

# **AA GUN SYSTEMS FIRE EFFECTIVITY PROGNOSIS**



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# PROGNOSIS OBJECT

## SHORAD Solution

- with respect to Czech Army doctrine of army structure and combat activity in different types of conflict and national defence budget in the course of Czech Defence Industry assistance

## SHORAD Suggestion

- to Czech Army and Defence Industry for active share on NATO SHORAD conception

# **PROGNOSIS BASE**

Prognosis is based on NATO SHORAD (GBLAAD) concept  
represented by

**Dr. Gene Paro,**

Chairman NATO Land Group 5 (SHORAD)

US Army Aviation and Missile Command

in

## **NATO LOW ALTITUDE AIR DEFENCE INITIATIVE**

delivered on 9<sup>th</sup> European Air Defence Symposium 13<sup>th</sup> – 15<sup>th</sup> March 2001

Royal Military College of Science, Shrivenham, UK

adapted for conditions of Czech Army

# SHORAD INITIATIVE

## SHORAD Initiative Idea:

### ■ Economic Factors

- Constrained National Defence Budget
- Escalating System/Personnel Costs

### ■ Political Factors

- Publicised Threat Focused on Ballistic Missile Defence
- Perception of a Reduced Air Threat

### ■ Combat Effectivity

- Effective Deterrent: Complicates Enemy Attacks Operations
- Cost effective: Engages Low Cost Enemy Air Threats
- Highly Mobile With Small Logistic Support Requirements

### ■ Multi-Mission

- Increased Battlefield Utility: to engage both Air and Ground Targets  
Ground to Air SHORAD: existing mission  
Ground to Ground SHORAD: new expanded mission

# SHORAD INITIATIVE

## ■ SHORAD Weapon System Concept bases

### Missile Weapon Systems Application

- Standard Ground to Air SHORAD Missiles:  
Stinger, Rapier, Starstreak
- Air to Air Missiles application for AD mission:  
AIM-9 Series (NATO Common), AMRAAM, ASRRAM

### *Question:*

**Is SHORAD Weapon System based on missiles only effective ?**

- Problems:
- Trends in Threats
  - Changes in Theatre of Operation
  - Air Threat Development

# TREND IN THREADS

- **Use of UAV especially for stationary ground objects.**
- **Larger weapon release distances combined with Precision Guided Munition.**
- **Improved terrain following capabilities.**
- **Sophisticated intelligence data gathering to support Air Attack Mission Planning**

# CHANGES IN THEATRE OF OPERATION

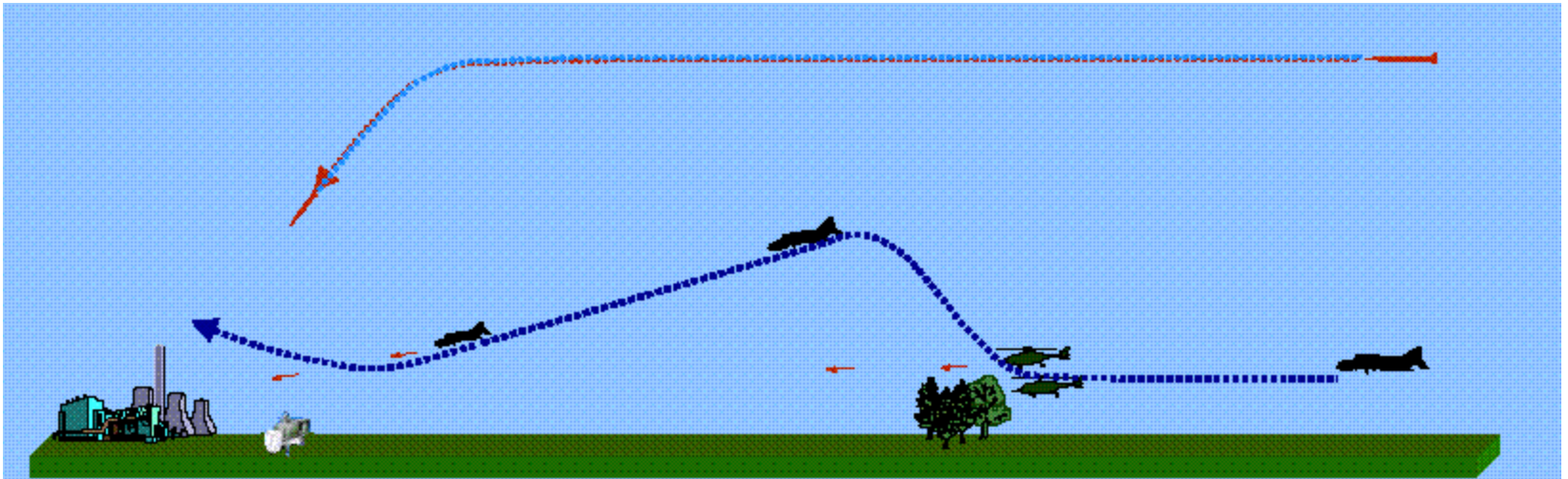
- Different type of conflict
  - Peace keeping
  - Peace enforcing
  - Full scale conflict
  
- Lower density own troops resulting in an open battlefield rather than distinct rear and front area

# AIR THREAD DEVELOPMENT

- The thread did depend on front or rear area operation.
- Due to change in theatre of operation each modern air threat can apply in most of situations.
- The modern air threat varies from:
  - fast flying fixed wing aircraft or cruise missiles using pitch-up attacks
  - pop-up helicopters with short exposure time
  - smart ammo launched at stand-off ranges and attacking the high value object with a steep dive
  - ARM for suppression of the air defence



