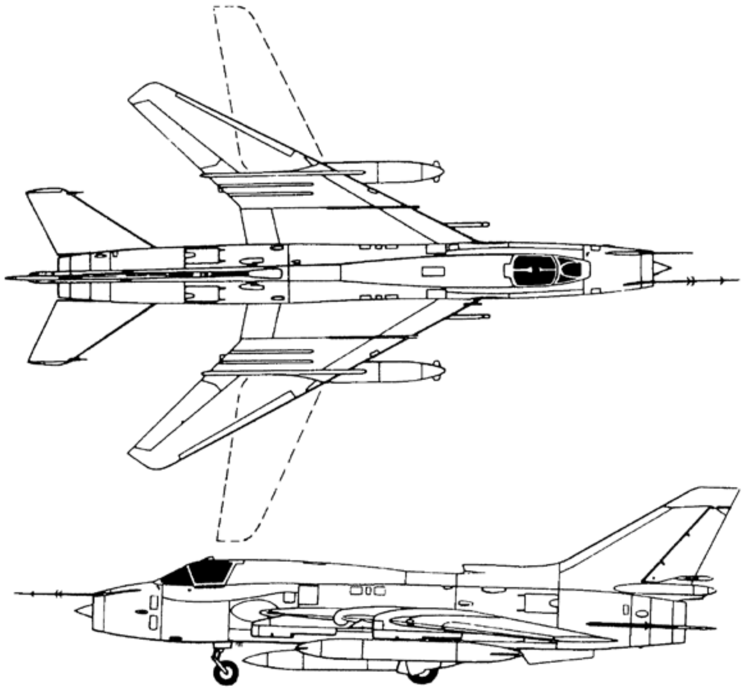
L39MS: Developmental version incorporating more advanced avionics and new 4,852 lbs thrust engine. Addressed Soviet AF requirement to train pilots for the MiG-29 Fulcrum and SU-27 Flanker aircraft

L59: Development of the L39MS with Western Engine, avionics, and Martin-Baker ejection seats

L-159: Ground attack variant of the L59.

NOTES
The L39 Albatros is a very widely flown trainer/light attack aircraft. The design is Czechoslovakian, though there are significant Soviet inputs and the aircraft is in service with various Soviet allies.

Russian Ground-Attack Aircraft Su-17/FITTER



Weapon & Ammunition Types	Combat Load
2x 30-mm NR-30 guns	**160**
Other Loading Options	
325-mm S-25 rockets (1 each) or 80-mm S-8 rocket pods (20 each) or 57-mm S-5 rocket pods (32 each)	
AS-7/KERRY ASM or AS-9/KYLE ASM or AS-10/KAREN ASM or AS-12/KEGLER ASM or AS-14/KEDGE ASM	
AA-2 ATOLL AAM or AA-8/APHID AAM or AA-11/ARCHER AAM launchers	**2**
23-mm SPPU-22 Gun Pods	
External fuel tanks (liters)	**800**
100-kg, 250-kg, and 500-kg unguided and guided bombs	

SYSTEM
Alternative Designations: Su-20, Su-22, Strizh or Martlet
Date of Introduction: 1970
Proliferation: At least 19 countries

Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: Low-mount, variable, swept and tapered with blunt tips
Engines: One in fuselage, intake in nose
Fuselage: Tubular with blunt nose
Tail: Swept-back and tapered, flats mounted on fuselage and swept-back
Engines: 1x 28,660-hp Lyulka AL-21F-3 (Su-17/20)/ or 1x 25,335-shp Tumansky R-29BS-300 (Su-22) turbojet with afterburner
Weight (kg):
Max Gross: 17,700 (M2)/19,500 (M4)
Normal Takeoff: 14,000 (M2) /16,400 (M4)
Empty: 10,000
Speed (km/h):
Max (at altitude): Mach 2.1
Max (sea level): Mach 1.1
Takeoff/Landing Speed: 265
Max "G" Force (g): +7.0
Ceiling (m):
Service (clean): 18,000/15,200 (M4)
With External Stores: INA
Vertical Climb Rate (m/s): 230
Fuel (liters):
Internal: 4,550
External: Up to 4x 800 liter tanks

Range (km):
Max Load: 1,500
With Aux Fuel: INA
Combat Radius: 330 to 685
Takeoff Run/Landing Roll (m):
Prepared Surface: 900/950
Dimensions (m):
Length: 18.8
Wingspan: 13.8 extended, 10.6 swept
Height: 4.8
Standard Payload (kg):
External: 4,000/4,250 (M4)
Hardpoints: 8

Survivability/Countermeasures:
Radar warning receiver, decoys, chaff and flares.
Armored cockpit on M3 and M4

ARMAMENT
The Su-17 has a 30-mm machinegun with 80 rounds, mounted in each wing.

30-mm machinegun, NR-30:
Range (m): (practical) 2,500
Elevation/Traverse: None (rigidly mounted)
Ammo Type: HEFI, APT, CC
Rate of Fire (rpm): 850

AVIONICS/SENSOR/OPTICS
Early variants of the Su-17 feature relatively simple avionics and targeting packages.

Newer variants, and upgraded aircraft can have better avionics, flight controls, targeting and fire control systems, attack computers, liquid-crystal displays, HUD, pulse-Doppler radar, laser designators, GPS, and self-defense packages with FLIR or TV packages provided by several western firms, and are modified to fire western armaments.

Night/Weather Capabilities:
The earlier models of the Su-17 are primarily daytime aircraft only.
Some newer versions have upgraded night and weather capabilities based on upgraded avionics and sensor packages, and are day, night, and all weather capable.

VARIANTS
Aircraft was derived from **Su-7 FITTER A** by incorporating variable wings.
Many variants are in use; however, the M3 and M4 are the most proliferated versions.
Domestic aircraft use nomenclature **Su-17.** Export versions use **Su-20** and **Su-22**.

Su-17/-17MK/-20/FITTER C: The first production version. Export is called **Su-20**.

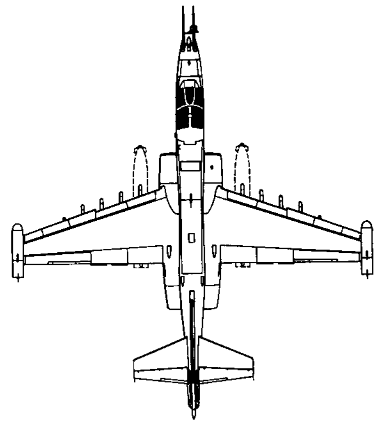
Su-17M/ -17M2/ -17M2D FITTER D: External Doppler-nav and internal laser rangefinder. Reconnaissance version called **Su-17R**.

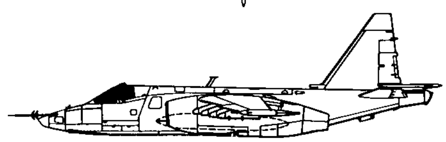
Russian Ground-Attack Aircraft Su-17/FITTER continued

Su-17UM/-22U/FITTER E: Two-seat trainer with components of Su-17M. **Su-17/FITTER G:** Combat-ready two-seat trainer variant of FITTER H. Export version is **Su-22**, with Tumansky engine. **Su-17/-17M3/FITTER H:** Increased pilot visibility by drooping the aircraft nose, and incorporated an internal Doppler-nav and laser rangefinder. Reconnaissance version called **Su-17M3R**. **Su-17M4/-22M4/FITTER K:** Fighter-bomber. Essentially same as above, but with an additional air intake. Employs digital navigation and attack avionics. **Su-22/FITTER F:** Export version of FITTER D with Tumansky engine. **Su-22/-22M3/FITTER J:** Similar to FITTER H, but with increased internal fuel capacity.		

NOTES
The mid-wing pivot point of the sweep wings allows for positions of 28, 45 or 62 degrees. Up to four external fuel tanks can be carried on wing pylons and under the fuselage. When under-fuselage tanks are carried, only the two inboard wing pylons may be used for ordnance. Available munitions are shown above; not all may be employed at one time. Mission dictates weapons configuration. External stores are mounted on underwing and underbody hardpoints. Each wing has two points, and the fuselage has four attachment points for a total of eight stations. Gun pods can be mounted to fire rearward.

Georgian/Russian Multi-role Attack Aircraft Su-25TM and Su-39





Weapon & Ammunition Types	Combat Load
30-mm twin barrel Gsh-30 gun	**200**
Other Loading Options	
AT-16 Vikhr-M ATGM (8 each)	**16**
23- or 30-mm GSH gun pods	**260 ea**
UB-20 80/122/240/340-mm rockets include semi-active laser homing	**8**
AS-10/KAREN ASM or AS-14/KEDGE ASM AS-11/KILTER ASM AS-17/KRYPTON ASM	**8**
AA-8/APHID (standard all roles)	**2**
AA-12/ADDER AAM and	**2**
AA-11/ARCHER (R-73 RMD2)	on hdpts
50-500-kg bombs	**4,000 kg**

SYSTEM
Alternative Designations: Gratch, Rook,
Date of Introduction: 1995 for Su-25TM
Proliferation: At least 16 countries
Description:
Crew: 1 for Su-25TM. Rear seat area contains avionics. Su-39 crew is 2.
Appearance:
Wings: High-mount, tapered back
Engines: Both along body, under wings
Engines: 2 x 9,900 lbs thrust R-195
Weight (kg):
Maximum Gross: 17,600
Normal Takeoff: 14,500
Empty: 9,525
Speed (km/h):
Maximum (at altitude): 880
Maximum (sea level): 950
Maximum Attack Speed: 690
Cruise: 700
Takeoff/Landing Speed: 220
Max "G" Force (g): +6.5 g
Service Ceiling: (m): 10,000 external stores
Vertical Climb Rate (m/s): 72
Fuel (liters):
Internal: 3,840
External: 800 or 1150 per tank, 2-4 tanks
Range Max Load (km): 500
Plus 2 Aux Fuel tanks: 750 or 1250
Ferry Range (Max Fuel): 2,500
Combat Radius: 556
The engines can operate on any type of fuel to be found in the forward-operating areas, including diesel and gasoline. Thus it can operate from unprepared airfields.
Takeoff Run/LandingRoll (m):
Prepared Surface: 550/600
Unprepared Surface: 650/750
Max Load: 1,200

Dimensions (m):
Length: 15.3
Wingspan: 14.5
Height (gear extended): 5.2
Standard Payload (kg):
External: 6,400
Hardpoints: 8 under-wing, w/500 kg ea + 2 light outer (± 65 kg) for AAM

Survivability/Countermeasures:
Armored cockpit and engines. Titanium cockpit is invulnerable to 20-mm cannon fire, and 30-mm fire from oblique angles. Other features are: 12-mm titanium plate added between engines, zero/100 km/hr ejection seat, self-sealing fuel tanks, and strengthened flight control linkages, IFF, and exhaust cooling. The Irtysh defensive aides suite includes: L166S1/Shokogruz EO infrared jammer, Sirena 3/Pastil radar warning receiver, and Omul ECM pods with UV-26 flares.

ARMAMENT
Available munitions are shown above. Mission and mount requirements limit the ammunition mix and dictate weapons configuration. External stores are mounted on under-wing hardpoints, with five points per wing (total ten stations). Adding external fuel tanks reduces hardpoints available for weapons.
The gun fits in the SPPU-22 gun pod.

Representative mix for targeting armor is: 30-mm gun, 4 pods (16) AT-16 ATGMs, and 2 pods of SAL-H guided rockets. Two other pods hold fuel or AS-10/12 missiles. Missiles may require a TV, radar or IR pod for guidance. Two outer mounts hold single AA-8 missile.

AVIONICS/SENSORS/OPTICS
The I-251 fire control system includes fuselage SUO-39 FCS pod with Shkval-M sight system and Mercury LLLTV), laser radar, Khod thermal imager, 23X image magnification aiming system (to 25 km), and active bomb sight. The stabilized auto-tracker ranges 12 km, and laser rangefinder/ designator 10-15 km. Kopyo-25 pulse Doppler multi-role radar (on lighter weight outer AAM mounts) range to 20-100 km against ground targets or 57 vs aircraft, and simultaneously engage 2 targets. Unguided bomb accuracy is 2-5 m. SAU-8 automated control system integrates aiming/nav systems (Voskhod with INS, GPS, and doppler radar). The aircraft are fully able to perform missions in day, night, and all weather.

VARIANTS
The **Su-25 (FROGFOOT A)** was the original 1-seat aircraft fielded in 1980, with **Su-25K** for export. Early Su-25s had 2x Soyuz/ Gavrilov R95SH engines. Most are now upgraded.

Su-25B/-25UB/-25UBK/-UBP/: A two-seat combat aircraft, naval version, and trainer. The **Su-25UT/UTG** trainers are aka **FROGFOOT-B.**

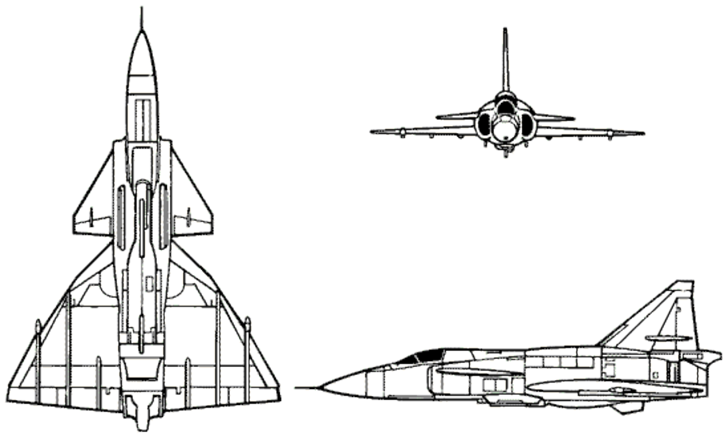
Su-39/Su-25TM (domestic): Developed from the Su-25UB 2-seat trainer. For FCS see above. Height is 5.2 m for avionics and extra fuel. New R-195 engines offer more thrust, range, ceiling, and load. New countermeasure suites are used.

Su-25UBM: The latest upgrade has the Sh013 navigation radar and the Pastel radar warner. The modernized cabin has heads-up and LCD color displays. It can launch KAB-500KL laser homing (SAL) and KAB-500KR TV guided bombs.

Su-25KM/Skorpion: Israeli/Georgian upgrade, with a choice among western avionics.

NOTES
The aircraft can carry a self-contained maintenance kit in 4 under-wing pods. The laser target designator can guide a variety of bombs, missiles, and rockets, including S-24 SAL-H rockets, S-25L rockets to 7 km, and S-25LD rockets to 10 km (see pg. 2-23).

Swedish Multi-role Attack Aircraft AJ37/Viggen



Weapon & Ammunition Types	Combat Load
30 mm Oerlikon KCA automatic cannon (JA37)	**150**
Other Loading Options	
AJ37 (7 to 9 pylons for 6,000 kg) RB24 or RB74 Sidewinder and RB28 Falcon AAM or RB75 Maverick AGM or 4 75mm 19-round rocket pods, or 4 135mm 6-round rocket pods or 30mm Aden gun pod and drop tanks	
JA37 Permanent gun pack for 30 mm Oerlikon KCA automatic cannon (7 to 9 pylons) for 6 RB74 Sidewinder AAM, 2 RB 71 Skyflash AAM or 4 135mm 6-round rocket pods and centerline drop tank	

SYSTEM
Alternative Designations:
Date of Introduction: 1971
Proliferation: Sweden

Description:
Crew: 1 (pilot)
Appearance:
Wings: Low-mounted, delta-shaped from body midsection to the exhaust. Small, clipped delta wings forward of main wings and high-mounted on body.
Engines: One turbofan in the body.
Fuselage: Short and wide with a pointed solid nose
Tail: No tail flats. Large, unequally tapered fin with a small, clipped tip.
Engines: 1 x 14,750 lbs thrust Svenska Flygmotor RM8A turbofan, 25,970 lbs thrust with afterburner
Weight (kg):
Maximum Gross: 20,500
Normal Takeoff: 16,000
Empty: 12,250
Speed (km/h):
Maximum (at altitude): 2,135, Mach 2
Maximum (sea level): 1,469, Mach 1.2
Max "G" Force (g): +7 g
Ceiling (m): 18,300
Vertical Climb Rate (m/s): 203
Fuel (liters):
Internal: 5,700
Range (km):
With Aux Fuel: 2000
Ferry: 2250
Combat Radius (km):
Hi-lo-hi: more than 1000
Lo-lo-lo: more than 500
Takeoff Run/Landing Roll (m): 400/500
Dimensions (m):
Length: 16.3
Wingspan: 10.6
Height: 5.6
Standard Payload (kg):
External: 6,000
Hardpoints: 7 – 9 pylons

Survivability/Countermeasures:
Equipped with 0-75 km/hr ejection seat.
ECM system, chaff dispenser, deception jammer, that is effective against both continuous wave and pulse radars, whether they are airborne or ground-based.

ARMAMENT
30 mm Oerlikon KCA automatic cannon (JA37):

AVIONICS/SENSOR/OPTICS
Automatic flight control system and two independent hydraulic systems. Standard computing system with a digital data bus for communications. Multi-mode monopulse radar, HUD, and Multi-function Displays.

Night/Weather Capabilities:
All-weather attack capability

VARIANTS
AJ37: All-weather attack aircraft with intercept capability.

AJS37: Viggens refitted for multi-role service with upgraded central computer and ESM/ECM pylon jamming pod developed for the JAS 39.

JA37: Air superiority fighter with strike capability; uprated RM8B engine and avionics.

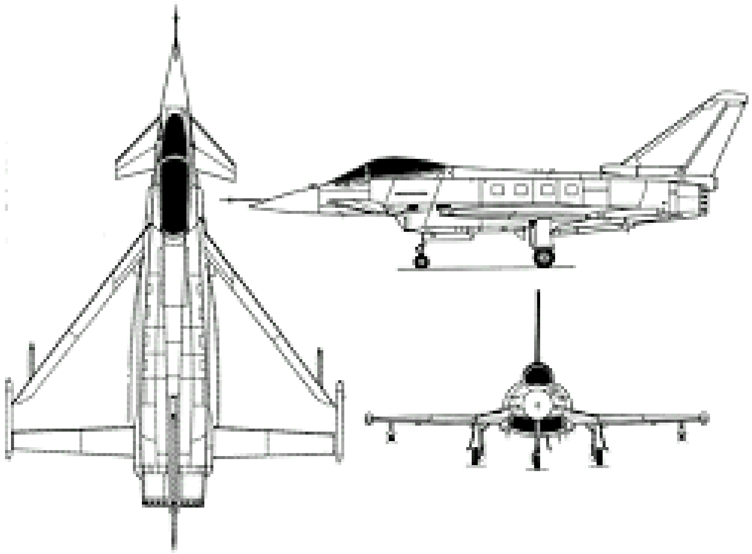
SF37: Armed photo reconnaissance version. Extensive IR and ESM fit including RWR and ELINT data recorders.

SH37: Maritime reconnaissance/strike version has 2 Sidewinder AAM on outer wing pylons.

SK37: Two-seat trainer version.

NOTES
The basic platform was the AJ37 attack aircraft, followed by the S37 reconnaissance versions and the JA37 fighter. The new aircraft had a novel and advanced aerodynamic configuration to meet the shot take-off/landing and other performance requirements: a fixed foreplane with flaps was mounted ahead of and slightly above the main delta wing. A total of 329 aircraft were built in attack, trainer, two reconnaissance versions and the more powerful fighter variant that included new avionics, new air-to-air missiles and Europe's first pulse-Doppler radar.

British/German/Italian/Spanish Multi-role Aircraft EF-2000 Eurofighter __________



Weapon & Ammunition Types	Combat Load
Mauser BK 27-mm revolver cannon	**150**
Other Loading Options	
Air Superiority Package	
BVRAAM/ASRAAM	**6/6**
1,500 L/1,000 L fuel tanks	**2/1**
Air Interdiction Package	
Storm Shadow/AMRAAM/ASRAAM	**2/4/2**
/Alarm/1,500 L/1,000 L	**2/2/1**
Suppression of Enemy Air Defense	
Alarm/AMRAAM/ASRAAM/	**6/4/4**
1,000 L	**1**
Close Air Support Package	
Brimstone/AMRAAM/ASRAAM/	**18/4/2**
1,000 L	**1**
Maritime Attack Package	
Penguin/AMRAAM/ASRAAM/	**6/4/2**
1,500 L/1,000L	**2/1**

SYSTEM
Alternative Designations: Typhoon
Date of Introduction: 2005
Proliferation: 5 countries (Britain, Greece, Germany, Italy, Spain)

Description:
Crew: 1 (pilot)
Appearance:
Wings: Constant leading edge swept delta, with all-moving canard foreplanes placed ahead and above the main wing
Engines: Two turbofan engines fed by a broad, angular group under the fuselage
Fuselage: Conventional semi-monocoque with heavy blending
Tail: Tall swept single fin has an inset rudder. No flats
Engines: 2 x 13,500 lbs thrust Eurojet EJ turbofans, 20,250 with afterburner
Weight (kg):
Maximum Takeoff: 23,000
Normal Takeoff:
Empty: 9,750
Speed (km/h):
Maximum (at altitude): 2,130, Mach 2.0
Max "G" Force (g): +9/-3 g
Vertical Climb Rate (m/s):
Fuel (liters):
Internal:
External: 4,000

Combat Radius (km):
Ground attack, lo-lo-lo: 601
Ground attack, hi-lo-hi: 1.389
Air defense with 3 hr CAP: 185
AD with 10-min loiter: 1,389
Takeoff Run (m): 300-700
Dimensions (m):
Length: 16.0
Wingspan: 11.0
Height: 5.3
Standard Payload (kg):
External: 6,500
Hardpoints: 13 (5 fuselage, 4 ea wing)

Survivability/Countermeasures:
Pilot on Martin-Baker zero/zero ejection seat.
DAAS (defensive aids sub-system) with electronic countermeasures/ support measures system (ECM/ ESM), front and rear missile warning, supersonic capable towed decoy system, laser warning receivers and chaff and flare dispensing system.

ARMAMENT
Internal Mauser BK 27-mm revolver cannon:

AVIONICS/SENSOR/OPTICS
Helmet Mounted Symbology (HMS) system and heads-up-display shows flight reference data, weapon aiming and cueing, and FLIR imagery. Three multifunction, color, head-down displays show the tactical situation, systems status and map displays.
Equipped with a multi-mode X-band pulse Doppler radar and Infrared Search and Track System (IRST).

Night/Weather Capabilities:
Capable of delivering a large payload over long distances, by day or night.

VARIANTS
Two-seat operational conversion trainer: Retains full combat capability. Second seat fitted in place of one fuselage fuel tank, canopy lengthened and dorsal line extended aft to base of tail.

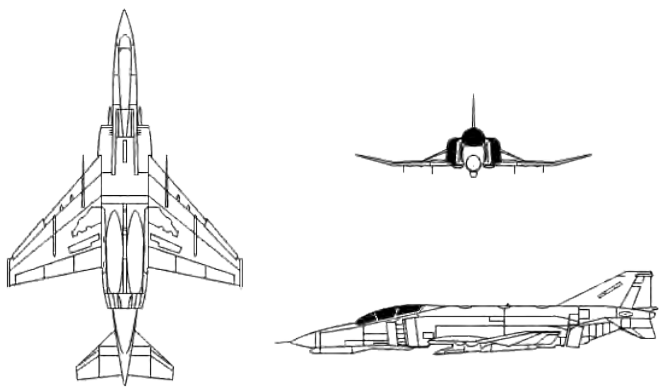
Typhoon: Originally, this was the name for the export variants, but it is likely to be applied to all aircraft with appropriate spelling changes.

Naval variant: Version proposed as a possible competitor to the Joint Strike Fighter for operations off future British carriers.

Interdictor variant: Long-range, deep-strike version, capable of surgical strike against ground targets using stand-off precision guided missiles that could be fitted with conformal fuel tanks for increased range.

NOTES
Eurofighter is a single-seat, twin-engine, agile combat aircraft which will be used in the air-to-air, air-to-ground, and tactical reconnaissance roles. The design of the Eurofighter is optimized for air dominance performance with high instantaneous and sustained turn rates, and specific excess power. Special emphasis has been placed on low wing loading, high thrust to weight ratio, excellent all round vision and carefree handling. The use of stealth technology is incorporated throughout the aircraft's basic design.

American Fighter-Bomber Aircraft F-4/Phantom



Weapon & Ammunition Types	Combat Load
1 x 20-mm cannon	**600**
Other Loading Options	
AIM-7 Sparrow, and	**4**
AIM-9 Sidewinder, and	**4**
227 kg bombs	**6**
or	
AIM-7 Sparrow, and	**4**
454 kg bombs	**8**
or/and	
A variety of rocket pods, fuel tanks, land attack missiles, reconnaissance pods and ECM pods	

SYSTEM
Alternative Designations: Phantom II
Date of Introduction: 1961
Proliferation: at least 8 countries

Description: (F-4S)
Crew: 2 (pilot and radar intercept officer)
Appearance:
Wings: Swept delta, leading edge having greater sweep than the trailing edges
Engines: Two afterburning turbojets housed side-by-side in the fuselage
Fuselage: Tubular with pointed nose and tapered engine housing on each side
Tail: Short, sharply swept fin and rudder
Engines: 2 x 17,900 lbs thrust General Electric J79-GE-10 turbojets with afterburners
Weight (kg):
Maximum Takeoff: 25,455
Empty: 13,990
Speed (km/h):
Maximum (at altitude): 2,334, Mach 2.2
Maximum (sea level): 1,465, Mach 1.2
Ceiling (m): 21,641
Vertical Climb Rate (m/s): 142
Fuel (liters):
Internal: 7,570
Range (km):
Fighter role: 844
Attack role: 504
With Aux Fuel: 2,963
Dimensions (m):
Length: 17.7
Wingspan: 11.7
Height: 5.0
Standard Payload (kg):
External: 7,257
Hardpoints: 5 (1 centerline, 2 pylons under each wing)

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seats, in-flight refueling.
Radar Warning Receiver (RWR), Electronic Countermeasures (ECM) pods, and Infrared detector.

ARMAMENT
20-mm cannon (Mk11 in Mk4 external gun pod or internal M61 Vulcan Gatling):

AVIONICS/SENSOR/OPTICS
Over the years the aircraft has had significant upgrades. Digital radar/fire control system, lead-computing optical sight (LCOS), and infrared scanners. Pylon-borne sensors include target designation pod and laser tracking and designator pod.

Night/Weather Capabilities:
The F-4 is a day and night all-weather fighter-bomber.

VARIANTS
F-4B: First production variant for U.S. Navy and Marine Corps.

F-4C: First production variant for U.S. Air Force.

F-4D: Similar to F-4C with improved radar, INS, gun sight and weapons release computer.

F-4E: Improved Air Force version with new radar, six-barrel cannon, added fuel and new engine.

F-4EJ Kai: Japanese update program, included pulse-Doppler radar, HUD, INS, and RWR.

Israeli F-4E Wild Weasel: F-4E configured to fire the AGM-78B Standard ARM missile.

F-4F: Similar to F-4E for German air force. Introduced leading-edge maneuvering slats.

F-4G Wild Weasel: Attack/electronic warfare (EW) version of the F-4E for anti-radar role.

F-4J: Navy F-4B upgrade of radar, fire control system, engine and drooping ailerons.

F-4K/FG1: Royal Navy version of F-4J for carrier operations.

F-4M/FGR2: Royal Air Force version of the F-4K

F-4N: Upgraded F-4B with improved weapons control system as wells structural strengthening.

F-4S: Rebuilt F-4Js, but with outer leading-edge maneuvering slats.

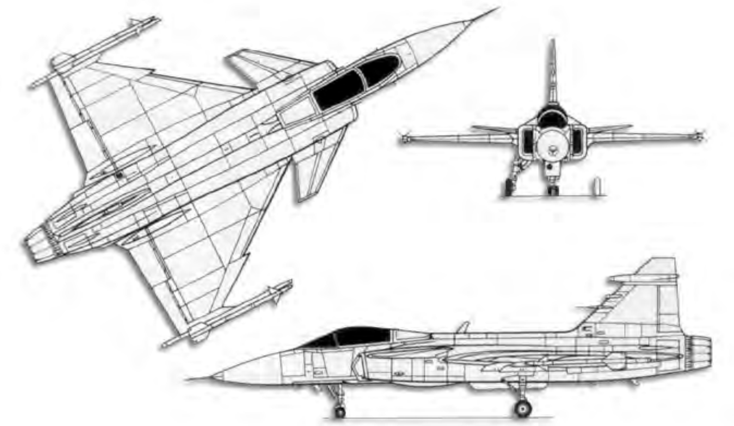
RF-4: Reconnaissance variant.

Kornas 2000/Super Phantom (Sledgehammer 2000): Israeli-developed upgrade to extend service life into the 21st century and serve as the base of the IAF's air-to-ground capability.

Israeli F-4E Super Phantom/Phantom 2000: Kornas 2000 variant fitted with new turbofan engines. Reduced take-off distance, increased rate of climb, and increased low-level speed.

NOTES
F-4s are no longer in service in the U.S. Military. The QF-4 target drone remains in US service. Several hundred F-4s remain in service with German, Japanese, South Korea, Israeli, Greek, and Turkish air forces, with several upgrade programs underway in several countries. Planned as an attack aircraft with four 20 mm guns, it was quickly changed into a very advanced gunless all-weather interceptor with advanced radar and missile armament. The aircraft flew every traditional military mission: air superiority, close air support, interception, air defense, suppression, long-range strike, fleet defense, attack, and reconnaissance.

Sweden Multi-role Fighter Aircraft JAS39/Gripen



Weapon & Ammunition Types	Combat Load
27-mm Mauser BK 27	**120**
Other Loading Options	
7 Hardpoints plus sensor hardpoint under intake	
AIM-9 Sidewinder on the wingtips	**2**
AIM-120 AMRAAM	**4**
AGM-65A/B Maverick	**4**
Saab RBS15F anti-shipping missile	**2**
Dasa DWS39 munitions dispenser or KEPD 150 pods	**2**
Bofors rocket pods	**4**
Conventional or retarded bombs	
Reconnaissance and electronic warfare pods	

SYSTEM
Alternative Designations:
Date of Introduction: 1997
Proliferation: Sweden (Hungary and South Africa – planned)

Description:
Crew: 1 (pilot) (JAS 39A/C), 2 pilots (JAS 39B/D)
Appearance:
Wings: Multi-sparred delta. Large, swept, all-moving foreplane canards mounted on engine intake shoulders
Engines: Turbofan with intake boxes on both sides of fuselage
Fuselage:
Tail: Leading edge swept fin with upright inset rudder.
Engines: 1 x 12,140 lbs thrust Volvo Aero RM12, 18,200 lbs thrust with afterburner
Weight (kg):
Takeoff: 12,500 (A/C), 14,000 (B/D)
Empty: 6.500 (A/C), 7,100 (B/D)
Speed (km/h):
Maximum (at altitude): 2,150, Mach 1.8+
Max "G" Force (g): +9/-3 g
Ceiling (m): 16,000
Fuel (liters):
Internal: 3,008 (A/C), 2,852 (B/D)
External: 3,300

Range (km):
Combat Radius: 800
Ferry: 3,000
Takeoff Run/Landing Roll (m): 800/800
Dimensions (m):
Length: 14.1 (A/C), 14.8 (B/D)
Wingspan: 8.4 over tip rails
Height: 4.5
Standard Payload (kg):
External: 3,600
Hardpoints: 7 (4 wing, 1 centerline, 2 wingtip rails)

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seat.
IFF and an integrated EW system that provides radar warning, electronic support measures, chaff, flare, and decoy dispensers.

ARMAMENT
27-mm Mauser BK 27:

AVIONICS/SENSOR/OPTICS
The long-range multi-purpose pulse Doppler radar has air-to-air operating modes covering long-range search, multi-target track-while-scan, multiple priority target tracking, air combat quick search modes, raid assessment and beyond visual range missile mid-course updates. Also equipped with INS, radar altimeter, and electronic display (incorporating wide-angle HUD), and FLIR.

Night/Weather Capabilities:
All-weather, all-altitude, day/night interceptor, attack, and reconnaissance aircraft.

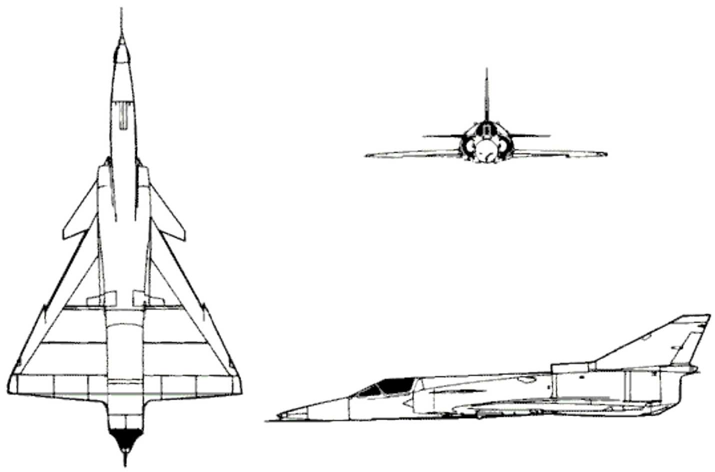
VARIANTS
JAS 39A: Original single-seat version supplied to the Swedish air force.

JAS 39B: Design-study contract for trainer/reconnaissance variant awarded to JAS in 1989; fuselage plug inserted to make room for second seat.

JAS 39C/D: NATO-compatible export variant equipped with OBOGS, FLIR, NVG-compatible cockpit, laser-designator pod, HMD. Higher gross takeoff weight. The 39D is the two-seat equivalent.

NOTES
The JAS 39 Gripen is a fourth generation, multi-role combat aircraft. The Gripen is the first Swedish aircraft that can be used for interception, ground-attack, and reconnaissance (hence the Swedish abbreviation JAS – Fighter (J), Attack (A), and Reconnaissance (R)) and it is now successively replacing the Draken and the Viggen. The JAS 39 is part of a system that fights the "information war" in which aircraft receive and convey information through an air-to-air tactical information data link system (TIDLS).

Israeli Multi-role Fighter KFIR (Lion Cub)



Weapon & Ammunition Types	Combat Load
2 Internal 30-mm cannons	**140**
Other Loading Options	
Missiles	
Python/Shafrir/AIM-9	**2**
AGM-45 Shrike ARM	**1**
AGM-65 Maverick	**1**
Bombs	
GBU-15 glide bomb	**1**
227 kg	**6**
363 kg or 454 kg	**2**
1,361 kg	**1**
ECM pods	
3 External fuel tanks (liters)	**4,700**

SYSTEM
Alternative Designations: C2; C7
Date of Introduction: 1975
Proliferation: 6 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Low-mounted , delta-shaped with a saw tooth in the leading edge
Engines: One turbojet
Fuselage: Tube shaped with a long, solid, pointed nose
Tail: No tail flats. Fin is swept-back and tapered with a step in the leading edge
Engines: 17,750 lbs thrust General Electric J79-GE-1JE Turbojet (C2) 18,750 lbs thrust (C7)
Weight (kg):
Maximum Takeoff: 16,500
Normal Takeoff:
Empty: 7,285
Speed (km/h):
Max (at altitude): 2,440, Mach 2.3
Max (sea level): 1,389, Mach 1.1
Takeoff/Landing Speed: 220
Max “G” Force (g): +7.5 g
Ceiling (m): 17,680
Vertical Climb Rate (m/s): 233

Fuel (liters):
Internal: 3,243
External: 4,700
Range (km):
Ferry: 2,991 (C2)
3,232 (C7)
Combat Radius (km):
Intercept Mission: 347 (C2), 776 (C7)
Combat Air Patrol: 699 (C2), 882 (C7)
Ground Attack: 768 (C2), 1,186 (C7)
Takeoff Run/Landing Roll (m):
Max Load: 1,455/1,555
Dimensions (m):
Length: 15.7
Wingspan: 8.2
Height: 4.6
Standard Payload (kg):
External: 4,277 (C2). 5,775 (C7)
Hardpoints: 7/9 including missiles (C2/C7)

Survivability/Countermeasures:
Cockpit pressurized, heated, and air conditioned. Martin-baker zero/zero ejection seats. In-flight refueling.
IFF, ECM pods, radar warning receiver, chaff and flares.

ARMAMENT
2 internal 30-mm DEFA 552 cannons

AVIONICS/SENSOR/OPTICS
Hands On Throttle And Stick (HOTAS), weapons delivery and navigation system, computerized stores management and release system, video subsystem, smart weapons delivery capability, and ranging radar.

Night/Weather Capabilities:
Day and night all-weather capable.

VARIANTS
KIFR C1: Initial production model, leased to the US Navy and Marine Corps and re-designated F-21A.

F-21A: Slightly modified C1, used to train US combat pilots in adversary tactics. Used by US Navy from 1985 to May 1988. Used by USMC from 1987 to Sep 1989.

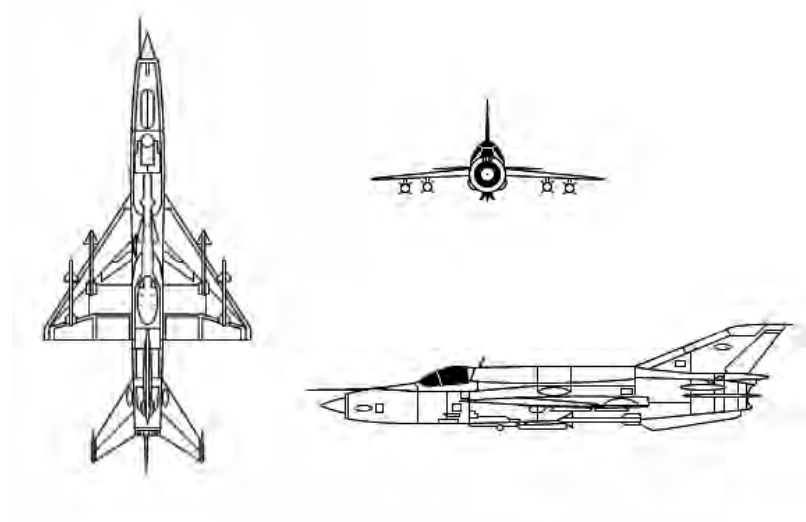
KFIR C2: Revised airframe with foreplanes and nose strake added.

KFIR C7: Upgraded version with new avionics: WDNS-391 weapons control system with stores management display, uprated GE J79-1JE engine and greater internal fuel capacity.

KFIR-2000: Designed as a cost-effective multirole aircraft.

NOTES
Over 230 aircraft were in military service with Israel and several other nations, but most of the Israeli KFIRs are now in storage.

Russian Multi-role Fighter Aircraft MiG-21/FISHBED



Weapon & Ammunition Types	Combat Load
23-mm Gsh-23 2-barrel cannon	**200**
Other Loading Options	
AA-8 Aphid	
AA-2C or D Atoll	
Gun Pods	
unguided bombs, rockets	
See **MiG-21-93** and **MiG-21 Bison** for more loading options.	

SYSTEM
Alternative Designations: J-7 (Chinese)
Date of Introduction: 1958
Proliferation: At least 40 countries

Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: Mid-mount, Delta, Squared tips
Engines: One turbofan in fuselage
Fuselage: Long and tubular, with blunt nose and bubble canopy
Tail: Swept-back, tapered with square tip. Flats are mid-mounted on the body, swept-back, and tapered with square tips.
Engines: 1x 12,675 lbs thrust w/afterburner Tumansky R-11F-300 (MiG-21)/ or 1x 14,550 lbs thrust Wopen-13 turbofan (J-7)
Weight (kg):
Normal Takeoff: 8,825
Speed (km/h):
Max (at altitude): 2,175 (Mach 2.05)
Max (sea level): 1,300 (Mach 1.05)
Landing Speed: 270
Max "G" Force (g): +8.5 g
Ceiling (m): 18,000
Vertical Climb Rate (m/s): 225
Fuel (liters):
Internal: 2,650
External: 2 fuel tanks (1470)
Range (km):
Ferry: 2,100
High Alt: 1,000 w/internal fuel and 2 AAM
Low Alt: 560 w/internal fuel and 2 AAM
Takeoff Run/Landing Roll (m): 900/650 with drag chute
Dimensions (m):
Length: 14.5 w/out probe 15.8 w/probe
Wingspan: 7.2
Height: 4.5
Standard Payload (kg): 1,200
4 under wing pylons

Survivability/Countermeasures:
Pressurized cockpit with ejection seat, radar warning receiver, chaff and flares.

ARMAMENT
Early models carried two NR-30 guns in the forward fuselage, one was usually removed for weight reasons. A gun pack with two GSh-23 23-mm cannons and 200 rounds is fitted to a ventral pylon on Fishbed-D and later models.

AVIONICS/SENSOR/OPTICS
The MiG-21 has the Spin Scan or Jay Bird airborne interception radar and a gyro-stabilized gun sight

Night/Weather Capabilities:
The MiG-21 is a short-range day fighter-interceptor with limited possibilities in adverse weather conditions.

VARIANTS
MiG-21 FISHBED-C, D, and F variants are fighters. Later Russian variants are multi-role fighters, except H (recon).

MiG-21F FISHBED-C: First production variant with RD-11 engine. 1 x NR-30 30-mm cannon.

MiG-21PF FISHBED-D: Interceptor with enlarged intake that became standard. Spin Scan radar. Pitot tube relocated to top of intake.

MiG-21PF FISHBED-E: Principal PF production version. GP-9 23-mm gun pack. Provision for rocket-assisted take-off, ground (RATOG).

MiG-21FL FISHBED-E: Export variant of PF without RATOG. Fitted with Spin Scan radar.

MiG-21 FISHBED-G: Derivative used to test lift and cruise engine vertical take-off and landing (VSTOL) design. Although not produced, configuration later reappeared in Yak-38 Forger naval VSTOL aircraft.

MiG-21R FISHBED-H: Recon version with electronic intelligence equipment in belly pack, for day/night photographic, laser, IR or TV sensors.

MiG-21PFMA FISHBED-J: Two additional wing pylons. Jay Bird radar capable of guiding semi-active radar homing advanced ATOLL AAM.

MiG-21MF FISHBED-J: Uprated PFMA using 14,550-lb static thrust Tumansky R-13-300 engine. Wing stressed for low-level flight permitting Mach 1.06 at low altitude.

MiG-21M FISHBED-J: Export version of MiG-21 PFMA with Tumansky R-11F2S-300 engine. Built in India from 1973 to 1981.

MiG-21SMB FISHBED-K: Similar to MiG-21MF, with extension of deep dorsal spine for fuel tank and aerodynamic shaping, ECM fairings on wing tip.

Russian Multi-role Fighter Aircraft MiG-21/FISHBED continued

MiG-21 bis FISHBED-L: Third generation MiG-21, simpler construction, longer fatigue life, greater fuel capacity. It has improved computer-based fire control.

MiG-21 bis FISHBED-N: Similar to Fishbed-L, but with 16,535-lb static thrust Tumansky R-25 engine.

MiG-21-93 FISHBED-N: Midlife upgrade package based on the MiG-21 bis. The latest version was also developed for upgrade of older MiG-21s, with upgraded fire control and the coherent pulse-doppler Kopyo radar, (permitting use of radar-guided and other precision munitions). Missiles available include: AA-12 Adder, AA-11 Archer, AA-10 Alamo, AS-10, AS-12, and AS-17. It can also deliver KAB-500r and KAB-500L guided bombs.A factory upgraded and exportable version is offered.

MiG-21 Bison. Indian licensed upgrade for their MiG-21s to the **MiG-21-93** standard, begun in the early 2000s. This program is probably ended, with a recent report that India will scrap its fleet of MiG-21s, and replace them with newer Russian aircraft.

MiG-21-2000: Israel Aircraft Industries (IAI) upgrade. Capable of using Russian standard armament and the Rafael Python 4 AAM

MiG-21 Lancer: Romania's Aerostar and Israel's Elbit jointly designed this upgrade program for 110 Romanian air force MiG-21s: 25 air defense, 75 ground-attack and 10 two-seat trainers.

MiG-21U Mongol-A: Trainer version with two-seats and with weapons removed.

MiG-21US Mongol-B: A modified version with no dorsal fin and broader vertical tail surfaces. Similar to Mongol-A, with SPS flap-blowing and retractable instructor periscope.

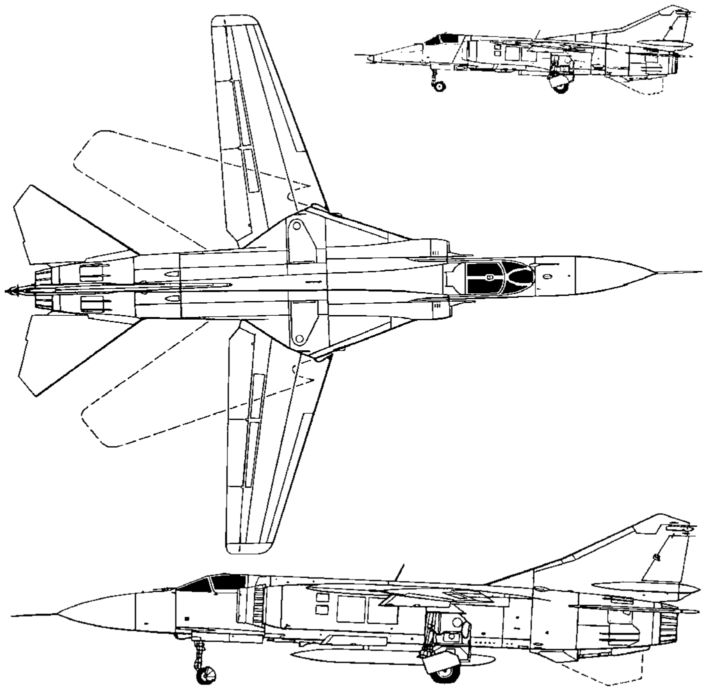
MiG-21UM Mongol-B: Trainer with R-13-300 engine. Similar to MiG-21F.

J-8: Chinese aircraft is loosely based on MiG-21and MiG-23 features.

NOTES

A principal weakness of the MiG-21 design is the rearward shift of the center of gravity as the fuselage tanks are emptied. A full one-third of the fuel on board cannot be used for this reason. The same limitation effectively reduces Mach 2 flight time to perfunctory high-speed tests. The MiG-21 is a simple, reliable aircraft with honest flying characteristics. It is also considered to be a competent dog-fighter against most Western aircraft. India has suffered an almost incredible string of MiG-21 crashes since 1998, including several notable incidents that have killed people on the ground. From January 1998 to December 2002 there were over 50 MiG-21 crashes, including three that killed a total of 13 people on the ground. Analysts are debating if the age of the aircraft is an issue or if there are serious errors in pilot training.

Russian Multi-role Fighter Aircraft MiG-23/MiG-27/FLOGGER



MIG-23 and MIG-27 (inset)

Weapon & Ammunition Types	Combat Load
23-mm Gsh-23L twin gun or	**200**
23-mm Gsh-6-23 Gatling gun	**260**
Other Loading Options	
2x AA-7 APEX (K-23R/T) or AA-8/APHID AAM launchers	**2**
Gun Pods	
AS-7/KERRY ASM or AS-10/KAREN ASM or AS-12/KEGLER ASM or AS-14/KEDGE ASM	**4**
240-mm S-24 rockets (1 e), or 80-mm S-8 rkt pods (20 ea), or 57-mm S-5 rkt pods (32 ea)	**4**
50-kg, 100-kg, 250-kg, or 500-kg unguided and guided bombs	
External fuel tanks (liters)	**800**

SYSTEM
Alternative Designations: MiG-27, Bahadur, or Valiant (Indian variant)
Date of Introduction: 1972
Proliferation: At least 23 countries
Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: High-mount, variable, tapered
Engines: One in fuselage
Fuselage: Long and tubular, with box-like intakes and large, swept belly-fin
Tail: Swept-back, tapered with angular tip, swept, tapered flats mounted on fuselage
Engines: 1x 28,660-shp Soyuz/Kachaturov R-35-300 (MiG-23)/ or 1x 25,335-shp R-29B-300 (MiG-27) turbojet, afterburner
Weight (kg):
Max Gross: 17,800 (MiG-23)/ 20,700 (MiG-27)
Normal Takeoff: 14,840 (MiG-23)/ 18,900 (MiG-27)
Empty: 10,200 (MiG-23)/11,908 (MiG-27)
Speed (km/h):
Max (at altitude): Mach 2.35 (MiG-23)/ Mach 1.7 (MiG-27)
Max (sea level): Mach 1.2
Takeoff/Landing Speed: 315/270
Max "G" Force (g): +8.5 g (MiG-23)/ +7.0 (MiG-27)
Ceiling (m):
Service (clean): 18,600
With External Stores: INA

Vertical Climb Rate (m/s): 240
Fuel (liters):
Internal: 4,250 (MiG-23)/ 5,400 (MiG-27)
External: Up to 5x 800 liter tanks
Range (km):
Max Load: 1,500
With Aux Fuel: 2,500
Combat Radius: 1,150
Takeoff Run/Landing Roll (m):
Prepared Surface: 500/750 (MiG-23)/ 950/1,300 (MiG-27)
Dimensions (m):
Length: 16.8 (MiG-23/ 17.1 (MiG-27)
Wingspan: 14.0 extended, 7.8 swept
Height: 4.8 (MiG-23)/ 5.0 (MiG-27)
Standard Payload (kg):
External: 3,000 (MiG-23)/ 4,000 (MiG-27)
Hardpoints: 6 (MiG-23 twin hardpoint under fuselage.)/7 (MiG-27)

Survivability/Countermeasures:
Pressurized cockpit with zero/130 ejection seat, infrared and radar jammer, radar warning receiver, decoy, chaff and flares.
Armored cockpit on MiG-27

ARMAMENT
The MiG-23 has Gsh-23L. Preferred load is 4 AA-7, and 2 AA-10 (intercept) or 2 ground attack pods. The MiG-27 has Gsh-6-23.

Gsh-6-23
23-mm twin gun, Gsh-23L:
Range (m): (practical) 2,500
Elevation/Traverse: None (rigidly mounted)
Ammo Type: HEFI
Rate of Fire (rpm): 9,000

23-mm 6x barrel Gatling gun, Gsh-6-23:
Range (m): (practical) 2,500
Elevation/Traverse: None (rigidly mounted)
Ammo Type: HEFI
Rate of Fire (rpm): 9,000

AVIONICS/SENSOR/OPTICS
The MiG-23 has an acquisition and tracking radar, IR sensor, and Doppler nav system.

The MiG-23B and MiG-27 series have a flattened nose section which houses a laser rangefinder/designator, TV sighting system, and a target tracker instead of the radar to attack ground targets.

Night/Weather Capabilities:
The MiG-23 is capable of attacking air targets day or night. The MiG-27 is capable of attacking ground targets in day, night, and poor weather conditions.

.

Russian Multi-role Fighter Aircraft MiG-23/MiG-27/FLOGGER continued

VARIANTS

MiG-23M/FLOGGER B: First production version as standard interceptor, - pulse doppler radar, improved engine, IRST, AA-7, etc

MiG-23U/-23UM/-23UB/FLOGGER C: A tandem seat combat and trainer variant.

Mig-23MS/FLOGGER E: Export built to **-B** standard. **MiG-23MF** downspec version

MiG-23B/FLOGGER F: Interim ground attack variant with AL-21 turbojet engine, no radar, and tapered nose. The **MiG-23BN** variant returned to the R-35-300 engine.

MiG-23ML/FLOGGER G: Lighteight version with improved engine and avionics

MiG-23P/FLOGGER G: Fighter variant similar to FLOGGER B, but with digital autopilot for ground control.

MiG-23BK/-23BM/FLOGGER-H: Ground attack versions with the uprated engine, and avionics pods borrowed from the MiG-27.

Mig-23MLD/FLOGGER K: Upgraded multi-role fighter with improved aerodynamics, latest missile, and other improvements. This is considered the best current production upgrade available.

MiG-27K/FLOGGER D: Ground-attack variant with internal **Gsh-6-23** 23-mm gun. Appearance differs by tapered nose.

MiG-27D/-27M/FLOGGER J: Appearance differs by a long downward-sloping, pointed nose. Aircraft has a TV/laser designator. Can be fitted with a three-camera recon pod.

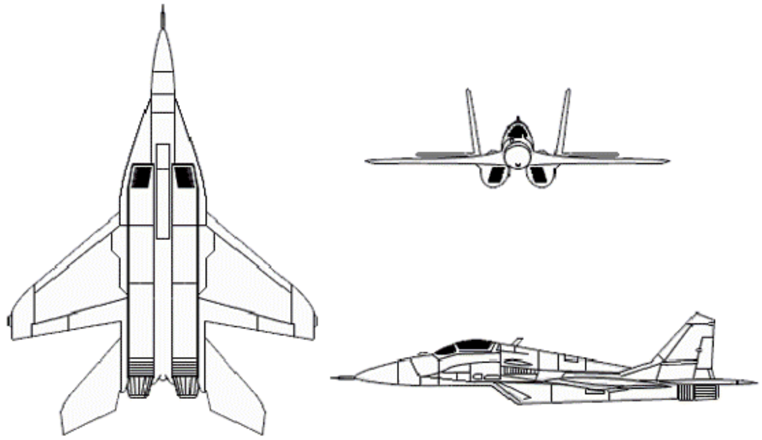
MiG-27L: Export versions built by Hindustan Aeronautics in India.

J-8: Chinese aircraft is loosely based on MiG-21and MiG-23 features.

NOTES

Inset line-drawing shows nose and intake differences of the MiG-27. This difference allows for a laser rangefinder/target designator. The sweep wing is capable of three angles: 16, 45, and 72 degrees. The ventral fin on the bottom rear of the fuselage folds for takeoff and landing. Up to five external fuel tanks can be carried on the MiG-23, and four on the MiG-27, but the MiG-27 can also be fitted for aerial refueling. Available munitions are shown above; not all may be employed at one time. Mission dictates weapons configuration. External stores are mounted on underwing and underbody hardpoints. Each wing has one point, two points are under the intakes along the fuselage, and the center fuselage attachment point gives five total stations. The MiG-27 then adds two more bomb racks under the wings for a total of seven stations.

Russian Multi-role Fighter Aircraft MiG-29/FULCRUM



Weapon & Ammunition Types	Combat Load
30-mm Gsh-30-1 cannon	150
Other Loading Options	
AA-8 APHID AAM or	6
AA-10 ALAMO AAM or	4
AA-11 ARCHER AAM or	4
AA-12 ADDER AAMs	4
AS-14 KEDGE or	2
AS-17 KRYPTON or	2
250 kg Bombs or	8
500 kg Bombs or	4
ZB-500 (Napalm tanks) or	4
KMGU-2 (submunition dispensers) or	4
130 mm and 240 mm rockets or	4
B-8M1 (20 x 80 mm) rocket pack	4
Fuel in 3 external tanks (liters)	4150

SYSTEM
Alternative Designations:
Date of Introduction: 1983
Proliferation: At least 25 countries
Description:
Crew: 1 (pilot)
Appearance:
Wings: Swept-back and tapered with square tips.
Engines: Twin jets mounted low and to the sides of the fuselage. Diagonal-shaped air intakes
Fuselage: Long, thin, slender body with long pointed drooping nose.
Tail: Fins have sharply tapered leading edges, canted outward with angular cutoff tips. Flats are high-mounted on the fuselage, movable, swept-back, and tapered with a negative slant.
Engines: Two Kimov/Sakisov RD-33 Turbofans (18,300 lbs) each
Weight (kg):
Max Gross: 22,000
Normal Takeoff: 16,800
Empty: 10,900
Speed (km/h):
Max (at altitude): 2,400
Max (sea level): 1,500
Takeoff/Landing Speed: 240
Max "G" Force (g): +9.0 g
Ceiling (m):
Service (clean): 18,000
With External Stores: 17,500
Vertical Climb Rate (m/s): 330
Fuel (liters):
Internal: 4,300
External: 4,150 (3 drop tanks)
Range (km):
Maximum: 1,500 (on internal fuel)
Low altitude: 710 (on internal fuel)
Ferry: 2,900 (3 external tanks)

Takeoff Run/Landing Roll (m):
Prepared Surface: 550/900
Afterburner/Drag Chute: 250/660
Dimensions (m):
Length: 17.3
Wingspan: 11.4
Height: 4.8
Standard Payload (kg):
External: 3,000, 4,000 FULCRUM-C/D and MiG-29SMT.
Hardpoints: 6 wing pylons

Survivability/Countermeasures:
Zero/zero ejection seat, radar jammer, radar warning receivers, chaff and flares.

ARMAMENT
The MiG-29 has a 30-mm cannon in the left wing root, and the primary missiles for air defense missions are the AA-8 Aphid, AA-10 Alamo, or AA-11 Archer

AVIONICS/SENSOR/OPTICS
The MiG-29 employs a coherent pulse-Doppler look-down/ shoot-down radar with a search range of 70 km and a track range of 35 km. It can track 10 target and engage two. Targeting information is coordinated by the weapons control computer and displayed on the Heads-Up-Display (HUD).
An infrared search and track system (IRST) is fitted in a small housing ahead of the cockpit. The pilot wears a helmet with a built-in sight for off-axis aiming.

Night/Weather Capabilities:
The MiG-29 basic version is capable of hitting air targets day and night, in weather, in free airspace and against the earth background and in active and passive jamming environments.

VARIANTS
MiG-29/FULCRUM A: Single seat tactical fighter designed to operate under ground control.

MiG-29UB/FULCRUM B: Operational conversion trainer; two-seat configuration. Air-defense role.

MiG-29S/FULCRUM C: Production multi-role variant fitted with dorsal hump housing upgraded avionics, and uprated flight-control system with some aerodynamic tweaking. Principal upgrade was NO-19 fire control radar, which can engage two targets simultaneously.

MiG-29SD: Fulcrum A export upgrade version of MiG-29 to FULCRUM C standard.

MiG-29SM: Current production upgrade with ASM capability.

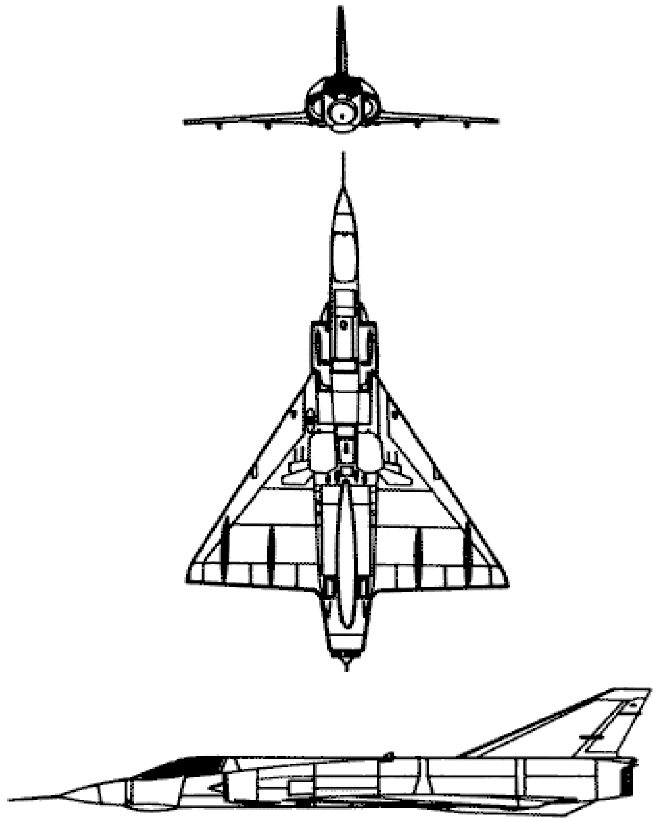
MiG-29K/FULCRUM D: A carrier borne version of the FULCRUM.

Baaz (Falcon): Name given to the MiG-29 Indian Air Force, which began operating the aircraft in 1987.

MiG-30: Proposed ground-attack variant offered to India in 1991 as substitute for the Light Combat Aircraft (LCA).

MiG-29SMT: Advanced multi-role design, with capability for improved ASMs, such as AS-14 and AS-17.

French Multi-role Fighter Aircraft Mirage 2000



Weapon & Ammunition Types	Combat Load
Two 30-mm DFEA 554 guns(C/E/-5)	**125 ea**
Other Loading Options	
AAMs:	
R550 Magic 2	**2-4**
AIM-9 Sidewinder	**2-4**
Super 530	**2**
MICA (2000-5)	**4-6**
AGMs:	
AS30L	**2**
BGL laser-guided rocket/gun pods	**1-2**
18-round 68 mm rocket pods	**4**
100 mm rocket packs	**2**
CC630 twin 30 mm cannon pack	**1**
BOMBS:	
35 kg BAP100 anti-runway	**18**
250 kg conventional	**18**
200 kg Durandal anti-runway	**16**
Belouga cluster	**5-6**
400 kg BM400 modular	**5-6**
1,000 kg BGL laser-guided	**1-2**
Anti-radar:	
Armat	**2**
Anti-ship:	
AM39 Exocet	**2**
Nuclear:	
ASMP cruise missile (2000N)	**1**
Pods:	
Recce/Offensive or intelligence ECM	**1**
FLIR navigation	**1**
Fuel:	
3 External fuel tanks (liters)	**4,700**

SYSTEM
Alternative Designations:
Date of Introduction: 1983 (C), 1993 (D)
Proliferation: 8 countries

Description:
Crew: 1 (Pilot) (B/C/D), 2 (pilot and Nav/Weapons officer) (B/C/N)
Appearance:
Wings: Low-mounted delta, clipped tips
Engines: Turbofan in the fuselage
Fuselage: Tube-shaped with a pointed nose and bubble canopy
Tail: Tall, swept-back and tapered with a clipped tip. There are no tail flats
Engines: 14,462 lbs thrust SNECMA M53-P2 Turbofan, 21,385 lbs thrust with afterburner
Weight (kg):
Maximum Takeoff: 17,000 (C)
Empty: 7,500 (C/E/-5), 7,616 (B/N/D/S)
Speed (km/h):
Maximum (at altitude): 2,630, Mach 2.2
Maximum (sea level): Mach 1.2
Max "G" Force (g): +9 g
Ceiling (m): 18,000
Vertical Climb Rate (m/s): 285
Fuel (liters):
Internal: 3,978
External: 4,700
Range (km):
Maximum Load: 2,960
With Aux Fuel (3 tanks): 3,600
Combat Radius: 900
Dimensions (m):
Length: 14.4
Wingspan: 9.2
Height: 5.2
Maximum Payload (kg): 6,300
Hardpoints: 9 (5 under fuselage, 2 under each wing

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seats. Canopy covered in gold film to reduce radar signature.
IFF. Integrated Electronic Countermeasures suite consisting of RWR, Radar jamming pods, chaff/flare dispenser, decoy system, and passive missile attack warning system.

ARMAMENT
Two 30-mm DFEA 554 guns (C/E/-5):

AVIONICS/SENSOR/OPTICS
Equipped with pulse doppler radar, look-down-shoot-down capacity, fly-by-wire, automatic pilot, 2 inertial guidance systems, terrain following radar, digital map, integrated GPS, LASER designation pod with thermal camera.

Night/Weather Capabilities:
Battlefield air interdiction mission capable in day, night, and all-weather conditions.

VARIANTS

Mirage 2000B: Two-seat, combat-capable trainer version. Lacks internal guns.

Mirage 2000C: Initial production single-seat version.

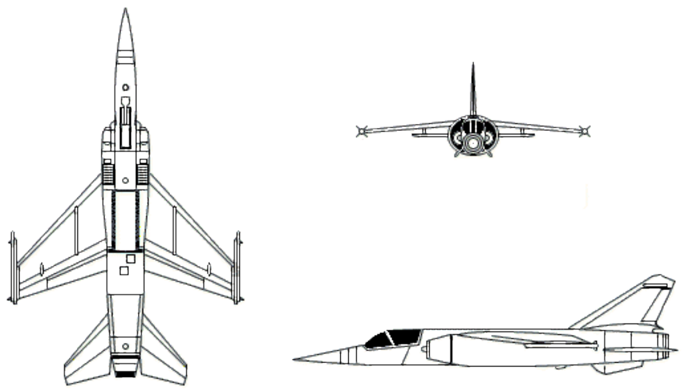
Mirage 2000N: Two-seat, nuclear-capable fighter/bomber version in French service only. No internal gun. Moving map display, 60 m penetration altitude.

Mirage 2000D: Two-seat, conventionally armed variant of the 2000N for low-level and night-time strike mission; some stealth measures applied including gold-film coating on the canopy and camouflage.

Mirage 2000-5: Conventional multi-mode fighter offered for export. A 22,050 lbs thrust SNECMA M53-P20 engine offered as an alternative.

Mirage 2000R: Reconnaissance version of 2000C. Fitted with camera pods, electronic intelligence and ECM equipment

French Multi-Purpose Fighter Aircraft Mirage F1



Weapon & Ammunition Types	Combat Load
Two integral 30-mm DEFA cannons	**135 ea**
Other Loading Options	
Super R530 AAM, or	**2**
Armat ARM, or	**1**
AM 39 Exocet anti-ship missile, or	**1-2**
AS30L AGM, or	**1-2**
30-mm DEFA gun pods, or	**2**
400kg or 1,000kg laser guided bombs	
ATLIS laser designation pod, or	
250kg/BAP 100/BAT-100	**14**
Durandal anti-runway bombs, or	
Belouga cluster bombs, or	
18 x 68 mm rocket pods, or	**8**
countermeasures pods, or	**1**
camera pods, or	**1**
R550 Magic or AIM-9 Sidewinder AAM	**2**

SYSTEM
Alternative Designations:
Date of Introduction: 1974
Proliferation: At least 11 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: High-mounted, swept-back, and tapered
Engines: One turbojet buried in the aft fuselage
Fuselage: Long, slender, pointed nose and blunt tail
Tail: Swept-back and tapered fin with a blunt tip. Flats are mid-mounted on the fuselage, swept-back, and tapered with blunt tips
Engines: 11,023 lbs thrust SNECMA Atar 9K-50 turbojet, 15,873 lbs thrust with afterburner
Weight (kg):
Maximum Takeoff: 16,200
Normal Takeoff: 10,900
Empty: 7,400
Speed (km/h):
Maximum (at altitude): 2,334, Mach 2.2
Maximum (sea level): 1,471, Mach 1.2
Ceiling (m): 20,000
Vertical Climb Rate (m/s): 213
Fuel (liters):
Internal: 4,200
External: 4,460

Range (km):
Cruise: 2,170
Ferry: 3,300
Dimensions (m):
Length: 15.3
Wingspan: 8.4
Height : 4.5
Standard Payload (kg):
External: 6,300
Hardpoints: 5 Pylons (1 centerline, 2 each wing

Survivability/Countermeasures:
In-flight refueling, Martin-Baker zero/zero ejection seats
IFF, infrared jammer, radar warning receiver, Electronic Countermeasures.

ARMAMENT
Two 30-mm DEFA 533 cannons

AVIONICS/SENSOR/OPTICS
Cyrano IVM radar (air-to-air, air-to-ground), inertial navigation system, panoramic camera, vertical camera, and IR thermographic captor.

Night/Weather Capabilities:
There are several versions now operational including all-weather interceptor, fighter-bombers and dedicated reconnaissance aircraft.

VARIANTS
F1-C: First production version for service with France and for export. Avionics orientated toward air-to-air interception.

F1-A: Initial production ground attack version with small Adia 2 target-ranging radar, retractable refueling probe, ground attack system avionics suite.

F1-B: Two-seat combat-capable trainer version of F1-C. Integral cannon removed.

F1-D: Two-seat combat-capable trainer version of the F1-E.

F1-E: Export version with stretched fuselage and improved avionics.

F1-R (F1-CR-200): Reconnaissance/ELINT/EW version. Fitted with ground mapping and other low-altitude modes radar, digital navigation/ attack computer, heads-up-display, inertial navigation system, and air data computer.

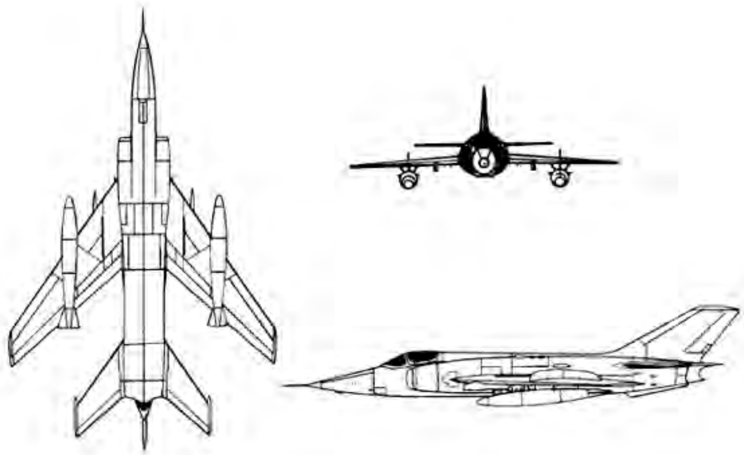
F1-CT: Canadian air force replacement for the older Mirage III and some Jaguar aircraft. Used as strike aircraft.

Mirage F1/M53: Fitted with 18,740 lbs thrust SNECMA M53, engine later adopted for Mirage 2000.

C-14: Spanish designation for Mirage F1.

NOTES
The Mirage F1 is a multi-purpose attack/fighter aircraft of considerable versatility. It can be employed in the intercept, ground attack, reconnaissance, training, electronic warfare, and electronic intelligence roles. The French air force ordered the Mirage F1 for its interceptor squadrons, and the first F1s entered service in 1973. The F1 proved a very popular export, with over 500 of them sold abroad in the first 10 years of production. More than 700 Mirage F1's have been sold to some 11countries.

Chinese Multi-role Fighter Aircraft Q-5/FANTAN



Weapon & Ammunition Type	**Combat Load**
2 x Norinco 23-2K 23mm cannon	**200 ea**
Other Loading Options	
Bombs: 225 kg or 250 kg	**6**
340 kg	**2**
Duranal anti-runway	**6**
BL755 cluster	**2**
Rocket pods: 8-round 57mm/68mm	**2**
7-round 90mm	**2**
130mm rockets	**4**
Missiles: PL-2/PL-2B/PL-7 anti-air	**2**
AIM-9 Sidewinder anti-air	**2**
Matra R550 Magic anti-air	**2**
CSS-N-4 Sardine anti-ship	
ECM Pods:	**2**
FUEL: 2 external fuel tanks (liters)	**760 ea**

SYSTEM
Alternative Designations: A-5 export version
Date of Introduction: 1970
Proliferation: At least 5 countries

Description:
Crew: 1 (pilot)
Appearance:
Wings: Mid-mounted, swept back, and tapered with blunt tips and wing fences.
Engines: two turbojets in the fuselage with semicircular air intakes and two exhausts.
Fuselage: Thick, flattened, with an upward taper to the rear section.
Tail: Flats are high-mounted on the body, swept-back, and tapered with square tips. Sharply swept-back tail fin has a blunt tip.
Engines: 2x 5,400 lbs thrust Wopen-6 turbojets 7,165 lbs thrust w/afterburner or 2x 5,400 lbs thrust Wopen-6A turbojets 8,930 lbs thrust w/afterburner (Exports)
Weight (kg):
Maximum Gross: 12,000
Empty: 6,636
Speed (km/h):
Maximum (at altitude): 1,340
Maximum (sea level): 1,120
Max "G" Force (g): +7.5 g
+5.0 g (max armament)
Ceiling (m): Service (clean): 15,900
Vertical Climb Rate (m/s): 148
Fuel (liters):
Internal: 3,648
External: 1,520
Range (km):
Maximum Load 1,816
Combat Radius: 550
Takeoff/Landing Roll (m): 1250/804
Dimensions (m):
Length: 15.7
Wingspan: 9.7
Height (gear extended): 4.5
Standard Payload (kg):
External: 2,000
Hardpoints: 10 (4 on fuselage, 3 under each wing)

Survivability/Countermeasures:
Pressurized and air conditioned armored cockpit with one-piece jettisonable canopy, zero/250 to 850 km/h ejection seat. ECM pod and RWR.

ARMAMENT:
2x internal Norinco 23-2K 23-mm cannons, one per wing root.

AVIONICS/SENSOR/OPTICS:
IFF, VHF transponder, radio compass, low-altitude radio altimeter, horizon gyro, and optical sight for level and dive bombing or for air-to-ground rocket launching. Later model upgraded with French inertial guidance and attack system, including Heads-Up-Display and laser range finder.

VARIANTS
Q-5: First version with internal bombbay. The Q-prefix indicates the aircraft is in the Chinese military service. The A-prefix denotes the export version

Q-5 I/A-5A: Became the standard configuration. Entered production in late 1970s. Internal weapons bay converted into additional fuel tanks, two fuselage pylons and outer wing pylons added. Forty exported to North Korea.

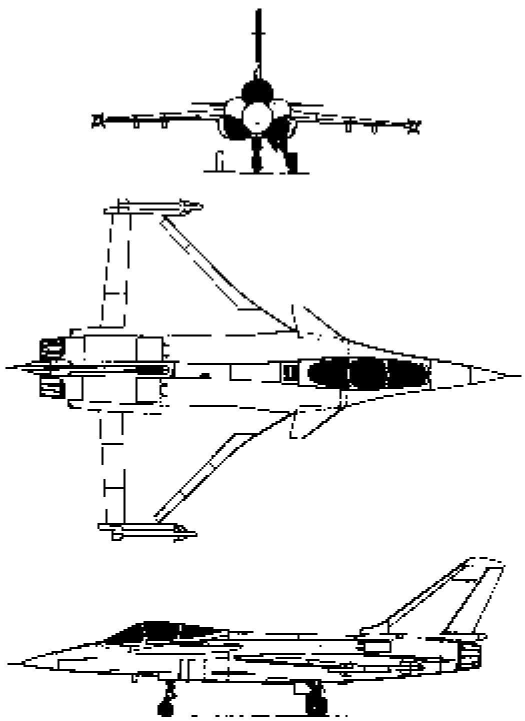
Q-5IA: Introduced key refinements, including the addition of two under wing pylons, better self-protection and improved optical sights.

Q-5 II/Q-5B/A-5B: Nearly identical to the Q-5IA. Includes RWR. May also have ranging radar and ALR-1 laser to work with precision-guided bombs. HUD, mission computer and ECM also included.

Q-5-III/A-5C: Major export version. A somewhat longer and wider Q-5 II. Includes improved avionics, Martin Baker PKD10 zero-zero ejection seat

NOTES
The Q-5 is a single-seat, twin-engine supersonic fighter developed by the Nanchang Aircraft Company of China. It offers enhanced combat performance particularly at low and super-low altitude. It is used mainly to assist ground troops in attacking concentrated targets on land, key transportation points and ships near the coast. It can also intercept and fight enemy aircraft.

French Multi-role Fighter Aircraft Rafale



Weapon & Ammunition Types	Combat Load
DEFA 791B 30-mm cannon	**300**
Other Loading Options	
Missiles:	
Magic/Mica/Sidewinder/	**6/10/6**
ASRAAM/AMRAAM	**6/5**
Exocet/Penguin 3/Harpoon	**4/4/4**
AS30L/Apache/Alarm/Harm/	**4/3/5/5**
Maverick	**4**
Bombs:	
1000 kg/400 kg/GBU 12/GBU 10	**3/5/5/3**
250 kg-Mk 82/400 kg-Mk 83	**20/10**
Belouga/Bap 100/Bat 120/Derandal	**10/**
Rockets	**4**
Fuel Tanks:	
1,300 L/1,700 L/2,000 L	**3/3/3**
Pods:	
PDLCT TV and FLIR	**1 ea**
ECM	
IR opt RECCE/SLAR/HAROLD	**1/1/1**
Twin gun pod (600 rounds)	**1**

SYSTEM
Alternative Designations:
Date of Introduction: 2001 (M), 2006 (B/C)
Proliferation: Expected to be exported

Description:
Crew: 1 (pilot) (M/C), 2 (pilots or pilot and weapons system officer) (B)
Appearance:
Wings: Mid-mounted Delta
Engines: Two turbofans buried in aft fuselage
Fuselage: Conventional semi-monocoque with some blending
Tail: Fin has sharply swept leading edge and swept, inset rudder. In place of horizontal stabilizers aft it has relatively large, swept, all-moving canards shoulder-mounted above and ahead of the wing leading edge.
Engines: 2 x 19, 955 lbs thrust SNECMA M-88-3 turbofans with afterburner
Weight (kg):
Maximum Gross: 24,500
Maximum Takeoff: 20,000
Empty: 9670 (M), 9,060 (B/C)
Speed (km/h):
High-Altitude: 2,125
Low-level: 1,853
Maximum: 2,390
Max “G” Force (g): +9/-3.6 g
Ceiling (m): 16,765
Vertical Climb Rate (m/s): 305
Fuel (liters):
Internal: 5,325
External: 6,000
Range (km):
Maximum Load: 2,110
With Aux Fuel (3 tanks): 3.520
Combat Radius: 1,882
Takeoff Run/Landing Roll (m): 400-1000/450
Dimensions (m):
Length: 115.3
Wingspan: 10.9
Height: 5.4
Standard Payload (kg): 9,500
External: 9,500
Hardpoints: 14 (13 on Rafale M)

Survivability/Countermeasures:
Martin-Baker zero/zero ejection seat. Canopy gold coated to reduce radar reflections.
Spectra Radar warning and ECM suite.

ARMAMENT
1 DEFA 791B 30-mm cannon:

AVIONICS/SENSOR/OPTICS
Cockpit has hands-on throttle and stick control (HOTAS). Pilot has a helmet-mounted sight and display. Cockpit is equipped with a head-up wide-angle holographic display, which provides aircraft control data, mission data and firing cues.
Multi-mode, passive electronically scanned radar; infrared search and track with laser range finder fire control system; inertial navigation system; IFF; GPS and voice alarm warning system. Look-down and shoot-down capable radar can track eight targets simultaneously.

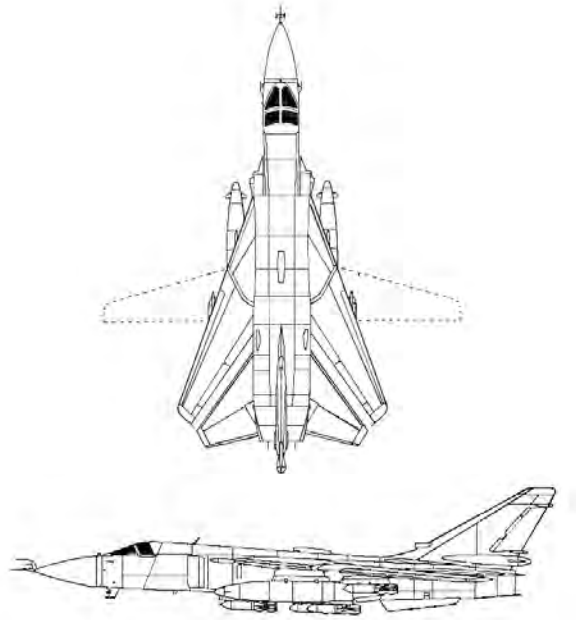
Night/Weather Capabilities:
Day/Night all-weather

VARIANTS
Rafale B/C ACT: Single-seat variant intended to replace SEPECAT Jaguar. One version will be armed with ASMP and replace the Mirage IV penetrating bombers. One version will be fitted with SNECMA M-88-2 engines and RDX radar.

Rafale M ACM: Carrier-capable strike aircraft to replace F-8 Crusader and Super Etendard. Empty weight will be 750 kg heavier than ACT. It also has a carrier-landing arrestor hook and one less hardpoint for weapons.

NOTES
Rafale is a twin-jet combat aircraft capable of carrying out a wide range of short- and long-range missions including ground and sea attack, air defense and air superiority, reconnaissance, and high-accuracy strike or nuclear strike deterrence.

Russian Multi-role Aircraft Su-24/FENCER



Weapon & Ammunition Types	Combat Load
23-mm 6x barrel Gsh-6-23 gun	**250**
Other Loading Options: TN1000 or TN11200 nuclear weapons	**8 mt external**
100-kg FAB-100 bombs	**38**
TV or laser-guided bombs	**4**
AS-7/KERRY ASM or AS-10/KAREN ASM or AS-11/KILTER ASM or AS-12/KEGLER ASM or AS-13/KINGBOLT ASM or AS-14/KEDGE ASM or AS-17/KRYPTON ASM	
S-25LD 266-mm precision rockets	
Gun pods	**3**
AA-8/APHID or AA-11 AAM	**2**
External fuel tanks (liters)	**2,000 or 3,000**

SYSTEM
Alternative Designations: See Variants
Date of Introduction: 1975
Proliferation: At least 11 countries
Description:
Crew: 2 (pilot, weapons operator)
Appearance:
Wings: High-mount, variable, tapered back
Engines: Both along body, under wings
Engines: 2x 17,200-shp Lyluka AL-21F-3A turbojet (24,700-shp with afterburner)
Weight (kg):
Maximum Gross: 39,700
Normal Takeoff: 35,910
Empty: 22,320
Speed (km/h):
Maximum (at altitude): 2,320
Maximum (sea level): 1,530
Maximum Attack Speed: 1,200
Cruise: INA
Takeoff/Landing Speed: INA
Max “G” Force (g): +6.5 g
Ceiling (m):
Service (clean): 17,500
With External Stores: INA
Vertical Climb Rate (m/s): 150
Fuel (liters):
Internal: 11,760
External: 8,000
Range (km):
Maximum Load: 940
With Aux Fuel: 1,230
Combat Radius: 950

Takeoff Run/Landing Roll (m):
Prepared Surface: 1,100-1,200/950
Dimensions (m):
Length: 24.6
Wingspan: 17.6 extended, 10.4 swept
Height (gear extended): 6.2
Standard Payload (kg):
External: 8,000
Hardpoints: 9 underwing

Survivability/Countermeasures:
Pressurized cockpit with zero/zero ejection seats, infrared and radar jammer, radar and missile warning receivers, chaff and flares.

ARMAMENT
23-mm 6x barrel Gatling gun, Gsh-6-23:
Range (m): 2,500 (practical)
Elevation/Traverse: None (rigid mount)
Ammo Type: HEFI
Rate of Fire (rpm): 9,000

AVIONICS/SENSOR/OPTICS
The Su-24 has integrated navigation and fire control radars, pulse-doppler terrain following radar coupled to autopilot, laser/TV targeting and weapon guidance system, and laser rangefinder/designator.

Night/Weather Capabilities:
Su-24 can attack ground and surface targets in day, night, and poor weather conditions.

VARIANTS
Su-24M/-24MK/FENCER D: Ground attack version and export model.

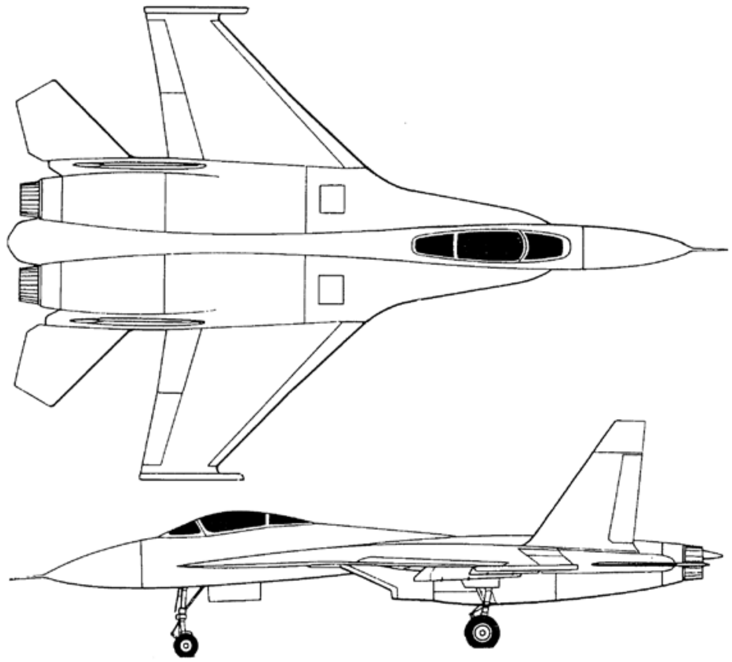
Su-24MK/FENCER D Modernized: Currently marketed ground attack variant has upgrades such as ILS-31 heads-up display computer GPS FCS, digital map display, KS-418E radar jammer pods, and access to recent missiles (e.g., AS-13, AS-17, S-25LD laser designated rockets, and AA-11 AAM).

