



## Cost Benefit Analysis Studies of the Introduction of Insensitive Munitions: Is IM Cost of Ownership Cheaper?



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# CBA Studies of the Introduction of IM

- **Introduction**
- **Brief Description of CBAM**
- **Cost Benefits Analyses:**
  - 1<sup>st</sup> Study: Short Range Air-to Air Missile
  - 2<sup>nd</sup> Study: 155-mm Artillery Munition
- **Conclusions**



# Introduction

- **June 2001: NIMIC organized the Costs & Benefits Analysis Workshop**
  - Definition of a set of requirements for a Cost Benefit Analysis Model
  - Development of a promotion methodology of IM to the Stakeholders
- **2002-2003: Development & Validation of the CBAM**
  - Code development
  - Validation studies
  - Release of the code to the NIMIC Nations (May 2003)



# Cost Benefit Analysis Model - CBAM

- **CBAM is primarily a tool to help calculate the cost differences of introducing IM into service**
  - i.e. compares the cost of ownership of IM vs. Non-IM over the whole of the life of a munition
- **It can also be used to calculate the cost of ownership of a munition**



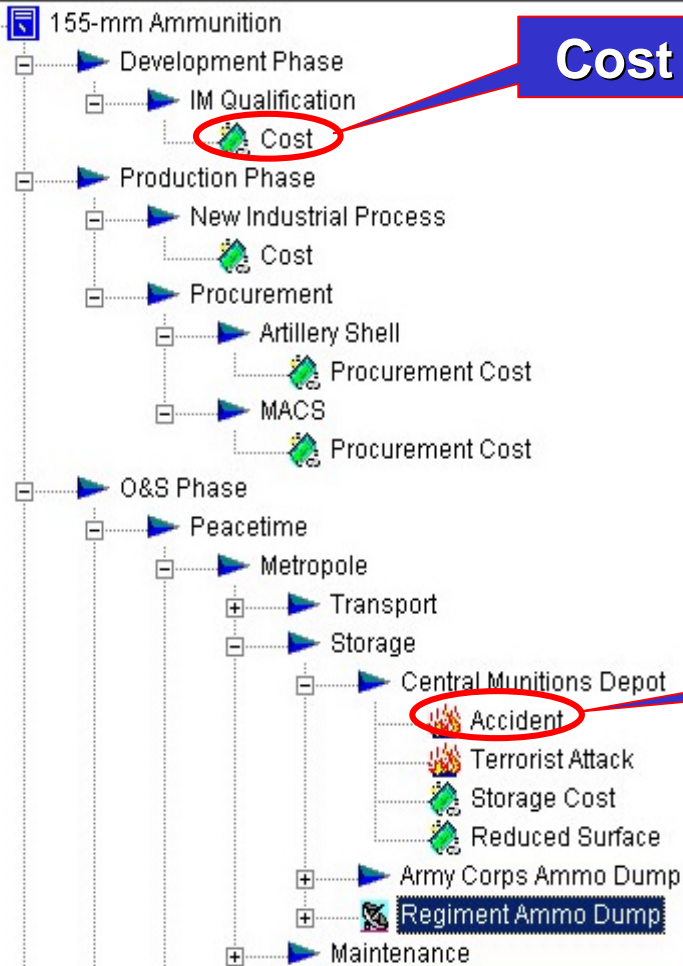
# Description of the Model

## CBAM calculates cost differences by:

- Aiding in the creation of a life cycle for a munition type
  - **Life-cycle Tree creation component**
  
- Providing a structured method for compiling cost data
  - **Modules to account for cost differences arising from:**
    - Risk Assessment
    - Direct cost
  
- Calculates cost by means of a Monte Carlo Simulation
  - **Takes into account the uncertainties**

# Life Cycle Component

BAM- Lifecycle  
Edit Calculation



**Cost Module**

**Risk Module**

Assessment Item Munitions Category

Name  
Regiment Ammo Dump

Description  
5 years

% Duration (Of Parent)    % of Whole L  
0                                    0

 Add Item  
 Add Risk/Threat Module  
 Add Cost Module  
 Add Favourite

# Cost Module

Direct Cost Module

**Cost**  
% Life Time = 0    % = 0    Year

**155-mm-noIM**

Number of Units   Apply Units Multiplier

**Duration**     Duration Linked

Days     Years

Apply Duration Multiplier (In Years)    % Uncertainty +  -

Category

Select From

Description

**Per Unit**    % Uncertainty +  -

**Overall Cost**    % Uncertainty +  -

Use in Calculation

**Cost/Year**

**No of Units**

**Calculate**

# Risk / Threat Module

Risk/Threat Module

## Accident

% Life Time **Exposure**

**Duration**  Duration Linked

Days  Years

Apply Duration Multiplier (In Years)  % Uncertainty

Category

Select From

Description

## Threat Details

Qualitative	Probability
Low	
Very Low	

**Consequences for each asset**

155-mm-noll

## Threat

Ammo Dump Accident

**Reaction Probability**

**Threat Probability**

Threat Probability  Uncertainty LIMITS

Probability of Mission Rxn.  % Uncertainty

**Asset Details** --> Select  <--

**Asset Data**

Asset	NoOfAssets
High Value Munition Igloo	14
High Value Munition Igloo	14
Low Value Munition Igloo	14