# AIR THREAD SUMMARY

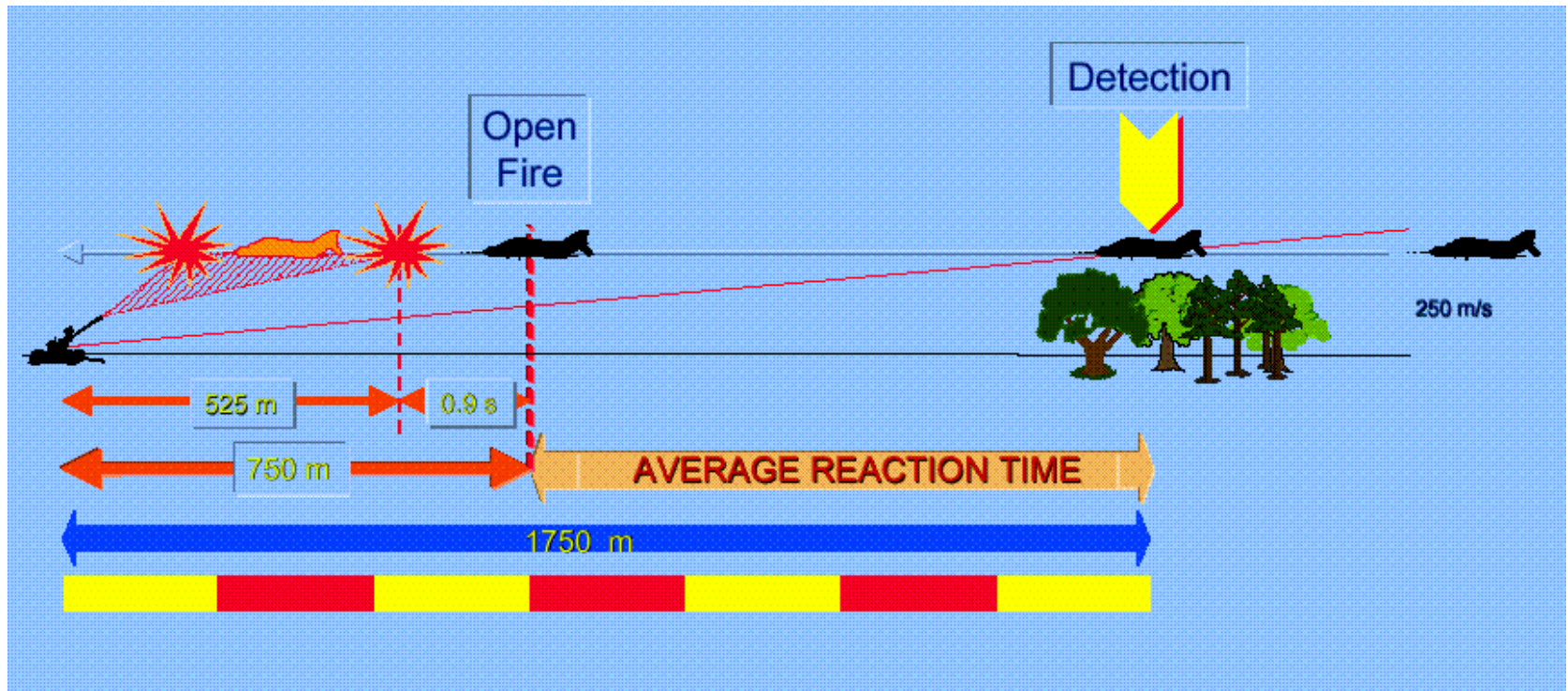


Smart Ammo, launched at stand-off ranges attacking with steep dive

Fighterbomber, or Cruise Missile using Pitch-up attack with short unmask time

Helicopter, performing pop-up attack with short exposure time close to clutter

# IMPORTANCE OF SHORT REACTION TIME



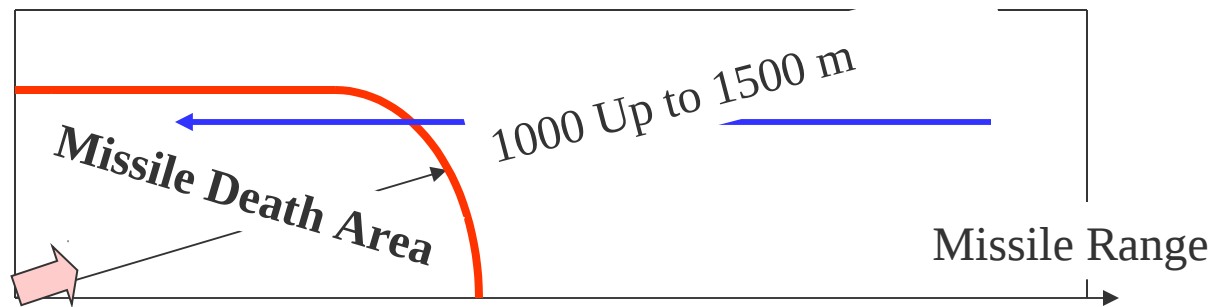
# SHORAD WEAPON MIX

## ■ Reason for a Weapon Mix: missile / gun

to prevent air attacks making use of Missile only AD weaknesses:

allows a low level attacks followed by pitch-up attack witch require extreme short fire reaction time

to cover missile death area by guns



**Gun System is to be an integral part of SHORAD**

# CHARACTERISTICS OF AA GUN FIRE

- **Criterion of the AD Gun Fire Effectivity:**  
quantity of killed air targets in the combat mission
- **AD Gun Fire Effectivity Factors:**
  - target hit probability,
  - endgame regime of projectile,
  - target vulnerability
  - effective range of fire
- **Principal rule for AD Gun Fire Effectivity:**

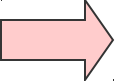
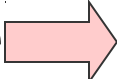
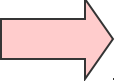
***when miss don't kill***

# CHARACTERISTICS OF AA GUN FIRE

## ■ Principle attribute for AD GFE:

*Target Hit Probability*

## ■ TPH reflects the Gun Weapon System properties:

- **Gun:** calibre  rate of fire, burst rate
- **Ammunition:** calibre  ballistic characteristics, killing effect
- **Fire Control System:** aiming accuracy  const

## ■ THP designating factor:

**GUN CALIBRE**

# GUN CALIBRE ANALYSIS

## ■ AD Gun Fire Character

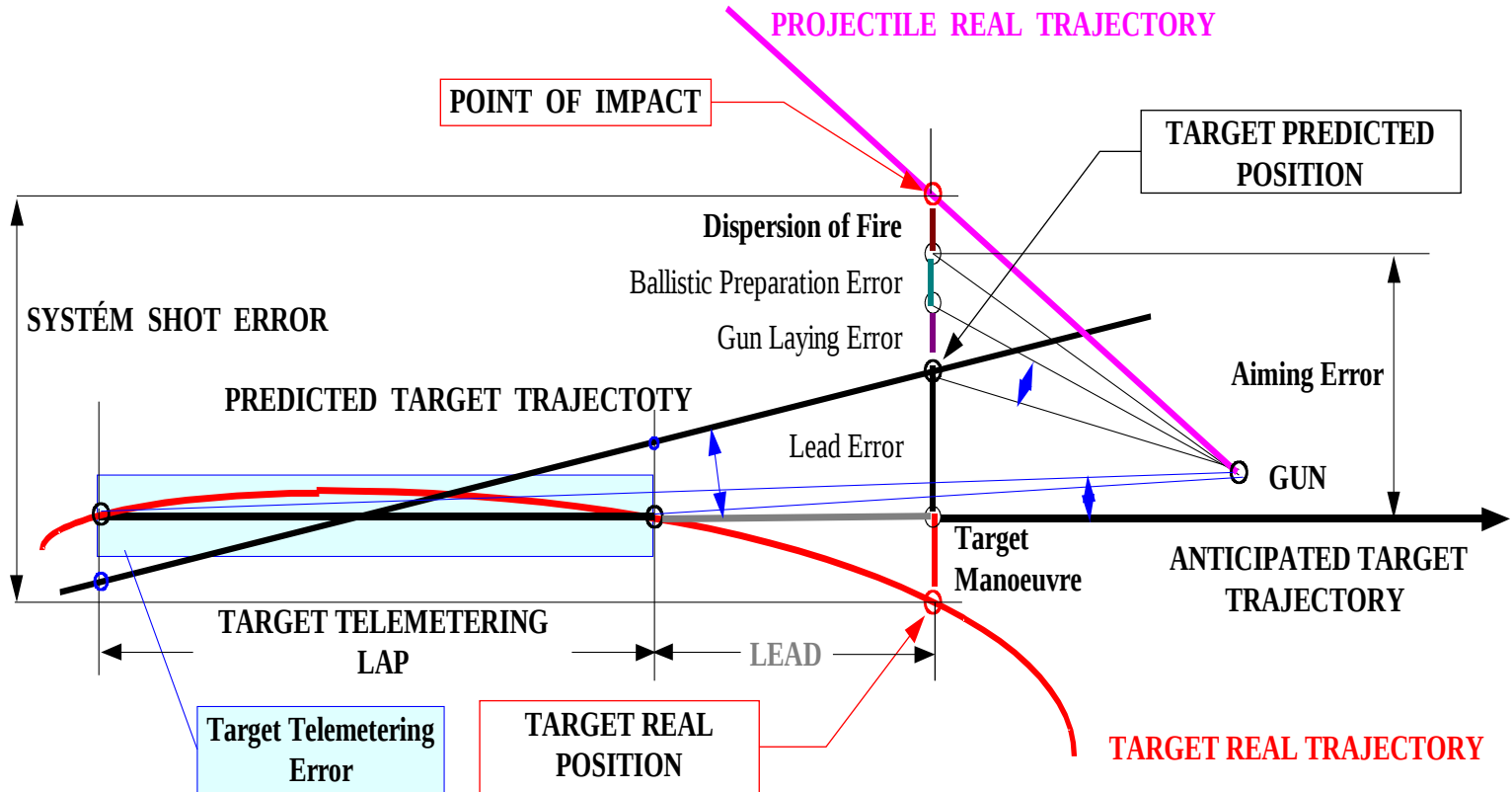
- unobserved fire: gun aiming cannot be corrected according to observation of fire-effect in the target
- THP:
  - ▶ *single-round hit probability,*
  - ▶ *burst rate*