Su-24MR/FENCER E: Reconnaissance variant for missions to 400 km, with BKR-1sensor suite: A-100 series and AP-402M cameras, Aist-M TV camera, Shpil-2M laser radar system, Zima IR Camera, and Shtik side-looking radar (24 km range, 5m accuracy). System can operate day or night. The BOK-2 ECM system is used. Options include Efir-1M radiation detection pod, Kadr film drop system, and Tangazh ELINT pod. Data other than optical is transmitted digitally. Another option is 2 xAA-8/APHID ASMs.

Su-24MP/FENCER F: Electronic warfare/ jamming/SIGINT variant. **Buket** series jammers are aka SPS-22, -33, -44, or -55. **Fasol** series (SPS-5, -5M, and -5-2X) radar noise jammers are available. **Geran** (SPS-161 or Geran F) is a 2nd gen active jammer. Geran/SPS-162 jams 6-12 GHz, with 100 kW. Armament includes 23-mm gun and (optional) 4 x AA-8 ASMs

NOTES
This aircraft was the first developed specifically for the ground-attack role, but has been adapted for others. Its variable swept wing can be set at 16, 45, or 69 degrees. Some aircraft are capable of aerial refueling. All can carry up to three external fuel tanks for extended range. There is no internal weapons bay. Not all munitions may be employed at one time. Mission dictates weapons configuration. External stores are mounted on underwing hardpoints. Each wing has four points. The center fuselage attachment point gives nine total stations.

Russian Multi-role Fighter Aircraft Su-27/FLANKER-B and Variants



Weapon & Ammunition Types	Combat Load
30-mm Gsh-30-1 cannon	**150**
Other Loading Options	**4,000 kg**
AA-10A-D/ALAMOAAM AA-8/APHID AAM AA-9/AMOS AAM AA-11/ARCHER AAM AA-12 ADDER AAMs	**10** (mix)
AS-10/KAREN ASM or AS-7/KERRY ASM or AS-12/KEGLER ASM or	**8**
AS-14/KEDGE ASM AS-17/KRYPTON ASM or	**6**
AS-18/KAZOO ASM	**2**
Gun Pods	
420-mm S-25 rockets (1 each) or	**4**
80-mm S-8 rocket pod (20 ea), or	**4**
122-mm S-13 rocket pod (5 each)	**4**
250-kg, or 500-kg unguided and guided bombs	

SYSTEM
Alternative Designations: Chinese J-11
Date of Introduction: 1986
Proliferation: At least 5 countries

Description: Variants in ( )
Crew: 1 (pilot)
Appearance:
Wings: Mid-mount, swept, square tips
Engines: Two in fuselage, with square underwing intakes
Fuselage: Pointed nose, rectangular from intakes to tail
Tail: Twin tapered, swept fins, with mid-mount, tapered, swept flats
Engines: 2x 27,557-shp Lyluka AL-31F turbojet with afterburner
Weight (kg):
Max Gross: 28,300/33,000 (SM)
Normal Takeoff: 23,000/23,700 (SM)
Empty: 17,690
Speed (km/h):
Max (at altitude): Mach 2.35
Max (sea level): Mach 1.1
Takeoff/Landing Speed: 250/231
Max “G” Force (g): Control limited to +9.0 g
Ceiling (m):
Service (clean): 18,000
With External Stores: INA
Vertical Climb Rate (m/s): 305
Fuel (liters):
Internal: 6,600/11,775 (SM)
External: no provision
Range (km):
Max Load: 3,790
With Aux Fuel: 4,390 (SM)
Combat Radius: 1,500

Hardpoints: 10 for FLANKER-B, 12 on-C

Takeoff Run/Landing Roll (m):
Prepared Surface: 500 to 650/600 to 720 (variant dependent)/ 1,200/1,200 (Su-35)
Dimensions (m):
Length: 21.9
Wingspan: 14.7
Height: 5.5
Standard Payload (kg):
External: 6,000

Survivability/Countermeasures:
Zero/zero ejection seat, infrared and radar jammer (SPS-171), radar and missile warning receivers, chaff and flares.

ARMAMENT
The Su-27 has a 30-mm gun mounted in the right wing, and primary AA missiles are AA-10 ALAMO variants.

30-mm gun, Gsh-30-1:
Range (m): (practical) 4,000
Elevation/Traverse: None (rigidly mounted)
Ammo Type: HEFI, APT, CC
Rate of Fire (rpm): 1,500

AVIONICS/SENSOR/OPTICS
The Su-27 employs a pulse-Doppler look-down/ shoot-down radar with a search range of 240 km and a track range of 185 km. It has multi-targeting capability, but cannot guide two missiles to separate targets

Aircraft has IR sensor, laser designator, HUD, helmet-mounted target-designating sight, and computerized fire control.

Night/Weather Capabilities:
It can attack air targets under day, night, or all-weather conditions. It has beyond visual range look-down/ shoot-down capability.

VARIANTS
Su-27/FLANKER B: Production single-seat air superiority fighter used in Russian units.

There are dozens of upgrade programs, more than a dozen fielded variants, and several developed aircraft with different designators (**Su-30**, **Su-34**, **Su-35**, and **Su-37**).

Su-27SK/-27P/FLANKER B: Variant exported to China with ground attack capability. **J-11:** Chinese built version.

Su-27SMK: Multi-role version, with 12 hardpoints, greater internal fuel and payload capacity, and air refuel capability.

Su-27UB/FLANKER C: Two-seat model (export **-UBK**), as command aircraft, trainer and interceptor. **JJ-11:** Chinese built version

Su-27K/FLANKER D: Naval variant, readily noticeable by canards forward of the wings.

Su-27M/FLANKER E: Multi-role upgrade with higher fins, upgraded avionics, etc., developed in late 1980s. An export version

Russian Multi-role Fighter Aircraft Su-27/FLANKER-B and Variants continued ___

called **Su-35** was marketed. It had more powerful 28,218-shp Lyluka AL-31FM engines, thrust-vectoring nozzles for higher gross weight and greater range. It also featured better radar and targeting systems for multiple engagements. Dimensions slightly increased, noticeable by canards forward of wings. Fielding was minimal, and none were sold. **Su-35UB** was a two-seater upgrade version.

Su-37/"Super FLANKER": Single-seat multi-role fighter with thrust vectoring capability and sufficient mobility for the ***kulbit*** pitch-up maneuver into a tight 360 degree somersault, as well as improved long-range weapons and fire control. Expected future production version is **Su-37MR**. However, after the one Su-27M conversion to Su-37 crashed during a ferry flight, all work on the aircraft ended in 2002. Production is unlikely.

Su-27/Su-30 Major/Minor Modernization: Upgrade programs are being implemented to bring Su-27s up to Su-30 standard, and some single-seat upgrades to the standard.

Su-30/FLANKER-F: Production two-seater aircraft developed from Su-27.

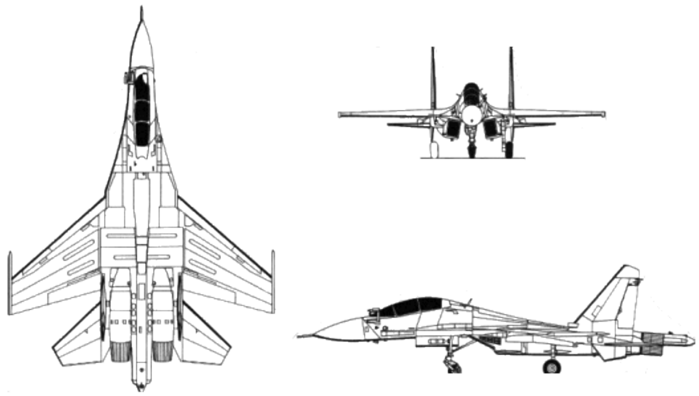
Su-34/FULLBACK: This 2-seat bomber version has a side-by-side cockpit, high payload for use in bomber missions and maneuverability similar to fighters. Earlier designations include: **Su-27IB**, **Su-32**, **Su-32FN**, and **Su-32MF**. Production and early fielding is now underway. This aircraft is scheduled to generally replace Su-24s in Russian forces for the strike role.

Su-35/Su-27BM: This new single-seater multi-role fighter is developed to replace Su-27M. The 4+++ generation prototype first flew in 2008. It includes a new airframe, with larger wings and intakes, but no canards. It has bigger engines, a new Irbis-E phased-array radar, new IRST, and 12 hard points for the latest weapons are included. The Su-35 export version is completely different from the previous aircraft with the same designation. The aircraft is due to begin production in 2010, with focus on export customers. An attractive feature is no use of western technology, which is vulnerable to exploitation or export restrictions. The Russian domestic version is **Su-35S**.

NOTES

The Su-27 is primarily an all-weather interceptor/fighter aircraft used for air defense. Later versions are capable of also performing ground attack missions. It is highly maneuverable because of a fly-by-wire control system, which automatically restricts aircraft angles of attack and maximum G-loads during flight. External fuel tanks can be carried on some variants, and some are fitted for aerial refueling, but these are generally naval versions rather than air defense or strike versions. Available munitions are shown above; not all may be employed at one time. Mission dictates weapons configuration. External stores are mounted on underwing and underbody hardpoints. Each wing has two points, and an additional rail on the wingtip. Two points are under the intakes along the fuselage, and two are centrally located underneath the fuselage near the centerline and between the intakes for a total of ten stations.

Russian Multi-role Fighter Su-30/FLANKER-F and Export Su-30MK Series



Weapon & Ammunition Types	Combat Load
30-mm single-barrel Gsh-301	**150**
Other Loading Options	**8,000 kg**
AA-10 Alamo	**6**
AA-11 Archer	**6**
AA-12 Adder	**6**
AS-17 Krypton	**6**
AS-14 Kedge	**6**
AS-18 Kazoo	**2**
Various guided and unguided weapons	
250/500-kg unguided and guided bombs	
KAB-500Kr, KAB-1500Kr Bombs	**6/2**
Anti-radiation Missiles	
Gun Pods	
420-mm S-25 rockets (1 each) or	
122-mm S-13 rocket pods (5 each) or	
80-mm S-8 rocket pods (20 each)	

SYSTEM
Alternative Designations: Su-27PU
Date of Introduction: 1996
Proliferation: China, India, Russia

Description: for Su-30MK
Crew: 2 (pilot, weapons officer)
Appearance:
Wings: Mid-mount, swept, square tips
Engines: Two in fuselage, with square underwing intakes
Fuselage: Pointed nose, humped profile at the cockpit and tapered to nearly flat at the engines
Tail: Twin tapered, swept fins, with mid-mount, tapered, swept flats
Engines: 2 x 16,755 lbs thrust Saturn AL-31F turbofans, 27,558 lbs thrust with afterburner
Weight (kg):
Maximum Takeoff: 38,000
Normal Takeoff: 24,140
Empty: 17,900
Speed (km/h):
Maximum (at altitude): 2,125, Mach 2.0
Maximum (sea level): 1,350
Max "G" Force (g): +8 g
Ceiling (m): 17,500
Vertical Climb Rate (m/s):
Fuel (liters):
Internal: 9,400

Range (km):
Unrefueled: 3,000
One refueling: 5,200
Takeoff /Landing Roll (m): 550/670
Dimensions (m):
Length: 21.9
Wingspan: 14.7
Height: 6.4
Standard Payload (kg):
External: 8,000
Hardpoints: 12 pylons

Survivability/Countermeasures:
Zero/zero ejection seats, infrared and radar jammer, radar and missile warning receivers, chaff and flares. Gaseous oxygen for 10 hours of flight.

ARMAMENT
30-mm 1 x barrel gun, Gsh-301:

AVIONICS/SENSOR/OPTICS
Same as the Su-27 including a new coherent pulse-Doppler look-down/shoot-down radar, able to engage targets simultaneously, and new navigation system based on Loran, Omega and Mars.

Night/Weather Capabilities:
The Su-30 is capable of attacking air targets under day, night, or all-weather conditions.
It has a beyond visual range look-down/shoot-down capability.

VARIANTS
Two-seater aircraft is significantly upgraded and derived from Su-27 single-seat aircraft.

Su-30M: The first real multi-role aircraft in the Su-27 family, with all necessary sub-systems. These were converted into demonstrators for exports.

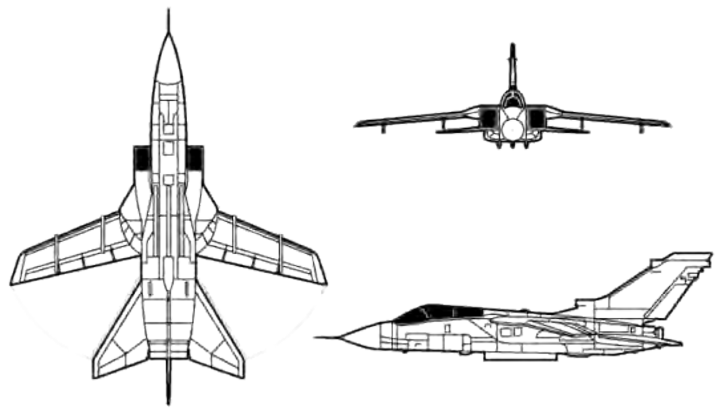
Su-30MK: Export series version. The Su-30MK2 anti-ship upgrade version has been exported.

Su-30MKK/FLANKER-G: Multi-role upgrade utilizing air-to-ground weapons to a more advanced version incorporating new radar, canards and thrust vectoring. **JJ-11:** Chinese license-built version.

Su-30MKI/FLANKER-H: Version of the Su-30MK made for India. Most will be produced by an Indian firm. Some Western equipment replaced much of the Russian systems. **Su-30MKM:** Version for use by Malaysia.

NOTES
A small number of the air superiority fighters have been produced. The greater export market is for multi-role versions.

British/German Multi-role Aircraft TORNADO IDS



Weapon & Ammunition Types	Combat Load
2 integral IWKA-Mauser 27-mm	**180 ea**
Other Loading Options	**up to 9,000 kg**
Bombs	
Air-to-air missiles	**Up to 8**
Anti-radar missiles	
Anti-runway submunition dispensers	
Stand-off weapons systems	
Air-to-surface missiles	
Brimstone ATGM	
Storm Shadow Cruise Missile	**1**
Sea Eagle Anti-Ship Missiles	**4**
Raptor EO/IR Recon Pod	**1**
Internal sensors	**3**
Paveway Laser-Guided Bombs	
Flares	
EW equipment	
1500 L or 2250 L drop fuel tanks	

SYSTEM
Alternative Designations:
Date of Introduction: 1982
Proliferation: Germany, Great Britain, Italy, and Saudi Arabia

Description:
Crew: 2 (pilot, weapons officer)
Appearance:
Wings: High-mounted, variable-geometry, swept-back, and tapered with angular, blunt tips
Engines: Two turbofans inside the body
Fuselage: Solid with a needle nose, thickens midsection and tapers toward the tail
Tail: Tall, swept-back, and has a tapered fin with a curved tip and a step in the leading edge. Flats are large, mid-mounted on the body, swept-back, and tapered with blunt tips
Engines: 2 x 9,000 lbs thrust Turbo-Union RB199-34R turbofans, 16,000 lbs thrust with afterburner
Weight (kg):
Max Takeoff: 20,411 (clean, full internal fuel) 27,215 (with full external load)
Empty: 14,091
Speed (km/h):
Maximum (at altitude): 2,340, Mach 2.2
Max “G” Force (g): +7.5 g

Ceiling (m): +15,000
Fuel (liters):
Internal: 6,393 (RAF, RSAF) 5,842 (others)
External: 4,500
Range (km):
Tactical Radius: 1,390 (hi-lo-hi profile with 2,629 kg)
Ferry: 3,890
Takeoff Run/Landing Roll (m): 900/370
Dimensions (m):
Length: 16.7
Wingspan: 13.9 extended, 8.6 swept
Height: 5.6
Standard Payload (kg):
External: 9,000
Hardpoints: 7 (3 under fuselage and 4 under wing)

Survivability/Countermeasures:
Two tandem Martin-Baker Mk 10A zero/zero ejection seats.
Typically includes a passive Radar Homing and Warning (RHAW) system receiver, an active ECM pod, chaff/flare dispensing pod, and an IFF.

ARMAMENT
2 integral IWKA-Mauser 25-mm cannons

AVIONICS/SENSOR/OPTICS
Multi-mode, ground-mapping and terrain-following radar; digital Inertial Navigation System (INS); Doppler radar with Kalman filter; Heads-Up-Display (HUD); and Laser Ranger and Marked Target Seeker (LRMTS)

Night/Weather Capabilities:
All-weather close air support/battlefield interdiction, interdiction/counter-air strike, naval strike and all-weather day and night reconnaissance capable aircraft.

VARIANTS
Tornado IDS: Designated GR1 in RAF service. Ground attack/ interdiction version. Some have been adapted for the anti-shipping role.

Tac-R Tornado GR1A: RAF GR1s modified as dedicated Tactical Reconnaissance aircraft. Fitted with a Marconi Defensive Systems emitter location system. Both 27-mm cannons were removed.

Tornado GR1B: Modified for maritime strike missions with Sea Eagle anti-ship missiles. RAF discarded GR1B designation in July 2001.

Tornado ADV: Air Defense Variant

Tornado ECR: Electronic Combat and Reconnaissance variant for German and Italian service

NOTES
Designed and built as a collaborative project in the UK, Germany, and Italy, the Tornado is in service with all three air forces and the German Navy. Tornado is also in service in Saudi Arabia and Oman. It is a twin-seat, twin-engine, variable geometry aircraft and is supersonic at all altitudes.

Russian Transport Aircraft An-2/COLT

SYSTEM
Alternative Designations: INA
Date of Introduction: 1948
Proliferation: At least 32 countries

Description:
Crew: 2 (pilots)
Appearance:
Wings: Biplane and rectangular-shaped with curved tips, one high-mount and one low mount (shorter), braced by struts
Engines: One mounted in nose
Fuselage: Short, thick, with blunt nose
Tail: Tapered with round tip, rectangular, low-mounted flats
Engines: 1x 1,000-shp Shevetsov Ash-62 or PZL Kalisz Ash-621R 9-cylinder radial piston driving a four-bladed, variable-pitch propeller.
Weight (kg):
Max Gross: 5,500
Normal Takeoff: INA
Empty: 3,450
Speed (km/h):
Max: 258
Min: 90
Cruise: 185
Takeoff/Landing Speed: 85
Max "G" Force (g): -1.0 to +3.7
Ceiling (m):
Service (clean): 4,400
Vertical Climb Rate (m/s): 3.0

Fuel (liters):
Internal: 1,200
External: None
Range (km):
Max Load: 900
Takeoff Run/Landing Roll (m):
Prepared Surface: 150/170
Unprepared Surface: 200/185
Max Load: INA
Dimensions (m):
Length: 12.7
Wingspan: 18.2
Height: 4.0
Cabin Dimensions (m):
Floor Length: 4.1
Width: 1.6
Height: 1.8
Standard Payload (kg):
Internal: 1,500
Transports 12 troops or paratroops, or 6 litters.

Survivability/Countermeasures:
None

ARMAMENT
Some early prototypes experimented with single 12.7-mm or 23-mm machineguns, and unguided aerial rockets. None produced.

AVIONICS/SENSOR/OPTICS
Flight avionics only.

Night/Weather Capabilities:
The An-2 is capable of flight under day and instrument meteorological conditions.

VARIANTS

This aircraft was originally built in Russia. Now it is produced in China and Poland.

An-2D/-2TD: Specially modified for parachute training and special operations.

An-2P/-2T/-2TP: Passenger and general transport variants.

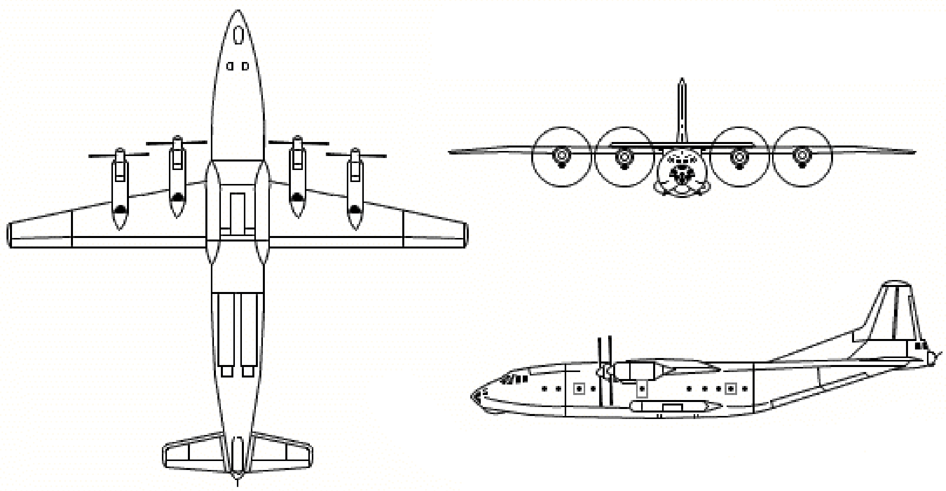
An-2V/-2M/-4: Seaplane variant with floats in place of main landing gear.

An-3: This variant employs an upgraded 1,450-shp Glushenkov TVD-20 turboprop engine, and a larger three-bladed propeller. This allows for an increased takeoff weight of 5,800 kg.

Y-5/C-5: Chinese-built version, and Chinese export nomenclature.

NOTES
The wings and elevators are fabric-covered, while the fuselage is metal. This aircraft can operate from unimproved airfields, and is noted for short takeoff and landing capabilities, and ruggedness. Its low acoustic signature and slower speeds allow for stealthy operation. Cabin contains tip-up seats, which can be easily folded to allow space for cargo. Skis or pontoons can be employed on the main landing gear struts.

Russian Cargo/Transport Aircraft An-12/CUB



SYSTEM
Alternative Designations:
Date of Introduction: 1959
Proliferation: At least 16 countries

Description:
Crew: 6 (including tail gunner)
Appearance:
Wings: High wing, tapered leading edge, straight trailing edges, and blunt tips.
Engines: 4 engines in thin nacelles extending forward from the underside of the wing.
Fuselage: Glazed rounded nose; constant cross-section cargo hold; broad, flat bottom turns upward to the tail gunner's position.
Tail: Set high on aft fuselage with double-tapered fin and full-height rudder mounted up gunner's position. Large dorsal fillet slopes down from fin to top of fuselage.
Engines: 4 x 4,000-shp Ivchenko AI-20K with 4-blade reversible pitch propellers.
Weight (kg):
Max Gross: 61,000
Normal Takeoff: 55,100
Empty: 28,000
Speed (km/h):
Max: 777
Min: 163
Cruise:
Max 670
Econ 580
Landing Speed: 200

Ceiling (m): 10,200
Vertical Climb Rate (m/s): 10
Internal Fuel (liters):
Normal: 13,900
Maximum: 19,100
Range (km):
Max Load: 1,400
10,000 kg Load: 3,600
Max Fuel: 5,700
Takeoff Run/Landing Roll (m): 700/500
Dimensions (m):
Length: 33.1
Wingspan: 38.0
Height: 10.6
Hatch Opening: (m)
Length: 7.7
Width: 3.0
Cargo Hold (m):
Length: 13.5
Width: 3.5
Height: 2.6
Volume: 122.8 cu m
Standard Payload (kg):
Internal: 90 troops or 60 paratroops
Vehicles and weapons or cargo.

Survivability/Countermeasures:
Warning radar in the tail

ARMAMENT
2 NR-23 23-mm cannons in tail turret

AVIONICS/SENSOR/OPTICS
I-band ground mapping and precision location radar in chin radome.

Night/Weather Capabilities:
Day only, clear weather capable.

VARIANTS
Cub (An-12BP): Standard transport/cargo version; several electronic blisters fitted.

Cub-A: ELINT version: blade aerials fitted on front of fuselage, aft of flight deck.

Cub-B: Naval ELINT version. Palletized passive receivers, frequency analyzers, recording equipment and accommodation for EW personnel in main cargo compartment.

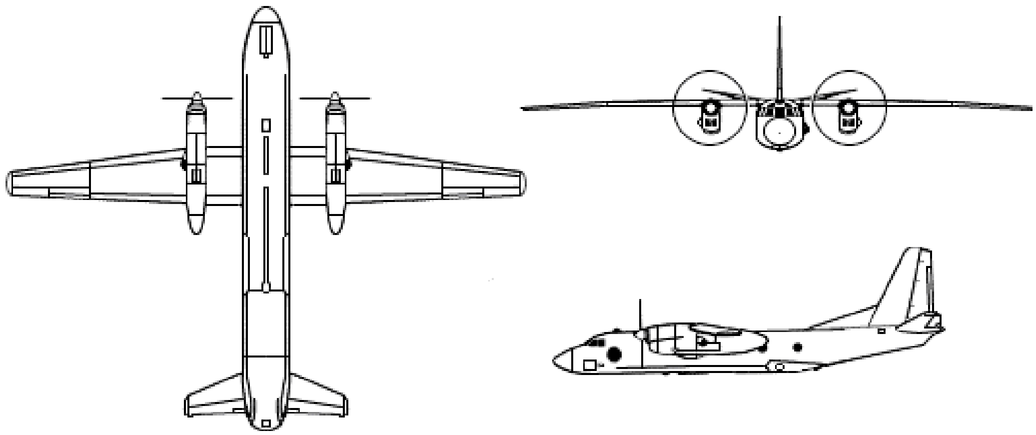
Cub-C: ECM version. Ventral antenna housings, jammers on pallets, and other features indicate the capability of ELINT collection.

Cub-D: Upgraded Cub-C with additional ECM equipment Naval electronic warfare version.

Shaanxi Y-8: Chinese manufactured.

NOTES
The An-12 Cub is a very widely used Russian cargo and paratroop aircraft, similar in appearance, payload and role to the C-130 Hercules. It is a military version of the An-10. Before the collapse of the Soviet Union, the Cub was the principal military transport and was adapted for the Electronic Intelligence (ELINT) and Electronic Countermeasures (ECM) roles by the Soviet Navy and possibly several other countries.

Russian Transport Aircraft An-26/CURL



SYSTEM
Alternative Designations:
Date of Introduction: 1970
Proliferation: At least 28 countries

Description:
Crew: 5 (pilot, copilot, navigator, flight engineer, radio operator)
Appearance:
Wings: High-mounted, equally tapered from engines to the blunt tips
Engines: Two turboprops mounted in pods beneath the wings, which extend beyond the wings' leading and trailing edges
Fuselage: Long and slender with an upswept rear section and a solid, rounded nose, featuring a stepped cockpit.
Tail: Back-tapered blunt tipped fin. High-mounted back-tapered flats with blunt tips, and have a positive slant
Engines: 2 x 2,820 ehp Ivchenko AI-24VT turboprops and 1 x 1,765 lbs thrust RU 19A-300 turbojet for takeoff assist.
Weight (kg):
Max Takeoff: 24,000
Empty: 15,020
Speed (km/h):
Max: 540
Cruise: 440
Takeoff/Landing Speed: 200/190
Ceiling (m): 7,500
Vertical Climb Rate (m/s): 8
Fuel (liters):
Internal: 7,050
Range (km):
Max Payload: 1,100
Max Fuel: 2,550
Takeoff Run/Landing Roll (m): 780/730
Dimensions (m):
Length: 23.8
Wingspan: 29.2
Height: 8.6
Cabin Dimensions (m):
Length: 11.5
Width: 2.4
Height: 1.9
Standard Payload (kg):
Internal: 4,500 (normal), 5,500 (max)
Transports: 38 to 40 seats in pressurized cargo bay or 24 litters and attendants

Survivability/Countermeasures:
Air-conditioned and pressurized cabin. Emergency escape hatch in door immediately aft of flight deck. Provision for chaff/flare dispensers pylon-mounted each side of lower fuselage below wings.

ARMAMENT
Provision for bomb rack on fuselage below each wing root trailing edge.

AVIONICS/SENSOR/OPTICS
Two ADF, radio altimeter, glide path receivers, glide slope receiver, marker beacon receiver, weather/navigation radar, directional gyro, and flight recorder. Optional OPB-1R sight for pinpoint dropping of freight, medical equipment, and liquid heating system.

Night/Weather Capabilities:
Day only, clear weather capable.

VARIANTS

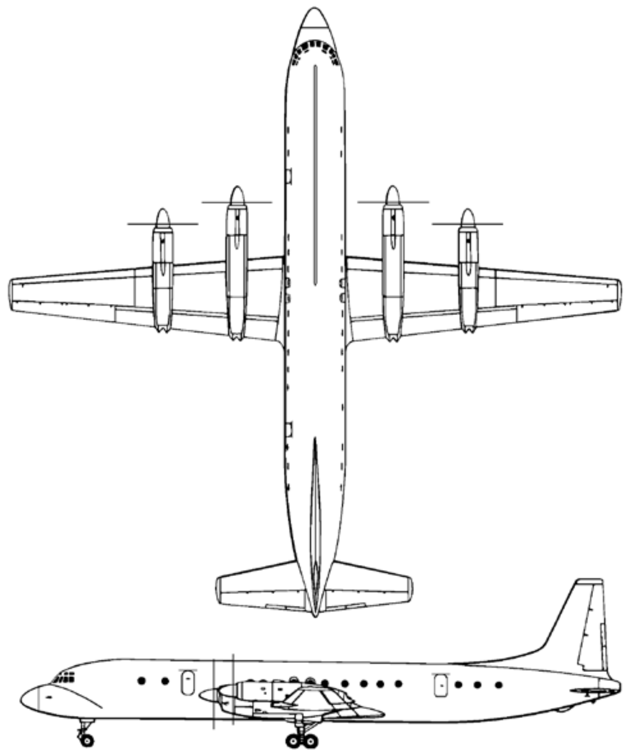
An-26: Original production version.

An-26B: Upgraded version with improved cargo handling equipment.

Y7H/Y7H-500: Chinese production version.

NOTES
The An-26 Curl is a widely used short-haul cargo/transport. It can be modified to perform paratroop transport, medical evacuation, or passenger transportation. The An-26 is produced in both military and civil air versions with essentially the same features.

Russian Transport Aircraft IL-18/COOT



SYSTEM
Alternative Designations: Il-20, Il-22
Date of Introduction: 1959
Proliferation: At least 5 countries

Description:
Crew: 5 (2x pilots, 1x navigator, 1x radio operator, 1x flight engineer)
Appearance:
Wings: Low-mounted and tapered with blunt tips
Engines: Four mounted on wings and extending forward
Fuselage: Round, cigar-shaped, tapered at rear with rounded nose
Tail: Tapered with square tip, fuselage-mounted, tapered flats
Engines: 4x 4,250-shp Ivchenko AI-20M turboprop driving 4x four-bladed, reversible-pitch propellers.
Weight (kg):
Max Gross: 64,000 (D)/61,200 (E)
Empty: 35,000 (D)/34,610 (E)
Speed (km/h):
Max: 675
Min: INA
Cruise: 625
Takeoff/Landing Speed: INA
Max "G" Force (g): INA
Ceiling (m):
Service (clean): 10,000
Operating Altitude: 8,000-10,000
Vertical Climb Rate (m/s): INA

Fuel (liters):
Internal: 30,000 (D)/23,700 (E)
External: None
Range (km):
Max Load: 4,000 (D)/3,200(E)
Normal Load: 6,500 (D)/5,200 (E)
Takeoff Run/Landing Roll (m):
Prepared Surface: 1,300 (D)/850
Unprepared Surface: INA
Dimensions (m):
Length: 35.9
Wingspan: 37.4
Height: 10.2
Cabin Dimensions (m):
Floor Length: 24.0
Width: 3.2
Height: 2.0
Standard Payload (kg):
Internal: 13,500
Transports 122 troops or 20 ELINT operators.

Survivability/Countermeasures:
None

ARMAMENT
None

AVIONICS/SENSOR/OPTICS
Flight avionics only.

Night/Weather Capabilities: INA

VARIANTS
This aircraft was originally designed as a civilian transport aircraft, but has been adapted for military uses.

Il-18D: Has a center fuel tank for longer flight duration and extended range.

Il-18E: Variant without center fuel tank.

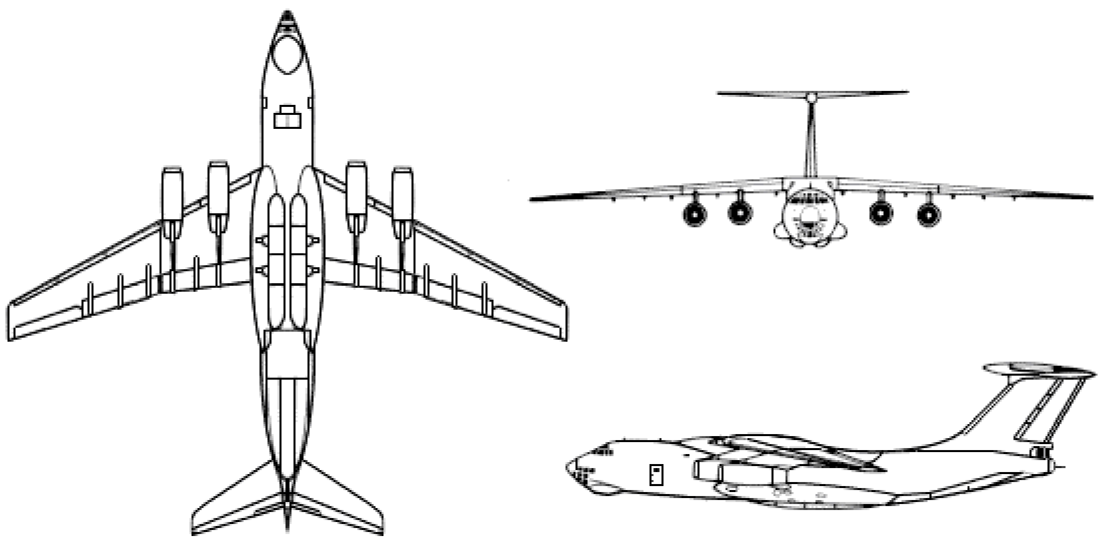
Il-20/COOT A: Unarmed strategic electronic intelligence/ reconnaissance and surveillance aircraft. The airframe is essentially the same as the Il-18D, but a cylinder containing a possible side-looking airborne radar is mounted under the fuselage forward of the wing. Smaller containers on the forward sides of the fuselage houses possible cameras and sensors. Many small antennas are located under the fuselage.

IL-20M: Version with a side-looking airborne radar (SLAR), A-87P LOROP cameras, and a Romb 4 SIGINT system.

Il-22M/COOT B: An airborne command post variant of the Il-18D airframe.

COOT-C: Later ELINT platform.

Russian Cargo/Transport Aircraft IL-76/CANDID



SYSTEM
Alternative Designations:
Date of Introduction: 1975
Proliferation: At least 12 countries

Description: (Il-76MD)
Crew: 7
Appearance:
Wings: High-mounted, swept-back, and tapered with blunt tips. Trailing edge has a slight crescent shape.
Engines: Four mounted pylons under and extending forward of wings' leading edge.
Fuselage: Long, round and tapering to the rear, rounded nose with chin radome.
Tail: T-tail with curved leading edge and inset rudder. Swept tailplanes meet at top of the tail.
Engines: 4 x 26,455 lbs thrust Rybinsk D-30KP II turbofan with thrust reversers.
Weight (kg):
Empty: 89,000
Takeoff:
General Max: 190,000
Allowable Max: 210,000
Unprepared Runway Max: 157,500
Speed (km/h):
Max: 919
Cruise: 780
Ceiling (m): 10,500
Fuel (liters):
Internal: 109,480 max in 12 tanks
External: None
Range (km):
Max Load: 3,800
Normal Load: 4,760
Max Fuel: 7,800
Small Load: 7,300 with (20,000 kg) payload
Takeoff Run/Landing Roll (m):1,700/900-1,000
Dimensions (m):
Length: 46.6
Wingspan: 50.5
Height: 14.8
Hatch: (m)
Height: 3.4
Width: 3.5
Cargo Hold (m):
Length to Ramp: 20.0
Length with Ramp: 24.5
Width: 3.5
Height: 3.4
Standard Payload (kg):
Internal: 47,000
Transports 140 troops or 125 paratroops.

Survivability/Countermeasures:
Entire aircraft pressurized, crew emergency escape hatch forward of main entry door. Flares for illuminating landing area.
Radar warning receiver, electron jammers, chaff and flares.

ARMAMENT
2 x GSh-23L twin-barreled cannon in tail turret.

AVIONICS/SENSOR/OPTICS
Standard flight controls. Weather radar in nose, navigation and ground mapping radar in radome.

Night/Weather Capabilities:
Full equipment for all-weather operation day and night,

VARIANTS
Il-76 CANDID-A: First production model.

Il-76M CANDID-B: Added rear turret with two 23-mm NR-23 guns and small ECM fairings each side of navigator's windows.

Il-76MD CANDID-B: Military version of Il-76T. T stands for transport; D stands for long-range.

Il-76MF: Military variant with stretched fuselage and more powerful engine.

Il-76MF-100: A derivative of the Il-76M with CFM56-5C turbofans. Range increased to 7,000 km with 40,000 kg load.

Il-76PP: Electronic countermeasures aircraft

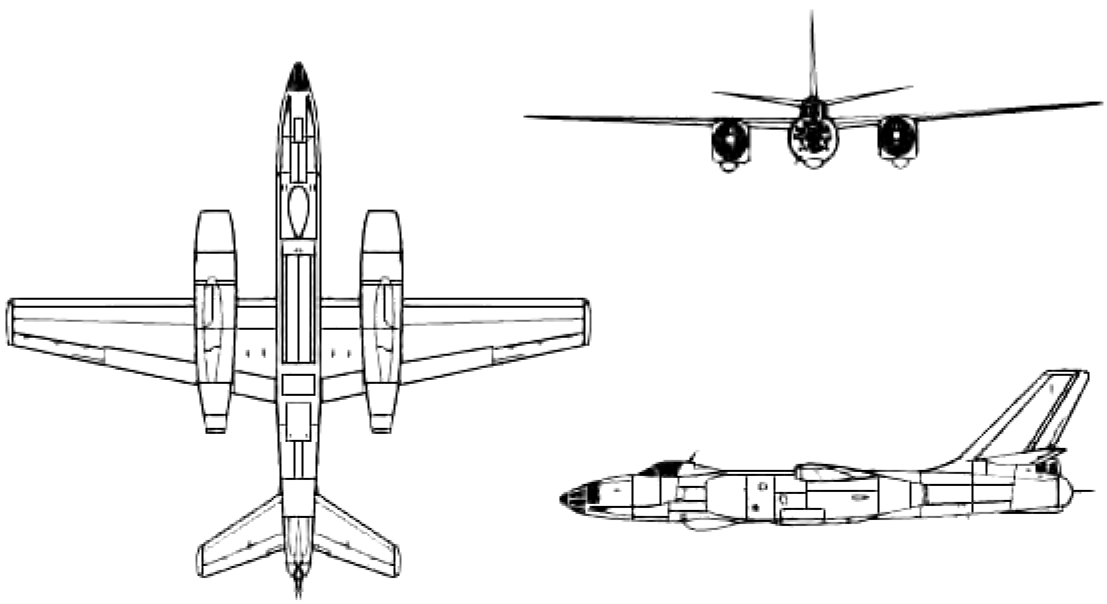
Il-76PS/Il-84: Search and rescue capable of 3-hour patrol with radius of 3,000 km.

Il-76VPK/Il-82 airborne command post: Variant of Il-76MD. Fitted with specialized communications equipment.

A-50/Mainstay: AWACS version.

Midas: Aerial tanker version.

Chinese Light Bomber Aircraft H-5 and Russian/Czech Il-28/BEAGLE__________



SYSTEM
Alternative Designations: Hongzhaji-5
H-5 is a Chinese adaptation of the IL-28.
Date of Introduction: 1966,
1950 for Il-28
Proliferation: At least 24 countries, still in service with more than 4.
Description:
Crew: 3 (pilot, navigator/bombardier, radio operator/gunner)
Appearance:
Wings: Shoulder-mounted well aft on fuselage
Engines: 2 Wopen turbojets housed in underwing nacelles
Fuselage: Circular-sectioned with some taper near the tail
Tail: Tall, swept fin has full-height rudder
Engines: 2 x 5,952 lbs thrust Wopen-5 turbojets
Weight (kg):
Max Takeoff: 21,200
Empty: 12,890

Speed (km/h):
Max: 900
Cruise: 769
Ceiling (m): 12,500
Vertical Climb Rate (m/s): 15
Fuel (liters): 7,908
Range (km): 3,550 empty
Combat Radius: 1,100 (w/max payload)
Takeoff Run/Landing Roll (m): 980/930
Dimensions (m):
Length: 17.6
Wingspan: 21.5
Height: 6.7
Weapons load (kg):
Max: 3,000
Normal: 1,000

Survivability/Countermeasures:
Pilot and navigator ejection seats, gunner/radio operator has escape hatch.

ARMAMENT
Cannon: 4 x 23-mm NR-23 cannons (2 fixed in nose and 2 in tail position) nose 100 rd each, tail 250 rd each
Bombs: 3,000 kg of bombs or torpedoes in internal weapons bay, including combinations of 500 kg bombs, 53 VA torpedoes, 250 kg bombs, or a single 3,000 kg bomb.

AVIONICS/SENSOR/OPTICS
Ground mapping radar

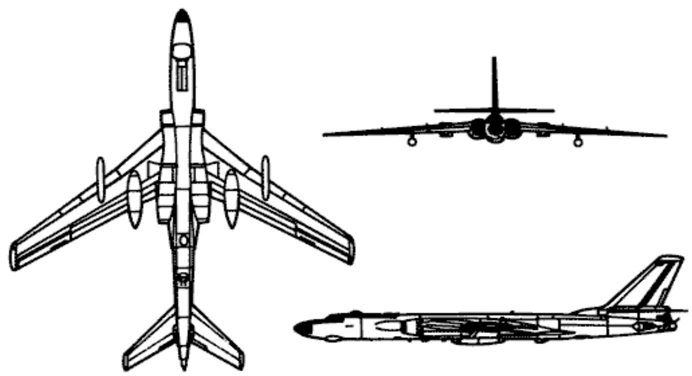
Night/Weather Capabilities:
Reduced night, all-weather capability.

VARIANTS
Chinese variants include the following.
H-5: Basic bomber version.
HJ-5: Trainer version.
HZ-5: Reconnaissance Version.

Russian variants include the following.
Il-28R: Photo-reconnaissance variant
Il-28RTR: Radar recon (ELINT) variant
An ECM version was also developed.
Il-46: Same design but twice as large.

NOTES
The twin-engine light bomber is also used as a maritime strike and trainer aircraft.

Chinese Medium Bomber H-6 (Hongzhaji-6)



Weapon & Ammunition Types	Combat Load
6 x Type 23-1 30-mm Cannon	
Other Loading Options	
C502 ASMs externally (no internal)	**2**
500kg Bombs	**12**
1000kg Bombs internally	**6**
10 kt to 3 Mt (nuclear Bombs)	**1 to 3**

SYSTEM
Alternative Designations: Hong-6, NOTES
Date of Introduction: 1968
Proliferation: Only China

Description:
Crew: 6 (2 pilots, navigator/bombardier, tail gunner, 2 observer positions in rear fuselage)
Appearance:
Wings: Mid-mounted, swept-back, and tapered with blunt tips
Engines: Two turbojets mounted in wing roots, which extend beyond the leading and trailing edges of the wing root.
Fuselage: Long, slender and bulging where engines are mounted and tapered to the tail.
Tail: Swept-back, tapered fin and flats with blunt tips,
Engines: 2x 20,944 lbs thrust Xian Wopen-8 turbojets
Weight (kg):
Maximum Takeoff: 75,800
Empty: 38,530
Speed (km/h):
Maximum Clean Speed: 992 at 6,000 m
Max Cruise: 786 w/2 x C-601 ALCMs
Takeoff/Landing Speed: 302/233
Max "G" Force (g): +6.5 g

Ceiling (m): 12,000
Vertical Climb Rate (m/s): 19
Fuel (kg):
Internal: 33,000
External: 2 underwing tanks, capacity unknown
Range (km):
Maximum: 4,300
Combat Radius: 1,800
Endurance: 5 hrs, 41 min
Dimensions (m):
Length: 34.8
Wingspan: 34.2
Height (gear extended): 10.4
Internal Payload (kg):
Normal: 3,000
Maximum: 9,000

Survivability/Countermeasures:
Defensive electronic countermeasures system.

ARMAMENT
6 x Type 23-1 30-mm Cannon: (1 twin-gun tail turret, 2 twin remote controlled ventral/dorsal barbettes).

AVIONICS/SENSOR/OPTICS
Automatic navigation system with Doppler and INS inputs. Offensive navigation/attack radar. RWR.

Night/Weather Capabilities:
Good high altitude capability, poor night and low level capability.

VARIANTS
H-6A I: Production model of the Chinese reverse engineering of the Tu-16 Badger. Export version are designed B-6. Nearly identical to the original Tu-16 Badger, Except it was powered by Xian WP8 turbojets.

H-9A I/E: Second generation of the H-6 bomber and the one used by the Chinese air force. Starboard side 23-mm nose cannon was removed and improved ECM/ESM, bombing and navigational systems were installed.

H-6B II, H-6C III: Equipped with a Doppler radar, a navigation computer and inertial navigation equipment.

H-6DU/H-6U Tanker: First flight in 1990. Carries two underwing hose-and-drogue pods to refuel two J-8Ds simultaneously..

H-6 Electronic Warfare Platform: Models have been seen. A long, canoe-shaped radome on the lower fuselage, an extra antenna fairing on the top of the fuselage and a solid nosecone. Could house a side-looking radar or aircraft could serve in an ELINT or Offensive ECM role.

NOTES
The H-6 is a Chinese adaptation of the former Soviet TU-16/BADGER medium bomber. It is used for air-launched cruise missiles as well as conventional and nuclear bomb delivery. It can also be used as a naval anti-shipping strike aircraft. It has gone through several variants since its introduction in the 1950s. The most current version is the Chinese navy's H-6D IV.

Russian Long-Range Bomber Tu-22M3/BACKFIRE-C

Weapon & Ammunition Types	Combat Load
23-mm twin barrel gun	
Other Loading Options	
Missiles:	
AS-4 Kitchen ASM, or	**1-3**
AS-17 Krypton ASM, or	
AS-20 Kayak ASM, or	
AS-9 Kyle ARM, or	
AS-16 Kickback short range attack	**6**
Bombs:	
3,000 kg, or	**2**
1,500 kg, or	**8**
500 kg, or	**42**
250 kg, or	**69**
100 kg, or	**69**
Mines:	
1,500 kg	**8**
500 kg	**18**

SYSTEM
Alternative Designations:
Date of Introduction: 1974
Proliferation: Russia and Ukraine

Description:
Crew: 4 (pilot, copilot, navigator, defensive systems operator)
Appearance:
Wings: Large fixed glove for variable-geometry swept wings
Engines: Turbofans fitted side-by-side in the aft fuselage
Fuselage: Circular forward of the wings, center fuselage flanked by rectangular engine intakes
Tail: All swept tail surfaces, with large dorsal fin
Engines: 2x 50,000 lbs thrust NK-25 turbofans
Weight (kg):
Max Takeoff: 126,000
Empty: 49,500
Speed (km/h):
Maximum (at altitude): 2,327 Mach 2.05
Maximum (sea level): 1,050, Mach 0.9
Cruise: 800
Takeoff/Landing Speed: 370/285
Max "G" Force (g): +2.5 g
Ceiling (m): 17,000
Fuel (liters): 16,500 est.
Unrefueled Combat Radius (km):
Maximum 4,000
Supersonic, hi-hi-hi, 12,000 kg weapons 1,500 - 1,850
Subsonic, lo-lo-lo, 12,000 kg weapons 1,500 – 1,665
Subsonic, hi-hi-hi, max weapons 2,200
Takeoff Run/Landing Roll (m):
2,000 – 2,100/1,200 – 1,300
Dimensions (m):
Length: 42.4
Wingspan: 34.3 extended, 23.4 swept
Height: 10.8
Standard Payload (kg): 24,000 Max
External: 12,000
Internal: 12,000

Survivability/Countermeasures:
All four crewmembers have individual ejection seats, allowing emergency exit at any speed.
Avtomat-3 Radar warning system, L-082 missile warning system, active phased array jammers, chaff, and flares

ARMAMENT
23-mm 2x barrel NR-23 gun, in the tail

AVIONICS/SENSOR/OPTICS
Automatic high- and low-altitude preprogrammed flight control, with automatic approach. Secure SATCOM datalink receiver and comms, missile targeting and navigation radar, and video camera to provide visual assistance for weapons aiming at high altitude. It has TV remote gun and bomb sights, PRS-3/Argon-2 ranging radar, and PNA-D attack radar.

Night/Weather Capabilities:
Aircraft has day and night all-weather capability.

VARIANTS
Tu-22M2 BACKFIRE-B: The initial production model. A refueling probe can be fitted, however most have been removed. Developed for the long-range strategic bombing role.

Tu-22M2Ye BACKFIRE-B: This variant has the New NK-55 engines and advanced flight control system. Flight characteristics were not improved.

Tu-22M3 BACKFIRE-C: Upgrades resulted in new radar, engine intakes, and engines. The aircraft has an improved weapons capability, increasing the bomb and cruise missile payloads.

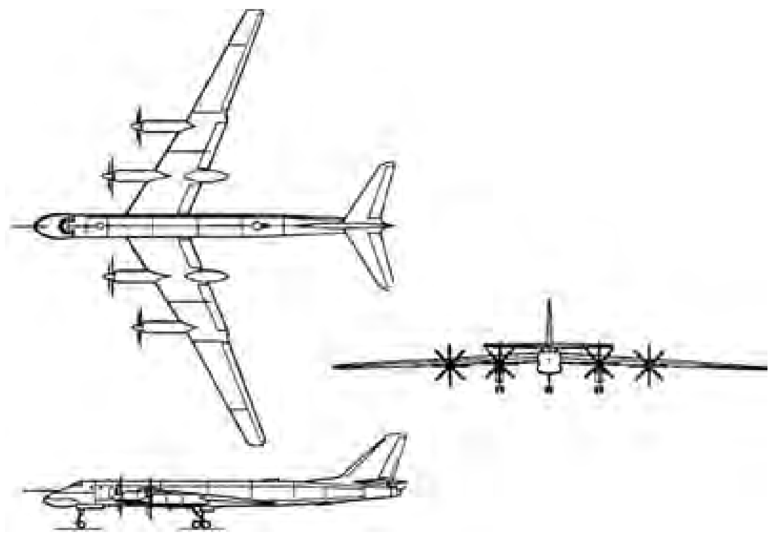
Tu-22MR: 1985 recon variant with Shompol SLAR and ELINT equipment.

Tu-22MP: IW variant, currently unfielded

Further upgrades are expected for delivery of additional precision munitions.

NOTES
The BACKFIRE is a long-range aircraft capable of performing nuclear and conventional attack, anti-ship, and reconnaissance missions. Its low-level penetration features make it a much more survivable system than its predecessors. Carrying either bombs or AS-4/Kitchen air-to-surface missiles, it is a versatile strike aircraft, believed to be intended for theater attack in Europe and Asia, but also potentially capable of missions against the United States. The Backfire can be equipped with probes for in-flight refueling, which would further increase its range and flexibility.

Russian Long-Range Bomber Aircraft Tu-95/BEAR



Weapon & Ammunition Types	Combat Load
1 or 2 x twin-barrel 23-mm GSh-23 in tail turret	
Other Loading Options	
AS-4 Kitchen ALCM	**2**
AS-15 Kent ALCM	**10**
Kh-101	**8**
Kh-65	**14**

SYSTEM
Alternative Designations:
Date of Introduction: 1955
Proliferation: India

Description: For Bear H
Crew: 7 (pilot, copilot, navigator/weapons officer, defensive system officer, flight engineer, tail gunner)
Appearance:
- Wings: Swept, high-mounted mid fuselage
- Engines: Four 8-blade turboprop engines in separate wing nacelles
- Fuselage: Slender, circular-section, semi-monocoque fuselage

Tail: Swept fin, with dorsal fillet and inset Rudder. Swept tailplanes mounted at base of fin
Engines: 4 x 15,000 eshp Kuznetsove NK-12MP turboprops (max) 9,870 eshp (cruise)
Weight (kg):
- Maximum Takeoff: 185,000
- Maximum In-flight: 187,000
- Maximum Landing: 135,000
- Empty: 94,400

Speed (km/h):
- Maximum (at altitude): 830
- Maximum (sea level): 550
- Cruise: 735
- Takeoff/Landing Speed: 300/275

Max "G" Force (g): +2 g
Ceiling (m): 10,500
Fuel (liters): 95,000 Internal
Range (km):
- No Refueling: 10,500 (normal load) 6,500 (max load)
- One Refueling: 14,100

Takeoff Run (m): 2,450
Dimensions (m):
- Length: 49.1
- Wingspan: 50.0
- Height: 13.3

Internal Payload (kg):
- Normal: 9,000
- Maximum: 20,000

Rotary Launcher: MKU-6 containing 6 x AS-15 Kent missiles

Survivability/Countermeasures:
No ejection seats. Conveyor in flight deck floor carries crewmembers to hatch in nose wheel bay, with landing gear lowered in emergency. Astrodome in roof over sixth crewmember.
ECM pods, infrared warning system, gun fire control radar, Ground Bouncer ECM jamming system, radar warning receiver, chaff and flares.

ARMAMENT
1 or 2 twin-barrel 23-mm GSh-23 in tail turret:

AVIONICS/SENSOR/OPTICS
Short range navigation system, navigation/ bombing radar, weather radar, terrain-following radar, IFF, thermal anti-icing.

Night/Weather Capabilities:
Day and night, all-weather capability.

VARIANTS
Tu-95/Tu-95M BEAR-A strategic bomber: Basic production version. Tu-95M had more powerful and fuel-efficient engines.

Tu-95V BEAR-A nuclear bomber: One aircraft made to carry large hydrogen bombs. Bomb weighed 27,500 kg and had 58 megatons yield.

Tu-95K/Tu-95KD BEAR-B missile carrier: Radome and additional 23-mm gun in nose, under fuselage fittings for large cruise missile, and ELINT equipment. Tu-95KD received an air refueling system.

Tu-95KM BEAR-C missile carrier/ reconnaissance: Similar to Bear-B, but with two ELINT systems and Crown Drum radar and Box Tail tail-warning radar.

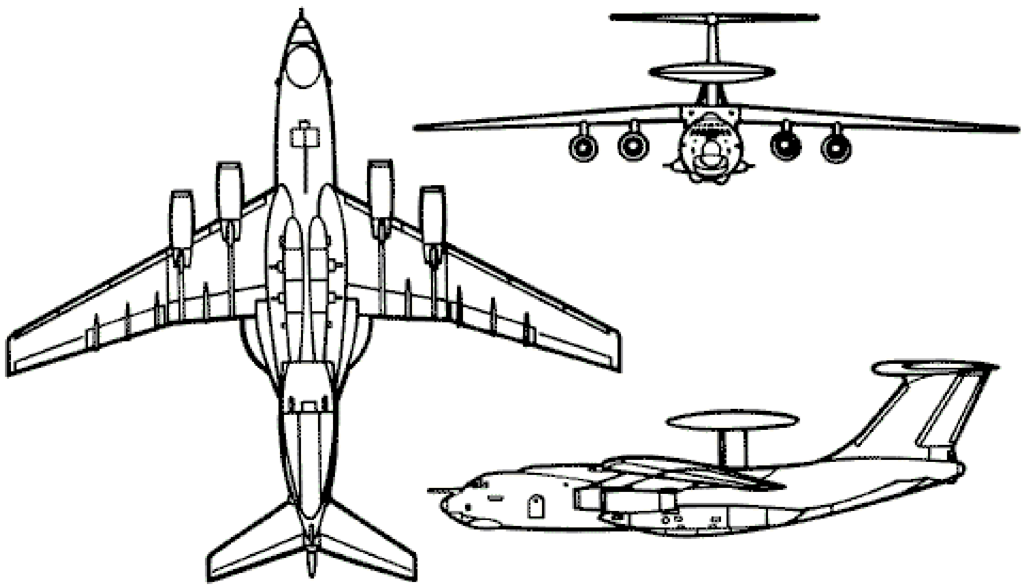
Tu-95RT BEAR-D ELINT reconnaissance: Naval reconnaissance and targeting variant.

Tu-95M BEAR-E photo-reconnaissance: Air Forces photo reconnaissance version.

Tu-95MS/Tu-95MS6/Tu-95MS16 BEAR-H bomber: Current main service version; with Toadstool terrain following and Clam Pipe ground mapping, target acquisition radar. Tu-95MS6 was first to carry missiles in an internal rotary launcher. Tu-95MS16 adds under fuselage and under-wing pylons to carry more missiles.

NOTES
The BEAR is a long-range strategic bomber, with variants in naval service in reconnaissance, anti-submarine warfare, and communications relay roles. It is the only turboprop-propelled strategic bomber in operational service in the world and is highly regarded by its crews.

Russian Airborne Warning and Control System Aircraft A-50E/MAINSTAY______



SYSTEM
Alternative Designations: See Variants
Date of Introduction: **1987** original
Proliferation: 6 for all variants
Description:
Crew: 5 (2 pilots, 3 other flight crew) + 10 Mission operators
Appearance:
Wings: High-mounted, swept-back, and tapered with blunt tips. Trailing edge has a slight crescent shape.
Chassis: IL-76/CANDID transport
Engines: Four mounted pylons under and extending forward of wings' leading edge.
Fuselage: Long, round and tapering to the rear, rounded nose with chin radome.
Large rotating radome above the fuselage
Tail: T-tail with curved leading edge and inset rudder. Swept tailplanes meet at top of the tail
Engines: 4 x 26,455 lbs thrust Soloview D-30KP turbofans
Weight (kg):
Max takeoff: 170,000 (Il-76M), 190,000 (Il-76MD)
Empty: 61,000
Speed (km/h):
Max: 850
Cruise: 750 - 800

Ceiling (m): 15,500
Fuel (liters):
Internal: 81,830
Range (km):
Max Payload: 5,000
Max Fuel: 6,700
Takeoff Run/Landing Roll (m): 850/450
Dimensions (m):
Length: 46.6
Wingspan: 50.6
Height: 14.8
Cargo Hold(m):
Length to ramp: 20.0
Length including ramp: 24.5
Width: 3.4
Height: 3.5
Standard Payload (kg):
Internal: 40,000 (M), 48,000 (MD)
Endurance: 4 hours with internal fuel and maximum payload.

Survivability/Countermeasures:
IFF. Wingtip countermeasures pod, flare pack each side of rear fuselage, IR warning receiver

ARMAMENT
Two 23-mm cannons fitted in a manned position at the base of the rudder

AVIONICS/SENSOR/OPTICS
Description (A-50E):
Color CRT displays for radar observers, and satellite data link to ground stations.
Weather radar in nose, ground-mapping and navigation radar under nose.
Signal detection radar: 50-500 MHZ
Electronic Intel radar: .5-18 GHZ
Capabilities (A-50E):
Detecting and tracking aircraft and cruise missiles flying at low altitude over land and water, and of helping direct fighter operations over combat areas as well as enhancing air surveillance and defense.
Ground Target Detect Range:
Single Target: 300 km
Target Node: 250 km (tanks, etc.)
Ship-size Target: 400 km
Air Target Tracking Range:
Bombers: 650 km
MiG- 21Target size: 230 km
Low-Flyers: To radio horizon
Night/Weather Capabilities:
All-weather, day and night, all latitudes.

VARIANTS
Earlier versions included **A-50** with Shmel radar. **The A-50U/MAINSTAY B** has a Shmel-M radar variant.
A-50M: Variant has Shmel-2 radar, resists most CM, similar to US AN/APY-1/-2.
A-50E: Has been exported. An Israeli modified variant with new engines and a Phalcon radar will be exported to India.

NOTES
Mainstay is intended to detect and identify airborne objects, determine their coordinates and flight path data and transfer the information to air defense CPs and acts as a control center to guide fighter-interceptors. It also detects ground and sea targets and guides tactical aircraft to combat areas to attack ground targets at low altitudes. The 10 mission operators can track 50 targets and guide interception of 10 simultaneously.

Chapter 4
Unmanned Aerial Vehicles and Related Technologies

The one technology which has the seen the greatest expansion of research and fielding activity in recent years is that of unmanned aerial vehicles (UAVs). A research center in 2008 listed 789 UAV programs and UAVs. Reasons for the expanded use are that these systems can extend our vision and reach over any terrain, against any force, with fewer restrictions, dangers, and support requirements than manned systems. Since they are unmanned, they can go into areas where risk to crews might hinder a mission. Uses for UAVs have expanded beyond the primary one of RISTA, to include, security patrolling, delivery of IW systems (e.g., jammers), communications retransmission, attack, counter-air harassment of enemy aircraft, and remote materials delivery. Revolutions in lightweight materials, imagery systems, and control technologies, particularly commercial, have lowered costs and facilitated these changes.

This chapter provides characteristics of selected unmanned aerial vehicles (UAVs) either in use or readily available to the OPFOR. Therefore, UAVs discussed in this chapter are those likely to be encountered by U.S. forces in various environments and levels of conflict, or are representative of the range of systems fielded and available. The selection of UAVs is not intended to be all-inclusive. New UAV technologies and applications continue to appear.

UAVs come in various types, sizes, and levels of complexity, each having their own niche over the battlefield. For example, fixed-wing, propeller-driven platforms excel in endurance and range. Jet-propelled UAVs trade endurance and maneuverability for speed. Rotary-wing UAVs can carry relatively large payloads, offer the best maneuverability, and trade higher initial cost for long-term reliability and reduced casualty rates.

An unmanned aerial vehicle is a system with three attributes: (1) self-propulsion, (2) maneuver capability, and (3) guidance. They used to be classed as either drone or remotely piloted vehicle (RPVs), depending on means of control. A drone is guided by an on-board computer with a flight path programmed prior to mission. RPVs use a data-linked ground control station, where a pilot/operator controls the flight. Many modern UAVs can operate either or both ways, with pre-programmed and piloted phases. Thus the terms RPV and drone are less useful.

Current fielded UAV sizes range from that of high-altitude reconnaissance aircraft, to tactical “mini-UAVs”, which can mount stabilized gimbaled balls with multiple sensors. A rapidly expanding trend is the proliferation of small mini-UAVs (MUAVs) and micro-aerial vehicles (MAVs) for use at the lower tactical level. For more detail see pg 4-3, and Chapter 7 (Improvised Aerial Systems, section ***Sensor Technologies for Tactical Ground Forces***).

One recent trend with historical roots is to configure fixed-wing or rotary-wing piloted aircraft for remote operation, thus, converting the aircraft into an improvised UAV. Improvised UAVs can include radio-controlled aircraft and powered airships with sensors (Chapter 7).

Many UAVs are used in various roles to support destruction of enemy systems and suppression of enemy missions. Those roles vary from target acquisition to direct attack with an impact kill by the UAV. The roles and technologies to support them are discussed on page 4-18.

Among the most critical considerations for selecting UAVs are their operating range, operating radius, and endurance (flight time). Tactical and operational systems must be resusable; so operating radius is critical. They must at least range beyond the longest weapon range, plus more to provide warning time. Those not directly supporting weapons must have more range and time to survey wide areas. Usually, fixed-wing systems are better suited for covering large areas, and RW for supporting tactical weapons and operating in defilade areas.

New transport and launch configurations are available for UAVs. Israeli helicopters can carry Skylite-B UAVs in ATGM racks, and launch them to survey areas where there may be some risk. Skylite-B can be canister-mounted to fit on vehicles for launch at short halts, or launch from mortars. A British project offers a mini-UAV to launch from 81 mm mortars. One operational UAV has launched mini-UAVs. Another likely mini-UAV launch platform in the Near-Term (1-5 years) is airships, e.g., powered blimps and air defense aerostat balloons. Ships are using UAVs; and submarines have demonstrated their use while operating at periscope depth.

Other terms have recently been used to categorize UAVs and other unmanned aerial surveillance systems. But the terms should be understood to avoid confusion.

- The acronym ***UAS*** is currently used in some U.S. communities, with different meanings, but usually as ***unmanned aerial sensors***, to emphasize the wide range of UAV designs available for U.S. force requirements, with a focus on RISTA applications.

- Some organizations also use UAS to mean ***unmanned aerial*** **systems**, or ***unmanned aircraft systems.*** Selected sources have used one of these meanings as well as the one above the same paragraph, for the same system. Each meaning can exclude some aspect of the other or include one beyond the other. An aerial sensor may not be an aircraft, and an aerial system may have roles beyond that of sensor. The OPFOR community should be wary of confusion between these two very different meanings for the same acronym**.**

- For some users, ***unmanned aerial sensors*** is an umbrella term which can include UAVs (vehicles both guided and self-propelled), as well as related technologies (unmanned aerial sensors other than UAVs). Thus related technologies include remotely launched sensor munitions, with still cameras or video-cameras which sense and emit while in their trajectory. Note related technologies in the section at pg. 4-7, and at Vol 1 pg 4-24. Another related technology is airships, such as balloons, with sensor pods mounted on them. Most airships are aerostats tethered to fixed sites or to vehicles, for long-term (days) or short-term (minutes) operations; but others can be propelled. For discussion of airships and their uses, see Vol 2 pg 7-2. The above UAS are primarily used as sensors, but can be used in other roles. Thus the term UAS is still misleading.

- Because of confusions with acronym UAS, the OPFOR will avoid it. The WEG will continue to use descriptions of specific technologies, such as ***UAV***, ***airship***, etc., and generically precise categories like ***weapon-delivered aerial sensor munitions***.

Questions and comments on data listed in this chapter should be addressed to:

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Mini-UAVs and Micro-UAVs for Use in Military Forces

On the modern three-dimensional battlefield, military forces are finding missions for UAVs at all echelons and in many branches, for combat and supporting units. Tactical UAVs can be supplemented with lighter shorter-range UAVs at battalion and below. Branches such as AD, AT, artillery, theater missile, and other units with stationary facilities requiring security patrols can use these UAVs to execute the mission while reducing personnel and vehicle requirements.


Bayraktar MUAV

Systems categories and descriptions can be vague and contradictory. Producers, users, and publications use varied categorizations. UAVs may be termed “small UAV”, “short range UAV”, etc. Terms gaining the most use are “mini-UAV” (MUAV <25 kg, like Skylark, pg 4-4) and “micro-aerial vehicle” (MAV - <5 kg). Please note that, at one time, the term mini-UAV was used for tactical systems such as Shmel-1 (pg 4-13, weighing 130 kg). As UAVs have decreased in size, weight categorizations have shrunk. Of the total of 829 UAVs listed in 2008, 200+ weighed less than 25 kg (most were MAVs less than 5 kg). MUAVs and MAVs must be easily repairable (such as using duct tape for US DragonEye) or be very sturdy.

There are factors which will hinder or delay acquisition of these systems. Currently, many MUAVs and most MAVs are easily damaged, thus must be low in cost and treated as disposable. A few, however, (e.g. rotary craft like the Russian Pustelga) offer stable flight control and designs with good survivability. Virtually all use electric motors for near silent operation at altitudes of 300 m or less. Initial costs, repairs and maintenance are factors. They must be integrated into communications schemes and air space restrictions. Some training is required. Nevertheless, as in the commercial sector, the military sector has found a need for them. Para-military and special-purpose forces use these and other UAVs.


Carolo P50 MAV


MESICOPTER CONCEPT (STANFORD)

There is intense interest in development of MAVs. Key reasons for the interest include a widespread need for lots of inexpensive aerial sensors to observe small areas rapidly. Commercial and scientific applications have resulted in a boom in development programs. Many are hand-size; but most conventional designs with front-mounted propeller have problems in control, wind stability, payload, range, and crash worthiness. Slightly larger sized hand-launched craft like P50 (right), or craft close to the 5 kg limit offer better capability. Rotary-engine designs (especially multi-motor) have the most potential. The Russian Pustelga is used with security forces. The 4-rotor MAV is stable with 5 km range, GPS map feed, and notebook display (pg 4-4). An attack option is offered. Improvised applications include RC aircraft with cameras (pg 7-8), as used by the Tamil Tigers. Remote-delivered aerial camera sensors (pgs 4-7 and Vol 1, pg 4-25) can be used by soldiers instead of MAVs or MUAVs.

Some Tier 1 forces have MUAVs in tactical battalions and companies. By the Near Term, forces will have MUAVs or MAVs in platoons. Squads and teams will carry MAVs or other aerial sensors (e.g., weapon-delivered sensors - pg 4-7). By Mid-term vehicles and dismounted squads and teams will have their own MAVs; and attack munitions will be fitted or optional.

Israeli Mini-Unmanned Aerial Vehicles Skylark, Skylark II, and Skylark IV

SYSTEM
Alternative Designations: Derived from the Skylark I (previously called Skylark)
Date of Introduction: 2004
Proliferation: Skylark I is used in at least 4 countries, and has been employed in Iraq and Afghanistan.

Description:
Engines: Electric, horsepower INA
Fuel (liters): Battery-powered
Propulsion: 2-blade pusher propeller
Weight (kg):
Takeoff: 5.5
Payload (combined): 0.5, 0.7 night
Speed (km/h):
Maximum (level): 74
Cruise: 74
Maximum Ceiling (m): 4,600
Endurance (hr): 2.0
Range (km): 10 mission radius
Dimensions (m):
Wing Span: 2.4

Deployment:
Crew: 2 (can be 3 dismounted). If vehicle carried, crewing is an alternate duty.
Number of aircraft: 3 per team
Carry: Breaks down for 2 backpacks
Launch Method: Hand launch. Other options are vehicle and aircraft
Recovery Method: One button for return flight and deep stall landing, without operator action.
Landing Method: Inflatable cushion

Survivability/Countermeasures:
It has a light composite structure, for low radar signature. The aircraft is extremely quiet. It has excellent flight dynamics for use in all climates and severe weather.

VARIANTS:
Skylark uses technologies from the Pointer program. Original Skylark is aka Skylark I. Skylark IV is a slightly improved version, ruggedized and gyro-stabilized.

Skylark II: Slightly larger (35-kg) UAV which can be vehicle launched from a rail.

SENSOR/OPTICS
Payload Type:
Day: Gimballed gyro-stabilized daylight CCD camera with EO auto-tracker. The auto-tracker aids tracking moving vehicles.
Night: Thermal camera

FLIGHT CONTROL
Control System:
Hand-held Miniature Ground Control Station (GCS) with color TV console
Other terminals (photo left) can be used.

Flight control Method:
Continuous telemetry transmission with Spectralink data link. It can use one of various radio channels to avoid channel interference.
Programmed Mode Option: Yes.
It can operate in "camera guide" mode, digitally tracing its map route with video recording for use in aircraft flight planning.

NOTES
Tactical UAVs sometimes crash. With a lower cost and volume production, they are more plentiful and more easily replaced than larger UAVs. A Skylark I crashed during operations in the West Bank, sustaining some damage. In one account, a Skylark experienced operational malfunctions in use by Canadian forces. Malfunctions have not been noted with Skylark IV.

Israeli Mini-Unmanned Aerial Vehicle Skylite B

SYSTEM
Alternative Designations: The version described is an improved Skylite B.
Date of Introduction: 2005
Proliferation: There are contracts for at least 3 countries.
Description: (Skylight B)
Engines: Electric engine, NFI
Fuel (liters): Battery-powered with rechargeable lithium-polymer batteries
Propulsion: 2-blade pusher propeller
Weight (kg):
Takeoff: 8.0
Payload (combined): 1.2
Total system (kg): 39
Cruise Speed (km/h): 70-100
Operating Altitude (m): 100-600
Endurance (hr): 3.0
Range (km): 35
Dimensions (m):
Wing Span: 02.4
Length (fuselage): 1.2
Body diameter: 0.12

Deployment:
Crew: 2, 3 dismounted. Many are vehicle carried, and crewed as an alternate duty.
Carry: Backpack, one for UAV, other pack for terminal, catapult, and support.
Launch Method: 4-kg catapult or ramp, or canister for vehicle/shoulder/ground launch
Recovery Method: Both parachute and inflatable bag. The battery, parachute, and bag are replaced prior to reuse (in 15 min).

Survivability/Countermeasures:
It has a light composite structure and small size, for low radar signature. The aircraft is very quiet. It has excellent flight dynamics for use in all climates and severe weather, with winds of up to 35 knots, and gusts of 55.

SENSOR/OPTICS
Payload Type:
Day: Gimballed gyro-stabilized daylight CCD camera, with EO auto-tracker
Night: LLLTV black and white

VARIANTS:
Skylite A: Canister-launch UAV for use on vehicles in tactical units. One canister version can be shoulder-launched.

An **–A** variant upgrade is the **Skylite B**, with improved cameras, larger wing, longer endurance, and 1.5-kg added weight.

FLIGHT CONTROL
Control System:
Separate Ground Control Station (GCS) and sensor station, using laptop computers.

Flight control Method:
Continuous telemetry transmission with GPS navigation and real-time down-link.
Encrypted digital data link and comms.
Programmed Mode Option: No

Once in place, it can be operated by one person.

NOTES
The UAV can be canister-launched from vehicles. With a Rafael system, Spike ATGM launchers on helicopters can launch Skylite UAVs, also pass off UAV control and data to ground units. They can mount on vehicles as a subsystem for added vehicle acquisition capability.

Russian Micro Unmanned Aerial Vehicle Zala 421-08

SYSTEM
Alternative Designations: NA
Date of Introduction: 2007
Proliferation: At least 1 country
Description:
Crew: 2
Engines: Electric
Propulsion: 2-blade propeller
Weight (kg):
Takeoff: 1.9
Fuel and Payload (combined): 2.55
Speed (km/h):
Maximum (level): 190
Cruise: 65-130
Ceiling (m):
Maximum: 3,600 Above Sea
Minimum: 15
Operating: 100-700
Fuel (liters): INA
Endurance (min): 90
Range (km):
RPV Mode: 10
Pre-programmed Mode: 40

Ground Control Station:
Man Portable Ground Control Station (GCS) (Hardened)
GCS controls UAV and payload independently
Power supply: 120/220 V (6 hours of continuous operation)
Setup time (min): 5

Dimensions (cm):
Wing Span: 81
Length (fuselage): 42.5
Height: 25
Launch Method: hand launched; catapult optional
Wind speed at launch: 15 m/s
Recovery Method: parachute (non-steerable)
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures: GPS / GLONASS Navigation

Payload Type:
10Mpx camera
infrared module
gas analysis module
dual axis stabilized full color video camera
Payloads fit in the standard mounting block that is interchangeable with other payloads

COMPOSITION OF UAV COMPLEX

- (2 X) UAVs ZALA 421-08
- (2 X) cases for transportation of UAVs
- (2 X) video roll-stabilized cameras
- (optional) infrared camera with resolution not less than 160x120
- Catapult (Optional made to order)
- Charger for battery and associated cables
- Maintenance tool set
- Spare parts

Total Weight: 9 kg

VARIANTS: INA

Weapon-Delivered Aerial Sensor Munitions

Several aerial imaging munitions have been developed for launch from weapon systems. They offer capability for real-time or near real-time overhead view of an enemy within or close to weapon range, even when the enemy may be concealed behind cover.

Weapon-delivered aerial sensor munitions were developed by 2000. However, they are not yet widely fielded, due to cost, difficulty of miniaturization, lack of portability, need for precise target location data, and lack of clear imagery. Advancements in image resolution, radio transmission and miniature servo-motor systems, now permit design of sensor (and even guided attack) munitions for delivery by grenade launchers, mortars and rocket launchers. Linking the downloaded image or video to a digital transmission system can also permit it to be shared with other users. Because the sensor uses munition propulsion, it can reach the target area well before launch and employment of a UAV or MAV.

Several munitions are offered for under-barrel grenade launchers (UBGLs), and shoulder launchers users those grenades. The munitions offer overhead imagery for infantry squads and teams at lower cost than UAVs. Users can employ laptop or smaller netbook computers, or PDAs as terminals. Examples include the Israeli FireFly 40-mm UBGL round with a camera eye and parachute, to give a top-down view of features beyond line-of-sight 600 m away. The image footprint is approximately 1,200 m. Another, the Israeli Reconnaissance Rifle Grenade (RRG) is launched from a rifle barrel, provides 6-7 seconds of image, and also has 600 m range. The Singaporean S407/Soldier Parachute Aerial Reconnaissance Camera System (SPARCS) fits a 40-mm UBGL, with 300-600 m range (est) and offers a real-time image to PDA or other display.

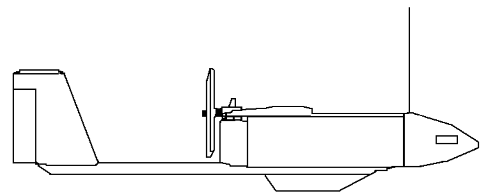

Singaporean SPARCS

A Pakistani firm is developing the Firefly (not the same FireFly as above) hand-launched camera reconnaissance rocket. The pistol-styled launcher will direct a plastic rocket to a range of 800-1000 m in 8 sec, with a digital data link to a PDA. It is called a “mini-rocket UAV”. However, no details on Firefly guidance (required for a UAV) have been detailed.

A few countries are developing mortar reconnaissance projectiles for 81 mm and 120 mm mortars. These are likely by the end of the Near Term (5 years). One developer predicts reconnaissance projectiles for 60 mm mortars. Prototypes and programs for 155-mm cannon fired reconnaissance projectiles are also underway and likely due by the Mid-Term (5-10 years).

One system developed in the 1990s is the Russian R-90 UAV rocket for launch by the 9A152 300-mm multiple rocket launcher (Vol 1, pg 7-66). It is actually part weapon delivered sensor, part RISTA UAV, and part attack UAV. It reaches 70-90 km in less than a minute. On arrival the 42 kg UAV ejects, then loiters for 30 minutes to execute target confirmation, adjust MRL fires, and perform battle damage assessment afterward. As the UAV reaches the end of its flight time, it can target a remaining target for an impact kill. The attack option presages an increasing trend for UAVs and sensor projectiles - offering direct attack and munition launch options (see pg 4-18 for more detail).

French Unmanned Aerial Vehicle Fox AT1



SYSTEM
Alternative Designations: ASPIC AT
Date of Introduction: 1988
Proliferation: France, United Nations, and civilian customers

Description:
Engines: 1 x Limbach 22 hp L 275 E two-cylinder, two-stroke, air-cooled
Propulsion: 2-blade push propeller
Weight (kg):
Takeoff: 90
Fuel and Payload (combined): 30
Speed (km/h):
Maximum (level): 216
Cruise: 145
Ceiling (m):
Maximum: 3,000
Minimum: 30
Fuel (liters): INA
Endurance (hr): 1.5
Range (km):
RPV Mode: 50
Relay/Programmed Mode: 100
Dimensions (m):
Wing Span: 3.6
Length (fuselage): 2.75
Height: 0.25

Launch Method: Hydraulic or sandow ramp.
Recovery Method: Parachute
Landing Method: skid
Maximum Flights Per Aircraft: INA

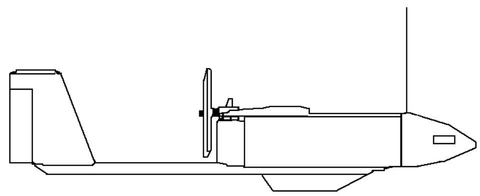
Survivability/Countermeasures: INA

SENSOR/OPTICS
Payload Type: CCD color video or infrared cameras, thermal analyzers, high definition line scanners, NBC and meteorological sensors.
Television field of view: INA
IR Linescan:
Length: INA
Resolution: INA

VARIANTS:
Fox AT2 UAV
Fox TX Electronic Warfare UAV
Fox TS1 Target Drone
Fox TS3 Target Drone
Mini-Fox Target Drone

NOTES
The Fox AT1 UAV is one of a family of low-cost UAVs designed by the French firm CAC SYSTEMES. Each UAV system is composed of a transport and launching system, a ground control station (GCS) mounted on a 4x4 truck frame, and four UAVs. The Fox AT1 is launched from a mobile launching catapult (transportation and launching system) that is mounted on a trailer with transportation compartments for 4 UAVs. Normally two of the four UAVs are equipped with CCD cameras for daytime missions and the remaining two are FLIR equipped for nighttime missions. Upon mission completion the UAV can be re-serviced and available for another mission in less than 30 minutes. The Fox AT1 is capable of carrying 15 kilograms of various payloads. Additionally, two underwing pods allow for four loads to be carried and dropped. Normally the GCS consist of a crew of three personnel: pilot, observer, and a technician. However, two people can deploy the UAV system and have it available for operation in less than 20 minutes. The guidance and control consists of an UHF data link with four proportional and eight numeric channels, of which four control the autopilot. Telemetry is through a 12-channel data link.

French Unmanned Aerial Vehicle Fox AT2



SYSTEM
Alternative Designations: None
Date of Introduction: 1988
Proliferation: France, United Nations, and civilian customers

Description:
Engines: 1 x Limbach 22 hp L 275 E two-cylinder, two-stroke, air-cooled
Propulsion: 2-blade push propeller
Weight (kg):
Takeoff: 135
Fuel and Payload (combined): 60
Speed (km/h):
Maximum (level): 216
Cruise: 145
Ceiling (m):
Maximum: 3,000
Minimum: 30
Fuel (liters): INA
Endurance (hr): 5
Range (km):
RPV Mode: 50, 100, 150 (200 as an option)
Relay/Programmed Mode: 350

Dimensions (m):
Wing Span: 4.0
Length (fuselage): 2.75
Height: 0.25
Launch Method: Hydraulic or sandow ramp.
Recovery Method: Parachute
Landing Method: Airbag
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures: INA

SENSOR/OPTICS
Payload Type: Panoramic CCD color Camera, Low Light Television (with zoom), IR linescan CAMELIA camera, SAR camera, FLIR, multi-sensor gimball platform (IR and visible), etc.
Television field of view: INA
IR Linescan:
Length: INA
Resolution: INA

VARIANTS:
Different versions are offered with varying ranges. The version selected for Tier 2 portrayal is the Fox AT2 (200), with 200-km range.

NOTES
The Fox AT2 UAV is one of a family of low-cost UAVs designed by the French firm CAC SYSTEMES. Each UAV system is composed of a transport and launching system, a ground control station (GCS) mounted on a 4x4 truck frame, and four UAVs. The Fox AT2 (like the Fox AT1) is launched from a mobile launching catapult (transportation and launching system) that is mounted on a trailer with transportation compartments for 4 UAVs. Normally two of the four UAVs are equipped with CCD cameras for daytime missions and the remaining two are FLIR equipped for nighttime missions. Upon mission completion the UAV can be re-serviced and available for another mission in less than 30 minutes. The Fox AT2 is capable of carrying 30 kilograms of various payloads. Additionally, two under-wing pods allow for two loads to be carried and dropped. Normally the GCS consist of a crew of three personnel: pilot, observer, and a technician. However, two people can deploy the UAV system and have it available for operation in less than 20 minutes. The guidance and control consists of an UHF data link with four proportional and eight numeric channels, of which four control the autopilot. Telemetry is through a 12-channel data link.

Chinese Unmanned Aerial Vehicle ASN-104 and ASN-105

UAV uses a reusable solid rocket booster prior to jettison after take off

SYSTEM
Alternative Designations: D-4
Date of Introduction: 1985
Proliferation: At least 1 country

Description:
Engines: 1x –30 hp HS-510 four-cylinder, two-stroke gasoline air-cooled piston
Propulsion: 2-blade wooden push propeller
Weight (kg):
Takeoff: 140
Fuel and Payload (combined): INA
Speed (km/h):
Maximum (level): 205
Cruise: 150
Ceiling (m):
Maximum: 3,200
Minimum: 100
Fuel (liters): INA
Endurance (hr): 2
Range (km):
RPV Mode: 60 for ASN-104, 100 for ASN-105
Relay/Programmed Mode: 100 (est.)

Dimensions (m):
Wing Span: 4.3
Length (fuselage): 3.3
Height: 0.9 (excluding skids)
Launch Method: Solid rocket booster on a zero length launcher.
Recovery Method: Parachute (nonsteerable)
Landing Method: 2 spring loaded skids
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures: INA

SENSOR/OPTICS
Payload Type: Panoramic Camera, Low Light Television (with zoom) and IR linescan
Television field of view: INA
IR Linescan:
Length: INA
Resolution: INA

VARIANTS:
ASN-105: An improved version of the ASN-104 UAV, with greater control range.