## Consequences

Quantitative Consequences  Qualitative Consequences  % Uncertainty

Probability of Consequence  % Uncertainty

**Consequence Probability**

## Consequence Data



Use in Calculation

Overall Cost  % Uncertainty



# Threat Database

- **Threats and Probability Database**
  - Threats and the probability of experiencing a threat

The screenshot shows the 'Calculation Parameters' window of the Threat Database software. It features three main data entry areas: 'Threats', 'Threat Details', and 'General Threat Descriptors'. Each area has a table with columns for 'Descriptor' and '\*Probability'. Handwritten red circles highlight the 'Threats' table, the 'Threat Details' table, and the 'General Threat Descriptors' table. A thought bubble labeled 'Threat' points to the 'Threats' table. Another thought bubble labeled 'Probability of the threat' points to the '\*Probability' column of the 'Threats' table. A third thought bubble labeled 'Threat Descriptors (e.g. High, Medium, Low)' points to the 'General Threat Descriptors' table. At the bottom, there are 'New', 'Edit', and 'X' buttons for each table, and an 'OK' button at the bottom right.

**Threat**

**Probability of the threat**

**Threat Descriptors (e.g. High, Medium, Low)**

# Asset & Consequences Database

Calculation Parameters

## Assets and Consequences Database

Lookup Box

Assets

Assets
Buildings - Semi-Urban
Buildings - Urban
High Value Munition Igloo
Igloo
Low Value Munition Igloo
Personnel
<b>Semi Trailer</b>
Workshop

Consequence Details

Descriptor	Financial
▶ Category I	0
Category II	0
Category III	0
Category IV	0

General Consequence Descriptors

Descriptor
▶ Category I
Category II
Category III
Category IV
killed
minor injury
serious injury

Copy Descriptors  
All <<  
Or

**Asset Designation**

**Cost or Repaired Cost of an Asset /**

**Consequence Descriptors (e.g. category I, II, III, IV – AOP-15)**

New Edit X    New Edit X    New Edit X    OK

# Calculation

The screenshot shows the 'Calculations' window of the NIMIC software. The interface is divided into several sections: 'Select Munition To Calculate', 'Munitions To Be Calculated', 'Result Filenames', 'Current Results Files', 'Calculation Options', and 'Progress'. Annotations include red circles around specific fields and a blue dashed arrow pointing from a 'Progress Report' box to a histogram.

**Select Munition To Calculate:** A dropdown menu shows '155-mm-nolM'. Buttons for 'Add >>', 'Add All >>', and 'Remove' are present.

**Munitions To Be Calculated:** A list contains '155-mm-IM' and '155-mm-nolM', both circled in red.

**Result Filenames:** A list contains '155-mm-IM4.OUT' and '155-mm-nolM4.OUT'.

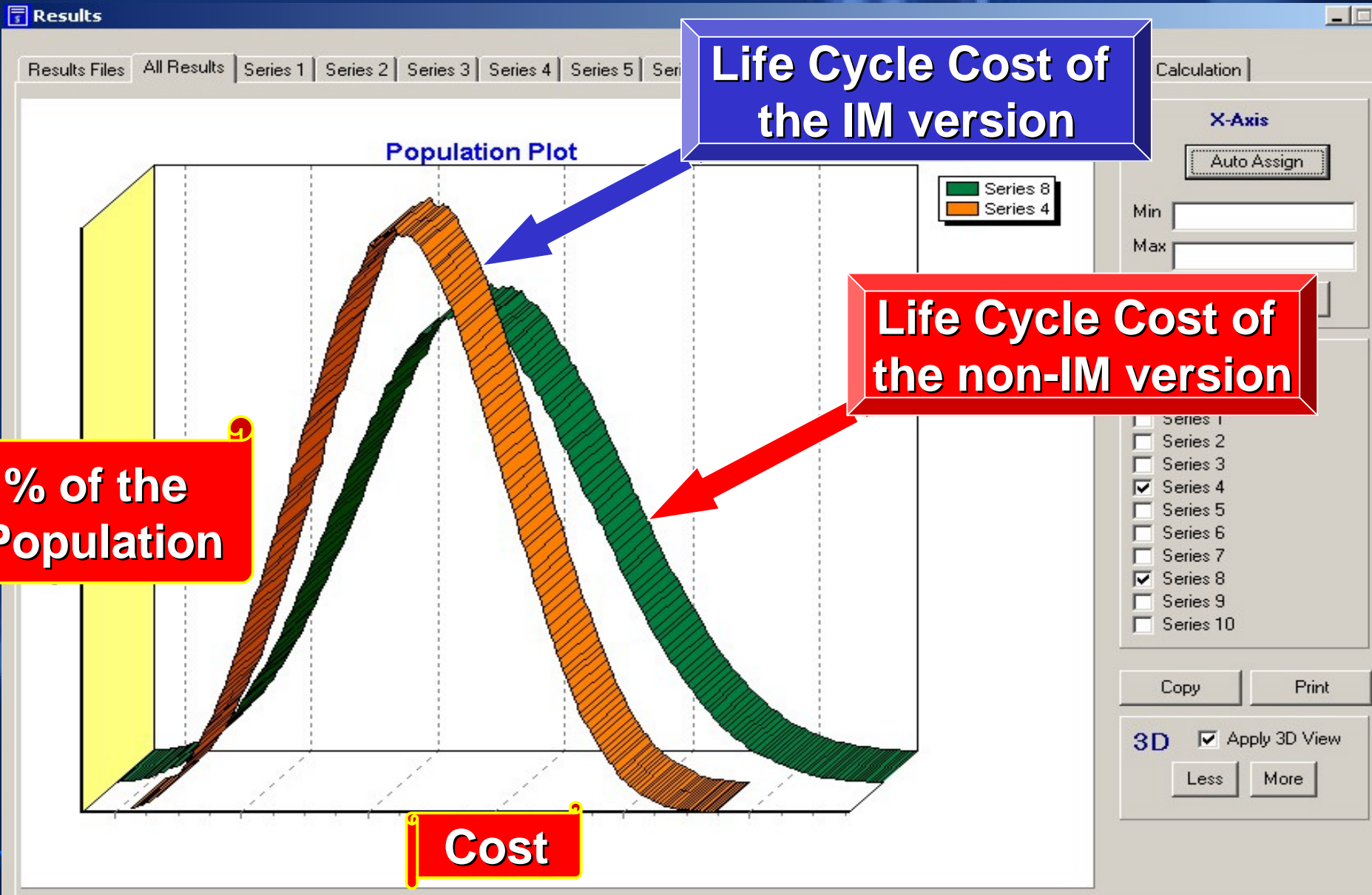
**Current Results Files:** A list contains '155-mm-IM1.OUT', '155-mm-IM2.OUT', and '155-mm-IM3.OUT'. Buttons for 'Delete File' and 'Delete All Files' are at the bottom.