## ■ AD Gun Fire Effectivity Mathematical Model

- Point of Impact Prediction Model
- System Shot Error Structure Model
- Endgame Regime of Projectile Model
- Target Vulnerability Model
- Target Hit / Kill Probability Model

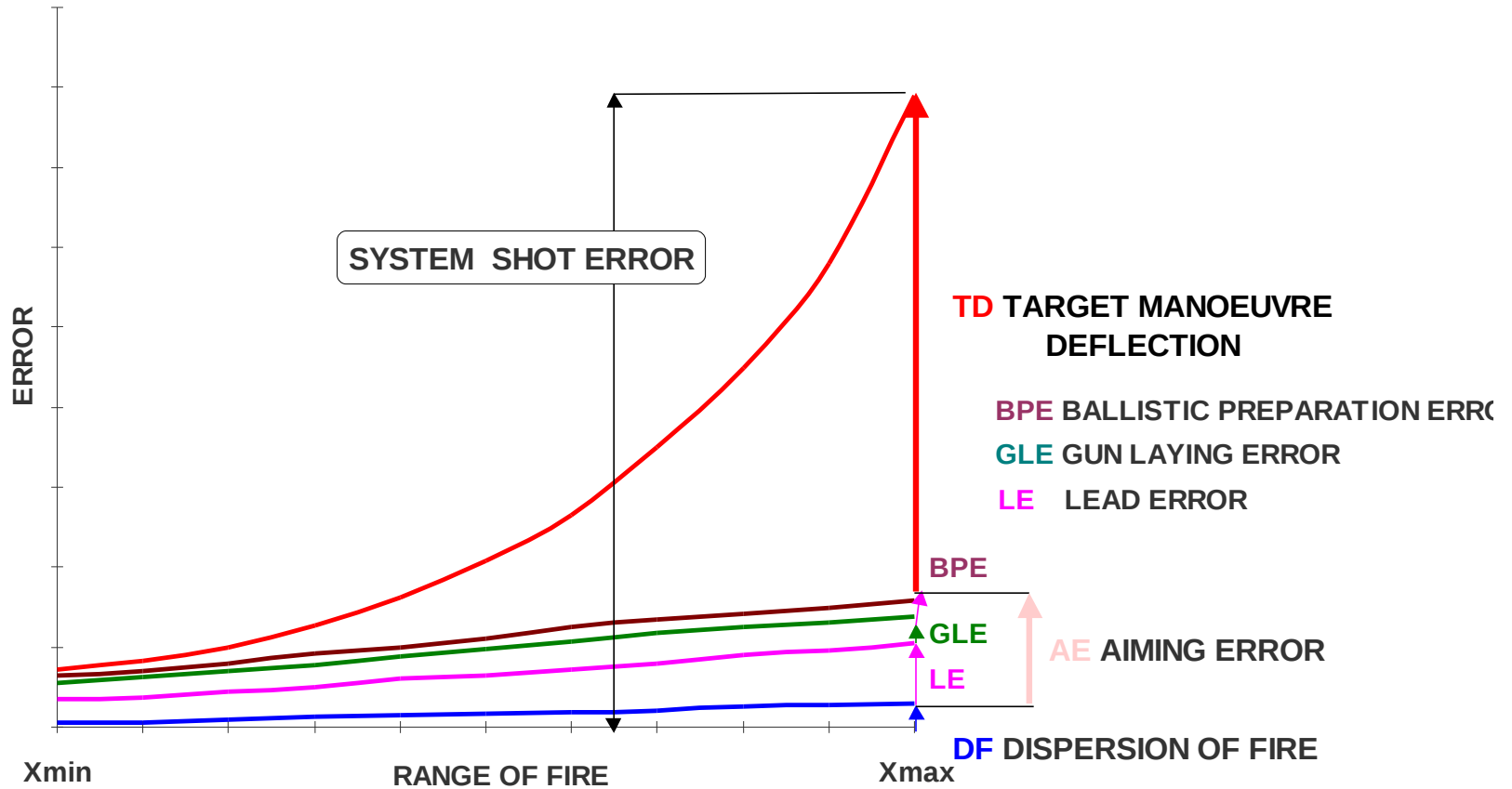
# AD GFE MATHEMATICAL MODEL

## POINT OF IMPACT PREDICTION MODEL



# AD GFE MATHEMATICAL MODEL

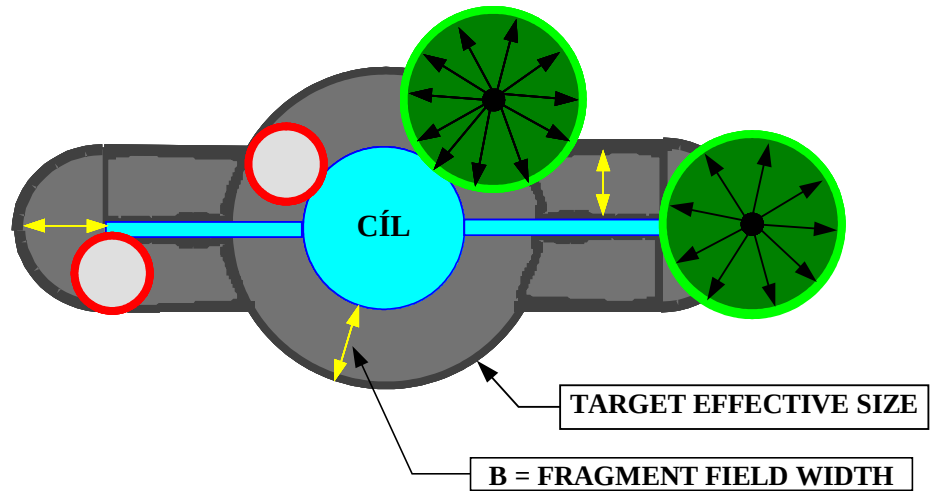