NOTES
The UAV is launched from a zero-length launcher using a solid rocket booster that is jettisoned after take-off.

Chinese Unmanned Aerial Vehicle (EW/ECM) ASN-207

UAV uses a reusable solid rocket booster prior to jettison after takeoff*

SYSTEM
Alternative Designations: D-4
Date of Introduction: 2002
Proliferation: At least 1 country

Description:
Engines: 1x –51 hp HS-700 four-cylinder, two-stroke gasoline air-cooled piston
Propulsion: 2-blade wooden push propeller
Weight (kg):
Takeoff: 222
Fuel and Payload (combined): 50
Speed (km/h):
Maximum (level): 210
Cruise: 150
Ceiling (m):
Maximum: 5,000-6,000
Minimum: 100
Fuel (liters): INA
Endurance (hr): 8-16
Range (km):
RPV Mode: 600
Pre-programmed Mode: 600

Dimensions (m):
Wing Span: 6
Length (fuselage): 3.8
Height: 1.4 (excluding skids)
Launch Method: Solid rocket booster on a zero length launcher.
Recovery Method: Parachute (nonsteerable)
Landing Method: 2 spring loaded skids
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures: INA
Pre-programmable waypoints for self correcting

EW/ECM
Payload Type:
JN-1102 EW/ECM suite which can scan, intercept, analyze, monitor, and jam enemy ground to air communications at 20~500MHz. The system consists of a UAV-mounted intercept subsystem a UAV-mounted jamming subsystem and a ground based intercept and control subsystem.
VARIANTS:

ASN-206: An older version of the ASN-207 UAV, with less control range smaller payload capacity and shorter endurance.

NOTES
*The UAV is launched from a zero-length launcher using a solid rocket booster that is jettisoned after take-off.

Austrian Unmanned Aerial Vehicle Camcopter S-100

SYSTEM
Alternative Designations: Al-Saber in UAE, Camcopter (less specific than S-100 due to prototype differences)
Date of Introduction: 2006
Proliferation: At least 4 countries, and in testing in other countries.
System: A launch section has a TUV/truck with a ground control station and 2 UAVs. Fuel and resupplies are in the trailer.

AERIAL VEHICLE
Description:
Engines: 55 hp Diamond aviation engine
Propulsion: 2-blade rotary wing propeller
Weight (kg):
  Takeoff: 200
  Payload Total: 55+ for 6 hrs, 50 in main bay, with 3 other bays and 2 pylons
Speed (km/h):
  Maximum (level): 223
  Cruise: 102 at max payload
Ceiling (m):
  Maximum: 6,000
  Minimum: <3
Endurance (hr): 6 cruise at max payload
Range (km):
  RPV Mode: 130 based on payload
Relay/Programmed Mode: 130
Hover capability: Yes
Dimensions (m):
  Width: 1.24
  Length (fuselage): 3.09
  Height: 1.04
  Rotor diameter: 3.4

Deployment:
Launch Method: DGPS autonomous (hands free) vertical launch from vehicle/ground base
Recovery Method: DGPS autonomous
Landing Method: Vertical to vehicle/ground
Maximum Flights Per Aircraft: No limit
Navigation: Inertial with GPS, <1-m precision

Survivability/Countermeasures:
Light carbon fiber structure for low radar signature. It is very quiet, with narrow profile for low visual signature. It has auto-return and recovery mode for lost control signal.

SENSOR/OPTICS
Payload Type:
Most will include a CCD TV day/all-weather camera, FLIR night camera, auto-tracker, and a laser range finder.

Example: IAI/Elta POP-3000 gimbaled ball with TV and FLIR for night use.

Example: IAI/Tamam POP200 gimbaled ball with FLIR, 3km night acquisition range.

Example: UAE version is projected with TV and high zoom for 20 km daytime acquisition.

Example: PicoSAR: Synthetic aperture radar for MTI surveillance and ground mapping

Other options: Laser target designator (LTD), NBC monitors, laser imaging radar (LIDAR), ground-penetrating radar (GPR), and signal intelligence assets.

FLIGHT CONTROL
Control System:
Ground Control Station (GCS) in vehicle
Image processing: Real-time UAV video feed can also be routed to other subscribers.

Flight control Method:
Pre-programmed or in-flight re-program. Press 1 button to exit craft from program mode, or to place it into hover. Change program waypoints in-flight any time, or shift to and from remote piloting.

VARIANTS:
An Unmanned Combat Aerial Vehicle (UCAV) attack version was developed and displayed in 2008, with 2 x Lightweight Multi-role Missiles (LMMs, see Vol 2, pg 6-55). Missiles can engage light armored vehicles, aircraft, and other ground targets.

A UCAV version could also mount guided rockets, machineguns, rockets, or automatic grenade launchers as needed for attack roles or self-protection. Small launchers for aerial rockets with SAL homing could fit on a craft with an LTD for deep attack.

NOTES
Aircraft is used for variety of military roles, including fire control and observation for fire and strike systems, border patrols, de-mining and naval ship-based roles. In the air defense role, it can be used for observation of likely flight routes, or for helicopter attack in UCAV configuration. A noted role is using a laser target designator to select targets and direct semi-active laser-homing munitions to the target for a kill. The system could also carry a jammer, including a GPS jammer.

Civilian roles could include area security, crowd suppression with dispersed tear gas, and search and rescue.

Russian Unmanned Aerial Vehicle Shmel-1 and Pchela-1K

Pchela-1K modernized version of Shmel-1. Note the lack of turned down wingtips

SYSTEM
Alternative Designations: Bumblebee, Pchela-1, and Malakhit (export) are UAV names. Stroi-P and Sterkh-1 are complexes (systems).
Date of Introduction: 1991
Proliferation: At least 6 countries
System: Includes launch vehicle, ground station, transporter/loader, technical support vehicle, and 3-10 UAVs.

LAUNCH VEHICLE
Designation: BTR-D
Alternative Designations: BMD M1979

Description:
Crew: 2
Combat Weight (mt): 6.7
Chassis Length Overall (m): 5.88
Height w/o Launch unit (m): 1.67
Width Overall (m): 2.63

Automotive Performance:
Engine Type: 240-hp Diesel
Cruising Range (km): 500
Speed (km/h):
Max Road: 61 (est.)
Max Off-Road: 35 (est)
Average Cross-Country: INA
Max Swim: 10 (est.)
Fording Depth (m): Amphibious

Radio: R-123

Protection:
NBC Protection System: Yes
Smoke Equipment: None

AERIAL VEHICLE
Endurance (hr): 2
Range (km):
RPV Mode: 60
Relay/Programmed Mode: 120 (est.)
Launch Method: Rocket-assisted catapult
Recovery Method: Parachute (nonsteerable)
Landing Method: 4 spring loaded landing legs
Maximum Flights Per Aircraft: 10 to 20

Description:
Engines: 1x 32-hp Samara/Trud (Kuznetsov) P-032 two-cylinder, two-stroke gasoline
Propulsion: 3-blade shrouded pusher propeller
Dimensions (m):
Wing Span: 3.25
Length (fuselage): 2.78
Height: 1.10
Weight (kg):
Takeoff: 130
Fuel and Payload (combined): 70
Speed (km/h): 180 max (level), 140 cruise
Ceiling (m): 100- 3,000
Number simultaneously controlled UAVs: 2

Survivability/Countermeasures:
The engine and propeller are enclosed in a shrouded ring that serves the purpose of reducing noise as well as reducing surface reflection and IR/heat signature.

SENSOR/OPTICS
Payloads: Video camera, TV, IR linescan
Television Field of View: 3º to 30º (zoom)
IR Linescan:
Length: 3 to 4 times aircraft altitude
Resolution: 3 milliradians

VARIANTS:
Pchela-1K: Upgrade design. It has 3.5 hrs endurance, 100 km RPV-mode range, and 100-3,500 m altitude. Gyro-stabilized sensor ball has LLL TV, IR imaging for night, and earlier sensor options.

Pchela-1T: System includes GAZ-66 truck launcher and various Pchela-1 versions.

Pchela-2: Developing upgrade with 62-hp engine, greater payload, and 100-km range.

Stroi-P: Military UAV complex with Shmel-1 mounted on a tracked BTR-D launcher.
Stroi-PD: Modern complex, with Pchela-1K, -1T, or -1S launched from a GAZ-66 truck.

NOTES
The transporter-launcher-controller (TLC) has positions for two UAV operators. Automatic pre-launch monitoring, launch, flight control, and displaying of the received data is conducted from the TLC. The display in the TLC indicates aircraft position overlaid onto the television image. Given the system's digital downlink, the IR image could also be recorded on magnetic tape or displayed on a video monitor. However, the data is almost certainly recorded on electronic medium for playback. The description of the system may indicate a problem involving the inability of the operator to translate aircraft coordinates to those of the targets being located. A laser rangefinder or designator could easily accomplish this, but such a capability is not indicated for the Shmel-1. The current system requires coordinate conversion from map association or photographic interpretation with a laser capability to be added later.

The area coverage of the sensor payload is excellent. Analysis indicates that the camera, at an altitude of 1500 meters and a field of view of 30º, can image an area of approximately 500,000 m^2 or a circle with a radius of 400 meters. The IR linescan at the same altitude would see a strip approximately 5,100 meters long and 4.5 meters wide. Ground resolution would decrease significantly at the ends of the scan. At a nominal speed of 120 km/h and flying the maximum altitude, the aircraft could observe a maximum of 192 km^2/hr with the television system, or 1,200 km^2/h with IR linescan.

Civilian versions include forest, pipeline, and coastal patrol versions. Military versions are often used with artillery units.

South African Unmanned Aerial Vehicle Vulture

SYSTEM
Alternative Designations:
Date of Introduction: 2006
Proliferation: At least 2countries.
System: A launch section has a truck-mounted launcher, a recovery truck, a GCS/ command van, and 2 UAVs for assembly. Fuel and supplies are ground-based onsite. The Samil 100 10t trucks are designed for off-road use.

AERIAL VEHICLE
Description:
Engines: 2-cyl 38-hp 2-stroke 498ia
Propulsion: 2-blade pusher propeller
Weight (kg):
  Takeoff: 100
  Payload Total: 25
Speed (km/h):
  Maximum (level): 161
  Cruise: 120
Ceiling (m): 5,000 max
Endurance (hr): 4 max
Range (km): 200 max
  RPV Mode: 60, 100 with retransmission
Relay/Programmed Mode: 100

Dimensions (m):
  Width: 0.7(rear wing)
  Length (fuselage): 3.1
  Height: 0.7
  Wingspan: 5.2

Deployment:
Flight Preparation: Air vehicle is modular, requiring assembly prior to deployment.
Deployment time (min): 30
Launch Method: DGPS autonomous launch from launcher vehicle.
Navigation: GPS with in view display
Recovery Method: DGPS autonomous
Landing Method: Arrest in recovery truck net, with landing on ground-based air cushion.
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures:
Light carbon fiber structure for low radar signature. In case of link failure, the UAV will automatically return to launch point.

SENSOR/OPTICS
Payload Type:
The UAV can be fitted with a variety of sensor packages. They include a stabilized ball with M-Tek CCD TV camera, FLIR night camera, auto-tracker, and a laser range finder (LRF) or laser target designator (LTD). Range is 20 km daytime, 3 km at night (est.). LTD range is 10 km.

FLIGHT CONTROL
Control System:
Ground Control Station (GCS) in vehicle, with C-band control link. The UAV sends a digital feed netted to artillery command and other users. It is designed to digitally link to artillery GPS-based automated tactical intelligence networks, such as AS2000.

Flight control Method:
Pre-programmed for most of flight, with in-flight re-programming, and remote piloting as the mission requires it.

VARIANTS:
The Prototype version was Unmanned Aerial Observation System (UAOS) . The fielded version and system have changed.

Projected variants offered include **Super Vulture** (25% larger and 8-hr payload) and **Sea Vulture**.

Sentinel 500M: 5 hr variant design with improved sensors, launched from the Vulture launch section.

NOTES
The UAV can be used for variety of roles; but the design role is locating targets, fire direction, and observation for tactical fire and strike systems. The system usually carries a laser target designator to direct SAL-homing munitions (rounds, rockets, bombs, and missiles).

Other versions include retransmission, electronic intelligence, and jamming. Civilian versions are now being offered (e.g., border and protected area patrolling and cloud-seeding operations).

Russian Unmanned Aerial Vehicle Tu-143/ Reis and Tu-243/Reis-D

Tu-143 on transporter-erector-launcher (TEL)

Tu-243 on launcher vehicle

SYSTEM
Alternative Designations: DR-3, Reys, VR-3 for Tu-143 system
Date of Introduction: 1973 for Tu-143, 1999 for Tu-243
Proliferation: Tu-143 in at least 7 countries, most no longer in service. Russian forces have both Tu-143 and Tu-243.
System: VR-3 includes a TEL, TZM-141 transporter/refueler, KPK-141 check system, and POD-3 ground control station. A squadron has 12 systems.

LAUNCHER VEHICLE:
Designation: SPU-141 TEL from a BAZ-135 truck on Tu-143.

AERIAL VEHICLE
Description:
Engine: 1 x TR3-117 turbojet, TR3-117A for Tu-243
Propulsion: Jet
Payload (kg) : 130
Fuel (liters): 190 for Tu-143
Dimensions (m):
  Wing Span: 2.24, 2.25 for Tu-243
  Length (fuselage): 8.06, 8.29 for Tu-243
  Height (excluding skids): 1.55, 1.76 for Tu-243
Speed (km/h): 940 maximum (level), 850 cruise
Ceiling (m):
  Maximum: 3,000, 5,000 for Tu-243
  Minimum: 100, 50 for Tu-243
Endurance (minutes): 13, 26 for Tu-243
Guidance Mode: Relay/Preprogrammed Only
Operating Range (km): 180, 360 for Tu-243
Operational Radius (km): 95, 180 for Tu-243

The Tu-143 can operate to a reconnaissance depth of 150 km and is preprogrammed prior to each mission.
Survivability/Countermeasures: Radar altimeter permits a flight profile with up to 4 altitude changes (15 for Tu-243).

Operations:
Launch Method: Solid rocket booster
Recovery Method: Drogue and main parachutes (non-steerable).
  A braking rocket engine in the fuselage activates at 1.8 m altitude to soften landing on tricycle gear (3 retractable skids)
Maximum Flights Between Maintenance: 10
Operational time (min): 35 from halt, 10 from receiving mission
SENSOR/OPTICS
Payloads:
Tu-143 has PA-1 panoramic camera, Chibis-B low-light-level TV, and radiation detection equipment. Camera data must be processed upon return. IR linescan (with side scan) and radiation detection equipment can be used.

Tu-243 has the AP-402M camera, Aist-M TV, and Zima-M IR camera for night use. Accuracy is 70 m. One sortie with the TV can cover 2,100 km^2. Processing time in-flight is 30 sec.

VARIANTS:
Tu-243/Reis-D: The VR-3D system received extensive upgrades from the earlier UAV. Russia is updating its Tu-143s to Tu-243 capabilities. Thus the upgrades are often referred to as Reis-D (or Reys-D).

NOTES
There is some evidence that North Korea used Tu-143 technology to upgrade its Luna (FROG) series artillery rockets for improved precision.

Israeli Unmanned Aerial Vehicle Hermes 450S

SYSTEM
Alternative Designations: INA
Date of Introduction: INA
Proliferation: At least 1 country, selected for testing by another
Description:
Engines: 70 hp gasoline UEL AR-80-1010 rotary engine
Propulsion: 2-blade pusher propeller
Weight (kg):
Takeoff: 450-500
Payload (combined): 150
Speed (km/h):
Maximum (level): 175
Cruise: 130
Ceiling (m):
Maximum: 6,200-7,000
Minimum: INA
Fuel (liters): INA
Endurance (hr): 24-30
Range (km):
RPV Mode: 200
Relay/Programmed Mode: 250+
Dimensions (m):
Wing Span: 10.5
Length (fuselage): 6.1
Height: 2.36, body diameter 1.7

Deployment:
Launch Method: Wheeled take-off
Recovery Method: Conventional landing
Landing Method: 3-wheeled, w/arrest cable
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures:
Light composite structure, low radar signature

SENSOR/OPTICS
Payload Type:
Sensor Pod: MOSP, high end
Television day/night, auto-tracker, auto-scan
Sensor Pod: FSP-1 mid-high end
FLIR with 3-FOV telescope
Sensor Pod: POP, low-mid-range
CCD Television day and/or night
Sensor Pod: ESP-600C, low end
Television, color, day only
Sensor Pod DSP-1: TV with recognition range of 10 km, and FLIR camera range of 3+ km. Detection range is 25 km.

Other options: MTI radar and SAR

VARIANTS:
Hermes 450: The original UAV has a weight of 450 kg, 52-hp engine, and flight duration of 20 hours.
Hermes 450S has an improved engine, higher weight, and longer duration. It uses the DSP-1 sensor pod.

An attack version of Hermes with missiles was employed this year in the Sudan against Iranian targets. The **Mikholit**, Israeli 10-km variant of Nimrod long-range missile, is designed for launch from the Hermes.

FLIGHT CONTROL
Control System:
Ground Control Station (GCS) vehicle

Flight control Method:
Pre-programmed or in-flight re-program

NOTES
An available option is DGPS automatic take-off and landing. Recommend that this option be played in simulations.

Israeli Unmanned Aerial Vehicle Hermes 900

Source: Wikipedia/Author Permission: Tal Inbar

SYSTEM
Alternative Designations: INA
Date of Introduction: May 2010
Proliferation: Chile (Jun 2011)

Description:
Engine: 105 hp gasoline Rotax 914 turbocharged engine
Propulsion: one-blade pusher propeller
Weight (kg):
Maximum Takeoff Weight: 970
Maximum Payload Weight: 300
Speed (km/h):
Maximum (level): 222
Cruise: 130-175
Ceiling (ft):
Maximum: 30,000
Minimum: INA
Fuel (liters): INA
Endurance (hr): 36
Range (km):
Maximum: 1,000
Relay/Programmed Mode: 250+
Dimensions (m):
Wing Span: 15.3
Length (fuselage): 6.1
Height: 2.36, body diameter 1.7

Deployment:
Launch Method: Wheeled take-off
Recovery Method: Conventional landing
Landing Method: 3-wheeled, retractable landing gear; independent takeoff and landing
Maximum Flights Per Aircraft: INA

Survivability/Countermeasures:
Light composite structure, low radar signature

SENSOR/OPTICS (can accommodate two Sensor Pods simultaneously)
Payload Types:
Sensor Pod: Gabbiano T200: long range surveillance radar, X band (8 to 12.5 GHz), 407 KM maritime range, MTI and SAR, >200 target Track-While-Scan (TWS).
Sensor Pod: DSP-1: TV with recognition range of 10 km, and FLIR camera range of 3+ km. Detection range is 25 km.
Sensor Pod: Tadiran Skyfix: COMINT DF and Elisra AES-210: ELINT
Sensor Pod: Elop DCoMPASS (digital compact multi-purpose advanced stabilized system): stabilized turret incorporating thermal imager, color TV, dual-band laser designator rangefinder, inertial measurement unit and laser spot tracker.

Additional Features: Air Traffic Control Radio, Radio Relay and IFF transponder.

VARIANTS:
An attack version of Hermes 900 may be possible. Each wing has two external hardpoints similar to the weaponized Hermes 450. The **Mikholit**, Israeli 10-km variant of Nimrod long-range missile, is designed for launch from the Hermes 450.

FLIGHT CONTROL
Control System:
Ground Control Station (GCS) vehicle; capable of controlling two Hermes simultaneously

Flight control Method: Pre-programmed or in-flight re-program; Secure redundant Line of Sight (LOS) data link and redundant satellite communication Beyond Line of Sight (BLOS).

NOTES
An available option is IATOL (Independent Auto Takeoff and Landing) system for automatic take-off and landing on non-instrument runways. Recommend that this option be played in simulations.

Unmanned Aerial Vehicles Used in Attack Missions

More modern forces are employing UAVs directly with fire support units. They offer responsive rapid fire observation with less risk to personnel and fewer terrestrial limitations to direct observation. Roles, capabilities, and configurations for integrated fires and strikes continue to expand. Range requirement for these tactical UAVs is 60+ km; and operational is 120+ km.

Abilities of UAVs to reconnoiter the battlefield, identify targets, give precise locations of targets, and provide fire correction depend on responsiveness and, stable viewing, and precision location. Improvements in GPS, stabilized sensor balls, and laser range-finders can now permit locations within 1-m accuracy, and stand-off viewing to 20+ km daytime and 3+ km at night. The image can be sent in real-time, and can be retransmitted with minimal delay. Some UAVs use SATCOM to extend the distance. Several forces use UAVs specifically designed for specific digital integrated fire and strike systems, for image and target location display at the battery or weapon monitor. The Russian Pchela-1K is designed for display with the 2S19M1. The South African Vulture UAV directly links with the AS2000 fire control system.

Rotary-wing UAVs offer superior capabilities for fire support roles. Because they can hover, they can approach targets at nap-of-the-earth level (8 m or level), between trees. They can also mount fairly hefty payloads of robust sensors (up to 55 kg for Camcopter S-100), in order to execute stand-off observation. RW aircraft generally offer better stability for precision viewing. All of these factors mean better all-weather capability with less risk of detection.

Other UAV missions include direct attack of fleeting targets. There are many programs to develop ***attack UAVs*** or convert UAVs for attack roles by mounting explosive warheads for an impact kill. The application goes back to WWII, with explosive-filled unmanned U.S. bombers directed by radio against German targets. UAV costs and limited fielding have limited use in attack roles. An exception is the Israeli and Chinese Harpy attack UAV (next page), specially designed as an ***attack UAV*** against high-value targets. This system can be called both a UAV and a cruise missile, as it can be piloted and/or programmed. The Russian R-90 UAV rocket is launched from 9A152 MRL, and has an attack option (pg 4-7). Since MUAVs and MAVs have been fielded, their lower cost means that attack versions will be likely. The Russian Pustelga MAV is noted to have an attack option. In the Near Term, weapon-launched sensor munitions (pg 4-7) will also have warheads and guidance for attack. UAVs armed or not can be used to harass and attack enemy RW aircraft. More attack UAVs or attack configurations will be seen.

The U.S. has demonstrated another UAV design for direct attack by mounting ATGMs UAVs as ***unmanned combat aerial vehicles (UCAVs).*** UAV-based UCAVs operate similarly to larger aircraft-based UCAVs. They can fire guns or grenades or launch missiles against air and ground targets. Israel demonstrated the method this year with ATGMs on Hermes 450S in Sudan. They were probably Mikholit, a Nimrod (Vol 1, pg 6-75) variant designed for UCAVs.

Emerging attack UAVs/CAVs will compete with cruise missiles against deep-strike NLOS targets to 200+ km (Vol 2, pg. 4-18). Nevertheless, most effective use of UAVs for attack remains in precision location and guidance. Best use is mounting a laser target designator to guide semi-active laser-homing munitions (from a UCAV mount or delivered by artillery, tanks, aircraft, mortars, and ships) against targets otherwise inaccessible to ground-based designators.

Israeli/Chinese/European Attack Unmanned Aerial Vehicle Harpy and CUTLASS _

Weapons & Ammunition Types	Typical Combat Load
UAV s on launcher	**18**
Harpy Anti-radiation UAV or CUTLASS or White Hawk	

SYSTEM
Alternative Designations: INA. Maker calls it an Air Defense Suppression System, with anti-radiation homing attack UAV. It can serve as a less-expensive cruise missile (see NOTES).
Date of Introduction: 1988
Proliferation: At least 5 countries
Primary Components: Launcher battery consists of 3 truck launchers with sealed launcher containers, 54 UAVs, battery control station, and logistical element.

Radio: INA

ARMAMENT
Transporter-Erector-Launcher
Chassis: 4x4 or 4x6 medium truck
Crew: 1-3 per truck

Protection:
Armor Protection: None
NBC Protection System: None

Launcher Performance
Land Navigation: GPS
Missiles per launcher: 18

Missile:
Name: Harpy
Type: Single-stage, liquid-fuel
Launch Mode: Side-launch
Range (km):
Max. Launch Range: 500
Max Piloted Range: 150
Range with retransmission, GPS pre-programming, and other modes and homing modes extends to 1,000.
Dimensions (m):
Length: 2.1
Wing Span: 2.7
Weight (kg): 135
Guidance: Pre-programmed/radar homing, or EO (CUTLASS/White Hawk)
Navigation: GPS with nav waypoints
Trajectory: Non-ballistic, cruise altitude
Endurance: 6 hrs, including several hours over target area
Velocity (kph): 185
Accuracy (m): 1, dive attack
Warhead: 18-22 kg, Frag-HE

Pre-Launch Operations: Missile has built-in test equipment, and can be de-fueled and refueled prior to launch

VARIANTS
Harpy is derived from design of the German Dornier **DAR** attack UAV.

The Chinese version uses an indigenous truck as a launcher.

The **Harpy** system can be mounted on decks of assault landing ships.

White Hawk: European version of Harpy with an EO camera for use as a remotely-piloted attack UAV. Endurance is initially same as Harpy, but is later due to be extended to 20 hrs.

CUTLASS (Combat UAV Target Locate and Strike System): UAV developed in concert with U.S. firm which uses semi-automatic guidance to 150 km, and multiple seeker options and GPS for extended range to 1000 km. CUTLASS flies at 6,000 ft to avoid ground fire. With different seekers, the UAV can be used to engage other targets, such as sites, vehicles, and theater missile launchers.

E-Harpy: Israeli upgraded CUTLASS with increased endurance, currently in development.

NOTES
Harpy modules can be carried aboard transport aircraft, or mounted on smaller, tactical vehicles.

Using the pre-program mode, the aircraft can be treated as a cruise missile. But it can also be considered a UAV, which can be piloted or used without a pilot (programmed or homing attack mode). Other UAVs, such as the South African Lark, feature radar attack modes. Alternative uses for Harpy can include attacking other high-value radar targets, such as artillery counter-battery radars and ground surveillance radars.

Chapter 5
Theater Missiles

In an era of increased emphasis on lethality and protection against manned aerial forces, military forces world-wide are seeking to extend their deep-attack capabilities by means other than manned aircraft. Thus, new missile systems are being fielded. The trend among military forces for acquisition of theater missiles has expanded with the growth of regional rivalries and the strategy of using long-range strike capability to gain regional leverage. Theater missiles are generally categorized among two types - ballistic missiles (BMs) and cruise missiles (CMs). They are launched from ground launchers, aircraft, or naval vessels. These systems are designed for deep strike missions—beyond those of close battle assets. Where missiles are subordinate to the ground force commander, they will be used as another strike asset to support his plan. They may be used for purposes other than execution of conventional strike missions, such as delivery of mines, and information warfare missions.

Theater ballistic missiles (TBM) are an expanding threat to U.S. soldiers, allies, and interests in regions where military forces are deployed, such as South Korea, Japan, Iraq, or Afghanistan. The trend among military forces for acquisition of theater missiles has expanded along with the growth of regional rivalries and the strategy of using long-range strike capability to gain regional leverage. TBM provide the OPFOR commander the ability to strike a target(s) 3,000 km (1,864 mi) away with a nuclear warhead or with an array of conventional warheads.

The role of cruise missiles (CMs) has changed. Prior to the 1990s, fielded designs were generally limited to ***anti-ship missiles*** **(**WEG Naval Vol 3, Littoral Chapter). Improved in guidance systems, propulsion, warhead options, launch platforms, and affordable designs have vaulted CMs to the role of the first option for deep attack against point and small area targets.

New missile systems have been developed which do not fit in the BM or CM category. These are long-range missiles flying non-ballistic trajectories with a mix of pre-programmed phase and options for manned guidance, loitering in the target area, as well as separate homing by GPS, radar or passive RF seeker, and/or IR/MMW homing. These systems may also be categorized as non-line-of-sight antitank guided missiles (NLOS ATGMs), or as unmanned combat aerial vehicles (UCAVs). They can be launched from ground vehicle launchers, ships, and/or aircraft. Some are developed as anti-ship missiles. Most have high-explosive warheads for multi-role use; and are large enough to kill armored targets and bunkers. They will supplement lethal strikes against high-value targets, including moving targets.

Systems featured in this chapter are the more common systems, or represent the spectrum of missile systems which can threaten US Army forces or interests within an operational environment. Questions and comments on data in this specific update should be addressed to

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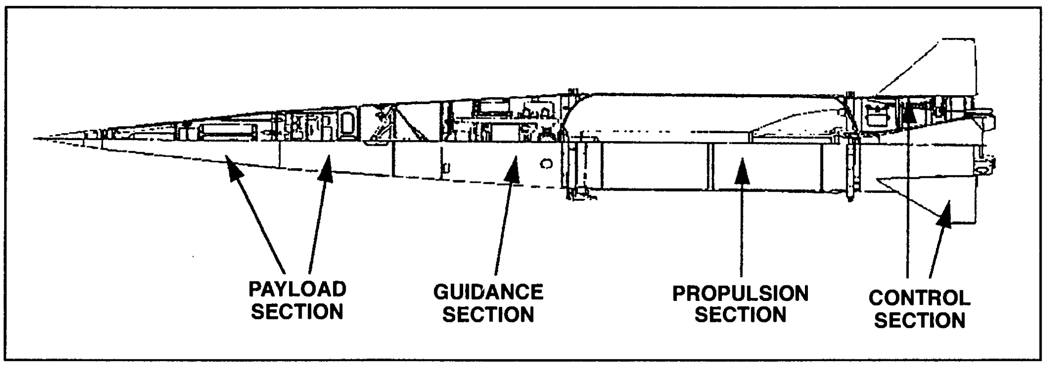
Theater ballistic missiles

Theater ballistic missiles (TBMs) employ a high-atmosphere or exo-atmospheric ballistic trajectory to reach the target. Because of the high cost and limited numbers of these systems compared to artillery, they will be used against high-priority targets at critical phases of a conflict, or against political targets. Selected OPFOR forces with limited numbers of missiles may hold them in a separate missile unit at echelons above the supported ground force commander. The most critical component of a theater ballistic missile system, which defines its capabilities and limitations, is the missile. Unlike rockets, all missiles have guidance or homing for precision strikes. Missiles are generally classified according to their range—

- Short-range ballistic missile (SRBM), 0-1,000 km.
- Medium-range ballistic missile (MRBM), 1,001-3,000 km.
- Intermediate-range ballistic missile (IRBM), 3,001-5,500 km.

Numerous countries are adding technologies to extend range and improve accuracy of ballistic missile systems. Approaches for improve range include increased use of solid fuel, lengthening missiles for increased fuel and longer burn time, improving motors (in the propulsion section), using more efficient solid fuel motors, and employing smaller and lighter warheads. Key additions for precision are maneuvering re-entry vehicles (RVs), and GPS. Below is an example of a modern missile (Russian Tochka-U SRBM) and its major components.



Mobility. These missiles employ a high-atmospheric or exo-atmospheric ballistic trajectory to reach the target. Most TBMs follow a set course that cannot be altered after the missile has burned its fuel. However some have the capability for non-ballistic trajectories and precision maneuver. Ballistic missiles have three categories of propellant for engines, which are liquid, hybrid, or solid, effect the distance a missile can travel and the CEP, or accuracy.

The majority of TBMs are able to launch from the ground, or naval assets. Missile ground launch platforms vary from fixed ground launchers, trailer launchers, mobile launch complexes (numerous vehicles) and transporter erector launcher (TELs). Fixed ground launchers may include hardened underground sites. Mobile ground launchers vary from older systems with simple modifications, to specialized vehicles designed for operation in all types of terrain. Newer launchers may incorporate improved mobility to reduce vulnerability to location by terrain analysis and intelligence preparation of the battlefield.

Lethality. Critical lethality considerations for TBMs include range, precision, munitions options, and responsiveness. The missile system is selected for a mission based on its ability to reach the target within targeting timelines, and its ability to deliver effective lethality on the target. Improved heavy multiple rocket launcher systems with course correction and increased-lethality warheads have replaced TBMs as preferred strike systems against selected deep targets. For instance, a Russian 9A52 MRL can deliver twelve 300-mm rockets 70-90 km with near-missile precision and minimal preparation time. However, a modern TBM can deliver twice the payload a farther distance with better precision against critical heavy targets.

The warhead (within the payload section) is the munition, the lethality mechanism which is selected for that strike mission and around which the system is designed. Many countries acquired ballistic missiles specifically to deliver weapons of mass destruction (WMD) against civilian targets such as urban centers. For such a mission, a less accurate system with a large payload capacity is sufficient for the mission. A substantial proportion of SRBM and some MRBM designs are copies or variants of the former-Soviet SCUD-B/SS-1c. Although these systems lack accuracy and responsiveness of some the newer systems, they can deliver large lethal payloads against fixed targets or targets whose limited mobility permits them to be stationary long enough for the TBMs' operational timelines.

Warhead developments include separating warheads, multiple warheads, maneuvering reentry vehicles (RVs), navigating and homing warheads, varied lethal and electronic warhead fills, warhead buses (e.g., submunitions), and warheads with countermeasures (penaids). Improved precision, in-flight targeting updates, warhead seekers, penaids, and other upgrades will further challenge theater missile defense assets to prevent strikes against priority targets.

Newer TBM designs with improved range, accuracy and operational considerations have been fielded. All missiles have some type of inertial guidance. Accuracy ranges 300 - 500m CEP for older systems, to less than 50m CEP for some advanced systems. These include several missiles with 10 m CEP. Some missiles add global navigation satellite systems (GNSS, eg,, GPS) for improved precision. Thus, older design systems can see immediate upgrades with that change. Further precision (5-9 m) is added with infrared (IR) or radiation-homing seekers.

Another critical consideration for effectiveness of TBMs is their responsiveness. Keys for timely delivery include target location, fire mission calculation and transmission, launcher and missile operational timelines. Therefore, modern missile system support equipment can include computerized fire control, location/navigation system (such as global positioning systems), as well as dependable secure communications. A key technology for increased TBM responsiveness is the use of solid fuel propellant, which removes the need for fueling a liquid fuel missile prior to launch. That step can increase preparation time at the firing point, and delay use or compel use when changing battlefield situation changes the mission. Solid fuel missiles are more consistent and reliable; and the modern trend is toward solid and away from liquid.

Operational timelines for missile crews of fixed launchers as well as mobile TELs are addressed in three phases: (1) time from leaving the hide to launch, (2) time from launch to leaving launch point, (3) and missile trans-loading time prior to next launch. These times are based on technology requirements as well as sound tactics. Steps in the launch sequence based on technology include surveying the launch site, launch coordination, emplacing the launcher, preparing the launcher and missile for launch, initiating safety measures, and the launch. Post-launch sequence includes displacement of the launcher, and displacement of support equipment. Missile transloading is executed far from the launch site; therefore time includes travel time, service to the launcher, fueling liquid-fuel missiles for the next launch if the next launch is less than 24-48 hours, planning coordination, then movement time to the next launch area (but not to the launch point). Additional time is included in TBM operational time lines because of survivability tactics, as noted below.

The warhead (within the payload section) is the munition, the lethality mechanism, which is selected for that strike mission and around which the system is designed. A number of newer TBM designs with improved range, accuracy and operational considerations including maneuvering reentry vehicles (RVs) have been fielded. Modern warhead developments include nuclear and chemical warheads, separating warheads, and multiple warheads. TBM can also deliver a wide variety of conventional munitions. Some examples are HE, anti-radiation (ARM), fuel-air-explosive (FAE), DIPCM, ICM cluster munition, varied lethal and electronic warhead and EMP fills, warhead buses (varied submunitions), precision navigating and homing warheads (such as IR homing). Countermeasures, including separating and maneuvering warheads, penaids, and other technical measures will further challenge the capability of theater missile defense assets to prevent strikes against priority targets.

Survivability. Technologies for increased missile reliability include almost total conversion from liquid to solid fuel. Some missiles are canisterized to protect them prior to use and permit easier handling and loading. With increased use of GPS correction and computer digital loading of propulsion system commands, possibilities of misfire and guidance failure are greatly reduced.

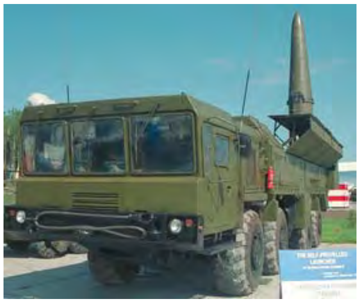
The high lethality of the missiles and their launchers means that both are considered by their adversary to be high priority targets for defeat and destruction. Therefore, the OPFOR can be expected to employ a variety of tactical and technical countermeasures to protect them. Tactical countermeasures include: using the missile's long range to outrange most adversary systems, use of hides (such as hardened artillery sites and terrain near the launch point or at trans-loading points to reduce exposure time, high mobility (high speed or all-terrain chassis) to move rapidly and reduce exposure time, use of OPSEC and deception operations (decoys, launch site emission control measures, movement in clutter, surge operations, etc.), and reduced launch sequence timelines (pre-surveyed site, pre-arranged communications, etc. These steps may sacrifice accuracy for reduced exposure time. More modern launchers will have a minimal preparation time between emplacement and execution of a fire mission.

Technical survivability measures for missiles include: improved coatings and camouflage patterns separating re-entry vehicles, non-ballistic trajectories (to foil trajectory prediction), cluster munitions, and penetration aides (such as jammers in warheads). Technical survivability measures for launchers include: improved coatings and camouflage patterns and nets, high mobility (to expand useable launch areas), self-survey capability (to minimize emplace time), short displacement time (<5 min), rapid launch sequence, non-ballistic trajectories (to foil back-tracking for counter-battery fires), employment of high-fidelity decoys, and SATCOM encrypted digital burst communications. These measures are intended to degrade the enemy's detection, targeting, impact or effectiveness kill, and lethality effects.

Other Considerations. State-of-the-art TBMs can cost more than a million dollars each. If the systems are not accurate enough, or if the enemy has ABM capabilities, those TBMs may not have a high assurance of success, and may not be a factor in the OPFOR plan. Thus, budgetary, political, and military considerations affect TBM decisions. The OPFOR may limit its missile requirement to systems used to gain regional political leverage by targeting civilian targets. Given the budget limitations and systems costs impacting most military forces in recent years, the OPFOR will likely have a mix of older and newer systems and selected upgrades. They may also balance the mix of TBMs with other, less costly, long-range precision strike assets. These can include ***precision artillery rockets***, ***precision artillery missiles***, non-line-of-sight antitank guided missiles (NLOS ATGMs), ***unmanned combat aerial vehicles (UCAVs)***, and ***cruise missiles***. Cruise missiles (CM) are discussed in the section beginning at pg 5-11.

Conclusions. Updates to both launch platforms and missiles systems are allowing the threat to become increasingly mobile and accurate. The extended range of both missiles and their mobile platforms create a dangerous combination providing a potential adversary the ability to launch missiles and strike well beyond preconceived ranges. These assets are a critical component of deep strike mission planning for conventional forces. They are also used as an asymmetrical political tool for use in affecting strategic power calculus in peacetime international struggles.

Russian Theater Ballistic Missile Transporter-Erector-Launcher Iskander



Weapons & Ammunition Types	Typical Combat Load
Missiles on launcher	**2**

SYSTEM
Alternative Designations: SS-26, SS-X-26
Iskander-M for Russian forces
Iskander-E for export
Date of Introduction: 1999
Proliferation: At least 1 country. Three other countries are considering acquiring the system. Iskander-M is in Russian service.

Primary Components:
Transporter-erector-launcher (TEL) and command vehicle. Rear support includes a transport and loading vehicle (9T250E), maintenance vehicle, mobile test and repair station, data preparation post, and life support vehicle. The system can also be linked into an integrated fires command (IFC).

ARMAMENT
Transporter-Erector-Launcher
Name: SPU 9P78E (MZKT-7930 variant)
Crew: 3
Chassis: MAZ-7930 (8x8)
Combat Weight (mt): 44.7 est based on chassis
Chassis Length Overall (m): 12.67
Height (m):
TER down: 3.02
Width Overall (m): 3.05

Automotive Performance:
Engine Type: Diesel, 500-hp
Cruising Range (km): 1,100
Speed (km/h):
Max. Road: 70
Max. Swim: N/A
Fording Depths (m): 1.4

Radio: INA

Protection:
Armor Protection: None
NBC Protection System: Yes

Countermeasures: Off-road mobility to concealed launchpoint, autonomous and passive operation at launchpoint. Missile non-ballistic trajectory in ascent conceals vehicle/launchpoint location. Missile reentry vehicle has decoys, and possible final-phase maneuver. With IR homing jamming is ineffective. Final phase is most likely non-ballistic pitch-over into a dive.

Launcher Performance
Land Navigation: GNSS
Missiles per launcher: 2
Total Emplace-Launch-Displace
Time (min): 15
Time Between Launches (min): 1, for 2nd missile
Reaction Time: 1 min
Position Location: Gyroscopic inertial with GNSS updates

Missile:
Name: Iskander-M/Iskander-E*
Type: Single-stage, solid-fuel
Launch Mode: Vertical launch
Range (km):
Max. Launch Range: 400/280*
Min. Launch Range: 50
Dimensions:
Length (m): 7.3
Diameter (mm): 920
Weight (kg): 3,800
Guidance: Inertial, with optional GNSS and/or optical/IR homing. Additional course correction uses the Radag radar correlator.
Trajectory: Ballistic with non-ballistic boost phase fly-out, and possible re-entry maneuver
Accuracy (m): 5-7 with IR-homing
10-20 without

FIRE CONTROL
Fire Control Computer: INA. The modern automated fire control system can be used as the battle management system for a reconnaissance-strike complex, or "integrated fires command", in concert with artillery and other reconnaissance and fires assets.

For IR-homing mode, computer loads target image from a satellite or UAV into the warhead. Thus, even when the GNSS or satellite is jammed or weather causes interference, the reentry vehicle will find the target.

VARIANTS
Early TEL variant (SPU 9P78) has one missile.

Iskander-E: Export variant (*) with shorter range (280 km). This missile was developed to comply with the Missile Technology Control Regime, which is no longer in effect.

Iskander-M: Domestic missile version with 400+-km range*.

Warhead Options
Type: HE, ARM, FAE, ICM cluster munition (10), ICM (54 submunitions), nuclear, chemical, tactical earth penetrator
Warhead Weight (kg): 700/480*

Other Missiles:
The developer now offers the Iskander-K cruise missile complex, with a launcher adaptation to mount 6 x R-500 (3M14?) missiles. Range is initially 280 km; but Near Term range is 500 km (est). It has GNSS programmed flight path, <100 m altitude, multiple waypoints, in-flight reprogram capability, velocity of 250 m/s, and <30-meter accuracy. Terminal guidance options include IR (correlator) or active radar homing. Production is due in 2009. Mid-Term upgrade could include a substantial range extension.

NOTES
* Range varies with different warheads and warhead weights. Potential range with the design is 500 km.
Future warhead options may include biological warfare and non-nuclear EMP warheads.

Russian Theater Ballistic Missile Transporter-Erector-Launcher Tochka-U ______

Tochka-U/SS-21 Mod 2/Mod 3

Weapons & Ammunition Types	Typical Combat Load
Missiles on launcher	**1**

SYSTEM

Alternative Designations: System with 120 km was called the SS-21 Mod 2/9K79M (see VARIANTS). For Tier 2 use SS-21 Mod 3.

Date of Introduction: 1989 for Tochka-U

Proliferation: At least 11 countries all variants
At least 3 countries Tochka-U

Primary Components:
Battery has 2 x TELs, 2 x 9T128-1 transloaders, and a C^2 vehicle. Rear support includes test vehicles, missile transporters, and maintenance vehicles. The system can also be linked into an integrated fires command (IFC). A met unit with END TRAY / RMS-1radar and radiosonde balloons provides updated weather reports.

ARMAMENT

Transporter-Erector-Launcher
Name: 9P129M-1
Crew: 3
Chassis: BAZ-5921 (6x6)
Combat Weight (mt): 18.3 loaded
Chassis Length Overall (m): 9.5
Height, TER down (m): 2.4
Width Overall (m): 2.8

Automotive Performance:
Engine Type: Diesel, 300-hp
Cruising Range (km): 650
Speed (km/h):
Max. Road: 60
Off-road: 30
Max. Swim: 8

Radio: R-123, R-124 on TEL

Protection:
Armor Protection: None
NBC Protection System: Yes

Launcher Performance
Land Navigation: GNSS for command vehicle
Missiles per launcher: 1
Emplace-launch time (min): 16 from march
Displace time (min): 1.5
Time Between Launches (min): 40
Position Location System: Inertial with GNSS updates

Countermeasures: Off-road move to concealed launch point. Likely autonomous and passive operation at launch point. Non-ballistic trajectory on ascent conceals vehicle launch point location. APU for minimum IR/noise.
Erect-to-launch time: 15 sec.

Missile:
Name: 9M79-1F/SS-21 Mod 3
Type: Single-stage, solid-fuel
Launch Mode: Vertical launch
Range (km):
Max. Launch Range: 120
Min. Launch Range: 20
Dimensions:
Length (m): 6.4
Diameter (mm): 650
Weight (kg): 2,010
Guidance: Inertial, with IR homing for Frag-HE. Other homing guidance for other munitions.
Warhead Weight (kg): 482 Frag-HE
Fuze: Laser proximity for Frag-HE
Trajectory: Ballistic with non-ballistic boost phase fly-out, and re-entry maneuver for homing missiles
Accuracy (m): 5-10 IR-homing ,or passive radar homing
10 without homing guidance

FIRE CONTROL

Fire Control Computer: INA. Automated fire control system can be used as the battle management system for a reconnaissance-strike complex (RSC), or "integrated fires command" (IFC), in concert with artillery and other reconnaissance and fires/strike assets.

For IR-homing mode, computer loads target image from a satellite or UAV into the warhead. Thus, even when the GPS or satellite is jammed, or weather causes interference, the reentry vehicle will find the target.

VARIANTS

SS-21Mod 1/9K79M/Tochka: First fielded system in 1976, with 70-km range, 150 m CEP.

SS-21 Mod 2: System with the 120-km 9M79M-F Frag-HE missile. CEP is 20-50 m.

Tochka-U/SS-21 Mod 3: Improved system (see Primary Components) with TEL, nav, and survey system, and new missiles. They include 9M79-1F, the Tochka-R, and others (below).

Warhead Options
Type: Frag-HE, cluster munition (50 APAM-size submunitions). Other warheads claimed to be available are: FAE, ICM DPICM, nuclear (10 KT and 100 KT), EMP, and chemical.

Tochka-R: Missile for SS-21 Mod 3 with ARM (anti-radiation homing missile), which launches on a non-ballistic trajectory, then targets radars.

An export missile can switch warheads between unitary Frag-HE and APAM cluster.

There are reports of tests with 2-missile versions with 180-km range.

NOTES
System also represents other modern TBMs which could threaten US Army forces. This is the Tier 2 system for use in OPFOR portrayal in Army training simulations (see pg 1-5). In later OPFOR time frames,(Near Term and Mid-Term), the Tochka-U Improved will include other option, such as biological warfare and non-nuclear EMP warheads.

Iranian Theater Ballistic Missile Mobile Erector-Launcher Shahab-3A and -3B_____

Iranian Shahab-3B Variant MRBM

Weapons & Ammunition Types	Typical Combat Load
Missiles on launcher	**1**

SYSTEM
Alternative Designations: INA
Date of Introduction: INA
Proliferation: Iran
Primary Components: INA

ARMAMENT
Mobile Erector-Launcher
Name: INA
Crew: 3 (EST)
Chassis: Based on No-dong 1type
Combat Weight (mt):
Chassis Length Overall (m):
Height, TER down (m):
Width Overall (m):
Description: Likely a highly mobile truck (NFI) built indigenously for the Shahab 3 based off the No-dong ballistic missile TEL .

Automotive Performance:
Engine Type: V8, Diesel Engines
Cruising Range (km): 550 (est)
Speed (km/h):
Max. Road: 70 (est based off of No Dong)
Off-road: UNK

Radio:

Protection:
Armor Protection: None
NBC Protection System: None

Launcher Performance
Land Navigation: GNSS
Missiles per launcher: 1
Emplace-launch time (min): 60 (est)
Displace time (min): INA
Time Between Launches (min): INA
Position Location System:

Countermeasures: Off-road move to concealed launch point. The warhead on a re-entry vehicle can maneuver separate from the missile body to challenge intercept systems.
Erect-to-launch time: INA

Missile:
Name: Shahab-3A
Type: Single-stage liquid with separating re-entry vehicle (RV)
Launch Mode: Vertical launch
Range (km):
Max. Launch Range: 1,300
Min. Launch Range: INA
Dimensions:
Length (m): 16.58
Diameter (mm): 1.38
Weight (kg): 15,862-16,250
Guidance: Gyroscopic inertial
Warhead Weight (kg): 760-1,158
Fuze: INA
Accuracy (m): 190

FIRE CONTROL
Fire Control Computer: INA

VARIANTS:
Variants have used different trucks and trailer designs. In the photo you labeled it as a variant. Are there fixed or other launcher variants?

The original **Shahab-3** missile and warhead resembled the Nodong-1, with a 1,200 kg warhead and a range of 1,300 km. Accuracy is said to be 190 m. With advent of the new missile design, it is now called **Shahab-3A.**

Shahab-3B: This version has a new design separating RV with 2,000 range and smaller 500-650 kg warhead. Accuracy is said to be 190 m. It mounts on a different MEL trailer.

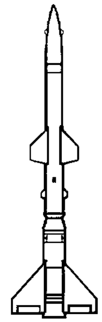
There are reports of **Shahab-C** and **D** in testing.

No-Dong-A1: A North Korean counterpart version of the Shahab-3B missile.

Warhead Options
Type: Nuclear, HE, chemical, or sub-munitions

NOTES
None

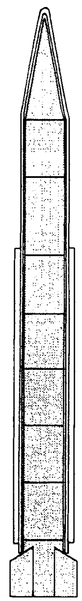
Tochka/SS-21 Mod 2



B610 / CSS-8

M-11/ CSS-7

SCUD-B / SS-1c



Nodong-1

DF-3 / CSS-2

Foreign Theater Ballistic Missiles

System Type	SRBM	SRBM	SRBM	SRBM	SRBM	SRBM	SRBM	MRBM	IRBM	**Technologies & Trends**
Name/ NATO Name Designator	Tochka-U SCARAB SS-21 Mod 3	M-7 B610 CSS-8	SCUD-B SS-1c	SCUD-B Mod 2 SS-1c Mod 2	M-11 DF-11 CSS-7	SCUD-C SS-1d	M-9 (export) DF-15 CSS-6	Nodong-1	DF-3 CSS-2	More SCUD variants
Producing Country	Russia	China	Russia North Korea	Russia	China	Russia North Korea	China	North Korea	China	Technology Transfer
Proliferation (countries)	At least 11 all variants	At least 2	At least 20	At least 1	At least 2	At least 5	At least 1	At least 1	At least 2	Increased proliferation
Type Launcher	TEL	TEL	Fixed, TEL	Fixed, TEL	TEL	Fixed, TEL	TEL	TEL	Fixed, Mobile complex	Mobile/decoy launchers
Propulsion	Single-stage Solid	Single-stage (est) Solid	Single-stage Liquid	Single-stage Liquid	Single-stage Solid	Single stage Liquid	Single-stage Solid	Single-stage Liquid	Single-stage Liquid	Non-ballistic trajectory
Range Min-Max (km)	20-120	50-150	50-300	300	50-300	500	200-600	170-1,300	1,500-3,000+	Increased range
Guidance	Inertial	Inertial	Inertial	Inertial IR homing	Inertial	Inertial	Inertial	Inertial	Inertial	Multi-sensor Homing
Accuracy (m) (Max Range)	5-10 IR-Hmg 15 without	150	1,000	50	300	<800	600	4,000	2,000-2,500	Improved Guidance
Payload (kg)	480	190	1,000	600	800	700	500-600	770	1,500-2,150	Separating multiple RVs
Warheads	HE, Chem, ARM, Nuc, IR Homing, APAM, ICM, EMP, DPICM	HE, Chem	HE, Chem, Nuc	Separating HE, Nuc	Separating HE, Nuc poss Chem	HE, Chem	Separating. HE, Nuc poss Chem Poss Fuel-Air Submunitions	HE, Chem poss Nuc	HE, Nuc, or 3 separating reentry vehicles (RVs)	Cluster, Volumetric, Submunitions BW warheads ARM, EMP
Comments	TEL is amphibious 2 msls/TEL	Modified SA-2 SAM Tracked TEL	Technology widely used	Previously called SCUD-E Requires compatible IR imagery	Exported as M-11	SCUD-B variant Russia limited production	Mod 2 range 1000 km DF-15B CEP 150-500 m DF-15C CEP 35-50 m	SCUD-B variant ND-2 IRBM variant Poss export	Variants with varied warheads and ranges Towed launcher Lengthy prep time	Autonomous operation, Penaids*/ Counter-measures, Reduced prep /displace times

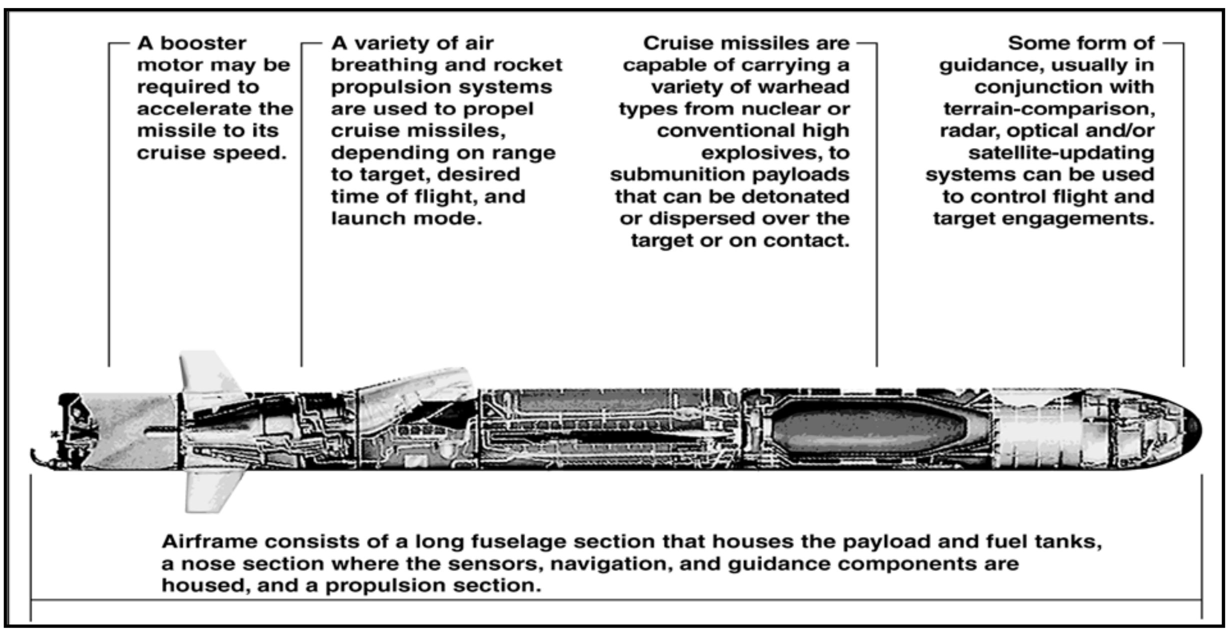
* Penaids - Penetration aids, such as RF jammer

Cruise Missiles

In the global arena many countries, including potential Threats to the U.S., are procuring cruise missiles (CM) as an inexpensive alternative to ballistic missiles and aircraft. CMs are economical and accurate delivery systems that can be used to deliver conventional, and nuclear, chemical and biological warheads. CM proliferation poses an increasing threat to U.S. National security interests. As the technology matures further, both State actors and non-state actors are becoming increasingly able to acquire cruise missile and effectively employ CM capabilities. The Hezbollah 2006 cruise missile attack on the INS Hanit illustrates the danger to units that are not technically prepared to meet this challenge.

Many older CMs are still used in less capable military forces. They fly a straight course to target with relatively slow speed (subsonic), are vulnerable to early detection, and can be shot down. Due to imprecision in guidance systems and the difficulty of flying long distance overland to ground targets, they are used as ***anti-ship missiles***. But in most forces they are being replaced by newer systems.

Cruise missiles (CM) are unmanned precision aerodynamic munitions with warheads propelled by rocket motors or jet engines, and designed to consistently fly a non-ballistic trajectory to the target. The diagram below illustrates the four main components of a basic cruise missile: (1) a propulsion system, (2) guidance and control system, (3) airframe, and (4) payload. CMs may have booster rockets which fall off after fuel is depleted. Then turbofan engine engages, the tail fins, and air inlet, and wings unfold. At the target the missile either dispenses its submunitions or impacts the target and is destroyed.



The overall sophistication of CMs have increased greatly with technological advancements. This is especially true with regard to guidance systems in the era of more capable Global Navigation Satellite Systems (GNSS) like GPS, Russian GLONASS, Chinese Beidou and the European Galileo. These advanced guidance systems, in combination with autonomous onboard systems, have allowed CMs to become more accurate in acquiring targets. The basic CM guidance controls consist of one of four different systems (below) that direct the missile to its target. Most newer CMs use a combination of systems to provide redundancy and precision in a combat environment.

1. Inertial Guidance System (IGS) tracks acceleration via accelerometers from missile movement compared against a known first position, usually the launch position to determine current location.

2. Terrain Contour Matching (TERCOM) uses a radar or laser altitude system, and compares terrain features enroute to a pre- loaded 3-D map terrain database.

3. GNSS (e.g., GPS), uses satellites and an onboard receiver to verify the missile's position.

4. Digital Scene Matching Area Correlation (DSMAC) uses a camera and image correlator to identify the target (good versus moving targets).

The most effective mix is IGS on the airframe, with TERCOM and/or GNSS with multiple route waypoints. Upon arrival in the target area, the missile can loiter or home based on warhead identification of target DSMAC, GNSS, or radiation confirmation. Some CMs can change route and target assignment while enroute, to maximize their effectiveness.

Technology of CMs is changing; and their role is expanding. CMs are relatively mobile and easy to conceal. Even after launch the missiles can avoid detection by traveling at low altitude, under many radar horizon and use terrain masking until the CM reaches the target. The newer CMs present even greater challenges to aircraft and air defense assets by integrating stealth features that make them even less visible to radars and infrared sensors. CMs can take roundabout routes to engage their targets, and are usually programmed to circumvent known defenses and engage targets from gaps in radar and SAM coverage. Modern cruise missiles offer flexibility for different configurations, and for air, sea, and ground-launch. In the COE, ground-launched CMs (GLCMs) can fly to targets within artillery range to support artillery fires, or deep to attack high-value ground targets. A CM's size, alterable course, and unique low flight profile makes it a convenient system for dispensing chemical or biological agents, for jamming, and for designating targets with an LTD. Examples of applications include *Exocet* and *Apache*. Swedish Bofors, South African Denel, and German LFK offer similar systems.

CMs used against ground targets are referred to as ***land-attack cruise missiles*** (***LACMs***). They can be ground, ship, or air-launched. Precision guidance has permitted rapid growth of multi-role ***air-launched cruise missiles*** **(ALCMs)**, for use against various naval and ground targets. ALCMs for land-attack are included in WEG chapters on aircraft (9 and 10) or in later issues. Cruise missiles vary in size, range (25-2,500+ km), and warhead payload. Larger ones can actually be manned bomber aircraft loaded with ordnance and controlled by a remote pilot system. An innovative modern small CM is the Harpy (pg 5-13), which can launch 18 missiles from a truck "cassette launcher". The BrahMos (pg 5-14) is an example of an operational level supersonic GLCM system, with future applications on other platforms. Initial uses are against ships, as well as high value nodes, such as airfields, C4, and missile launch sites. BrahMos ALCM and ship-launched versions are due out soon.

Israeli Cruise Missile/Attack Unmanned Aerial Vehicle Harpy and CUTLASS _____

Weapons & Ammunition Types	Typical Combat Load
UAV s on launcher	**18**
Harpy Anti-radiation UAV	

SYSTEM
Alternative Designations: INA. Maker calls it an Air Defense Suppression System, with anti-radiation homing UAV. It can serve as a less-expensive cruise missile (see NOTES).
Date of Introduction: 1988
Proliferation: At least 5 countries
Primary Components: Launcher battery consists of 3 truck launchers with sealed launcher containers, 54 UAVs, battery control station, and logistical element.

Radio: INA

ARMAMENT
Transporter-Erector-Launcher
Name: INA
Crew: 1-3 per truck
Chassis: 4x4 or 4x6 medium truck

Protection:
Armor Protection: None
NBC Protection System: None

Launcher Performance
Land Navigation: GNSS
Missiles per launcher: 18

Missile:
Name: Harpy
Type: Single-stage, liquid-fuel
Launch Mode: Side-launch
Range (km):
Max. Launch Range: 500
Min. Launch Range: INA
Dimensions (m):
Length: 2.1
Wing Span: 2.7
Weight (kg): 135
Guidance: Radar homing, with or without inertial patrol route using navigational waypoints
Trajectory: Non-ballistic, cruise altitude
Endurance: 6 hrs, including several hours over target area
Velocity (kph): 185
Accuracy (m): 1, dive attack
Warhead: 18-22 kg, Frag-HE

Pre-Launch Operations: Missile has built-in test equipment, and can be de-fueled and re-fueled prior to launch

VARIANTS
Harpy is derived from design of the German Dornier **DAR** attack UAV.

The **Harpy** system can be mounted on decks of assault landing ships.

CUTLASS (Combat UAV Target Locate and Strike System): UAV developed in concert with U.S. firm which uses semi-automatic guidance to 150 km, and multiple seeker options and GNSS for extended range to 1000 km. CUTLASS flies at 6,000 ft to avoid ground fire. With different seekers, the UAV can be used to engage other targets, such as sites, vehicles, and theater missile launchers.

NOTES
Harpy modules can be carried aboard transport aircraft.

Using the preprogram mode, the aircraft can be treated as a cruise missile. But it can also be piloted as a UAV, with homing mode for attack. Other UAVs, such as the South African Lark, feature radar attack modes.

Alternative uses for the Harpy could include attacking other high-value radar targets, such as artillery counter-battery radars and ground surveillance radars.

Indian/Russian Supersonic Cruise Missile BrahMos and BrahMos II

Brahmos missile canisters on a TEL

Weapons & Ammunition Types	Typical Combat Load
Missiles on launcher	**3**

SYSTEM
Alternative Designations: PJ-10
Date of Introduction: By 2006. First Army ground launch regiment was fielded in 2007.
Proliferation: Developed and offered for export. Russian system is fielded in at least 1 country. Indian contract signed for $2 billion in missiles. Talks have been held with five other countries.

Description: Primarily developed as an anti-ship missile. It can be used as a land-attack cruise missile (LACM). Launchers include land-based TEL, aircraft and ships (e.g., destroyers). It can also be launched from submarine, fixed ground site, or pontoon underwater silo.

Primary Components:
Transporter-erector-launcher (TEL) is called a Mobile Autonomous Launcher (MAL) linked into an integrated fires command (IFC). There is also a Mobile Command Post (MCP) with it. Reload missiles will be loaded at a transload point from a transloader vehicle (see above).

ARMAMENT
Transporter-Erector-Launcher
Name: Tatra variant (NFI)
Crew: 3 est
Chassis: 12x12
Description: It is described as a high-mobility truck (NFI) built indigenously for the MAL.

Radio: INA

Protection:
Armor Protection: None
NBC Protection System: Yes

Launcher Performance
Land Navigation: GNSS
Missiles per launcher: 3
Total Emplace Time (min): 5

Missile:
Name: BrahMos
Type: Two-stage, solid-propellant launch and kerosene ram-jet cruise
Launch Mode: Angular or vertical
Range (km):
  Max. Launch Range: 290
  Min. Launch Range: INA
Altitude (m):
  Max: 14,000
  Min: 5-10
Missile Speed: Mach 2.8-3.0
Dimensions:
  Length (m): 8.9
  Diameter (mm): 670
Weight (kg): 3,000
  4,500 with canister
Guidance:
  Inertial, with GNSS
  Mid-course correction sensor with up to 20-km adjustment from a distance up to 50 km out.
  Terminal homing radar correlator

Trajectory: Non-ballistic. Most likely use is hi-lo profile (high, early phase, low on approach to target).

Accuracy: Homes to ship and aims using radar correlation to hit centroid. Accuracy varies by seeker, with <20 m.
Warhead:
  Weight (kg): 250
  Type: Shaped Charge anti-ship
Other Warheads:
  BrahMos A weighs 300 kg.
  For ground targets, HE warhead is available.
Countermeasures: Missile shifts from radar to inertial at the end of its high approach phase, uses terrain data to shift to the low approach, then and uses radar for its course correction. Loss of radar due to jamming or other cause still permits inertial guidance off its latest course. High speed and low flight mode will challenge almost all detection and intercept radar and weapon systems.

VARIANTS
This is an Indian-produced system from a Russian-Indian joint venture. It is a variant of Russian **SS-N-26/Yakhont**, aka 3M55 Oniks. The supersonic Yakhont has been exported.

The Russian missile has a range of 300 km with hi-lo flight profile. The Russians employ the Yakhont in reconnaissance-strike complexes (RSCs - similar to integrated fires commands).

BrahMos A: Aerial launch version. Launch tests from Su-30MKI fighters are imminent.

BrahMos Army version: Features include terrain following capability. An IR seeker will be available for the Army version

BrahMos II: Air-launched hypersonic CM is approved for fielding. Expected speed is Mach is 5+.

A BrahMos shipboard launcher is in testing, and is due out soon, as is a sub launch version.

NOTES
BrahMos 2 is a concept for a future Indian hypersonic cruise missile with Mach 6-7 velocity.

Israeli Lynx Rocket/Missile Launcher with Extra and Delilah Missiles


Lynx Rocket/Missile Launcher Vehicle with LAR-160 rockets

Weapons & Ammunition Types	Typical Combat Load
Rocket/missile Modules	**2**
Grad-type rocket	40
LAR/AccuLAR rocket	26
EXTRA missile	8
Delilah cruise missile	2
Mixed loads on modules	½ each module

SYSTEM

Alternative Designations: Lynx is both the launcher module which can fit on various mounts, and the Israeli launcher vehicle name.

Date of Introduction: By 2007. Delilah cruise missile used in combat in 2006.

Proliferation: At least 3 countries. Two others are testing versions of the system and adaptations of rockets and/or missiles. Others are looking at adopting TCS to their MRLs.

Description: Because the launcher can launch a variety of rockets (122 mm of various, 160 mm Israeli LAR, with or without TCS), and either EXTRA or Delilah-GL missiles, it is likely that the primary munition mix will depend on organization level of the launcher. If it is at tactical level, it is likely to be used primarily to launch rockets, with a few maybe designated for EXTRA missiles. Those launchers at the operational/strategic level are more likely to launch missiles, and perhaps AccuLAR (LAR-160 with TCS) rockets.

Primary Components:
Transporter-erector-launcher (TEL) and Mobile Command Post (MCP) van. Reload modules will be transloaded at a TL point from a transloader truck with four modules, to service two launchers.

ARMAMENT
Transporter-Erector-Launcher
Name: Mercedes 3341
Crew: 3
Chassis: 6x6
Range: 500 km (estimated)

Protection:
Armor Protection: None. The LAROM and perhaps other variants are armored.
NBC Protection System: INA

Launcher Performance
Land Navigation: GPS/inertial
Missiles per launcher: See the Loads above. They can use separate loads on the 2 modules (or launch pod containers, LPCs).
Total Emplace Time (min): 5
Reload time (min): 20

AMMUNITION
Name: **LAR-160 Rocket**
Type: Composite solid-propellant
Range (km):
  Max. Launch Range: 45
  Min. Launch Range: 10
Rocket Speed: 1,022 m/s
Dimensions:
  Length (m): 3.48
  Diameter (mm): 160
Weight (kg): 110
Warhead options: Frag-HE/PD or DPICM with time-fuze dispense

OTHER AMMUNITION

GRADLAR: Israeli upgrade package with improved FCS converts MRLs for modules of 122-mm Grad rockets and 21-45 km range. Any type of Grad 122-mm rocket can be used.

LAR-160 or LAR: 160-mm rocket (13 per module) with a 45-km range. The warhead is a canister; to carry Frag-HE, sub-munitions, or any 155-mm round.

Guided Rockets and missiles on Lynx and other MRLs/TELs can use the **Trajectory Correction System (TCS)**. TCS can control >12 rockets/missiles equipped for Inertial/GPS guidance, vs 12 separate targets. Accuracy is 10 m. India tested **TCS** on the Pinaka MRL, and uses it in the recently tested Prahaar SRBM.

AccuLAR rocket is a GPS fuzed variant of LAR-160, with 14-40 km range and 10 m CEP). At least 4 countries use these rockets.

EXTRA (Extended Range Artillery): The 300mm ballistic missile (4/launch module) ranges 150 km with a 10-m CEP. It has a 120-kg payload, and flies a ballistic trajectory, corrected with GPS. Various warheads are offered.

Delilah: This cruise missile has a length of 3.2 m, weighing 230 kg. It cruises at Mach 0.3-0.7, and 8,600 m altitude. It can be launched from ships, aircraft, and the lynx ground launcher (GL) to 250 km, with programmable guidance, and multiple waypoints. **Delilah-GL** has launch assist. Air, ship, and helicopter versions are offered. The missile uses GPS homing, or can loiter and use a CCD/FLIR seeker to home to target.

VARIANTS

Lynx is both a vehicle, and a launcher to fit on vehicles. Ground launchers include tracked armored vehicles and 8x8 trucks. Israel markets the Lynx 6x6 truck (above). But the launcher fits on other user-preferred chassis. Other user countries have licenses for the conversion. Many of the customers have substantial supplies of 122-mm rockets.

Azerbaijan Lynx: Indigenous MRL/missile TEL with Lynx launcher on 8x8 Kamaz-6350 truck. With autonomous FCS, it launches 122/ 160 mm rockets, or EXTRA ballistic missiles

Naiza: Kazakh import/production MRL with Lynx for LAR-160 on Kamaz truck.

LAROM: Romanian 2-module MRL can launch 122-mm Grad or LAR-160 rockets

NOTES

The LAR-160 rocket offers a lethal effects area per rocket of 31,400 m^2. With TCS (e.g., AccuLAR), rockets perform a pitch-over for top attack and an optimized circular pattern for Frag-HE warhead effects or sub-munitions. Thus, AccuLAR rockets should have even greater lethal effects.

Other Options for Land-Attack

The overall decline in military budgets is likely to restrict the number of high-technology cruise missiles for land-attack to strategic and operational-strategic systems. For operational level, newer and lower-cost technologies such as semi-active laser-homing (SAL-H) and fiber-optic guidance (FOG), coupled with preprogrammed inertial/GNSS navigation, offer more precision long-range strike systems for forces with somewhat constricted budgets. Examples are *Nimrod* and *Hermes*. These systems are extensions of ATGM technologies, but with fire control mechanisms which resemble those of precision-guided artillery (see Vol 1, pgs 6-72 to 75). An example of a bridge system is the Israeli Nimrod 3 (SAL-H), which is listed with the NLOS ATGMs; but its range (55+km) places it in the same range band as precision guided artillery. Better-equipped forces (Tiers 1 and 2) have some AT units for long-range AT strikes, and perhaps in artillery units in the Integrated Fires Command (IFC), against high value targets. A Russian counterpart is Hermes SAL-H missile (initially 18 km) also listed with NLOS ATGMs. By Near Term it will range 100 km, for strikes against deeper high-value targets and guided by UAVs with laser target designators.

Another type of affordable technology cruise missile has emerged—the attack UAV. UAVs differ from cruise missiles in that an operator can guide the aerial vehicle, using its downloaded camera view and ground station controls. Most early ones used less precise pre-programmed inertial guidance, but with camera guidance for a precise hit-to-kill terminal phase. High UAV costs delayed fielding for these attack UAVs. However, the difference has become more discrete with with GNSS-based route programming on the approach and return phases to reduce operator fatigue. Thus the UAV operator can focus his attention to the attack phase. Most attack UAVs (see pg 3-15) use less precise programmed guidance than CM (e.g., the Italian/former Iraqi Mirach 150), since they have camera guidance for a precise hit-to-kill terminal phase. As systems have become more robust, recent attack UAVs now offer precise GNSS, with capability for dozens of waypoints and capability for immediate changes, better-stabilized camera guidance, and IIR or MMW radar-homing for the terminal phase, similar to CMs. High UAV costs similar to CM may limit their fielding. Still, modern CM like Israeli Delilah offer programmable navigation and camera view guidance for the terminal loiter/attack phase, similar to most attack UAVs. More successful were ***anti-radiation missiles (ARMs),*** such as Harpy (pg 5-13), special-designed to destroy high-value radar targets.

New technologies and a continued requirement for unpiloted deep strike systems have accelerated R&D activity offered new attack systems. Smaller, more effective, and less costly systems are available. They can be separate weapons, canister/MRL launched, or dispensed from bus UAVs as munitions/submunitions. Some use GNSS phase, camera guidance, and IIR or MMW radar-homing terminal guidance, which will blur the lines between attack UAVs and CMs. Recently, UCAVs as ordnance delivery platforms have been fielded (such as Hermes 450 with Mikholit missiles, see pg 4-18). New longer-range NLOS ATGM systems (see Vol 1, pg 6-75) can also serve in the role of cruise missiles. These, attack UAVs and UCAVs will compete with CM for most battlefield targets to a range of 200 km.

The potential for adaptation of new technologies into attack UAVs or ***LACMs*** strains current paradigms for weapon system boundaries. Artillery rocket launchers can launch course-corrected (or maneuvering) rockets or missiles. The Russian *R-90* reconnaissance UAV demonstrates the viability of such a vehicle for future attack variants. Russian developers also have demonstrated a niche capability, claiming that SA-11 variant (Buk-M1 and Buk-M1-2) SAMs can be used to attack high-value ground and sea targets. Modern LACMs, as well as adaptive applications such as the ones noted, can bridge requirements of ATGMs, artillery, SAMs, and TBMs for OPFOR deep attack.

Selected Non-Ballistic Land-Attack Systems

System Name	Producing Country	Proliferation (countries)	Type Launcher	Propulsion	Range Min/Max (km)	Guidance	Accuracy (m)	Warhead Types	Payload (kg)	Comments
Nimrod Nimrod 3	Israel	At least 3	Tracked veh or TUV	Missile motor	0.8-26 0.8-55	Semi-active laser Inertial mid-course	Home to beam (1)	HEAT (800 mm)	15 kg warhead	Dive attack Requires laser designator
Mirach-150 UAV (poss)	Italy, Iraq	At least 5	Ground veh ramp	Turbojet	up to 470	Radio and pre-program	INA	HE est	INA	Attack version of recon UAV
Polyphem/ TRIFOM Polyphem-S (Naval) Triton, torpedo based	Consortium France Germany Italy	In final testing in 2002	Ship, MRL-type, Truck, TUV/ATV	Missile motor	60 TRIFOM 100 future Triton 15	Fiber-optic Infrared. Pre-program mid-course phase	Guide to target (1)	HEAT + Frag/HE	20-25 kg warhead	. ATGM version expected. Concept for remote launch canister and TV control link
Brahmos and Yakhont	India Russia	At least 2	Truck, ship, FW (due)	Ramjet	290	GPS/Inertial	<20	Frag-HE	250	Supersonic
R-90	Russia	1	MRL	Rocket	90	Camera	.5	HE		Adjust fire, BDA
Harpy	Israel	At least 5	Truck	Rocket	500	GPS, Radar	1	Frag-HE	18-22	
Delilah	Israel	At least 1	Truck, ship, FW	Turbojet	250	GPS/Inertial	1	HE	30	Waypoints, loiter

Chapter 6
Air Defense

The increased effectiveness of aerial systems in modern warfare continues to drive a corresponding commitment for most forces to improving air defense forces, tactics, and technologies to counter them. Air defense is organized to address all capabilities of adversary aerial systems which can be used against a force. In addition, AD is integrated with other units (Infowar, tactical units, ground RISTA, and aircraft units) to counter aerial threats. The AD plan means a force-wide strategy with active and passive all-arms counters, first to negate the effects of aerial systems, and second to destroy aerial systems when possible.

Air defense engages the array of systems including: fixed-wing and rotary-wing aircraft, ballistic and cruise missiles, unmanned aerial vehicles (UAVs), unmanned aerial combat vehicles (UCAVs), air-delivered munitions (such as missiles, rockets, bombs, etc.), ground-launched rockets, and airships. For nearly a century, as developers of aerial systems developed new capabilities, AD developers responded with new tactics and technologies to counter them. In turn, aerial forces responded to the AD. Both sides of this antagonistic struggle continue fielding new technologies, counter-tactics, and countermeasures, even counter-countermeasures.

The AD forces are finding new ways to integrate those changes with more aggressive planning and organization. AD requires integration of separate functions: reconnaissance, target acquisition, C^4 and battle management, and target engagement – often with those assets separated by several kilometers. Assets for each can be vulnerable to physical attack, with links vulnerable to Infowar deception. Thus, AD forces continue updating mature systems and fielding new ones. As with aerial threats, AD is finding new missions and new approaches for success.

In this struggle, the aerial forces are generally the aggressors, because of their ability to move and strike in any terrain. Key capabilities for modern aerial assets must be addressed. The most challenging are traditional ones, but with new and greater technologies. They are:

- SEAD, for AD destruction, and Infowar attack (including jamming and cyber-attack).
- Surges, with multiple aircraft, multiple types of systems, and multi-aspect approaches,
- Strikes, with improved precision surveillance (satellites) and weapons (ballistic missiles),
- Stealth, in aircraft design, UAVs and UCAVs, and use of terrain flight profiles.

Air defense depends on efficient C^2 for responsive, integrated, and survivable counters to enemy aerodynamic weapons. Because of increased threats from stealth, surges during air operations, aerial long-range weapons, and ***suppression of enemy air defense (SEAD)***, more forces are using improved C^2 to form ***integrated air defense systems (IADS)***. However, the increased challenges to air defense C^2 also require ability operate autonomously or in small units.

Key aspects of AD effectiveness against surges are: use of redundant overlapping systems with varied C^2 and RISTA nets, digitally linked and autonomous batteries, increased responsiveness, increased missile loads, and improved missiles for single missile kill per target. Modern battle management centers in IADS can de-conflict targets and maximize AD effects.

Sensors are a critical component of AD systems, since they perform surveillance and tracking functions against fleeting targets. Radars have dramatically improved, and receive the most attention among AD sensors. But increasingly, acquisition packages use multiple sensors, including acoustics, electro-optics, etc. In recent AD weapons, radars are integrated with passive sensors, such as optics, electro-optics, TV cameras, night vision sights, auto-trackers, and laser rangefinders. Throughout the force, air approach/attack warners are used, and may be linked with MANPADS. Night sights are now common on weapons such as machineguns and MANPADS.

Weapons trends focus on guns and missiles, e.g., fitting both onto one chassis. Guns and missile launchers are increasingly more mobile and reliable under all conditions. They are becoming better integrated for responsive operation at AD brigade, in small units, and down to the single weapon. Most systems have onboard C^2 and passive electro-optical (EO) acquisition systems which permit them to operate precisely and autonomously.

AD systems will counter strike capabilities which could threat both SAMs and launchers. Improved LRAD and MRAD SAM systems feature increased velocity and acceleration, high-G turn capability, and precision for use in ballistic missile defense (BMD). SHORAD systems include the use of high velocity missiles (HVM), which can intercept high-speed anti-radiation missiles (HARMs). AD use of low probability of intercept (LPI) radars and signature reduction technologies challenge the ability of aggressors to locate and engage the systems.

AD Forces are increasingly focusing on countering stealth capabilities. Many SHORAD upgrades are designed to counter low-flying helicopters using covert tactics and CM. New technologies include laser and radio frequency weapons, and hypervelocity kinetic energy missiles. Modern man-portable AD systems (MANPADS) can be found in lower-tier forces. Improved missiles with proximity fuzes can fly lower to kill helicopters flying at nap-of-the-earth. New munitions such as frangible or electronically fuzed rounds increase gun lethality. Modular missile launchers and remote operated guns can transform vehicles or towed chassis into AD systems. MANPADS launchers can mount on vehicles with improved sensors and C^2 links for robust AD support. Upgrade sensors and weapons can rejuvenate older AD systems.

New missile systems with multi-spectral nets and robust phased-array radars are being used to better detect stealth aircraft. Older early warning radars and newer IW passive RF systems are being linked into IADS in the effort. AD aircraft, nets with substantial numbers of aerial observers, unattended sensors, and nets of modern infrared sensors are used in this effort.

The priority for countering air threat applies force-wide. Most OPFOR weapons and sensors, including infantry and vehicle guns can engage helicopters and other AD targets. Thus the acronym AD, rather than AA (antiaircraft), applies. New weapons, munitions, and sensors can engage small UAVs. More weapons are multi-role or air defense/antitank (AD/AT). All machineguns can be used for AD. The OPFOR mixes legacy systems, improvised weapons, and recent equipment to improve AD across the AO. Modernization trends cover all aspects of the AD network, including short-range air defense (SHORAD), and long-range AD (LRAD).

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Air Defense Command and Control and RISTA

Portrayal of combat systems capabilities in training simulations is never exact, and often may display serious limitations which hamper realism. Portrayal of air defense is particularly challenging, because effective AD requires timely and effective integration of weapons, support assets, and C^2, and skillful planning. Budget constraints, hardware, and other limitations can impact portrayals. The OPFOR is required to be ***reasonable, feasible, and plausible***. These priorities equally apply in OPFOR air defense systems portrayal. The following describes OPFOR air defense technologies and capabilities to be addressed in training simulations.

Responsive, efficient, effective, and survivable air defense requires effective C^2 in weapons units and the IADS. Flexible and integrated C^2 is particularly difficult to portray in simulations. These divergent priorities are in conflict. The AD system must link weapons with sensors. It begins with the individual air defense system, with the fire control system providing autonomous C^2. Increasingly, forces are providing autonomous capability for AD systems.

Many forces are producing mobile AD battle management centers. At the tactical level, they are in armored command vehicles (ACVs) for AD batteries and battalions. Tier 1 and 2 AD units have ACV/radar vehicles (e.g., Sborka). They can also be used in separate batteries plus link to the IADS. A modern ACV can receive, process, and pass a message in seconds (roughly 15, 4 for digital links), with parallel multi-function processing and multiple addressees (6-12). Older ACVs, e.g., PPRU, use analog voice and/or digital data links with longer processing/ transmission times. An IADS with analog C^2 is still an IADS, but may be a less responsive one. An IADS is physically dispersed for autonomous action, yet operationally integrated as required.

Air defense organizations balance capability with survivability by managing an array of sensors to provide full 360° coverage, surveillance in depth, with long-range assets supported by mobile reconnaissance assets and overlapping search sectors. The system requires: centralized linkage of various gun, missile, and gun/missile units, and coordination with AD aircraft units. Units will be relocated and re-assigned to prevent gaps in coverage. Airborne warning and command systems (AWACS), and other airborne air defense assets (aerial patrols, etc.) will be used. The IADS integrates AD nets and links them with other RISTA nets (air, ground recon, artillery, etc.) to fuse the battle picture, cue AD assets, and warn of approaching aircraft throughout the force. An IADS provides early warning (EW), assures that weapons resources are efficiently assigned to service all targets at the maximum possible stand-off, and reduces delay for vehicle halt and weapon response time. It also provides target acquisition (TA) data during jamming, avoids fratricide for aircraft operating in the area, and reduces redundant fires.

Missions are netted through the IADS with battery/battalion radars, command posts, longer-range radars for battle management at brigade and above, and various other sensors (acoustic, infrared, TV, visual, and other technologies). Modern EW units use long-range radars located behind the forward area to see for hundreds of miles, and use radar signal parameters to reduce jamming and terrain restrictions. These radars feed approach warnings throughout the net, so that most AD systems can operate passively and not reveal their locations until the moment of engagement. They help facilitate AD ambushes, by transmitting aircraft locations and allowing weapons radars to radiate only at the last minute, when air targets are within range. Many SAM systems can use the IADS digital feed instead of their radars, for passive operations.