**Calculation Options:**  
- 'No. of Calculations': Input field '500' with a multiplier 'x1000'.  
- 'Apply Normal Distribution Function': A checkbox is checked, with '95%' and '99%' options.  
- 'Select Part of Lifecycle': A dropdown menu labeled 'Select Category'.  
- 'Select Branch of Lifecycle': A section with checkboxes for 'Calculate This Part Only' and 'Vary Selected Parameter', and a 'By: 0%' input field.

**Progress:** Shows 'Number of Calculations: 0', 'Munition Being Calculated: None', and 'Messages: None'.

**Annotations:**  
- A blue box labeled 'Progress Report' has a dashed arrow pointing to a red histogram.  
- Three thought bubbles contain the text: 'Select the Munitions to be calculated', 'Select the Calculation Options', and 'Select the Number of Calculations'.  
- A fourth thought bubble at the bottom contains the text 'Calculation Options'.

# Results



# 1<sup>st</sup> Study: Short Range Air-to-Air Missile

- **Why:**

- High-value munition on a high value platform
- Data availability in NIMIC

- **Life Cycle (cradle-to-grave sequences):**

- Peacetime (~24 years):

- Storage (~ 90 % of the life cycle)
- Transport (road, rail, sea and air)
- Maintenance
- Training
- Disposal

- Crisis (6 months)

- Deployment, operational training, etc

- Conflict (1 month)