## SYSTEM SHOT ERROR STRUCTURE





# AD GFE MATHEMATICAL MODEL

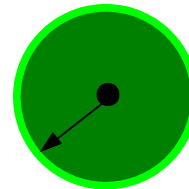
## ENDGAME REGIME OF PROJECTILE MODEL



AHEAD – AXIAL FRAGMENT EJECTION



$B = D$

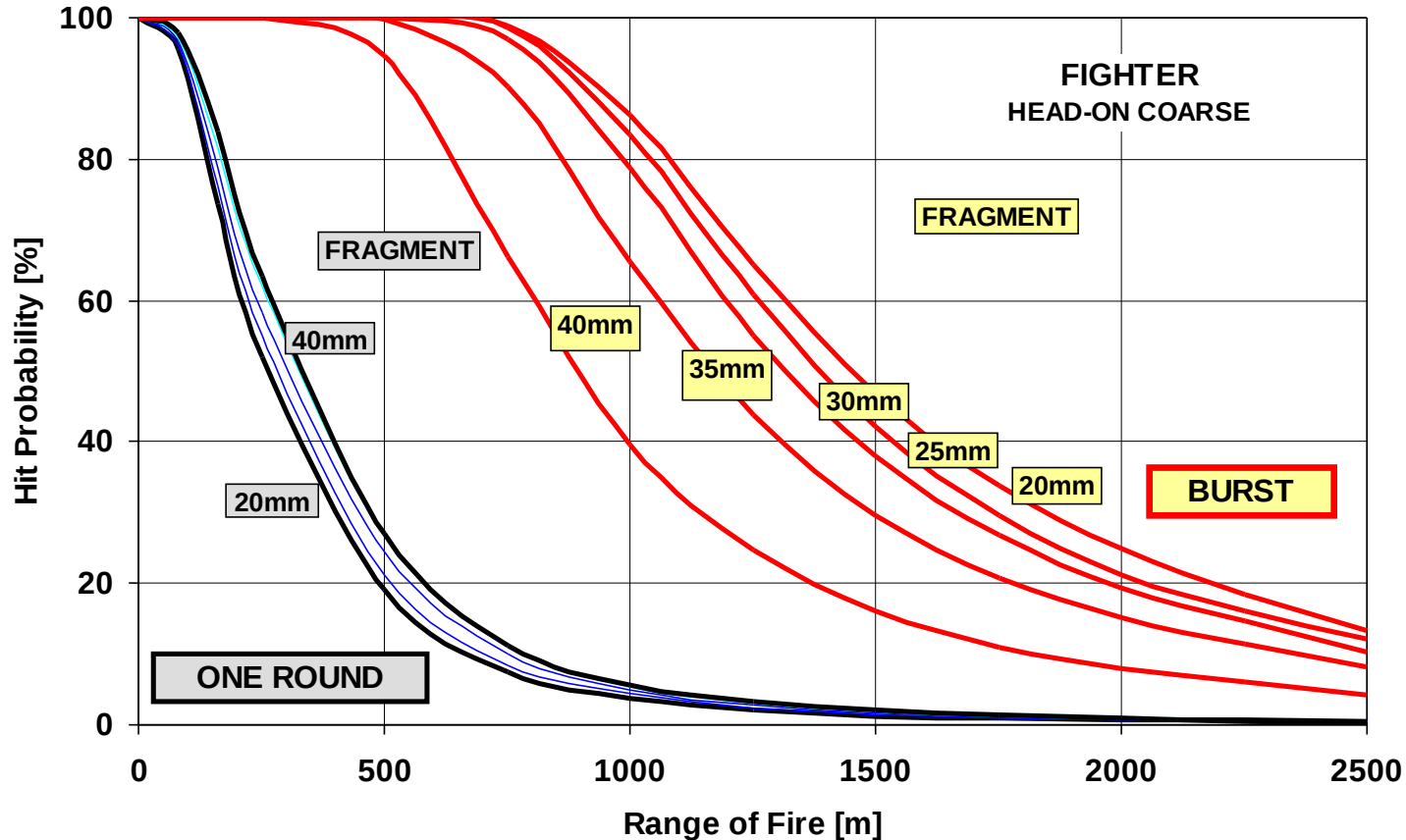


$B = R$

P3 – RADIAL FRAGMENT SCATTER

# AA GUN FIRE EFFECTIVITY ANALYSIS

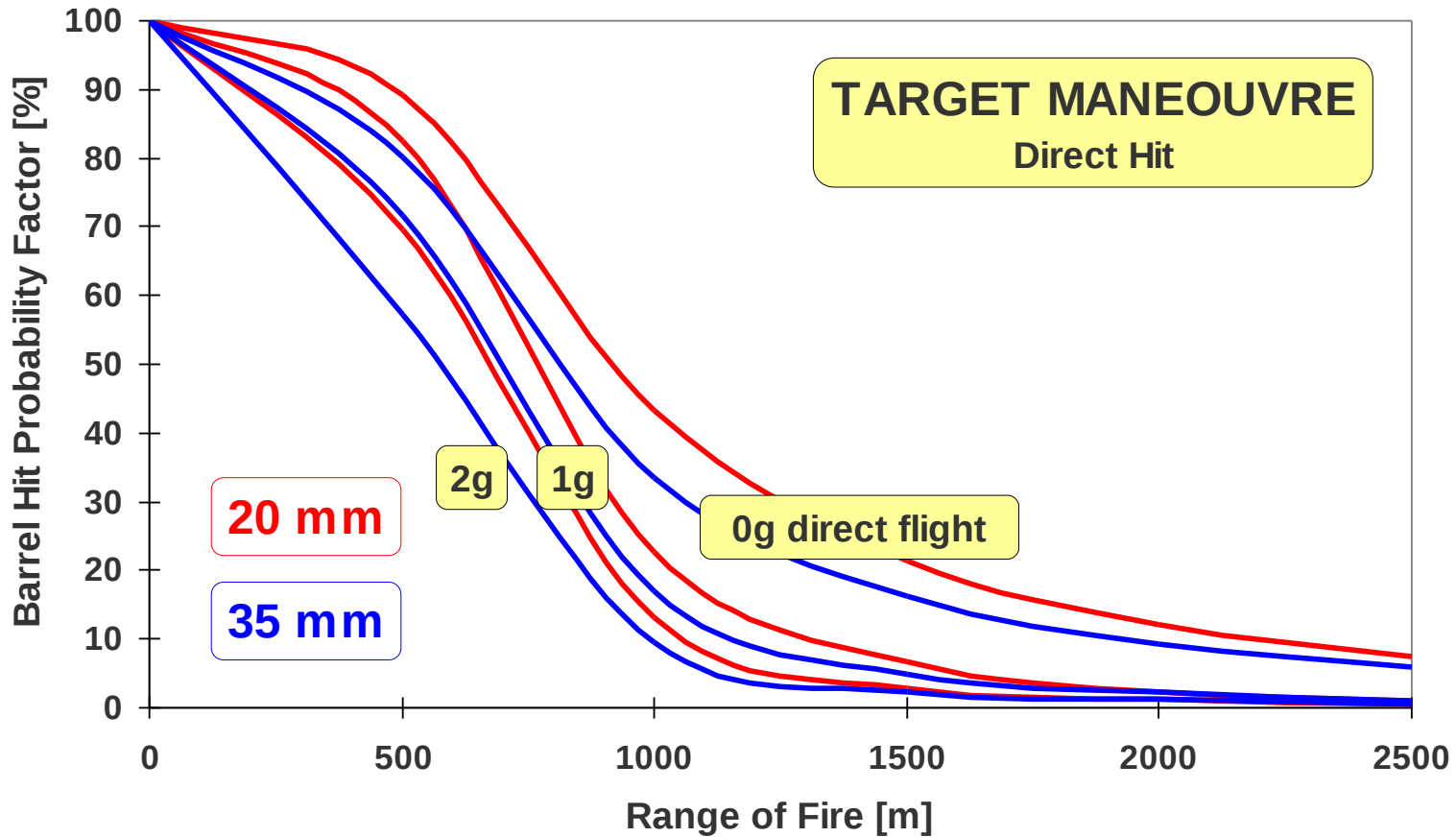
ONE ROUND / BURST RATE HIT PROBABILITY per BARREL