The primary detection and acquisition system for air defense units is radar. Radars can more easily detect and track aircraft with less operator input than other sensors (e.g., EO sights). Radars are usually categorized by function; and functions usually correlate to certain frequency bands. Older early warning (EW) radars generally operate in low frequency bands (A-E), for longer detection ranges. They can track targets and cue precision sensors to support an IADS.

Air Defense Radar Bands in the Electromagnetic Spectrum			
NATO Band	US Band	Low-End Freq (GHz)	Wavelength
A		0.0	
B		0.25	Decimetric
C		0.5	
D	L	1	
E	S	2	Centimetric
F	S	3	
G	C	4	
H		6	
I	X	8	
J	Ku	10	
K	K, Ka	20	Millimetric
L	L	40	
M		60	
X		8-12	

The AD units employ a mix of radar systems operating at different frequencies, in varied intervals, with some radiating while others surveil passively. More mobile radar systems are being fielded with ability to quickly employ radars or operate radars while moving. Target acquisition (TA) radars are used to acquire aerial targets (and assign them to the fire control system for launch) often operate in I and J bands. Other bands offer precision and range while undetectable at scanned frequencies. Fire control (FA) radars (which track missiles and targets and direct weapons to target) often operate in H-J bands, but can operate in less detectible bands. Many more modern systems use dual-mode/multi-mode radars that can simultaneously perform EW, TA, FC or combination, with (automatic) target tracking during the engagement. For the OPFOR, unless air missions are scheduled, free-fire zones do not require IFF checks. Thus most OPFOR sectors are free-fire zones; and the OPFOR AD usually launches on first detection.

Radar performance is affected by technical factors such as: functional requirement (EW, TA or fire control), type (phased array vs continuous wave or pulse), operating paramaters (fan angle, power levels, operating time, frequency, etc), mount (stationary, mobile, missile mount on active homing missiles), target (radar cross section, countermeasures, speed, altitude, etc), and environment (curvature of the earth, terrain, weather, etc). Performance is also affected by tactical considerations by the target (aircraft dispersion, their use of stand-off weapons, etc), requirement for support systems, and survivability tactics for the radar (narrowing beam width, limited operation times, passive modes, frequent moves, etc.)

Increasingly, IADS also use passive sensor systems, such as acoustic-triggered unattended ground sensors, remote-operated EO systems with auto-trackers, radio-frequency direction-finders, and sensors operating in other regions of the electro-magnetic spectrum. Acoustic sensors include acoustic arrays, such as the HALO stationary microphone complex. They also include vehicle systems such as Israeli Helispot, with microphones mounted onboard or dismountable. Russian sound-ranging systems (AZK-5, -7, etc.) can detect helicopters. Links from nearby units (recon, maneuver, artillery, etc.) can also supplement AD sensors.

An affordable low-technology response to air threats is AD observation posts (OPs). Forward OPs can support EW radars, as well as AD OPs in tactical units. They can also include special purpose forces or civilian supporters near airfields or helicopter FARPs, who can engage aircraft or notify AD units. Assets may include day/night observation systems, remote IR cameras, acoustic sensors (such as sound-ranging systems), anti-helicopter mines, and MANPADS. In Tiers 1 and 2 they will use laptop computer terminals and digital links to pass data. Sensors can include man-portable radars such as FARA-1. These OPs use goniometer-based laser range-finders, GPS, and radios for precise location and warning, and rapid reporting. In Tiers 1 and 2, MANPADS operators have azimuth warning systems which alert them day and night to approaching aircraft. In lower tier forces, radars can be supplemented with forward OPs (perhaps with binocs, compass and radio) to cover defilade areas and masked areas of approach. In the Near Term, OPs will have micro-UAVs to detect and attack helicopters, or chase them off.

An IADS does not limit autonomous fires, rather provides early warning and reduces delay for vehicle halt and weapon response time. Because the enemy will attack C^2 nodes and detected AD radars, most AD systems and subunits must be able to operate passively and autonomously, with mobility and dispersion. It also provides target acquisition data for AD during jamming, avoids fratricide for aircraft operating in the area, and reduces redundant fires.

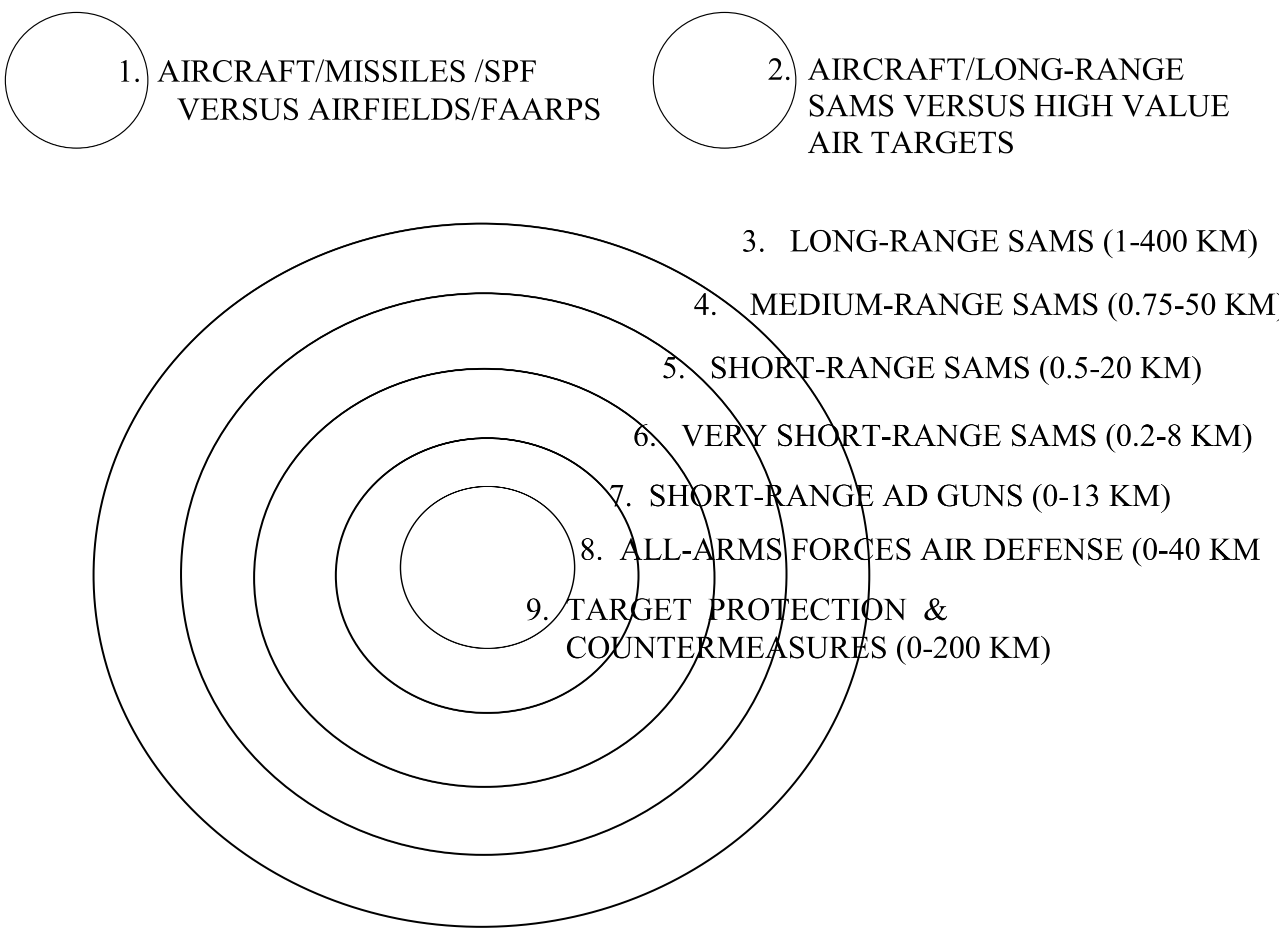
Most air defense systems have passive EO sights for use when radars cannot be used. They include TV day sights, infrared or thermal night sights, and target and missile trackers. Sights can have zoom capability with 24-50 + power, acquisition range equal to or greater than a radar, and minimum altitude down to the ground (0 meters). Range may be limited, however, by line-of-sight. Thus, EO range is comparable to a targeted aircraft's EO sensor acquisition range.

An IADS can operate as low as brigade level, with AD working in concert with other units and other echelons. Even when a formal IADS is not established, responsive and coordinated AD is possible. For instance FOs can notify AD weapons of enemy approach and direction. A Fara-1 radar can easily be mounted onto AD guns for day/night operation. Anti-helicopter mines can be used to cue AD ambushes. Innovations such as remote weapons and sensors, and portable digital FCS, are updating older AD weapons, permitting them to link to IADS. Battery ACVs such as Sborka feature EW/TA radars for RISTA and link to IADS.

Air Defense Systems and Domains

In modern warfare, the initial air operation is considered to be the critical component to success against modern enemy forces. That operation is expected to disrupt or destroy critical C3 nodes, exploit vulnerabilities in the air defense nets, and facilitate widespread aircraft and missile strikes against military targets. That operation would include stealth precision aircraft and missile strikes, and rotary wing aircraft flying low level deep strike missions. These would be generally conducted prior to entry of ground and naval forces, to facilitate early entry safely. In modern forces using aggressive planning, the air defense plan will be designed in detail to counter each aspect of the air operation. Thus, the air defense operation must begin prior to the air operation, to deny it success and insure integrity of the threatened forces and area. Air operation forces and air defense forces continue to see changes in plans, tactics, and equipment to counter the other's advantages, while operating within modern military budget constraints. A number of forces are choosing to reduce the size of costly fixed-wing aircraft, while increasing the sizes of theater missile and air defense forces, to deny adversaries air superiority. Trends noted on page 6-13 affect systems, fielding choices, and capabilities in all AD domains.

There are at least nine air defense plan domains, each with distinct missions, tasks, weapons, sensors, and phases in the air defense operation. Actions may require simultaneous effort in all nine domains. It is an all-arms effort involving more than just air defense forces. Range figures for these systems are general, variable, and changing, with range overlaps.



Deep Attacks in Domain #1. The plan calls for a combination of pre-emptive, reactive, and passive air defense measures being conducted simultaneously. Surveillance assets, especially forward observers, will be deployed around all potential adversary landing areas, including helicopter lighting points, to monitor activities. In the initial phase, and later as the adversary's aircraft reach forward locations, pre-emptive measures will be conducted by IW and deep-attack assests, to degrade the adversary's air operations before they even reach defended airspace. Forces will attack airfields and helicopter lighting points and FAARPs with air-launched stand-off weapons, ballistic and cruise missiles, and special purpose forces. At critical phases of the operation, they will disrupt satellite systems, attack adversary long-range surveillance assets.

Domain # 2. Generally, AD air and ground forces will attempt to engage and disrupt enemy air activities as early and distant as possible to decrease the chance for enemy air success. Air intercept aircraft and long-range AD (LRAD) systems will attack reconnaissance aircraft, AWACS aircraft, SEAD aircraft, and bombers. Because of curvature of the earth limitations on SAMs, aircraft will operate at altitudes below the minimum altitudes of the SAMs, at ranges of 250 km, or more. Special nets of radars and passive Electronic Support (ES) systems will be created specifically for detection of stealth aircraft and cruise missiles, flying at lower altitudes.

The AD plan includes flexible prioritization of AD systems to deal with key events, such as enemy surges, ballistic missile and cruise missile strikes, and AD forces to survive air and SEAD operations, and ground forces attacks. The two main deployment priorities are site defense and area defense, and they activate as targets come into range. Forces hold out a portion of LRAD/MRAD launchers for site defense against ballistic missiles. Even when aircraft reach the range of MRAD systems, LRAD may service targets while MRAD SAMs conduct AD ambushes, monitor the IADS, and use passive electro-optical fire control systems (FCS).

Long Range Air Defense (LRAD) Systems. These SAMs (pg 6-74) include Russian and Chinese missile systems, e.g., SA-5, SA-10, SA-12, SA-20b, SA-21, SA-23, and HQ-11. These upgraded and new systems are networked with long-range early warning radars and electronic support measures (ESMs) to form the base for operational IADS. In the past, the size of the missiles limited them to selected roles, like counters to high priority aircraft (Domain #2), long range defense versus small formations (Domain #3), and anti-ballistic missile defense of high priority sites (Domain #9). However, several LRAD systems are being modified to fit canisters of "small missiles", to counter surges and all air targets in the other domains (#4-8) as well.

A wide variety of RISTA assets, including forward observers, other HUMINT and RISTA systems support AD operations. Early warning systems have lost appeal in certain AD circles, but are still useful. They operate in low bands outside of bandwidth of most radar detection systems, and have long detection ranges. Many are being modernized with multi-target precision tracking, and digital transmission and display systems. As aircraft approach the range of AD weapons, they are acquired by EW radars, which conduct IFF queries and feed intelligence to the Integrated Air Defense Systems (IADS). There is one overall IADS for the force. But other overlapping area and AD brigade IADS are used, in case the central IADS is defeated by enemy SEAD. The IADS battle management center will select target acquisition radars to conduct surveillance and track targets, update the plan, and assign new targets. New phased-array TA radar and battle management systems have interface and networking features to form autonomous IADS, and autonomous firing units down to the battery level, and challenge SEAD and evasive aircraft tactics. As aircraft approach the targets, noted at 9, they have entered engagement zones of not one, but many types of AD systems and RISTA nets, each linked to the IADS and its RISTA nets. Thus, they are detected by multiple radar frequencies, ground observers, vehicle EO/IR acquisition systems, sound-ranging assets, and AD Infowar (IW) assets. Although the diagram depicts concentric circles with a single epicenter, defended forces are arrayed throughout the area; and multiple MRAD/SHORAD epicenters and assets overlap.

Medium-Range Air Defense (MRAD) Systems. Most MRAD systems in Domain # 4 (pg 6-66) are Russian, e.g., SA-3, SA-4, SA-6, SA-11, and Buk-M1-2. Some are highly mobile, can move with ground forces and challenge air surge capabilities of expected adversaries. Because of their high cost which approaches that of LRAD, most MRAD systems in use are older. But a number of users are updating them to approach modern capabilities, to counter short-range ballistic missiles, cruise missiles, stealth aircraft, and low-flying helicopters. Other countries are looking at the possibility of adapting LRAD systems to handle surge requirements and reduce the need to upgrade or produce MRAD systems. Other forces, e.g., Israelis (Spyder), Italians (Aspide 2000), and Indians (Akash) designed systems, some more affordable and mobile.

Short-Range Air Defense (SHORAD) Systems. These SAMs in Domain #6 include a wide array of systems produced and exported throughout the world. Leading producers include China, Russia, U.S., and European countries. Many have been upgraded. Although they include semi-mobile towed systems, most are vehicle mounted, and can be brought into action from the move in 0.5-5 minutes. Many can move with supported maneuver forces. Others cover critical assets which are likely air targets. Some are assigned to cover areas with defilade terrain and man-made features which could approaches by aircraft flying contour or nap-of-the-earth (NOE) profiles. These systems have substantial missile inventories to respond during enemy surges. Many modern SAMs are configured as gun-missile systems (5-17), to engage almost all aerial targets (including cruise missiles, UAVs, air-to-ground missiles, and helicopters flying NOE).

Very Short-Range Air Defense System (VSHORAD) SAMs. These systems in Domain #6 are also called Man-portable SAMs, or Man-portable Air Defense Systems (MANPADS). They can be dismounted; however, some vehicle systems have been developed, which use these missiles. A wide variety of upgrades are expanding lethality (including range) of these systems. In addition, multi-role missile systems (such as Starstreak, pg 6-55), are being fielded.

Very Short-Range Air Defense Guns. AD gun systems (Domain # 7) are not as widely used as in the past. Reasons for this include the limited effective range of most guns. Although gun range is noted as out to 13 km (KS-19M2 with radar, pg. 6-42), most AD guns are effective at ranges of 4 km or less. A lot of forces upgraded those guns by merging guns and missiles systems in gun-missile systems. Some forces still field new self-propelled AD guns. Substantial upgrades (pg 6-31 to 39) have increased effectiveness and utility of most weapons.

All-Arms Forces Air Defense. Modern forces proliferate weapons (especially machine guns) for self-defense, especially versus air threats (see pg 6-33). Ground and air responses to air threats include more medium guns, improved AD munitions, and more responsive missiles and FCS.

Target Protection and Countermeasures. Developments in Domain #9 include use of CCD technologies and tactics, as described on the next two pages, and in Chapter 9.

Aircraft Survivability and Air Defense Countermeasures

Modern forces focus much attention to protecting aircraft during air operations, through a blend of tactical measures and technical capabilities, which are collectively known as ***suppression of enemy air defense (SEAD)***. Separate SEAD aircraft and IW assets are engaged in locating, AD assets, jamming AD C^2 and RISTA assets, and attacking systems in the AD network. Often SEAD aircraft will accompany FW and helicopters in carefully coordinated air missions. In addition, modern tactical aircraft and supporting aircraft can be equipped with aircraft survivability equipment (ASE) to countermeasure incoming AD missiles.

The OPFOR, like most forces in the world today, have developed technologies and tactics to counter ASE and SEAD. The first priority for AD effort is always force survivability. The OPFOR knows that SEAD usually facilitates other aircraft conducting missions; thus air protection measures are addressed in all units and at all levels. These include a network of air warning receivers to sound air alerts down to battalion level and below.

The most common and challenging air threat is probably from helicopters, because of their proliferation, and their ability to use concealed approaches. Also, they may directly engage AD assets early in the air operation. Helicopters will use terrain and cover to mask their approach, with terrain flight modes (low level, contour, or nap-of-the-earth - NOE). The OPFOR conducts an intelligence preparation of the battlefield (IPB) early on to determine routes, and assign OPs, sensors and on-call AD weapons to cover areas which offer concealment. Air defense priorities are engaging all aerial targets primarily, and countering SEAD secondarily.

Selected Air Defense Tactics Used to Counter Air Attacks and SEAD Operations

Considerations	Examples
Protection and Countermeasures	Use concealment, mixing with civilian sites and traffic Use cover (dug-in positions, hardened facilities, urban structures) Disperse assets and use autonomous capabilities Relocate frequently Use protection envelope of friendly forces Deception operations for convoys, crossings, etc.
Tactics	AD conduct bounding overwatch during movement. Air defense ambush with passive mode (EO, radars turn just at launch) Direct attacks against AWACS, SEAD aircraft, airfields, and FARPs Engage SEAD/ASE aircraft from an aspect outside of the jamming arc Conduct beyond borders operations against air capabilities.
RISTA	Use intelligence preparation of the battlefield - approach routes, etc Passive radar and EO modes. Use IADS links for TA data. Emissions control measures Utilize civilians and insurgent links. Use lots of OPs linked to AD units, including forward-based SOF, etc. Employ non-AD sensors and units available to feed reports to IADS.
Command and Control	Mobile, redundant, concealed systems Comms OPSEC measures
Weapons	Engage aircraft, air-to-surface missiles, and ARMs beyond their range Prepare all weapons to respond to aircraft. All units conduct air watches with weapons at ready at all times

Airborne SEAD and SIGINT operations and technologies include radar acquisition systems, radar jamming assets, and anti-radiation missiles which can home on and kill radars compel AD units to acquire more robust even longer range radar systems, and to more carefully manage radar assets. The OPFOR will use equipment and tactics to degrade SEAD effectiveness, deceive it, and attack SEAD directly. Some of those responses are listed below.

Selected Air Defense Technologies Used to Counter SEAD Operations

Technologies	Examples
Command and Control	IADS, directional comms, SATCOM, retransmission systems, etc. IADS links to artillery, recon, maneuver units, SOF, etc. Digital comms with reduced response time. Mobile, redundant, easily concealed systems
Radars	Low-frequency long-wave early warning radars (50-100 km setback) Low Probability of Intercept (LPI) radars (frequency, power control) Multiple-mode, multiple frequency, frequency-agile radars Phased array radars and guidance modes that negate jamming Counterstealth radars and passive sensors integrated for fast response Aerial radars on helicopters, UAVs, mobile airships, with retrans links Mobile radar systems for frequent moves, or operation on the move
Other Sensors	Sensors using passive modes (EO, IR, acoustic, other bands) Mobile goniometer based fire control sets with GPS and digital comms Remote sensors, unattended ground sensors, linked to AD nets. Remote IR and EO cameras (Sirene, ADAD), and on UAVs/airships
Weapons	SEAD-resistant missile guidance modes (semi-active radar homing, active radar homing, track-via-missile, laser beam rider, etc.) Home-on-jam missiles attack AWACS, SEAD, ASE (Aspide, SA-5) AD missiles can destroy ARMs and HARMs (Pantsir, SA-15b) Responsive autonomous or battery AD weapon systems (SA-11, 2S6) Passive guidance, e.g., IR-homing or EO FCS (Mistral, GDF-003)
Countermeasures	Encryption and secure comms modes Decoys: corner reflectors, multi-spectral, bridge mock-ups, etc, Electronic Warfare: SIGINT/ELINT, GPS/fuze jammers, deception

Most units operating in flight paths are subject to air attack and use active measures to respond to air threats. Dismounted infantry units will have AD OPs and will engage aircraft as required. Any AD weapon can alert its ACV and the IADS net of spotted aircraft. Of course the delays from transmitting reports through these links should be considering figuring response time (15 sec Tiers 1 and 2, 30 for lower for each message link from observer to AD weapon).

To counter the helicopter threat, a wide variety of tactical and combat support vehicles have MANPADs/MGs with AA sights to engage aircraft. Two greatest advantages for helicopters are weapons stand-off, and ability to use terrain cover on approach. Many ground force and AD weapons can match the stand-off, and inflict damage to force aircraft to disengage. When flying NOE (20-25 ft from the ground), a helicopter rotor is still 40 ft high. A helicopter terrain masking cannot easily engage targets or to evade missiles, but can be targeted by ground weapons. Nearly all SAMs, small arms and direct-fire crew weapons (ATGMs, ATGLs, AGLs, etc.), can engage it. ASE includes IR decoys which can be foiled by improved IR missile seekers, and RF jammers with dead zones (and limited effects against modern radars).

Engagement Factors and Data for Air Defense Simulations

No simulation can predict or reflect reality; but a well-designed air defense simulation can be robust enough and detailed enough to represent reality. Air defense engagements offer a difficult challenge for realistic portrayal in training simulations. A simulation might be expected to depict robust and responsive RISTA assets executing the acquisition stages (detection, classification, recognition, and identification) with early warning and target acquisition/ battlefield surveillance radars, C^2 processing (report posting on battle management nets, analysis, tracking, target assignment, and shooter assignment), target engagement (TA radar, location and tracking), missile launches, probability of hit (Ph) data, and probability of kill (Pk) by type of kill calculation. Degrading factors can be factored into calculations: e.g., target type, evasive tactics, battlefield environment constraints, AD systems limitations, and AD counter-tactics. In the real world, RISTA capabilities are affected by a variety of factors, which can affect capabilities calculations by system, by class of system, and in various ways. Here are key ones.

Selected Factors Which Affect Air Defense Functionalities

Technologies	Factors	Data Entry
Sensors for Acquisition, EW, And Fire Control	System range	km
	Target tracking range	km
	Night range (EO sensors)	km
	Range to target	km
	Radar down time	min
	Radar search sector (horizontal/vertical from mid-line)	degrees
	Radar altitude	km/m/ft
	Curvature of earth range limiter (based on sensor and target altitudes)	max km
	Terrain feature effects on line of sight (LOS) (limiter which interrupts LOS)	km
	Aircraft altitude	km/m/ft
	SEAD/aircraft ASE effects (sector of scan)	km x km
	Counter-SEAD capabilities (0 % degradation)	0 %
Command and Control (C^2)	Report time (x number of links)	min
	Report-processing time (x links)	min
	Authorization to fire	Yes/No
	IFF time	sec
	Target assignment time	sec
Weapons	Missile/gun effective range	Km
	Number of missiles/rounds per target	# x Ph
	Missile/gun minimum altitude	m, or band
	Weapon reaction time	sec
	Area of munition warhead effects (range and altitude)	m or Ph
	Aircraft ASE against missile seeker (degrader x Ph)	%
	Munition ASE CCM capability (0 % degradation)	%
	Ph against target types (RW, FW, ASM, UAV, TBM)	type/name
	Pk-Mobility, Firepower, Comms, Catastrophic, etc	type/name
	Munition approach/impact aspect vs target (if needed)	Ph
Target Effects	Target flight altitude, speed, range, etc	m, km, etc.
	Target countermeasures and counter-tactics	Ph factors

Many AD data adjustment factors are expressed in range or altitude, which can be used by the simulation to match AD system to target. Some of the factors (or degraders, such as LOS or ASE) can then adjust the capabilities. For time-based capabilities, degraders (such as report time) are critical considerations that can affect the likelihood of AD engagement within the time span of aircraft approach, while the aircraft is still outside of range for ordnance delivery.

Capabilities of AD weapons to engage, hit, and degrade aircraft physical viability, and effectiveness are expressed in various data. These include range, altitude, and time (noted above), and probabilities of hit and kill. Once target and shooter are within geospatial and time windows, with authorization to fire, the key data are probabilities of hit and kill.

Probability of hit can be affected by many factors (as noted in the table above). Sources vary widely in Ph data for the same systems. Often a range is listed, such as 40%-96%, without clear explanation of calculation criteria, and with many detection variables rolled in the figures. Russian sources often state their figures as "single shot kill probability", combining hit and kill in one figure (Ph x Pk). The Ph figures noted below in the WEG for missile systems are averages based on probabilities at all aspects, within operational ranges and altitudes, and against aircraft in noted classes (usually FW and RW). Different fixed-wing (FW) and rotary-wing (RW) aircraft will have different radar cross-sections, IR heat detection levels, and different Ph levels. Other aeronautical targets, such as UAVs, cruise missiles, air-to-surface missiles, and theater ballistic missiles will have different Ph figures by type, system, and aspect. The simulations should use the Ph in the WEG as a single figure for the technical capability. Degraders such as factors noted in the above table could then be applied for use in the simulation. Often AD units will launch multiple missiles at a target. Two missiles will have greater Ph, possibly 2 x one Ph.

Developments in missile seekers and guidance and gun ammunition technologies are greatly improving probabilities of hit for AD weapons. One of the most deadly AD missiles to threaten modern aircraft is anti-radiation missiles which home in on an aircraft's ASE or SEAD radar jammer. Another modern AD missile capability is active radar homing missiles, which cannot be easily counter-measured. Both missile types have a higher P-hit. The Starstreak MANPADS system offers another new step in missile precision and countermeasure resistance, with laser beam-rider guidance. Starstreak has a very high Ph against less maneuverable aircraft, especially helicopters conducting terrain flying such as NOE. Some modern AD guns now have rounds proximity fuzes, for higher Ph. Others fire rounds with AHEAD-type fire control system (a laser range-finder-based computer sets electronic time fuzed rounds, for precision air bursts).

Probability of kill (given a hit) can require even greater variety of figures based on type, system, and aspect, and by munition type or specific munition. Because those Pk figures require laboratory-produced data based on precisely determined conditions, they will not be noted in this publication. However, a few concepts can be noted. A missile with a proximity fuze and large warhead will have a large lethal radius, and a high probability of kill given a hit or detonation. For small missiles, partial kills have a greater probability than total (catastrophic) kills.

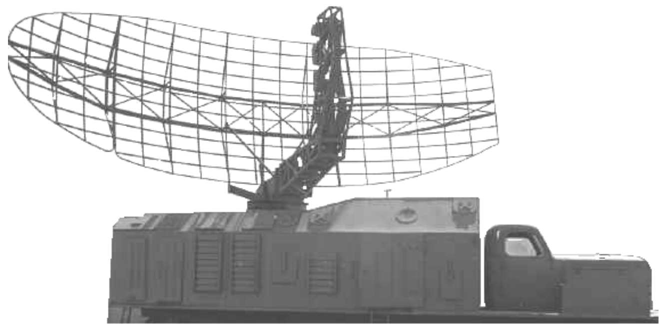
Dramatic improvements in AD weapon lethality are raising Pk figures. Increased use of HMX explosive has raised Pks. Frangible gun rounds fly like KE rounds, permitting better range and precision than HE rounds. But they shatter inside of the target, offering high explosive Pk figures similar to HE rounds. Some missiles (e.g., Pantsir and SA-18S) have frangible rods in their warheads. Others have multiple sabot penetrators and HE effects (3 x "darts" in Starstreak).

Air Defense Systems: Key Technology Trends

Aircraft upgrades and proliferation of other aerodynamic threats (cruise and ballistic missiles, air-delivered munitions, UAVs, etc.) have increased the aerial threat to military forces worldwide. Thus forces expanded their emphasis on all systems engagement of aerial threats or counters to those threats. Forces worldwide are fielding new air defense (AD) systems and upgrading legacy systems.

System Category	Technology Trend	Reference Vol/Page	System Example	Ref Page
Short-Range Air Defense (SHORAD) Systems	Missiles engage <1-20 km range, and 0-10,000 meters altitude	New pg	Pantsir-S1	5-30
	Radars integrated with passive electro-optical/thermal fire control	New pg	Crotale-NG	5-30
	High-velocity missiles engage aircraft, munitions, UAVs, and missiles	New pg	2S6M1	5-17
	Drop-in overhead turrets and remote weapons for AD vehicle systems	New pg	Strelets/Igla launcher	5-10
	Guns and missiles integrated into gun-missile systems	New pg	Zu-23-2M1	5-18
	Many missiles, most guns defeat all countermeasures		Mistral 2	
	New or upgrade robust shoulder-fired SAMs throughout the battlefield		SA-24/Igla-Super	
Medium-Range Air Defense (MRAD) Systems	Missiles engage 1-45 km range, and 0-25,000 m altitude	1/5-1	Buk-M1-2	5-27
	Tracked or wheeled with increased mobility and responsiveness	1/5-45	Pechora-2M	5-28
	Some systems mix MRAD and SHORAD missiles for high surge rate	--		5-27
	New autonomous launchers melded in old units to add more FC radars	1/5-29	SA-6b with Buk-M1	5-43
Long-Range Air Defense (LRAD) Systems	Missiles engage 5-400 km range, and 0-50,000+ m altitude	1/5-2	SA-21/Triumf	5-19
	Vertical launch and increased velocity against ballistic missiles	1/5-2	SA-21b/Samoderzhets	5-13
	Anti-radiation/radar-homing missiles defeat SEAD/AWACS/JSTARS	1/5-2, -61	FT-2000	5-14
	Launcher can add canisters of 1-120 km “small missiles” for surges	--	SA-20b/Favorit	5-11
C4ISR	Phased array/low probability of intercept (LPI) radars and more range		FLAP-LID B	
	Radars mounted on RISTA/weapons to operate and rotate on the move		Sborka-M1-2	
	Other RISTA sensors, e.g., forward observers, UGS, passive IR, IW			
	Integrated air defense Systems (IADS) across echelons and branches	5-2	Giraffe AMB	
	Autonomous unit and systems capability in a jamming environment			
	Redundant encrypted fiber-optic, wire, radio, and subscriber C^2 nets			
	IADS, FOs, and overlaps mean responsive AD even in high-jam areas			
Multi-role Systems	Multi-role (AD/AT) missiles, gun, vehicles, for AD and AT, etc.	5-4	Starstreak	5-
	EW and other Infowar add to RISTA and deceive/deny aircraft C4ISR	2-53	Orion	5-67
Other Systems for AD Use	All-arms AD weapons/munitions damage or defeat low-flying aircraft	12-9	12.7-mm/.50-cal MG	12-11
	Anti-helicopter mines or mines which can be used in the role	6-24	Helkir	6-25
	Airships in acquisition, jamming, or obstacle fields against helicopters	5-5		1-14
	Concealment or deception measures limit aircraft effectiveness	7-6		7-28

Russian Mobile Air Defense RADAR Vehicle LONG TRACK



SYSTEM
Alternative Designations: P -40. The name LONG TRACK is actually the radar.

Date of Introduction: IOC 1967
Proliferation: More than 35 countries
Description: Twenty-five foot high single conventional parabolic mesh reflector antenna with multiple stacked feeds that is vehicle mounted.

Chassis: A modified version of the AT-T heavy tracked transporter vehicle (426 U).
Engine: 465-hp diesel.
Weight (mt): 35

Automotive Performance: On/off road mobility is very good.
Max Road Speed (km/h): 55

RADAR
Functions: Surveillance, target acquisition, and early warning. LONG TRACK was the first highly mobile early warning radar.
Antenna: Elliptical parabolic. The antenna is folded for transport.
Auxiliary Power Unit: 400 Hz gen and gasoline engine

Frequency Band: E- band (UHF)
Frequency: 2.6 GHz
Sweep Rate (rpm): 12-15
Display range (nm): 200
Effective Range (km): 167
Tracking Range (km): 150
Effective Altitude (km): 30
Track Targets on Move: No
Emplacement Time (min): INA
Displacement Time (min): INA
Tracking Range (km): 150
Dead Time (min): 0
Max Targets displayed: >8

Associated SAMs: SA-4/GANEF, SA-6/GAINFUL, SA-8/GECKO
ADA Unit Level: Employed at division and echelons above division
The system is used in Tier 3 and 4 units.

Other Radars: The radar system links to the IADS to provide analog warning and to pass analog data.

VARIANTS
Polish **Jawor** (circa 1965) and Polish **Farm Gate** (Truck mounted).

NOTES:
By comparing results at various frequencies, the LONG TRACK can be used to detect stealth aircraft.

Russian Air Defense Armored Command Vehicle Sborka-M1 and Sborka-M1-2 _____

Sborka-M1 with DOG EAR radar

Sborka-M1-2

Weapons & Ammunition Types	Typical Combat Load
None	

SYSTEM
Alternative Designations: 9S80M-1, PPRU-M1. System is referred to as a "mobile aerial target reconnaissance and command post". Some sources incorrectly refer to DOG EAR radar as the name of the system.

Date of Introduction: circa 1989, with -M1 upgrade by 2000
Proliferation: At least 2 countries
Description:
Crew: 2 for vehicle
Troop Capacity: 5-8 Command and staff workstations or modules
Chassis: MT-LBu tracked vehicle, expanded variant of MT-LB
Combat Weight (mt): 16.1 est
Chassis Length Overall (m): 7.86
Height Overall (m): 2.72, with radar folded down
Width Overall (m): 2.97

Automotive Performance:
Engine Type: 240-hp Diesel
Cruising Range (km): 500
Speed (km/h):
Max Road: 60
Max Off-Road: 26
Average Cross-Country: 30
Max Swim: 5-6
Fording Depth (m): Amphibious
Emplace Time (min): 1-3

Protection:
Armor, Turret Front (mm): 15 mm
NBC Protection System: Collective
Smoke Equipment: Not standard

Command: Configuration for **r**ear compartment has 1-4 officer workstations, 3-6 communications/battle staff consoles, and one radar operator console (depending on vehicle role and echelon).
Command level: AD battery and battalion in mech and tank brigades
Associated AD units/systems: SHORAD systems (ZSU-23-4, 2S6, SA-9, SA-13, SA-15, MANPADS)
Target missions generated simultaneously: 1 or 2
Target alert simultaneous rate: 5-6
Number of weapons with automatic control: 6 separate weapons
12 with 2 per mission
CP can operate autonomously/in network: Yes/Yes
Number of sources which can generate targets: 6 plus Sborka
Encryption: Yes, E-24D
Digital navigation monitor: Yes, GPS, inertial and map display
Automated networks: Baget- 01-05 or -06 computer workstations

Communications:
Radios, frequency, and range:
3-6 x VHF with range 30 km (60 km stationary with mast)
2 x HF with range 50 km (350 km stationary with mast)
Note: Mast and dipole antennae for longer range optional.
Intercoms: 2
Other communications links: 7, including Integrated Air Defense System, brigade, and division for passive battle operations
Vehicle can communicate on the move: Yes
Data formats: Graphic and digital data transmission and display
Onboard generator: Yes
Whip antennae for mobile comms: 2 HF whips, 3 VHF
Other antennae: VHF discones masted, HF dipoles and 11-m mast
Digital link to 1L15-1 MANPADS azimuth plotting board: Yes

RADAR
Name: DOG EAR
Function: Target acquisition
Frequency: F/G band
Range (km): 80 detection
35 tracking 500m and higher
22 tracking targets flying 25-499 m
Targets display and simultaneous tracking: 63, 6 earlier version
Target processing to assignment and track: 1-step auto-track
Scan rate (s): 2-5, 30 revolutions per minute
Data Transmission rate (s): 4
Scan coverage (°): 360 azimuth (rotating antenna) x 30 elevation
Antenna scan rate (rpm): 30
Antenna horizontal pattern width (°): 5.5 lower plane, 1.6 upper
Clutter suppression (dB): 30 or more
Operating time max: 48 hrs, but usually use shorter on/off times
Acquire on the move: Yes

Other Assets: Links to Integrated Air Defense System (IADS) for early warning and target acquisition data in the air defense net. It is also used as the AD battery CP for AD units at division and below.

VARIANTS
An earlier version of the vehicle was PPRU-1/9S80/Ovod. **PPRU-M1** offers improved C3 and target processing for use versus a higher target volume. It shares the MT-LBu chassis with Ranzhir, MP-22 and other AD CP vehicles, but with different C3 equipment and the added radar.

Sborka-M1-2/PPRU-M1-2/9S80M1-2: The new variant has a solid-state radar. The radar is more compact and fits on a heavier mast for operation while moving. Thus set-up and displace times are near 0 sec. The radar is similar to the TA radar on the latest version of Pantsir

NOTES:
Units with tracked weapons use tracked CP vehicles (CPVs). Wheeled AD batteries can use these or PU-12M6 or PU-12M7 BRDM-2-based CP vehicles. Tier 1 or 2 units without onboard acquisition radars on weapon systems use Sborka for the radar. Sborka's radar can extend the range for systems with radars. Sborka C3 offers digital links, IFF, improved battle management, and redundant support for most of the systems. For independent or autonomous force missions, the vehicle can be equipped with a SATCOM antenna and radios to extend transmission range.

Swedish Air Defense Radar/Command Vehicle Giraffe 50AT and Giraffe AMB ______

Giraffe 50 AT

Giraffe AMB

SYSTEM
Alternative Designations: See Variants
Date of Introduction: 1992
Proliferation: Various configurations in at least 18 countries
Description: Radar has a broadband fully coherent traveling-wave-tube (TWT) transmitter, and a vertically polarized parabolic reflector antenna lifted on an elevating arm. Hydraulic elevating arm height is 13m, 7m for Giraffe 50AT and HARD.
Crew: INA

Data for Giraffe 50 AT chassis (Bv208)
Chassis: The most mobile systems are Giraffe 50AT and Hard, on a Swedish Hagglunds Bv208 All Terrain Tracked Carrier, with an articulated chassis. It is a diesel-engine variant of Bv206.
Weight (mt): 6.34, INA with arm
Length (m): 6.9, INA with arm
Width (m): 1.9
Height (m): 2.4 for chassis, INA with arm
Engine Type: 125-hp Mercedes Benz OM Diesel
Cruising Range (km): 330
Max. Road Speed (km/h): 50
Mobility: Off road mobility is very good on tracked chassis, off-road speed is slightly reduced due to arm.
Fording Depth (m): Amphibious; however, arm may affect it.

Associated AD systems: RBS70, RBS90, RBS 23/BAMSE, Stinger, Rapier, Mistral, AA guns, and any other air defense systems with compatible C^2 networks. Employed to support short- and medium- range firing units, AD, and coastal defense networks.

RADAR CAPABILITY
Functions: Surveillance, target acquisition and early warning. Vehicle is also AD battlefield management center for IADS.

Features: Radar is designed to operate in a ground clutter and ECM environment. Signal processor uses digital MTI Doppler processing, with current ECCM, such as automatic jumps to avoid jammed frequencies, and extracts jammer bearings from display. Radar has automatic target detection and tracking.

Giraffe 50AT Specifications:
Frequency Band: G-band, except for HARD (H/I-band)
Sweep Rate (rpm): Antenna rotates 60 rpm.
Effective Range (km): 50 km.
Resolution 0.1 sq m target (km): 20-25
Effective Altitude (km): 10
Low flying targets, up to 12 (in light of target resolution and aspect)
Fire Units Controlled/Targets simultaneously handled: 20
Track Targets on Move: No

Other Assets: Giraffe radars link to Integrated Air Defense System (IADS) for early warning and target acquisition in the air defense net. They fuse data from other AD and and non-AD units, to perform battle management at division and below. They also pass data to other units and IADS.

Giraffe AMB: System has an ISO modular container on a 10-wheel cross-country truck, with a 3-D monopulse phased array multi-beam radar on a 12-m mast. Frequency is 5.4-5.9 GHz, with capabilities of 100 km range, >20-km altitude. Low antenna sidelobes and frequency agility offer outstanding jam resistance. It can track over 100 targets simultaneously in the onboard AD battle management center. Emplace/Displace times are 10/3 min. Splinter and NBC protection for the cab.

VARIANTS
Giraffe 50: System featured above, with reduced detection and reaction time, and better clutter resistance.
Giraffe (PS-70/R): Original system for use with RBS70, with 40 km surveillance, 20 km target designation range.
Giraffe 40: Truck-mounted system for AA guns and MANPADS support nets.
Giraffe 75 (PS-90): Truck-mounted medium-range system, which can control up to 20 fire units.
Coastal Giraffe: Coastal defense variant.
Giraffe AD: Medium-range variant focused on ECCM and C^2.
Giraffe CS: Short-range and coast defense variant.
HARD (PS-91): Short-range variant on Bv-208 chassis. The H/I-band operating frequencies provide low probability of intercept (LPI).

NOTES
The AMB can be mounted in vehicle configurations, such as tracked vehicle, wheeled APC, or truck, and be ship- mounted. Fixed site versions are also available. The radar net alerts missile firers, and assigns sector on plotting boards within the sight units for RBS-70 and RBS-90 MANPADS.

Electronic Intelligence (ELINT) Support to Air Defense

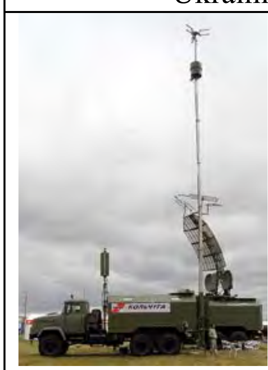
ELINT (or Electronic Support, e.g., ES) systems have been in AD forces for decades. They include specialized systems to specifically detect aircraft electronic emissions. General use ELINT systems to detect air, ground, and naval emitters can also be effective with AD forces.

These sensors offer key benefits, including: long range, and ability to operate passively, continuously (for days at a time). Thus they are well suited as early warning assets, particularly against aerial systems using radios, radars, or jammers. They can cue the IADS and use triangulation to locate approaching aircraft. Most systems use multiple stations and a control post; but an individual station could be data-linked with radars or other IADS sensors for location. ELINT systems are ineffective against stealth aircraft when the aircraft are not emitting.

Specialized systems include the Czech Ramona (aka KRTP-81 or -81M). The system was first seen in 1979 and deployed in at least 3 countries. It is complicated, with 3 or more stations with 12 hours to emplace, and locates targets by triangulation from the separate stations. The system is difficult to operate; but can track up to 20 targets emitting in a band of 1-8 GHZ. Tamara (KRTP-84) followed in 1987, mounted on a rapid deploying 8x8 truck chassis. With a band of 820 MHz-18 GHz, Tamara can track 72 targets to a maximum range of 450 km.

Modern systems include the Czech trailer-mounted Vera-E and Borap, Chinese DLW002 and YLC-20, and Russian Valeria and Avtobaza. Below systems are for both AD and EW units.

Ukrainian Kolchuga-M




SYSTEM
Alternative Designations: None
Date of Introduction: 2000 for Kolchuga-M
Proliferation: At least 4 countries. There are reports of sale to Iran.
Components for Complex: 2-3 vehicles plus control post
Crew: 2 at the receiving station, 3or 4 at control post
Platform: 6x6 van

Antenna and Receiver:
Antenna Type: 4 in VHF, UHF, and SHF
Frequency Range: 0.13-18 GHz (to include X and Ku bands)
Azimuth Coverage (°): 360

PERFORMANCE
Surveillance range (km): 450-620 depending on target altitude and frequencies. The latter figure is for targets at 18.5 km altitude. Manufacturer claims 800 km (may be valid - some frequencies).
Effectiveness Against Stealth: Reported but not likely.
Maximum Number of Targets Tracked: 32
Range for a Complex (km): 1,000 frontage or 450-600 radius
Operation Duration Time (hrs): 24

Russian Orion

SYSTEM
Alternative Designations: 85V6-A or 85V6E
Date of Introduction: By 2000
Proliferation: At least 3 countries
Components for Complex: 3 stations and control post
Crew: 2 per station, 3-5 at the control post
Platform: URAL 43203 6x6 van, for receiver and for control post
Power source: Vehicle PTO, or diesel APU on a trailer

Antenna and Receiver:
Antenna Type: Spinning omni-directional and dish receiver antenna
The antenna can be manually pointed or set on auto-track
Frequency Range: 0.2 – 18 GHz C-D (up to 40 option)
Azimuth Coverage (°): 360
Elevation Coverage (°): 0-20
Bearing Accuracy (°): 1-2 for .2-2 GHZ, 0.2 for 2 GHz or more

Operation:
Maximum Distance Between Stations (km): 30
Maximum Control Post Separation (km): 20, near ELINT user
Deployment time (min): 5-10 for station, 40 for system. Receiver stations may make several local moves before the CP moves. Some users will locate the CP near a receiver station
Report Format: Digital map display plus acoustic alert, RF signal
Map update Sequence: (sec): 6-10

PERFORMANCE
Surveillance range (km): 400, beyond horizon for some frequencies
Target ID Probability (%): 90
Maximum Target Descriptions Catalogued for ID: 1000
Maximum Number of Targets Classified/Passed: 100 per complex
Maximum Number of Targets Tracked: 60-100 per complex

VARIANTS
A single station may be employed with digital link to a compatible radar/RISTA network in IADS or unit, using map displays.

Airship Support to Air Defense

Airships ("lighter-than-air" craft) have been used in warfare since the 1800s, when balloons offered elevated platforms for military observers. Airships are increasingly used in civilian venues and offer capabilities for military use, including air defense. Roles include support to communications, with airship lift for longer range antennae, and airborne mounting of communications retransmission systems. AD electronic warfare and RISTA units can use aerostats to raise recon systems. A simple method would be to attach a jammer round on a cable. A GPS jammer could be mounted on a vehicle-based aerostat or a dirigible moving within protected zones.

Some signal intelligence and communications units have the option of using aerostats to raise antennae for increased operating range. British Allsopp developed the Mobile Adhoc Radio Network (MANET), with three steerable Low Visibility Skyhook Helikites bearing ITT Spearnet radios to 65-m height. They demonstrated that an infantry radio, usually limited to 1 km range, can send video data (with a 15 kg helikite backpack) to a receiver 10 km away. The company claims that antenna altitude could rise up 500 m.

Electronic warfare units can use aerostats to raise antennae on jammers and recon systems. A simple method would be to attach a jammer round on a cable. A GPS jammer could be mounted on a vehicle-based aerostat or on a dirigible moving within protected zones. Artillery units have long used weather balloons in meteorological units to supply data for calculating fire adjustments. Those units also have helium generators for supplying the gas.

The most widely-used role for airships is reconnaissance, including low level aerial surveillance. Airship-mounted camera systems can detect helicopters flying at low altitudes (using forest canopy for cover) earlier than their ground-based counterparts. Some military and civilian forces use large aerostat balloons with cameras for border aerial surveillance. Elevated view offers a long-range unobstructed field of view, and extended viewing duration. Airship-mounted sensor arrays vary from a simple camera or camcorder hung underneath to a day/thermal video-camera or TV transmitting real-time to a palm pilot or laptop, or over a digital net. The Israeli Speed-A stabilized payload system with automated EO/thermal imager and laser rangefinder fits on lightweight airships. Gondolas can have a camera bar, stabilized mount, or even a gimbaled sensor ball (above) with multiple sensors, laser-rangefinder (LRF), auto-track, and 60+ power digital/optical zoom. Navigation can include GPS location, ground-based location with a LRF, or inexpensive in-viewer display.

As airships become better-controlled and more stable, other sensors can be added to the payload. An airship could be used in reconnaissance units to mount a small light-weight radar antenna, such as on the FARA-1E (Vol 1, pg 4-29). The Russian Gepard airship automated platform offers an electric link and 300 kg payload to 2 km. Airships could raise a cordon of light-weight radar antennae over obscured approaches for detection of helicopters and other threats. Because they may be vulnerable to enemy aerial threats, the airships can be motorized with paramotors for remote steering and navigation. Thus they can avoid a fixed location for easy interdiction. The airships can also be raised and lowered from transport vehicles, which can rapidly relocate.

Another air defense use can be resurrected from the World War II era using modern airships as barrage balloons. They can deny low-level airspace to enemy aircraft by:

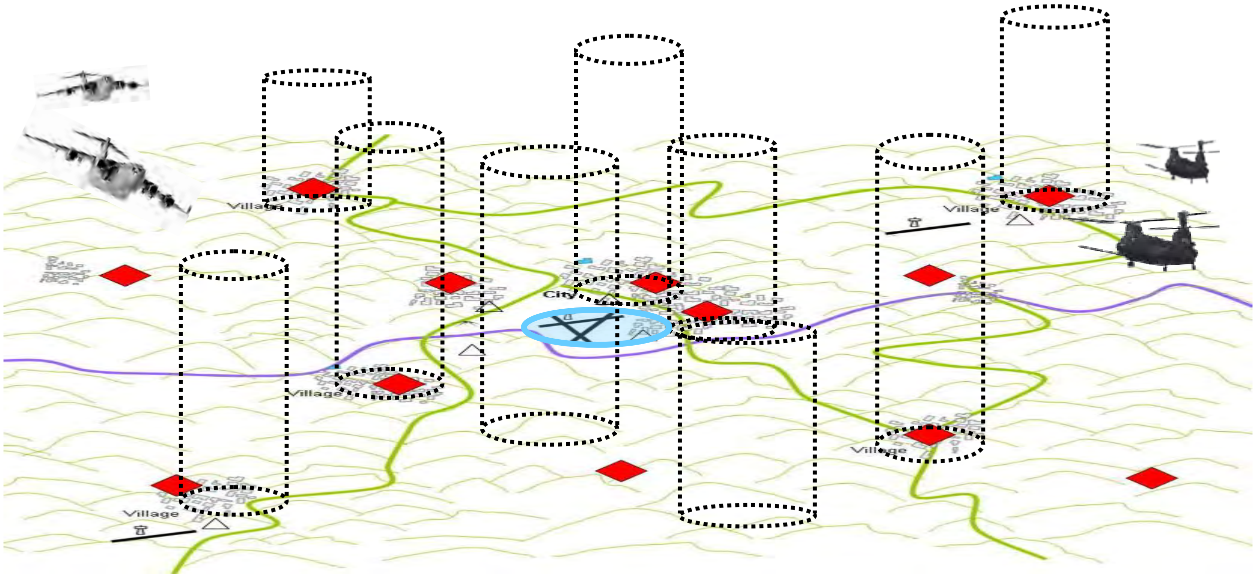
- Forcing aircraft to fly at higher altitudes, thereby decreasing surprise and attack accuracy,
- Limiting direction of attack, permitting more economical use of AD assets, and
- Presenting definite mental and material hazards to pilots by cables and airships.

During WWII in 1944, the UK had 3,000 aerostats operating. During the Blitz, 102 aircraft struck cables (66 crashed or forced landings), and 261 V-1 rockets were downed. The blimps were 19 m long. Modern more compact airships offer more flexible options, with fast vehicle-mount winches, powered dirigibles, and lighter and stronger cables. Although modern aircraft have better sensors (such as thermal sights for night use), most airships have no thermal or radar signature, and can be camouflaged and concealed for rapid rise with minimal visual signature. Latest recorded catastrophic collision of an aircraft with aerostat cable was 2007 in the Florida Keys. The Iranians have demonstrated ***air mines***, barrage balloons with explosive charges.

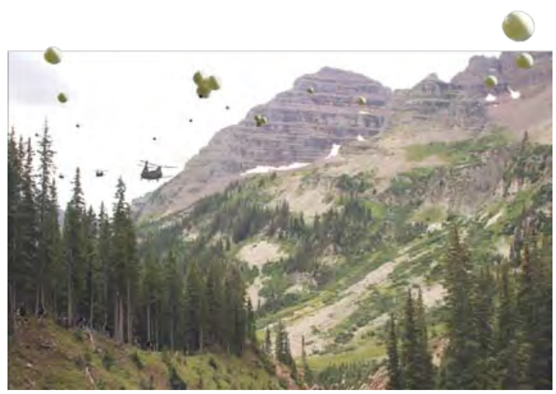
The tether cable and loose lines are the main threat to low-flying aircraft. Tether cables are next to impossible to detect in either day or night conditions, and can be steel, kevlar, PBO or nylon. Type and length of tether material is determined by lift capacity of the balloon. Multiple loose lines and/or tethers may be suspended from the balloon. Short-notice balloon fields can be emplaced in 10-20 minutes, and raised or lowered with fast winches

in 1-5. Netting, buildings, and trees can be used to conceal inflated balloons between uses. Smaller (e.g., 1-m) inflated shaped balloons can be used in target shaping, altering appearance of buildings, vehicles, weapons, etc. They can also be raised as AD aerostats.

Although some balloons will use concealment, others will be clearly displayed to divert aircraft, or trigger a response and draw aircraft into air defense ambushes. Captured marker balloons can divert search and rescue aircraft into ambushes. Balloons can be used in deception as decoys to draw aircraft away from high-value targets.



Two areas where airships are most effective in air defense are urban and complex terrain.



Recent Developments in Very Short Range Air Defense (VSHORAD) Systems

VSHORAD systems include a wide variety of technologies defined by mission (AD) and their range (to 8 km). These systems are proliferated throughout the battlefield, and are used for area defense, site defense, and as multi-role systems for use against a wide variety of targets on the battlefield. They are used by modern forces, and by irregular forces with limited budgets, limited training, and limited mobility assets.

The most widely proliferated VSHORAD threats are weapons throughout the force in the All-Arms Defense. These weapons are primarily used against low-flying aircraft (helicopters, UAVs, etc) which venture into their area, and into range of those weapons. These include infantry small arms, vehicle guns, grenade launchers, and missiles. The single most prolific and dangerous category among these weapons is machineguns. Medium (12.7-mm) and heavy (14.5-mm) MGs permit dismounted personnel and any vehicle, boat, or RV to protect themselves and/or attack those targets. These can also be used against the growing UAV threat.

All-arms weapons include new multi-role weapons and munitions for use in ground forces, and which can engage aerial targets. Antitank guided missiles (ATGMs) have always been able to engage low-flying aircraft (most of which must fly at slow speeds). However, some ATGMs fly at higher speeds (such as AT-9) for superior intercept. The AT-9 and some others feature an anti-helicopter missile, with proximity fuze and increased lethal radius warhead. The following section (pg 6-22) also notes other adaptive weapons for the mission. Tactical units can use selected mines, including anti-helicopter mines (pgs 6- 24 to 26), to support AD activities.

The most widely fielded VSHORAD weapons for lower-tier forces are AD guns, including MGs, and medium cannons to 57 mm. There are even heavy AD cannons (76-100+ mm, see pg 6-42). With improved fire control (e.g., radars) and improved munitions, some of these remain a viable threat to aircraft flying at 0-6,000 m. Forces are upgrading some ground mounted guns by fitting them on vehicles, with modern fire control (6-31 to 39). They are also fielding multi-role systems (AD/AT) and infantry fire support vehicles with improved AD guns.

More modern forces have generally chosen a different route. They mounted robust AD capable guns on ground force IFVs and APCs, but equipped AD forces primarily with missiles. The most widely proliferated missiles in any force are man-portable SAMs (aka: man-portable air defense systems – MANPADS). These are missiles launched from disposable canisters attached to hand-held gripstocks. They are used not only with dismounted soldiers, but also mechanized units, in missile launcher vehicles, on helicopters, ships and boats. Some mount MANPADS on support vehicles, e.g., motorcycles, ATVs, and light strike vehicles, and fitting them on AD guns (pgs 6-46 and 57). MANPADS have seen upgrades in fire control (EO/thermal and auto-trackers), in warheads (proximity fuzing, larger Frag-HE fills with HMX explosive, KE frangible, etc., and in missile motor design (high velocity speeds and improved maneuverability). Most MANPADS use IR homing with seekers cooled by an attached battery coolant unit (BCU), with modern upgrades such as two-color IR with improved detectors and needle shockwave dampers for cooler seekers, better clutter rejection for improved lock-on and countermeasure rejection and a probability of hit of up to 85% (90% versus helicopters). Recent guidance modes include SACLOS laser beam rider (LBR on Starstreak) and semi-active laser (SAL) homing to defeat countermeasures with a P-hit of 95% or more. The Lightweight Multi-role Missile variant of Starstreak is due out soon, and is offered on a Camcopter UAV combat variant (pg 4-12).

Adaptive Weapons for Air Defense in Close Terrain

Military forces worldwide generally recognize the need to counter aerial threats throughout the battlefield. Fixed-wing threats used to drive the requirements for air defense systems; but since the Vietnam War era, most countries have increased capabilities throughout the force to counter rotary-wing aircraft. These weapons may not destroy the aircraft; but their damage can disrupt the aircraft mission, and take them out of action for subsequent missions.

The OPFOR will employ conventional AD weapons against helicopters when available. In some environments, however, many AD weapons are less effective, such as in dense terrain or urban areas. In dense terrain helicopters may be spotted at <500m, with concealment or sudden appearance requiring fast reaction, minimum range, altitude, or which limits use of most surface-to-air missiles (SAMs). Helicopter countermeasure systems may degrade SAM performance.

Tactical forces may employ teams and assets in addition to specified air defense assets, to counter the helicopter threat, as well as ground threats in the area.

--Tactical security elements are special-designed units which operate in the OPFOR rear area and use weapons such as machineguns to protect rear area assets from ground and air attack.

--Air defense observers. Units will assign AD observers for moving and stationary units. At least one observer team (1-3 people) per platoon is assigned the role of AD observation. Most tactical units are linked into the tactical warning net with an alarm system which can warn of ground and air attacks. The team may be assigned a machinegun or other weapon for the role.

--Air defense teams. Infantry forces in close terrain and in dispersed operations may send out teams (2-3 men) against helicopters. These teams can also move with other units for tactical and security missions. A team has to travel fast and light, and engage quickly, thus maximum weapon weight recommendation is 20 lbs (9.1 kg). The AD team should employ a weapons mix against air and ground threats. The most common AD weapon is a 7.62 or 12.7-mm MG. An AD team may encounter numerous targets. Systems need ammunition for 2-5 encounters per mission. Equipment needed includes a radio, night vision equipment, and laser rangefinders. These teams can use light vehicles, but might be better served with motorcycles or ATVs.

--Combat support and combat service support vehicles with machineguns, medium guns, or automatic grenade launchers will generally not initiate engagements with aircraft, rather have weapons for defense. They may destroy or damage aircraft, force aircraft to break off engagements, and deny aircraft the option for low-altitude flight over wide areas.

--Combat vehicle weapons. Desert Storm demonstrated the capability of helicopters against fighting vehicles. Therefore, AFVs are increasingly addressing that threat with improved weapon systems. Training experience has shown tank main guns with sabot rounds to be a significant threat to rotary-winged aircraft. High-angle-of-fire turrets and air defense sights for LAFV medium guns and machineguns are being fielded and upgraded to address aerial threats. Frangible rounds offer KE-type accuracy and HE-like lethal effects against aircraft. Vehicle guns with programmable-fuze ammunition (such as BMP-3M and T-80UK) can approach the lethality of AD systems such as Skyguard. Antitank guided missiles, especially gun-launched (WEG Vol 1 pp 6-41 to 6-45), are a threat to slow-moving or hovering aircraft.

--Anti-helicopter mines or directional mines (such as Claymore or Russian MON series) (See WEG Vol 2, pp. 5-66) can be used. Conventional mines can be adapted with acoustic or multi-sensor units (such as Ajax) to create anti-helicopter mines. RW aircraft obstacle systems can include wire obstacles at LZs and airship nets (armed or unarmed).

Here are a few adaptive weapons for use against aircraft.

Type system	Example
ATGM Launcher	- Short-range systems like Eryx, and man-portable ATGMs like Gill, AT-13, AT-7
	- Portable systems European HOT, Russian Kornet, AT-5B
Machineguns	- In squads there are Russian 7.62-mm PKM
	- In companies 12.7-mm w/API, sabot, and frangible
Sniper/Marksman rifle	- 7.62-mm SVD, or .338, with API rounds
	- .50-cal Barrett rifle w/ SLAP, AP, API, or frangible
	- Fr Le Gepard M3 12.7-mm, box mag, scope
Under-barrel grenade launcher	- 40-mm GP-30 HE grenade
Rifle grenades	- BE FN Bullet-thru AV (Anti-vehicle), 3 per rifle
Lightweight grenade launcher	- M79 40-mm grenade launcher
Automatic grenade launcher	- CH 35-mm W-87 w/HEDP, 30-mm AGS-17 (HE) Singapore CIS 40GL, HEDP or air burst munitions
Antitank Grenade Launcher	- Any ATGLs, esp with longer-range DP or HE grenades
	- Carl Gustaf M3, w/HEDP grenade, LRF and night sight
	- German PZF3-T600 or -IT600 with HE and DP grenades
Recoilless Rifle	- Yugoslavian M79, U.S./Swedish M40/M40A1
Antitank Disposable Launcher	- German Armbrust, Russian RPO-A
Mini-UAVS/Micro-Aerial Vehicles	-With or without warheads, to attack/harass RW aircraft
Air-to-surface Rocket Launcher	-"C-5K" Iraqi or Chechen launcher with S-5 57-mm rockets
Semi-active laser Homing	-Recent ATGLs and ASRs with SAL-H homing munitions

--Improvised rocket launchers. Man-portable air-to-surface rockets of less than 100 mm (Vol 1 pp 16-5) can be launched at low-flying helicopters. Rockets include Russian S-5 series, French 68-mm SNEB, and others. Most improvised launchers lack sights with enough precision. However, some fabricators use fairly standard designs, and have employed sights from the Russian RPG-7V ATGL. These sights are adequate for use out to a range of 500 m. To avoid the current problem of high amounts of ash discharge, some fabricators added plexiglass shields. With these improvements, launchers for these high velocity rockets with very flat trajectories are a viable threat to helicopters, and are claimed to have downed at least one in Iraq.

Air defense teams teams using man-portable air defense systems (MANPADS) are not adaptive responses; but MANPADS can be employed in an adaptive manner. Because of its vulnerability to detection and priority as a target, an AD team needs to be equipped to address multiple targets - air and ground. The Starstreak MANPADS system offers a unique flexibility. It was optimized against helicopters; but it can also be employed against FW aircraft, light armored vehicles, and selected other priority targets, such as snipers in bunkers or buildings. Thus a team equipped with Starstreak and other multi-use weapons (e.g., ATGLs, AGLs, machineguns, etc) can be used a wide array for security, ambush or attack missions. The MANPADS can be linked to MG or cannon fire control, or mounted on reconnaissance vehicles.

Anti-helicopter Mines for Use in Air Defense

The modern attack helicopter, with increasing agility and weapons payload, is able to bring enormous firepower to bear on enemy forces. To counter this threat, some forces employ air defense mines to assist to support air defense ambushes. The intent is less to destroy helicopters, than to: (1) force low-flying helicopters to rise or change course, (2) alert air defenders to trigger the ambush, and (3) distract pilots while engaging them with ground weapons. Some ground-based mines, such as Mon-100 and Mon-200 directional fragmentation mines can be pointed upward for use against helicopters.

Additionally a recent type of mine—the anti-helicopter mine—was developed. By borrowing technologies from side-attack and wide-area landmines, anti-helicopter mines may make use of acoustic fuzing to locate and target potential low-flying targets at significant distances. Their multiple-fragment warheads are more than capable of destroying light-skinned, non-armored targets and damaging any helicopters at closer ranges.

A simple anti-helicopter mine can be assembled from an acoustic sensor, a triggering IR sensor, and a large directional fragmentation mine. More advanced mines use a fairly sophisticated data processing system to track the helicopter, aim the ground launch platform, and fire the kill mechanism toward the target. As the helicopter nears the mines, the acoustic sensor activates or cues an IR or MMW sensor. This second sensor initiates the mine when the helicopter enters the lethal zone of the mine. A typical large fragmentation warhead is sufficient to damage soft targets such as light armored vehicles and aircraft. Alternate warhead designs include high-explosive warheads and single or multiple explosively-formed penetrators.

This data was developed for and incorporated in the Engineer Chapter (7) of Volume 1. However, OPFOR forces would be expected to deploy the mines in Air Defense units to support air ambushes. Therefore, pertinent data was duplicated here to assist the Air Defense planner.

Austrian Anti-helicopter Mine HELKIR

SYSTEM

Alternative Designations: None
Date of Introduction: In current production
Proliferation: At least 1
Description:
Shape: Rectangular
Color: Green
Case Material: Metal
Length (mm): INA
Height (mm): INA
Diameter (mm): INA
Total Weight (kg): 43

DETECTABILITY

Ready: Visual

EXPLOSIVE COMPOSITION

Type: INA
Weight: 20

FUZE/SENSOR

Types: Dual, acoustic, and IR
Number of Fuze Wells: INA
Resistant to Explosive Neutralization: Yes

PERFORMANCE

Armor Penetration (mm): 6 @ 50 m or 2 @ 150 m
Effect: Directed fragmentation
Effective Range (m): 150
Target Speed (km/h): 250
Emplacement Method: Manual
Controllable (remotely detonated): Yes
Antihandling Device: Yes
Self-Destruct: INA

VARIANTS
None

NOTES
The HELKIR anti-helicopter mine is designed to engage nap-of-the-earth targets. The sensor is a dual acoustic-IR. The acoustic sensor listens for a valid noise input and turns on the IR sensor. The IR sensor is located coaxially to the warhead. When a hot IR signature is detected, the warhead is functioned.

Anti-helicopter Mines

Name	Country of Manufacture	Number of User Countries	Emplacement Method	Armor Penetration (mm)/ Kill Mechanism	Effective Range (meter) Maximum /Minimum	Detectability/ Composition	Target Velocity (m/s)	Fuze Type/	Warhead Type/Total Weight (kg)	Status
AHM-200	Bulgaria	1	manual	10 @ 100 m	max 200	visual		combined acoustic & Doppler SHF	Total weight: 35 kg	in production
HELKIR	Austria	1	manual	6 @ 50 m 2 @ 150 m		visual		dual acoustic & IR	Total weight: 43 kg	in production
TEMP-20	Russia	0	manual		detection 1,000 max 200	visual	100	dual acoustic & IR	Total weight: 12 kg	development
AHM	UK	0	manual remote		200/50	visual		dual acoustic & IR	multiple EFP	development

Air Defense and Other Technology Counters to Unmanned Aerial Vehicles (UAVs)

UAVs are proliferating worldwide. These aircraft are used in various configurations and sizes, and for an increasing variety of missions. Their size ranges from bomber size to palm-size micro-aerial vehicles. Missions include attack (attack UAVs and UCAVs), reconnaissance, fire support roles, C^2, INFOWAR, etc. Responses generally fit within the categories: C3D (pg. 9-1), information warfare (IW), and direct attack. Military tactical and technical responses can vary with the configurations and missions, and require an all-arms approach (see TC 7-100-2, Ch 11).

Forces will use C3D to counter a wide range of threats, including UAVs; but the proliferation of these aircraft throughout the area will require increased emphasis on C3D discipline. Measures include more use of IR/absorbent and vehicle conformant camouflage, screens for dismounted positions, and use of deformers, deception, and signature modification. Greater availability of responsive smoke and digging equipment will assist in rapid concealment.

Although INFOWAR assets can jam UAV operating and C2 mechanisms, they have limitations. Jammers generate a signature subject to detection and destruction, and must limit use time. Intermittent brief jamming can confuse and neutralize many UAVs, and challenge enemy counter-jamming capabilities. Even limited jam assets can counter many UAVs within a critical area at critical times to counter guidance and controls (and neutralize/crash the aircraft, or to cause them to return to launch point). Intercept assets may be able to detect signals for UAV control and image display.

The most likely and most widely available IW counter is the global positioning system (GPS) jammer. These can be miniaturized with low-power, significant range, and wide area effects. Stationary jammers can be detected and destroyed by direct attack; but mobile jammers can fit on ground vehicles. They also can be mounted on UAVs flying prescribed routes with visual markers, or on tethered or powered airships. They can also be linked with AD as a lure for air ambush. Although GPS jammers also jam their own forces, defenders and most adversary forces are generally less reliant on GPS precision than modern offensive-minded forces.

Most forces will prefer to destroy UAVs upon detection, using direct action. Early detection is a critical factor. This task requires use of air watches and RISTA assets to surveil all approaches. Thus we see a trend in the proliferation of new, more flexible sensors for use on ground and vehicle mounts. They include aerial sensors, e.g., airships with radars and thermal/EO sensors (pg 6-18). They also include acoustic systems: sound-ranging sets, unattended ground sensors, vehicle/tripod acoustic microphone counter-measure sets. Remote camera arrays offer 24/7 monitoring of large areas. Scores of lightweight remote weapon stations or EO sensor pods fit on vehicles or stands with 30-50+ magnification and fast slew. These can be linked to integrated AD nets, e.g., IADS (pgs 6-3 to 4), to cue other sensors and weapons, or to send warnings to possible units along the UAV flight path using the attack alert systems and azimuth warning receivers (pg -51). Lightweight, portable, and more responsive radars now fit ground and vehicle mounts, for sector searches that include scanning the horizon for aircraft. Larger UAVs with signatures similar to FW aircraft and flying at higher altitudes will be treated like those targets. New stealthy designs in UAVs and unmanned combat aerial vehicles (UCAVs) will challenge conventional air defense radars. Thus more forces will adopt recent IADS RISTA nets specifically designed to counter stealth aircraft (and their supporting radars).

The enemy will attack UAVs on encounter, and support assets: i.e. launcher, ground station, and link assets. Weapons for attack vary with UAV size. Conventional aircraft sized UAVs can be acquired and engaged by the same assets as their manned counterparts. Tactical UAVs generally feature smaller visual, thermal, and radar signatures. Reduced UAV thermal signature at night can challenge observation by systems other than air defense, and air defense systems without radars. However, most can be detected by modern radars and acoustics, some using high-resolution thermal sights. At range, missiles and rounds with proximity or AHEAD type fuzes (pg 6-38) can be used against these aircraft. More calibers of AD rounds will use these fuzes. Tactical UAVs which fly below 3,500 m altitude may be engaged by modern man-portable SAMs and guns. Vulnerability varies with design and flight profile. If a tactical UAV flies below 300 m altitude, it is vulnerable to nearly all weapons, including shoulder weapons. Rotary-wing UAVs are more likely to fly at a low altitude, because of their low-speed control. Anti-helicopter mines can be command-detonated or sensor-fuzed to destroy low-flying UAVs.

UAVs which may present the greatest challenge to air defense are small UAVs of less than 25 kg (pg 4-19) -- mini-UAVs (MUAVs) and micro-aerial vehicles (MAVs). Battery power eliminates their acoustic and thermal signatures. Unless radars or other specialized AD sensors are used, there will not be timely detection to use most of the weapons in the UAV flight path. For MUAVs, small size almost eliminates radar signature beyond a few km. If they use a camouflage pattern and fly above 300 m, they are very difficult to see in daytime. However, due to limited camera range and wind patterns above tree lines, many will fly within 300 m of the ground. Machineguns can be somewhat effective. Rifle fire against them will be more difficult ("big sky – little bullet"). It is difficult to gauge range without ground level background as a gauge; therefore, a laser rangefinder is essential for aiming. A preferred weapon, found in some infantry units, is a shotgun with duck hunter loads. Automatic grenade launchers with precision optics and air-bursting munitions (Vol 1, pg 2-24) offer a counter to MUAVs. They have displayed AGLs fitted with bore-sighted FARA-1 man-portable radars (Vol 1, pg. 4-29) for near instantaneous cuing.

In the Near Term, as these MUAVs proliferate, forces will seek additional counters. A possible development will be proximity-fuzed grenades for 20-40 mm grenade launchers. About a dozen or so producers have developed shoulder-mount grenade launchers for these munitions, with a range 500 - 1,000 m. Such a weapon with precision optics and a proximity-fuzed or ABM grenades would enable squads or weapons teams to respond quickly. Vehicle mount light remote weapon pods with multiple cameras for 360° monitor displays and rapid slew are likely.

Micro-aerial vehicles are less widely fielded. They vary from palm-size to hand-launched weighing 5 kg, with 0.67 m wingspan (see pg. 3-19). Many have small batteries short range (<5 km), close camera view (<300 m), and low altitude (often <300 m). With instability and high potential for crashing, many must be treated as disposable. Most are daytime only, but limited night capability is available. Good C3D practices such as camouflage and smoke can challenge them. Jammers can defeat them. Weapons in the above paragraph can defeat them, especially the larger MAVs. It is likely that forces will seek other weapon counters specifically against MAVs. But detection and rapid destruction will be a challenge. Most will detect targets before they are destroyed. Because MAVs are used by adversary low-level units or site security units, a target force must have assets and alert nets to quickly warn of their presence, and be ready to respond. Indeed, a weapon response may alert the adversary and accomplish the MAV's mission.

Air Defense/Antitank (ADAT) Vehicles

The battlefield has always held a requirement to fight dispersed, and to be able to engage a variety of threats. In the era of large conventional forces, requirements could be met efficiently and inexpensively by task organizing units to meet any fighting requirement. Most weapon systems can be employed against multiple targets. Any machinegun can be employed against aircraft, as well as unarmored and some light armored vehicles. Most forces will include weapons in tactical vehicles to address various threats. But technologies and budgets now permit tactical forces to use systems which can be effective in both air defense and anti-armor missions.

In the Infantry chapter (pages 3-55 to 57), we discussed *infantry ADAT vehicles*. By the 1960s, infantry fire support vehicles were distributed within infantry and dispersed throughout the battlefield. The vehicles had some limited ADAT capability; but their primary role was to carry dismount teams, with weapons corresponding to the particular subunit support mission. More capable and responsive vehicles for infantry ADAT, and AD and AT units are available.

Technological changes, force reductions, and increased emphasis on rapid deployment equipment (which may have to fight disperse) have led to development of more capable *ADAT vehicles*. Improvements in fire control systems and weapons stabilization are crossing over from the antitank arena into air defense. Reverse technologies from air defense systems are also available for antitank and anti-armor roles. The ADAT vehicle has multi-mission capability.

Among the modern specialized systems advertised with this dual capability is the Canadian Air Defense/Antitank System (ADATS). The system features a high-velocity missile launcher on a tracked chassis. It offers responsiveness, high lethality, and lethal SHORAD capability for use in specialized roles or at the division/brigade level.

The German Rheinmetall SkyRanger Advanced Maneuver Support System is advertised as a multi-mission vehicle. With a 35-mm revolver cannon on a Piranha IV wheeled APC chassis, it can defeat aircraft (and vehicles other than tanks) out to a 4,000-m range. Rounds include electronically-fuzed AHEAD (Advanced Hit Efficiency and Destruction, electronically fuzed) rounds against aircraft, some vehicles, and selected ground targets. The highly mobile unit also includes a Bolide SAM launcher vehicle and a radar vehicle on the same chassis.

The Starstreak ADAT application was discussed earlier. Armored Starstreak is the missile launcher vehicle which could be used for multiple roles, including AD and anti-armor use. Now there is another Starstreak application, the Thales Thor remote weapon system. The light-weight (0.5 mt) RWS features a turret with four launchers, modern responsive day/night fire control system, and remote laptop displays and controls. The launchers will accommodate Starstreak, and other MANPADS, such as Mistral and Stinger. It also launches ATGMs such as HELLFIRE, TOW, Ingwe (and probably Mokopa), and Spike-LR.

The Multi-purpose Combat Vehicle (MPCV) is a French and German system, with an RWS missile launcher mounted atop a VBR combat support vehicle. The launcher in AD configuration holds 4 x IR-homing Advanced Short-Range Air Defense (ASRAD) MANPADS missiles. In the AT configuration it can launch 4 x MILAN-ER ATGMs. The system includes a CCD camera, laser range-finder, and 3rd general thermal sight. The missiles cannot be mixed.

Some ADAT vehicles were designed from the beginning to fulfill the multi-role requirement. Most were modified from existing systems with replacement subsystems, or added capabilities. Add-ons, e.g., Strelets remotely operated MANPADS launcher, or the Israeli RWS with the Spike ATGM launcher enable vehicles to perform multiple missions at less cost than special-built designs, but comparable capability. Thus, the BTR-80 APC features a higher angle-of-fire gun to address aircraft and other higher-angle targets. Ukrainian KMDB developed a twin 23-mm cannon to replace turrets or fit atop existing turrets and engage fast-moving targets which cannot be engaged by other vehicle guns. The 23-mm round is also affective against light armored vehicles, materiel, and personnel such as snipers firing from high angles.

A Russian developer offers a replacement turret for the PT-76B amphibious tank (and other AFVs). The **PT-76E** turret uses a 57-mm stabilized auto-cannon from S-60, with modern FCS (Vol 1, pg 6-52). The 57-mm KE round defeats almost all light armored vehicles at 2,000 m, and accurate fires to 3,000+ m. The upgrade converts the tank into an effective AD/anti-armor system with mobility superior to almost all other vehicles, and at a fairly low cost.

Most ATGMs can be employed against helicopters. The faster missiles, such as gun-launch missiles, and those from the Russian 9P149/Shturm-S ATGM launcher vehicle (Vol 1, pg 6-63), are more effective in intercepting a fast-flying helicopter. The 9P149 now features an Ataka missile AD variant with a segmented rod designed for use against helicopters. The Spike-ER ATGM, with fiber-optic guidance and IIR-homing option, is advertised as an effective missile for use against tanks and helicopters. Vehicle remote weapon stations include launchers for this missile, with range out to 8+ km. Modern RF threat warning systems can warn of attacks from aircraft and ground vehicles, and differentiate the threats. Some of those systems designate direction of threat approach, with azimuth warning systems such as the 1L15-1.

The ADAT requirement has also driven improvements in ammunition and sensors. Modern Russian tanks can remotely fire their AAMGs using special air defense sights. The Russian FARA-1E radar can be attached to weapons including the NSV 12.7-mm MG, as a fire control radar for use against ground and aerial targets. Long range AD sensors, such as 3rd gen FLIR on the MPCV, offer night range comparable to day range. Improvements in AD gun ammunition are discussed on pages 6-35 (MGs) and 6-37 to 38 (medium cannon).

Many air defense systems mount guns and missiles which can easily engage and destroy light armored vehicles. The Russian 2S6M1, Pantsir-S1, and Sosna-R drop-in turret all feature 30-mm twin-tube auto-cannons and high-velocity missiles with kinetic energy effects. The manufacturers claim that these can be effective against aircraft and light armored vehicles. Similarly, the SA-11/SA-11 FO/SA-7 systems are claimed to be effective against ground targets. The 690 or 715 kg missiles (even with only Frag-HE warheads) can destroy any vehicle. But with the cost of SAMs, ADAT systems mostly use guns and ATGMs against ground vehicles.

Current trends indicate that recent technology improvements offer a greater variety of ADAT vehicles. Technologies include gimbaled and gyro-stabilized RWS and OWS, better recoil compensation systems, auto-trackers and stabilized fire control, computer-based integration, radars, EO, acoustics, laser systems, and GPS-based digital C^2. Breakthroughs in ammunition and vehicle drive stabilization offer more responsive precision. In the Near Term, these capabilities become prevalent, so that forces will increasingly be organized economically to fight dispersed, with the ability to engage air and land force threats with equal deadly effect.

Short-Range Air Defense: Gun and Gun/Missile System Technology Trends

The primary role of air defense continues to be defensive, to deny any adversary the opportunity to use OPFOR air space. A fundamental tenet in that role is to provide area-wide protection. That protection is accomplished with three methods: maintain sufficient inventory, achieve high system mobility, and engage all units to achieve an effective air defense. Methods include use of passive counter-air protective measures and use of lethal counter-air weapons. The focus for many force and weapons designers in recent years has been on missile systems, because of their range and precision against modern aircraft. Gun range limits them to the Very Short-Range Air Defense (VSHORAD) role, but that role is increasingly critical today.

Many countries have significant inventories of air defense guns and are modernizing their inventory of guns. Reasons for this activity are the following:

- Large inventories, offer wide dispersion for area and point protection of assets.
- Guns rarely lose their operability over time. Even older guns can be used.
- Guns are very difficult to put out of action. A vehicle can be killed, and personnel can be killed. But the weapon can usually be brought back into action quickly.
- They are generally less costly to produce, train on, and use than missile systems.
- They can respond to air threats more quickly than missile launchers.
- There is no "dead zone", compared to missile systems. Guns can engage targets down to 0 meters altitude and at a few hundred feet minimum range.
- They are nearly immune to countermeasures.
- They are multi-target systems that can engage a variety of aerial targets (including most likely air threats – helicopters and unmanned aerial vehicles), and a variety of ground threats (including infantry and light armored vehicles).
- They can engage small aerial targets (mini-UAVs, rockets, etc.) which missiles cannot engage.
- The active market in add-on subsystems supports improvements in gun mobility, survivability, fire control, weapon function, ammunition handling, and C^2.
- New types of ammunition increase range, precision, and lethal effects.

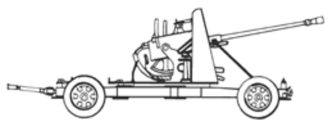
New gun systems are being produced; but the greatest activity is in the area of upgrading existing gun systems. To examine modernization activities in AD guns, we will look at them from the aspect of three primary factors: Mobility, Survivability, and Lethality.

The most numerous guns used for air defense are not specifically AD guns. These are small arms and general weapons in tactical and supporting units which can engage aerial targets which fly within range. Weapons used in these units to engage aerial targets include grenade and rocket launchers, ATGM launchers, combat shotguns, tiltable mines, and IEDs.

The most numerous gun systems which are effective for air defense are machineguns in 7.62 mm to 14.5mm. These weapons are used for targets of opportunity, especially aerial targets. These can be ground-mounted (shoulder-fired, tripod, or bipod), can be fitted onto a pintle for vehicle mount, or can be integrated into a vehicle fire control system (turret or remote weapon station (RWS) mount, coaxial with a main gun, or fired from a firing port. Most tactical vehicles use machineguns as the vehicle main gun.

Even AD unit missiles and medium guns also use common MGs in supporting units and on combat unit support vehicles

Mobility. The guns, missile systems, and gun/missile systems in AD units are generally towed, porteed, or vehicle mounted. Most towed guns have limitations in mobility. They cannot be towed cross-country and in amphibious crossings as easily as with self-propelled anti-aircraft guns (SPAAGs). There are a few towed guns, like the Russian 37mm M1939 which can be quickly halted, mounted, and fired during a road march. A few developers have marketed towable gun complexes which permit them to be manned and operated during the march (such as the Oerlikon 25mm Diana). These ventures have not found market success because they are still less mobile and responsive than SPAAGs, and are almost as expensive as SPAAGs.


M1939

A new kind of ground mount is the remote-operated modular gun system. An example is the Skyshield 35 35-mm AA gun unit (2 guns, radar, and generator), for use in the Skyguard air defense system. An entire gun unit can be carried on a flatbed truck, hoisted to the ground, and brought into operation in a few minutes. These guns can locate on uneven ground and orient to level with their servo drive, using computer-adjusted fires. Operators can be up to 500 m away.

Some tow systems can be porteed, then dismounted upon arriving at an AD site. Vehicles can operate in locations beyond towed guns. The BTR-ZD in airborne AD units (pg 6-47) transitioned from tow to portee carry. Although portee improves gun mobility, the penalty is that emplacement time may be even greater than normal transition from a towed mount. Thus, after an initial displacement from an airborne LZ, the BTR-ZDs are more likely to mount their ZU-23 AA gun onboard, using a simple method of fitting the gun on top of the hull.

Hull mount is one basic way of converting a vehicle into a SPAAG. Another common mount is in the bed of a “gun truck”. An early example was the BTR-152A truck-based APC SPAAG variant (Vol 1, pg 3-21), with a 14.5-mm ZPU-2 in the bay. Many insurgent forces and Third-World military forces, “technicals” use pick-up and utility trucks with AD guns. Some developers offer trucks with medium guns on flatbed trailers, in highly integrated mobile gun systems. These gun trucks offer general fire support against all air and ground threats.