- Platform vulnerability, Airbase and Ammo Dump vulnerability

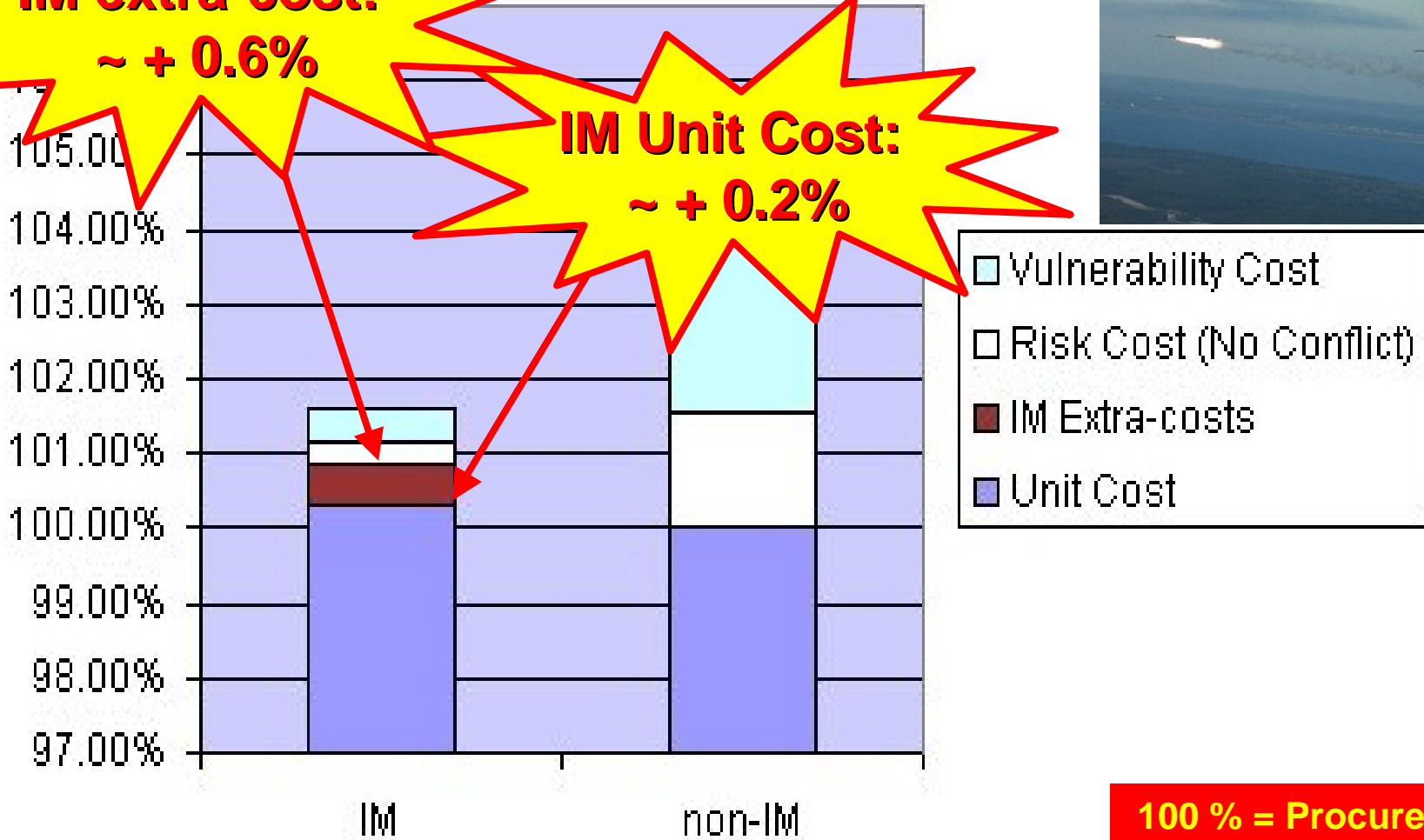


# SRAAM: CBA results



**IM extra-cost:  
~ + 0.6%**

**IM Unit Cost:  
~ + 0.2%**

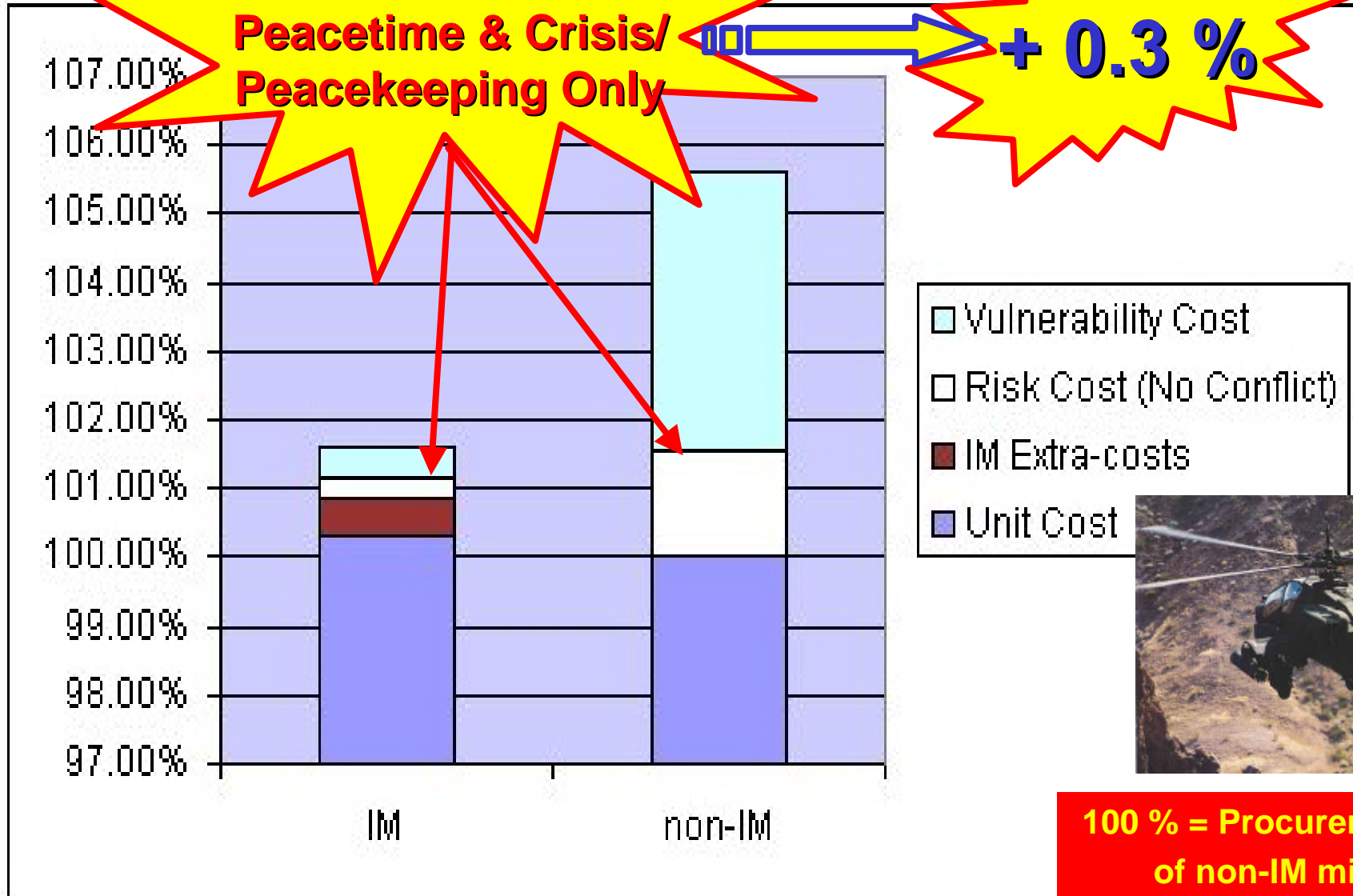


**100 % = Procurement Co  
of non-IM missiles**

# SRAAM: CBA results

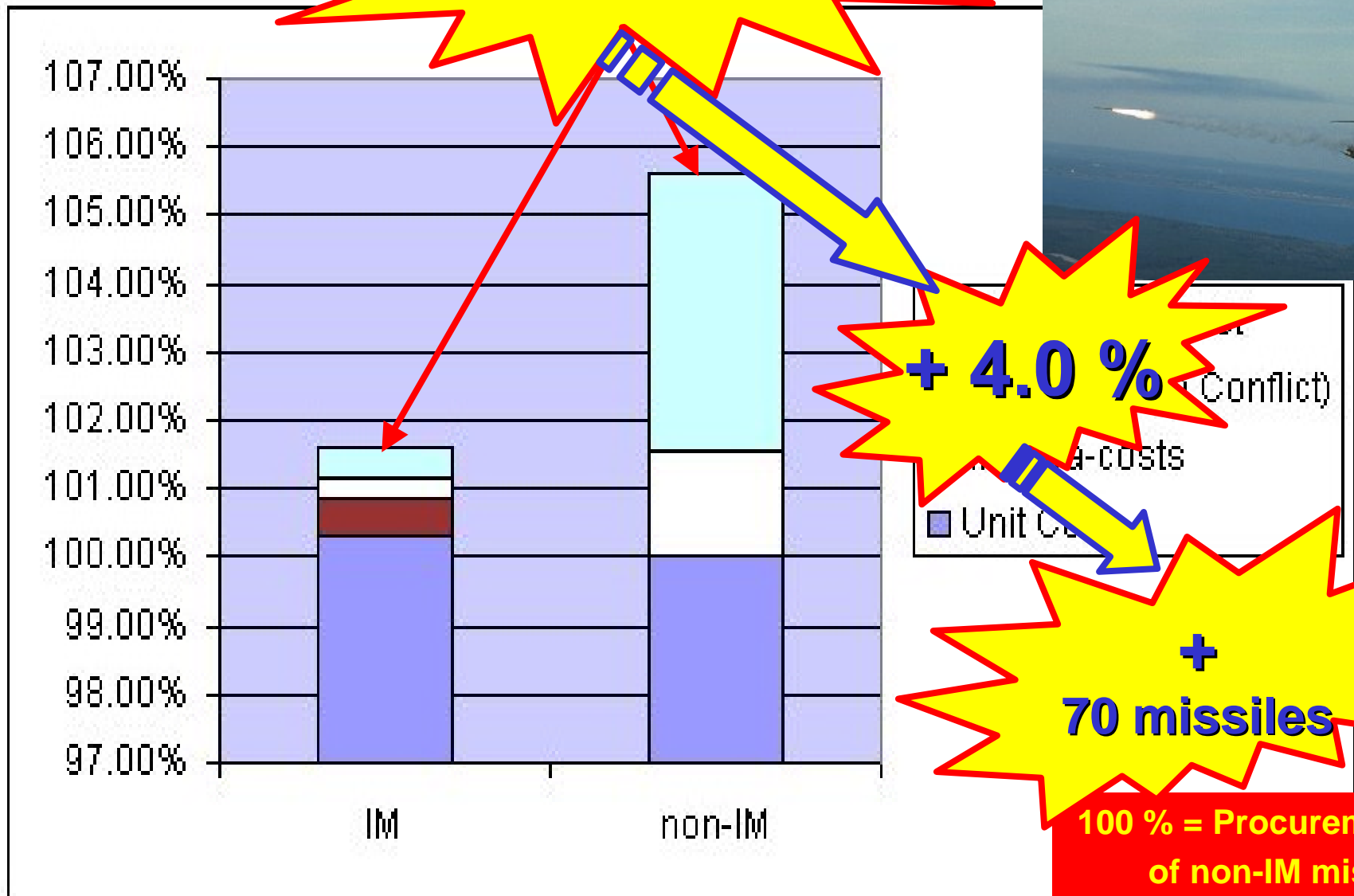
**IM LCC Benefits:  
Peacetime & Crisis/  
Peacekeeping Only**

**+ 0.3 %**



**100 % = Procurement Co  
of non-IM missiles**

**IM LCC Benefits:**





# SRAAM Cost Benefit Analysis: Lessons

- **Main lessons (Small and High value missile – High Value platform)**
  - **Limited benefits in transport**
    - **No. of missiles transported limited by the volume**
    - **Consequences of accidents limited (low NEQ)**
  - **Limited benefits in peacetime storage**
    - **Peacetime storage adapted to HD 1.1**
    - **Consequences of accidents limited (low NEQ)**
  - **Main Benefits in Operations:**
    - **Training**
    - **Crisis and Peacekeeping operations (Armed helicopter)**
    - **Reduced vulnerability of Air Bases**
    - **Reduced vulnerability of helicopters (Note: 1 or 2 % reduced vulnerability is enough to get significant cost-benefits)**