the small calibre gun makes better results in hit probability than guns of greater calibre

# AA GUN FIRE EFFECTIVITY ANALYSIS

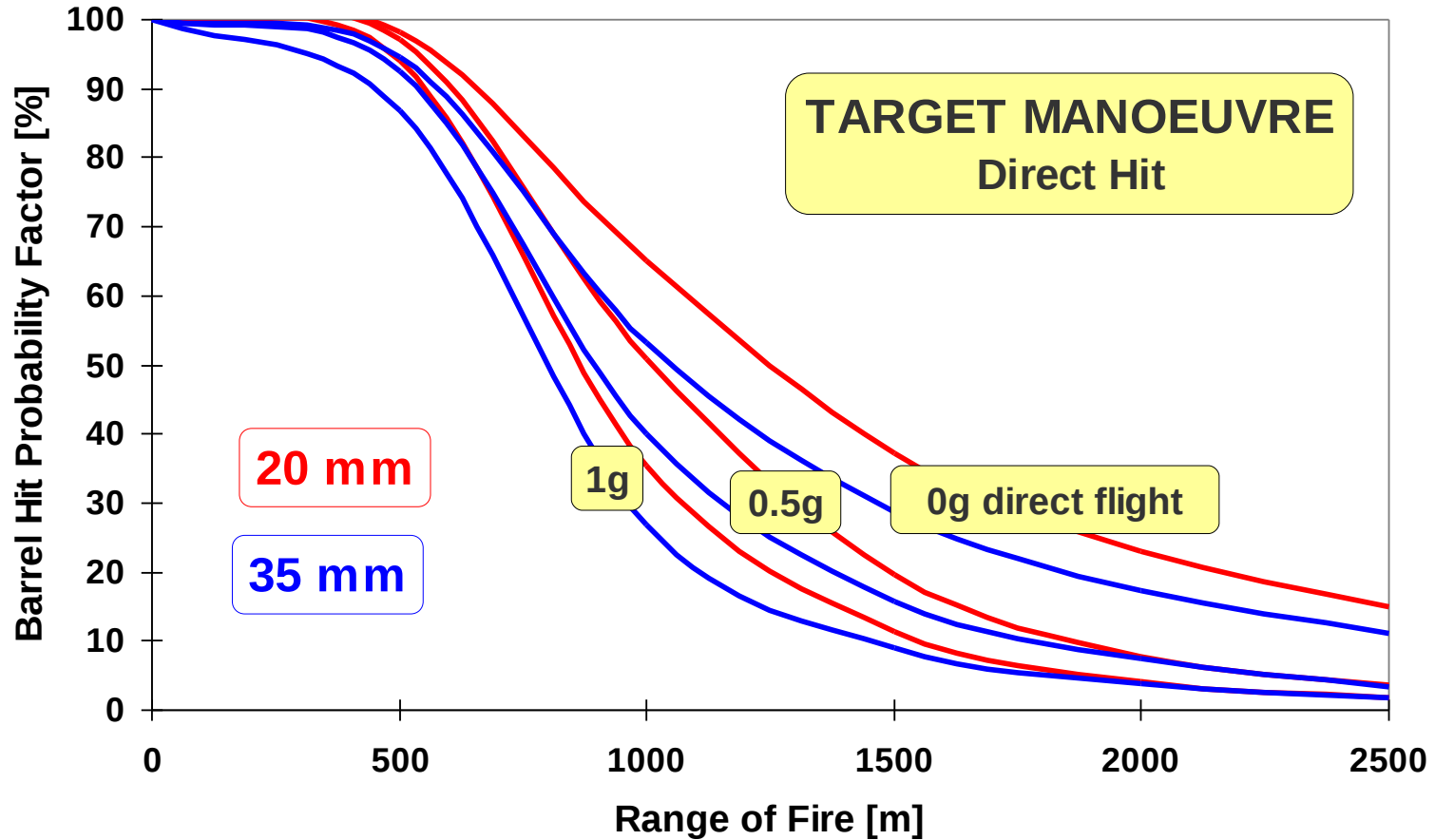
FIGHTER  
HEAD-ON-COURSE



# AA GUN FIRE EFFECTIVITY ANALYSIS

## ATTACK HELICOPTER

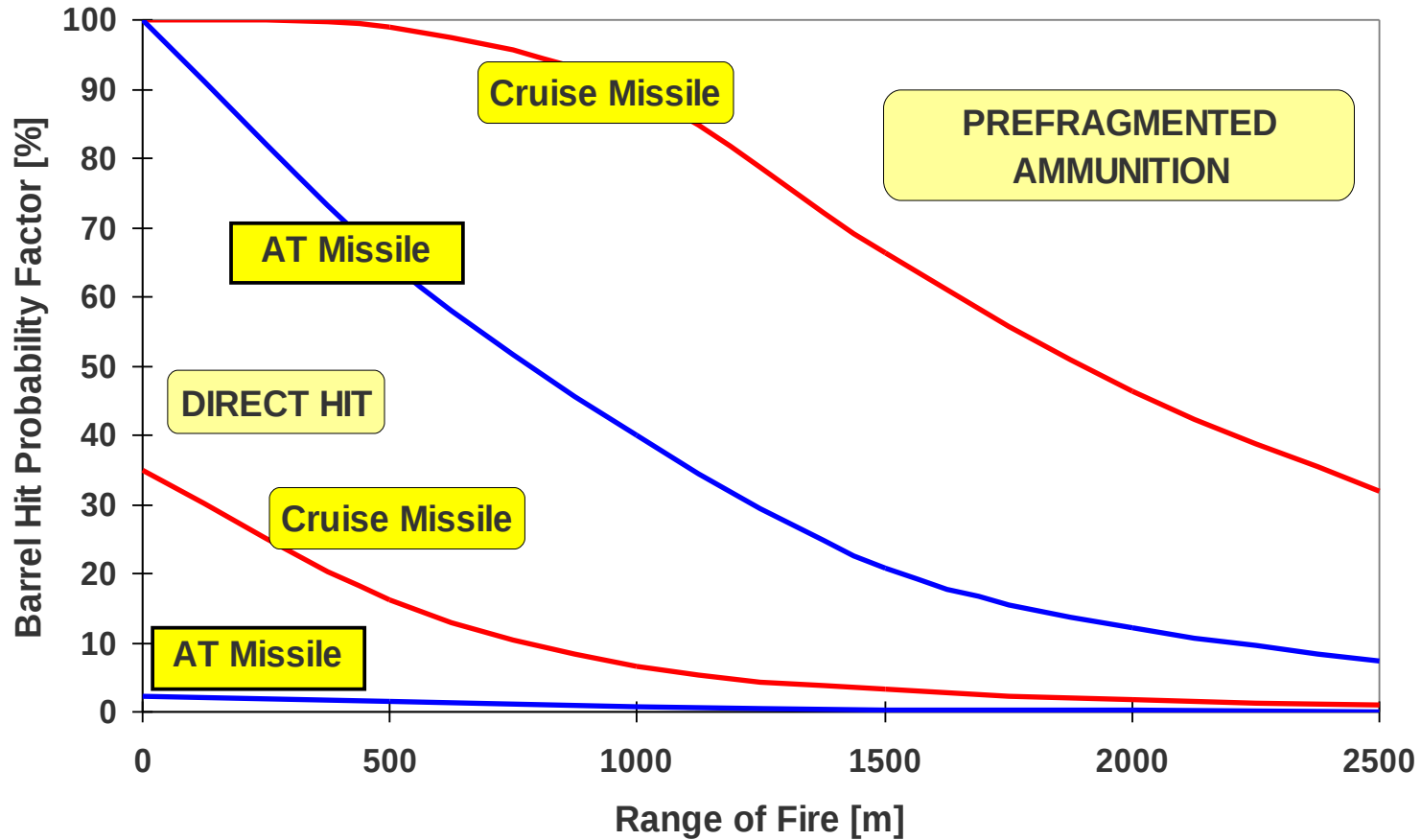
HEAD-ON-COURSE



# AA GUN FIRE EFFECTIVITY ANALYSIS

## CRUISE MISSILE - AT MISSILE

HEAD-ON COURSE



# AA GUN FIRE EFFECTIVITY ANALYSIS

## Effective Range of Fire

### ■ Fighter / Attack Helicopters

- Direct Hit Fire: 1500 up-to 2000 m

**20 mm calibre** makes better results in hit probability than guns of greater calibre by greater number of rounds fired in a burst. Proper supplementary weapon system to existing SHORAD missiles systems for missile fire death area cover.

### ■ Smart Ammo: stand-off weapons - C/M - AT/M

- Direct Hit Fire: useless