Self-propelled anti-aircraft guns (SPAAGs) have been in use well before World War II. Most early SP systems use AA guns in shielded open turrets, so that crews can easily feed ammunition and slew the guns. Later SPAAGs with auto-cannons, auto-loaders, and integrated wide-aspect FCS, can be responsive and precise without the need for large gun crews and open turrets. To handle the recoil of medium caliber guns (20-75mm), SPAAG chassis are generally heavier than on commercial vehicles. Best-suited chassis for handling gun weight, and providing a stable mount for precision fires are tracked, especially modified tank chassis. However, those chassis may be costly, and are less mobile on roads while travelling with wheeled units. A good rule is for the SPAAG to use the same chassis, or more mobile chassis, as the units supported. Thus, SPAAG often use existing chassis (especially APC/IFV or combat support vehicles) used by tactical units. For instance, the Russian Pantsir gun/missile system (pg 6-29) initially was fitted on a


M42 Duster

truck chassis; but early sales favored the turret (Pantsir-S1-0) on a BMP-3 IFV chassis. Considerations for some forces include cross-country capability and swim capability, to assure that units can bring their AD systems with them wherever they go. A few new SPAAGs have been offered on the world market; but sales have been slow. Current trends favor using modular AD turrets or RWS which can be fitted to a variety of existing chassis. Other forces are adding gun, FCS, and ammo subsystem upgrades and vehicle conversions to the AA role.

Survivability. Factors for survivability of AD guns combat are similar to other AD systems and the force in general (see pgs 6-8 to 6-12). Forces are upgrading them to improve survivability. Improved mobility and lethality aid survivability. Use of CCD (including MMW/IR netting) and the low profile inherent in many towed guns still challenge modern air and ground threats.

Two other factors which help counter modern air threats and SEAD are autonomy and integration. Modern guns are increasingly equipped to function effectively as a battery, platoon, or single gun. Thus they can be assigned to tactical units as support. They may have effective links to the AD network, or to direct links with their own forward observers (FOs) or use assigned unit air watches. Attack alerts and azimuth warning receivers like 1L15-1 (pg 6-51) are dispersed to tactical unit CPs and AD guns, to alert them to approaching targets with direction. At the same time that autonomy is improved, AD units have increased integration. Widespread use of comms and improvements such as digital systems, encryption, frequency agility, SATCOM, and redundancy can assure the integrity of C^2 for IADS (pg 6-2), AD units, and links to nearby tactical and supporting units. Vehicles like Sborka (pg 6-15) and Giraffe AMB (pg 6-16) link to IADS and adjacent units to assure that gun crews are aware of air activities in their sector.


FO with LRF

Lethality. The most dramatic upgrades in AD gun capabilities are in the area of lethality. As with other tactical weapons, lethality can be addressed in terms of its components: gun, mount, sensors and fire control, C^2, and ammunition. Modernization continues in all of the components. Conventional wisdom for AD guns is that success means putting more rounds onto the target. Therefore, most gun design improvements focus on longer range, better gun stabilization (and reduced recoil and barrel-whip) for better accuracy, reduced weight for shorter response, and increasing rate-of-fire while decreasing overheating – for more rounds per salvo.

Machineguns. The most proliferated guns used for AD are small-caliber (5.45-14.5 mm), because of the inventory of machineguns in all forces. Because MG size and lower cost separate them from medium-caliber guns, they should be treated separately. The inventory for MGs is so large because they can be ground-mounted and easily added to light vehicles with a pintle mount. All MGs can be used against aerial as well as ground targets.

Machineguns are increasingly available for use on unarmored or lightly armored combat support vehicles, including tactical utility vehicles, motorcycles, and all-terrain vehicles. Vehicle mounts include pintle mounts, remote weapon stations, overhead weapon stations, and turrets. Using economical laptop computer FCS, servo-motors and stabilization, MG add-ons are increasingly being used for vehicle main weapons or as secondary weapons to supplement main weapon fires and


12.7mm AAMG

provide general and AD security. For more information on MG applications, see the section at Vol 1, pg 6-12, *Auxiliary Weapons for Infantry Vehicles*.

A general rule for guns is that AD range can be calculated at 100 times the mm bullet size, in meters. Of course range actually varies by the components noted above, especially ammunition. But under that rule of thumb, a 7.62-mm MG has a 1,000-m AA range, and a 12.7-mm MG ranges about 1,300 meters. Those estimates are pretty close (see Vol 1, pgs 2-16 and 17). Vehicle-mounted with a good FCS, it can extend ranges somewhat farther (Vol 1, pg 3-46). Better range and penetration usually favors 12.7mm mm over 7.62 mm. The 14.5 mm round is larger than 12.7 mm, with a marginal edge in penetration and range. But the round weight and larger gun size and recoil favor 12.7 mm MGs for use as AA for dismounts and light vehicles.

The 14.5 MGs are widely fielded on APCs, such as BTR-80 (Vol 1, pg 6-34). But Russian forces consider it to be obsolete (Tier 4) for AD guns. Thus they have generally replaced ZPU guns (pg 6-45, on towed mounts of 1, 2, or 4 guns) with 23-mm cannons. Nevertheless, these guns endure, and can still be found in more than 45 countries. Improvements available for these guns include a fire control radar (like SON-9), and improved command and radio links, such as an azimuth warning receiver and handheld encrypted radios.


BTR-80 MG turret

Machineguns in AD units or specifically noted as AD MGs tend to be better equipped to deal with air threats, with features like improved recoil damping and stabilization, and twin barrels for higher rate-of-fire. Another modern trend is to chain-drive guns. With chain drive has come more efficient and compact guns with multiple barrels and better precision at range. Air defense MGs often use quick-change barrels and superior air cooling for successive 10-15 round bursts and increased practical rate of fire (100 rounds per minute up to 250-300). Like other MGs, many AA MGs are remote-operated with electronic triggers. Due to their shorter range, MGs will employ low technology support, including air watches, forward observers, and links (to nearby units for warning, to AD command nets, and to air warning nets).

Fire control system improvements have caught up with gun and mount technologies. Gun mounted or stabilized remoted day/night ballistic computer sights with EO and LRF are available. The FARA-1E MMW radar (Vol 1 pg 4-29) can be mounted and bore-sighted for immediate fire control. Binocular LRF such as the Sophie-LR or –MF offer thermal day/night use with other functions. For responsive C^2, hand-held radios and the 1L15-1 azimuth warner give alerts and azimuth. In vehicle mounts with good telescopic EO sights, effective gun AA range is extended up to 2,000 m. Russian AD sights offer a high-angle view for the AD role.


FARA-1E on MG

An emerging trend among small-caliber AD guns is the Gatling-type multi-barrel gun. The weapon was modernized in the U.S. 20-mm towed M168 Vulcan cannon and was employed in the 1950s. The M163 AD vehicle was an M113 with the Vulcan cannon. Other countries, including Russia, have fielded Gatling-type guns in 12.7, 20, 25, and 30 mm. The U.S. Dillon Aero M134 fires 7.62-mm ammunition. There are inherent advantages in these guns. The multi-barrel design permits larger salvos against a fleeting enemy before overheating. The flanged barrels reinforce each other to eliminate barrel-whip. They can use chain-drive, for maximum recoil dampening with precision fires. Recoil is still significant, but it can be damped to a constant amount, which permits accurate aiming. The design also reduces halts due to jammed rounds. But Gatling guns have significant limitations. Recoil and system weight can overwhelm light vehicles (and require stopping). The huge ammo requirement can strain logistic assets. Cost per kill is greater. Thus, Gatlings have seen limited use as light vehicle main guns or in vehicle auxiliary AD weapon station upgrades. The greatest limitation for small-caliber Gatlings is insufficient range against aircraft weapons. In the future, if ranges for small-caliber ammunition improve with the guns, higher carry capacity with smaller rounds may make 12.7-mm Gatling-type guns a preferred replacement for MGs (versus medium guns).


GE Miniguns

<u>Ammunition developments are the single greatest factor for improving air defense.</u> Improved ammunition is increasing range, precision, and lethality for all air defense guns. Although small-caliber guns have less variety of rounds than medium/large guns, there are new types. Improved armor-piercing incendiary tracer rounds can extend useable range for MGs. Chinese and Russian 12.7-mm duplex rounds (e.g., Russian 1SLT) have two separate projectiles, doubling the pattern of projectiles in any salvo fired. These rounds are especially useful against close-in small targets, like UAVs. Several countries make 12.7-mm sabot rounds like the U.S. Olin M903 SLAP round, with greater precision and penetration at maximum range. Frangible rounds are made in calibers 7.62, and 12.7 mm and .50-cal. They fly like KE rounds, and can be ballistically matched to KE rounds (unlike HE), yet are more lethal at the target than KE (like explosive HE rounds). The most lethal mix may be KE and frangible. One problem associated with having more than one type of ammunition on hand is being able to switch between or among them against fleeting targets. With some MGs using box feed, the mounts permit two boxes, left and right. Thus an ammunition switch can be very fast.

<u>Medium AD Guns</u>. In order to increase lethality, the best course is to go up in gun size to medium guns. As we noted in the range rule, a 12.7-mm MG ranges about 1,300 meters. But a 30-mm gun can range 3,000 m; and a 57-mm gun ranges 5,700 m. Emphasis in modern AD guns is on medium calibers (20-75 mm). There are still some larger caliber guns in 76, 85, 100, and 122 mm; but upgrades are limited to adding radars, radios, and azimuth warners (KS-19M2, pg 6-42). Within medium AA guns, calibers are creeping up to better range aerial threats.

Medium-caliber guns (cannons) have seen the greatest variety of upgrades. Medium guns suffer from many of the same problems of MGs, like barrel whip, overheating, and recoil. In the 1950s and 60s, most AD cannons were of 20, 23, 37, 40, and 57 mm. Most are still in use today, and are recoil/gas-operated. Many are twin guns, like the Russian 23-mm ZU-23 and Chinese 37-mm Type 65. Later, 25, 30, and 35 mm auto-cannons have grown in useage. Many use chain-drive. Modern guns like the Russian 30-mm 2A38 and Swiss 35-mm GDF-003 can fire at rates up to 2,400 rds/min (for 2A38), with 25-round bursts. But limited salvo size and practical rate-of-fire still limit fires to avoid over-heating.


GDF-003

The modern gun size that has received the latest technology is 35-mm. With lightweight designs (some less than 100 kg), these guns can be fitted on ground chassis like the GDF-003 (pg 6-40) and vehicle-mounted in modern turrets like the South African LCT35 for IFV or SPAAG. The best AA gun examples are in the 35-mm and 40-mm guns (made by manufactures like Bofors, Oerlikon, and LIW). These modern can range to 4 km accurately, and exploit new round technologies. For instance, the Swedish Skyshield-35 gun uses a compact 35/1000 revolver cannon (with single barrel, rotating cylinders, and linkless rounds in a conveyor feed system). The gun weighs half the weight of the GDF-series 35-mm guns.

A new AD gun technology is the RMK-30 30x173mm recoilless auto-cannon from Rheinmetall, fielded on the Spanish Pizarro and Austrian Ulan IFVs. The combustible case rounds produce gas blowback, expended out of the cannon rear to <2 feet. Rate of fire for the 100 kg gun varies from 300-800 rds/min. Fitted in a RWS, the gun can mount on nearly all light tactical vehicles. It fires sabot and frangible rounds, and AHEAD-type programmable air-burst rounds to 3,000 m effective range. The gun could replace MGs in light AD and combat vehicles.

Some countries use Gatling-type cannons for AD. The U.S. M163 SPAAG with 20-mm Vulcan gun was followed by the Blazer with a 25-mm Gatling gun on a Bradley chassis, and the LAV AD with Blazer gun on the USMC LAV chassis. A French program fitted the gun on a French chassis, with radar FCS. The Chinese M1990 30-mm towed gun features a 4-barrel Gatling system. Nevertheless, because of reasons noted on the page above, Gatling AD guns are not widely fielded. Also, as they increase in caliber, recoil and the ammunition storage burden increase dramatically. Better gun precision and range more than offset the advantages of high-volume fire with Gatlings.


M163

The AD gun mount is a critical consideration in gun system, as noted in the discussion of mobility (pg 6-36). For ground systems, we do not see an auxiliary power unit, like the APUs such as on the GHN-45 artillery cannon, and on the Russian 2A45M AT gun. But some modern guns have lift hooks for rapid mount/dismount. Motor gun drive, such as on the Chinese Type 79, permits faster slew to target, for more precise fires and more salvoes against fleeting targets.

Some SPAAGs have stabilized guns for AA fire on the move. Stabilization kits are available and are fairly inexpensive. Turrets for IFVs and several RWS are easily accurate enough for AA use, and can be fitted on a variety of vehicles. For vehicle mounts, cannon recoil has led some forces to use tank chassis to absorb the load and assure accuracy. The Polish Loara SPAAG features twin 35-mm guns on the PT-91 (T-72 upgrade) chassis. Light turrets such as the Russian Sosna turret (either 30-mm guns or gun/missile system) can fit on IFV/APC chassis of supported units, which means that they offer amphibious or airborne chassis. The German RMK-30/Wiesel can be used with airmobile units. The Bofors TriAD turret fits on IFVs such as the Swedish CV90 and the Piranha APC. With the radar, superior EO, and quick response 40-mm L70 gun, the SPAAG fires programmable 3P HE rounds for lethal fires.


CV90C with TriAD

A few new SPAAGs have been developed. The Rheinmetall SkyRanger is actually a multi-role system, and is discussed on pg 6-29. Recent truck-mounted SPAAGs include the South African Zumlac, with a mine-protected SAMIL (4x4) truck, and a ZU-23 gun on the rear bed. China offers its FAV light strike vehicle with the ZU-23 on the rear and extendable spades. Oerlikon and Skoda proposed a SPAAG with a Tatra T815 8x8 truck, and a Skyshield 35 gun mounted on the rear. A disadvantage with large truck-mounted SPAAGs is that they can be distinguished from other vehicles, making them high-priority targets for destruction. Note that most of the systems mate existing guns and vehicles, rather than costly special-design systems.

Slovak BRAM

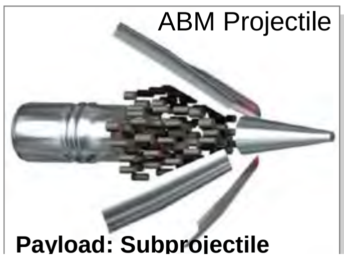
Improvements in fire control include day/night all-weather EO computer-based sights and monitors, with digital transmission capability. Many older AD guns have added target acquisition radars, such as AA guns noted at pgs 6-40 to 50. With added onboard computers, radars (and EO TV/thermal sights with auto-tracker for day/night passive operation), older guns like the ZU-23 (pg 6-46) can be converted into a responsive autonomous weapon, like ZU-23M or ZU-23M1. Vehicles can integrate a FCS from disparate fire control elements (CCD TV day sight, thermal night sight, ballistic computer, voice radio nets and forward observers, digital C^2 nets in the IADS and other AA and tactical nets, auto-tracker, dual-mode radar, AD net azimuth warning system, laser rangefinder, laser radar, RF detectors, digital displays from remote cameras, robots, UGS, acoustic sensors, UAVs etc). Many of these can also be linked to laptop monitors or FCS displays for ground AA gun systems, or transmitted to the unit net or IADS.

The greatest changes for AD guns are in new ammo for longer range and better precision. These rounds for medium guns generally make the the previous requirement for higher rates of fire irrelevant to air defense lethality. Air defense guns generally have rounds such as HEI, API-T, and SAPHEI-T. More recent guns use sabot (APFSDS-T) rounds, frangible rounds, and proximity-fuzed HE rounds. These rounds enable many systems, which could not reach beyond 2,000 m without losing velocity and their probability of hit to reach out to 3,000+ m accurately. Most of the older guns can also use these rounds, as well. The Russians offer a 30-mm “CC” round (with 28 sub-projectiles) for use on aircraft guns. It could be a good anti-UAV AD round.

Proximity fuzing permits guns to reach farther and higher, and offsets the inaccuracies of HE rounds compared to KE rounds. One proximity-fuzed round is more accurate (because a near miss still detonates the round for a “hit”) than ten rounds of HEI. Salvo size and cost per kill are lower with proximity rounds, making existing or older gun systems effective and lethal in the air defense role. However, proximity-fuzed rounds can be countermeasured or decoyed when fired in obstructed areas. Environmental clutter such as vehicles and power lines can predetonate the rounds. Swedish Bofors developed the 3P HE round in 40-mm and 57-mm with a 6-way programmable fuze, which can avoid pre-detonation. One of the fuze modes is gated proximity, which desensitizes the round until near-impact time. Even when engaging helicopters flying nap-of-the earth at low altitude, effects of electronic jammers and clutter are negated. The 40-mm round produces a cloud of 2650 fragments. This is a very affordable option, as fewer rounds are needed, and more costly rounds are selected only for specific targets.

3P 40-mm PFHE

Another round for medium guns is the Swiss Oerlikon AHEAD (Advanced Hit Efficiency And Destruction) round (and similar technology rounds), for use in 30 mm, 35 mm, 40 mm and 57 mm guns. The rounds, also known as Air Burst Munition (ABM), can range 4000 m, using their electronically-programmed time fuze to dispense a wall of tungsten sub-projectiles at an aerial target 10-40 m away. A 40-mm gun round dispenses 152 sub-projectiles. From a 35-mm gun, 24 AHEAD rounds (1-2 sec) usually assure a kill against a fleeting aircraft. The round can be used against even small targets, like mini- and micro-UAVs, artillery rounds, and rockets, or for top/direct attack against ground vehicles, dismounted troops, and materiel targets. Russian Aynet tank round and BMP-3M HEF round are also programmable, for AD and against ground targets like AT assets.



One of the most lethal AD calibers continues to be 57 mm, in the Russian 57-mm S-60 (pg 6-43 and their variants), and Swedish 57-mm naval guns. The rounds are large enough to deliver substantial bursts out to 6000 m. A variety of upgrades are offered for the guns, and proximity and AHEAD rounds are available for effective fires out to the maximum range

Improvements in ammunition-handling are keeping pace with the weapons systems. Selected gun systems have multiple ammunition feed systems for the different types of rounds. Cased-telescoped gun systems (and their CT ammunition, round in the photo right) are a recent development - which may supplant existing designs. Cased rounds shorten round length, permitting smaller gun breaches that better fit inside of vehicle turrets and weapon stations. The rounds enable autoloaders to hold more ammo in smaller spaces and more easily manipulate rounds in loading trays. Faster loading and more rounds decrease jams and ammo outages at critical moments.


Medium rounds

<u>Gun/Missile Systems</u>. Another lethality trend which has reinvigorated SHORAD is widespread fielding of, or conversion to, gun/missile systems. Most SHORAD systems are being converted to having both guns and missiles. Thus the guns, with their links to the AD net and improved FCS, can also serve as platforms for missiles. The guns and missiles can protect each other to provide lethality beyond effective range for most guns, no dead spots for the missiles, and effective lethality despite aircraft countermeasure systems.

A significant amount of SHORAD modernization activity includes gun/missile systems. We have noted some new SPAAGs have been marketed without missile capability. Nevertheless, most new AD gun systems actually fielded are gun/missile systems, such as BRAM, in the photo on pg 6-38. A few of systems feature robust SAMs. The Russian 2S6M1 (pg 6-58 was followed by the Pantsir (pg 6-59), with 18-km high-velocity missiles and 30-mm twin auto-cannons. The Ukrainian Donets mounts a ZSU-23-4 turret (with four 23-mm AA guns) on a tank chassis. Also mounted on the turret is an SA-13 missile launcher. China's Type 95 pairs 25-mm guns and QW-2 MANPADS. TY-90 has a 12.7-mm MG and six robust SAMs.

The Russians now offer modular turrets for the robust gun/missile systems. Pantsir-S1-0 turret can be fitted to a wide variety of chassis. They can use IFV/APC chassis, are almost visually indistinguishable from them, and are compatible with the mobility and maintainability of supported units. With existing chassis and indigenous installation, fielding costs are lower.

Another turret, the Sosna-R, uses a twin 30-mm AA gun and Sosna-R 8-km laser beam-rider missile. The turret is lighter and less costly than Pantsir, and fits many combat vehicles. Its range, precision, and responsiveness can challenge aerial systems well beyond gun range.

Several ground-based gun/missile complexes include robust missile systems. The best of these is Skyguard (pgs 6-40 and 6-67), which feeds compatible digital fire control and radar to both guns and missiles. The Chinese PL-11 system is similar. Many countries will co-locate guns and missiles for mutual fires and support. Germany employs a "team" which includes Roland SAMs and Gepard SPAAGs. Similarly, the French army mixes Roland and AMX-13.

Most gun/missile systems use the less costly low-technology approach of pairing guns and man-portable SAMs (aka: MANPADS). Vehicles such as the U.S. Avenger, LAV-AD, and Blazer, use Stinger SAMs. China likes this upgrade approach. The recent FAV light strike AD vehicle mounts a ZU-23 gun and twin MANPADS launcher. Russian variants of MT-LB include the MT-LB6MB3 IFSV/APC with 23-mm GSh-23L twin cannon, 30-mm AGL, and 7.62-mm MG. But the MT-LB6MB5 IFSV has a 2A38 twin 30-mm AD gun, MGs, AGL, and SA-18 SAM launchers. The Polish Sopel tracked system mounts a turreted twin 23-mm gun and twin Grom MANPADS launcher. GMW developed a twin Stinger launcher for mounting on the Gepard AA gun. A French-marketed variant of the Blazer turret features a 25-mm Gatling-type gun and four Mistral MANPADS missiles. The turret also has a radar FCS; and it can be fitted on LAVs such as M113.

MT-LB6MB3

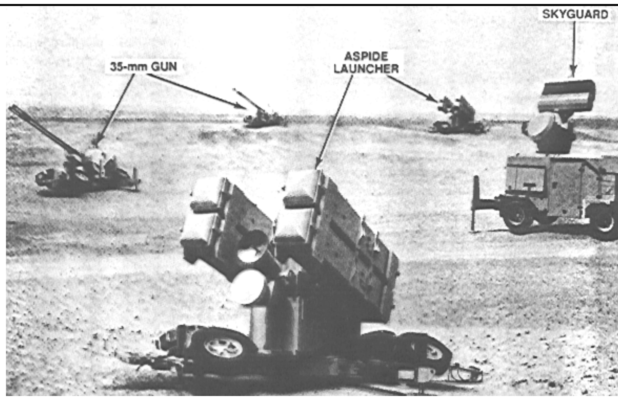
The widely fielded ZSU-23-4 SPAAG (6-7,000) is the subject of various upgrade packages (pg 6-49). Several include adding MANPADS, integrated into the fire control system. The Russian ZSU-23M5 mounts one or two Strelets MANPADS modules (each with two SA-18 missiles). The Polish Biala fits four Grom MANPADS launchers onto the turret. A Ukrainian upgrade includes a swing-up launcher with six SA-18 missiles. Other modernizations include GPS navigation, a new radar for some, ballistic computer and TV FCS with thermal sights, digital communications, NBC protection, side skirts, and smoke grenade launchers. An Iranian version includes an auto-tracker and laser warning system.

ZSU-23-4

Towed gun systems can also be fitted with missile launchers. The widely fielded Russian ZU-23 offers an –M1 upgrade (pg 6-46) with a Strelets two-SAM module, also integrated into gun FCS. The FCS in ZU-23M and ZU-23M1 has TV and thermal sights, LRF, IR auto-tracker, and a ballistic computer. Strelets module (with SA-18 SAMs) can be fitted to many AA systems.

Included in the market for AD guns are turrets, remote weapon stations, and subsystem upgrades for infantry vehicles which enable them to reach similar capabilities as specialized AD guns and gun/missile systems. Developments in this area for infantry vehicles are discussed in Vol 1, pgs 3-12 to 14, and 3-55 to 57. Infantry fire support vehicles in maneuver battalions and below offer mobile and responsive AD and AT support (Vol 1, pages 3-52 to 54). For more discussion of AD guns, see ***Air Defense/Antitank (ADAT) Vehicles,*** in this chapter at pg 6-39.

Swiss 35-mm Towed AA Gun GDF-003/-005, and Skyguard III System___________



Weapons & Ammunition Types	Typical Combat Load
35-mm automatic cannon	**238**
FAPDS	119
APFSDS-T	119
(Preferred mix)	
AHEAD	74
FAPDS	74
APFSDS-T	74
(Estimated w/ AHEAD)	

SYSTEM
Alternative Designations: Skyguard Gun/Missile Air Defense System (See VARIANTS, Skyguard).
Date of Introduction: Circa 1981-84
Proliferation: At least 3 countries
Description:
Crew: 3
Carriage: 4-wheeled/2-axle towed chassis
Combat Weight (kg): 6,400
Length Overall (m):
Travel Position: 7.8
Firing Position: 8.83
Length of Barrel (m): INA
Height (m):
Travel Position: 2.6
Firing Position: 1.72
Width Overall (m):
Travel Position: 2.26
Firing Position: 4.49
Prime Mover: Medium (5t 6x6) truck

Automotive Performance:
Max. Towed Speed (km/h): 60
Emplacement Time (min): 1.5
Battery Emplacement Time: 15
Displacement Time (min): 5

ARMAMENT
Gun:
Caliber, Type: 35x228 35-mm autocannon
Number of Barrels: 2
Operation: Gas-operated
Rate of Fire (rd/min):
Cyclic: 1,100 (550/barrel)
Practical: INA, bursts up to 25 rounds
Loader Type: 2x56-rd magazine automatic feed
Reload Time (sec):
Traverse (°): 360
Traverse Rate (°/sec): 120
Elevation (°): -5 to +92
Elevation Rate (°/sec): 60
Reaction time (sec): INA

FIRE CONTROL SYSTEM
On-carriage: :
Sights: Lead-computing optical sight, or GUN KING electro-optical system on GDF-005

Off-carriage:
Name: **Skyguard** radar and CP system
Platform: Towed compartment
Sights: SEC-Vidicon TV tracking system
Range: 25 km day only
Laser rangefinder: Yes
Search and track radars:
Name: Skyguard Mk II (SW)
Function: Dual mode doppler MTI
Detection Range (km): 25-45
Tracking Range (km): 25
Frequency: 8-20 GHz, I/J Band
Rotation Rate/min: 60
Mean Power (W): 200
Link: System uses a wire link among major components. Digital data is invulnerable to ECM, frequency hops

Other Fire Control:
Guns are linked to battery/battalion nets and the IADS, and receive digital alerts of approaching aircraft. Guns, battery, and battalion use air watches and forward observers for fast response

VARIANTS
Skyguard: System/complex described for the OPFOR has a radar, 2 Aspide (pg 6-67) missile launchers, and generators. AD complexes can vary widely. Since they are organized around the Skyguard radar/CP unit, they may guns only or missile launchers only. The most effective AD arrangement is the one noted above, as a gun/missile system.

GDF-001: System has a simple sight.
GDF-002: System links to Skyguard.
GDF-003: Adds gun system upgrades.
GDF-005: Upgrade (for -003 with NDF-C kit) has Gun King 3-D autonomous sight system, onboard power supply and auto-loader. Can fire AHEAD rounds.

Skyguard Retrofit Kit: Upgrade kit (gun computer, software, muzzle velocity sensor, and electronic fuze programmer) permits **-003** gun to fire AHEAD rounds.

Skyguard III: GDF-005 guns, Skyguard III I-band radar, and Skyguard Retrofit Kit.

Skyshield 35 configuration has X-band radar and two remote firing 35/1000 single-barrel revolver cannons. Ammunition includes AHEAD electronically fuzed rounds.

MAIN ARMAMENT AMMUNITION
Best ammunition mix: See above.
Type: HEI-T
Range (m):
Tactical AA range: 4,000 (self-destruct)
Tracer range: 3,100+
Effective Altitude (m): 3,100-4,000
Self-destruct time (sec): 6-12

Type: Semi-armor-piercing HEI-T (SAPHEI-T)
Range (m): 4,000
Tactical AA range: 4,000 (self-destruct)
Effective Altitude (m): 4,000 (est)
Self-destruct time (sec): 6-12
Penetration (mm, KE): 40 at 1,000 m

Type: APDS-T
Range (m): 4,000
Tactical AA: 4,000
Tracer range: 2,000
Effective Altitude (m): 4,000 (est)
Penetration (mm, KE): 90 at 1,000 m

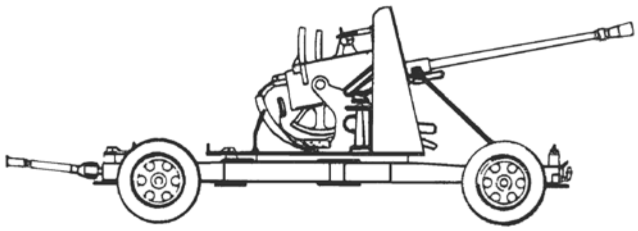
Type: APFSDS-T
Range (m): 4,000
Tactical AA range: 4,000
Tracer range: 3,100-4,000
Effective Altitude (m): 4,000 (est)
Penetration (mm, KE): 115+ at 1,000 m

Type: Frangible APDS (FAPDS)
The round has higher velocity and flat trajectory of a APFSDS-T round (same gun data), and Frag-HE effects. On impact with the target surface, penetrator breaks into 100s of KE fragments.

Type: AHEAD (Advanced Hit Efficiency and Destruction), designated **AG 35x228.** The AHEAD round uses a programmable time fuze and HE charge to dispense a cloud of 152 pellets (3,800 from a 25-round burst) at or in the path of a target helicopter, LAV, or soft target. Other fuze modes include proximity and PD.

NOTES
Original Mk I radar range was 20 km. System can also be used against ground targets.

Russian 37-mm Towed AA Gun M-1939



Weapons & Ammunition Types	Typical Combat Load
1 x 37-mm AA gun	**500**
HE HE-FRAG-T AP AP-T HVAP HVAP-T HEI-T	

SYSTEM
Alternative Designation: None
Date of Introduction: 1939 (61-K)
Proliferation: At least 50 countries

Description:
Crew: 8, 4 (est) while traveling
Carriage: Four-wheels
Combat Weight (kg): 2,050
Length Overall (m): 6.04
Length of Barrel (m): 2.73
Height Overall (m): 2.11
Width Overall (m): 1.95
Prime Movers: Utility vehicles, small, and medium trucks

Automotive Performance:
Max. Towed Speed (km/h): 60
Cross Country (km/h): 25
Fording Depth (m): 0.7
Emplacement Time (sec): 8.5 while traveling. Gun can be fired from a halt without dropping trails.
30 full emplace, to drop trails
Displacement Time (sec): 8 sec while traveling.
30 from full emplacement

ARMAMENT
Gun
Caliber, Type: 37-mm rifled
Number of Barrels: 1
Breech Mechanism: Rising Block
Rate of Fire (rd/min):
Cyclic: 180
Practical: 80
Clip Capacity (rds): 5, gun magazine holds 2 clips for 10 rounds
Loader Type: Manual gravity feed
Reaction Time (sec): 4.5, 4 to stop and fire during a move (without radar)
Reload Time (sec): 2 per clip
Traverse (°): 360
Traverse Rate (°/sec): 61
Elevation (°) (-/+): -5/+85
Elevation Rate: (°/sec): 22

FIRE CONTROL
Sights w/magnification:
AZP-37 Optical sight, also stereoscopic rangefinder, commander's telescope.

Other Fire Control:
The gun is linked to the battery net,and receives analog voice radio alerts of approaching aircraft, including direction, altitude, and aircraft type. Guns, batteries, and battalions use air watches and forward observers. Also available are RF 1L15-1 or similar azimuth warners to provide alerts with approach direction, to ready the guns for fast response.

Off-carriage Fire Control Systems:
Several directors can be used with telescopic sight, and with an added laser range-finder.

Radar: Chinese Type 311 optional. This is a continuous wave fire control radar was designed and produced to support 37-mm and 57-mm guns. The I/J-band trailer-mount radar with computer automation can conduct surveillance and target acquisition. It has at least three variants, with ranges of 30 km (311-A), 35 km (311-B), and 40 km (311-C). Target tracking range is 25 km for the -A variant. Emplacement time is 15 minutes. Radar gives user weapons a nighttime and adverse weather capability. The radar has been exported.

AMMUNITION
Type: HE, HE-FRAG-T, AP, AP-T, HVAP, HVAP-T, HEI-T
Range (m):
Max Range: 8,500
Max. Effective (slant): 3,500
Max Effective (ground targets): 3,500
Altitude (m):
Max: 6,000
Max Effective: 3,000
Min: 0
Armor Penetration (mm): 55 @ 500 m
Projectile Weight (kg):
HE: 0.74
AP: 0.77
HE-FRAG-T: 0.73
HVAP: 0.62
HEI-T: INA
Muzzle Velocity (m/s):
HE: 880
AP: 880
HVAP: 960
HEI-T: INA
HE-FRAG-T: 880
Self-Destruct (sec): 8 to 12
Self-Destruct Range (m): 3,700 to 4,700

VARIANTS
M-1939 is a derivative of the BOFORS L60.

Type 55: Chinese copy of original gun

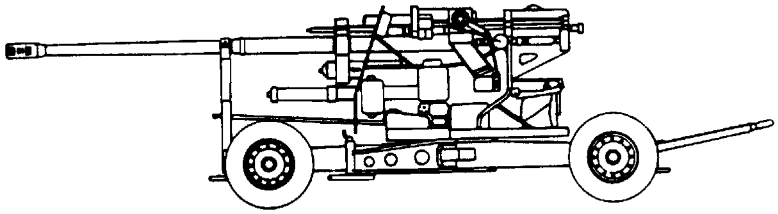
Type 65: Chinese twin barrel version, and other variants, see page 6-44.

Type 74 is a Chinese twin gun with a higher rate of fire (360-380). The Type 311 radar (see left and pg 6-43) is often used with this gun system. Max effective range and altitude with these are 4,700 m

NOTES
The M-1939 is a towed 37-mm antiaircraft gun mounted on a four-wheeled carriage. Normal emplacement requires the wheels to be removed or raised and a jack placed under each axle for support prior to firing. The rounds are gravity fed into the vertically opening sliding breech with the empty cartridges automatically extracted.

When used without a radar, the M-1939 is considered to be effective only during daylight and in fair weather.

Russian 100-mm Towed AA Gun KS-19M2



Weapons & Ammunition Types	Typical Combat Load
100-mm gun	**100**
Frag-HE AP-T APC-T	

SYSTEM
Alternative Designations: None
Date of Introduction: 1949
Proliferation: At least 20 countries

Description:
Crew: 15
Carriage: Towed 2-axle, 4-wheel carriage
Combat Weight (kg): 11,000
Length Overall (m): 9.3
Travel Position: 9.45
Firing Position: INA
Length of Barrel (m): 5.74
Height (m):
Overall: 2.2
Travel Position: INA
Firing Position: 7.62
Width Overall (m): 2.32
Prime Mover: Towing vehicle AT-S or AT-T

Automotive Performance:
Max. Towed Speed (km/h): 35
Emplacement Time (min): 7
Displacement Time (min): 6

ARMAMENT
Gun:
Caliber, Type: 100-mm gun
Number of Barrels: 1
Service Life of Barrel (rds): 2,800
Rate of Fire (rd/min):
Maximum: INA
Practical: 10-15

Loader Type: Manual
Reload Time (min): INA
Traverse (°): 360
Traverse Rate (°/sec): 20
Elevation (°) (-/+): -3 to 89
Elevation Rate (°/sec): 12
Reaction time (sec): 30

FIRE CONTROL
On-carriage:
PO-1M telescope
Field of View (°): 14
Power: 5x
Range: 3,500 m
PG panoramic telescope:
Field of View (°): 10
Power: 4x

Off-carriage:
Rangefinder: D-49 (off carriage)
Radar:
Name: SON-9/SON-9A (FIRE CAN)
Function: Fire Control
Detection Range (km): 80
Tracking Range (km): 35
Frequency: 2.7-2.9 GHz (E/F-band)
Peak Power (kW): 300

PUAZO 6-19 or 6-19M fire control director

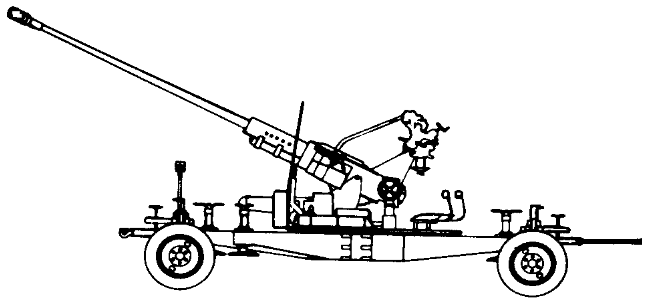
Other Fire Control:
The gun is linked to the battery net which receives analog voice radio alerts for approaching aircraft, including direction, altitude, and direction. Guns, batteries, and battalions use air watches and forward observers. Also available is 1L15-1 or similar RF azimuth warners to provide alerts with approach direction, to ready the guns for fast response.

VARIANTS
Type 59: Chinese variant.

MAIN ARMAMENT AMMUNITION
Types: Frag-HE, AP-T, APC-T
Range (m):
With on-carriage sight: 3,500
With off-carriage radar: 12,600
Altitude (m):
Max: 14,500
Max Effective: 13,700
With on-carriage sight: 3,500
Min: 0
Projectile Weight (kg):
Frag-HE: 15.61
AP-T: 15.89
APC-T: 16
Muzzle Velocity (m/s): 900-1,000
Fuze Type: Proximity and Time
Self-Destruct (sec): 30

NOTES
The KS-19M2 may also be employed in a ground support role.

Russian 57-mm Towed AA Gun S-60

	Weapons & Ammunition Types	Typical Combat Load
	57-mm gun	200
	FRAG-T APC-T	

SYSTEM
Alternative Designations: None
Date of Introduction: 1950
Proliferation: At least 46 countries

Primary Components: Battery usually has 6 guns, a fire-control radar, and a fire-control director. Mobility needs and organizational subordination determines vehicles and other equipment available.

Description:
Crew: 7
Carriage: Four-wheel
Weight (kg): 4,500
Length Overall (m):
  Travel Position: 8.50
  Firing Position: 8.84
Length of Barrel (m): 4.39
Height (m):
  Overall:
  Travel Position: 2.37
  Firing Position: 6.02
Width Overall (m):
  Travel Position: 2.08
  Firing Position: 6.9
Prime Mover: Ural-375D

Automotive Performance:
Max. Towed Speed (km/h): 60
Emplacement Time (min): 1
Displacement Time (min): 3

ARMAMENT
Gun:
Caliber, Type: 57-mm automatic cannon
Number of Barrels: 1 each
Service Life of Barrel (rds): INA
Rate of Fire (rd/min):
  Cyclic: 105-120
  Practical: 70
Loader Type: 4 rd clip, manual
Reload Time (sec): 4-8
Traverse (°): 360
Traverse Rate (°/sec): 40
Elevation (°) (-/+): -4 to +87
Elevation Rate (°/sec): 34
Reaction time (sec): 4.5

FIRE CONTROL
On-carriage:
Optical mechanical computing sight AZP-57:
  Target Range (m): 5,500
Direct fire telescope

Off-carriage:
Rangefinder: D-49
Fire Control Director: PUAZO 6-60
Radar:
  Name: Son-9/Son-9A (NATO FIRE CAN)
  Function: Fire Control
  Detection Range (km): 80
  Tracking Range (km): 35
  Frequency: 2.7-2.9 GHz
  Frequency Band: E
  Peak Power (kW): 300
Alternative Radar:
  RPK-1/FLAP WHEEL: Range 34 km
  Type 311: See below

Other Fire Control:
The gun is linked to the battery net, and receives analog voice radio alerts of approaching aircraft, including direction, altitude, and type. Guns and battery/ battalion use air watches and forward observers.
Also used by Tier 1-3 units are RF 1L15-1 or similar azimuth warners to provide alerts with approach direction, for fast AA response.

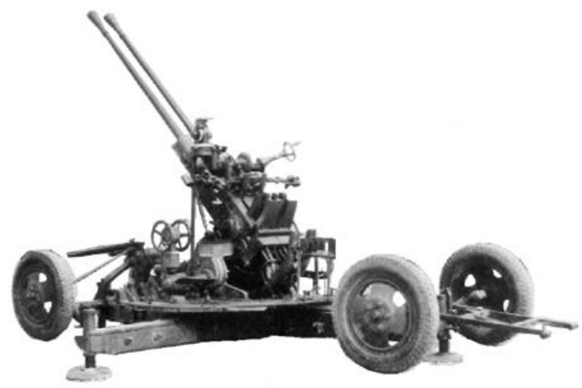
VARIANTS
Type 59: Chinese variant
SZ-60: Hungarian license-built variant

MAIN ARMAMENT AMMUNITION
Type: 57x348 SR, FRAG-HE, APC-T
Preferred round: UBR-281U APHE
Range (m):
  Max Effective: 4,000 on-carriage sight
    6,000 w/off-carriage radar
Altitude (m):
  Max Effective: 4,300 on-carriage sight
    6,000 w/off-carriage radar
  Min: 0
Projectile Weight (kg):
  FRAG-T: 2.81
  APC-T: 2.82
Muzzle Velocity (m/s): 1,000
Fuze Type:
  FRAG-T: Point detonating
  APHE: Base detonating
Self-Destruct (sec): 13-17
Penetration (mm CE): 130 mm at 1000m, APHE

NOTES
The S-60 also has an ammunition ready rack that can hold 4 four-round clips near ammunition feed mechanism on left side of the breech. The S-60 can also be used in a ground support role. The S-60 can be fired with wheels up, or with wheels on the ground.

Fire control radars such as the Chinese Type 311 can be used with this weapon.. The Chinese Type 311 continuous wave fire control radar was designed and produced to support 37-mm and 57-mm guns. The I/J-band trailer-mount radar with computer automation can conduct surveillance and target acquisition. It has at least three variants, with ranges of 30 km (311-A), 35 km (311-B), and 40 km (311-C). Target tracking range is 25 km for the -A variant. Emplacement time is 15 minutes. The radar gives user weapons a nighttime and adverse weather capability. This radar has been exported.

Chinese 37-mm Towed AA Gun Type 65



Weapons & Ammunition Types	Typical Combat Load
37-mm automatic cannons	400

SYSTEM
Alternative Designations: INA
Date of Introduction: Circa 1965
Proliferation: At least 7 countries

Description:
Crew: 5 to 8
Carriage: 4-wheeled/2-axle towed
Combat Weight (kg): 2,700
Length Overall (m): 5.940
Travel Position: 6.036
Firing Position: INA
Length of Barrel (m): 2.729
Height (m): 2.080
Overall: INA
Travel Position: 2.105
Firing Position: INA
Width Overall (m): 1.901
Prime Mover: INA

Automotive Performance:
Max. Towed Speed (km/h): 60
25 cross-country
Emplacement Time (min): 1 (est)
Displacement Time (min): 3 (est)
Fording Depth (m): 0.7
Turning Radius (m): 8

ARMAMENT
Gun:
Caliber, Type: 37-mm automatic gun
Number of Barrels: 2
Operation: Recoil
Service Life of Barrel (rds): 2,500+
Barrel Change time (min): 2-3
Rate of Fire (rd/min):
Cyclic: 320-360 (160-180/barrel)
Practical: 80
Loader Type: Two 5-round clips
Reload Time (sec): 4-8

Traverse (°): 360
Traverse Rate (°/sec): INA
Elevation (°): -5 to 85
Elevation Rate (°/sec): INA
Reaction time (sec): INA

FIRE CONTROL
Sights w/magnification: Optical mechanical computing sight
Azimuth warning receiver: 1L15-1

Off-carriage Radar: Optional. The Chinese Type 311 continuous wave I/J-band fire control radar was designed and produced to support 37-mm and 57-mm guns. The trailer-mount radar with computer automation can conduct surveillance and target acquisition. It has at least three variants, with ranges of 30 km (311-A), 35 km (311-B), and 40 km (311-C). Target tracking range is 25 km for the -A variant. Emplacement time is 15 minutes. Radar gives user weapons night-time and adverse weather capability. This radar has been exported.

Other Fire Control:
The gun is linked to the battery net which receives analog voice radio alerts for approaching aircraft, including direction, altitude, and direction. Guns and battery/ battalion have air watches and forward observers.

VARIANTS
Chinese direct copy of the Soviet twin barrel export version of the M-1939.

Type 65 is Chinese twin-barreled variant of Russian M-1939 AD gun.

Type 74 is a similar Chinese twin gun with a higher rate of fire (360-380). The Type 311 radar (see pg 6-44) is often used with this gun system. Max effective range and altitude with these are 4,700 m.

Type P793 is a Type 74 on an improved carriage with a Galileo electro-optical FCS, and an electric motor for vertical and horizontal slewing. The gun can be employed on an SP tracked vehicle mount.

M1985: NKPA has mounted the dual 37-mm Type 65 gun on an open turret VTT APC chassis. Slant range and effective altitude are 2,500 m with an optical sight. Ground target range is 3,500 m. This system appears to sometimes be confused with the **M1992** SPAAG, which has 30-mm guns. There is no 37-mm SPAAG called **M1992**.

Type 88 is a Chinese SPAAG with the Type P793 gun on the Type 69-III tank chassis. The vehicle has an electro-optical fire control system, IFF, and a fire control radar with a range of 15 km.

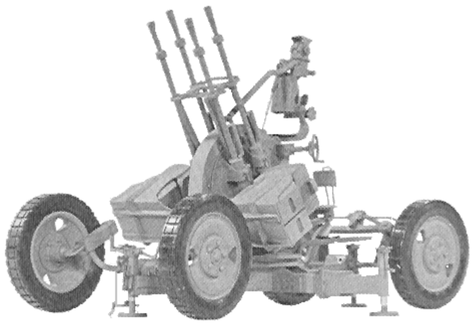
MAIN ARMAMENT AMMUNITION
Types: AP-T, HE-T, HEI-T
Range (m):
Max. Effective (slant): 3,500
Max Effective (grnd targets): 3,500
Altitude (m):
Max Effective: 3,000
Min: 0
Self-destruct time (sec): 8-12
Self-destruct range (m): 3,700-4,700

NOTES
Strengths: Highly reliable, rugged and simple to operate. Ammunition is interchangeable among Types 55, 65, and 74 AA guns.

Weaknesses: Short range, small projectile. Type 65 has no organic radar. Because it lacks a radar and powered gun laying motors, the Type 65 and most other towed 37-mm guns, when used without a radar, are considered to be effective only during daylight and in fair weather. The Type 74 and other later systems add radars to correct that weakness.

Also available are RF 1L15-1 or similar azimuth warners to provide alerts with approach direction, to ready the guns for fast response.

Russian 14.5-mm Heavy Machinegun ZPU-4



Weapons & Ammunition Types	Typical Combat Load
4 barreled KPV 14.5-mm heavy machinegun AP-T API API-T HEI HEI-T	**4,800 rds** (1,200 rds/barrel)

SYSTEM
Alternative Designations: None
Date of Introduction: 1949
Proliferation: At least 45 countries

Description:
Crew: 5
Carriage: 4 wheeled/2 axle towed chassis
Combat Weight (kg): 1,810
Length Overall (m):
Travel Position: 4.53
Firing Position: 4.53
Length of Barrel (m): 1.348
Height (m):
Overall: INA
Travel Position: 2.13
Firing Position: INA
Width Overall (m): 1.72
Prime Mover: INA

Automotive Performance:
Max. Towed Speed (km/h): 35
Emplacement Time (min): 2
Displacement Time (min): 2

ARMAMENT
Gun:
Caliber, Type: 14.5 mm machinegun
Number of Barrels: 4
Service Life of Barrel (rds): INA
Rate of Fire (rd/min):
Max: 2,200-2,400 (600/barrel)
Practical: 600 (150/barrel)
Loader Type: Belt of 150 rds
Reload Time (sec): 15
Traverse (°): 360
Traverse Rate (°/sec): 48
Elevation (°): -8 to +90
Elevation Rate (°/sec): 29
Reaction time (sec): 8
The ZPU-4 can be fired from a brief stop (<10 sec) with wheels in travel position.

FIRE CONTROL
On-Carriage:
Optical mechanical computing sight
Telescope, ground targets

Off-Carriage:
Generally, there is no organic radar except with variants NK Type 56 and M1983. Many radars are available
Optional Radar: SON-9/SON-9A, aka FIRE CAN (NATO)
Function: Fire Control
Detection Range (km): 80
Tracking Range (km): 35
Frequency: 2.7-2.9 GHz
Frequency Band: E
Peak Power (kW): 300

Other Fire Control:
The gun is linked to AD nets, and receives analog voice radio alerts of approaching aircraft, e.g,. type, altitude, and direction.

Guns and AD Battery/battalion have air watches and forward observers.

Units can add RF 1L15-1 or similar azimuth warners to provide alerts with approach direction, for fast AA response.

VARIANTS
ZPU-4 is the member of the ADA gun family (ZPU-1, ZPU-2) with the highest rate of fire.

Type 56: Chinese and NK variant. It is usually used with a DRUM TILT fire control radar.

M1983: NK SP version with a ZPU-4 type gun on a VTT-323 APC chassis, with an open turret, and a MANPADS launcher. It also tows a DRUM TILT fire control radar.

MR-4: Romanian single axle variant

VTT-323: North Korean APC (Vol 1, pg 3-24), with a twin ZPU gun.

MAIN ARMAMENT AMMUNITION
Types: API, API-T, HEI, AP-T, HEI-T
Range (m):
Max: 8,000
Max. Effective (slant): 1,400
Altitude (m):
Max: 5,000
Effective: 0-1,400

Name: BZT-44M API-T
Range (m):
Max: 8,000
Max. Effective (slant): 2,200
Altitude (m):
Max: 5,000
Effective: 0-2,200

NOTES
It may also be employed in a ground support role.

Strengths: Highly reliable, rugged and simple to operate. It has quick-reaction time, is widely deployed, and has an explosive round.
Weaknesses: The short-range small projectile requires a direct hit.

Russian 23-mm Towed AA Gun ZU-23

Weapons & Ammunition Types	Typical Combat Load
2 x 23-mm AA guns	**2,400**
HE-I HEI-T API-T APDS-T FAPDS TP	
See best mix below.	

SYSTEM
Alternative Designation: ZU-23-2
Date of Introduction: 1962
Proliferation: At least 50 countries
Description:
Crew: 5
Carriage: Two-wheeled
Combat Weight (kg): 950
Length Overall (m):
Travel Position: 4.57
Firing Position: 4.60
Length of Barrel (m): 2.01
Height Overall (m):
Travel Position: 1.87
Firing Position: 1.28
Width Overall (m):
Travel Position: 1.83
Firing Position: 2.41
Prime Movers: MTLB-T, GAZ-69 4 x 4 truck, BMD-2, BMD-3, BTR-3

Automotive Performance:
Max. Towed Speed (km/h): 70
Emplacement Time (sec): 15-20 Can fire from travel position in emergencies.
Displacement Time (sec): 35-40

ARMAMENT
Gun:
Caliber, Type: 23-mm, gas-operated gun, 2A14 or 2A14M
Number of Barrels: 2
Breech Mechanism: Vertical Sliding Wedge
Rate of Fire (rd/min):
Cyclic: 1,600-2,000
Practical: 400 in 10-30 rd bursts
Feed: 50-rd ammunition canisters fitted on either side of the upper mount assembly
Loader Type: Magazine
Reload Time (sec): 15
Traverse (^{0}): 360
Traverse Rate (^{0}/sec): INA
Elevation (^{0}) (-/+): -10°to +90°
Elevation Rate: (^{0}/sec): 54
Reaction Time (min): 8 (est.)

FIRE CONTROL
Sights w/magnification:
Optical mechanical sight for AA fire.
Straight tube telescope for ground targets. Range: 2,000 m
Azimuth warning receiver: 1L15-1

Other Fire Control:
Gun linked to battery net which receives analog voice radio alerts for approaching aircraft, including direction, altitude, and direction. Fire control radars can be used off-chassis with the system. A simple optional addition is the FARA-1 BSR. It can be attached and bore-lined to the gun.

Guns and AD units use air watches and forward observers.

VARIANTS
ZU-23-2M: Russian upgrade variant replaces optical sight with an EO fire control system employing a ballistic computer with day TV, thermal night channel, a laser rangefinder, and an auto-tracker. Hit probability increases 10-fold over the ZU-23.

ZU-23-2M1: Upgrade adds a twin MANPADS launcher (SA-16 or SA-18), which can aim, track, and launch using above FCS. The FCS also adds a digital monitor. Operator can use MANPADS at range out to 6,000 m, then shift to gun when the target is in gun range.

ZUR-23-2KG Jodek-G: Polish upgrade and export version of ZU-23-2M1 with FAPDS-T rounds and GROM missiles.

BTR-ZD is BTR-D with towed or ported ZU-23 and MANPADS. The **BTR-ZD Improved** is a BTR-D with porteed ZU-23M1 and SA-18S MANPADS.

SH-23M: Egyptian produced ZU-23, also referred to as ZU-23M.

BAU-23 X 2: Ukrainian turret with gun shield for mounting on vehicle hulls or on top of vehicle turrets. This gun is similar to ZU-23 and adds an effective AA gun to armored vehicles. They can fit on the backs of vehicles. At least one application added the turret on top of an existing BMP-1 IFV turret.

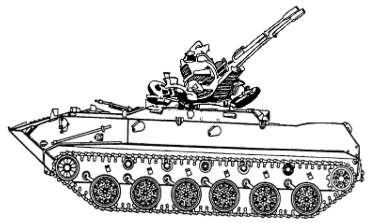
MAIN ARMAMENT AMMUNITION
Can fire the same ammunition as ZSU-23-4. Best mix for modern versions (ZU-23M and ZU-23M1) is 1,200 APDS-T and 1,200 FAPDS. Rounds are ballistically matched and no HEI is required.

Type: APDS-T and Oerlikon FAPDS-T (Frangible APDS-T). NOTE: FAPDS-T is ballistically matched to the APDS-T round.
Range (m):
Max Effective: 2,500+
Altitude (m):
Max. Effective: 1,500+
Projectile Weight (kg): INA
Muzzle Velocity (m/s): 1,180
Fuze Type: API-T: Base igniting
Self-Destruct (sec): 11
Penetration (mm KE): 19 @ 1000 m API-T
INA for APDS-T
16+ @ 1500 m, FAPDS-T
(helicopter simulant laminate array)

Type: 23x152 HE-I, HEI-T, API-T, TP,
Range (m):
Max Effective: 2,500, 2,000 against light armored ground targets such as LAVs
Altitude (m):
Max Effective: 1,500
Min: 0
Projectile Weight (kg):
HE-I: 0.18
HEI-T: 0.19
Muzzle Velocity (m/s): 970
Fuze Type:
HE-I: Point detonating
HEI-T: Point detonating
Self-Destruct (sec): 11

NOTES
This is a highly mobile air-droppable system. The ZU-23 can also be used in a ground support role against personnel and light armored vehicles.

Russian 23-mm SP AA Gun System BTR-ZD/BTR-ZD Improved



Weapons & Ammunition Types	Typical Combat Load
2 x 23-mm AA guns	**2,400**
HE-I or HEI-T	
API-T, or FAPDS	
1 x SAM Launcher	**Missiles 5**
SA-18	
BTR-ZD Improved	
2 x SAM Launcher	**Missiles 10**
SA-18S	

SYSTEM
Alternative Designation: BTR-3D, incorrect name from translation error
Date of Introduction: 1979-1980
Proliferation: At least 1 country
Description:
Crew: 7, 2 for vehicle and 5 for gun
Combat Weight (mt): 8 est
Chassis: BTR-D APC chassis
Chassis Length Overall (m): 5.88
Height Overall (m): 6.3
Width Overall (m): 2.63

Automotive Performance: See BTR-D, Vol 1, p. 2-9. The BTR-ZD is one of only a few SP air defense systems which can swim.

Radio: R-123
Protection: See BTR-D, Vol 1, p. 2-9

ARMAMENT
Gun:
Caliber, Type: 23-mm, gas-operated
Name: ZU-23 (see p. 7-5)
Number of Barrels: 2
Breech Mechanism: Vertical Sliding Wedge
Rate of Fire (rd/min):
Cyclic: 1,600-2,000
Practical: 400 in 10-30 rd bursts
Feed: 50-rd ammunition canisters fitted on either side of the upper mount assembly
Loader Type: Magazine
Reload Time (sec): 15
Traverse (^{0}): 360
Traverse Rate (^{0}/sec): INA
Elevation (^{0}): -10°to +90°
Elevation Rate: (^{0}/sec): 54
Reaction Time (min): 8 (est.)
Fire on the Move: No, in 8 sec stop

Missile Launcher:
Use SAM noted for each tier. For Tier 2 use SA-18. For Tier 1 use SA-18S.

FIRE CONTROL
Sights w/magnification:
Optical mechanical sight for AA fire
Straight tube telescope for ground targets
Optional Sights: See ZU-23M/ZU-23M1 below
Missile support equipment: Gun/launcher has a night sight (thermal, Mowgli-2 2 gen II, or II night vision goggles). One man operates a 1L15-1azimuth plotting board and Pelengator RF direction-finder. (see p. 5-35)

Other Fire Control:
Fire control radars can be used off-chassis. A simple optional addition is the FARA-1 or MT-12R MMW BSR. It can be attached and bore-lined to the gun. Guns use air watches and forward observers, and are linked to AD nets.

VARIANTS
BTR-ZD can tow or portee-mount the system. Usually, the vehicle and gun are landed apart. The gun is towed out of the landing zone, then mounted on the vehicle. Vehicle holds 2 SAM launchers. In the earliest units, the vehicle had no AA gun, rather had 6 MANPADS launchers, reload racks, and launch crews (1-2).

Tier configurations include employing updated versions of the gun system and SAMs. In early versions (Tiers 2 - 4), the SAM launchers are shoulder-mounted. In the latest version (Tier 1), they are mounted on the gun. The SAMs usually launch first at approaching targets.

ZU-23M: Replaces optical sight with an EO fire control system employing a ballistic computer with day TV, thermal night channel, laser rangefinder, and auto-tracker. Hit probability increases 10-fold over the ZU-23. For OPFOR simulations, this is the Tier 2 airborne (abn) SPAAG capability.

ZU-23M1: Upgrade mounts a twin SA-18 /18S MANPADS launcher, which can aim, track, and launch with the ZU-23M FCS. The FCS adds a digital monitor. A single operator can use the missile at ranges out to 6,000+ m, then shift to gun when the target is in range. Chinese light mech infantry use the Iron Eagle LSV with a rear-mount ZU-23M1-type gun missile system.
BTR-ZD Improved: BTR-ZD with ZU-23M1. The system also uses a FARA-1 radar for fire control. SAM is SA-18S. This system is the Tier 1 airborne SPAAG capability.

MAIN ARMAMENT AMMUNITION
Can fire the same ammunition as ZSU-23-4. Best mix for modern versions (ZU-23M and ZU-23M1) is 1,200 APDS-T and 1,200 FAPDS. Rounds ballistically matched. No HEI required.

Type: APDS-T and Oerlikon FAPDS-T (Frangible APDS-T). NOTE: FAPDS-T is ballistically matched to the APDS-T round.
Range (m): 0-2,500+ Effective
Altitude (m): 0-1,500+ Effective
Projectile Weight (kg): 0.189 API-T
Muzzle Velocity (m/s): 1,180
Fuze Type: API-T: Base igniting
Self-Destruct (sec): 11
Penetration (mm): 19 @ 1000 m API-T
16+ @1500m FAPDS-T
(helicopter simulant laminate array)

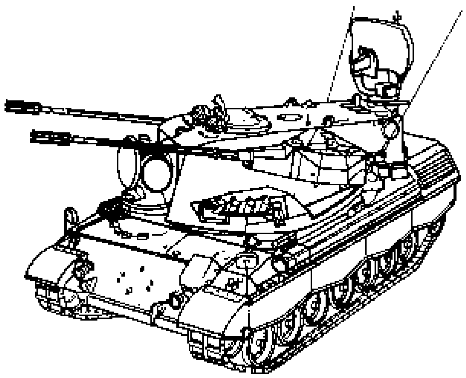
Type: 23x152 HE-I, HEI-T, API-T, TP,
Range (m):
Max Effective: 2,500, 2,000 against light armored ground targets such as LAVs
Altitude (m): 0-1,500
Projectile Weight (kg):
HE-I: 0.18
HEI-T: 0.19
Muzzle Velocity (m/s): 970
Fuze Type:
HE-I: Point detonating
HEI-T: Point detonating
Self-Destruct (sec): 11

Missiles:
Name: SA-18 Tier 2, SA-18S Tier 1
Range (m): 500-6,000+
Altitude (m): 10 (0 degraded Ph) - 3,500

Other Missiles: Tier 3 is SA-16, 4 is SA-14

NOTES
Vehicle mount arrangements can be executed in the field. Similar ad hoc mounting of AD gun, machinegun, rocket, or grenade launchers is used by paramilitary forces with commercial or military trucks, pick-up trucks, cars or utility vehicles to create "technicals". When the gun is mounted on the vehicle, it can tow a trailer with additional ammo and supplies. The gun can also be used in a ground support role, including use for high-angle fire in urban and defilade environments.

German/Swiss 35-mm SP AA Gun System Gepard



Weapons & Ammunition Types	Typical Combat Load
2 x 35-mm cannons	
HEI-T	**680**
SAPHEI-T	
FAPDS	
APDS-T/APFSDS-T	

SYSTEM
Alternative Designations: 5PFZ-B2L
Upgrade variant known as FlakPz 1A2
Date of Introduction: 1976 original
Proliferation: At least 5 countries

Description:
Crew: 3
Combat Weight (mt): 46
Chassis: Leopard 1 tank chassis
Chassis Length Overall (m): 7.16
Height (m):
Radar up: 4.23
Radar down: 3.01
Width Overall (m): 3.25

Automotive Performance:
Engine Type: 830-hp Diesel
Cruising Range (km): 550
Speed (km/h):
Max. Road: 65
Fording Depths (m): 2.25
Auxiliary power unit has 90-hp engine.

Radio: INA

Protection:
Armor (mm): 40
NBC Protection System: Yes
Smoke Protection: 8 grenade launchers

ARMAMENT
Gun:
Caliber, Type, Name: 35x228 gun, KDA
Number of barrels: 2
Rate of Fire (rd/min): 1,100 (550/barrel)
Reaction time (sec): 6-10
Ammunition Loader: Twin belt
Reload Time (min): INA
Elevation (°): -10 to +85°
Fire on Move: Yes (est)

FIRE CONTROL
FC System: EADS digital computer-based FCS
Sights w/magnification:
Stabilized video sights for -1A2 upgrade
Magnification: INA
Field of View (°): INA
Night sights: Thermal for -1A2 upgrade
IFF: Yes, MSR-400
Navigation system: Computerized
Laser Rangefinder: ND Yag (1.06μ)
Linked to Air Defense Net: Yes

Radars:
Name: INA, Siemens Manufacture
Function: Target Acquisition
Detection Range (km): 15
Tracking Range (km): INA
Frequency Band: S
Search on the Move: Yes

Name: INA
Function: Fire control
Detection Range (km): 15
Tracking Range (km): 15
Frequency Band: Ku

Armored Command Vehicle
System will link to an ACV which may have a radar for EW and target acquisition. For example, see Sborka ACV and radar (pg 6-15).

Other Radars: Links to Integrated Air Defense System (IADS) for early warning and target acquisition data from radars: Giraffe AMB at Separate Brigade and Division, LONG TRACK or similar EW/TA radar echelons above division, and radars in SAM units, e.g., SA-10.

Other Fire Control:
Guns use air watches and forward observers, and are linked to AD nets.

VARIANTS
Gepard 1A2: Upgrade variant with new FCS, including stabilized thermal sight and video auto-tracker, integrated C^2, increased range, reduced reaction time, and FAPDS.

Gepard CA1: Dutch variant (also called 95 Cheetah) uses Signaal I-band MTI radar and dual I-band K-band tracking radars.

PRTL-35mm GWI: Upgrade Dutch variant, with upgrades similar to 1A2 and new radios, but with different radars. Range with FAPDS is claimed to be 3,500-4,500.

MAIN ARMAMENT AMMUNITION
Type: HEI-T
Range (m):
Tactical AA range: 3,500 (self-destruct)
Tracer range: 3,500
Effective Altitude (m): 3,100
Min Altitude (m): 0
Self-destruct time (sec): 6-12

Type: Semi-armor-piercing HEI-T (SAPHEI-T)
Range (m): 4,000
Tactical AA Range: 3,500 (self-destruct)
Effective (m): 3,500 (est)
Self-destruct time (sec): 6-12
Penetration (mm KE): 40 at 1,000 m

Type: APDS-T
Range (m): 4,000
Tactical AA: 3,500
Tracer: 2,000
Effective Altitude (m): 3,100
Penetration (mm KE): 90 at 1,000 m

Type: APFSDS-T
Range (m): 4,000
Tactical AA: 3,500
Tracer range: INA
Effective Altitude (m): 3,100
Penetration (mm KE): 115+ at 1,000 m

Type: Frangible APDS (FAPDS) for upgrades. On impact with the target surface, the penetrator breaks into several KE fragments. The round has Frag-HE effects with the higher velocity and flat trajectory of a sabot round.

Other Ammunition Types: HEI

NOTES
KMW is developing an upgrade with 2x Stinger MANPADS missile launchers added to a gun, and integrated with the FCS.

Russian 23-mm SP AA Gun ZSU-23-4

Weapons & Ammunition Types	Typical Combat Load
4x 23-mm AA guns	**2,000**
HE-I HEI-T API-T APDS-T FAPDS TP	
See best mix below.	

SYSTEM
Alternative Designation: Shilka
Date of Introduction: 1965
Proliferation: At least 28 countries
Description:
Crew: 4
Combat Weight (mt): 20.5
Chassis: GM-575 Tracked, six road wheels, no track support rollers
Length (m): 6.5
Height (m):
Radar up: 3.75
Radar down: 2.60
Width (m): 3.1

Automotive Performance:
Engine Type: V6R-1 diesel
Cruising Range (km): 450
Speed (km/h): 50 max road

Radio: R-123
Protection:
NBC Protection System: Yes

ARMAMENT
Gun Caliber, Type, Name: 23-mm liquid-cooled AA 2A7/2A7M
Rate of Fire (rd/min):
Practical: 400, in 10-30 rd bursts
Cyclic: 850-1,000
Reload Time (min): 20
Elevation (º): -4° to +85°
Fire on Move: Yes
Reaction Time (sec): 12-18

FIRE CONTROL
Sights w/magnification:
Day and night vision devices:
Driver periscope: BMO-190
Driver IR periscope: INA
Commander periscope: TPKU-2
Commander IR periscope: TKH-ITC
IFF: INA

Radar: 1RL33M1
Name: GUN DISH
Function: Acquisition and Fire Control
Detection Range (km): 20
Tracking Range (km): 13
Frequency: 14.8 to 15.6 GHz
Frequency Band: J

RPK-2: Optical-mechanical computing sight and part of FC subsystem

Armored Command Vehicle
Name: Sborka (9S80-1 or PPRU-M1)
Chassis: MTLB-U
Radar**:** DOG EAR (use in OPFOR units)
Function: Target Acquisition
Frequency: F/G band
Range (km): 80 detection, 35 tracking
ACV links to supported tactical unit nets.

Other Radars: Using the above ACV, if an Integrated Air Defense System (IADS) is available, ZSU-23-4 links indirectly for early warning and target acquisition data from radars.

Other Fire Control:
Guns use air watches and forward observers, and are linked to AD nets

VARIANTS
ZSU-23-4M4: Russian modernized gun/missile vehicle with 2 Strelets launch modules (4 missiles) with an upgrade radar, and computer-based FCS with CCD TV sight and night channel.

Donets: Ukrainian ZSU-23-4 upgrade, with a new radar system replacing GUN DISH, plus a sensor pod believed to include day/night camera, and a laser rangefinder. Mounted above the radar/sensor pod is a layer of 6 Russian SA-18 MANPADS launchers.

Biala: Polish upgrade with thermal sight, Grom MANPADS, FAPDS-T.

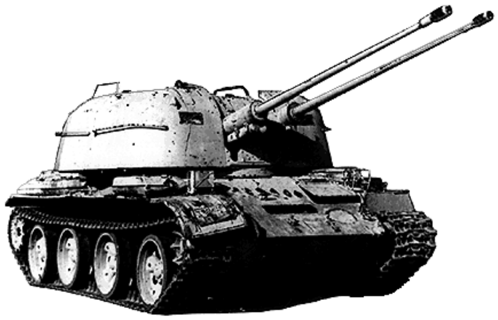
MAIN ARMAMENT AMMUNITION
Can fire the same ammunition as ZU-23. Best mix for modern versions (ZU-23M and ZU-23M1) is 1,200 APDS-T and 1,200 FAPDS. Rounds ballistically matched. No HEI required.

Type: APDS-T and Oerlikon FAPDS-T (Frangible APDS-T). NOTE: FAPDS-T is ballistically matched to the APDS-T round.
Range (m):
Max Effective: 2,500+
Altitude (m):
Max. Effective: 1,500+
Projectile Weight (kg): INA
Muzzle Velocity (m/s): 1,180
Fuze Type: None
Self-Destruct (sec): 11
Penetration (mm KE): INA APDS-T, 16+ @ 1500m FAPDS-T (helicopter simulant laminate array)

Type: 23x152 HE-I, HEI-T, API-T, TP,
Range (m):
Max Effective: 2,500, 2,000 against light armored ground targets such as LAVs
Altitude (m):
Max Effective: 1,500
Min: 0
Projectile Weight (kg):
HE-I: 0.18
HEI-T: 0.19
API-T: 0.189
TP: 0.18
Muzzle Velocity (m/s): 970
Fuze Type:
HE-I: Point detonating
HEI-T: Point detonating
API-T: Base igniting
Self-Destruct (sec): 11
Penetration (mm KE): 19 @ 1000 m API-T

NOTES
Ammunition is normally loaded with a ratio of three HE rounds to one AP round. ZSU 23-4 is capable of acquiring, tracking and engaging low-flying aircraft (as well as mobile ground targets while either in place or on the move). Resupply vehicles carry an estimated additional 3,000 rounds for each of the four ZSUs in a typical battery.

Russian 57-mm Self Propelled SP AA Gun ZSU-57-2



Weapons & Ammunition Types	Typical Combat Load
Twin 57-mm automatic cannons	**300**
Frag-HE AP-T APC-T	

SYSTEM
Alternative Designations: None
Date of Introduction: 1955
Proliferation: At least 16 countries

Description:
Crew: 6
Carriage: 4 road wheels/T-54 modified chassis
Combat Weight (mt): 28.0
Length Overall (m): 8.4
Length of Barrel (m): INA
Height Overall (m): 2.75
Width Overall (m): 3.270
Prime Mover: A shortened T-54 chassis with thinner armor and only four road wheels.

Automotive Performance:
Emplacement Time (min): N/A
Displacement Time (min): N/A
Engine Power (hp): 520
Max Road Speed (km/h): 50
Cruising Range (km): 400
Fording Depth (m): 1.4

Armor Protection: 13 mm front hull and turret

ARMAMENT
Gun, Caliber, Type:
57-mm recoil-operated air-cooled cannons, S-68
Number of Barrels: 2
Rate of Fire (rd/min):
Cyclic: 210-240 (105-120/gun)
Practical: 140 (70/gun)

Loader Type: Two 5-round clips, manual, 10 rds
Reload Time (sec): 4-8
Traverse (°): 360
Traverse Rate (°/sec): 30
Elevation (°): -5 to +85
Elevation Rate (°/sec): 20

FIRE CONTROL
Sights w/magnification:
Optical mechanical computing reflex sight (not radar controlled)
Later variants were fitted with a more sophisticated sighting system, identified by two small ports in forward upper portion of the turret.

Other Fire Control:
Absence of a tracking radar, a night vision device, and an enclosed turret makes this a daylight, fair weather weapon system only. Off-carriage radars, such as the Son-9/Son-9A (NATO FIRE CAN), RPK-1/FLAP WHEEL, or Type 311 can be used (see pg 6-50)

The gun is linked to the battery net which receives analog voice radio alerts for approaching aircraft, including direction, altitude, and direction. Guns and battery/ battalion have air watches and forward observers.

VARIANTS
Type 80 Chinese variant on Type 69-II main battle tank chassis.

MAIN ARMAMENT AMMUNITION
Types: 57 x 348 SR
APHE, Frag-T, APC-T, HVAP-T, HE-T
Uses same ammo as the towed single S-60
Range (m):
Max Effective: 4,000
Altitude (m):
Max Effective: 4,237 at 65°
Min Effective: 0
Projectile Weight (kg):
Frag-T: 2.81
APC-T: 2.82
HE-T: 2.85
Muzzle Velocity (m/s): 1,000
Fuze Type:
Frag-T (point detonating fuze)
APC-T (base detonating fuze)
HE-T (Yugoslavian, impact [super quick] action with pyrotechnical self-destruct)
Self-Destruct time (sec): 13-17
Armor Penetration (mm CE):
130 at 1,000m, APHE
96 APC-T at 1,000 m

NOTES
The ZSU-57-2 can be employed in a ground support role.

No NBC system and no amphibious capability.

Fuel drums can be fitted on rear of hull.

The gun has auto-traverse with manual backup.

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Russian Man-portable SAM System SA-7b/GRAIL

Weapons & Ammunition Types	Typical Combat Load
ready missile	1
	Normal Dismount 2
	From AD Vehicle 5

SYSTEM
Alternative Designation: 9K32M Strela-2M
Date of Introduction: 1972
Proliferation: Worldwide
Target: FW, heli
Description:
Crew: 1, Normally 2 with a loader

ARMAMENT
Launcher
Name: 9P54M
Dimensions:
Length (m): 1.47
Diameter (mm): 70
Weight (kg): 4.71
Reaction Time (acquisition to fire) (sec): 5-10
Time Between Launches (sec): INA
Reload Time (sec): 6-10
Fire on the Move: Yes, in short halt

Missile
Name: 9M32M
Range (m): 500-5,000
Altitude (m):
Max. Altitude: 4,500
Min. Altitude: 18, 0 with degraded Ph
Dimensions:
Length (m): 1.40
Diameter (mm): 70
Weight (kg): 9.97
Missile Speed (m/s): 580
Propulsion: Solid fuel booster and solid fuel sustainer rocket motor.
Guidance: Passive IR homing device (operating in the medium IR range)
Seeker Field of View (°): 1.9°
Tracking Rate (°/sec): 6°
Warhead Type: HE
Warhead Weight (kg): 1.15
Fuze Type: Contact (flush or grazing)
Probability of Hit (Ph%): 30 FW/40 heli
Self-Destruct (sec): 15
Countermeasure resistance: The seeker is fitted with a filter to reduce effectiveness of decoy flares and to block IR emissions.

FIRE CONTROL
Sights w/Magnification:
Launcher has a sighting device and a target acquisition indicator. The gunner visually identifies and acquires the target.
Gunner:
Field of View (°): INA
Night Sight: None standard
Acquisition Range (m): INA

IFF: Yes (see NOTES)

VARIANTS
The main difference between the SA-7 and SA-7b is the improved propulsion of the SA-7b. This improvement increases the speed and range of the newer version.
SA-N-5: Naval version
HN-5A: Chinese version

National War College Photo

Strela 2M/A: Yugoslavian upgrade
Sakr Eye: Egyptian upgrade

Strela-2M2: A Lomo upgrade seeker for SA-7/7b and Strela-3 /SA-14 missiles converts them to this variant, similar to SA-18 capability.

SA-7b can be mounted in various vehicles, boats, and vessels in four, six, and eight-tube launchers. It can also mount on helicopters (including Mi-8/17, Mi-24/35, and S-342 Gazelle).

NOTES
This missile is a tail-chasing heat (IR) seeker that depends on its ability to lock on to heat sources of usually low-flying fixed- and rotary-wing aircraft. When launched toward a receding aircraft, the MANPADS can be used to scan the direction and lock on without the target being visually acquired in the sights.

An identification friend or foe (IFF) system can be fitted to the gunner/operator's helmet. Further, a supplementary early warning system consisting of a passive RF antenna and headphones can be used to provide early cue about the approach and rough direction of an enemy aircraft.

The gunner may have an optional 1L15-1 portable electronic plotting board, which warns of location and direction of approaching target(s) with a display range of up to 12.5 km.

A variety of night sights are available, including 1 gen II (2,000-3,500), 2 gen II (4,500), and thermal sight (5,000-6,000). British Ring sights permit II night sight to be mounted to any MANPADS.

Russian Man-portable SAM System SA-14/GREMLIN

Weapons & Ammunition Types	Typical Combat Load	
ready missiles	One-man	1
	Normal Dismount	2
	From AD Vehicle	5

SYSTEM
Alternative Designation: 9K34 Strela-3
Date of Introduction: 1978
Proliferation: Worldwide
Target: FW, heli
Description:
Crew: 1, Normally 2 with a loader

ARMAMENT
Launcher
Name: 9P59
Dimensions:
Length (m): 1.40
Diameter (mm): 75
Weight (kg): 2.95
Reaction Time (sec): 14
Time Between Launches (sec): 35-40
Reload Time (sec): 25
Fire on the Move: Yes, in short halt

Missile
Name: 9M36 or 9M36-1
Range (m):
Max. Range: 6,000
Min. Range: 600
Altitude (m):
Max. Altitude: 6,000
Min. Altitude: 10
0 with degraded Ph
Dimensions:
Length (m): 1.4 m
Diameter (mm): 75 mm
Fin Span (mm): INA
Weight (kg): 10.3
Missile Speed (m/s): 600
Propulsion: 2-stage solid-propellant rocket
Guidance: passive IR homing
Seeker Field of View: INA
Tracking Rate: INA
Warhead Type: Frag-HE
Warhead Weight (kg): 1.0
Fuze Type: Contact/grazing
Probability of Hit (Ph%): 50 FW/50 heli
Self-Destruct (sec): 14-17

FIRE CONTROL
Sights w/Magnification:
Launch tube has simple sights
Gunner:
Field of View (^{o}): INA
Acquisition Range (m): INA
Night Sight: None standard, but available
Acquisition Range (m): 6,000

IFF: Yes

VARIANTS
Igla-M/ 9M39 (SA-N-8): Naval version

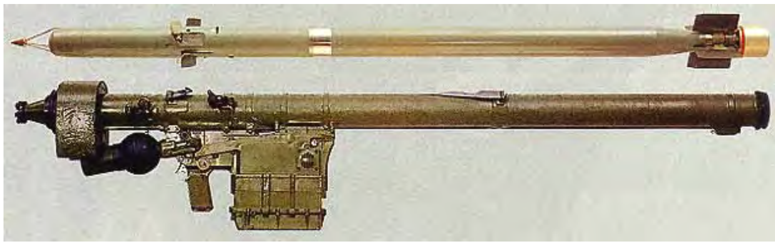
A Lomo seeker can upgrade SA-7/Strela-2 and Strela-3/SA-14 missiles to Strela-2M2, with near SA-18 capability.

NOTES
The gunner may have an optional portable electronic plotting board, which warns of location and direction of approaching target(s) with a display range of up to 12.5 km.

A variety of night sights are available, including 1 gen II (2,000-3,500), 2 gen II (4,500), and thermal sight (5,000-6,000). British Ring sights permit II night sight to be mounted to any MANPADS.

Given warning on approach azimuth at night, or launched toward a receding aircraft, the MANPADS can be used to scan the direction and lock on without the target being visually acquired in the sights.

Russian Man-portable SAM System SA-16/GIMLET


SA-16 missile, and launcher with protective pad and missile cap for transport

Weapons & Ammunition Types	Typical Combat Load
One-man	1
Normal Dismount	2
From AD Vehicle	5

SYSTEM
Alternative Designation: 9K310 Igla-1
Date of Introduction: 1981
Proliferation: At least 34 countries
Target: FW, heli, cruise missile, UAV
Description:
Crew: 1, Normally 2 with a loader

ARMAMENT
Launcher
Name: 9P322 launch tube
9P519 launcher gripstock
Dimensions (m):
Length: 1.708
Diameter: 0.08 tube, 0.33 overall
Weight (kg): 7.1
Reaction Time (sec): 5-7 seconds
Time between launches: INA
Reload time (sec): <60
Fire on the Move: Yes, in short halt

Missile
Name: 9M313
Range (m):
Max. Range: 5,200 other aspects
4,500 approaching
Min. Range: 600
Altitude (m):
Max. Altitude: 3,500 receding slow
3,000 slow approach
2,500 receding fast
2,000 fast approach
Min. Altitude: 10
0 w/ degraded Ph
Dimensions (mm):
Length: 1,593
Diameter: 72
Weight (kg): 10.8
Missile Speed (m/s): 570
Propulsion: Solid fuel booster and dual-thrust solid fuel sustainer rocket motor.
Guidance: Passive IR homing
Seeker Field of View: 80° Unusually wide FOV permits the missile to respond more quickly to maneuvering targets, such as helicopters.
Tracking Rate: INA
Warhead Type: Frag-HE. Also, fuel residue is ignited to enhance warhead blast
Warhead Weight (kg): 1.27
Fuze Type: Contact
Probability of Hit (Ph%): 60 FW/70 heli
Self-Destruct (sec): 14-17
Countermeasure resistance: (See Notes)

FIRE CONTROL
Sights w/Magnification:
Front hooded ring, rear optical
Gunner:
Day sight:
Field of View (º): INA
Acquisition Range (m): 5,200+
Night Sight: Ring mount with II NVG
Field of View (º): INA
Acquisition Range (m): 3,500

NOTE: To portray the system as a 2nd Tier MANPADS, include 2 gen II night sight. For a 3rd Tier system, 1 gen II sight may be used.

Other Acquisition Aids:
Acrft approach warn system: Vehicle alarm
Azimuth warn system: 1L15-1 plotting board
Other: Pelengator RF direction-finder system

These will be found in Tier 2 mech infantry units, and in Tier 3 at brigade level.

IFF: Yes

VARIANTS
The SA-16 is a variant of the **Igla** (SA-18) design. Because of delays in the Igla program, the Igla-1with a simpler and slightly less capable seeker was rushed into production and fielded 2 years prior to its progenitor. The SA-16 is designed especially to be able to engage helicopters.

Specialized applications include an LUAZ utility carrier designed for a MANPADS firing unit. The vehicle has a rack for mounting five 9P322 SA-16 launcher tubes. This rack could be used in other man-portable AD unit vehicle applications.

Djigit: Russian twin launcher complex mounted on a rail frame with operator's seat and tripod. Missiles can be simultaneously launched using centrally mounted sight. A Hungarian mount with this system on a GAZ-630 4x4 truck is called **Igla-1E**.

Igla-1E: Russian export variant. Unlike the base system, fuel remnants are not fuzed along with the warhead. IFF interrogator can be tailored to customer specifications.

Igla-1M: Export variant similar to -1E, but lacking an IFF interrogator.

NOTES
Launcher deployment time is 5-13 seconds. Missiles are preloaded in the launch tube for quick loading to the gripstock. A tube can be used up to five times. The missile is cooled by a disposable bottle of refrigerant. The bottle and launcher battery are useable for 30 seconds after activation. Because the nose extends past the launcher tube, the nose is protected with an extended cap which is removed before launching. Once the operator reaches the launch area, he will often remove the protective pad, and will remove the missile cap prior to use.

Maximum speed for targets engaged varies from 320 m/s rear aspect, receding targets, to 360-400 m/s head-on, approaching targets.

The gunner may have an optional portable electronic plotting board, which warns of location and direction of approaching target(s) with a display range of up to 12.5 km. For Tier 1 and Tier 2 OPFOR simulations and units operating from vehicles, this system and Pelengator are likely.

Missile seeker features a two-color seeker with improved proportional convergence logic, and an ***Igla*** (needle) device on the seeker, with mirror and tripod to cool the seeker and facilitate more rigorous g-load turns with reduced seeker warming. With these features, the SA-16 offers superior maneuver and countermeasure resistance over the previous MANPADS, and a base level of precision against maneuvering aircraft that is similar to SA-18. Nevertheless, this missile is more vulnerable to EO/IR decoy countermeasures than the later SA-18.