# 2<sup>nd</sup> Study: 155-mm Artillery Ammunition

- **Why:**

- Low-cost munition on a relatively low-cost platform
- Data availability in NIMIC

- **Life Cycle (cradle-to-grave sequences):**

- **Peacetime (~24 years):**

- Storage (~ 90 % of the life cycle)
- Transport (road, rail, sea and air)
- Maintenance
- Training
- Disposal

- **Crisis (6 months)**

- Deployment, operational training, etc

- **Conflict (1 month)**

- Platform vulnerability, Land base and Ammo Dump vulnerability

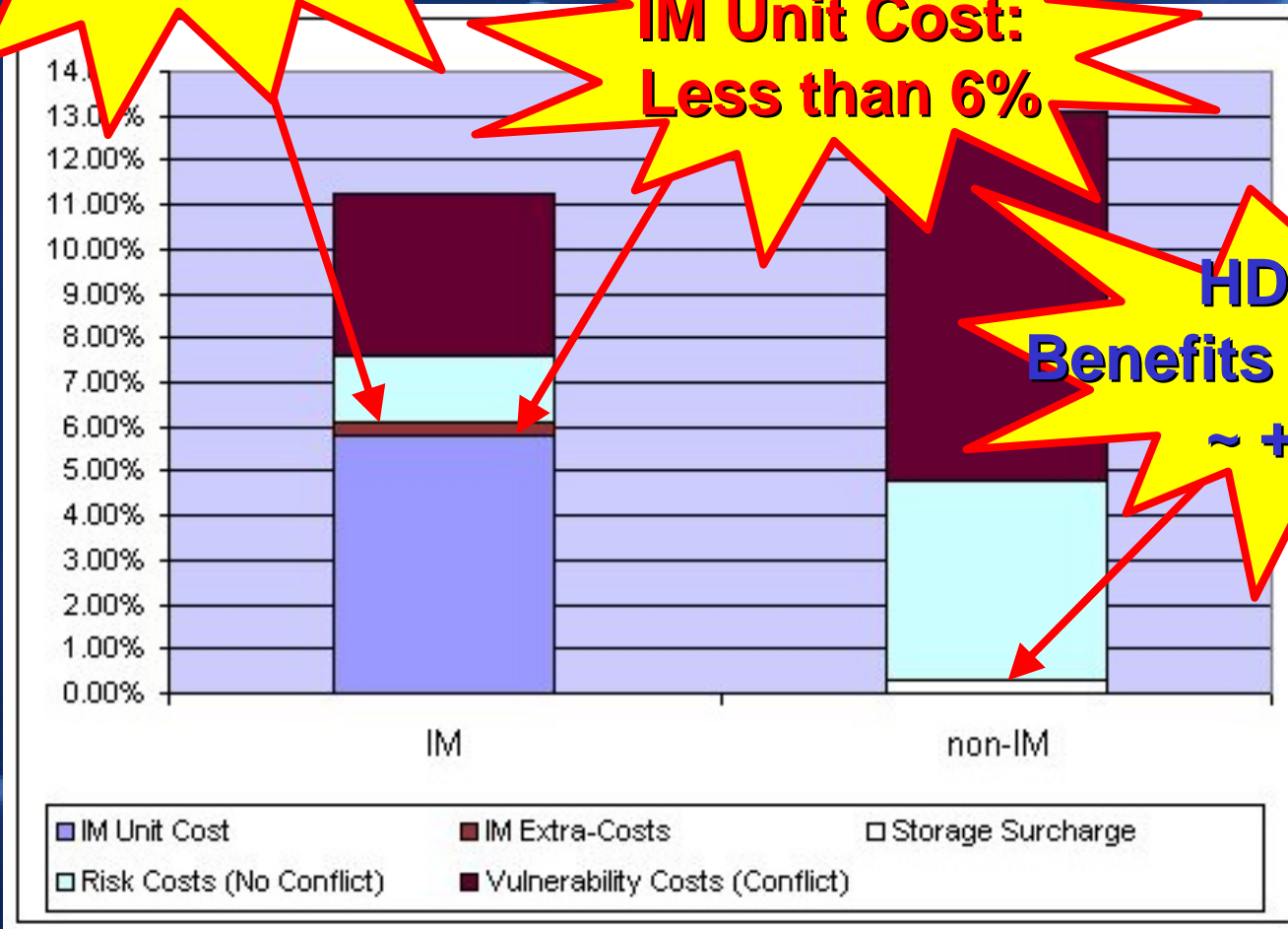


# 155-mm Artillery Ammunition: results

**IM extra-cost:  
~ + 0.3%**

**IM Unit Cost:  
Less than 6%**

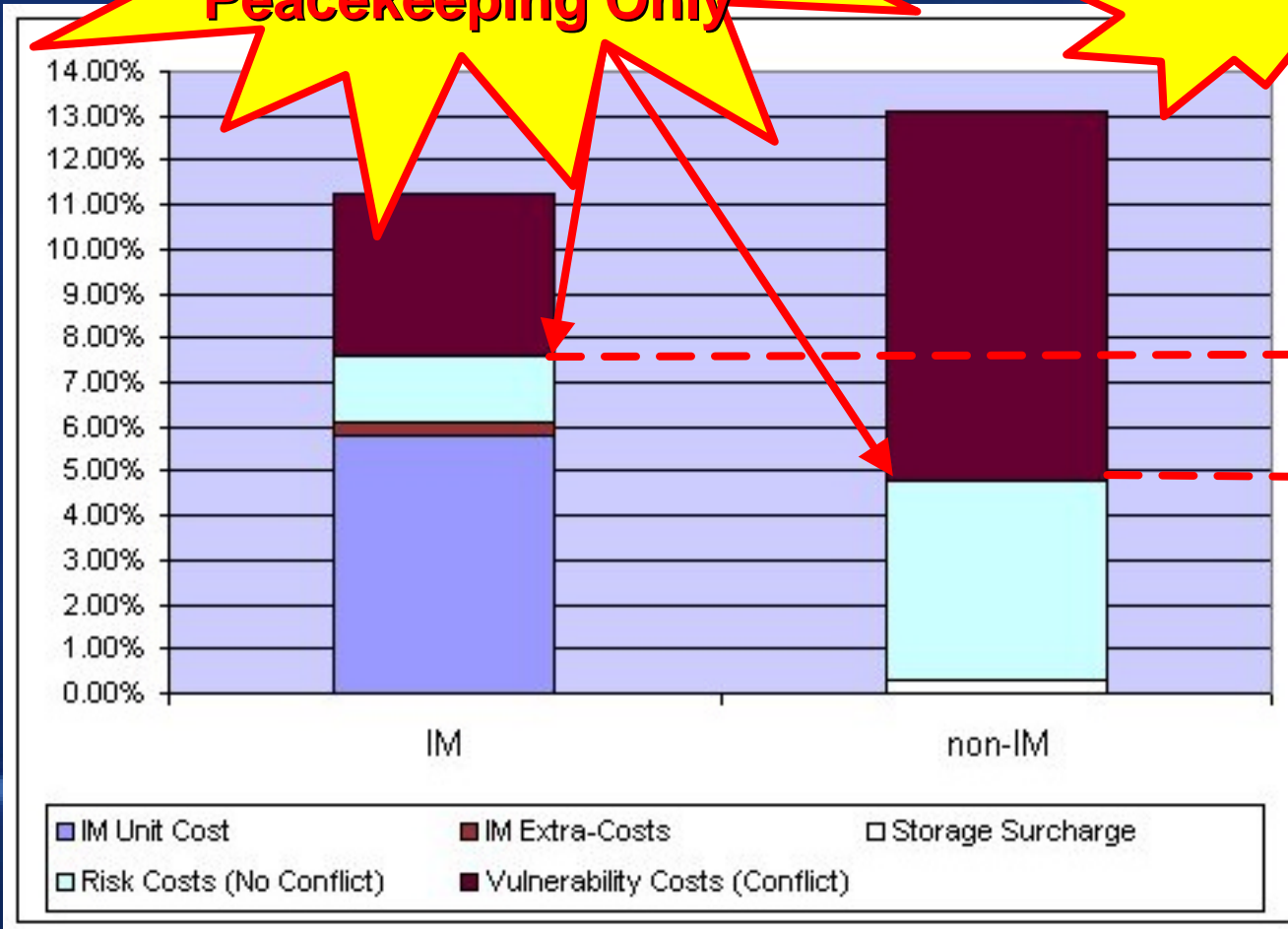
**HD 1.2.3  
Benefits in Storage:  
~ + 0.3%**