- Fragmentation Effect Fire: up-to 1000 m

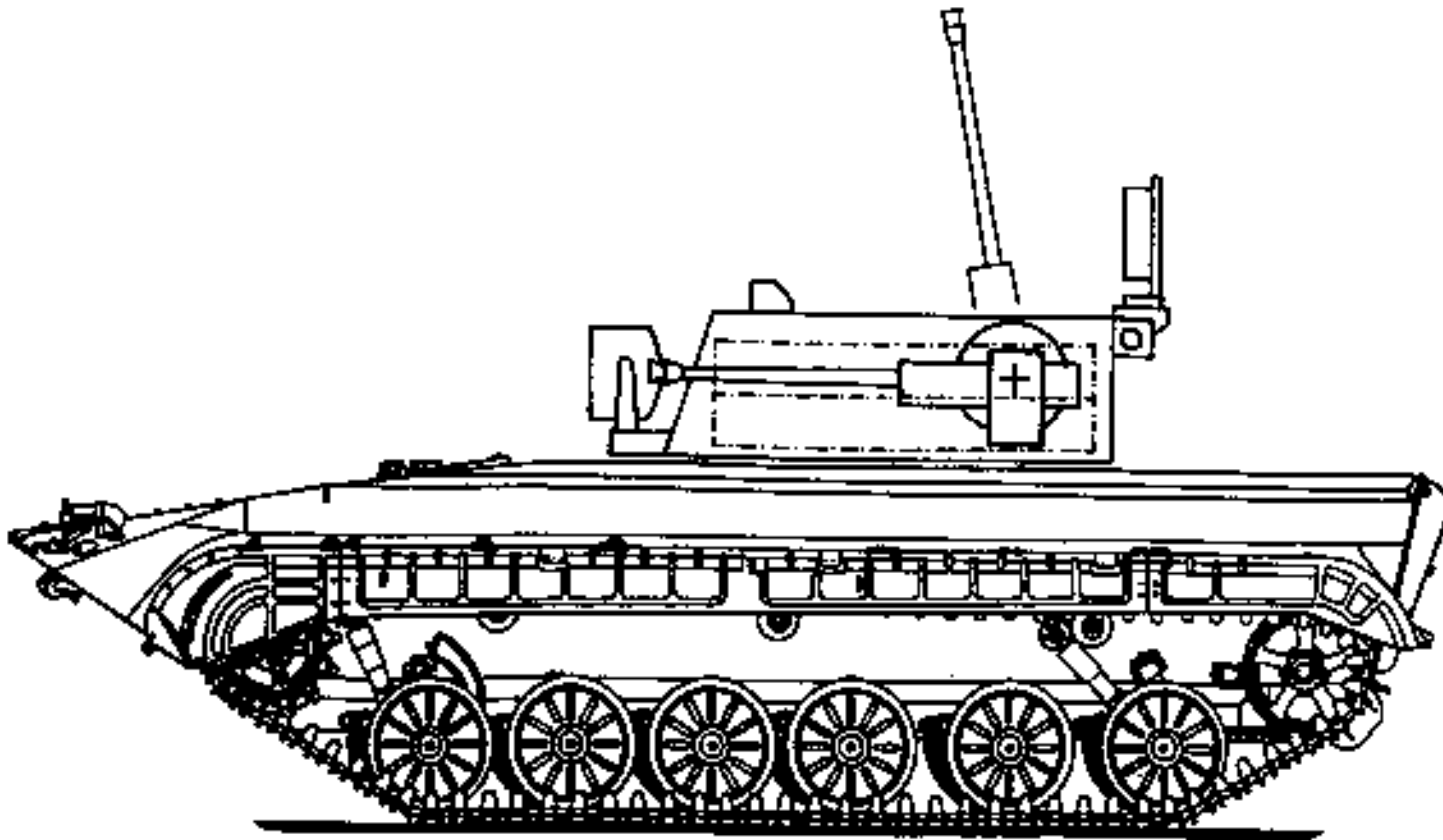
**35 mm calibre** Oerlikon-Contraves AHEAD - Skyshield Gun Weapon System for AD of Highest Value Assets which will be attacked above all by stand-off weapons

# CZECH SHORAD CONCEPT

## Self Propelled 20 mm AA Gun / Missile Weapon System

- **20 mm gun ZPL-20 „PLAMEN“**  
mounted on BMP-1 or ACV Platform
- **Twin Gun Pad Mount**  
Rate of Fire: 2 x 2600 rounds per minute  
Total burst rate: 2 x 50 rounds at min.- 4 barrels  
Ammunition: HEI, API-T
- **Integration of SHORAD Missile System**  
Missile: 4
- very high number of engagements
- high ammunition capacity in limited volume of SPAAG
- smart design in dimensions and weight
- compact architecture characterised by a low contour
- easy gun mount on any proper ACV