Russian Man-portable SAM System SA-18/GROUSE, and SA-24/Igla-Super

SA-18/Igla

Vehicle with SA-18 for AD fire support

Weapons & Ammunition Types	Typical Combat Load
ready missiles	One-man 1
	Normal Dismount 2
	From AD Vehicle 5

SYSTEM
Alternative Designation: 9K38 Igla
Date of Introduction: 1983
Proliferation: At least 6 countries
Target: FW, heli, CM, UAV
Description:
Crew: 1, Normally 2 with a loader

ARMAMENT
Launcher
Name: 9P39
Dimensions (m):
Length: 1.708
Diameter: INA
Weight (kg): 1.63
Reaction Time (sec): 6-7
Time Between Launches (sec): 16
Reload Time (sec): 10
Fire on the Move: Yes, in short halt
The launcher can launch either SA-18 or SA-16 missiles.

Missile
Name: 9M39
Range (m): 500-6,000+
Altitude (m):
Max. Altitude: 3,500
Min. Altitude: 10
0 with degraded Ph
Dimensions (mm):
Length: 1708
Diameter: 70
Weight (kg): 10.6
Missile Speed: Mach 2 (570 m/s) mean velocity
Propulsion: Solid fuel booster and dual-thrust solid fuel sustainer rocket motor.
Guidance: Passive IR homing
Seeker Field of View: INA
Tracking Rate: INA
Warhead Type: HE
Warhead Weight (kg): 1.27
Fuze Type: Contact
Probability of Hit (Ph%): 70 FW, 80 heli
Self-Destruct (sec): 15
Countermeasure resistance: Seeker resists and degrades all pyrotechnic and electronically operated IR CM

FIRE CONTROL
Sights w/Magnification:
Gunner:Day sight:
Acquisition Range (m): 6,000+
Night Sight: Mowgli-2 2 gen II
Acquisition Range (m): 4,500

Other Acquisition Aids:
Pelengator RF DF system (NOTESow).
IFF: Yes
9S520: Package with night sight, aircraft approach warning system, vehicle alarm, and**1L15-1** azimuth plotting board.

An SA-18 battery at brigade/division usually has a **Sborka** ACV (pg 6-15).

VARIANTS
Igla-D: Launcher used in airborne forces. It can be separated in two parts for easier portability, but this adds 60 seconds to the reaction time.
Igla-N: Increased lethality due primarily to the warhead mass increased to 3.5 kg, and can be separated in two parts.
Igla-V: Air-to-air version
Igla-Super (Igla-S)/SA-24: Improved missile with proximity and PD fuze, a heavier explosive charge, and segmenting rods which increase fragmentation effects. Added countermeasures further resist flares and other IRCM. Thus, the missile greatly increases P-hit and P-kill even at low altitudes and against CM. Launcher nose modified to fit the change. It has been exported to several countries.

Strela-2M2: Upgrade version SA-7/Strela-2 missile with improved Lomo seeker gives it near SA-18 capability.

Grom-1: Polish copy of SA-18
Igla-1 (SA-16): Economical variant of the Igla MANPADS especially suited for out-maneuvering helicopters.

Djigit: Russian twin launcher complex mounted on a rail frame with operator's seat and tripod.

Strelets is a twin missile launch module and coolant unit, with two launchers mounted and remotely linked to a sighting and launch control system. The Strelets permits users to mount SA-16/SA-18 on guns, platforms and vehicles, and integrate them into robust fire control systems and complexes. It can simultaneously launch two missiles at a single target. Strelets may be used as a pair, or linked for 4-launcher, 8-launcher or other arrangements. An early application is the **ZU-23M1** air defense gun/ missile system with a launch module mounted on the towed gun chassis and linked to a gun-mount FCS on a notebook computer with FLIR night sight.

SA-18 Launcher Vehicles: The Russians, following a rend in AD systems, developed a variety of mounts for launchers on AD guns and vehicles.

The **Djigit** twin-launcher can be mounted on a TUV to form a low-cost AD launcher vehicle with remote sighting and dual missile launch capability.

The **Fenix** air defense system consists of the Vodnik TUV with an IR auto-tracker passive FCS and four Strelets launcher modules (8 missiles).

IGLA SAM System turret for mount on APC, IFV, or other chassis features an SA-13 type 1-man turret with EO FCS and 4 Strelets (8 launchers). The turret has been displayed on MT-LB and BRDM-2.

LUAZ/IGLA features a Strelets launcher on the amphibious TUV, as an all-terrain AD vehicle.

A modernized **ZSU-23-4** SP gun is now a gun/ missile vehicle with 2 launch modules (4 missiles) linked to a computer-based FCS with LLLTV sight.

NOTES
In Tier 1 and 2 units, Pelengator RF helmet-mount direction-finder system permits the missile operator to slew to target, and ranges 20+ km. Available night sights include 1-3 gen II and thermal sights. British Ring sights permit an II night sight to be mounted to any MANPADS.

British Air Defense/Anti-Armor (High Velocity) Missile System Starstreak


Starstreak Lightweight Multiple Launcher

Weapons & Ammunition Types	Typical Combat Load
Ready missiles	Dismount 3 Team in Vehicle 5

SYSTEM
Alternative Designation: Manportable is Shoulder- Launched (SL) Starstreak.
Date of Introduction: 1997 vehicle (SP HVM), 2000 man-portable (-SL)
Proliferation: 2-6 countries
Target: FW, heli, ground vehicles
Description: (SL configuration)
Crew: 2 with a loader (one possible)

ARMAMENT
Launcher
Name: Aiming Unit
System Dimensions: See Missile
System Weight (kg): 24.3 with missile
Reaction Time (sec): <6
Time Between Launches (sec): <30 sec
Reload Time (sec): <25 sec est
Fire on the Move: Yes, in short halt

Missile
Name: Starstreak
Range (m): 300-7,000 max (guided)
Altitude (m): 0-5,000
Dimensions (mm): 1400 length
127 diameter:
Weight (kg): 14.0
Max Missile Speed: 1,364 m/s, Mach 4
Propulsion: Canister launch booster, bus missile, and 3 darts (sub-missiles)
Flight Time to max range (sec): 5-7
Guidance: Laser beam rider SACLOS
Warhead Type: Three 25-mm darts- tungsten KE tip and case & HE fill
Penetration (mm KE): 120+ all LAVs (Equal to 3 x 40-mm APFSDS-T rds)
HE detonates after for frangible effects
Fuze Type: Contact with time delay.
Probability of Hit (Ph%): 60 FW, >95 heli (each dart 67% for heli).
Self-Destruct (sec): Yes, INA

Other Missiles
Starstreak II: Improved missile has 8-km range and better precision. Fielded 2010.

Lightweight Multi-role Missile/LMM: A multi-role missile option with a single 3-kg tandem (HEAT/HE) warhead and proximity fuze. At 13 kg, the lower-cost missile flies 8-km at 1.5 Mach. It is due in 2013, and was successfully launched by a Camcopter S-100 UCAV variant. Other projected upgrades are semi-active laser-homing and/or dual-mode (LBR/SAL-H).

FIRE CONTROL
Sights w/Magnification:
Day sight: Avimo stabilized optical sight with lead bias system
Field of View (°): INA
Acquisition Range (m): 7000+
Night sight: Thales clip-on thermal sight
Acquisition Range (km): 4-5 est

Other Acquisition Aides:
ADAD: British passive thermal IR scanners on remote tripod or vehicle mount with 240° FOV automatic cueing.

Missile team employs an azimuth plotting board (e.g., Russian 1L15-1), for direction of approach on aerial targets (see pg 5-33).

VARIANTS
The most common launcher used is–SL.

Starburst: Javelin SAM launcher adapted for Starstreak LBR guidance- in production

Lightweight Multiple Launcher (LML): Pedestal launcher for three missiles (above). The launcher can also mount on a light vehicle, e.g., TUV. A demonstrator is LML on a Panhard tactical truck.

Starstreak II: Improved launcher uses Starstreak or Starstreak II missile. It has an auto-tracker for hands-free guidance. It was fielded in 2010.

Starstreak Lightweight Vehicle (LWV): Land Rover truck converted into an SP SAM system with a 6-canister launcher, ADAD auto-tracker, and TV/ thermal FCS. This launcher can be mounted on other vehicles.

Armored Starstreak or (SP HVM): Vehicle is a Stormer tracked APC chassis, with an 8-missile launcher. The passive IR fire control system uses ADAD, an auto-tracker and thermal sight. The launcher can be mounted on other vehicles.

Seastreak: Single-stage missile naval variant in a 12-missile launcher, with mm-wave radar FCS.

Optional Use: As a low-cost air defense/anti-armor (multi-role) system, Starstreak can be employed against ground targets, such as light armored vehicles, and snipers in bunkers or buildings. The missile and its darts, with a unique combination of penetrator and following Frag-HE, have been successfully tested against vehicle targets. With a missile cost of 1/2 to 1/3 of competing MANPADS, the system could be used as a fire support asset to complement ATGM launchers and vehicle weapons. See Vol 1, pgs 6-2 and 17 regarding anti-armor use.

Thor: British Multi-Mission Air Defense System is a RWS, with 4 missile launchers, TV, FLIR, and an auto-tracker. Weighing .5 mt, it mounts on trucks, vans, TUVs, APCs, etc., with a remote operator. Designed for Starstreak, launchers, it can also mount other MANPADS, and ATGMs, such as Ingwe, TOW, HELLFIRE, Mokopa, Spike, etc.

NOTES
Ground-based AD system optimized for use against armored helicopters and low flying fixed-wing aircraft. Missile employs smokeless propellant for minimal signature. Flight time (5-8 sec) and LBR guidance make it essentially immune to countermeasures. Because of the high velocity, the system exceeds the hit probability of competing systems against high -speed aircraft on receding flight paths.

The Starstreak's lower cost and capabilities as a multi-role missile system offers varied uses. Two considerations are the semi-automatic command line-of-sight (SACLOS) guidance and contact fuzes which make it less effective against agile fixed-wing aircraft from some aspects. Thus a more practical course would be to replace 33-50% of the MANPADS. With the lower cost of Starstreak and its multi-role capability, it could replace a portion of the expensive single-role MANPADS with Starstreaks. For instance, an 18-MANPADS battery could be reduced 33% to 12 MANPADS while adding 12 Starstreaks, with the latter used as a multi-role system. With 50% of the MANPADS replaced, the mix would be 9 MANPADS and 18 Starstreaks. Added anti-armor capability is a bonus. Substitution could vary with the expected adversary target mix.

U.S. Man-portable SAM System Stinger

Weapons & Ammunition Types	Typical Combat Load	
Ready missiles	One-man	1
	Dismount	2
	From AD Vehicle	5

SYSTEM
Alternative Designation: FIM-92A Basic Stinger
Date of Introduction: 1981
Proliferation: At least 22 countries, base and all variants

Description:
Crew: 1, Normally 2 with a loader
System: Grip-stock (with battery coolant unit, IFF, impulse generator, and seeker redesign), missile, night sight, radio and other acquisition aides

ARMAMENT
Launcher
Name: Stinger grip-stock
System Dimensions:
Length: 1.52+ launch tube
Diameter: INA
System Weight (kg): 15.2 launch-ready
2.6 belt-pack IFF
Reaction Time (sec): 6 tracking and missile activation (3-5 cooling)
Time Between Launches (sec): INA
Reload Time (sec): <10
Fire on the Move: Yes, in short halt

Missile
Name: FIM-92A
Range (m):
Max. Range: 4,000+
Min. Range: 200
Altitude (m):
Max. Altitude: 3,500
Min. Altitude: 0 with degraded Ph
Dimensions (mm):
Length: 1.52
Diameter: 70
Weight (kg): 10.0
Missile Speed: 745 m/s, Mach 2.2
Target maneuver limit: Up to 8 g
Propulsion: Solid fuel, dual-thrust (ejector motor and sustainer motor)
Guidance: Cooled 2nd gen passive IR homing (4.1-4.4 μm)
Seeker Field of View: INA
Tracking Rate: INA
Warhead Type: Frag-HE
Warhead Weight (kg): 1.0
Fuze Type: Contact with time delay
Probability of Hit (Ph%): INA
Self-Destruct (sec): 20

FIRE CONTROL
Sights w/Magnification:
Day sight: Ring and bead, most launchers
Optical sight with lead bias available
Field of View (°): INA
Acquisition Range (m): 4000+

Night sight: Optional AN/PAS-18, Wide-Angle Stinger Pointer System (WASP) thermal sight
Field of View (°): 20° x 12°
Acquisition Range (km): 20-30 side or tail aspect, 10 head-on aspect

Other Acquisition Aides:
IFF: AN/PPX-1 trigger-activated on grip-stock, with battery belt-pack

Target Alert Display Set (TADDS): US portable graphic display set w/audio alert, VHF radio, and IFF.

ADAD: British passive thermal IR scanners on remote tripod or vehicle mount with 240° FOV automatic cueing system.

Radar Equipment Providing Omni-directional Reporting of Targets at Extended Ranges (REPORTER): German/Dutch EW system with I/J band radar and IFF. Range: 40 km. Altitude: 15-4000 m.

Several U.S. and foreign radars are available for use with Stinger.

VARIANTS
Stinger-Passive Optical Seeker Technique (POST) / FIM-92B: limited production upgrade in 1983 added an IR/UV seeker with improved scan technique improved flare CM resistance. Seeker adds Target Adaptive Guidance (TAG), which shifts impact point from the exhaust plume to a more critical area of the target. Max range increases to 4,800 m, and Max Altitude increases to 3,800 m.

Stinger-Reprogrammable Micro-processor (RMP) / FIM-92C: production began in 1989. The upgrade permits uploading new CCM software. Export version lacks reprogram capability but uses an embedded IRCM program.

The MANPADS has been adapted for launch from APC or IFV chassis. It has also been adapted for light utility vehicles and combat support vehicles, such as the German Wiesel-based Fliegerfaust-2 (FLF-2). A variety of air defense launcher systems can use Stinger, Mistral, or other MANPADS.

Pedestal Mounted Stinger (multiple launcher with Stinger MANPADS and integrated FCS). **Duel**

Mounted Stinger is a Danish easily mounted tripod launcher with operator seat and console, which can be mounted on boat or truck bed.

An aircraft mount is **Air-to-Air Stinger - ATAS**.

NOTES
A number of U.S. upgrades and Stinger applications are in development.

French MANPADS Launcher Vehicle Albi/Man-portable SAM System Mistral 2

Albi with Mistral 2

Mistral on Tripod Launcher

Weapons & Ammunition Types	Typical Combat Load
Mistral 2 missiles	**8**
On launcher	2
Normal reload	4
Added reload (est)	2
7.62-mm Machinegun	**1200**
API-T	

SYSTEM
Alternative Designations: VBR Mistral
Date of Introduction: 2000-2001 Albi and Mistral 2, 1988 original Mistral
Proliferation: 25+ countries for missile, at least 2 for launcher vehicle
Target: FW, heli, CM, UAV
Description: System includes Mistral Coordination Post and up to 12 fire units
Launcher Vehicle:
Description: Tactical utility vehicle with foldable MANPADS launcher turret
Name: Albi for turret, and vehicle system
Crew: 2-3; driver, gunner, assistant gunner
Chassis: VBL tactical utility vehicle
Vehicle description: See VBL, pg. 3-66

Automotive Performance: See VBL
Radio: INA
Protection: See VBL, pg. 3-66

ARMAMENT
Launcher:
Name: Albi twin launcher on turret
Reaction Time (sec): 5 stopped, 3 with warning and azimuth from terminal
Time Between Launches (sec): <5
Reload Time (min): <1.5
Fire on Move: No, stop or short halt
Launcher Elevation (°): 0/+80
Emplace/Displace Time (min): 0.08

Missile:
Name: Mistral 2
Range (m):
Max. Range: 6,000
Min. Range: 600
Altitude (m):
Max. Altitude: 3,000
Min. Altitude: 5, 0 with degraded Ph
Dimensions (mm):
Length: 1.86
Diameter: 90
Weight (kg): 18.7
Missile Speed (m/s): 870 (Mach 2.7)
Maximum Target Speed (m/s): INA

Propulsion: Solid motor plus booster motor
Guidance: Passive infrared homing with digital multi-cell pyramidal seeker
Warhead Type: HE with Tungsten Balls
Warhead Weight (kg): 3
Fuze Type: Laser proximity/contact
Probability of Hit (Ph%): 70 FW, 80 heli
Self-Destruct (sec): INA
Countermeasure resistance: Mistral 2 resists nearly all IR countermeasures.

Auxiliary Weapon:
Caliber, Type, Name: 7.62-mm MG, AAT 52
Rate of Fire (rd/min): 250 practical (est)
900 cyclic, in bursts
Loader Type: 200-rd magazine
Ready/Stowed Rounds: 200/1000
Fire on Move: Yes

FIRE CONTROL
Sights w/Magnification:
Day sight: EO/IR sight:
Range (m): 6,000 or more
Night sight: Alis or MATIS thermal sight
Range (m): 5,000-6,000

Other Acquisition Aids:
Weapon Terminal links to alert system and provides azimuth of approaching aircraft.
--French Army Samantha digital alert system with GPS.
--or export **Aida** terminal linking to MCP
IFF: Thompson SB14 on MCP or other

ASSOCIATED VEHICLES/RADARS
Name: Samantha aircraft warning station
Chassis: VBL
Radar**:** Griffon TRS 2630
Function: Target acquisition radar
Band: S
Range (km): 15-20

Name: Mistral Coordination Post (export)
Chassis: VBL or other, such as Unimog truck
Radar**:** SHORAR
Function: Alerting radar, target acquisition
Range (km): 25

VARIANTS
The **Mistral** portable launcher employs tripod, seat, and single launcher stand. Original **Mistral 1** missile was more vulnerable to IR countermeasures.

Alamo: Cypriot mount of single Mistral launcher on 4x4 TUV.

Albi can be mounted on a variety of vehicles.

Aspic: 4-missile launcher for vehicle mount

Atlas: A twin launcher on a portable stand. Hungary purchased Unimog 4x4 light trucks with Atlas platform-mounted launchers. The launchers can be quickly removed from a vehicle and ground mounted.

One **Blazer** AD vehicle variant uses Mistral and 25-mm auto-cannon.

Guardian is HMMWV w/Mistral launchers.

SANTAL: Turret 6-missile launcher, for use on armored vehicles.

Air-to-Air Mistral (ATAM): Twin missile pod for use on helicopters.

The French Navy uses a variety of launcher configurations, e.g., **SADRAL, SIMBAD**, **SIGMA, TETRAL**, and **LAMA**.

FN-6: Recent Chinese MANPADS-a likely copy or variant of Mistral on a lightweight man-portable launcher. It will be exported to Malaysia and other countries. **Ytian/TY-90** is AAM/vehicle launch version of Mistral with 8- launcher turret, 3-D radar, and EO. Turret fits on LAV, TUV, or tow carriage.

The Mistral has been evaluated and tested as an upgrade MANPADS option for a variety of launchers on Very Short Range Air Defense (VSHORAD) vehicles, and as an air-to-air missile for use on helicopters.

NOTES
This system is an ideal VSHORAD vehicle to provide mobile and responsive AD for airborne, amphibious, motorized, and rapid response forces. Vehicles are fairly vulnerable near front lines, but offer flexible protection for deeper brigade high-value assets. They offer a lower-cost but less effective substitute for systems such as 2S6M. An Albi could replace a MANPADS squad (APC/IFV, TUV, etc, and two MANPADS launchers).

Albi response time moving is 15 sec after stop. However, most of the time, the vehicle is stopped and conducting overwatch rather than moving. Also, thanks to the missile warning system, the vehicle has ample time to be stopped and ready to launch prior to aircraft approach. With a two-man crew, the missile reload capacity in the rear can be increased to 10 or more. A 3-man crew with 8 missiles is a rational compromise, permitting the third crewman to monitor the Weapon Terminal to rapidly respond to alerts, and to assist in reloading the launchers.

Russian 30-mm SP AA Gun/Missile System 2S6M1

Weapons & Ammunition Types	Typical Combat Load
2 x 30-mm twin-barrel cannons	**1,904**
Frangible APDS AP-T, APDS Frag-T HE-I API	
SA-19/GRISON	**10** On Launchers 8 Stowed Inside 2

SYSTEM
Alternative Designations: 2K22M, Tunguska-M, Tunguska-M1
Date of Introduction: 1990
Proliferation: At least 2 countries
Target: FW, heli, cruise missile (CM), and UAV, as well as ground targets
Description:
Crew: 4 (cdr, radar op, gunner, driver)
Combat Weight (mt): 34
Chassis: GM-352M tracked vehicle
Chassis Length Overall (m): 7.93
Height (m):
TAR up: 4.02
TAR down: 3.36
Width Overall (m): 3.24

Automotive Performance:
Engine Type: V-12 turbo diesel
Cruising Range (km): 500
Speed (km/h):
Max. Road: 65
Max. Swim: INA
Fording Depths (m): INA

Radio: R-173
Protection:
NBC Protection System: Yes

ARMAMENT
Gun:
Caliber, Type, Name: 30-mm gun, 2A38M
Rate of Fire (rd/min): 4,800 (4-brls total)
Reload Time (min): Gun ammunition and missiles in about 16 min.
Elevation (°): -10 to + 87
Fire on Move: Yes

Missile:
Name: 9M311M / SA-19 / GRISON
9M311-1M for 2S6M1, Variants
Range (m):
Max. Range: 8,000, 10,000 low-flyers
Min. Range: 2,500
Altitude (m):
Max. Altitude: 6000 for 2S6M1
Min. Altitude: 0 for 2S6M1
0 w/ degraded Ph 2S6M
Dimensions:
Length (m): 2.83
Weight (kg): 57 (in container)
Missile Speed (m/s): 600-900
Guidance: Radar SACLOS
Seeker Field of View (°): INA
Tracking Rate: INA
Warhead Type: Frag-HE
Warhead Weight (kg): 9
Fuze Type: Proximity, 5 m radius
Probability of Hit (Ph%): 65 FW, 80 heli
Simultaneous Missiles per target: 2
Self-Destruct (sec): INA
System Reaction Time (sec): 6-12
Fire on Move: Yes, short halt or slow move

FIRE CONTROL
Sights w/magnification:
Gunner sights:
Day: Stabilized EO sight 1A29M
Magnification: 8x
Field of View (°): 8°
Night: 1TPP1 thermal sight
Range: 18 km, 6 ground targets
Commander's day/night sight: IR

IFF: Yes

Radars: HOT SHOT
Name: 1RL144 (TAR)
Function: Target Acquisition
Detection Range (km): 18-20
Tracking Range (km): INA
Frequency: 2-3 GHz (E Band)

Name: 1RL144M (TTR)
Function: Fire Control
Detection Range (km): 16
Tracking Range (km): INA
Frequency: 10-20 GHz (J band)

Armored Command Vehicle
Name: Sborka AD ACV (pg 6-15)
Chassis: MTLB-U
Radar**:** DOG EAR (use in OPFOR units)
Function: Target Acquisition (EW to 80 km)
Frequency: F/G band
Range (km): 80 detection, 35 tracking
ACV also links to supported tactical unit nets.

Other Radars: Links to Integrated Air Defense System (IADS) for early warning and target acquisition data from radars: Giraffe AMB at Separate Brigade and Division, LONG TRACK or similar EW/TA radar echelons above division, and radars in SAM units, e.g., SA-10.

VARIANTS
2S6: Pre-production design mounting 4 missiles
2S6M: Fielded system before upgrades.
2S6M1: Upgrade version with improved FCS and digital C2 integration, 9M11-1M missile, improved ECM resistance, and 0 m min altitude.

Upgrade 9M311-1M missile has a pulse coded xenon beacon for resistance to IRCM, a new RF proximity fuze, improved kinetics for a 10 km range to all targets, and operating altitudes of 0 - 6000 m with high precision and high Ph.

The missile may be suitable as an upgrade on existing 2S6M launchers.

MAIN ARMAMENT AMMUNITION
Types: Frangible APDS-T is the preferred round.
Other Rounds: AP-T, APDS, Frag-T, HE-I, API

Type: Frangible APDS-T
Range (m):
Max: 4,000
Min: 0
Altitude (m):
Max: 3,000
Min: 0
Penetration (mm KE): 25 at 60° 1,500 m, APDS

NOTES
Main operating mode is radar mode, with day/night capability. Other modes offer reduced reduced radar signature.
Thermal sight listed is optional, representing a rational upgrade to existing 2S6M and is standard on 2S6M1system.

Russian Gun/Missile System Pantsir-S1 and Pantsir-S1-0

Pantsir-S1-0 System with Unified Turret on BMP-3 Chassis

Weapons & Ammunition Types	Typical Combat Load
2 x 30-mm twin-barrel auto-cannons Mix of FAPDS-T and APFSDS-T	**1,400**
57E6-E Missiles	**Total** **Pantsir -S1 12** **-S1-0 12** On Launchers 8 Spares inside 4

SYSTEM
Alternative Designations: SA-22E.
Other spellings: Pantsyr, Pantzyr, Pantzir.
Date of Introduction: By 2004
Proliferation: At least 3 countries, with tracked version under export contract
Target: FW, heli, CM, ASM, UAV, guided bomb
Primary Components: System (battery) has a command post, up to 6 combat vehicles (gun/missile launch vehicles), and 73V6-E tranloaders (1 per 2 CVs).

Combat Vehicle Description:
Crew: 3 (cdr, gunner, driver)
Combat Weight (mt): 20 est
Chassis: BMP-3 (and see VARIANTS)
Chassis Length Overall (m): 6.73
Height (m): INA
Width Overall (m): 3.15

Automotive Performance:
Performance data based on BMP-3.
Engine Type: 500-hp diesel
Cruising Range (km): 600
Speed (km/h):
Max. Road: 65-70 est
Max. Swim: 10 est
Fording Depths (m): Amphibious

Radio: R-173, R-173P

Protection:
NBC Protection System: Yes

ARMAMENT
Gun:
Caliber, Type, Name: 30-mm, 30x165 2A38M auto-cannon
Rate of Fire (rd/min): 4,800 (2 twin guns)
Reload Time (min): 15-16 min, gun ammunition and missiles
Elevation (°): -5 to + 87
Fire on Move: Yes

Missile:
Name: 57E6-E/9M335/SA-22E
Range (m):
Max. Range: 12,000 below 1,500 m
18,000 above 1,500m
Min. Range: 1,500
Altitude (m):
Max. Altitude: 10,000
Min. Altitude: 5, 0 with degraded Ph
Dimensions:
Length (m): 3.2 in canister
Diameter (mm): 170/90 second stage
Weight (kg): 65, 85 in container
Missile Speed (m/s): 1,300
Guidance: Radar SACLOS, ACLOS, Home-on-Jam
Seeker Field of View (°): INA
Warhead Type: Fragmenting rod and HE
Warhead Weight (kg): 16
Fuze Type: Proximity, PD, and KE impact
Probability of Hit (Ph%): 80 undegraded
Simultaneous missiles: 3 (1-3 per target)
Self-Destruct (sec): INA
System Reaction Time (sec): 5-6
Fire on Move: Yes, short halt or slow move
Simultaneous targets: 2 per vehicle

FIRE CONTROL
Sights w/magnification:
Gunner: 1TPP1 stabilized day/night, dual channel thermal sight
Field of View (°): 1.8 x 2.6
Acq Range (km): 18 air targets, 4-6 grd
Commander’s position IR day/night sight
Auto-tracker: Dual Infrared/video tracker

IFF: Yes
Countermeasure resistance: Passive acquisition modes. Resists IR and most RF SAM CM and suppression systems.

Radars:
Name: INA, 3D Phased Array
Function: Target acquisition
Detection Range (km): 36-38
Frequency Band: INA
Simultaneous target detection: 20 targets

Name: INA
Function: Fire control and guidance
Tracking Range (km): 24-30
Scan sector: 90° x 90°
Frequency Band: Ku and Ka
Signal Processing: Digital
Guidance channels: Two simultaneous
C3 modes: Netted, battery, autonomous
Target-Handling rate: Up to 2 targets/min
Up to 12/min btry

Name: Ranzhir ACV or Sborka ACV (see above pg and pg 6-15)
Chassis: MTLB-U
ACV also links to supported tactical unit nets.

Other Radars: Links to Integrated Air Defense System (IADS) for early warning, and data from target acquisition radars, esp. Giraffe AMB or LONG TRACK at Separate Brigade and Division, EW/TA radar echelons above division, and radars in SAM units, e.g., SA-10.

VARIANTS
Pantsyr-S1: The gun/missile system module can be mounted on various chassis. The early version is mounted on a URAL-5323 truck, used for site defense of stationary targets. It had three radars and 2A72 gun. The production version has newer radars, guns, and 12 missile launchers.

Pantsir-S1-0: "Unified Armament Turret" with 8 launchers (12 SAMs) and 2 guns mounts on various chassis (e.g., trucks, BTR-80, BMP-3, BMD-3, trailers, and stands). A simplified version uses missiles with only EO guidance.

MAIN ARMAMENT AMMUNITION
An optimized mix uses 2 rounds, with each having similar ballistics. The below rounds offer flat trajectory, long range, armor penetration, high P-hit, and frangible round (KE/'CE) effects.

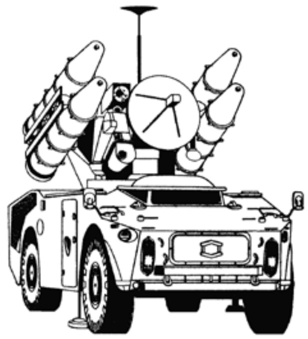
Type: Frangible APDS-T
Range (m): 200-4,000
Altitude (m): 0-3,000

Type: APFSDS-T, M929
Range (m): 200-2,500+
Altitude (m): 0-3,000
Penetration (mm CE): 45 (RHA) 2,000 m

Other Ammunition Types: Earlier 30 x 165 rounds: Frag-HE and HEI-T, API, API-T, APDS

NOTES
The guns can be used to engage ground targets, primarily for self-defense.

French SAM System Crotale 5000 and Chinese FM-90



Weapons & Ammunition Types	Typical Combat Load
R440 missile canisters	**8**
On launchers	4
Onsite resupply	4+

SYSTEM
Alternative Designations: TSE 5000
Date of Introduction: 4000 in 1988
Proliferation: At least 9 countries
Target: FW, heli, CM, ASM
also ARM for FM-90
Description: Battery has 2 platoons (4 TELARs), tech, and resupply vehicles.

TELAR: P4R 4x4
Crew: 3 launcher vehicle
Combat Weight (mt): 15.0
Length (m): 6.22
Height (m): 3.41
Width (m): 2.72

Automotive Performance:
Engine Type: INA
Cruising Range (km): 600
Max. Road Speed (km/h): 70
Fording depth (m): 0.68

Radio: INA
Protection:
Armor protection (mm): 3-5
NBC Protection System: No

ARMAMENT
Launcher:
Name: Crotale
Weight (mt): INA
Set-up time (min): 5
Reaction Time (sec): 6.5
Time Between Launches (sec): 2.5
Reload Time (min): 2
Fire on Move: No

Missile:
Name: R440
Range (m):
Max: 10,000, 14,600 heli
15,000 FM-90
17,000 ARM mode FM-90
Min. Range: 500
Altitude (m):
Max. Altitude: 5,000
Min. Altitude: 15, 7 w/blast radius

Dimensions (mm):
Length: 2890
Diameter: 150
Weight (kg): 84, 100 with canister
Missile Speed (m/s): 750
Maneuver capability (Gs): 27
Propulsion: Solid propellant motor
Guidance: RF CLOS
Warhead Type: Focused frag-HE, 15 kg
Lethal radius (m): 8, proximity fuze
Probability of Hit (Ph%): 80 FW, heli
Simultaneous missiles: 2 per target

FIRE CONTROL
Sights w/Magnification:
Day Camera: TV tracker, low elevation
Range (km): 14.0
Optical sight: back-up binocular tracker
Day/Night Camera: Thermal sight is on most Crotale 4000, all HQ-7 and FM-90
Field of view (°): 8.1/2.7
Elevation (°): 5.4/1.8
Range (km): 19.0
Missile Tracker: IR, for remote control
Countermeasures: Digital C^2 and ECM.
IFF: Yes, dipole on ACU (See Notes)

Radar:
Name: Mirador IV pulse doppler
Function: Target acquisition, surveillance
Antenna rotation rate (rpm): 60
Detection Range (km): 18.5
Altitude coverage (m): 0 - 4,500
Target Detection: 30 targets per rotation
Multiple target tracking: 12 targets.
Frequency Band: E

Radar:
Name: INA, on launcher vehicle
Function: Fire Control
Targets tracked: 1
Missile guidance, simultaneous: 2
Detection Range (km): 17
Altitude coverage (m): 0 - 5,000
Frequency (GHz): 12-18
Frequency Band: J, monopulse
Associated radar: I-band (8-10 GHz) cmd

Other Assets: The SAM system links to the IADS to get digital AD data and warnings. Associated radar for EW and TA data is radar at Brigade and Division Tier 1 and 2. System can also pass data to the net.

VARIANTS
System is mounted on vehicles, shelter, ships
Crotale 1000: Initial version 1971 w/cable link
Crotale 2000: Variant with TV and IFF.
Crotale 3000: Variant has TV auto-tracker.
Crotale 4000: Has radio data link and thermal
Crotale 5000: Adds IR auto-tracker, and new surveillance antenna. The launcher can add 2 Mistral missiles.
Crotale Improved: An Air force upgrade has planar radar, improved ECCM.
Crotale Naval: Features a doppler-fuzed R440N missile. **Crotale-S** system for Saudi Arabia is a passive all-weather system, which can be fitted to previous naval systems.

Cactus: Saudi variant for SAHV-3 missile.

FM-80/HQ-7: Chinese improved version with E/F-band TA radar, EO range of 15 km, IR localiser, and HQ-7 missile range of 12 km.

Shahab Thaqeb: Iranian FM-80 variant with the 45km Skyguard radar (25 tracking) /CP unit. Range is 12 km. ECCM defeats all CM.

FM-90: Chinese 1998 fielded and exported upgrade with: new digital C^2, thermal sight, dual band TA tracking radar (range 25 km). A new faster missile has a range of 15 km in EO/ radar modes, a new fuze system, and 17 km range in anti-radiation missile mode. Max altitude is 6 km. Digital ECCM has near jam-proof FCS. Launcher can engage three simultaneous targets IADS link can feed remote FC radar guidance.

Shahine: Upgrade has R460 15-km missile on AMX-30 tank chassis. **Shahine 2** features radar range to 19.5 , M3.5 velocity, and 5-m minimum altitude (slow movers). The radar can track 40 targets and assign 12 per battery.

NOTES
The all-weather system is deployed in platoons. A platoon includes an Acquisition and Coordination Unit (ACU) vehicle and 2-3 "firing units" (launcher vehicles). A battery includes two platoons. Battery reloads are delivered on trucks. An ACU uses the same P4R chassis and a surveillance radar, IFF interrogator, battle management computer, digital RF data link, and VHF radios. With RF data link, interval can be up to 10 km between ACUs, and up to 3 km between ACU and launcher vehicles. Off-chassis remote control system can be used to guide the missile.

European SAM System Crotale-New Generation

XA-181 SAM Launcher Vehicle

Weapons & Ammunition Types	Typical Combat Load
VT-1 missile canisters	**8**

SYSTEM
Alternative Designations: Crotale-NG, XA-181 (Finnish Launcher vehicle)

<u>This is not a modification to Crotale. It is a completely new modular system.</u>

Date of Introduction: 1991-92
Proliferation: At least 5 countries, all variants
Target: FW, heli, CM, ASM, UAV
Description: Data is for launcher vehicle TELAR: XA-181 is XA-180 (PASI) 6x6 APC with Crotale NG launcher system
Crew: 4
Combat Weight (mt): 23.0 launch-ready
Length (m): 7.35
Height (m): 2.3 for vehicle hull +2-3 m
Width (m): 2.9

Automotive Performance:
Engine Type: 240-hp diesel
Cruising Range (km): 800
Max. Road Speed (km/h): 80
Swim capability: No
Radio: INA

Protection:
Armor protection: 6-12 mm
NBC Protection System: Yes

ARMAMENT
Launcher: TELAR
Name: VL-VT-1
Weight (mt): 4.8
Reaction Time (sec): <6
Time Between Launches (sec): 1-2
Reload Time (min): 10
Fire on Move: No

Missile:
Name: VT-1
Range (m):
Max. Range: 11,000
Min. Range: 500
Altitude (m):
Max. Altitude: 6,000
Min. Altitude: 5
0 with degraded Ph
Dimensions (mm):
Length: 2300
Diameter: 170
Weight (kg): 75
Missile Speed (m/s): 1,250
Maneuver capability (Gs): 35
Propulsion: Solid propellant motor
Guidance: RF CLOS
Warhead Type: Focused frag-HE, 14 kg
Warhead Weight (kg): 14
Lethal radius (m): 8
Fuze Type: Proximity
Probability of Hit (Ph%): 80 FW, heli
Simultaneous missiles: 2 per target

FIRE CONTROL
Sights w/Magnification:
Day Camera: Mascot, CCD TV
Field of view (°): 2.4
Elevation (°): 1.8
Range (km): 15
Night Camera: Castor, thermal
Field of view (°): 8.1/2.7
Elevation (°): 5.4/1.8
Range (km): 19
Missile Tracker: IR missile localizer on CCD camera for passive TV tracking
IFF: Yes

Radar:
Name: TRS 2630 Griffon
Function: Target acquisition
Antenna: Planar array
Detection Range (km):
Aircraft: 20
Hovering rotary wing aircraft: 11
Altitude coverage (m): 0-5000
Multiple target tracking: Automatic track-while-scan for up to 8 targets.
Frequency Band: S
ECCM: Low sidelobes, wide-band frequency agility, search on the move capability

Radar:
Name:
Function: Fire Control, tracking
Detection Range (km): 30
Frequency (GHz): 35 doppler TWT (travelling wave tube)
Frequency Band: Ku
ECCM: Wideband frequency agile

Other Assets: The SAM system links to the IADS to get digital AD data and warnings. Associated radar for EW and TA data is radar at Brigade and Division Tier 1 and 2. System can also pass data to the net.

VARIANTS
System is in a modular pod, designed to fit on on ships, vehicles, and on stationary platforms. The modular all-weather system includes acquisition, tracking, launch, and supporting computer units integrated on one vehicle, for management by a single system operator.

Vehicle platforms include APCs, e.g., M113, Korean IFV, Piranha 10x10, and the XA-180 as noted.

The system can be retrofitted onto existing Crotale launcher vehicles.

Pegasus: South Korean system with a different missile

NOTES
Russian Fakel VL-VT-1 launcher gives the VT-1 hypervelocity missile (HVM) vertical 40-m rise before pitch-over to target. It permits 360° launch without need to re-orient the vehicle, and a shorter reaction time.

Russian SAM System SA-8b/GECKO Mod 1 and SA-8P/Sting

Weapons & Ammunition Types	Typical Combat Load
SA-8b in canisters	6

SYSTEM
Alternative Designation: Osa-AKM
Osa-AKM-P1for Polish upgrade
Date of Introduction: 1973**,** 1980 for AKM
Proliferation: At least 25 countries
Target: FW, heli, CM, ASM, UAV, bomb

Description:
Battery includes 4 TELARS, 2 TZM transporter -loaders, PU-12M battery CP, 9V914 survey vehicle, maintenance vehicle, 9V242-1 test station, and ground set

Launcher Vehicle:
Name: 9A33BM3 for updated version
Description: TELAR
Chassis: BAZ-5937 6x6 vehicle
Crew: 3
Combat Weight (mt): 9
Length (m): 9.14
Height (m): 4.2 surveillance radar folded down
Width (m): 2.75

Automotive Performance:
Engine Type: D20K300 diesel
Cruising Range (km): 250
Speed (km/h): 60 max road
30 off-road
Cross-country: 10
Max. Swim: 8

Radio: R-123M

Protection:
Armor (mm): None
NBC Protection System: Yes

ARMAMENT
Launcher:
Name: 9P35M2
Dimensions:
Length (m): 3.2
Diameter (mm): INA
Weight (kg): 35
Reaction Time (sec): 18-26
Time Between Launches (sec): 4
Reload Time (min): 5
Fire on Move: No
Emplacement Time (min): 4 or less
Displacement Time (min): <4 (est.)

Missile:
Name: 9M33M3 latest fielded
Dimensions (mm):
Length: 3158
Diameter: 209.6
Weight (kg): 170
Missile Speed (m/s): 1020
Propulsion: Solid propellant rocket motor
Guidance: RF CLOS
Warhead Type: Frag-HE
Warhead Weight (kg): 16
Fuze Type: Contact and proximity
Probability of Hit (Ph%): 80 FW, 65 heli
65 against heli w/EO
Simultaneous missiles: 2 per target
Self-Destruct (sec): 25-28

Performance:
With radar: Note: Primary mode with higher probabilities of hit and kill for targets above 25 m. Aircraft can be sighted to max altitude
Range (m): 1,500-10,000
Altitude (m): 25-5,000

With EO sight: Preferred (passive) mode for use vs low flyers and ECM.
Range (m): 2,000-6,500
Altitude (m): 10-5,000 FW
0-5,000 helicopters

FIRE CONTROL
Sights w/Magnification: Secondary mode. Electro-optical LLLTV with EO IR assist, for low flyers and target tracking in low visibility and heavy ECM environment
EO system day/night range (km): 6
IFF: Yes

Onboard Radar system:
Name: LAND ROLL
Function: Dual (TA and FC)
Can system operate autonomously: Yes

Radar Antenna:
Function: Search (target acquisition)
Detection Range (km): 45 in -AKM
Tracking Range (km): 20-25
Frequency: 6-8 GHz
Frequency Band: H

Radar Antenna:
Function: Fire control (monopulse TTR)
Detection Range (km): 20-25
Tracking Range (km): 20-25
Frequency: 14.2-14.8 GHz
Frequency Band: J

Radar Antenna:
Function: Fire control (missile guidance)
Frequency Band: I
Counter-countermeasures: 2-channel FH agile

Other Radars: Associated radar for EW and TA data is Giraffe AMB at Separate Brigade and Division Tier 1 and 2, or LONG TRACK at Tier 3 and 4. The SA-8b can also link to the IADS to get analog AD data from: Sborka AD battery ACV (pg 6-15), radars in echelon above division SAM units (e.g., SA-10).

VARIANTS
SA-8a: Initial production model that carried four missiles on exposed rails.

Osa-1T, SA-8b Mod 1: Belorussian system on MZKT-69222 chassis, with a variety of upgrades (e.g., night sights, integrated digital C^3, and improved missiles) are available.
T-38/Stilet, with Osa-1T missile, range of 12 km, altitude 8,000 m. P-hit /kill is 85%.

SA-8P/Osa-AKM-P1/Sting: Polish upgrade with SIC 12/TA FCS (TV day sight, 3rd gen FLIR sight, IR auto-tracker, and LRF. Passive EO range is 40 km. Rega-2 automated C2 has inertial and GPS nav. Digital system links to modern IADS nets. Day/night range with the Osa-1T missile is 12,000 m, altitude 0-8,000 m. The first scheduled export customer is India. Future goal is to add fire-and-forget missiles.

NOTES
This is one of the longest-range fielded amphibious systems in the world. This system is also air-transportable and cross-country capable. One transloader vehicle (carrying 18 missiles boxed in sets of three) supports two TELARs.

Russian SAM System SA-9/GASKIN

Weapons & Ammunition Types	Typical Combat Load
9M31M missiles	**6**
Ready	4
With Add-on racks	+2

SYSTEM
Alternative Designations: Strela-1M,
Date of Introduction: 1968
Proliferation: At least 30 countries
Target: FW, heli
Description:
An SA-9 platoon complex (9K31) includes four 9A31M TELs. One SA-9a TEL (aka BRDM-2A1) mounts a passive RF direction-finder system (see FIRE CONTROL). Three SA-9b TELs (BRDM-2A2) do not. Platoon ACV is the PU-12M or PPRU CP vehicle. The complex includes resupply vehicles.

Launcher Vehicle:
Name: 9A31M
Description: Transporter-Erector-Launcher
Crew: 3
Chassis: BRDM-2
Combat Weight (mt): 7.0
Length (m):
Launch position: 5.8
Travel position: 5.8
Height (m):
TEL up: 3.8
TEL down: 2.3
Width (m): 2.4

Automotive Performance:
Engine Type: V-8 gasoline
Cruising Range (km): 750
Speed (km/h):
Max. Road: 100.0
Max Swim: 10

Radio: INA

Protection:
Armor (mm): 14 front
NBC Protection System: Collective

ARMAMENT:
Launcher:
Name: 9P31
Reaction Time (sec): 6
Time Between Launches (sec): 5
Reload Time (min): 5
Missiles per target: 1 or 2
Fire on Move: No, stop or short halts
Emplacement Time (min): <2.0
Displacement Time (min): <2.0

Missile:
Name: 9M31
Range (m):
Max. Range: 4,200 (6,100 tail aspect)
Min. Range: 800
Altitude (m):
Max. Altitude: 3,500
Min. Altitude: 30
0 with degraded Ph
Dimensions (mm):
Length: 1.80
Diameter: 120
Weight (kg): 32
Missile Speed (m/s): 580
Propulsion: Single-stage solid propellant
Guidance: Photo contrast IR-homing, 1-3μm
Warhead Type: Frag-HE
Warhead Weight (kg): 2.6
Fuze Type: Proximity and contact
Probability of Hit (Ph%): 60 FW, 70 heli
Simultaneous missiles: 2 per target
Self-Destruct (sec): Yes

Auxiliary Weapon:
None

FIRE CONTROL
Sights w/Magnification:
Electro-optical/Infrared system:
Day Range (m): 6,500
Night Range (m): 2,000 tail chase only

Navigation: Inertial
IFF: INA

RF Direction-Finder: The FLAT BOX-A passive system uses several Pelengator sensors mounted on the vehicle to detect aircraft navigation signals for early warning and DF of approach azimuth. Detection range is up to 30 km. Many forces with this older air defense system are not proficient in using the RF DF system.

ASSOCIATED VEHICLES/RADARS
Name: PPRU-1/Ovod AD ACV (pg 6-15)
Chassis: MTLB-U
Radar**: DOG EAR** (use in OPFOR units)
Function: Target Acquisition
Frequency: F/G band
Range: 80 detection, 35 tracking

Other Radars: The SA-9 can also link to the IADS to get analog AD data and warnings.

Radar: GUNDISH. In the earlier unit configuration, an SA-9 platoon is employed in an AD battery/ battalion with ZSU-23-4 SPAA guns. The radar on those systems support the SA-9 platoon by providing detection and warning. Some of the users employ a truck-mounted J-band GUN DISH acquisition radar in the platoons, instead of the Pelengator system.

VARIANTS
Upgrade **9M31M** missile has a 1-5 μm seeker with improved range (8 km all aspect, 11 km against slow movers and tail chase). Altitude increases to 6,100m. Night range is 4,000+ m. The improved and cooled seeker makes this missile fairly resistant to IR countermeasures. System with this missile is called GASKIN MOD 1.
Target: FW, heli, CM, UAV

NOTES
Generally, the system would be expected to have the FLAT BOX-A but not the GUN DISH radar in the platoon. The insensitive missile seeker was difficult to lock on target and was fairly easily countermeasured from any aspect except the tail aspect.

System can use the Sborka PPRU-M1 upgrade ACV. However, the above system matches the lower tier technology and earlier fielding of SA-9.

Russian SAM System SA-13b/GOPHER

Weapons & Ammunition Types	Typical Combat Load
9M333 missiles	**8**
Ready	4
Reload	4
7.62-mm MG RPK	2,000

SYSTEM
Alternative Designations: Strela-10M3, 9K35M3
Date of Introduction: 1981
Proliferation: At least 22 countries

Description: Battery has 6 TELARs, Sborka ACV (CP/radar vehicle), and truck.
Target: FW, heli, CM, selected UAV
Launcher Vehicle:
Description: TELAR/Platoon Cmd TELAR
Name: 9A34M3/ 9A35M3 (see NOTES)
Crew: 3
Chassis: MT-LB
Combat Weight (mt): 12.3
Length (m):
Launch position: 6.45
Travel position: >6.45
Height (m):
TAR up: 3.8
TAR down: 2.22
Width (m): 2.85

Automotive Performance:
Engine Type: 290-hp diesel
Cruising Range (km): 500
Speed (km/h):
Max. Road: 61.5
Max Swim: 6

Radio: INA
Protection:
Amor protection (mm): 7.62-mm anti-bullet
NBC Protection System: Yes

ARMAMENT
Launcher:
Reaction Time (sec): 7-10
Time Between Launches (sec): <5
Reload Time (min): 3
Fire on Move: No, stop or short halts
Launcher Elevation (°): -5/+80
Emplacement Time (min): 0.67
Displacement Time (min): <1.0
Auxiliary Power Unit: Yes, gasoline power
Note : The SA-13 can launch SA-9 SAMs, and can mix the SAMs.

Missile:
Name: 9M333/Strela-10M3
Range (m):
Max. Range: 5,000, fly-out to 7,000+ m
Min. Range: 800
Altitude (m):
Max. Altitude: 3,500
Min. Altitude: 10, 0 with degraded Ph
Dimensions (mm):
Length: 2,223
Diameter: 120
Weight (kg): 42
Missile Speed (m/s): Up to 800/517 average
Maximum Target Speed (m/s): 420
Propulsion: Single-stage solid propellant
Guidance: Photo-contrast or dual-band IR-H
Warhead Type: HE with fragmenting rod
Warhead Weight (kg): 5 (4 m lethal radius)
Fuze Type: Laser proximity (3 m), contact
Probability of Hit (Ph%): 60 FW, 70 heli
Simultaneous missiles: 2 per target
Self-Destruct (sec): 29
Countermeasure resistance: System resists nearly all IR countermeasures.

Auxiliary Weapon:
Caliber, Type, Name: 7.62-mm MG, RPK
Rate of Fire (rd/min): 600/150 practical, bursts
Loader Type: 40/75-rd magazine
Ready/Stowed Rounds: 1000/1000
Fire on Move: Yes

FIRE CONTROL
Sights w/Magnification:
Electro-optical/IR system with auto-slew, electro-mechanical aiming, and auto-tracker:
Range (km): 10 helicopter, 5 FW
Night Sight: passive IR, Strizh TV/thermal, video display
Range (m): 6,000 IR, 12,000 thermal

IFF: 1RL246-10-2/PIE RACK (RF)
Onboard Radar:
Name: 9S86/SNAP SHOT on 9A34M3
Function: Range only
Detection Range (km): 10
Frequency: K-band

Other Onboard Sensors:
9S16/FLAT BOX -B passive radio DF system. Range is 30 km.

ASSOCIATED VEHICLES/RADARS
Name: Sborka AD ACV (pg 6-15)
Chassis: MTLB-U
Radar**: DOG EAR**
Function: Target Acquisition
Frequency: F/G band
Range: 80 detection, 35 tracking
Previous battery ACV: PU-12M.

Other Assets: The SA-13b can also link to the IADS to get digital AD warnings and data. System can also pass data to the net.

VARIANTS
SA-13a: Earlier system with SA-9 missile - 7 km range, but lower overall lethality.

Missile Variants: Strela-10M has uncooled lead sulphide (PbS) IR seeker. **Strela-10M2** has uncooled PbS seeker or cooled indium antimonide Mid-IR single-mode seeker. **Strela-10M3** detection range 10 km day/night, engage UAVs to 4,000m.

Czech SNAP SHOT radar: Version with height adjustment capability, and improved automation and communications

SAVA: Yugloslav variant of Strela-10M/ SA-13a on a BVP M80A IFV chassis.

Strijela-10Croal: Croatian variant with a TAM 150.B 6x6 vehicle chassis, TV-based fire control and thermal night sight.

9A34A: Upgrade TELAR with thermal sight, better integrated C^2, improved FCS, and a PKM machinegun. Detection range with the FCS is 10-12 km.

Muromteplovoz offers a launcher vehicle with the launcher on a BTR-60 chassis.

NOTES
The SA-13a replaced SA-9 with an updated launcher mounted on a different chassis. The MT-LB hull offers half the protection of the SA-9 BRDM-2 chassis, but with more mobility. The battery set uses centralized digital target warning net; but each launcher must individually acquire and launch against targets. Associated equipment includes a 9V915M maintenance vehicle, 9I11 external power supply system, and a 9V839M test vehicle. The platoon cmd launcher (9A35M/TELAR-1) has a FLAT BOX -B, and can pass data to the other launchers (9A34M/TELAR-2).

Russian SAM System SA-15b/GAUNTLET

Weapons & Ammunition Types	Typical Combat Load
Ready missiles	**8**

SYSTEM
Alternative Designations: 9K331 Tor-M1
Date of Introduction: 1990
Proliferation: At least 5 countries
Target: FW, heli, CM, ASM, UAV, bomb
Description: Battery system includes 4 TELARs a CP vehicle, transloaders, and maintenance vehicles

Launcher Vehicle:
Description: TELAR
Name: 9A331
Crew: 3
Chassis: GM-355 tracked vehicle
Combat Weight (mt): 34
Length (m): 7.5
Height (m): 5.1 (TAR up)
Width (m): 3.3

Automotive Performance:
Engine Type: V-12 diesel
Cruising Range (km): 500
Speed (km/h):
Max. Road: 65

Radio: INA

Protection:
Amor protection: Small arms (est)
NBC Protection System: Yes

ARMAMENT
Launcher
Name: INA, vertical launch
Dimensions: INA
Length (m): INA
Diameter (mm): INA
Weight (kg): INA
Reaction Time (sec): 3-8, +2 halt from move
Time Between Launches (sec): see NOTES
Reload Time (min): 10
Fire on Move: Yes
Emplacement Time (min): 5
Displacement Time (min): Less than 5

Missile:
Name: 9M331
Range (m):
Max. Range: 12,000
Min. Range: 1,000
Altitude (m):
Max. Altitude: 6,000
Min. Altitude: 10
0 with degraded Ph
Dimensions (mm):
Length: 2,900
Diameter: 235
Weight (kg): 167
Missile Speed (m/s): 850
Propulsion: INA
Guidance: Command
Warhead Type: Frag-HE
Warhead Weight (kg): 15
Fuze Type: RF Proximity
Self-Destruct (sec): INA
Probability of Hit (Ph%): 90 FW, 80 heli
Simultaneous missiles: 2 per target

FIRE CONTROL
Sights w/Magnification:
Electro-optical (EO) television system with IR auto-tracker
Range: 20 km

IFF: Yes

Radar:
Name: SCRUM HALF
Function: Target acquisition (TAR)
Detection Range (km): 25+
Tracking Range (km): 25
Targets tracked: 10
Frequency Band: G/H-band 3D doppler, stabilized for use on move
Target detection time (sec): 1.5-3.0

Radar:
Name: INA, sometimes called "Tor"
Also SCRUM HALF, some sources
Function: Dual - acquisition and fire control (includes tracking and guidance)
Detection Range (km): 25+
Tracking Range (km): 25, farther with slower reaction time
Targets engaged simultaneously: 2
Frequency Band: J/K-band doppler phased array

ASSOCIATED VEHICLES/RADARS
Name: Sborka AD ACV (pg 6-15)
Chassis: MTLB-U (same as Ranzhir)
Radar**: DOG EAR**
Function: Target Acquisition
Frequency: F/G band
Range: 80 detection, 35 tracking
or
Name: Ranzhir/Rangir/9S737 AD ACV
Chassis: MTLB-U
Radar: None, via radar reports from SA-15b

Other Assets: Associated radar for EW and TA data is Giraffe AMB at Separate Brigade and Division Tier 1 and 2. It links to the IADS to get digital AD data from: Sborka AD battery ACV (pg 6-15), radars in echelon above division SAM units (e.g., SA-10). The SA-15b can also pass data to the net.

VARIANTS
SA-N-9: Naval version

Tor-M1T: Versions on the ground or towed trailers. The crew sits 50 m away from the antenna/launcher trailer. The **-M1TA** has a box-body (BB) crew truck. The **–M1TB** has a BB trailer. A ground-mount version is **Tor-M1TS**. Only differences are emplace/ displace times, and 0 versus 1, or 2 trucks.

Tor-M2: Version with launcher on armored Kamaz 6x6 tactical truck chassis. **Tor-M2E** export version has a new jam-resistant TA radar. Max engagement altitude is 10,000 m.

NOTES
SA-15b is designed to be a completely autonomous air defense system (at division level), capable of surveillance, command and control, missile launch and guidance functions from a single vehicle. The basic combat formation is the firing battery consisting of four TLARs and the Rangir battery command post. The TLAR carries eight ready missiles stored in two containers holding four missiles each. The SA-15b has the capability to automatically track and destroy 2 targets simultaneously in any weather and at any time of the day.

Recent Developments in Medium-Range Air Defense (MRAD) Systems

In the past, the U.S. and Russia dominated military markets in medium-range SAM systems. Most well-fielded MRAD systems are Russian systems, or license-produced copies or variants of those systems. Most still have some effectiveness for AD, especially with upgrade programs. But new systems and new producers are expanding options for their MRAD choices.

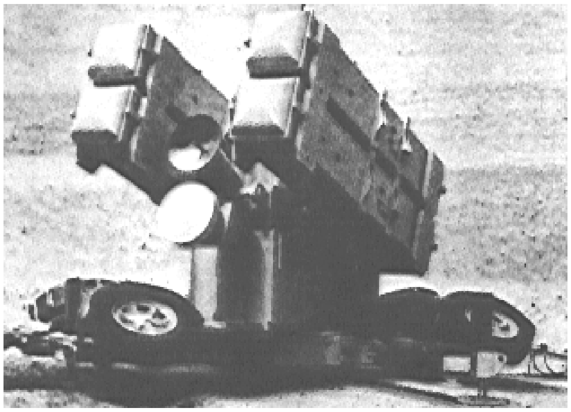
For military forces in most countries, with substantial portions of their territory lacking strategic targets or vulnerabilities, MRAD SAMs (aka: MSAMs) are more practical AD systems than the more expensive and restricted mobility long-range SAM systems. Requirements for these systems include ranges from <1 km to 20-50 km, and altitudes of 5 m to 6-50 km. Many MRAD SAMs operate within these range limits, which are less than LRAD SAMs, but offer high-altitude protection against flight profiles of most fixed-wing aircraft and many missiles.

The most proliferated MRAD SAMs are former Warsaw Pact, e.g, SA-2, SA-3, SA-3b, SA-6/SA-6b, SA-11, Buk-M1-2, or U.S. HAWK and I-HAWK. These include towed semi-mobile and vehicle-mounted mobile systems. Most legacy systems have seen many upgrades. In recent years the pace of upgrades increased, with availability of digital data systems, computer integration, imaging fire control systems, and radar improvements. Improved supporting target acquisition and fire control radars are adding improvements in overall systems capabilities. Several towed systems are now mounted on vehicle chassis. Missile improvements include missile motor/range upgrades, new warhead designs, and improved missile guidance modes. Many MRAD systems are upgraded to meet recent AD challenges (e.g., stealth, SEAD, cruise missiles, low-flying helicopters, air-launched munitions, UAVs, and ballistic missiles).

The widely fielded Russian SA-6a/Kvadret system has seen many upgrades, including improved missiles (Kub-M1 and Kub-M3), and unit upgrades in 1996-1998. Most SA-6 units were converted to SA-6b (a unit upgrade, with addition of a Buk TELAR). After 2000, further Russian upgrades included addition of SA-11/Buk-M1 or Buk-M1-2 TELARs, and wider use of Kub-M3 SAMs or unit conversion to SA-11/Buk-M1-2 SAMs. Similar conversions have been provided to export customers. Meanwhile, because of delays and cost issues in fielding the forecasted SA-17 system, Russia upgraded older SA-11 systems with conversion to the SA-17 missile (9M317), in the Buk-M1-2. The net effect of these changes may undercut fielding of the SA-17 in Russia and its budget-constricted customer states. The trend for increased missile loads on Russians LRADs may also further delay any domestic fielding of MRAD systems.

Other countries have entered the development arena for indigenous MRAD systems. A number of air-to-air missiles have been adapted for ground mounts as medium-range SAMs. Others are indigenous developments, which offer export capabilities and flexible adaptation to meet specific customer needs. See some of the many variant examples with the Aspide 2000 missile (next page). Other systems have been developed by Sweden (RBS 23/BAMSE) Israel (Spyder-MR), and South Korea. Israel is also developing Arrow as an anti-theater ballistic missile (ATBM) system. India and several other countries have foreign system acquisition/upgrade programs, as well as indigenous development programs underway. European countries (SAMP-T), Norway (NASAMS, with the AMRAAM missile), and Turkey are currently in MRADS development programs. China is offering its KS-1A system. European firms are adapting the IRIS-T AAM for ground launchers.

Italian Aspide 2000 Medium-Range SAM System (in Skyguard Battery)



Aspide 4-canister configuration

Weapons & Ammunition Types	Typical Combat Load
Launch canisters	**4/6** (depending on confiiguration)
Total missiles	**12**

SYSTEM
Alternative Designations: Missile formerly called Aspide Mk II. System is also called Skyguard gun/missile air defense system
Date of Introduction: 1986 for Mk I
Proliferation: At least 18 countries
Target: FW, heli, CM, UAV, ASM, bombs

LAUNCHER
Description: Towed 4/6 canister MEL
Name: INA
Reaction Time (sec): 11
Time Between Launches (sec): INA
Fire on Move: No
Number of fire channels: 2
Emplacement Time (min): 15

ARMAMENT
Missile:
Name: Aspide 2000 (aka: Aspide Mk II)
Range (km):
Max. Range: 45
Min. Range: 0.75
Altitude (m):
Max. Altitude: 6,000+
Min. Altitude: 10
0 with degraded Ph
Dimensions:
Length (m): 3.65
Diameter (mm): 203
Weight (kg): 230
Missile Speed (m/s): 1,288
Velocity (mach): 4.0
Maneuver capability (Gs): 35-40
Propulsion: Solid fuel booster
Guidance: J-band semi-active radar homing, active or passive homing, and home-on-jam
Warhead Type: Frag-HE
Warhead Weight (kg): 33
Fuze Type: Proximity and contact
Probability of Hit (Ph%): 80 FW and heli
Simultaneous missiles: 2 per target

FIRE CONTROL
Onboard Fire Contol: Remote controlled K-band **t**racking radar and RC illuminator radars, I/J-band on launcher

Off-carriage:
Name: Skyguard radar and CP unit
Platform: Towed compartment
EO Sights: SEC-Vidicon TV system
EO Auto-tracker: TV tracking system
Range: 25 km day only
Laser rangefinder: Yes
Radars:
Name: Skyguard Mk II (SW)
Function: Dual (target acquisition and fire control)
Detection Range (km): 45
Tracking Range (km): 25
FC Radar Frequency: 8-20 GHz
Frequency Band: I/J doppler MTI
Rotation Rate/min: 60
Mean Power (W): 200
Link: Digital data invulnerable to ECM, including frequency jumps

Other Assets: Skyguard links to the IADS to get digital AD warnings and. Data. Associated radar for EW and TA data is radar at Bde and Div Tier 1 and 2. System can also pass data to the net.

VARIANTS
Skyguard ADA complexes can vary widely. Since they are organized around the **Skyguard** radar and CP unit, it may be organized with guns only or missiles only. However, the most effective configuration is a gun/missile system. The system in OPFOR organizations is the gun/missile system, with radar/ CP unit, is Aspide 2000 (see right and pg 6-67), generators, trucks, and a Giraffe EW radar (possibly div/bde level).

Skyguard FCS is compatible with other digital ADA FCS formats. The **GDF-003** gun and Allenia **Aspide** missile are also employed with radar and CP units other than Skyguard.

Aspide 2000: System has Skyguard II radar, GDF-005 gun system (pg 6-40), and Aspide 2000 (aka: Aspide Mk II) missile.

Skyguard Mk I radar range was 20 km.

Skyguard Retrofit Kit: Gun upgrade FCS, radar, and fitted for AHEAD ammunition.

Skyguard III: GDF-005 gun, Skyguard III I-band radar, and Skyguard Retrofit Kit.

Other guns and missiles can be used with the **Skyguard** radar and CP unit.

Amoun: Egyptian Aspide/Sparrow system

Aramis: Brigade SAM system with 6-canister launcher.

LY-60: Chinese naval variant

PL-11: Chinese variant with upgrades. Range for **PL-11C** is 75 km.

Spada: Italian Air Force launcher version.
Spada 2000: Kuwaiti system with Aspide 2000 missile.

Sparrow: System from which Aspide is derived and is interchangeable in the launcher.

Other compatible missiles include: **ADATS, ASRAD, AIM-7E/Sparrow, SAHV-IR,** and **LY-60.**

NOTES
GPS is used for surveying systems in position. Skyguard connection link is 1,000-m cable link or 5000-m radio link.
To counter SEAD jamming operations, the fire control system tracker is K-band. The Aspide missile seeker can use Home-on-Jam mode.
Skyguard fire control system integrates acquisition radar with remote controlled illumination (guidance) radars.

Russian SAM System SA-2/GUIDELINE Russian SAM System

Weapons & Ammunition Types	Typical Combat Load
Single rail ground mounted	1
	Six launchers per battery

SYSTEM
Alternative Designations: Volga-75SM, S-75 Dvina, V-75 Volkhov
Date of Introduction: 1959
Target: FW, heli, CM
Proliferation: At least 41 countries

ARMAMENT
Launcher
Description: Single-rail, ground- mounted, not mobile but transportable
Name: INA
Dimensions: INA
Weight (kg): INA
Reaction Time (sec): 8 lock-on
2-3 Volga-M
Time Between Launches (sec): INA
Reload Time (min): 10-12
Fire on Move: No
Emplacement Time (min): < 4 hours
Displacement Time (min): < 4 hours
Simultaneous missiles: 3 at 6-second intervals

Missile: V750K/Volga Volga-2A
Name: INA
Range (m):
Max. Range: 35,000-50,000
60,000 Volga-2A
Min. Range: 6,000-7,000
Altitude (m):
Max. Altitude: 30,000
Min. Altitude: 100
Dimensions:
Length (m): 10.6 to 10.8
Diameter (m): 0.50
Weight (kg): 2,300-2,450 at launch
Missile Speed (mach): 4.5
Propulsion:
Solid fuel booster 5 sec duration
Sustainer liquid <70 sec duration

Guidance: Command RF
Warhead Types: HE, Nuc
Warhead Weight (kg): 195 HE
Bursting Radius (m): 125-135
Kill Radius (m): 65
CEP (m): 76.3
Fuze Type: Proximity or Command
Probability of Hit (Ph%): 50 FW, 40 heli
Volga-2A: 75 FW, 60 heli
Simultaneous missiles: 3 per target
Command destruction at (sec): 115

FIRE CONTROL
Radar:
Name: FAN SONG, A-F variants
Function: Fire control
Control Range (km): 60-120 A, B
70-145 for C, D, E
INA for F
Frequency Band: E/F for A-B,
G for C-E,
INA for F
Location: Within battery formation

Radar:
Name: SPOON REST, P-12
Function: Target acquisition, early warning
Detection Range (km): 275
Frequency Band: A=A (VHF)
B=VHF below A band
Location: Outside battery formation

Radar:
Name: FLAT FACE, P-15
Function: Target acquisition, early warning,
Detection Range (km): 250
Frequency Band: C
Location: At regimental HQ

Radar:
Name: SIDE NET, PRV-11
Function: Height finding radar
Detection Range (km): 180
Frequency Band: E
Location: At regimental HQs in some cases

Radar:
Name: KNIFE REST A
Function: Early warning radar
Detection Range (km): 370
Frequency Band: A
Location: INA older system

VARIANTS
SA-2a (Mod 0): FAN SONG A
SA-2b (Mod 1): FAN SONG B, longer missile
SA-2c (Mod 2): FAN SONG C, longer range, lower altitude engagement
SA-2d (Mod 3): FAN SONG E, EW enhanced
SA-2e (Mod 4): FAN SONG E nuc variant
SA-2f (Mod 5): FAN SONG F, EW enhanced Backup optical, home-on jam missile
SA-N-2: Naval test version, unsuccessful
HQ-2: Chinese variant (CSA-1), with a 30 km range.
HQ-2B: Chinese upgrade, with GIN SLING FC radar and improved missile, digital encrypted C2, computer FCS, EO passive alternative FC, and tracked launch vehicle. Range is 40 km.
Iraqi Mod: Infrared terminal guidance/missile.
KS-1A/HQ-12: Chinese HQ-2 upgrade to 50 km, on a wheeled launcher vehicle.
Volga-M: Mid 90's upgrade, with digital subsystems, 41 miles range, less maintenance. System uses Volga-2A missile.

Upgraded radars may be associated with this system. For instance, P-12M and SPOON-REST-B/P-12NP upgrades are fielded.

NOTES
The SA-2/Guideline is a two-stage medium-to-high altitude, radar-tracking SAM. Because its range is generally in the 35-50-km band, it is more MRAD system than LRAD. The weapon is a national-level asset usually found in the rear area with the mission of site defense of static assets such as supply and command installations. It is fired from a single-rail ground-mounted launcher that can be moved by a truck. The missiles are carried on a special transloader-semi-trailer towed by a Zil truck. An SA-2 regiment consists of three battalions, each having a single firing battery. Each battery has six launchers arranged in a star formation, a central positioned FAN SONG fire control radar, and a loading vehicle. The two forward batteries usually locate 40 to 50 km behind front lines; the third battery locates approx 80 km behind.

Limitations include limited effectiveness against updated ECM, restricted mobility, and limited effectiveness against low-altitude targets.

Russian SAM System SA-3/GOA, Pechora-2M Launcher Vehicle

Weapons & Ammunition Types	Typical Combat Load
Launch rails	2 or 4

SYSTEM
Alternative Designations: S-125 Neva, S-125 Pechora (export)
Date of Introduction: Twin launcher 1961/ quadruple launcher 1973.
Proliferation: At least 39 countries
Target: FW, heli, CM
Also ASMs, UAVs Pechora-M

LAUNCHER
Description: Towed twin or quad-rail launcher
Name: INA
Dimensions: INA
Weight (kg): INA
Reaction Time (sec): 8
2-3 Pechora-M
Time Between Launches (sec): INA
Reload Time (min): 50 (quad launcher)
Fire on Move: No
Emplace Time (min): 120
30 Pechora-M
Displacement Time (min): 100
30 Pechora-M

ARMAMENT
Missile:
Name: 5V24, Pechora-2A, 5V27DE
Range (m):
Max. Range: 25,000
28,000 Pechora-2A
35,000 5V27DE
Min. Range: 2,400
Altitude (m):
Max. Altitude: 18,300
Min. Altitude: 20, 7.5 blast radius
Dimensions:
Length (m): 6.1
Diameter (mm): 550
Weight (kg): 946
Missile Speed (m/s): 650-1,150
Velocity (mach): 3.5
Propulsion: Solid fuel booster
Guidance: Command RF

Warhead Type: Fragmenting Rod-HE
Warhead Weight (kg): 73
Kill Radius (m): 12.5 m
Fuze Type: Proximity RF, 20 m detection
Probability of Hit (Ph%): 70 FW, 70 heli
80 Pechora-M, -2M
Simultaneous missiles: 2 per target

FIRE CONTROL
Radar:
Name: LOW BLOW
Function: Fire control (tracking and command guidance)
Control Range (km): 85
Detection Range (km): 110
Frequency Band: I
Tracking Capability: 1 target (1-2 missiles)
2 tgts UNV Model 1999 mod

Radar:
Name: FLAT FACE/P-15
Function: Target acquisition
Detection Range (km): 250
Frequency Band: C

Radar:
Name: SQUAT EYE/P-15M
Function: Target acquisition (low altitude, instead of FLAT FACE)
Detection Range (km): 128
Frequency Band: C
Tracking Capability: 6 targets

Radar:
Name: Kasta-2E2for Pechora-M/-2/-2M
Function: Target acquisition and EW
Detection Range (km): 150 EW
95 TA FW 55 heli
Frequency Band: INA
Tracking Capability: 50 targets
Countermeasures: Frequency agile, phase modulation

VARIANTS
SA-3a: Two-rail launcher. Missiles without interstage fins.
SA-3b (GOA Mod 1): Two-rail launcher. Missiles have inter-stage fins.
SA-3c: Four-rail launcher.
Newa SC: Polish modernized system

Pechora-M: Upgrade fielded in 1994 and used in at least 3 countries. It has digitized FCS, and laser/EO/thermal auto-tracker for use without a radar. It added the Kasta-2E2 TA EW radar.

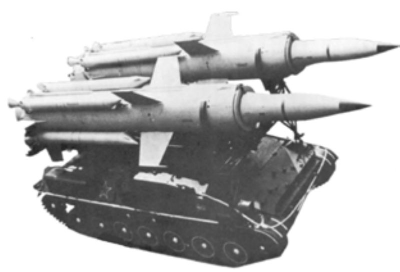
Pechora-2/UNV Model 1999: Further upgrade with truck-mounted LOW BLOW FC Radar), tracks 2 targets. It is resistant to aircraft ECM.

www.mvdv.ru

Pechora-2M: Russian mobile variant of **-2,** with launcher mounted on a truck chassis modified into a transporter-erector-launcher (TEL). Other changes: the 2-rail launcher has a storage compartment underneath for support and test equipment. Navigation and automated fire control terminal are mounted onboard. The cab has room for two or three crew members. The latest missile is 5V27DE. The trailer-mounted UNV Model 1999 FC radar (up to 300 m away) can emplace and displace in 5 minutes or less. This system has been exported to several countries.

NOTES
The SA-3/GOA is a two-stage, low- to medium-altitude SAM. Two ready missiles travel in tandem on a modified truck or tracked vehicle from which the crew loads the missiles onto a ground-mounted, trainable launcher for firing. It is principally a point/small area defense weapon. SA-3 is not mobile. It is movable, with considerable displacement time. Pechora-2M (above) is a highly mobile system, is picking up sales.

Russian SAM System SA-4b/GANEF Mod 1



SA-4a launcher with earlier missile

SA-4b launcher with 9M8M2 missile

Weapons & Ammunition Types	Typical Combat Load
Launch rails	**2**

SYSTEM
Alternative Designations: Krug-M1. Complex is 2K11 or ZRD-SD (anti-aircraft missile system - medium range).
Date of Introduction: 1974 for -M1 variant
Proliferation: At least 8 countries for SA-4
Target: FW, RW, CM
Description: System (battery) has 3 twin-launch TELs, up to 4 TZM transloaders, a missile guidance station (with radar), and technical support. Battalion has up to six batteries, 36-72 missiles, a command post van, radar vehicle, and support vehicles. At bde level, add LONG TRACK and THIN SKIN radars, 9S44 C2 complex and support assets.

Launcher Vehicle:
Name: 2P24M1 or SA-4b
Description: Transporter-Erector-Launcher
Chassis: GM 123, 7-roadwheel tracked chassis
Crew: 3-5
Combat Weight (mt): 28.2
Length (m): 7.5, 9.46 with missiles
Height (m): 4.47
Width (m): 3.2

Automotive Performance:
Engine Name, Type: 520-hp diesel
Cruising Range (km): 450
Speed (km/h):
Max. Road: 35-45
Max Off-Road: 20-30
Fording Depth (m): 1.5

Radio: R-123M, initial system

Protection:
Armor, Turret Front (m): 15
NBC Protection System: Collective

ARMAMENT
Launcher:
Name: 2P24M1 (same as above vehicle)
Time Between Launches (sec):
Simultaneous targets launcher: 1
Simultaneous targets battery: 1, 3 if launchers are operating autonomously in the battery
Simultaneous missiles per battery: 1-6
Simultaneous missiles launcher: 1or 2
Reaction Time (min): 1
Reload Time (min): 10-15 per missile
Emplace/Displace Time (min): 5
Fire on Move: No

Missile:
Name: 9M8M2/SA-4b
Range (m):
Max. Range: 50,000
Min. Range: 6,000
Altitude (m):
Max. Altitude: 24,500
Min. Altitude: 150
Dimensions:
Length (m): 8.30
Diameter (mm): 800
Weight (kg): 2,450
Missile Speed (m/s): 800-1000
Propulsion: Solid fuel
Guidance: RF command guidance
Semi-active radar-homing
Missile Beacon: CW radar transponder
Warhead Type: Frag-HE
Warhead Weight (kg): 135
Fuze Type: RF command or prox
Probability of Hit (Ph%): 70 FW and heli
Simultaneous missiles: 2 per target

FIRE CONTROL
Launcher:
Sights w/Magnification: Mounted on TEL, remotely controls msl cmd radar
EO day sighting system
IR night vision system

Missile Guidance Station :
Name: 1S32
Chassis: GANEF tracked variant
Function: Battery fire control vehicle
Radar: PAT HAND
Frequency Band: H
Function: Fire control and guidance
Range (km):
Detection: 120-130
Tracking/Guidance: 80-90
IFF: Yes

ASSOCIATED SYSTEMS
Radar:
Name: LONG TRACK
Function: Battlefield surveillance, target acquisition, early warning
Chassis: AT-T tracked P-40 variant
Unit level: AD brigade
Detection Range (km): 167
Tracking Range (km): 150
Frequency: 2.6 GHz
Frequency Band: E

Radar:
Name: THIN SKIN on Prw-16 vehicle
Function: Height finding
Chassis: AT-T tracked variant
Unit and level: AD brigade
Detection Range (km): 240
Tracking Range (km): INA
Frequency Band: H

Transloader:
Name: TZM (generic)
Chassis: URAL-375 truck
Unit and level: AD battery and above
Missiles per vehicle: 1

Automated Fire Control Complex:
Name: 9S44, K-1 (Krab)
Chassis: Van
Unit and level: AD brigade

VARIANTS
SA-4a: Original 1967 system with earlier long-nosed missile (9M8/-8M/-8M1) and terminal homing. But min range (9 km) and altitude (3 km) mean a large dead space.

SA-4b/Krug-M1: Uses **9M38M2** missile, which decreased minimum range and altitude (see left) to reduce dead space. The missile has a shorter nose section than earlier versions. The **2P24M1 i**mproved TEL added electro-optical fire control.

9M8M3: Modified version of earlier series (9M8 - 9M8M1) missile with characteristic longer nose, but adapted to SA-4b launcher

NOTES
A variety of more modern automated control complexes, such as Polyana, can be used to upgrade the system and process data more rapidly. Batteries may use a mix of SA-4a and SA-b missiles to maximize range, altitude, and guidance modes available, while reducing dead space.

Russian SAM System SA-6/GAINFUL and SA-6b/GAINFUL Mod 1

SA-6/SA-6a TEL

Buk-M1/SA-11 TELAR

Weapons & Ammunition Types	Typical Combat Load
Launch rails	**3**

SYSTEM
Alternative Designations: SA-6a or Kub Kvadrat (export)
For SA-6b and Kub-M4 see VARIANTS
Date of Introduction: 1966, 1976 Kub-M3
Proliferation: At least 22 countries
Target: Low to medium altitude FW and heli for SA-6a. FW, heli, CM for SA-6b FW, heli, TBM, CM, UAV, and ground targets for Kvadrat-M

Description:
Battery has 4 triple-launcher TELs, battery control truck, STRAIGHT FLUSH, and two TZM reload vehicles (3 missiles each).

Launcher Vehicle:
Name: SA-6/2P25M2 common upgrade. Launcher is called SA-6a.
Description: Transporter-Erector-Launcher
Chassis: Modified PT-76
Crew: 3
Combat Weight (mt): 14
Length (m): 6.09
Height (m): 4.45
Width (m): 3.04

Automotive Performance:
Engine Name, Type: V-6R, 6 cyl diesel
Cruising Range (km): 250
Speed (km/h):
Max. Road: 45
Max. Swim: N/A

Radio: INA
Protection:
NBC Protection System: Collective

ARMAMENT
Launcher:
Name: 2P25M2 (same as vehicle)
Reaction Time (min): 22-24
Time Between Launches (sec): INA
Reload Time (min): 10
Fire on Move: No
Simultaneous targets launcher: 1
Simultaneous targets battery: 1
Simultaneous missiles battery: 1-4
Emplacement Time (min): 5 or less
Displacement Time (min): 15 for a battery

Missile:
Name: Kub-M3/3M9M3
Range (m): 4,000-25,000
Altitude (m): 30-14,000
Dimensions:
Length (m): 6.20
Diameter (mm): 335
Weight (kg): 630
Missile Speed (m/s): 700
Propulsion: 2-stage, solid fuel
Guidance: Semi-active radar terminal-homing, 2-3 channels
Warhead Type: Frag HE
Warhead Weight (kg): 50
Fuze Type: Proximity RF
Probability of Hit (Ph%): 70, 80 heli
SA-6b 80 FW/heli
Simultaneous missiles: 2-3/target

FIRE CONTROL
Sights w/Magnification:
EO sighting system: TV
Range (km): 30
Commander and driver: IR
IFF: Pulse-doppler

Radar and fire control vehicle:
Name: STRAIGHT FLUSH
Function: Dual (battery target acquisition and fire control)
Frequency:
G/H-med altitude acquisition
H-illumination-med alt tracking
I-low altitude tracking
Detection Range (km): 60-90
Tracking Range (km): 28

Radar:
Name: LONG TRACK
Function: Surveillance, target acq, early warning, on vehicle
Detection Range (km): 167
Min. Range: 4,000
Altitude (m):
Max. Altitude: 14,000
Min. Altitude: 25
Tracking Range (km): 150
Frequency: 2.6 GHz
Frequency Band: E

Radar:
Name: THIN SKIN
Function: Height Finding
Detection Range (km): 240
Tracking Range (km): INA
Frequency Band: H

Onboard Radar, Buk Launcher for SA-6b:
Name: FIRE DOME
Function: Dual (TA/FC) replaces or supplements STRAIGHT FLUSH
Detection Range (km): 80, 100 (3 m^2 target)
Targets tracked: 1
Frequency: 6-10 GHz (Freq Band H/I)
IADS link: Digital link for TA data from IADS

Other Radars: Links to Integrated Air Defense System (IADS) for early warning and target acquisition data from radars: EW/TA radar echelons above division, and radars in SAM units.

VARIANTS
Kvadrat/SA-6 have generally replaced 3M9, 9M9 missiles with 3M9M3/Kub-3M since 1976. Other improvements include the TV electro-optical sight system and launcher improvements.

Kvadrat (Modernized): Upgrades to SA-6 in 1996-1998 included improved radar guidance and command, reduced signature, and improved 2P25M2 launcher with an improved TV/EO sight.

SA-6b/Buk: The SA-11 (pg 6-71) was designed to replace SA-6 as a medium range SAM. Initial (Buk) TELARS were added in SA-6 batteries, (then called SA-6b), initially mounting SA-6/9M9 missiles. The Buk added a modern CP (digitally linked to IADS) and a second (more capable) dual mode battery radar which can direct fires. Later Buk-M/-M1 TELARs are also used with SA-6b/Kvadrat/Kvadrat-M batteries.

Kvadrat-M: Fielding for the **Kub-M4** upgrade began in 1999-2000, with the 2P25M2E launcher vehicle, MTI radar, digital processing, new TV optical sight and guidance radar. One Buk-M1-2 launcher (see 6-73), 9S470M1 CP vehicle, and Orion intel is included. A Buk-M1-2 launcher-loader is usually added, which increases battery launch capability. Missile range is 42 km.

NOTES
Two or more battery missiles may be launched at a target during an engagement. It has radio-command guidance with semi-active radar terminal homing. The associated STRAIGHT FLUSH fire control/target acquisition radar vehicle uses the same chassis as the SA-6a TEL.

Russian SAM System SA-11/GADFLY

Weapons & Ammunition Types	Typical Combat Load
Self-Propelled launcher	**8**
TELAR	**4**
Onboard Reload	**4**
Loader-launcher	**8**
On launch rails	**4**
On transport rails	**4**

SYSTEM
Alternative Designations: Buk-M1, Gang
For OPFOR Buk-M1 is a Tier 2 system.
Date of Introduction: 1979/ 83 for -M1
Proliferation: At least 5 countries
Target: FW, heli, CM, UAV, guided bomb, artillery rocket, ground targets, ships
Description:
Brigade assets include bde/btry CPs and radars, TELARs, launcher-loaders, TM-9T229 missile transporter, maintenance and test units.

Launcher Vehicle:
Name: 9A310M1 or BUK-M1
Description: TELAR
Crew: 4
Combat Weight (mt): 32.34 for TELAR
Chassis: GM-569 armored tracked for CP, radar, TELAR, launcher-loader
Description: TELAR
Length (m): 9.3
Height (m): 3.8 travel/7.72 deployed
Width (m): 3.25

Automotive Performance:
Engine Name, Type: 700-hp diesel
Cruising Range (km): 500
Max. Road Speed (km/h): 65, 30 TELARs up
Fording depth (m): 1
APU: Yes for TELARs, LL, radars, CP

Radio: INA
Protection:
Amor protection: Small arms (est)
NBC Protection System: INA

ARMAMENT
Launcher:
Missiles per launcher: 4
Reaction Time (min): 0.25-0.5
0.1 for low-flyers
Time Between Launches (sec): 3
Reload Time (min): 12
Fire on Move: No
Emplacement time from march (min): 5
Displacement Time (min): 5
Emplace time for reposition (sec): 20 for a 100-200 m survivability move.
Simultaneous targets per launcher: 1
Simultaneous missiles per launcher: 2

Missile:
Name: 9M38M1
Range (m):
Max. Range: 36,000
Min. Range: 3,000
Altitude (m):
Max. Altitude: 22,000
Min. Altitude: 15, 0 with degraded Ph
Dimensions:
Length (m): 5.55
Diameter (mm): 400
Weight (kg): 690
Max target speed (m/s): 830
Max missile Speed (m/s): 1,200
Propulsion: Solid fuel
Guidance: RF command, inertial correction, semi-active radar homing
Warhead Type: Frag HE
Warhead Weight (kg): 70
Warhead lethal radius (m): 17
Fuze Type: Proximity RF
Probability of Hit (Ph%): 80 FW and heli
Simultaneous missiles: 2 per target

PROTECTION/COUNTERMEASURES
Jam ECCM: Noise jam 240-330 w/MHz
Passive Jam ECCM: 3 Packets/100m
Measures: One launcher operates radar, while others are passive. Other guidance modes reduce radar illumination time.
IFF: Pulse-doppler

FIRE CONTROL
Sights: TV optical auto-tracker
Acquisition range (km): 20
Navigation systems: Available on all

Onboard Radar:
Name: FIRE DOME
Function: Dual (acquisition and fire control)
Detection Range (km): 80 (2 m^2), 100 (3m^2)
Targets tracked: 1 per SPL vehicle
Frequency: 6-10 GHz (H/I band)
Guidance range: 42 km

Other Assets: SA-11 digitally links to the IADS (e.g., aircraft, intel , and other SAM units. SA-10/20/11 FO radars share data with other units in the IADS net. Other assets are FOs and ELINT, e.g., Orion (pg 6-73).

Radar:
Name: 9S18M1/SNOW DRIFT
Function: Battery target acquisition radar
Description: Armored tracked chassis w/ phased array radar and dipole antenna
Detection range (km): 100-150
Range precision (m): 400
Detection altitude (km): 25
Targets Tracked: 75
Frequency: centimetric 3-D phased array
Azimuth Coverage (°): 360 with rotation
Emplace/Displace (min): 5

Other Radars: Regiment/Bde will have EW/TA radars, such as SPOON REST (pg 6-68) or Kasta-2E2 (pg 6-69).

Launcher-loader (LL)
Name: 9A39M1
Function: Battery resupply and TEL
Fire Control: None, TELARs guide.
Missile load: 8
Reload Time (min): 15
Emplacement Time (min): 5

C^2 Vehicle:
Name: 9S470M1
Function: Battery Command Post
Data links: Wire and radio AD net, to IADS net, and to SA-10/Osnova
Targets tracked: 15 (with 6 at TELs)

VARIANTS
Buk/SA-6b: Initial launcher production preceded the missile. So it was fitted for the SA-6 (9M9) missile and 1 launcher added to each SA-6 battery, transforming the battery from SA-6a to SA-6b. See SA-6 (pg 6-71, SA-6b) for details.

Buk-M: System with SA-11 missile. It had the inadequate TUBE ARM, replaced by SNOW DRIFT. Few bns were fielded. Most SA-11 units use **Buk-M1.**

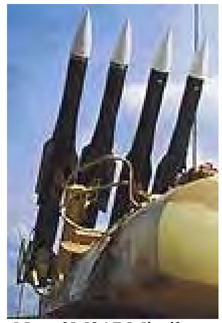
Buk-M1-2 and **SA-17/GRIZZLY:** Upgrade systems (page 6-73).

Buk-M3: Upgrade with new radar, and TBM intercept speed of Mach 4.

NOTES
TELARs can operate autonomously. Launcher-loader can launch with TELAR command. SA-11 can launch SAMs against ground targets.

Russian SAM System Buk-M1-2 (SA-11 FO) and Buk-M2E (SA-17)


Buk-M1 Launcher with 9M38M1 Missiles


New 9M317 Missiles

Weapons & Ammunition Types	Typical Combat Load
System/Complex Total	**72**
Self-Propelled Launcher	**8**
TELAR	4
Onboard Reload	4
Loader-launcher	**8**
On launch rails	4
On transport rails	4

SYSTEM
Alternative Designations: 9K37M1-2
In OPFOR this is a Tier 1 system.
Date of Introduction: 1997
Proliferation: At least 3 countries, export
Target: FW, heli, TBM, CM, ASM, UAV, artillery rocket, ships, ground targets
Primary Components:
System is a modernized version of the SA-11/Buk-M1 system. It adds elements of the SA-17/GRIZZLY system (missile, LRF fire control) to the system.
Battalion/Complex: CP vehicle, radar, 6 transport, maintenance, mobile test vehs.
Chassis: GM-569 armored tracked for CP, radar, TELAR, launcher-loader

Launcher Vehicle:
Name: 9A310M1-2
Description: TELAR
Crew: 4
Combat Weight (mt): 32.34
Description: TELAR
Dimensions (m) : 9.3 length x 3.25 width 3.8 travel/7.72 deployed height

Automotive Performance: See SA-11
Radio: INA
Protection:
Amor protection: Small arms (est)
NBC Protection System: Collective

ARMAMENT
Launcher:
Missiles per launcher: 4
Reaction Time (min): 0.25-0.5
0.1 for low-flyers
Time Between Launches (sec): 2
Reload Time (min): 12
Fire on Move: No
Emplace/Displace time (min): 5
Emplace time, reposition (sec): 20 for a 100-200 m survivability move.

Missile:
Name: 9M317
Range (km): 3-42, 15 with TV sights
Altitude (m):
Max. Altitude: 25,000
Min. Altitude: 0 with degraded Ph
Dimensions: 5.5 m length, 400 mm diameter
Weight (kg): 715
Max target speed (m/s): 1,200
Max missile Speed (m/s): 1,200
Propulsion: Solid fuel
Guidance: RF command, inertial correction, Semi-active radar homing
Warhead Type: Frag HE
Warhead Weight (kg): 70
Warhead lethal radius (m): 17
Fuze Type: Proximity RF or contact
Probability of Hit (Ph%): 70 TBM, 80 other
Simultaneous missiles: 2 per target
Other Missile: 9M317A is an anti-radiation homing missile/attack missile interceptor

PROTECTION/COUNTERMEASURES
Jam ECCM: Noise jam 240-330 w/MHz
Passive Jam ECCM: 3 Packets/100m
Measures: One launcher operates radar, while others are passive. Other guidance modes reduce radar illumination time.
IFF: Pulse-doppler

FIRE CONTROL
Laser Range-finder: New addition to FCS. This permits system to engage ground targets to 15 km, waterborne targets 25 km.
Sights: TV optical auto-tracker
Acquisition range (km): 20, permits passive missile guidance, day and night
Navigation systems: Available on all

Onboard Radar:
Name: FIRE DOME, see pg 6-72

Radar:
Name: 9S18M1-1/SNOW DRIFT
Note: It is similar to 9S1M1 on pg 6-72.

Other Radars: Brigade will have EW/TA radars, such as Kasta-2E2 (pg 6-69), or one similar to Giraffe AMB (pg 6-16). Upgrade options include radars and support vehicles from the SA-17 System.

Other Assets: The SA-11 digitally links to the IADS (e.g., aircraft, intel , and other SAM units. SA-10/20/11 FO radars share data with other units in the IADS net. Assets include FOs and ELINT, e.g., Orion (pg 6-17).

Launcher-loader (LL): 9A39M1-1, see 9A38M1, pg 6-71.
C^2 Vehicle: 9S470M1-2, see 9S470M1, pg 6-71.

VARIANTS
Predecessors, **Buk** and **Buk-M1**, see pg 6-71

China is working on a Buk-M1-2 upgrade version called **HQ-16.**

SA-N-12: Naval version with 12 x 9M17M/ Shtil-1 missiles in a vertical-launch canister.

SA-17/GRIZZLY/Buk-M2E/URAL: Russian redesign/follow-on of SA-11. It uses 9M317 missiles and 2 new radars. The system has 2 **Giraffe** vehicles (with dual mode radars on telescope arms), 4 TELARs, 8 LLs, Orion RF intel system, and a support coordination vehicle. All battery radars are CHAIRBACK phased array with 160 km detection, 120 for low flyers. System simultaneously tracks 10 targets and engage 4 (or 24/bn). Effective range is 45 km with Ph of 90% for FW/heli, 80 TBMs. Minimum altitude is 0 m with 80% P-hit. It now has limited fielding in 1 country.

A wheeled version of SA-17 is **Buk-M2EK** on a 6x6 Belorussian cross-country chassis**.**

Buk-M3: An **u**pgrade in testing for all previous Buk-M systems with a new radar, and TBM intercept capability to Mach 4.

NOTES
The Buk-M1-2 is a multi-role system for SAM and surface-to-surface missile (SSM) ground/sea target attack missions.

Recent Developments in Long-Range and High-Altitude Air Defense Systems

The worldwide trend in modernization of long-range AD (LRAD) and high-altitude continues, even in times of shrinking military budgets. The trend is driven by expanding strategic threats of aerodynamic systems (e.g., ballistic and cruise missiles, UAVs, and stealth aircraft), and deadly munitions (e.g., weapons of mass destruction and effects, and precision weapons).

Challenges of rising costs and constricted budgets affect the modernization patterns. Most countries continue to focus most of their air defense modernization programs on upgrading and reconfiguring existing systems. There are upgrade missiles, C^2 and fire control assets for Russian SA-5 and other older SAM systems (pgs 6-75 to 6-78). A few other countries are developing new systems, including anti-ballistic missile (ABM) systems.

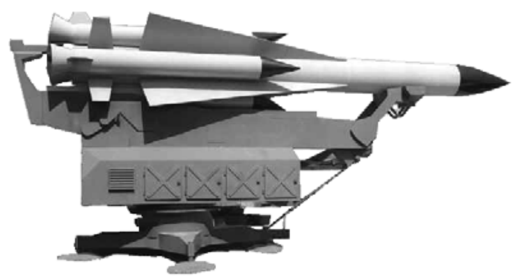
The non-US strategic systems which have received most world attention in recent years are the Russian SA-10, SA-12, and SA-20 series missile systems. S-300P (SA-10/-20) series have seen a lot of changes, and a confusing mix of names and designators. To clarify those nomenclatures, the table appears below. Export and Russian forces systems in each series may have same capabilities; but in some cases, due to the lengthy export contract negotiation process, export systems may be upgraded by time of shipment. Upgrades succeed only when radars and fire control match missiles with range and altitude coverage to use their capabilities.

In recent years we have heard much about the new Russian 4^{th}-generation missile system, **S-400/Trumf**. Due to developmental delays and budget issues, the program was delayed. The delays expedited Russian efforts to modernize SA-10 and SA-12 systems, and to incorporate comparable missile/support capabilities into them. Thus **SA-10d** and **SA-10e** upgrades were further modernized and re-designated **SA-20a** and **SA-20b**. An upgraded SA-12 is fielded and designated **SA-23**. The S-400/Triumf is now fielded, and designated **SA-21a**. SA-20b and S-400 systems can launch two different sizes of missiles (see SA-20b at pg 6-81, and SA-21 at pg 6-82). The large missiles offer superior performance for ballistic missile defense (BMD), and for long-range defeat of AWACS, RISTA, stealth, and SEAD targets. With the changes in SA-20 and SA-21 programs, many sources have confused those systems and their details.

Changes in strategic systems may impact fielding of medium-range air defense systems (MRADs). As the 9M96-series small missiles improve, they will form the majority of missiles on S-300/400 launchers, to service most aerial targets. Some countries may choose not to acquire MRADs (e.g., Buk-M1-2), rather upgrade strategic systems like SA-10/20a to SA-20b capability. But ground forces also want long-range AD. Most MRADSs range only to 50 km, yet lack surge capacity of the SA-20b and later long-range systems (up to 16 SAMs, pg 5-81). SA-12/23 units currently have limited surge capacity. Users can now add canisters of small missiles to existing LRADS TELs for increased surge capacity, without the need to add new expensive MRADs.

Russia intends to upgrade strategic SAM systems and upgrade all S-300 and S-400 systems into an integrated network. Priorities are for every battery to be able to counter ballistic missiles, surges, and high-value systems (stealth, AWACS, and SEAD). China is upgrading its SA-10/SA-20 systems and to compete with Russian systems. Many forces are adding new long-range EW and TA radars and other sensors, and upgrading older systems to extend range and digitally integrate them into IADS. These include ELINT, other passive sensors, and responsive, jam-resistant, secure C^3 networks to destroy UCAVs and stealth aircraft.

Russian Long Range SAM System SA-5b/GAMMON



Weapons & Ammunition Types	Typical Combat Load
Single-rail ground mounted	1
	Six launchers per Battalion

SYSTEM
Alternative Designations: S-200V, S-200M, or Vega
Date of Introduction: 1963
Proliferation: At least 15 countries
Target: FW, CM

ARMAMENT
Launcher:
Description: Single-rail ground-mounted not mobile but transportable
Dimensions: INA
Weight (kg): INA
Reaction Time (sec): INA
Time Between Launches (sec): INA
Reload Time (min): INA
Fire on Move: No
Emplacement Time (min): Days
Displacement Time (min): Days

Missile:
Name: 5V28M/S-200M
Range (km):
Max. Slant Range: 300
Effective Range: 250
Min. Range: 17
Altitude (m):
Max. Altitude: 29,000
Effective ceiling: 30,000
Min. Altitude: 300
Dimensions:
Length (m): 10.7
Diameter (mm): 750
Weight (kg): 7,100
Wrap around Boosters:
Length (m): 4.9
Diameter (mm): 500
Missile Speed (m/s): 1,100
Propulsion: 2-stage liquid fuel, four wrap-around solid fuel rockets
Guidance: Semi-active homing, active radar homing terminal phase, home on jam

Warhead Type: Conventional (HE) or nuclear
Warhead Weight (kg): 60 HE
Fuze Type: INA
Probability of Hit (Ph%): 75 FW/85 large
Simultaneous missiles: INA
Self-Destruct (sec): INA
Booster separation at (km): 2
Reload Time (min): 5

Other Missiles:
S-200A: Original missile, 160 km
S-200 Vega/SA-5b: Improved to 300 km, 40 km ceiling
S-200VE: Export, range 250 km, 29 ceiling
S-200M/5V28M: Improved to 300 km, 29 ceiling. It can replace S-200VE as upgrade.
S-200D/SA-5c: Upgrade 400 km, 40 ceiling

FIRE CONTROL
Radar:
Name: SQUARE PAIR
Function: Dual mode - target acquisition and fire control
Effective Range (km): 350
Frequency (GHz): 6.62-6.94
Frequency Band: H
Located: With firing units

Associated Radars:
Name: BAR LOCK B (P-50) follow-on (BACK NET initially)
Function: Target acquisition/early warning
Range (km): 250/ 390
Frequency Band: E/F-band (2-2.5 GHz),
Location: Generally with separate EW or signals recon bns

Name: BIG BACK
Function: Very long-range early warning
Effective Range (km): 600
Frequency Band: 3-d L-band
Location: Brigade Level

Name: TALL KING
Function: Very long-range early warning
Effective Range (km): 500-600
Frequency Band: A-band (150-180 MHz)
Location: Generally with separate early warning or Signals Recon battalions

Name: BACK TRAP
Function: Very long-range early earning
Effective Range (km): 410
Frequency Band: A-band (172 MHz)
Location: Brigade Level

Name: ODD PAIR, E-band follow-on (SIDE NET/PRV-11 initially)
Function: Height finding radar
Range: INA
Frequency Band: E-band
Location: Generally with separate early warning or Signals Recon bns

Other Radars: The SA-5 can also link to the IADS or to other AD units to get analog AD data. Newer radars, such as the Nebo-SVU mobile EW radar (pg 6-80), are marketed, and can be used with SA-5 series systems.

VARIANTS
Russian articles have predicted modernization Programs, in addition to missile upgrades.

There are reports that the SQUARE PAIR can be linked with and (perhaps) slaved to a S-300P series target acquisition radar, to engage targets tracked by that radar. Thus an SA-10 or SA-20 unit could integrate launches with the SA-5b to engage targets beyond their own 200 km range (with limited threat from atmospheric systems), and could protect the SA-5 launchers with their ballistic missile capabilities. SA-10/20 phased array radars greatly reduce detectable RF signal.

Iran claims to have upgraded its systems with better radars and digital C^2.

NOTES
The SA-5/Gammon is a long-range, strategic semi-active guided missile system for targeting medium-to-high altitude high-speed aircraft.

The missile has a long cylindrical body with a conical nose, four long chord cruciform delta wings, four small cruciform rectangular control surfaces at the extreme rear, and four jettisonable, wraparound solid-fuel boosters with canted nozzles. It uses a liquid propellant, dual thrust rocket engine, and the missile travels about 2 km before booster separation. The sustainer has four cropped delta wings and steerable rear fins. Control is assisted by ailerons.

S-300P Series Strategic Air Defense Systems Comparison*

NATO DESIGNATOR	SA-10b GRUMBLE	SA-10c GRUMBLE	SA-20a (SA-10d) GARGOYLE	SA-20b (SA-10e) GARGOYLE
LAUNCHERS	5P85SU cmd TEL** 5P85DU slaveTEL** 5P85 trailer lchr w/KrAZ-260V	5P85SU cmd TEL** 5P85DU slaveTEL** 5P85T trlr lchr w/KrAZ-260V	5P85SE cmd TEL** 5P85TE trlr lchr w/KrAZ-260V	5P85SE2 cmd TEL** 5P85TE2 Trailer w/KrAZ-260V
MISSILES Range (km) Altitude (km)	5V55R 7-75 0-25 blast radius Also 5V55V (nuc option) 5V55KD (upgrade variant of 5V55K)	5V55RUD 5-90 0-27 blast radius Also 5V55V nuc 5V55PM anti- radiation (ARM) 48N6E (upgrade option)	48N6/ 48N6E export 5-150 0-27 blast radius Also 5V55V nuc 5V55PM anti-radiation (ARM) 48N6E2 (upgrade option)	48N6M /48N6E2 export 5-200 5-200 0-27 blast radius ***<u>"Small missile" (4 per canister)</u> 9M96 /9M96E 9M96M /*9M96E2 5-40 5-40 5-120 5-120 0-35 0-35 0-35 0-35 Near term small missiles will range 200 km (upgrade option).
RADARS	64N6/BIG BIRD Bd* bde TA radar vehicle 30N6/FLAP LID-B Battery FC rdr veh 76N6/CLAM SHELL TA on tower trailer (36D6/TIN SHIELD TA trlr in older units)	64N6/BIG BIRD D* (in 83M6 Bd C^2 sys) 30N6/FLAP LID-B 76N6/CLAM SHELL TA on tower trailer (Optional 96L6E Bn TA radar vehicle)	64N6E/ BIG BIRD E** (in 83M6E1 Bd C^2 sys) 30N6E1/TOMBSTONE Battery FC rdr veh 96L6E Bn TA rdr veh (76N6/CLAM SHELL Optional supplement) Option: NEBO-SVU	64N6E2/ BIG BIRD E** bde TA radar vehicle 30N6E2/TOMBSTONE Battery FC rdr vehicle 96L6E2 Bn TA radar vehicle 76N6/CLAM SHELL bn option sup NEBO-SVU target track radar (Bn)
OTHER SUPPORT	54K6 CP veh (in the 83M6 Bde C^2 system) 1T12 survey trk 22T6 loading trk Baikal-1 Bde Intel Ctr 5157 power station MAZ-537 for rdr twr	54K6/Baikal-1 Bde Intel Ctr (in 83M6 Bde C^2 system) 1T12-2M, 22T6 5157 power station MAZ-537 for rdr twr 48III6y MRepair Base	54K6E CP veh (in the 83M6E Bde C^2 system) 1T12-2M survey trk 22T6 loading trk Baikal-1 Bde Intel Ctr 5157 power station MAZ-537 tows rdr twr 48III6y M Repair Base	54K6E2 CP veh (battle management center in 83M6E2 Bde C^2 system) 1T12-2M survey trk 22T6 loading trk Baikal-1 Bde Intel Ctr 5157 power station trailer MAZ-537 tows the radar tower 48III6y Mobile Repair Base

TA radar = Target Acquisition (surveillance, detection, target tracking, IFF)
FC radar = Fire Control (illumination and guidance, missile tracking, IFF).
Many modern FC radars are dual-mode (capable of TA and FC functions). The 30N6 series radars are dual-mode.

* Fielded systems may adopt radars or missiles of earlier or later versions. Supporting vehicles carry forward, or be upgraded/replaced with new versions. Thus 30N6 on SA-10b and SA-10c is replaced by 30N6E1 on SA-10d. For SA-10b, a76N6 TA radar replaced the36D6 TA radar. An exception to upgradability is the obsolete SA-10a, missile which used radio command guidance, incompatible with later systems. SA-10a units were converted to SA-10b. Missiles with <u>E</u> designators are for use in exported systems, but could be used in domestic Russian launchers. Mobile AD radars with counter-stealth ability, e.g., Nebo-SVU, and older EW radars, can be used with SA-10/20. Substantial numbers of air observers will be used. SHORAD systems (including 2 MANPADS/TEL are co-located).

** The TELs are variants of MAZ-543M. Radar and C^2 vehicles are on MAZ-543M or MAZ-7910 chassis. Various other trucks and vans are used for support. Radar tower trailers have supporting units for erection and disassembly.

*** Some strategic anti-ballistic missile (ABM) SA-20b units only have 48N6-type "big missiles" and ARMs. In other units, one or more canisters of 4 small missiles will be used. As the smaller (9M96 series) missiles improve in range closer to the big missiles, more launch pods will convert from big missiles to small missiles. Thus the firing units will be able to disperse more widely, with up to four times the target-handling capacity of current firing units.

**** In SA-20a and 20b systems, there are no slave versions of the TELs, only command. Many have the trailer launchers operating out of battalion as primarily transport vehicles for resupplying firing units. They can, however, be used as launchers during air surge activities. Firing units which lose trailer-launchers may then add more TELs.

Russian SAM System SA-10b/GRUMBLE

Missiles	Typical Combat Load
In canisters onboard TEL	**4**
SA-16 MANPADS	**2**

SYSTEM
Alternative Designation: S-300PM
Date of Introduction: 1980
Target: FW, heli, TBM, CM, ASM, UAV
Proliferation: At least 8 countries
Primary Components: Group (equals a brigade) has 83M6 C^2/ battle management complex (with Baykal-1/54K6 CP vehicle and 64N6 surveillance radar vehicle). The C^2 can control 6x 90Zh6E complexes (bns). A group also has technical support facilities. Stationary group for area defense has up to 72 launchers. OPFOR bde is 18. A 90Zh6 missile complex totals 6-12 launchers with bn CP, 76N6 or 36D6 Bn TA radar, and 2-4 fire units. It also has vehicles (trucks,) UAZ-452T2 survey vehicle, etc.), and equipment. Tactical AD assets (e.g., MANPADS), are included.

Primary Components per Battery:
1 5P85S cmd TEL
1 5P85D slaveTEL
1 5P85 trailer launcher
1 30N6 radar/fire control vehicle
A 5P85SU launcher has a command shelter behind the cab. A 5P58DU TEL does not.

ARMAMENT
Transporter-Erector Launcher (TEL):
Name: 5P85S or 5P58D (see NOTES)
Time Between Launches (sec): 3
Reaction Time(sec): 8-10 (vertical-launch missiles for no slew time)
Reload Time (min): INA
Crew: 6
Fire on Move: No
Emplace/Displace Time (min): 5/30 TEL
30/30 trailer launcher

Automotive Performance, 5P85S TEL:
Chassis: MAZ-7910 (8x8)
Engine: D12A-525 525-hp diesel
Cruising Range (km): 650
Max. Road Speed (km/h): 63
Weight (kg): 42.15 with missiles
Dimensions (m): 13.1 L x 3.1W x 3.7 H with missiles

Missile:
Name: 5V55R
Range (km): 7-75aircraft, 5-35 TBMs
Altitude (m):
Max. Altitude: 25,000
Min. Altitude: 25, 0 with blast radius
Speed (m/sec):
Target: 50-1,200
Max SAM: 2,000
Dimensions:
Length (m): 7.25
Diameter (mm): 508
Weight (kg): 2,340 in canister:
Guidance: Track-Via-Missile (TVM) and missile radar-homing
Warhead Type: Frag-HE
Warhead Weight (kg): 130
Fuze Type: Radio Command
Probability of Hit (Ph%): 80 FW and heli
Simultaneous missiles: 2/target (2 x P-hit)

Other Missiles: 5V55PM anti-radiation missile (ARM), and 6Zh48 nuclear. The SA-10/SA-20 systems launchers can use most older missiles and some newer missiles, limited by fire control range.

VARIANTS
SA-10A/S-300P: First system, semi-fixed on trailers, with 5V55K (50 km) missile. Early SA-10b units used the 36D6/TIN SHIELD TA radar, later supplemented or replaced by 76D6/CLAM SHELL

SA-10b: Added TELs, 5V55R (75 km) missiles, and FLAP LID B improved radar
HQ-2: Chinese copy, indigenous launchers
HQ-9: Chinese variant and upgrade

SA-10c: Russian export upgrade system (aka: S-300PMU) with improved missile.

SA-10f/SA-N-6: Russian naval version. For other variants, see pgs 6-76 and 78.

Forces may mix earlier and later assets. Thus a system may start as SA-10b, and upgrade to SA-10c or SA-20b (see pg 6-76 and 78).

ASSOCIATED RADARS
Name: 64N6
NATO Designation: BIG BIRD B
Function: Early warning, target acquisition
Unit: Grouping (brigade) level, supports 3-6 90Zh6E complexes (bns), and 12-36 launchers
Mobility: MAZ-7910 van
Detection range (km): 300 FW/heli, 127 TBM
Number of Targets detected: up to 200
Targets for Simultaneous Lock and Track: 100
Frequency Band: F, 3-D phased array
Azimuth Coverage (°) 180, 360 with rotation

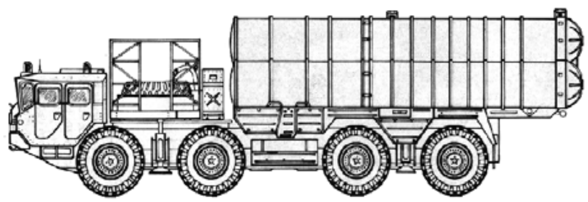
Name: 30N6
NATO Designation: FLAP LID-B
Function: Dual (tgt acquisition/fire control)
Mobility: MAZ-7910 8x8 van
Dimensions (m): 14.5 L x 3.2 W x 3.8 H
Unit Associated With: Firing battery
Interception Altitude (m): 25 and higher
Targets Engaged Simultaneously: 6
Missiles Guided Simultaneously: 12
Frequency Band: I/J phased Array
Linked to Integrated Air Defense: Yes
Detection range (km): 200
Guidance Range (km): 90+, auto-track
Azimuth Coverage (°): 120, 360 with rotation

Many SA-10B units were fielded with 36D6/ TIN SHIELD TA radars. Most were later replaced with 76N6/CLAM SHELL (pg 6-78).

Other Assets: The SA-10b links to the IADS to get digital AD data from EW assets, AD aircraft, AD intel, and other SAM units. SA-10 radars share data with other AD units. Forward observers are distributed throughout the coverage area. Other EW and TA radars can used in SA-10 groups and complexes.

NOTES
Although many SA-10B units were fielded with 36D6/TIN SHIELD TA radars, most were later replaced with 76N6/CLAM SHELL.

Russian SAM System SA-10c/GRUMBLE (export)



Missiles	Typical Combat Load
TEL and trailer launcher	**4**
5V55RUD	4
5V55PM/HQ-2 ARM	4/battery
SA-18 MANPADS	**2**

SYSTEM
Alternative Designations: S-300PMU
Original fielding was Russian only. This was a commonly exported version of the S-300PM system, including upgrades.
Date of Introduction: 1984
Proliferation: At least 6 countries
Target: FW, heli, TBM, CM, ASM, UAV
Primary Components:
SeeSA-10b. TELs are designated 5P85SU and 5P85DU. A new semi-trailer permits faster employment from the move.

ARMAMENT
TEL and New Semi-trailer Launcher
Name: 5P85T (road-mobile only)
Missiles per launcher: 4
Reaction Time(sec): 8-10, vertical-launch missiles for no slew time
Time Between Launches (sec): 3
Reload Time (min): INA
Crew: 4-6
Fire on Move: No
Emplace/Displace Time (min): 5/30

Automotive Performance:
For TEL see SA-10b, except.
Cruising Range (km): 800
Road/Dirt road Speed (km/h): 60/30
The 5P85TE trailer-launcher is normally towed by a KRAZ-260B 6x6 truck.

Missile:
Name: 5V55RUD
Range (km): 5-90
Altitude (m):
Max. Altitude: 27,000
Min. Altitude: 25, 0 with blast radius
Speed (m/sec):
Max Target: 1,200
Max SAM: 2,100
Dimensions:
Length (m): 7
Diameter (mm): 513
Weight (kg): 2,300 in canister
Guidance: Track-Via-Missile, missile radar homing, home on jam
Warhead Type: Frag-HE
Warhead Weight (kg): 133
Fuze Type: Radio command
Probability of Hit (Ph%): 80 FW and heli
Simultaneous missiles: 2 per target, doubles the probability of hit

Other Missiles: 5V55R, in early units 5V55PM anti-radiation missile (radar homing missile), 6Zh48 nuclear warhead missile. An optional upgrade is 48N6. HQ-2 Chinese ARM for FT-2000.

VARIANTS
Radars, missiles, and C^2 are compatible among system variants. Forces may use a mix of earlier and later assets. Later C^2, missiles, and radars are compatible, and other upgrade assets are also compatible. For other SA-10/20 variants, see pg 6-76.

HQ-9: Chinese upgrade SA-10b system to near SA-10c, with indigenous TELs and missiles (100-km), and HQ-2 75-km ARM.
FT-2000: Adds a 100-km passive ARM.

National War College Photo

COMMAND AND CONTROL
The 83M6 Bde automated C^2 system includes the 54K6/Baikal CP van and the 64N6 radar. The Baikal contains the bde battle management center and digital data transmission system.

With this C^2 and other compatible nets, <u>the SA-10 complex can be used as the base for an area integrated air defense system</u>. The SA-10c digitally links to EW assets, AD aircraft, AD intel. SA-10 radars share data with other units in the IADS net. The system can be linked directly or thru IADS with other AD missile system complexes, such as SA-5, earlier SA-10, and SA-11. The 83M6E can pass detections (of up to 60 targets) directly to the Rubezh-2M air intercept control net.

The Osnova-1E integrated air defense system C^2 vehicle can process 120 targets at a time. It can simultaneously sort out aircraft ECM (with the AKUP-22 system) and pass up to 80 targets to Baikal-1E or other AD missile systems, as well as to Rubezh-2M.

Even if IADS and brigade nets are taken out of operation, dual-mode radars on 30N6 permit a fire unit (battery) to operate autonomously.

ASSOCIATED RADARS
Name: 64N6
NATO Designator: BIG BIRD D
Function: Early warning, target acquisition
Unit: Grouping (brigade) level, supports 3-6 90Zh6E complexes (bns), and 12-36 launchers
Mobility: MAZ-7910 8x8 van
Detection range (km): 300 aircraft, 127 TBMs
Number of Targets detected: up to 200
Targets for Simultaneous Lock and Track: 100
Frequency Band: F, 3-D phased array
Azimuth Coverage (°) 180, 360 with rotation

Name: 30N6 (FLAP LID-B)
See SA-10b, pg 6-77.

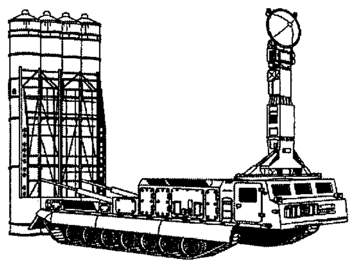
Name: 76N6
NATO Designation**:** CLAM SHELL
Function: Low altitude target acquisition
Unit Associated With: Battalion and bde
Mobility: Mounted atop 40V6 trailer tower
Antenna station is on a 5T58 truck
Operation: Station can operate 500m from radar
Emplacement time (hrs): 1-2
Detection Range (km):
@ 500 m altitude: 93
@ 1,000 m altitude: 120
Targets Tracked Simultaneously: up to 180
Target Generation Time/Target (sec): 3
Resolution of Target RCS: .02 m^2 @ 1400 kts
Frequency Band: I, 3-D radar
Azimuth Coverage (°): 120, 360 with rotation

Recent upgrade **96L6LE** all-altitude target acquisition radar vehicle can replace the CLAM SHELL towed (stationary) site radar. See next page.

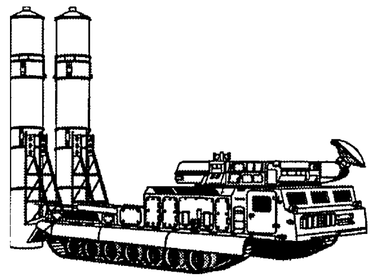
Other Assets:
Forward observers are distributed throughout the coverage area.
SA-10c group includes 85V6E/Orion ELINT. The Nebo-SV mobile radar system or newer Nebo-SVU can be linked to the SA-10c, with counter-stealth detection capability to 350 km.

NOTES
Most units use TELs only, not semi-trailer MELs (mobile erector launchers). Chinese upgrades similar to SA-10c are called HQ-10 and HQ-15.

Russian SAM System SA-12a and SA-12b, Antey-2500, and SA-21b



SA-12a/GLADIATOR on 9A83 TELAR



SA-12b/GIANT on 9A82 TELAR

Missiles	Typical Combat Load
SA-12a canisters on TELAR	**4**
SA-12b canisters on TELAR	**2**
SA-18 MANPADS	**2**

SYSTEM
System Designation: Antey S-300V
Date of Introduction: 1982
Proliferation: At least 6 countries
Target: FW, heli*, TBM, CM, ASM, UAV
Primary Components: System (brigade) has 9S457-1 CP vehicle, 12-24 TELARs or (heavy or light) loader-launchers, and radars Brigade has 2-4 batteries. A battery has 2-4 SA-12a TELARS, 1-2 SA-12b TELARSl.

Launcher Vehicle:
Name: 9A83, GLADIATOR, SA-12a
9A82, GIANT, SA-12b

Description: TELAR
Crew: 4
Chassis: 9M83 and 9M82 are on MT-T (Type 830) heavy tracked chassis
Weight (mt): 48
Dimensions (m):
Length: 12.3 LLVs & 9A85, 14.5 9A82
Width and height: 3.38 and 3.78

Automotive Performance:
Engine: 525-hp Diesel
Cruising Range (km): 450
Max road speed (km/h): 50

ARMAMENT:
Transporter-Erector-Launcher:
Reaction Time (sec): 40 alert, 15 launch
Time Between Launches (sec): 1.5
Reload Time (min): INA
Brigade missile load: 96-192 (4-8/TELAR)
Fire on Move: No
Emplacement/displacement time (min): 5
Navigation equipment: FCS embedded
Onboard fire control: Illum/guidance radar
AzimuthCoverage (°): 180, 360 per rotation

MISSILES
Name: 9M83 aka GLAD or GLADIATOR, also Zur-2, SA-12a
Type: Two-Stage, solid-fuel
Primary Targets: Dual - aircraft/missiles
Launch Mode: Vertical launch
Range (km): 6-80, 30 TBMs
Altitude (km): 0.025 - 25
Max Speed (m/sec): 3,000 target,
1,700 SAM
Dimensions: 7.0 m x 800 mm diameter
Weight (kg): 2,400
Guidance: inertial/radar SAH Home on jam
Warhead Type: Focused Frag-HE
Warhead Weight (kg): 150
Fuze Type: radio cmd or proximity
Probability of Hit (Ph%): 90 FW, 70 heli
Simultaneous missiles: 2 per target

Name: 9M82 aka GIANT, Zur-1, SA-12b
Type: Two-Stage, solid-fuel
Primary Target: TBMs-IRBMs
Launch Mode: Vertical launch
Range (km): 13-100 aircraft, 40 TBMs
Altitude (km):
Max. Altitude: 25 TBMs, 30 aircraft
Min. Altitude: 2 TBMs, 1.0 aircraft
Max Speed (m/sec): 3,000 target,
2,400 SAM
Dimensions: 8.5 m x 800 mm diameter
Weight (kg): 4,600
Guidance: Inertial, radar semi-active homing (SAH), home on jam
Warhead Type: Focused Frag-HE
Warhead Weight (kg): 150
Fuze Type: radio command or proximity
Probability of Hit (Ph%): 80 FW, 70 TBM
Simultaneous missiles: 2 per target

COMMAND AND CONTROL
Name: 9S457-1
Function: Command Post tracked vehicle
Unit: Brigade, links to up to 4 9S15
Targets Detected: 200
Targets tracked: 70, 24 assigned at a time
Navigation: Onboard nav key vehicles
Comms: All major vehicles have an APU. All vehicles have link for response/set-up. System can use SA-10c C2/radar assets, including Osnova-1 automated complex .

Other Assets: The SA-12 system digitally links to the IADS (e.g., EW assets, aircraft, intel , and other SAM units. Radars share data with other units in the IADS net. Other assets are FOs and ELINT (Orion pg 6-17).

ASSOCIATED RADARS
Name: 9S15MTS
NATO Designator: BILL BOARD-A
Function: Early warning, target acquisition
Unit Associated with: Brigade
Mobility: Tracked vehicle-mounted
Detection range (km): 10-250
Range accuracy (m): 250
Azimuth Coverage/Sweep: 360° in 6-12 sec
Number of Targets tracked: up to70
Frequency Band: F (3-4GHz), phased array
ECCM: Operate in jam 1-2kW/MHz, 200 km
Emplace/Displace (min): 5

Name: 9S19
NATO Designation**:** HIGH SCREEN
Function: Sector target acquisition for TBMs
Unit Associated With: Brigade
Mobility: Tracked vehicle-mounted
Detection Range (km): 200
Targets Tracked: 16-20 based on jamming
Frequency Band: INA 3-D phased array
Azimuth Coverage (°): 90, 360 with rotation

Name: 9S32-1
NATO Designation: GRILL PAN
Function: Dual (TA/FC). In FC tracks missile and remote controls TELAR guidance radars
Unit: Battery, receives mission from CP
Mobility: Tracked vehicle-mounted
Detection Range (km): 150, 140 automatic
Targets Tracked Simultaneously: up to 12
Missiles Guided Simultaneously: up to 6
Frequency Band: INA 3-D phased array
Azimuth Coverage (°): 42, 340 with rotation

LOADER-LAUNCHER VEHICLES (LLVS):
Name: 9A84 - GIANT, 9A85 - GLADIATOR
Function: Primary role is to reload TELARs. Vehicles use same chassis. LLVs can launch when TELARs/FC radars are nearby.

VARIANTS
SA-23/S-300VM: Upgraded 5 units around Moscow, with 9M82M /-3M upgrade missiles. 9M82M ranges 200 km, is immune to ECM, and can intercept ballistic missiles at 4,500 m/s (MRBMs from 2,500 km). The 9M83M ranges to 110 km. Export name is **Antey-2500**.

SA-21b/S-400M/Samoderzhets: New system uses SA-21a chassis, with 9M82M, and 9M96 canisters (pg 5-55). Initially they may be used with existing units to supplement their fires. The SA-21b launcher will replace those on some older TELs or TLs. A later program will link all S-300/S-400 systems with same missiles and FC to assure kills versus TBMs, CMs, ARMs and surges, and range 200 ± km.

NOTES
The system generally does not target helicopters, but will for self-defense. The Nebo-SV/BOX SPRING counter-stealth radar can also be used.

Russian SAM System SA-20a/GARGOYLE

Missiles	Typical Combat Load
TEL and trailer launcher	**4**
48N6E	4
5V55PM/HQ-2 ARM	4/battery
SA-18 MANPADS	**2**

SYSTEM
Alternative Designations: S-300PMU1 Previously, system was called SA-10d..
Date of Introduction: 1990-93
Proliferation: At least 6 countries
Target: FW, heli, TBM, CM, ASM, UAV

Primary Components:
See SA-10c, above. Note the updated equipment in the Comparison Table.

ARMAMENT
TEL and Trailer Launcher
Name: 5P85SE TEL only, ground units 5P85TE trailer launcher for site defense
See SA-10c, above. Note other updated equipment in the Comparison Table.

Automotive Performance:
For 5P85SE TEL on MAZ-5910, see SA-10b, except the following.
Cruising Range (km): 800
Road/Dirt road Speed (km/h): 60/30
The 5P85TE trailer-launcher is normally towed by a KRAZ-260B 6x6 truck.

Missile:
Name: 48N6/ 48N6E export
Type: Single-Stage, solid-fuel
Launch Mode: Vertical launch
Launch Range: 5-150
Max Range TBMs: 40
Targets .5-1 km altitude: 28-38
Altitude (m): 6-27,000
0 with blast radius
Speed (m/sec):
Max Target: 2,800
Max SAM: 2,100, 25g turn
Dimensions: 7.5 m length
519 mm diameter
Weight in Canister (kg): 2580
Guidance: Track-Via-Missile, missile radar homing, home on jam
Warhead Type: Frag-HE
Warhead Weight (kg): 145, twice the previous KE from warhead fragments
Fuze Type: Radio command
Probability of Hit (Ph%): See pg 6-81
Simultaneous missiles: up to 2 per target (doubles probability of hit)

Other Missiles: 5V55R, original missile. First export missile was 5V55RUD. Optional export upgrade (see above) is 48N6E. 5V55PM anti-radiation missile, 6Zh48 nuclear warhead missile.
HQ-2 Chinese ARM for FT-2000.

VARIANTS
SA-10c: This is a commonly exported version of S-300. Optional upgrades of C^2, missiles, and radars are available.

SA-20a/SA-10d/S-300PMU1: This system upgrade was designed for 48N6/48N6E missiles. Most equipment is compatible with SA-10c. China has acquired SA-20a, and is upgrading earlier launchers to this capability. It is also trying to upgrade to SA-20b.

SA-20b/Favorit: Russian improved system with upgrade to 200-km 48N6E2 missile as well as 9M96 series "small missile" (see pg 6-76 and 81).

ASSOCIATED RADARS
Radar:
Name: 64N6E
NATO Designator: BIG BIRD E
Function: Early warning, target acquisition
Unit: Grouping (brigade) level, supports 3-6 90Zh6E complexes (bns - 12-36 launchers)
Mobility: MAZ-7910 8x8 van
Detection range (km): 300
Number of Targets detected: up to 200
Targets Simultaneous Lock and Track: 100
Frequency Band: F, 3-D phased array
Azimuth Coverage (°): 360 with rotation
Emplace/Displace Time (m): 5

Name: 30N6E1
NATO Designation: TOMBSTONE
Function: Dual (TA/FC) and battery CP
Unit: Battery (SAM system), for 3 launchers
Mobility: MAZ-7930 8x8 van
Detection range (km): 300
Guidance Range (km): 200 auto-track
Targets Engaged Simultaneously: up to 6
Missiles Guided Simultaneously: up to 12
Frequency Band: I/J, 3-D phased array

Name: 96L6E
Function: All-altitude target acquisition and processing center - replaces CLAM SHELL
Unit Associated With: Battalion (2-6 btries)
Mobility: MAZ-7930 8x8 van
Operation: Up to 5 remote workstations
Emplacement/Displacement time (min): 5 for truck, 30 towed, 120 for mast mounted
Range (km): 300, more with 40V6M tower
Targets Tracked Simultaneously: up to 100
Frequency Band: Centimeter L-band, 3-D phased-array
Azimuth Coverage (°): 120, 360 with rotation

The antenna can be mounted on a 40V6M tower with same height as CLAM SHELL.

9L96E TA radar/processing center

Nebo-SVU/1L119: VHF TA phased array radar is in SA-20/SA-21 brigades and IADS. Its range is up to 350 km, with 100 km altitude. Deployment time is 25 minutes. Coordinating with 9L96E and TOMBSTONE, and using triangulation, the radar can digitally acquire stealth and other LPI aircraft, and cue the IADS.
Azimuth Coverage (°): 120 est

Some forces (Tier 3) may still use CLAM SHELL with SA-20a. Others employ new, indigenous or legacy target acquisition radars.

Other Assets: The SA-20a digitally links to the IADS, including AD aircraft, and other SAM units in the IADS net. Forward observers are deployed throughout the coverage area. Each brigade also has an 85V6E/Orion ELINT (pg 6-17). For Osnova-1E IADS C^2 vehicle and 83M6E automated C^2 system, see pg 6-78.

NOTES
The "big missile" could be replaced with 48N6M/48N6E2 (next page). Although 30N6E1 dual mode radar may not be able to use the full 200 km missile range against some smaller aerial targets, it can use the improved range against larger targets.

Russian Universal SAM System SA-20b/Favorit

Favorit with 3 x 48N6-type missiles and a 9M96-type canister set (4 x “small missiles”).

Missiles	Typical Combat Load
TEL and trailer launcher	**7 (4-16)**
48N6E/ 48N6E2/ARM (“big missile”)	3 (1-4)
9M96E2 (“small missile”)	4
Near Term	(16-0)
SA-18S MANPADS	**2**

SYSTEM
Alternative Designations: S-300PMU2/ GARGOYLE or GARGOYLE B.
The system has several stages of upgrade. Favorit is Russian forces and export (-E2).
Date of Introduction: 1996
Proliferation: Fielded in 6 countries
Target: FW, MRBM, heli, CM, ASM, UAV, and artillery rockets
Primary Components: Group (equal to brigade) see page 6-77. Nomenclature for system components ends with –E2 (e.g., 83M6E2 battle management complex, versus -E for SA-10C, -E1 for SA-20A). The 83M6E2 has improved ABM ability.
A battery (firing unit) has 3 launchers.

ARMAMENT
TEL and Trailer Launcher
Name: 5P85SE2 TEL and 5P85TE2 TL
Chassis: MAZ-5910 chassis for TEL
KRAZ-260 tractor for TL (MEL)
Missiles per launcher: 4 for 48N6E2
16 for 9M96E/E2, in 4 pods

Automotive Performance:
5P85SE2 TEL on MAZ-5910, see pg 6-82.

Missile:
Name: 48N6M/48N6E2 “big missile”
Type: Single-Stage, solid-fuel
Launch Mode: Vertical launch
Launch Range (km): 5-200
Max Range TBMs: 40
Targets .5-1 km high: 28-38
Altitude (m):
Max. Altitude: 27,000
Min. Altitude: 6, 0 with blast radius
Speed (m/sec):
Max Target: 2,800
Max SAM: 2,100, 25g turn
Dimensions: 7.5 m length
519 mm diameter
Weight in Canister (kg): 2580
Guidance: Track-Via-Missile, missile radar homing, home on jam
Warhead Type: Frag-HE
Warhead Weight (kg): 180
Fuze Type: radio command
Probability of Hit (Ph%): 90 FW, 70 for high-speed missiles and TBMs, 80 others
Simultaneous missiles: up to 2 per target

Name: 9M96E2/9M96M “small missile”
Type: Single-Stage, solid-fuel “Hittile” – (agile “hyper-maneuver” with small HE)
Launch Mode: Vertical launch
Launch Range: 1-120
Altitude: 30,800
Min. 5, 0 with blast radius
Speed (m/sec):
Max Target: 4,800
Max SAM: 1,800 and 20+ g turns with thrust vectoring
Dimensions: 5.65 m length
240 mm diameter
Weight (kg): 420, 2,700 for container of 4
Guidance: Track-via-missile, active radar homing, also ARM and home on jam
Warhead Type: Controlled frag-HE
Warhead Weight (kg): 24
Fuze Type: “Smart” prox, frag shaping
Probability of Hit (Ph%): 90 FW, and heli
80 others
Simultaneous missiles: up to 2 per target

Other Missiles: Previous 48NE missile (150 km) can be used. 9M96E ranges 40 km. Domestic 9M96M ranges 120 km.

VARIANTS
This system (originally called SA-10e) was designed against ballistic missiles and low maneuverable systems such as UAVs, artillery rockets (like MLRS), and air-launch missiles. Improved from SA-10d, it is compatible with most of the equipment for SA-10b, c, and d (SA-10a). I

China is ordering SA-20b and upgrading other launchers to SA-20b capability.

S-400/SA-21a: The system was fielded in 2007 with Russian vehicles (pgs. 6-82). It shares 9M96-series missiles with SA-20b. The system will use new, more powerful radars, including Protivnik-GE and Nebo-M, and will interlink with SA-20 launchers.

SA-21b/Samoderzhets: Near-Term upgrade for all S-300/S-400 systems (pg 6-82). The program has improved integration and missile.

ASSOCIATED RADARS
Name: 64N6E2
NATO Designator: BIG BIRD E
See 64N6E at SA-20a, pg 6-80
Detection range (km): 400

Name: 30N6E2
NATO Designation: TOMBSTONE
See 30N6E1 at SA-20a, pg 6-80,
Guidance Range (km): 200

Name: 96L6E Target acquisition radar and battle mgt center at battalion (See pg 6-80).

Nebo-SVU VHF TA radar (pg 6-80) is in the SA-20b brigade, located at brigade level.

Nebo-SVU

Other Assets: The SA-20b digitally links to the IADS, and shares data with other units in the net. Forward observers are deployed in the coverage area. Each brigade also has an 85V6E/Orion ELINT system (pg 6-17). For discussion of the Osnova-1E IADS C^2 vehicle, Baikal-1E, Rubezh-2M, 83M6E2 automated C^2 system , and other assets, please see pgs. 6-76 and 6-78.

NOTES
Above photo shows Favorit with 1 canister of 9M96E2 missiles. By shifting from 1 small-missile pod per launcher to 2-4, the number of missiles per launcher can increase from 7 to 10, 13, or 16. Strategic ABM units have only big missiles.

Russian SAM System SA-21a/GROWLER/S-400

Missiles	Typical Combat Load
TEL and trailer launcher	**7**
40N6 (with 1x 9M96E2 canister)	3 Near Term 2
9M96M/E2 ("small missile")	4 Near Term 8
SA-18S MANPADS	**2**

SYSTEM
Alternative Designations: Triumf, Triumph as a translation
Date of Introduction: 2007
Proliferation: Fielded in 1 country
Target: FW, IRBMs to 3,500 km, heli, CM, ASM, UAV, and artillery rocket
Primary Components: Group (equal to brigade) see page 6-77. Components include the 5P85TE2 MEL, 55K6E 8x8 van, 5T58-2 missile transporter, towed trailer-launcher, 22T6-2 loading crane, and radars. A battery (firing unit) has 3 MELs.

ARMAMENT
Mobile Erector Launcher
Name: 5P85TE2 MEL (trailer launcher)
Tractor: BAZ-64022 6x6 tractor
Missiles per launcher: 3 x 40N6
4 x 9M96E2 (current likely mix)

Automotive Performance:
For 5P85TE2 MEL
Cruising Range (km): 800 (est)
Road/Dirt road Speed (km/h): 60/30 (est)

Missile:
Name: 40N6 "big missile"
Type: Solid-fuel
Launch Mode: Vertical launch
Launch Range (km): 5-400
Max Range TBMs: 40
Targets .5-1 km high: 28-48
Altitude (m):
Max. Altitude: 50,000+
Min. Altitude: 5, 0 with blast radius
Speed (m/sec):
Max Target: 5,000
Max SAM: 4,800
Dimensions: 7.5 m length (est)
519 mm diameter (est)
Weight (kg): 2,000, 2,800 in canister
Guidance: Track-Via-Missile, missile active radar homing, home on jam
Warhead Type: Frag-HE
Warhead Weight (kg): 180+
Fuze Type: Radio command
Probability of Hit (Ph%): 90 FW. 80 heli
Simultaneous missiles: up to 2 per target (doubles probability of hit)

Name: 9M96E2/9M96M "small missile" See pg 6-81. A canister of 4 can fit on the SA-21 launcher in place of a big missile. It is possible that most launchers in most batteries (by the Near Term) will have 2 canisters of small missiles (8 total).

Other Missiles: The system can also launch older missiles for SA-10 and SA-20 systems. There are reports of a 48N6DM missile, which offers longer range than the 48N6. This may have been an interim missile for use until 40N6 was fielded.

VARIANTS
The **S-400** series uses a new array of trucks, tractors, and trailers. Due to S-400 production delays, the SA-20 series was confused with it. Many S-400 upgrades can be applied to SA-10, SA-12, and SA-23. China is ordering SA-20b and upgrading other launchers to SA-20b capability.

S-400/SA-21a: The system was fielded in 2007 with Russian vehicles. Early units are strategic and use only 40N6 400-km big missiles. Most launchers can also mount canisters of 9M96 series small missiles.

SA-21b/S-400M/Samoderzhets: A Near-Term upgrade for all S-300/S-400 systems is noted at (pg 6-79). Unlike the other SAMs, SA-21a's 40N6 will range 400 km.

ASSOCIATED RADARS
Name: 91N6E
NATO Designator: INA. This is derived From the BIG BIRD. It is a brigade-level EW/TA radar like its predecessor, with an AD intel processing center on a MAZ-7930 towed van trailer. It is co-located with the brigade CP/battle management center. See 64N6E at SA-20a, pg 6-80. Detection range for 91N6E is at least 400 km.
Azimuth Coverage (°): 360

Name: Nebo-SVU/1L119
This VHF target acquisition radar is at Brigade level. The first search priority is stealth aerial systems. Because of limited sector coverage, it is likely that up to 4 will be used (see pg 5-54 and 5-55).

Name: 96L6E TA radar and battle mgt center is at battalion (pg 6-80).

Name: 92N2E
NATO Designation: GRAVESTONE
Function: Dual (TA/FC) radar vehicle and CP
Unit: Battery (SAM system), for 3 launchers
Mobility: MAZ-7930 8x8 van
Detection range (km): 400
Guidance Range (km): 400 auto-track
Targets Engaged Simultaneously: up to 6 (est)
Missiles Guided Simultaneously: up to 12 (est)
Frequency Band: I/J, 3-D phased array
Azimuth Coverage (°): 120, 360 with rotation

Name: 59N6/Protivnik-GE
Function: All-altitude target acquisition and
Unit Associated With: Battalion (2-6 btries)
Mobility: Trailer with KrAZ-260 tractor
Operation: Digital links to battery, battalion, and brigade/IADS processing center
Emplacement/Displacement time (min): 15
Range (km): 400
Targets Tracked Simultaneously: up to 150
Frequency Band: AESA Decimetric L-band, 3-D phased-array
Azimuth Coverage (°): 120, 360 with rotation

Other Assets: The SA-21a digitally links to the IADS, and shares data with other units in the net. For discussion of Osnova-1E IADS C^2 vehicle, Baikal-1E, Rubezh-2M, 83M6E2 automated C^2 system , and other assets, see pgs. 6-76 and 6-78. Forward observers are deployed throughout the coverage area. Each brigade also has an 85V6E/Orion ELINT (pg 6-17).

An IADS with digital interface among Nebo-SVU, Protivnik, and 96L6E, can overlay detections. Using analysis by triangulation, they claim to be able to detect and track stealth aircraft. The **Nebo-M** Multi-band Radar System integrates these components with three vehicles. **RLM-D** has an L-band radar. **RLM-S** has X-Band. **RLM-M** has a VHF radar, similar to the Nebo-SVU. The network is specifically designed against stealth aircraft similar to F-35. The system is not yet marketed or fielded.

NOTES
There are also reports of a system in development called **S-500**, with longer range and a design velocity of 10,000 m/s. No details are available.

Chapter 7
Improvised Aerial Systems

The conflict spectrum in the Contemporary Operational Environment includes forces across the capability spectrum. They will use specially-designed military technologies, as well as improvised weapons and other systems. They will also employ all available assets for innovative applications.

That creativity will also extend into the vertical dimension. Increasingly, as modern forces are able to gain air superiority, adversaries will seek innovative ways to deny airspace, while operate in that airspace. They will increasingly turn to innovative and improvised systems. Aerial roles will include reconnaissance for ground forces and for air defense and air attack.

Improvised air and ground systems will also be used for air defense. Creativity in air defense includes decoy and camouflage arrangements. The threat from rotary-wing aircraft has led to responses such as obstacle systems in likely landing zones, use of mines and improvised explosive devices (IEDs). New technologies such as unmanned aerial vehicles (UAVs) can be used in counter-helicopter roles. As noted in Volume 1, Chapter 14 (Improvised Military Systems)…, *the list of improvised weapons available is limited only by human imagination.*

We would like to thank Mr. John Pruiksma of TRISA Wargaming, Experimentation, and Test & Evaluation Directorate, for his support with sources, data, and graphics for this chapter. Questions and comments on this chapter should be addressed to the below POC.

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Airships in Military Applications

Airships ("lighter-than-air" craft) have been used in warfare since the 1800s, when balloons offered elevated platforms for military observers. Airships are increasingly used in civilian venues and offer capabilities for military use. Primary roles are:

-- communication support
-- support to electronic warfare (EW) and artillery units
-- surveillance platforms,
-- and air defense support.

With their low cost, low upkeep, commercial availability, and ability to stay aloft with minimal signature for substantial periods, they will offer more and wider uses for military forces.

Airships can be categorized as non-rigid, semi-rigid, and rigid. Non-rigid describes balloons and blimps. ***Balloons*** can be of various shapes but without internal structure except air pockets for shaping. Most are round. ***Blimps*** (see right) generally fit the characteristic shape. Blimps can orient better in wind than round ones. Airships which are moored to a winch on the ground or on a vehicle are also ***aerostats***. Semi-rigid airships have some struts or framing, but use inflation to fill part of the structure. Rigid airships have their overall structure supported with framing. Some aerostats, especially larger ones, are semi-rigid or rigid. ***Dirigibles*** are airships powered by electric or internal combustion engines, and are rigid or semi-rigid**.** Their max speed varies up to70 km/hr. ***Zeppelins*** are special-designed airships trademarked by a German company.

Airships come in various shapes and sizes. They are made of varied materials, mostly PVC or UV-treated nylon. Wind speed should not exceed 25-35 km/hr during flight. Although they can be filled with hydrogen, hot air, etc., the vast majority use helium. Helium can be produced by generators in ground stations or in trailers, compressed in tanks, and distributed to airship users. Helium tanks will sustain a small airship for days. Most airships can absorb several hits while remaining aloft. Most rips and bullet holes can be easily and quickly repaired. An electric hoist can be vehicle-mounted for stationary launch, frequent relocation, and re-launch.

1. Support to Communications. Balloons can be used in a manner similar to ancient use of pennants and mirrors, to passively signal change in conditions or start an action, while avoiding intelligence and jamming systems. Commercial users often use balloons to trail streamers behind or stretched to the ground to draw attention and mark location of an activity. They can mark location of an LZ, flight corridor, or a registration point for navigation or fires.

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Balloons can be used for rescue missions. The below helikites are offered for military uses. A jungle backpack includes aerostat, valve, helium bottle, line, handle, strobe light, bag, and instructions.

Some signal intelligence and communications units have the option of using aerostats to raise antennae for increased operating range. British Allsopp developed the Mobile Adhoc Radio Network (MANET), with three steerable Low Visibility Skyhook Helikites bearing ITT Spearnet radios to 65-m height. They demonstrated that an infantry radio, usually limited to 1 km range, can send video data (with a 15 kg helikite backpack) to a receiver 10 km away. The set can also be used to retransmit, or to control UAVs in almost any terrain. The company claims that antenna altitude could rise up 500 m.

3. Electronic warfare units can use aerostats to raise antennae on jammers and recon systems. A simple method would be to attach a jammer round on a cable. A GPS jammer could be mounted on a vehicle-based aerostat or on a dirigible moving within protected zones. Artillery units have long used weather balloons in meteorological units to supply data for calculating fire adjustments. Those units also have helium generators for supplying the gas.

4. The most widely-used role for airships is reconnaissance. In the U.S. Civil War, balloon gondolas were used by some military observers. Today some military and civilian forces use large aerostat balloons with cameras for border and aerial surveillance. Some sporting events use blimps and dirigibles to feed TV imagery for real-time broadcast. Survey, engineering, and land use organizations also use airship sensor products. The elevated view offers a long-range unobstructed field of view, and extended viewing duration. With the proliferation of small and medium-size commercial balloons, stabilized and gimbaled sensor mounts, and smaller high-resolution optical systems, use of improvised systems is expanding.

Technologies developed for commercial and recreational video-photography, and for remote military sensors and robot systems can be readily adapted to airships. Thus airship-mounted sensor arrays vary from a simple camera or camcorder hung underneath to day/thermal video-camera or TV transmitting real-time to a palm pilot or laptop, or over a digital net. Gondolas can have a camera bar, stabilized mount, or even a gimbaled sensor ball with multiple sensors, laser-rangefinder (LRF), auto-track, and 60+ power digital/optical zoom. Navigation can include GPS location, ground-based location with a LRF, or inexpensive in-viewer display.

The easiest and most numerous applications would be to attach a camera or camcorder underneath. On page 7-7 is a demonstrated sensor set for RC aircraft. It can be mounted on aerostat balloons less than 1-m for quick over-the-hill surveillance. A separate cord can be attached to the camera or balloon to orient it in the desired direction.

Controllable Camera Mount

Mount on a Camera Bar

Gimbaled Ball

Manufacturers such as Inflateable4less offer small aerostat blimps (3-m, below) which can carry a camera. Range for an HF transmitter can limit distance to a ground station (2 km for a low-cost unit); but a hand-held display unit can operate from a vehicle.

Below is a 5-m aerostat blimp with a camera bar.

Mini-zepp blimps come in sizes 6-13 m, for use as aerostats or as dirigibles. The dirigibles include 2 electric motors and a gas-powered motor. Options include a video head and HF transmission system. In event of a power failure, a cable drops to the ground for recovery.

The Skymedia Pro aerostat system is offered for $4,999. It includes:
-- 2.4-m urethane-coated ripstop nylon balloon,
-- highly precise camera bar (210° tilt pan, 2 x 360° zoom shoot carbon fiber camera platform),
-- HF transmitter on the platform (2 km range),
-- remote control unit, system integrated (HF receiver patch antenna LCD color display 13 cm)
-- a suitcase with all necessary chargers, battery, etc.


Skymedia Pro System

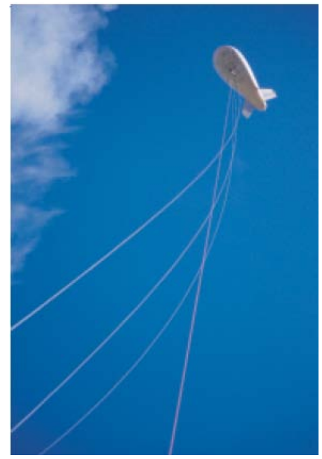
As airships become better-controlled and more stable, other sensors can be added to the payload. An airship could be used in tactical reconnaissance units to mount a small light-weight radar antenna, such as on the FARA-1E (Vol 1, pg 4-29). The Israeli Speed-A stabilized payload system with automated EO/thermal imager and laser rangefinder fits on lightweight airships.

5. Air defense units will use airships in above roles. Airship antennae can extend the range of tactical AD radio nets. Airship-mounted camera systems can detect helicopters flying at low altitudes (using forest canopy for cover) earlier than their ground-based counterparts. Airships could also raise a cordon of light-weight radar antennae over obscured approaches for early detection of helicopters and other threats.

Another air defense use can be resurrected from the World War II era using modern airships as barrage balloons. They can deny low-level airspace to enemy aircraft by:

- Forcing aircraft to fly at higher altitudes, thereby decreasing surprise and attack accuracy,
- Limiting direction of attack, permitting more economical use of AD assets, and
- Presenting definite mental and material hazards to pilots by cables and airships.

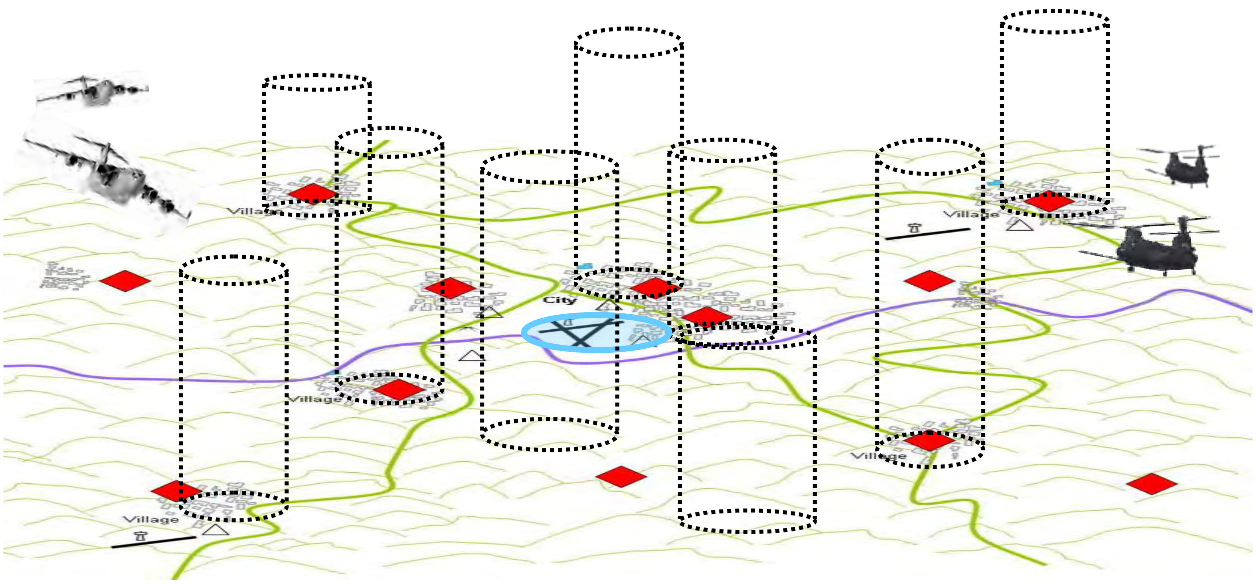
During WWII in 1944, the UK had 3,000 aerostats operating. During the Blitz, 102 aircraft struck cables (66 crashed or forced landings), and 261 V-1 rockets were downed. The blimps were 19 m long. Modern more compact airships offer more flexible options, with fast vehicle-mount winches, powered dirigibles, and lighter and stronger cables. Although modern aircraft have better sensors (such as thermal sights for night use), most airships have no thermal signature, and can be camouflaged and concealed for rapid rise with minimal visual signature. Latest recorded catastrophic collision of an aircraft with aerostat cable was 2007 in the Florida Keys. The Iranians have demonstrated air mines, barrage balloons with explosive charges.



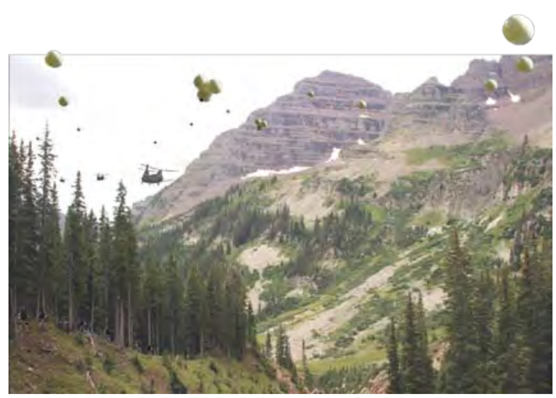
The tether cable and loose lines are the main threat to low-flying aircraft. Tether cables are next to impossible to detect in either day or night conditions, and can be steel, Kevlar, PBO or nylon. Type and length of tether material is determined by lift capacity of the balloon. Multiple loose lines and/or tethers may be suspended from the balloon. Short-notice balloon fields can be emplaced in 10-20 minutes, and raised or lowered with fast winches in 1-5. Netting,

buildings, and trees can be used to conceal inflated balloons between uses. Smaller (e.g., 1-m) inflated shaped balloons can be used in target shaping, altering appearance of buildings, vehicles, weapons, etc. They can also be raised as AD aerostats.

Although some balloons will use concealment, others will be clearly displayed to divert aircraft, or trigger a response and draw aircraft into air defense ambushes. Captured marker balloons can divert search and rescue aircraft into ambushes. Balloons can be used in deception as decoys to draw aircraft away from high-value targets.



Two areas where airships are most effective in air defense are urban and complex terrain.



Remote-Controlled Aircraft and Micro-UAVs for Military Use

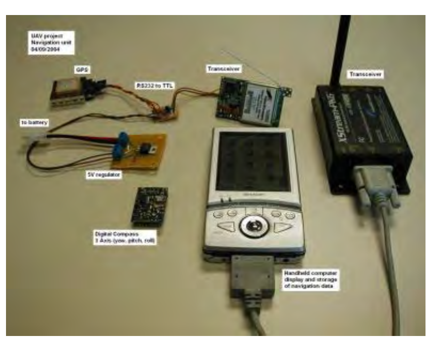
A wide variety of unmanned aerial vehicles are available in commercial and military sectors for use in military roles. However, cost can be a limiter for wide use. Some forces have turned to use of ***micro-UAVs***, in order to more widely distribute assets for close-in aerial surveillance. There is a burgeoning array of commercial and military options for these aerial systems. The term micro-UAV is open to wide variation, from palm size, to 1-2 meters. They can be almost as costly as mini-UAVs (up to $150,000 per set), or can cost only a fraction of that ($10,000 per set for a Russian Pestulga set). For even lower cost (and reduced capability), some forces turned to remote-controlled (RC) aircraft.


Carolo

These aircraft can be used for several roles, including surveillance, electronic warfare, and attack. Some use gas engines; but others are battery-powered. Most are composed of wood, plastic, or composite materials, with almost no radar signature. With camouflage and a flying altitude of more than 100 meters, most have almost no acoustic, visual, or thermal signature, and would be very hard to shoot down with current weapons. The greatest threat to them is shotguns. The surveillance role is obvious, with range of 1 or 2 km and flight range varying from a 0.5 kilometer (RC aircraft) to 10-100 km for some micro-UAVs. Beyond surveillance, other roles include electronic warfare (mounting a pocket-size GPS jammer onboard), and attack (with onboard IED charges or grenades). Piloted aircraft do not like to fly where UAVs may operate. Thus micro-UAVs can be used in air defense to challenge/attack incoming aircraft. Micro-UAVs can fly harassing flights over military and civilian targets in a PSYOPS role. Low cost of the systems means that they can be used as reusable or disposable assets, with ample re-supply.

Hobbyists have been flying RC aircraft for decades. In the last decade, camera technology has advanced to the point that commercial applications for the technology have been used. They permit acquisition of affordable aerial views of buildings, wildlife areas, industrial sites, and terrain, which otherwise would require expensive use of aircraft. Military applications have been used. Tamil Tigers in Sri Lanka were found to have two aircraft with small cameras mounted inside.

A recently demonstrated RC aircraft conversion with video camera showed potential of this technology. The aircraft had a 20-km 900MHz telemetry link and 32-km flight path. Navigation data from GPS permitted precise aircraft location and image orientation. Sharp PDA for display and flight recording was used. The same imagery system could be used with airships.



The Nokia N95 camera was displayed in an RC aircraft system described as "your personal Google Earth". It features the Multiplex EasyStar battery-powered RC aircraft with a 1.37-m wingspan, weighing 680 grams. With a GPS display unit and hand-held Optic 6 RC terminal, the system is ready to use in 10 minutes. Initial system assembly from kit, set-up, and training time is 2 hours. Pict'Earth software is used to download imagery.

There are now clubs and internet forums for radio-controlled UAVs. More robust recreational aircraft are being marketed. An example is the E2 Electronic Surveillance Infrared UAV from Imaging1. The battery-powered craft (with pusher prop) is a flying wing configuration 1.85 m wide, weighing 2.7 kg. It can fly 3 hours (up to 160 km) and 1,500 m in altitude. Standard payload (up to 2.7 kg) is a CCD camera. It features autonomous take-off and landing. Thermal camera is optional. Cruise speed is 30 knots. With graphite construction, this craft offers durability for military and law enforcement applications.

A Russian micro-UAV is the Pustelga, which they call a "flying micro-vehicle" (FMV). The composite aircraft weighs less than 0.3 kg, and is hand launched. The whole system, with battery-powered UAV weighs less than 5 kg. It features a TV camera, laptop terminal, inertial/GPS navigation, digital map and azimuth display. With a skeletal frame, it has virtually no visual or acoustic signature. The "strike version" can mount a charge for attack missions.

Other micro-UAV programs are underway. These will yield even smaller systems for military applications. Most MAVs are intended as disposable sensors, for hand or canister launch from ground units or vehicles. Attack versions are being considered, with hit-to-kill attack profiles. Use of loiter and "swarm" behaviors have been demonstrated for MAV control.

Powered Parachutes, Paragliders, Hang Gliders, and Wingsuits

Often military, paramilitary, and insurgent forces will attempt to operate in areas where they do not control the skies. At key times forces will attempt to surreptitiously emplace teams behind enemy lines. To do so quickly may require the use of aircraft. But aircraft flying beyond unit can be detected, and perhaps engaged, endangering the mission and exposing inserted teams. Aids for airborne insertion permit troops to more accurately land at the intended point and at the same time mask their landing location. Assets include the use of rotary-wing aircraft, and low-flying low-signature fixed-wing aircraft (see, An-2/Colt, pg 3-35). Terms ***parachute, paraglider,*** and ***hang glider***, are not standardized, and are used indiscriminately. They are sometimes classed as ultralight aircraft; but the link is random, and due in part to sharing of facilities and the sky.

Parachuting has greatly advanced with development of the cruciform shaped (rectangular) steerable canopies, which can stay aloft longer and offer glide ability (3-4:1 glide angle) to veer from the aircraft flight path and land precisely at selected landing points. Their superior lift permits them to launch from heights, e.g., cliffs, bridges, or balloons. These parachutes can take off from the ground at lower speeds as well as descend at a slower rate than older round chutes with a soft landing, usually erect and without injury. With their drogue-type pilot chute to open the main chute, they can launch from a towing boat or vehicle. An unattached cart can bear the chutist in a tow launch. Without propulsion, parachutes lack the lift and glide ability to stay aloft for a prolonged period after launch. Chutes tethered to a towing system are called ***Parasails.***

A spin-off technology is the ram-air parachute, also commonly known as a ***Paraglider.*** The airfoil design has two layers of fabric with an open front to catch air and inflate the semi-rigid structure. Like parachutes, paragliders use nylon, which is subject to UV ray degradation.

Medium performance canopies are rectangular, whereas high-performance canopies are elliptical, weighing 55-139 kg. Some are triangular wing structures, with greater glide angles (5-6:1) to extend flight distance for longer range and stay aloft longer. For experienced users, the technology offers capabilities beyond those of parachutes. They are also more subject to mishap. Poor wind can limit performance. User mistakes, and wind turbulence can result in catastrophic results, such as spin or canopy collapse. Another phenomenon is "cloud suck", which can carry the chutist to 9 km or more, where temperatures can drop to -40 ° farenheit. A chutist can also carry a reserve parachute. In most cases, a collapsed paraglider will recover on its own in about 100 m. Glide speeds can mean faster landing speeds with paragliders.

An adjunct to parachuting or paragliding is ***powered parachuting*** or ***powered paragliding***. This can involve a backpack ***paramotor,*** which can propel and steer troops. Units for parachutists generally require 40 to 70 hp. ***Powered parachutes (PPC)*** convert parachutes into aerial vehicles. With them, troops can stay aloft for long periods and long distances. The paramotor is mounted on the chutist's back, and is surrounded by a cage. A user can launch from a stationary standing position, and land erect. Most use a gasoline engine, and weigh 20-37 kg. With easily assembled

cages, the motors can be transported in the trunk of a car. A Chinese electric paramotor, the Yuneec ePAC, is in pre-production testing and will likely soon be marketed.

When linked with paragliders, paramotors transform them into ***powered paragliders (PG)*** to fly 100 kilometers on a tank of gas. Paramotors for paragliders need a power range of only 15 to 30 hp. The equipment can be set up in 15 minutes. Disassembly into 3-4 parts takes about 3 minutes. Flight speed is is 32-40 km at 150-5,500 meters altitude. They generally cannot launch from standstill.

An efficient design for military units is to suspend a ***trike*** under the canopy and mount the paramotor onto it. Then the operator is freed to fly the craft; and can suspend combat gear to the frame. Some are erected at launch site, whereas others are solid welded structures. Trikes require larger parachutes than for parachutists or paragliders (discussed below). The chutes have 30 cells, compared to a normal design with 13. Wind and gust should not exceed 10-15 mph in flight. Paragliders and parachutes with trikes usually take off and land from paved surfaces; however, parachute versions have lower stall speeds, and can use unpaved areas as well. One example of a commercial trike is the Powrachute Sky Rascal. The one-seat craft weighs 105/117 kgs, with 40 or 52-hp engine, max payload of 136/159 kgs, and air speed of 67-90 km/hr. Typical trike specifications are as follows:

- Continuous flight capability: ~3hrs w/ 10gal fuel tank
- Take off distance: < 30 meters
- Flight speed: 40 – 111 km/hr
- Flight elevation: up to 5,500 m AGL (150-450 typical)
- Range: Approx. ~185 km round trip
- Glide Ratio: 4-5:1
- Cost: Single Seat $6000 - $10000 USD, Two Seat: $15000 - $20000 USD
- Payload: Up to 1,100 kg (varies by engine type, GVW, and canopy)
- System Assembly / Disassembly: ~10 min w/ 1 person
- Training: 5 – 7 days

Various other structures have been added to powered paragliders, including rubber inflatable boats (RIBs, Vol 3, pg 3-11), pontoons (right) , and wheeled cab designs. A new feature for PPC is Rapid Launch Amphibious Powered Parachute, a rectangular ram-air canopy with helium-filled chambers forming a balloon. The rigid canopy lifts even at standstill, permitting launch from stationary position. Various mounts are permitted, but the one displayed with Rapid launch is a catamaran boat.

Missions with these craft include reconnaissance, insertion, and delivery of critical materials. Trikes can also be used to launch parachutists. With night vision goggles, GPS, coordination with ground support, and nighttime illumination along flight routes, they can operate at night. Illuminated areas are safer for take-off and landing. For powered PPCs and PGs, most of the time, altitude is low (less than 500 m) to reduce likelihood of detection. Flight time is about 2-2.5 hours between refills. With refills and ground support, the craft can fly hundreds of kms. A passenger on trike could use a laptop or PDA controller to operate small UAVs to fly ahead or conduct area surveillance along the flight path. A paramotor FARP can be as simple as a pickup truck with communications and 5-gallon fuel cans at a pre-coordinated point. Powered parachutes and paragliders are similar to ultra-light aircraft in that reliability, operator errors, wind conditions, and landing/take-off conditions can cause accidents and injuries. However, because of their slower speed and superior lift, consequences of PPC and PG accidents are usually less severe than with ultra-light aircraft.

Powered parachutes and paragliders are an inexpensive alternative to UAVs, or they can be used in conjunction with them. Iran, India, Pakistan, China, Cuba, and Lebanese Hezbollah have all demonstrated either a PPC or PG capability. In 2002 Beijing's China Central Television showed members of Special Forces reconnaissance militia using trikes and a powered paraglider with a small rubber boat similar to a small Zodiac RIB.

Hang gliders can be classified as paragliders. Some hang gliders use rectangular parachutes or paragliders, or paraglider wings to bear them when aloft. Higher performance hang gliders use erectable Dacron rigid wings or triangular structures, with bars underneath. The operator lies prone underneath. Hang gliders offer glide angles of up to 20:1, for long flight times and distances. The wing above can block the user's skyward view; so some use transparent material to expand viewing area. Many hang gliders use erectable struts, which can be disassembled and fit into a tube 6 m long, for vehicle mount. A few makers, such as Wills Wing and Finsterwald, offer structures which can fit into 2-meter tubes and inside of vehicles. Triangular wing paragliders with paramotors are often included in the category of ultra-light aircraft, and operate with similar capability and vulnerabilities.

Another recreational development with possible application to military actions is the ***wingsuit*** (aka ***jumpsuit***). Developed for base jumping, the suit permits a user to glide to earth, then pop a parachute for a safe landing. Obviously, there is risk associated with this arrangement, with flight speeds of 80-200 km/h and glide ratios of 2-3:1. Training is critical. With schools, clubs, and competitions, designs vary greatly. Brands include Phoenix-Fly, V3, and many others, plus experimental and privately made creations. The jet-powered Go Fast has demonstrated a safe landing without parachute. Wingsuits permit SOF to insert personnel with less visible signature and shorter vulnerability time than those on paragliders. Wingsuits can deploy from 2-man ultralights or trike-powered paragliders, enabling insertion personnel to exit the aircraft quickly. Military designs include the German Gryphon, which has been demonstrated and displayed at exhibitions. With rigid wings and jets, it is intended to offer 40 km range and payloads for military missions. In the Near Term, more composites and inflatable sections may add rigidity for stabilization. It is likely that military versions will offer safer and practical designs for tactical roles.

Ultralight Aircraft and Military Uses

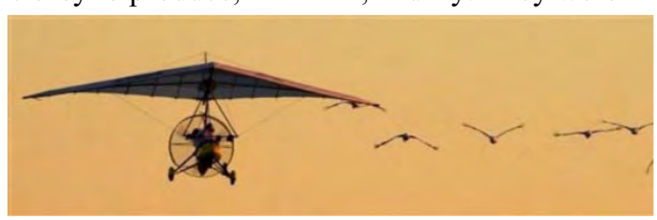
Recreational use of ultralight aircraft has generated a myriad of activities and flying organizations worldwide. Their designs are much less regulated than conventional aircraft, which has led to thousands of makes and designs. They require much shorter and less developed airfields than other aircraft, with few organizational procedures, with primary focus on operational procedures to fly the aircraft.

Many operate on water, to ease dangers of takeoff and landing. In many cases, these are the only craft that can operate in some remote areas. At right is one of several craft operating in the Nepalese mountains. Ultralight aircraft are generally cheap to operate and operators can be trained in a matter of days. The craft can travel for thousands of kms, stopping only for refueling. A number of them can hold more than two persons as well as several hundred kilograms of cargo.

Key descriptors that set ultralights apart from other aircraft are that they are manned, are smaller than conventional aircraft, and are powered. The most common configurations are the following:

- Hang-glider type with a paramotor and seat,
- Smaller conventional wing-over-cab design, and
- Rotary-wing design.

Powered hang-glider type ultralights are easy to produce, maintain, and fly. They were an outgrowth of the expansion in recreational hang-gliding. Designs widely differ; but they usually use Dacron fabric, and a triangular wing design. Similar versions employ conventional wings with swept angles. They are light and require less fuel than other designs. If the paramotor were to fail, the craft can glide to a landing.



Most ultralights have rigid structures; but many combine those structures with fabric wings and shock units. Many are fitted for water take-off and landings. The Italian Polaris FIB (left) has sold more than a thousand units in several models throughout Asia, Europe, and in the U.S. The FIB 2001 Flying Inflatable Boat is an upgraded design using a Lomac RIB hull and weighting 58 kg. It is fitted with a 48-hp Rotax 503 twin-cylinder 2-stroke engine selected for noise suppression. Other FIBs include the 503 (right), with a tandem overhead wing.

Conventional tandem wing-over-cab designs vary from finished craft with attractive designs, dashboard gauges, and shocked retractable landing gear, to Spartan frame structure. The Fotos Seamax is an example of the former. For military use, the craft are apt to be closer to the latter, but with additional features. Military craft are apt to have an open cockpit design with two seats, light weight, ample cargo capability for military gear, and ruggedized for long use and wear and tear of possible combat conditions in difficult weather and terrain. The craft should also be able to accommodate night missions. An example of this kind of craft is Quicksilver Sport 2S (see data sheet next page).