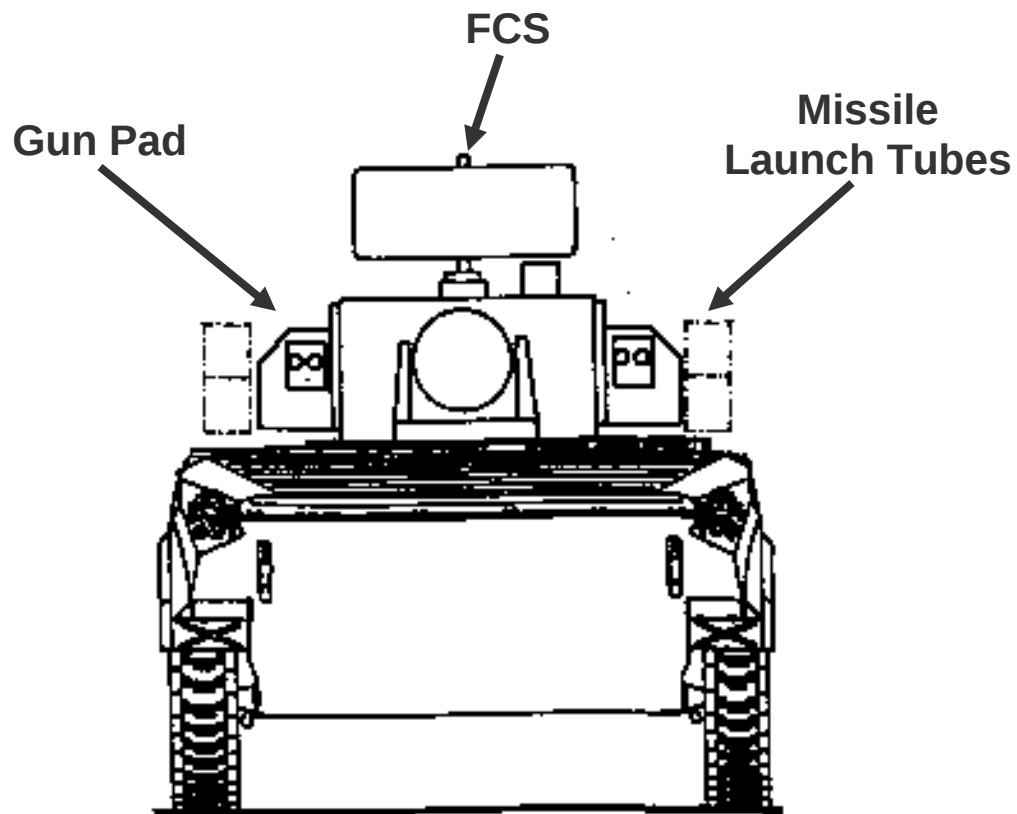
# CZECH SHORAD CONCEPT



Self Propelled 20 mm AA Gun / Missile Weapon System



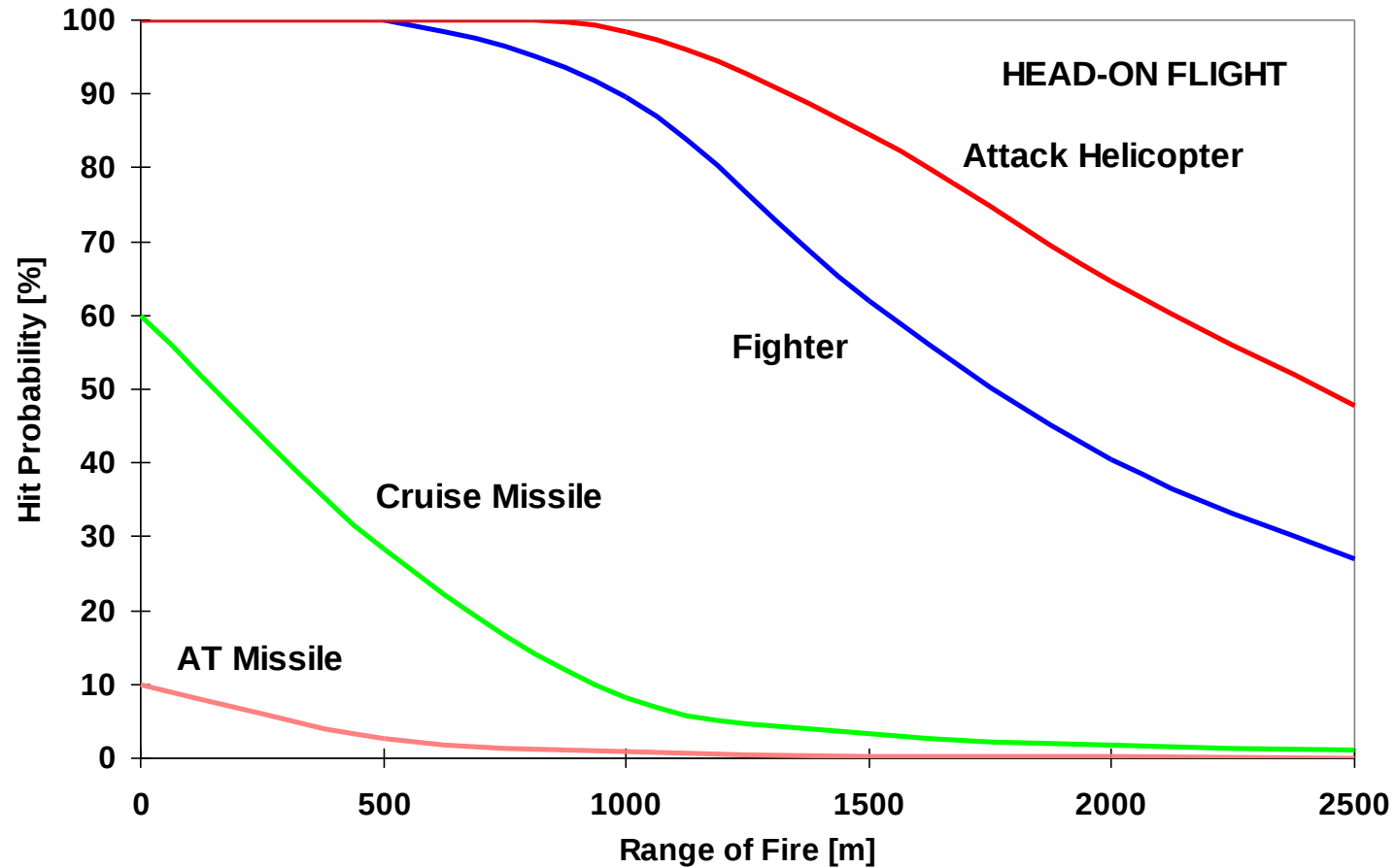
# CZECH SHORAD CONCEPT



Self Propelled 20 mm AA Gun / Missile Weapon System

# CZECH SHORAD CONCEPT

## 20 mm SPAAGS



# SHORAD COMBAT MULTI-MISSION

## Air Defence Mission of Armoured Combat Vehicles

### Combat Multi-Mission:

ACV (IFV, APC) weapon systems, gun and missile, are to be subjected to up-grading for