Ultralight helicopters are made mostly in the U.S., Russia, and European countries. They have been sold in other areas. Many are often referred to as gyrocopters and rotorcraft. Most are built from kits, and are 1-seater designs. The Russian K-10 (left) was an early craft used to support Naval icebreakers. An example of a more finished design is from the Italian firm Elisport. The Kompress (Angel CH-7) is a single-seat craft with a 65-hp Rotax 582 engine. It weighs 1,078 lbs, with 2.5 hrs endurance. There are a few 2-seaters available. Civilian and military roles for these rotorcraft include ambulance duty, surveillance, search and rescue, agricultural spraying, etc. Some military versions are equipped to fly unmanned.

Ultralight aircraft vary widely in their reliability and capabilities. All are more subject to weather and terrain considerations than conventional craft. Recently a Hamas-operated ultralight craft broke up off the coast of Israeli in the Mediterranean Sea. Even well-designed craft are subject to adverse events. Nevertheless, these craft offer cost-effective aerial use, by civilian and military organizations.

Today ultralight craft are employed in military operations. Most common military missions are insertion of special operating forces, reconnaissance, patrol and quick-reaction units, and delivery of materiel in difficult terrain. They generally have reduced signatures. They can fly low (below radars), and land in areas where conventional fixed-wing aircraft cannot land. Military versions of these craft are used in various countries, including India, Iran, and China. Iran produces ultralight aircraft in a variety of designs. The Iranian Saba Airline Company ultralight is offered for sport flying, short-haul freight, crop dusting, fire fighting, urban taxi service, police patrolling, as well as military roles. The Saba Company offers an unmanned version of its craft for military surveillance. Ultralights could also launch small UAVs, conduct jamming missions, retransmit signals, and attack targets. Craft useable for crop dusting could also deliver chemical agents.

U.S. Ultralight Aircraft Quicksilver Sport 2S

SYSTEM
Description:
Minimum flight crew – 1
Seats – 2
Blades: Propeller - 68in x 36,
Selected for less noise
Engine: Rotax 582, 2-stroke, 64 hp
No. of Cylinders - 2
Displacement - 580.7cc
Dual CDI Electronic Ignition
Dual Carburetor Engine
Dimensions (m):
Length (m): 18ft 1/2 in
Height (m) 8 ft
Wingspan (m) 31 ft
Wing area (m^2): 174.1 sq ft
Weight (kg):
Empty: 430 lb
Max Takeoff: 996 lbs
Useful payload: 566, 530 full fuel
Fuel capacity - 6 U.S. gal

Performance:
Speed (km/h):
Cruise: 70 mph
Max: 87 mph, 69 mph sea level
Landing approach: 46 mph
Rate of climb - 500 ft/min
Minimum sink rate - 660 ft/min
Required Distances (m):
Takeoff , ground roll - 240 ft
50 ft obstacle - 660 ft
Landing with brake - 220 ft
Glide ratio - 5.5:1
Crosswind capability: Good

Features:
Design: Tapered stabilizer,
tubular-braced tail
Double surface wings
Aluminum steerable nose wheel
Main wheel brakes
Conventional 3-Axis controls
Tail boom fits propeller up to: 72"
Inflight adjustable trim control
Breakdown for transport (m): INA,
considered "quick"
Kit assembly time (hrs): 40 - 60 ave
Airspeed indicator included

VARIANTS
An amphibious version of the Sport 2S is available. Similar modification with pylons could be made with most ultralights; but factors such as endurance and performance on takeoff and landing in water can vary.

Sprint 01: 1-seat model available.

GT500 Agricultural Spray System:
A Quicksilver cab aircraft offers 65 mph spray speed. It has 94 liter and 140 liter fiberglass spray tanks. Spray rate is 6 acres (2.5 hectares)/min, flying at 3.7-4.7 meters altitude. Spray mixtures can vary for different spray rates. Similar ultralite craft could be used in military roles for dispensing chemical agents.

NOTES
There are many systems of similar design, with different features and performance levels. This craft has a reasonable capability level to expect in a kit ultralight. Most ultralights can be modified to fit specific uses, such as adding cage for adding cargo, more gauges (such as GPS for navigation), radio, and even mounting a weapon pintle (for MG or grenade launcher), or weapon cradle for quick deployment. Accessories just as NVGs could be used. None of these models are marketed by the manufacturer for use in military roles; but they could be used for them.

Chapter 8
Equipment Upgrades

Armed forces worldwide employ a mix of legacy systems and selected modern systems. In the current era characterized by constrained military budgets, the single most significant modernization trend impacting armed forces worldwide is upgrades to legacy systems. Other factors impacting this trend are:

- A need for armed forces to reduce force size, yet maintain overall force readiness for flexibility and adaptiveness
- Soaring costs for modern technologies, and major combat systems
- Personnel shortages and training challenges
- Availability of a wide variety of upgrade packages and programs for older as well as newer systems
- New subsystem component technologies (lasers, GPS, imaging sensors, microcircuits, and propellants) which permit application to platforms, weapons, fire control systems, integrated C2, and munitions old and new, and
- An explosion of consortia and local upgrade industries, which have expanded worldwide and into countries only recently introduced to capitalism.

The upgrade trend is particularly notable concerning aerial and ground vehicles, weapons, sensors, and support equipment. From prototype, to low-rate initial production (LRIP), to adoption for serial production, minor and major improvements may be incorporated. Few major combat systems retain the original model configuration five or more years after the first run. Often improvements in competing systems will force previously unplanned modifications.

Upgrades enable military forces to employ technological niches to tailor their force against a specific enemy, or integrate niche upgrades in a comprehensive and well-planned modernization program. Because of the competitive export market and varying requirements from country to country, a vehicle may be in production simultaneously in many different configurations, as well as a dozen or more support vehicle variants fulfilling other roles. In light of this trend, OPFOR equipment selected for portrayal in simulations and training should not be limited to the original production model of a system, rather a version of the system that reflects the armed force's strategic and modernization plans and, as well as likely constraints that would apply.

The adaptive OPFOR will introduce new combat systems and employ upgrades on existing systems to attain a force structure which supports its plans and doctrine. Because the legacy force mix and equipment were historically selected earlier in accordance with plans and options, upgrades versus costly new acquisitions will always be an attractive option. A key consideration is the planned fielding date. For this document, OPFOR time frame is current to near-term. Thus, only upgrades currently available (or marketed, with production capability and fielding expected in the near term), are considered. Also, system costs and training and fielding constraints should be considered.

The following tables describe selected upgrades available for system modernization. The lists are not intended to be comprehensive. Rather, they are intended to highlight major trends in their respective areas. For instance, for armored combat vehicles, the focus is on upgrades in mobility, survivability, and lethality.

The category of survivability upgrades includes countermeasures (CM). The CM upgrades can apply not only to systems targeted initially in specific branches (tanks, IFVs, and air defense guns), but in time to other systems subject to similar threats based on availability of the applications. An example of this is the proliferation of smoke grenade launchers to artillery and air defense vehicles.

Implementation of all upgrade options for any system is generally not likely. Because of the complexity of major combat systems and need for equipment subsystem integration and maintenance, most force developers will chose a mix of selected upgrades to older systems, as well as limited purchases of new and modern systems. Please note that systems featured in this document may be the original production system or a variant of that system. On data sheets, the **VARIANTS** section describes other systems available for portrayal in training and simulations. Also, equipment upgrade options (such as night sights) and different munitions may be listed, which allow a user to consider superior or inferior variants. Within the document chapters, multiple systems are listed to provide other substitution options. Of course there are thousands of systems and upgrade options worldwide which could be considered by an adaptive OPFOR.

An OPFOR trainer has the option to portray systems or upgrade packages not included in the OPFOR Worldwide Equipment Guide, to reflect an adaptive thinking OPFOR. In future WEG updates, we will expand on the upgrade tables with names descriptions of upgrade options and specific systems applications which have been noted. Our functional area analysts are available to assist OPFOR users in selecting reasonable upgrade options for system configuration in specific force portrayals. Questions and comments on tables and data in this chapter should be addressed to the POC for each chapter impacted by the below tables.

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OPFOR AERODYNAMIC SYSTEM UPGRADES

ROTARY-WING AIRCRAFT	UNMANNED AERIAL VEHICLE (UAV)	THEATER BALLISTIC MISSILE (TBM)
Older airframes and utility helicopters can be upgraded sensors and weapons Western upgraded avionics, fire control computers, sights, and technology readily available to retrofit into existing older airframes Many new aircraft being built with cost controls to make entice new markets in developing nations. Emerging belief in upgrade of existing platforms rather than developing new airframes, primarily due to financial constraints Development of quieter, more efficient main and tail rotor blades and engines to increase aircraft performance Digital data-linking with ground systems and air defense networks Increased use of millimeter wave, FLIR, and NVG technologies to allow greater night/ weather weapons delivery and mission completion Service life extension programs Improved weapons and munitions, including ATGMs, air-to-service missiles, and precision bombs **<u>UPGRADE PRIORITY</u>** MMW, FLIR, and NVG technologies Upgraded avionics Service life extension programs	Extend operational radius and endurance Reduce sensor-shooter timeline Enhanced third-generation image intensifiers and second-generation thermal imagers may be available to limited countries. Multiple sensors will be employed on the same platform for enhanced target detection under all-weather conditions and may be linked to weapon delivery platforms. Integrated laser target designators for smart munitions in priority target areas Multiple sensors for chemical and biological agents will be employed on this platform and may be linked to comms platforms. Precision attack variants, such as anti-radiation UAVs for radar attack **<u>UPGRADE PRIORITY</u>** Extend operational radius and endurance Obtain improved EO capability Reduce sensor-shooter timeline Laser target designator integration	Improved launcher (swim capability, multiple missile capability, reduced signature) Reduced preparation time, emplace and displace times, shoot and scoot operation Automated secure digital C2 network, linking with artillery, air, EW, and reconnaissance units Navigation system with GPS/inertial update, linked to automated net Autonomous operations or increased interval Launcher countermeasures: decoys, missile non-ballistic launch trajectory Missile countermeasures (e.g., non-ballistic trajectory, penetration aids, separating warhead, multiple maneuvering re-entry vehicles) Extended range missiles Improved smokeless propellant Multi-sensor or other improved homing with increased accuracy (<50 m CEP) Advanced munitions (cluster munitions, FAE/ thermobaric munitions, biological, electro-magnetic pulse, anti-radiation missiles), larger payloads **<u>UPGRADE PRIORITY</u>** Improved smokeless propellant Separating warhead and larger payloads Survivability countermeasures.

OPFOR AIR DEFENSE SYSTEMS UPGRADES

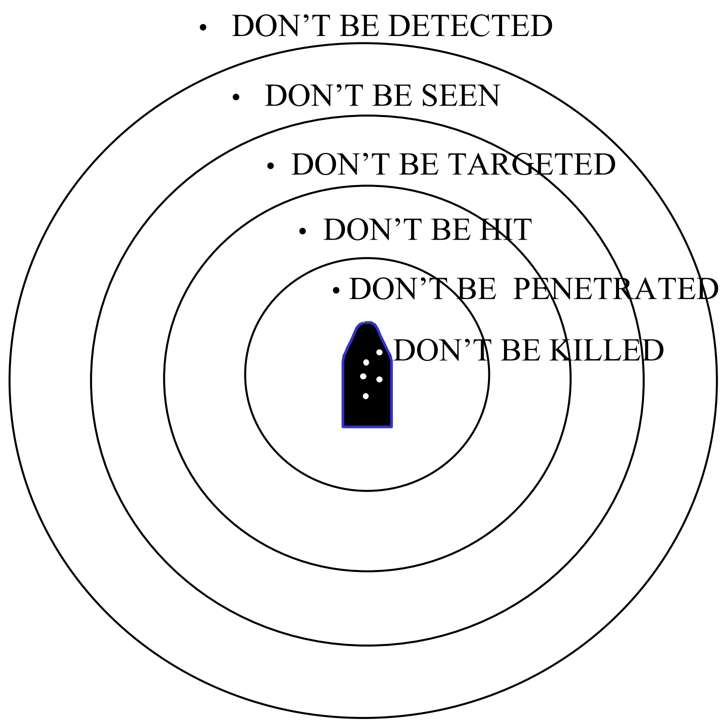
AIR DEFENSE GUN/GUN-MISSILE SYSTEM	MANPORTABLE AIR DEFENSE SYSTEM	SURFACE-TO-AIR MISSILE
Light AD vehicle: Combat support vehicle with light armor and TV, thermal sights, Add encrypted voice and digital data capability, and overhead launcher turret Armored AD vehicle: See IFV upgrades, e.g.: improved armor, and suspension, 2-man turret CM, e.g., multi-spectral smoke grenades, LWR Upgraded FCS: Cdr's independent viewer, 2-plane stabilized TV gunner sights, FLIR, multi-mode targeting (TV/radar, day/night modes). Improved target acq radar, longer range, low probability of intercept. Reduced radar mean-time to detect and system response time Links to AD network, encrypted voice, digital data transmission capability, computer display GPS and inertial land navigation, IFF Improved multiple MGs/auto-cannons to 40 mm or cannons to 100 mm, with stabilized guns with fire on the move capability Improved rounds, e.g., electronic-fuzed HE, APFSDS-T, and frangible rounds Mounting air-to-air missiles on SHORAD SAM launchers, to out-range helicopter launch missile systems. MANPADS or multi-stage AD missiles with ACLOS radar dual and multi-band seekers Kinetic-energy missiles with sabots, for use in AD role, and against ground vehicle targets **UPGRADE PRIORITY** Improved day/night optics and radar Automated secure links to AD network Improved multiple stabilized guns, rounds Improved missiles and guidance	Vehicle, ground platform, helicopter mounts Thrust-vectoring capability All-aspect engagement capability Strap-on imaging infrared or thermal sights Early warning datalinks and alert display boards for mount on launcher Upgraded IFF capabilities Missiles in disposable launch tubes Improved missiles and seeker heads with better counter-countermeasure resistance Uncooled seeker heads, wider FOV Increased range Improved warheads and blast/frag effects, base fuzing of propellant for increased blast Improvements in aerodynamics, fuels, and materials, for increases in speed, reduced smoke signature, maneuverability, and accuracy Integrate with anti-helicopter mines **UPGRADE PRIORITY** Improved sights and warning display boards Strap-on II/FLIR Improved seekers, warheads, propulsion Uncooled seeker heads, wider FOV Flare rejection capability	Improved vehicle or platform launcher for rapid emplacement/displacement CM, e.g., multi-spectral smoke, LWR Upgraded FCS: 2-plane stabilized TV gunner sights, 1 - 2 gen FLIR, multiple target engagement capability, All-weather fire control, multi-mode targeting, with TV and radar, day and night. Improved EW and target acq radars, longer range, low probability of intercept, and signal processing in radars Reduced radar mean-time to detect, and system response time Links to AD network, encrypted voice, digital data transmission capability, computer display GPS and inertial land navigation, and graphic display battle management system, IFF Missiles with SACLOS, ACLOS radar, IR or multi-band terminal seekers, more lethal warheads, longer range, maneuverability with improved counter-countermeasure resistance Vertical missile launch **UPGRADE PRIORITY** Improved FCS with day/night optics and radars, and multi-target capability and modes Automated secure links, digital AD network Improved missiles and guidance CM protection from jamming and ARMs

Chapter 9
Countermeasures
(Modified Extract of Volume I, Ch 14)

Countermeasures (CMs) are survivability measures to preserve the integrity of assets and personnel by degrading enemy sensors and weapons effectiveness. These measures often fit within the US Army term CCD (camouflage, concealment and deception) or within the OPFOR term C3D (camouflage, cover, concealment and deception). Decoys used by tactical units within branch operations are designed to aid survivability, and are considered to be countermeasures. Countermeasures can take the form of tactical CMs (or reactive measures), or they can be technical CMs. The variety of tactical CM changes with new unit tactics techniques and procedures (TTP), to adapt to a given situation, within rules of engagement. This document focuses on technical CM. In specialized branches new technical CMs continue to appear.

Modern forces will upgrade systems with selected countermeasures. Many CMs noted are intended to protect combat vehicles from anti-armor sensors and weapons. Although the below CM can be used to counter precision weapons, many were developed for use against conventional weapons. Priorities for countermeasures are dictated by the goals of survival, mission success, and maintaining effectiveness. The first CM priority is to avoid detection until you can control the events. Among goals for using countermeasures, highest is mission success.

COUNTERMEASURE PRIORITIES



Survival ("Don't Be Killed") is defined holistically, including the following requirements in order of priority: operating system or network survival, vehicle survival, vehicle avoidance of major damage, crew survival, and vehicle avoidance of minor repair. A compatible suite of countermeasures may be limited to a more modest goal, to preserve a measure of effectiveness, even at the cost of system survival. Effectiveness in this context could be defined as: ability to successfully execute the immediate and subsequent missions, until system or subsystem failure interrupts this process. Effectiveness includes: crew effectiveness, crew fitness, mission success, operating system effectiveness, and vehicle/soldier readiness for employment.

Several factors must be considered when selecting countermeasures.

- Countermeasures should be fielded and mounted on systems with a holistic and rational approach to assure survivability. The rational developer will focus his countermeasures with the highest priority given to assure protection against the most likely and most lethal threats. However, with changing threat capabilities over time, and conflicting priorities, the current CM mix may not be successful. Most CM are responses to specific perceived threats, and are limited by cost and weight budget concerns. With the modern reliance on precision weapons, military forces may develop complex and expensive countermeasure "suites" to degrade their effects.

- Some countermeasures can degrade a variety of sensors and weapons capabilities. They can be grouped by threat to be countered, such as artillery or ATGM CMs. Others are more adversary technology-specific, and may not be fielded until that technology is fielded. Driven by threatening technologies, designers may launch a short-response program to produce or purchase countermeasures for rapid mounting.

- The R&D process has led to the development of counter-countermeasures, intended to negate the effects of CMs. However, at some level, these are also CMs. To avoid confusion on labeling, these will also be called countermeasures.

- When countermeasures are added to a vehicle or within close proximity, they must be mutually compatible and compatible with other subsystems. Thus issues such as electromagnetic interference and self-blinding with smokes must be considered.

- Although a variety of countermeasures are now marketed, many technical and financial factors can negate their advantages. Countermeasure development may be restricted due to resource, technology, and fabrication limitations, which vary by country and time frame. Budget limitations may limit fielding of feasible and valuable CM, or compel selection of less capable countermeasures. For instance, active protection systems can counter some weapons; but they are expensive, hazardous to soldiers, and ineffective against many weapons. Thus they may be unsuitable and unlikely for application to many systems. OPFOR users should consult the POC below for assistance in selecting CMs for a specific system.

- Countermeasures will not replace the need for armor protection and sound tactics.

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LETHALITY COMPONENT VERSUS COUNTERMEASURE RESPONSES

Intent of this table is to assist in selection of CM and understanding the categorization for use in upgrade schemes. Many of the more widely-fielded countermeasures are designed to degrade a variety of sensors and munitions, for minimal upgrade cost. Thus, countermeasure types may be repeated under several functions. Because new technologies are emerging rapidly, and systems are finding applications which can place them in several CM types, the placement of CMs can be somewhat arbitrary. Use against artillery vs ATGMs vs ground vehicle weapons will vary. The following list of CM can be used for artillery, air defense, antitank, armor, aircraft, theater missile, and other systems, depending on the platform, gun, sensor, and munition configuration of the system.

Capability to Be Degraded	Type of Countermeasure
Detection and location	Camouflage: nets, paints, fasteners for added natural materials Cover: entrenching blades, hole-blast device, underground facilities Concealment: screens, skirts, thermal engine covers, scrim, other signature reduction Deformers, engine exhaust diversion, other signature alteration measures Aerosols: smoke and flares, water spray systems Decoys, clutter, and acoustic countermeasures Counter-location measures: GPS jammers, laser and radar warning systems
C2/sensor-shooter links	See Information Warfare (IW) Chapter
Platform or weapon	Counterfire: directional warning systems, laser radars, for rapid response Directed energy weapons (DEW), such as high-energy lasers System prioritization for hard-kill, e.g., anti-helicopter mines (See Ch 7)
Weapon sensors and fire control	CCD as noted above. Directed energy weapons, such as low-energy lasers (LEL) Electro-optical countermeasures (EOCMs)
Submunition dispensing/activation	Global positioning system (GPS) jammer Fuze (laser/IR/RF), RF barrage jammers, acoustic jammers
Precision munition and submunition sensors	CCD as noted above. False-target generator (visual, IR, RF/acoustic) Electromagnetic mine countermeasure system, to pre-detonate or confuse Fuze jammers (laser/IR/RF), RF barrage jammers, acoustic jammers
Munition/submunition in-flight, and its effects	Sensors to detect munitions: MMW radars, RF/IR/UV passive sensors Air watch and air defense/NBC warning net, to trigger alarm signal Active protection systems, for munition/submunition hard kill Cover, additional armor to reduce warhead effects
Other system effects	Miscellaneous CM (See below)

COUNTERMEASURES AGAINST SENSORS

Type Countermeasure	Countermeasure	Example	Application
Camouflage	Camouflage nets Camouflage paints, IR/radar/and laser-absorptive materials/paints Fasteners, belts for attaching natural materials	Russian MKS and MKT Salisbury screen rubber epoxy Chinese "grass mat" set	Variety of vehicles Variety systems Uniforms and vehicles
Cover	Natural and manmade cover, civilian buildings Entrenching blade to dig in vehicles Hole-blast devices for troop positions, spider holes Underground facilities, bunkers, firing positions	Tree cover, garages, underpasses T-80U tank, BMP-3 IFV, 2S3 arty Hardened artillery sites, bunkers	TELs, vehicles, troops IFVs, tanks, SP arty Infantry, SOF Iraqi and NK sites
Concealment	Screens, overhead cover for infantry (conceal IR/visible signature) Canvas vehicle cover, to conceal weapons Thermal covers, vehicle screens Scrim, side skirts and skirting around turret	Colebrand netting Cover on Chinese Type 90 MRL Kintex thermal blanket over engine French "Ecrim" track cover scrim	Infantry, weapon, sensor Truck-based weapons For combat vehicles Combat vehicles
Deformers/ signature modification	"Wummels" (erectible umbrellas to change/conceal shape/edges) Exhaust deformers (redirect exhaust under/behind vehicle) Engine and running gear signature modification (change sound) IR/radar deformers (in combination with RAM and RAP, etc)	Barracuda RAPCAM/TOPCAM Russian exhaust deflectors Track pads, road wheel/exhaust change Cat-eyes, Luneberg lens	Vehicles, sites, weapons Combat vehicles Tracked, other vehicles Tracked, other vehicles
Aerosols	Visual suppression measures, smokes, WP rounds Multi-spectral smokes for IR and or MMW bands, Flares, chaff, WP, to create false targets, disrupt FLIR Toxic smokes (irritants to disrupt infantry and weapons crews) Water spray systems (to reduce thermal contrast)	Smoke generators, fog oil, S-4, RPO-D ZD-6 Smoke grenades (visual/IR) WP rounds, Galix 6 flare system, Adamsite and CN in smoke mix Add-on kits for vehicles	Blinding, screening Vehicle protection Combat vehicles, arty Smoke generators Recon, C2, AD, arty
Decoys	Clutter (civilian/military vehicles, structures, burning equipment) Low to high-fidelity (multi-spectral) decoys Radar/IR decoy supplements (to add to visual/fabricated decoys) Acoustic countermeasures (to deceive reconnaissance, sensors)	Log site, truck park, tank farm, derricks Barracuda decoys, Corner reflectors, KFP-1-180 IR heater Acoustic tape/speaker systems	Artillery, combat vehicles Vehicle/site decoys Vehicles, sites
Counter-location measures	Degrade GPS by jamming to reduce precision location capability Jam radars/IR sensors Laser, IR, and radar warning systems (to trigger move/CM)	Aviaconversia GPS jammer SPN-2 truck-borne jammer set Slovenian LIRD laser warner	Infantry and others tactical/operational area Combat vehicles

COUNTERMEASURES AGAINST WEAPONS AND WEAPON SENSORS

Type Countermeasure	Countermeasure	Example	Application
Added protection (supplements to armor in reaction to specific capability)	Armor supplements (ERA, screens, bar or box armor, sand bags) Armor skirts over road wheels Mine rollers, plows and flails Vehicle belly armor, raised or redesigned belly design, skirt Vertical smoke grenade launchers (to counter PGM top attack)	Barracuda, SNPE ERA KMT-5, KMT-6	
EOCM	Use EOCMs such as IR jammer/IR searchlights to redirect ATGM	KBCM infrared CM system	Combat vehicles
False-target Generators	Acoustic jammers and directed acoustic countermeasure Laser false-target generator (against semi-active laser homing) Electromagnetic mine countermeasure system, counters fuzes	In development, can be improvised In development	To distract acoustic seekers Combat vehicles
Jammers	Altimeter jammer (counters submunition dispersion altimeter) Fuze jammers (to spoof RF proximity fuzes on munitions) Incoherent infrared jamming (to jam IR fuzes on munitions) GPS jammers to confuse navigation and course correction systems	SPR-1 armored ECM vehicle	High priority sites, CPs etc.
Active countermeasures	Active protection systems, for munition hard kill. High energy laser weapons to destroy munitions or sensors Low energy lasers to blind or dazzle. Radio-frequency weapons to burn electronics and detonate munitions Directed MGs	Arena hard-kill system ZM-87 laser weapon VEMASID counter-mine system	Tanks, recon vehicle, IFVs AT, AD systems
Counterfire/ Threat response warners	Directional warning system (locate laser/radar, to direct weapons) Employ sensors (RF/IR/UV - to detect munitions) Acoustic directional systems (to detect munitions) Laser radars (laser scanner to locate optics and direct weapons) Directed energy weapons (against optics) Anti-helicopter mines (against aircraft) Employ air watch/security, AD, NBC, nets to trigger alarm signal Dazzle grenades (temporarily blind personnel)	Pilar acoustic detection system Star-burst grenades	Infantry
Miscellaneous CM	Optical filters to degrade effect of battlefield lasers. Pulse code/thermal CCM beacons on SACLOS ATGMs (to counter EOCM)	HOT-3 ATGM	

COUNTERMEASURES BY FUNCTIONAL AREA AND TYPE SYSTEM (CONTINUED)

Functional Area	System	Type Countermeasure	Countermeasure
Air Defense , Artillery, Radar units, Theater Missile Units , Aviation, Headquarters,	Command and communications vehicles, Radars, missile launchers, Aircraft (High value targets)	Camouflage	Camouflage paints, IR/radar/and laser-absorptive materials/paints
		Cover	Natural and manmade cover, civilian buildings Entrenching blade to dig in vehicles Underground facilities, bunkers, firing positions
		Concealment	Canvas vehicle cover, to conceal weapons when not in use Thermal covers, vehicle screens
		Deformers/signature modification	Scrim, side skirts and skirting around turret "Wummels" (erectible umbrellas to change/conceal shape/edges) Exhaust deformers (redirect exhaust under/behind vehicle) Engine and running gear signature modification (change sound) IR/radar deformers (in combination with RAM and RAP, etc)
		Aerosols	Visual suppression measures, smokes, WP rounds Multi-spectral smoke grenades for IR and or MMW bands, Flares, chaff, WP, to create false targets, disrupt FLIR
		Counter-location measures	Degrade GPS by jamming to reduce precision location capability Jam radars/IR sensors Laser, IR, and radar warning systems (to trigger move/CM)
		Decoys	Clutter (civilian/military vehicles, structures, burning equipment) Low to high-fidelity (multi-spectral) decoys Radar/IR decoy supplements (to add to visual/fabricated decoys) Acoustic countermeasures (to deceive reconnaissance, sensors)
		CM Operational Technologies	Anti-helicopter mines (against aircraft) Beyond line-of-sight modes Non-ballistic launch modes Anti-radiation missiles Low energy lasers to blind/dazzle optics on designators/aircraft Encoded laser target designators to foil false target generators Radio-frequency weapons - burn electronics/detonate munitions High energy laser weapons to destroy munitions or sensors Laser false-target generator (against semi-active laser homing) Altimeter jammer (counters submunition dispersion altimeter) Fuze jammers (to spoof RF proximity fuzes on munitions) Incoherent infrared jamming (to jam IR fuzes on munitions) GPS jammers to confuse navigation and course correction systems Optical filters to degrade effect of battlefield lasers

COUNTERMEASURES BY FUNCTIONAL AREA AND TYPE SYSTEM (CONTINUED)

Functional Area	System	Type Countermeasure	Countermeasure
Aircraft Units **Reconnaissance UAVs** **Theater Missile Units**	Helicopters Fixed-wing aircraft UAVs Attack UAVs Missiles	Camouflage Decoys Counter-location measures CM Operational Technologies	Camouflage paints, IR/radar/and laser-absorptive materials/paints Launcher decoys Flares, chaff, WP - decoy seekers, create false targets, disrupt FLIR Clutter (civilian/military vehicles, structures, burning equipment) Jam radars Stealth materials and coatings GPS jammers to confuse navigation and course correction systems Jam IR sensors and seekers with laser/IR devices Fuze jammers (to spoof RF proximity fuzes on munitions) Radio-frequency weapons - burn electronics/detonate munitions Laser, IR, and radar warning systems (to trigger move/CM) Low energy lasers to blind or dazzle Optical filters to degrade effect of battlefield lasers. Encoded CCM beacons on SACLOS ATGMs (to counter EOCM) Stand-off precision munitions (maneuvering Beyond line-of-sight and over-the-horizon modes Non-ballistic launch modes for missile launcher/missile survival Anti-radiation missiles to counter radars and aircraft Maneuvering re-entry vehicle (with warhead) for ballistic missiles
Information Warfare/ **Deception Units**	IW vehicles	Camouflage Cover Deformers/signature modification Aerosols Counter-location measures Decoys	Camouflage paints, IR/radar/and laser-absorptive materials/paints Natural and manmade cover, civilian buildings Underground facilities, bunkers, firing positions "Wummels" (erectible umbrellas to change/conceal shape/edges) IR/radar deformers (in combination with RAM and RAP, etc) Visual suppression measures, smokes, WP rounds Multi-spectral smoke grenades for IR and or MMW bands, Flares, chaff, WP, to create false targets, disrupt FLIR Degrade GPS by jamming to reduce precision location capability Jam radars/IR sensors Laser, IR, and radar warning systems (to trigger move/CM) Clutter (civilian/military vehicles, structures, burning equipment) Low to high-fidelity (multi-spectral) decoys Radar/IR decoy supplements (to add to visual/fabricated decoys) Acoustic countermeasures (to deceive reconnaissance, sensors)

COUNTERMEASURES BY FUNCTIONAL AREA AND TYPE SYSTEM (CONTINUED)

Functional Area	System	Type Countermeasure	Countermeasure
All Units	Combat support vehicles (Light strike vehicles, Tactical utility vehicles, Motorcycles, ATVs, Armored CSVs, etc), Trucks	Camouflage	Camouflage paints, IR/radar/and laser-absorptive materials/paints Fasteners, belts for attaching natural materials
		Cover	Natural and manmade cover, civilian buildings Underground facilities, bunkers, firing positions Armor supplements (ERA, screens, bar or box armor, sand bags)
		Concealment	Thermal covers, vehicle screens
		Deformers/signature modification	Engine and running gear signature modification (change sound) IR/radar deformers (in combination with RAM and RAP, etc)
		Aerosols	Multi-spectral smoke grenades for IR and or MMW bands, Flares, chaff, WP, to create false targets, disrupt FLIR
		Decoys	Clutter (civilian/military vehicles, structures, burning equipment)
		CM Operational Technologies	Air watch/security, AD, NBC, nets to trigger alarm signal Acoustic directed counterfire system

Chapter 10
Emerging Technology Trends
(Modified Extract of Volume 1, Ch 17)

In order to provide a realistic OPFOR for use in Army training simulations, we must describe the spectrum of contemporary and legacy OPFOR forces in the current time frame, as well as capabilities in emerging and subsequent operational environments (OEs). This chapter does not predict the future, rather notes emerging adversary capabilities which can affect training.

The OPFOR timeframes for emerging OPFOR are: 2012-2015 (Near Term) and 2016-2020 (Mid-Term). The subsequent time frame is "future" OPFOR. Time lines were determined in part to assist in building OPFOR systems and simulators and for use in Army training simulations. The timeframes are arbitrary and selected for ease in focusing and linking various trends. However, they also generally match force developments for U.S. Army forces, as well as thresholds in emerging and advanced technologies which will pose new challenges to military force planners and developers.

In these time frames, the mix of forces will continue to reflect tiered capabilities. The majority of the force mix, as with all military forces, will use legacy systems (see COE OPFOR tier tables, Chapter 1). Periods 2012 and after will also see new OPFOR systems and whole new technologies. The most notable difference between the OPFOR force mix and U.S. forces is that the OPFOR will have a broader mix of older systems and a lower proportion of state-of-the-art systems. Rather, OPFOR will rely more on adaptive applications, niche technologies, and selected proven upgrades to counter perceived capabilities of their adversaries. Force developers for OPFOR will retain expensive legacy systems, with affordable upgrades and technology niches. A judicious mix of equipment, strategic advantages, and sound OPFOR principles can enable even lesser (lower-tier) forces to challenge U.S. military force capabilities.

The OPFOR systems must represent reasonable responses to U.S. force developments. A rational thinking OPFOR would study force developments of their adversaries as well as approaches of the best forces worldwide, then exploit and counter them. For instance, Future Combat System technologies would trigger OPFOR to modify equipment and tactics to counter them.

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OPFOR TECHNOLOGIES AND EMERGING OPERATIONAL ENVIRONMENTS

As noted in Chapter 1 on COE OPFOR, the adaptive OPFOR will introduce new combat systems and employ upgrades on existing systems to attain a force structure which supports its plans and doctrine. Because a legacy force mix and equipment were historically selected earlier in accordance with plans and options, upgrades versus costly new acquisitions will always be an attractive option. A key consideration is the planned fielding date. To project OPFOR capabilities in future, we should look at the technologies in various stages of research and development today, as well as those in the concept stage for applications in the Future OPFOR time frame. Military engineering experience has demonstrated that the process of formulating military requirements, as well as technology, engineering, and budgeting factors can dramatically affect equipment modernization time lines. In addition, scientific discoveries and breakthroughs in the civilian sector have greatly contributed to the so-called "Revolution in Military Affairs", which has increased the capability for battlefield awareness, integration, timeliness, and lethality.

The table below shows OPFORs in emerging and Future OEs, and some considerations.

Considerations in Determining Emerging OPFOR Technologies by Time Frame

OPFOR Consideration	Near-Term (2012-2015)	Mid-Term (2016-2020)
Challenging OPFOR	Emerging OPFOR	Objective OPFOR
Technology Source	Current marketed/fielded systems and subsystems	Recent major weapons, upgrade applications
Budget	Constricted but available for niche technologies	Improved, some major system acquisitions
Implications for OPFOR equipment	Many subsystem upgrades, BLOS weapons, remote sensors, countermeasures	More costly subsystems, recent major weapons, competitive in some areas.
Implications for OPFOR tactics and organization, Implications for U.S.	COE tactics with contingency TTP updates. Slight subunit changes add BLOS and AT systems for integrated RISTA and strikes.	Integrated RISTA with remotes. Strikes all levels. Combined arms integrated in small units for increased lethality and autonomy

The information revolution has also decreased response time in which system developers in the military marketplace can seize a new technology and apply it in new systems or in upgrades to older systems (see Chapter 8). The following technologies and possible applications of those technologies will influence R&D as well as fielding decisions for future force modernization and expected OPFOR capabilities to be portrayed in future operating environments.

TECHNOLOGIES AND APPLICATIONS FOR USE BY OPFOR: NEAR AND MID-TERM

TECHNOLOGY CATEGORY	TECHNOLOGY	TECHNOLOGY APPLICATION
Psychological Operations	Mood altering aerosols Reproductive terrorism Non-lethal technologies	Military and civilian targets, for short-term and long-term goals.
Information Operations: Sensors	Higher-resolution multispectral satellite images New sensor frequencies for acquisition New sensor frequencies operational security Use of other light bandwidths (ultraviolet, etc) Passive detection technologies and modes Auto-tracking for sensors and weapons Image processing and display integration Micro-sensors/imaging system miniaturization Unmanned surveillance, target acq/designation Multispectral integrated sensors and Multispectral integrated transmission modes Precision navigation (cm/mm three-dimension) Undersea awareness (sensors, activity) Underground awareness (sensors/mines)	High-intensity use of LITINT (internet, periodicals, forums) Increased use of information from commercial, industrial, scientific and military communities Increased use dual-use technologies
Information Operations: Computers and Comms	Low-Probability-of-Intercept communications New power sources and storage technologies: Micro-power generation Energy cells Advanced Human/Computer Interface Automatic Language Translators	New communities (Blogs, flash mobs, etc, to coordinate and safeguard comms) Secure encryption software New communications tools (internet and subscriber links)
Electronic Attack	Anti-Satellite weapons for RF, EMP, Hard kill Wide area weapons (EMP graphite bombs, etc) EMP Precision (small area) weapons Computer Network Attack Worms, viruses, trojan horses Net-centric warfare Spoofing sensors Spoofing/Intercepting data stream/ spyware	Attack electronic grid or nodes at critical times
Chem/Bio/ Radiological Attack	Dirty bombs Genetic/Genomic/DNA tagging to assassinate Genetic/Genomic/DNA targeting for Bio attack Designer Drugs/Organisms/Vectors Biologically based chem (Mycotoxins) Anti-materiel corrosive agents and organisms	Agricultural attack (animal and plant stocks and supplies) Use of tagging to decapitate of political leaders.

TECHNOLOGIES AND APPLICATIONS FOR USE BY OPFOR (CONTINUED)

TECHNOLOGY CATEGORY	TECHNOLOGY	TECHNOLOGY APPLICATION
Physical Attack	Mini-cruise/ballistic missiles for precision, surgical strikes, and widespread use Atk UAVs (land, sea, undersea-UUV, Micro-aerial vehicles-widespread use Swarming for coordinated attack Notebook command semi-autonomous links Vehicle launch for NLOS attack/defense Multi-mode guidance: pre-programmed/ guided/homing New types of warheads Wider area/different effects Tailorable warhead effects Precision Munitions Course-corrected/guided/homing Widespread - almost all weapons Loiter/IFF DEW Blinding/high energy lasers RF Weapons against electronics RF against people, vs structures/systems Directed acoustic weapons	
Sustainment, Protection	New battery/power cell technologies Neurological performance enhancers Better lightweight seamless body armor Personal actuators, exoskeletons, anti-RF suits Active armor and active protection systems Countermeasures to defeat rounds and sensors Counter-precision jammers, esp GNSS All-spectrum low observable technologies Anti-corrosives Biometric prosthesis and cybernetics Robots assist dismounts, sensors, and logistics Robotic weapon systems	Battlefield fabrication of spare parts Airborne/shipborne refineries Potable water processing systems Transportable power generation systems

OPFOR CAPABILITIES: NEAR-TERM AND MID-TERM

The next table provides projected system description and capabilities for analysis of the OPFOR environment facing U.S. forces in subsequent time frames. Data for the first timeframe (2012-2015) reflects generally known systems and subsystems, with their introduction to the emerging OPFOR adversary force. Timelines reflect capability tiers for systems which may be fully fielded (not Interim Operational Capability or First Unit Equipped) in brigade and division unit levels during respective time frames.

The systems projections are not comprehensive, and represent shifting forecasts. They may accordingly shift as we approach the specified time frames. Once we get beyond the turn of the decade, our current view of the future trends becomes less specific. Therefore, the second column (Mid-Term 2016-2020) focuses more on technologies—less on defined systems.

The columns can be treated as capability tiers for specified time frame OPFOR. Please note: ***No force in the world has all systems at the most modern tier.*** The OPFOR, as with all military forces worldwide, is a mix of legacy and modern systems. Thus the emerging OPFOR force comprises a mix of COE time frame Tier 1-4 systems and newer systems. One would expect that some Near- or Mid-term adversaries with lower military technology capabilities could move up one or two capability tiers from (for instance) current COE capability Tier 4, to COE Tier 2. The most likely upgrade for emerging OPFOR used in most training simulations would be to move the OPFOR from COE Tier 2 to Tier 1, with added niche emerging systems.

We have previously stated that an OPFOR force can portray a diverse force mix by separating brigades and divisions into different tiers. The OPFOR also has the option of incrementally adding higher tier systems to lower tier units, as selective upgrades. Because most of the below systems in the 2012-2015 column are currently fielded, an adversary might also incrementally upgrade COE Tier 1 or 2 units by adding fielded assets from 2012-2015 as described in that column. However, until that time frame, we cannot assure beforehand when all of those technologies will appear. Again, the tables are not predictive. The OPFOR force designer may choose a middle road between current Tier 1-4 and future systems; in many countries they are upgrading legacy and even recent systems to keep pace with state-of-the-art systems. Thus they may look to subsystem upgrades such as noted in Chapter 8.

If a specialized system for specific role is missing from the table below, continue to use the OPFOR system noted in Tiers 1-4. Please remember that these projections reflect "possible" technology applications for future systems. They incorporate current marketed systems and emerging technologies and subsystems, may be combined in innovative ways. The table below is not a product of the U.S. intelligence community, and is not an official U.S. Army forecast of future "threats". It is approved only for use in Army training applications and simulations.

Future OPFOR (2021 and after) is described in various portrayals. But it is generally FOUO or classified and is not included in the WEG.

PROJECTED OPFOR CAPABILITIES: NEAR- AND MID-TERM

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
RECONNAISSANCE, INTELLIGENCE, SURVEILLANCE, TARGET ACQUISITION		
Smart Dust	Rocket/UAV/aircraft scattered crush sensors emit for 1/2 hour.	Scatterable, attach to metal. Acoustic/crush/seismic. Emit 1 hour.
Acoustic sensor vehicle	Vehicle mounts microphones or dismount array, DFs/acquires aircraft, vehicles, or artillery. Rapid queuing and netted digital display. Range 10 km, accuracy 200m. Three vehicle set can locate artillery to 30 km with 1-2% accuracy in 2-45 sec. DF/ cueing rate 30 targets/min.	Range extends to 20-30 km with 10 m accuracy. Micro-UAVs with microphones to supplement the network in difficult terrain. Track and engage multiple targets. Range and accuracy SAB. Hybrid electric/diesel drive.
Ground or Vehicle Launch Mini-UAV and Micro-UAV	2-backpack system. Man-portable ground launcher, and laptop terminal. Vehicle-launch from rail or canisters. TV/FLIR. Range 35 km, 3-hr endurance.	IR auto-tracker. Laser designator. Cassette launcher for vehicles. Signal retransmission terminal. Bus dispense micro-UAVs, UGS, mines
Micro-UAV	Hand-launch 4-rotor, 4 kg, 5 km/1 hr, GPS map/view on PDA/netbook. Atk grenade	< 1 kg for dismount sqd/tm, 2 km range. Add grenade for atk UAV
Airborne (Heliborne) MTI Surveillance Radar	Range 200 km, endurance 4 hrs.	SAR mode added. Range to 400 km
Commercial Satellite Imagery	Resolution 5 m for IR, SAR also available. <2 days for request. Terminal on tactical utility vehicle at division. Can be netted to other tactical units.	Response time reduction (to <6 hours). 1-m resolution.
ANTI-TANK		
Manpack Air Defense and Antitank (ADAT) Kinetic-Energy Missile Launcher (also listed in Air Defense)	Co/Bn substitute for ATGMs and AD. Targets helicopters and LAVs. Shoulder launch missile with 3 KE LBR submissiles 8 km, 0 m altitude. Submissiles have 25-mm sabot/HE warhead. Nil smoke. Mount on robotic launcher (below). FLIR night sight.	Fits in 45-100mm guns. Defeats all targets up to 135 mm KE. Range 8 km, time of flight 6 sec. Fused FLIR/II sight 10 km. Launch from enclosed spaces. Can mount on robotic ADAT launcher or ADAT Robot vehicle (below).
Robotic ADAT Launcher ADAT Robot Vehicle	Pintle mount shoulder/ground/ATV/ vehicle launch. Robotic launcher-60 m link. Twin auto-tracker. Operator in cover/spider hole. MMW/IR absorbent screen and net for operator, launcher and surrounding spall. CPS/ATS.	Masted 4 missile, hybrid drive. Self-entrench, moves to launch point. Fused FLIR/II sight 10 km. Remote link to 10 km. Most AD and AT vehicles have 2 control stations, 2 robots. ATGM is SAB. CPS.
Attack UAV	Hit-to-kill system. Day/night 60+ km, up to 2 hours. GNSS/inertial navigation, TV/FLIR, Frag-HE warhead. They include an anti-radiation variant.	Cargo UAV 100 km dispenses IR/ MMW/SAL DP (600mm HEAT) submunitions, EMP munitions, SAL ATGMs – UAV LTD 30 km.
Attack UAV Launcher Vehicle	Hit-to-kill UAV launch from modular launcher, 18 UAVs. GPS/inertial nav, to 500 km. First version anti-radiation homing. Added TV guided and multi-seeker attack (hit-to-kill) UAV. Laser designator range 15 km. CPS/ATS.	Hybrid drive. Bus reuseable UCAV with 4 ATGMs to 10 km, SAL-H bombs, or bus dispensing 16 terminally-homing submunitions (with MMW/ IR seekers, or laser-homing DP submunitions). CPS. LTD
Micro-Attack UAV	Hand or canister -launch UAV with TV and FLIR guidance to 10 km, 100-600 m altitude, with .25-.5 kg warhead.	Cassette/smoke grenade launcher launch for tactical vehicles. Recon and attack (top-attack) UAVs.
Mini-Attack UAV	Hand or vehicle canister -launch UAV with TV and FLIR guidance to 35 km, 100-600 m altitude, 1-4 kg warhead.	Cassette launcher launch for tactical vehicles. Recon and attack (DP with tandem 600 mm top-attack).

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
ENGINEER		
Scatterable Mines	Deliver by artillery, cruise missile, UAV, rotary or fixed-wing aircraft. Non-metallic case, undetectable fill, resistant to EMP and jammers, w/self-destruct.	Advanced multi-sensor mines with wake-up and target discrimination. Prox fuze mines. Controlled mine-fields and intelligent mines.
Off-Route Mines (Side-Attack and Top-Attack)	Autonomous weapons that attack vehicles from the side as the vehicles pass. 125-mm Tandem HEAT (900+ mm). Target speed 30-60 km/h, range 150m acoustic and infrared sensors.	Sensor-fuzed EFP 600mm KE top attack. Remote or sensor actuated (controller turn-on/off), 360-degree multi-sensor array. Hand/ heli/ UAV/arty/ATGL mortar emplace.
Controlled Mines and Mine-field	AT/AP, machine emplaceable. Armed, disarmed, detonated by RF command. Chemical fills and non-metallic cases are undetectable. With CM and shielding, negate jammers/pre-detonating systems.	Control may be autonomous, based on sensor data and programmed in decision logic, or by operators monitoring with remote nets.
Smart Mines	Wide-area munitions (WAM) smart autonomous, GNSS, seismic/acoustic sensors. AT/AV top-attack, stand-off mine. Lethal radius of 100 m, 360. Hand-emplace	Discriminate targets. Report data to monitor, evaluate target paths, built-in logic. Use GNSS to artillery/ heli-emplace. Non-nuclear EMP or HPW options
INFORMATION WARFARE		
Electronic Warfare Radio Intercept/DF /Jammer System, VHF	Intercept, DF, track & jam FH; identify 3 nets in non-orthogonal FH, simultaneous jam 3 fixed freq stations (Rotary/fixed wing/UAV capable)	Integrated intercept/DF/jam for HF/VHF/UHF
Radio Intercept/DF HF/VHF/UHF	Intercept freq range 0.1-1000 MHz. (Rotary/fixed wing/UAV capable)	Wider Freq coverage. SATCOM intercept. Fusion/cue w/other RISTA for target location/ID
Radio HF/VHF/UHF Jammer	One of three bandwidths; 1.5-30/20-90/100-400 MHz, intercept and jam. Power is 1000W. (Rotary/fixed wing/UAV capable)	Increased capability against advanced signal modulations. UAV and mini-UAV Jammers.
Portable Radar Jammer	Power 1100-2500W. Jam airborne SLAR 40-60km, nav and terrain radars 30-50km. Helicopter, manpack.	UAV and long range fixed wing jammers.
High-Power Radar Jammer	Set of four trucks with 1250-2500 watt jammers at 8,000-10,000 MHz. Jams fire control radars at 30-150 km, and detects to 150 km.	UAV jammer and airship jammer. Hybrid electric/diesel drive.
Portable GPS jammer	4 -25 W power, 200-km radius. Man-portable, vehicle & airborne GPS jammers, airship-mounted jammers.	Manportable, vehicle & airborne (UAV) GPS jammers-increased range and power, and improvements in antenna design
Missile and UAV-delivered EMP Munition	Cruise missiles and ballistic missile unitary warhead and submunition.	Increased capability against advanced signal modulations
Cruise Missile Graphite Munitions and Aircraft "Blackout Bombs"	400-500 kg cluster bombs/ warheads with graphite strands to short out transmission stations and power grids.	Rocket precision and UAV-delivered munitions.
COMMAND AND CONTROL		
Radio, VHF/FM, Frequency-hopping	30-88 MHz, 100 hps, channels: 2,300, Mix of analog and digital radios, tactical cellular/digital phone, all nets digitally encrypted. Burst trans. UAV Retrans	Digital radios, tactical cellular/digital phone, and satellite phones, all nets encrypted

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
DECEPTION & COUNTERMEASURE SYSTEMS		
Air Defense System Decoy	Manufactured and improvised decoys used with decoy emitter. Covered by AD systems in air defense ambushes.	Multispectral simulators of varied gun and missile systems mounted on robotic chassis.
Air Defense System Decoy RF Emitter	Expendable RF remote emitters with signal to match specific nearby radars, to trigger aircraft self-protection jammers.	Mounted on robotic chassis.
ROTARY WING AIRCRAFT		
Attack Helicopter	30-mm auto-cannon , 8 NLOS FOG/IIR-homing ATGMs, range 8 km. Two pods semi-active laser homing (SAL-H) rockets 80mm (20x 8 km) or 122mm (5x 9 km). 2x LBR KE ADAT msl (warhead w/3 KE submissiles, 8 km range). Laser designator 15 km. UAVs to 30 km. 2nd gen FLIR auto-tracker. Radar and IR warners and jammers, chaff, flares	Tandem cockpit, coax rotor, 30-mm auto-cannon. 8 x RF/SAL-H ASMs to 40 km (28+kg HE=1300+mm), 2x SAL-H rocket pods (80mm or 122mm), 2 ADAT KE msl 8 km, and 2x MANPADs. 1/3 have ASM to 100 km. Fire control fused II/ FLIR to 30 km, and MMW radar, link to ground LTD. Radar jammer. Atk and LTD UAVs to 30 km.
Multi-role Medium Helicopter and Gunship	24 troops or 5000kg internal. Medium transport helicopter. Range 460km. 30-mm autocannon, 8 FOG-M/IIR ATGMs to 8 km, 40 x 80 mm laser-homing rockets, 4 AAMs. ATGM launchers can launch mini-UAVs and more AAMs. Mine pod option. Day/night FLIR FCS.	Fused FLIR/II to 15 km. 6x SAL-H ATGMs 18 km, 2 AAMs, 2 x 80/ 122-mm SAL-H rocket pods (20 or 5 ea). Laser designator to 15 km, and link to ground LTD. Aircraft survivability equipment (radar jammers and IR countermeasures).
Multi-role Helicopter and Gunship	12 troops (Load 400 kg internal, 1,600 external. Range 860 km. 23 mm cannon, 2 AAM, 4 SACLOS ATGMs to 13 km, TV/FLIR, day/night. Mine delivery pods	Launch 6x SAL-H ATGM to 18 km, 28+kg HE warhead. 2 x AAM Air-to-surface missile to 100 km. Pod w/7x SAL-H 90-mm rockets. Fused FLIR/II to 15 km. ASE
Light Helicopter and Gunship	3 troops (Load 750 kg internal, 700 external). Range 735 km. 20 mm cannon, 1 x 7.62mm MG, 6 SAL-H ATGMs to 13 km, 2 AAMs. FLIR night sight. Laser target designator. Mine pods	4x SAL-H ATGMs, 18 km range. Fused FLIR/II to 15 km.
Helicopter and Fixed-Wing Aircraft Mine Delivery System	Light helicopter pod scatters 60-80 AT mines or 100-120 AP mines per sortie. Medium helicopter or FW aircraft scatters 100-140 AT mines or 200-220 AP mines per sortie.	Controllable and intelligent mines for aircraft delivery. Larger aircraft can hold multiple pods.
FIXED WING AIRCRAFT		
Intercept FW Aircraft	30-mm auto-gun, AAM, ASM, ARMs TV/laser guided bomb. 8 pylons Range 3,300 km. Max attack speed: Mach 4.	Stealth composite. ASE. Max G12+ All weather day/night. Unmanned option
Multi-Role Aircraft	30-mm gun, AAM, ASM, ARM pods, guided, GNSS, sensor fuzed bombs, 14 hardpoints. Thrust vectoring. FLIR	Improved weapons, munitions. Unmanned option. ASE all radars. Max G12+ All weather day/night
Ground-Attack Aircraft	Twin 30-mm gun, 8 x laser ATGMs 16 km 32 kg HE, 40 SAL-H 80mm rockets, ASMs, SAL-H and GNSS sensor fuzed bombs, AA-10 and KE HVM AAM. 10 hardpoints. Range 500+km. FLIR	Stealth composite design. ASE. Unmanned option. Max G12+ 80-mm/122-mm rockets SAL-H, SAL-H ASM (28+kg HE=1300+ mm), to 40 km, 2 gen FLIR, radar jammer, day/night

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
OTHER MANNED AERIAL SYSTEMS		
High-altitude Precision Parachute and Ram-air Parachutes	High-altitude used with oxygen tanks. Ram-air parachute includes powered parachute with prop engine.	Increased range and portability. Reduced signature. Increased payload.
Ultra-light Aircraft.	Two-seat craft with 7.62-mm MG, and radio. Folds for carry, 2 per trailer.	Rotary-winged, two-seat, MG, 1/ trailer. Auto-gyro, more payload.
UNMANNED AERIAL VEHICLES		
UAV (Brigade) It may also be employed in other units (e.g., artillery, AT missile, and naval)	Rotary wing, TV/FLIR/auto-tracker, with LRF and LTD designates targets to 15 km. Flies 180 km/6 hours, 220 km/hr, 2-5,500 m alt, 100 kg payload. Can carry 2 AD/anti-armor missiles+MG for atk	Range extends to 250 km. Increased payload. Attack version can carry 2 SAL-H ATGMs (12 km range) or 1+ 4 70-mm SAL-H rockets (7 km, defeats 200 mm).
UAV (Divisional)	Day/night recon to 250 km. GNSS/inertial nav, digital links, retrans. SLAR, SAR, IR scanner, TV, ELINT, ECM suite, jammer/ mine dispensers. Laser designator 15 km.	Increased range, endurance. Diff GNSS. Composite materials, lower signature engine. SATCOM Retrans / relay links. Attack submunitions.
UAV (Operational)	Day/night recon to 400+km. GNSS/ inertial nav with digital links. SLAR, SAR, TV, IR scanner, ELINT, ECM suite. Jammer option. Mine dispense. Laser target designator 15 km. Retrans/relay	Increased ranges, endurance. Diff GNSS. High altitude ceiling (35 km) option. Retrans/ relay/ SATCOM links. UAV attack submunitions. Laser target designators.
Unmanned Combat Aerial Vehicle (on Operational UAV platform)	Medium UAV with 4 ATGMs (flyout 10 km), laser guided bombs. Laser designator 15 km. Mine dispensers. GNSS jammer, EW jammers. Range 400+ km.	Stealth composite design. ASE. Twin dispensers (pylons) with 16 terminally-homing submunitions, MMW/IR seekers. Range 500+ km
	THEATER MISSILES	
Short-Range Ballistic Missile and Cruise Missile Launcher	Twin launch autonomous vehicle (GNSS / inertial nav, self-emplace and launch). Range 450 km. Non-ballistic launch, separating GPS corrected reentry vehicle (RV) with decoys, CCD, 10-m accuracy. ICM, cluster, nucs. EMP warhead. Some convert to 6-Cruise missile launch capability (500 km, 3-m accuracy, below radar). Vehicle decoys. Vehicle has visual/MMW/ IR signature of a truck.	Missile improve range (TBM 800 km, cruise 1,000), with 1-m accuracy. TBM has GNSS-corrected maneuvering RV. Warheads for both: terminal-homing submunitions, precision cluster munitions, EMP. Cruise missiles pre-program or enroute waypoint changes. Countermeasures include penaid jammers.
Medium-Range Ballistic Missile	Autonomous vehicle. Separating maneuvering warhead to 1300 km. GNSS 10-m CEP. Warheads: ICM, cluster, EMP, and nucs. Penaids include decoys, jammers. Truck visual/MMW/IR signature	Range 2,300 m, 1-m CEP. Diff GNSS, terminal homing, separating warhead. Warheads include EMP, terminal-homing cluster munitions. Non-ballistic launch and trajectory
Cruise Missile Cassette launcher Vehicle	Off-road truck, GNSS for autonomous ops. 16/lchr. Range 470 km, preprogram GNSS inertial guidance, with in-course correction, 10 CEP. Munitions include cluster, chemical, thermobaric, DPICM and mine submunition scatterable.	Launcher fire direction. Supersonic missile Diff GNSS/ inertial nav, 1-m CEP. Range 900 km. EMP warhead option. Warheads include homing cluster munitions. Penetration aids-countermeasures.
Cruise Missile/AD Missile (Multi-role) Launcher Vehicle Category includes specialized cruise missiles, long-range ATGMs, and SAM systems to engage targets at 12+ km.	Truck with 24 launchers. Range 100 km. 28-kg Frag-HE warhead=1,300 mm. AT Pre-program GNSS/inertial nav phase. LTD veh range 25 km range. Thermal camera to 10 km. Radar 40 km. Support UAV with LTD. FW/ship/anti-ship versions. Anti-heli RF guided, MMW radar.	Penetration aids (countermeasures). IR Terminal-homing warhead or IR-homing submunitions can be used. MMW lock-on before/after launch.

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
Land-attack SAM system (secondary role for system)	The SAM system uses its EO sight and LRF (short/med range, strat "hittiles")	Range extends with SAM ranges. Passive operation with TV/FLIR.
AIR DEFENSE		
General Purpose and Air Defense Machinegun	12.7mm low recoil for ground tripod. Chain gun light strike vehicle, ATV, motorcycle, etc, on pintle. TUV/LAV use RWS. Remote operated ground or robot option. Frangible rd 2 km, sabot 2.5 km. RAM/RAP/IR camouflage/ screens. TV/FLIR fire control. Lightweight MMW radar 5 km. Display link to AD azimuth warning net. Emplace 10 sec. RF/radar DF set. ATS control option.	Stabilized gun and sights. Remote-operated computer FCS with PDA/ laptop. Fused II/ FLIR 5 km. Frangible, sabot rds to 3 km. Laser dazzler blinds sights. Robot mount and micro-recon/heli atk UAVs. Some light/AD vehicles replace gun with 30-mm recoilless chain gun on RWS firing AHEAD round 4 km, and add-on ADAT missile launcher
Improvised Multi-role Man-portable Rocket Launcher (AD/Anti-armor)	4-tube 57-mm launcher with high-velocity dual-purpose rockets. EO day/ night sight. Blast shield. Range 1,000 m. Penetration 300 mm, 10 m radius.	Prox fuze, 1,500 m range. Penetration 400 mm, 20 m radius.
Man-portable SAM launcher	6 km day/night range/ 0-3.5 km altitude all aircraft, velocity mach 2.6. Thermal night sight. Proximity fuze, frangible rod warhead (for 90% prob hit and kill). Approach/ azimuth link to AD warning net. Twin launcher vehicle quick mount. Nil smoke. Mount on robotic AD/AT launcher. RF/radar DF set on helmet.	Warhead/lethal radius increased air/ground targets. Improved seekers - not be decoyed by IR decoys/jammers. Fused II/ FLIR 10 km. Launch from enclosed spaces. Laser dazzler. Optional AD/AT LBR KE warhead missile – 8 km. Mount on AD/AT robot vehicle
MANPADS Vehicle Conversion Kit (Lt Stk Veh, Van, recon TUV, truck, etc)	Twin launcher and ADMG on improvised IR SAM vehicle. Day/night IR autotrack FCS, MMW radar. Display link AD net. RF/radar DF set to 25 km. Camouflage	Replace launcher with 3-missile launcher: 2x ADAT KE SAMs, 1x IR SAMs. Total 6 missiles, (3+3)
Manpack Air Defense and Antitank (ADAT) Kinetic-Energy Missile Launcher (also listed in Anti-tank)	At company/Bn, can replace ATGMs and SAMs. Targets heli and LAVs. Missile has 3 KE LBR darts (submissiles) 8 km, 0 m altitude. Camou screen. Dart is 25-mm sabot with HE sleeve. Nil smoke. Fits on robotic ADAT launcher. Helmet RF/radar DF.	Larger sabot kills all targets up to 200 mm (KE) armor. Range 8 km, time of flight 5 sec. Fused II/ FLIR 10 km. Launch from enclosed spaces. Can mount on 3x remote launcher w/ IR auto-tracker, which. fits on AD/AT robot vehicle
Towed/Portee/Vehicle Mount AA Short Range gun/missile system	2x23mm gun. MMW/IR Camou/screen. Frangible rd to 3,000 m (17mm pen). On-board radar/TV FC with ballistic computer, 5 km MMW radar, thermal night sight, auto-tracker, net azimuth warner. Twin MANPADS. RF/radar DF set, 25 km. RWS on veh hull/turret. CPS/ATS.	Replace with twin 30-mm recoilless chain. Frangible, sabot, AHEAD rds to 4 km. TV/fused II/FLIR auto-tracker 10 km. MMW radar, Twin MANPADS/ADAT KE missile 8 km) lchr. APU for self relocate or robot mount. Laser dazzler.
Air Defense System Decoys (visual decoy, decoy emitter)	See DECEPTION & COUNTERMEASURE SYSTEMS	
Brigade gun/missile turret for mount on tracked mech IFV, wheeled mech APC, truck (motorized) chassis	Twin 30-mm gun, APFSDS/frangible rds 4 km. 30-mm buckshot rd for UAVs. Mounts 4x hyper-velocity LBR-guided SAMs to 8 km, 0 m min altitude. Passive IR auto-tracker, FLIR, MMW RADAR. 2/battalion. Track/launch on move. Targets: air, LAVs, other ground. RF/radar DF set, 25 km range. CPS/ATS	Dual mode (LBR/radar guided) high velocity missile, 12 km, 0 m min altitude. Auto-tracker (launch/fire on move). Phased array radars. Fused II/FLIR 19 km. Twin 30-mm recoilless chain gun with AHEAD-type rds to 4 km. Micro recon/heli atk UAVs. TV/IR attack grenades.

SYSTEM	NEAR-TERM OPFOR (FY 12-15)	MID-TERM OPFOR (FY 16-20)
Divisional gun/missile system on tracked mech IFV, wheeled mech APC, truck (motorized) chassis	Target tracking radar 24km. TV/FLIR. 8 x radar/EO FCS high velocity missiles to 18 km/12 at 0 m min altitude. Auto-track and IR or RF guided. 2 twin 30mm guns to 4 km. 30-mm buckshot rd for UAVs. RF/radar DF. CPS/ATS	Hybrid drive. Missile 18 km at 0 m, and kill LAVs. Fused II/FLIR auto-tracker, launch on move. Radar 80 km. Home on jam. Twin 30-mm re-coilless chain gun, electronic fuzed air-burst rds to 4 km. Micro-recon/ heli-atk UAVs. TV/IR atk grenades.
APC Air defense/AT Vehicle in APC Bn (Company Com-mand Vehicle, MANPADS Vehicle in Bn/Bde)	1-man turret on 8x8 chassis. 30mm gun, 30-mm buckshot rd for UAVs. 100-X TV, 2 gen FLIR. 2x LBR ATGM lchrs 6 km, 2x veh MANPADS lchrs. Two dismount teams. 1x MANPADS lchr, 1x ADAT KE lchr. Total 18 msls. 12.7-mm MG. RF/radar DF to 25 km. CPS/ATS.	10x10 whld hybrid drive, box armor. 30-mm recoilless gun RWS. Add AHEAD-type 4 km, 2 veh launchers for 5 AD/AT KE LBR HV SAM 8 km. Anti-helicopter surveillance/atk micro-UAVs. Fused II/FLIR 10 km. MMW radar. TV/IR atk grenades.
IFV, HIFV, or Tank ADAT Vehicle in Bn/Bde MANPADS	Vehicle on IFV, HIFV, or tank chassis with above features and weapons.	See AIR DEFENSE, APC ADAT above for weapons and upgrades
Towed Medium Range AA gun/missile system	35mm revolver gun 1,000 rd/min. Rds: frangible, HE prox, electronic-fuzed. 4 SAMs/lchr, 45 km, 0 m min alt. Radar 45 km, 4 tgts. Resists all ECM. 2 gen FLIR auto-tracker 20 km. RF/radar DF 25 km. SAM includes active homing, home-on-jam. RAP/RAM/IR camou. CPS/ATS.	Hybrid-drive auxiliary power unit short moves. Improved FCS, radars phased array low probability of intercept acq to 80 km. Fused II/3rd gen FLIR auto-tracker to 35 km in day/night all-weather system. Track and engage 8 targets per radar.
Medium-range ground SAM system	Tracked lchr. Radar to 150 km. 4 x radar-homing SAMs to 45km, 0 m min altitude (4 targets at a time). Home on jam. Use as cruise missile - priority ground tgts to 15 km, water 25 km. Fused 3rd gen FLIR auto-track . RF/radar DF. CPS/ATS	Hybrid drive. Improved FCS with radars and EO, fused II/3rd gen FLIR day/night all-weather system to range 50 km. Radar range 200 km.
Strategic SAM System	Cross-country truck launchers, 1 x track-via- missile SAMs 400 km, at Mach 7. 1x ATBM/high maneuver missile to 200 km. Also 8 x "hittile" SAMs to 120 km. Mod-es are track-via-missile and ARM (home-on-jam). All missiles 0 m to 50 km alti-tude vs stealth aircraft/UAVs/ASMs. All strat/op missiles in IADS. Local IADS all AD. Battery autonomous option. Over-the-horizon TA radar vehicle to 400 km. Mobile radar 350 km. Site CM, decoys.	Off-road trucks or tracked with hybrid drive. Most units, launchers have 2 big missiles+8 small "hittile" missiles ranging 200 km, altitude 0 m - 50 km. All missiles Mach 7. OTH radars operate on the move 600 km range. Targets include all IRBMs. Increased target handling capacity (100/ battery in autonom-ous operations).
Operational-Strategic SAM System	Same as above on tracked chassis. Mobile FOs all batteries. AD radars on airships.	Same as above on tracked chassis.
Anti-helicopter Mines (Remote and Precision Launch)	In blind zones force helos upward or deny helo hides and landing zones. Range 150m. Acoustic and IR fuse, acoustic wake-up, or cmd detonation. Directed fragmentation. Precision-launch mines use operator remote launch, proximity fuze for detonation. RF/radar DF.	Stand-alone multi-fuse systems. Remote actuated hand-emplaced mines with 360-degree multi-sensor array, pivoting/orienting launcher, 4-km IR-homing missile. Operator monitors targets and controls (turns on or off) sections, mines or net.
Helicopter Acoustic Detection System	Early warning of helicopters. Acoustic sensors to 10km, 200m CEP. IR sensors can also be linked to air defense net.	Range 20 km, 50 m CEP. Track and engage multiple targets. Digi-tal link to AD net, AD unit, IADS.

MILITARY TECHNOLOGY TRENDS FOR VOLUME 2 SYSTEMS IN 2021

Year 2021 is a demarcation line for focusing on future military technologies. Even with the "Revolution in Military Affairs", most major technology developments are evolutionary, requiring one or more decades for full development. Most of the technologies noted below are in conceptual or early developmental stage or fielded at this time. Many exist in limited military or commercial applications, and can be easily extrapolated to 2021 and the near future time frame. Over the 15-year period and beyond, military forces will see some legacy systems fade to obsolescence and be replaced, or be relegated to lesser roles or lower priority units. Most will be retained and updated several times. New systems and technologies will emerge, be developed, become widely implemented, mature, and reach evanescence, requiring updates. Additional technologies/adaptations not currently conceived will emerge with little warning, be quickly adopted, and significantly impact these trends.

SENSORS

- Multi-spectral immediate all-weather sensor transmission with real-time display
- Remote unmanned sensors, weapon-launch and robotic sensors and manned sensors
- Sensor nets integrated and netted from team to strategic and across functional areas
- Micro-UAVs and remote overhead camera munitions for vehicles and dismount teams

AIRCRAFT

- Continued but selective use of FW and rotary wing for stand-off weapons, sensors
- Aircraft critical for transport, minelaying, jamming, other support missions•
- Laser designators on AT grenade launchers, also used for precision artillery/air/naval rounds/ATGMs

OTHER AERIAL SYSTEMS

- Recon/attack low-signature UAVs at all levels down to squads, high-altitude UAVs and micro-UAVs
- Attack UAVs and UCAVs with low signature and stand-off munitions at all levels down to squad level
- Ballistic missiles with non-ballistic trajectories, improved GNSS/homing re-entry vehicles, precision submunitions, EMP
- Shift to canister launchers of tactical cruise missiles with precision homing and piloted option, cluster warheads, EMP
- Laser designators on AT grenade launchers, also used for precision artillery/air/naval rounds/ATGMs
- Airships and powered airships for long-duration and long-range reconnaissance, and variety of other roles
- Increased use of ultra-lights and powered parachutes

AIR DEFENSE

- Integrated Air Defense System with day/night all-weather RISTA access for all AD units
- Improved gun rounds (AHEAD/guided sabot) and missiles (anti-radiation homing, jam-resistant)
- Autonomous operation with signature suppression, counter-SEAD radars and comms
- Shoulder-launch multi-role (ADAT) hypervelocity missiles/weapons immune to helicopter decoys and jammers,
- Micro-UAVs for recon and helicopter attack
- Acquisition/destruction of stealth systems and aerial munitions and ground rockets to 500+ km

INFORMATION WARFARE

- Jammer rounds most weapons, electro-magnetic pulse rounds, weapons of mass effects
- UAVs, missiles and robots carry or deliver jammers/EMP/against point targets and for mass effects
- Multi-spectral decoys for most warfighting functions
- Computer network attack and data manipulation

ACCESS DENIAL

- Use of nuclear/bacteriological/chemical weapons to deny entry, access to areas or resources
- Use of media and public opinion for access denial
- Remotely delivered RF-controlled, smart and sensor-fuzed mines and IEDs defeat jamming

NON-LETHAL WEAPONS

- EMP/graphite/directed energy weapons to degrade power grid, information networks, and military systems
- Space-based data manipulation to deny adversary use of satellite systems
- Population control effects (acoustic devices, bio-chemical and genetic weapons, resources attack, dirty bomb)
- Anti-materiel agents and organisms (microbes, chemicals, dust, and nanotech)
- Countermeasures, tactical and technical, in all units to degrade enemy sensor and weapon effectiveness.

GLOSSARY

AA - antiaircraft
acquisition range - sensor range against a category of targets. Targets are usually categorized as infantry, armored vehicles, or aircraft. Acquisition includes four types (or levels of clarity, in ascending order of clarity): detection, classification, recognition, and identification. Where the type of acquisition is not specified, the acquisition range will be regarded as sufficient for accurate targeting. This range is comparable to the former Soviet term *sighting range*.
AAM - air-to-air missile
AD - antihandling device (mines)
ADHPM -artillery-delivered high-precision munition. This term can be used to describe various artillery precision munitions, including guided, terminally homing, SAL-homing, and course-corrected mortar and cannon rounds and rockets.
AGL - automatic grenade launcher
AIFV- airborne infantry fighting vehicle
aka - also known as
ALCM - air-launched cruise missile
AL/RDX - aluminized RDX (ammunition) is an enhanced-blast filler with aluminum added to the RDX high explosive, often used in Russian Frag-HE munitions with increased lethality.
AM - amplitude modulated (communications)
antitank - functional area and class of weapons characterized by destruction of tanks. In the modern context used in this guide, the role has expanded to fit the term "anti-armor" (which includes systems and munitions which can be employed against light armored vehicles)
AP - antipersonnel
APAM - antipersonnel - anti-materiel (ammunition)
APE - armor-piercing explosive (ammunition)
APERS-T - antipersonnel - tracer (ammunition)
APC - armored personnel carrier
APC-T - armor-piercing capped tracer (ammunition)
AP HE - armor-piercing high explosive (ammunition)
API-T - armor-piercing incendiary tracer (ammunition)
APERS-T - antipersonnel tracer (ammunition)
APS - active protection system. This is a protection system on a vehicle which uses sensors to trigger launch of a grenade or other projectile to intercept and negate an incoming munition.
APT - armor-piercing tracer (ammunition)
APU - auxiliary power unit; auxiliary propulsion unit
ARM - anti-radiation missile. The missile homes in on the radar pulse to kill a radar system.
ASM - air-to-surface missile
AT - antitank
ATGL - antitank grenade launcher
ATGM - antitank guided missile
aux - auxiliary
average cross-country (speed) - vehicle speed (km/hr) on unimproved terrain without a road
AVLB - armored vehicle-launched bridge

BMD - ballistic missile defense
burst (rate of fire) - artillery term: the greatest number of rounds that can be fired in 1 minute

BW - biological warfare, including ammunition type.

cal - caliber
caliber - barrel length to gun bore ratio (for all gun systems), and used as a measure of gun barrel size or as a component of ammunition/gun size. In the case of US-made infantry weapons and machineguns, diameter of ammunition/gun bore only, measured in inches, and used to describe ammunition/gun size
canister - close-range direct-fire ammunition which dispenses a fan of flechettes forward
C - centigrade
CC - cargo-carrying (ammunition)
CCD - cover, concealment, and deception; or a charged-coupled device, (imaging sensor which operates in the visual and near-IR bands, with day and limited night capability).
CCM - counter-countermeasure
CE - chemical energy: the class of ammunition which employs a shaped charge for the lethal mechanism. Ammunition types which employ CE include HEAT and HESH (see below).
Chem - chemical (ammunition type)
CM - countermeasure
coax - coaxial
CRV - combat reconnaissance vehicle
CW - continuous wave (communications)
cyclic (rate of fire) - maximum rate of fire for an automatic weapon (in rd/min)

decon - decontamination
direct-fire range - maximum range of a weapon, operated in the direct-fire mode, at which the bullet's trajectory will not rise above the height of the intended point of impact on the target. At this range, the gunner is not required to adjust for range in order to aim the weapon. The comparable Russian term is *point blank range*.
DPICM - dual-purpose improved conventional munitions (ammunition)
DPICM-BB - dual-purpose improved conventional munitions, base-bleed (ammunition)
DU - depleted uranium (ammunition)
DVO - direct-view optics

ECM - electronic countermeasure
EFP - explosively-formed penetrator (ammunition); kinetic-energy penetrator which is created by a plate shaped into a slug by an explosive charge, then propelled by it to a target
EIOC - estimated IOC
EMD - engineering, manufacture and development. Fielding phase between prototype and IOC.
EMP - electro-magnetic pulse, including ammunition type. The pulse can kill electronic micro-circuits in a target area.
EO - electro-optic, electro-optical
ERA - explosive reactive armor
ERFB - extended range full-bore (ammunition)
ERFB-BB - extended range full-bore, base-bleed (ammunition)
est - estimate
ET - electronic timing (ammunition fuze type)

European - from a consortium of firms located or headquartered in several European countries
EW -electronic warfare.

FCS - fire control system
FFAR - folding-fin aerial rockets
Fire Control- Process of acquiring target, directing weapon at target, and engaging to the hit. In air defense a radar or electro-optical aiming/guidance system to perform **FC** functions.
FAE - fuel-air explosive (ammunition). This munition technology is employed in aerial bombs and artillery munitions, and uses a dispersing explosive fill to produce intense heat, a long-duration high-pressure wave, and increased HE blast area
flechette – small steel darts (much like nails) used to fill artillery rounds (and some bombs). Generally thousands of these darts are fired (similar to a shotgun in an anti-personnel role) dispensing the flechettes forward over a wide area. Unlike **canister rounds,** FSU artillery rounds use a time fuze, permitting close-in direct fire, long-range direct fire, and indirect fire.
FH - frequency-hopper (radio, communications)
FLIR - forward-looking infrared (thermal sensor)
FLOT - forward line of own troops
FM - frequency modulated (communications)
FOV - field of view
frag-HE - fragmentation-high explosive (ammunition)
FSU - former Soviet Union

GCS - ground control station
gen - generation. Equipment such as APS and (thermal and II) night sights are often categorized in terms of 1st, 2nd or 3rd generation of development, with different capabilities for each.
GNSS - Global Navigation Satellite System. Any satellite based autonomous geo-spatial positioning system that uses low power signals and small receivers to triangulate the position of users by navigation and timing (PNT) service for military and commercial purpose.
GP MG - general-purpose machinegun
GPS - global positioning system, a GNSS used in the U.S. and many other counties

HE - high explosive (ammunition)
HEAT - high-explosive antitank (also referred to as shaped-charge ammunition)
HEAT-FS - high-explosive antitank, fin-stabilized (ammunition)
HEAT-MP - high-explosive antitank, multi-purpose
HEFI - high-explosive fragmentation incendiary (ammunition)
HEI - high-explosive incendiary (ammunition)
HEP-T - high explosive plastic-tracer (ammunition)
HESH - high-explosive squash head (ammunition)
HF- high frequency (communications)
hps - hops per second (communications)
HUD - head-up display
HVAP-T - hypervelocity, armor-piercing tracer (ammunition)

IADS - Integrated air defense system. Air defense network which links multiple sensors, multiple weapons systems, and multiple AD C^2 nodes, and which links multiple echelons.
ICM - improved conventional munition (ammunition, round containing submunitions/grenades)

IFF - identification friend-or-foe
IFV - infantry fighting vehicle **-** improved conventional munition; frag-He bomblet submunition
II - image intensification (night sighting system)
ILS - instrument landing system
INA - information not available
incend - incendiary
IOC - interim operational capability
IR - infrared
IRBM - intermediate-range ballistic missile (3,001-5,500 km)
I-T - incendiary - tracer (ammunition)

K-kill - catastrophic kill (simulation lethality data)
kbits - kilobites per second (communications)
KE - kinetic energy: class of ammunition which transfers energy to the target for the lethal mechanism. Ammunition types which employ KE include AP, APFSDS-T, and HVAP-T.

LAFV - light armored fighting vehicle
LLLTV - low-light-level television
LMG - light machinegun
LPI - low probability of intercept (for radars, aircraft, and other targets of surveillance systems)
LRF - laser rangefinder

mach - speed of sound, based on atmospheric conditions (1160 km/h at sea level)
max - maximum
maximum aimed range - maximum range of a weapon (based on firing system, mount, and sights) for a given round, with direct-fire aiming at a ground target or target set. The range is not based on single-shot hit probability on a point target, rather on tactical guidance for firing multiple rounds if necessary to achieve a desired lethality effect. One writer referred to this as *range with the direct laying sight*. Even greater ranges were cited for *salvo fire*, wherein multiple weapons (e.g., tank platoon) will fire a salvo against a point target.
max effective range - maximum range at which a weapon may be expected to achieve a high single-shot probability of hit (50%) and a required level of destruction against assigned targets. This figure may vary for each specific munition and by type of target (such as infantry, armored vehicles, or aircraft).
max off-road (speed) - vehicle speed (km/hr) on dirt roads
MCLOS - manual command-to-line-of-sight
MEL – mobile erector launcher. Trailer missile launcher, towed by a tractor.
MG - machinegun
Mk - Mark
MRBM - medium-range ballistic missile (1,001-3,000 km)
MRL - multiple rocket launcher
MMW - millimeter wave (sensor mode, band in the electromagnetic spectrum)
MVV - muzzle velocity variation (RF tracker for monitoring round-to-round variations in muzzle velocity variations due to tube wear, or for tracking artillery course-corrected rounds for command course adjustment)

N/A - not applicable
NBC - nuclear, biological, and chemical

Nd - neodymium, type of laser rangefinder
NFI - no further information
normal (rate of fire) - artillery term: rate (in rd/min) for fires over a 5-minute period
Nuc - nuclear (ammunition type)
NVG - night-vision goggle
NVS - night-vision system

PD - point-detonating (ammunition fuze type)
penaid - Penetration aid, countermeasure system in the warhead to counter air defense weapons effectiveness.
Ph - probability of hit (simulation lethality data)
PIBD - point-initiating base-detonating (ammunition fuze type)
pintel - post attached to a firing point or vehicle, used to replace the base for a weapon mount
Pk - probability of kill (simulation lethality data)
Poss - possible
practical (rate of fire) - maximum rate of fire for sustained aimed weapon fire against point targets. The rate includes reload time and reduced rate to avoid damage from overuse. Former Soviet writings also refer to this as the **technical rate of fire**.

RAP - rocket-assisted projectile (ammunition type)
ready - rapid detectability under normal mobility conditions (mines)
mirecon - reconnaissance
rd - round
ready rounds - rounds available for use on a weapon, whether in autoloader or in nearby stowage, which can be loaded within the weapon's stated rate of fire
RF - radio frequency
RHA - rolled homogeneous armor, often used as a standard armor hardness for measuring penetration of anti-tank munitions
RHAe - RHA equivalent, a standard used for measuring penetrations against various type armors
rpm - rounds per minute (aircraft)
RV - reentry vehicle; that portion of a TBM separating (or multiple separating) warhead which reenters the atmosphere and maneuvers to the target.

SACLOS - semiautomatic command-to-line-of-sight; missile guidance method. An operator holds the sight aim point on the target, and the launcher keeps the missile line on the target.
SAL-H - semi-active laser homing; guidance method. Operator illuminates the target with a laser target designator. A (possibly remote-launched) laser-homing munition homes to the beam.
SAM - surface-to-air missile
SHF - super high-frequency (sensors)
SFM- sensor-fuzed munition (artillery ammunition)
shp - shaft horsepower (aircraft)
SLAP - saboted light armor penetrator (ammunition). Small arms/machinegun round with a sub-caliber penetrator guided down a gun bore by sabots, designed to defeat light armor.
SP - self-propelled
SOF - special operations forces
SRBM - short-range ballistic missile (0-1,000 km)

SSM - surface-to-surface missile (can include IRBM, MRBM, or SRBM, or cruise missile)
stadiametric - in this guide, a method of range-finding using stadia line intervals in sights and target size within those lines to estimate target range
stowed rounds - rounds available for use on a weapon, but stowed and requiring a delay greater than that for ready rounds (and cannot be loaded within the weapon's stated rate of fire)
sustained (rate of fire) - artillery term: rate (in rd/min) for fires over the duration of an hour

tactical AA range - maximum targeting range against aerial targets, aka: **slant range**
TAR - target acquisition radar. In air defense units, it acquires and precisely locates targets, identifies as friend-foe, tracks them, and passes targets to the weapons for destruction.
TBM - theater ballistic missile
TEL - transporter-erector-launcher. Vehicle which carries, raises, and launches TBMs.
TELAR - transporter-erector-launcher and radar
thermobaric - HEI volumetric (blast effect) explosive technology similar to fuel-air explosive and used in shoulder-fired infantry weapons and ATGMs
TLAR - transporter-launcher and radar
TOF - time of flight (seconds)
TTP - tactics, techniques, and procedures
TTR - target tracking radar
TV - television (sensor mode)

UAV - unmanned aerial vehicle, class of unmanned aerodynamic systems which include remotely piloted vehicles and preprogrammed (drone) aircraft
UHF - ultra-high frequency (communications)
UI - unidentified

VEESS - vehicle engine exhaust smoke system
VHF - very high frequency (communications)
volumetric - class of explosive ammunition fill which produces high long-duration blast and heat (includes thermobaric and FAE)
vs - versus

w/ - with (followed by associated object)
WMD - weapons of mass destruction (ammunition type). These generally consist of nuclear, bacteriological, and chemical munitions.
WP - white phosphorus (ammunition)