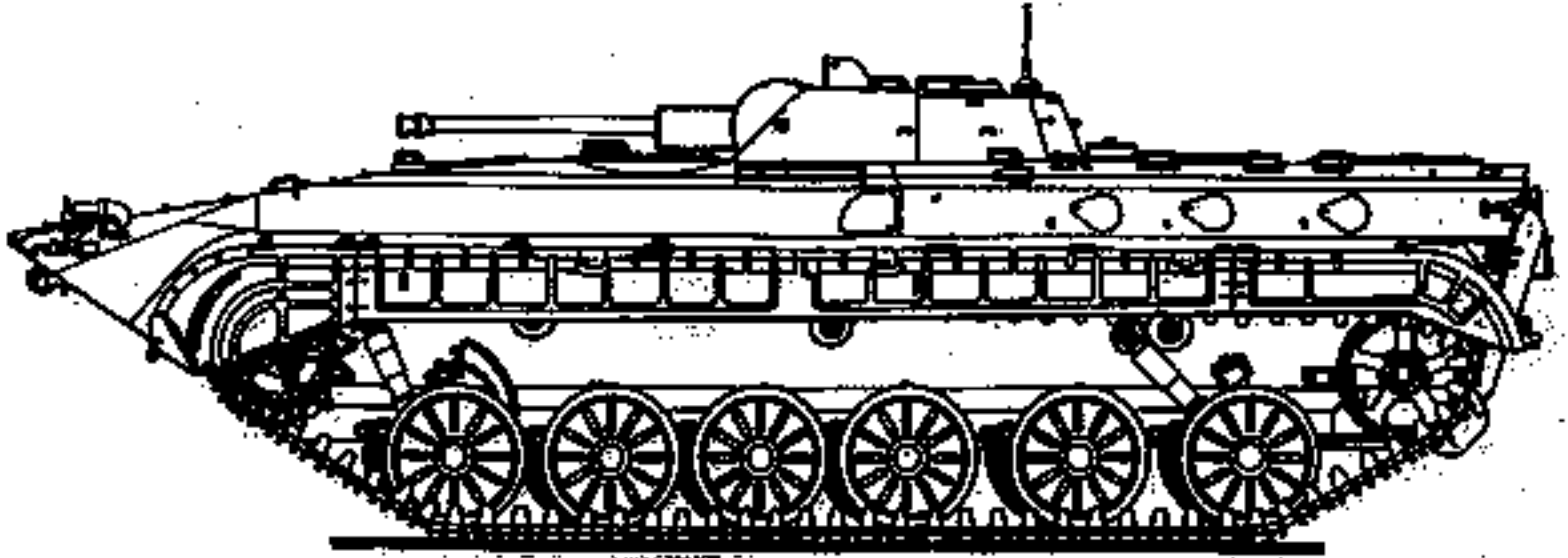
- general fire support weapon,
- antitank weapon,
- air defence weapon.

ADW: to reduce the permeability of the air defence to let down another layer of the air defence more by using of weapon systems appointed to annihilate ground targets only

### Gun Weapon System for Combat Multi Mission:

**20 mm gun ZPL-20 “PLAMEN”**

# SHORAD COMBAT MULTI-MISSION



**Upgraded BMP-1: 20 mm gun ZPL-20 „PLAMEN“**

**rate of fire: 2600 rounds per minute**

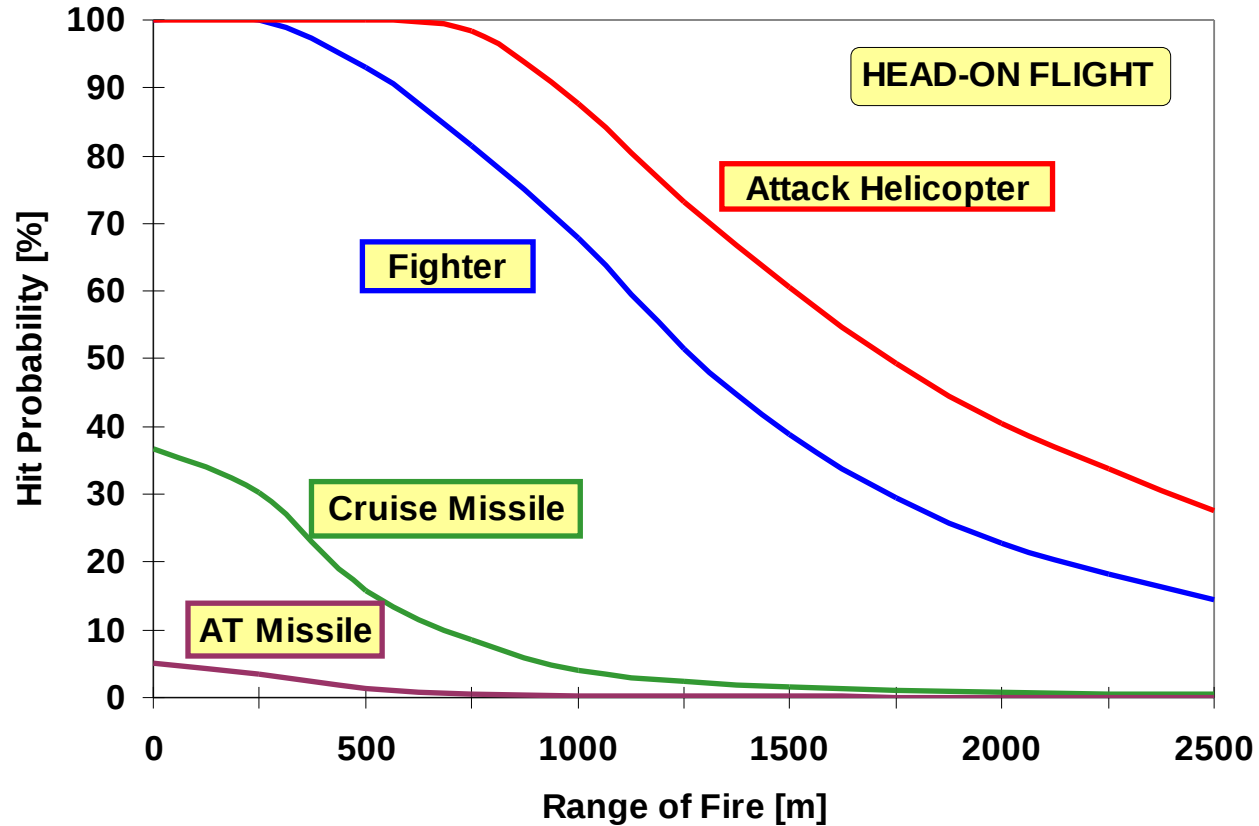
**burst rate: 50 rounds at minimum**

**ammunition: HEI, API-T.**

**min. effective range of AA gun fire: of about 1500 m**

# SHORAD COMBAT MULTI-MISSION

## 20 mm BMP-1



# SHORAD COMBAT MULTI-MISSION