# 155-mm Artillery Ammunition

**IM LCC Benefits:  
Peacetime & Crisis/  
Peacekeeping Only**

**+ 3 %**

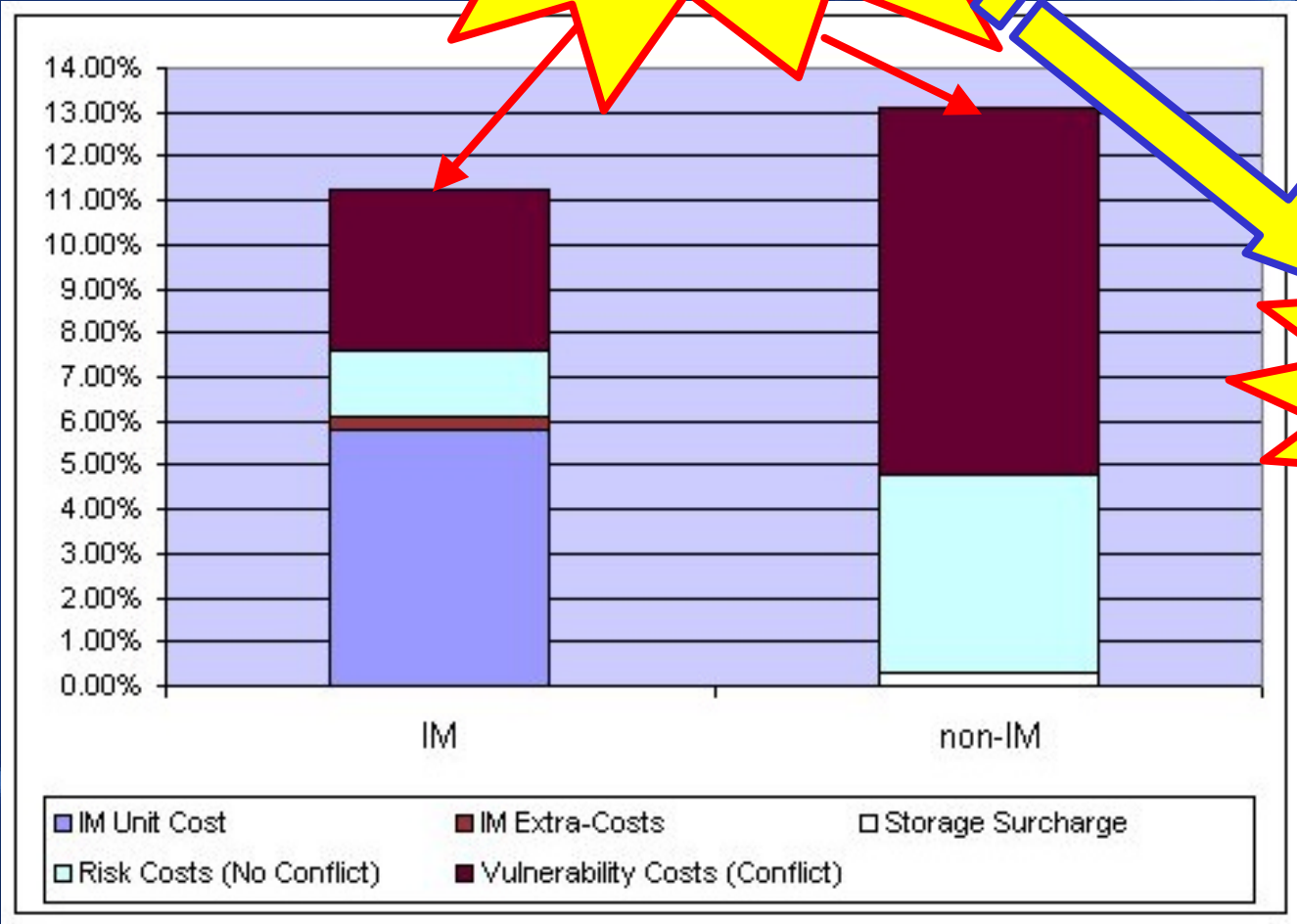


**IM Benefit  
- 2.5%**



# 155-mm Artillery Ammunition

**IM LCC Benefits:**



**~ 2.0 %**



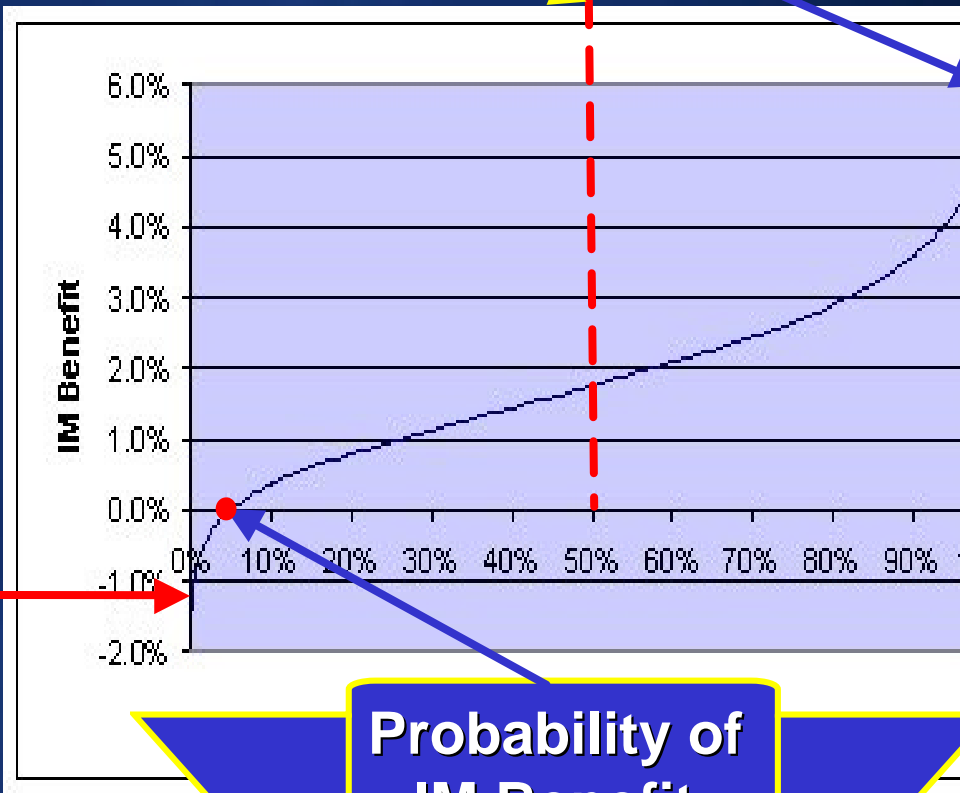
# 155-mm Artillery Ammunition

Results presented earlier are mean value  
(Monte Carlo - linear distribution)

Max. Rate of Return  
IM Investment:  
~ 200 %

Probability of having a  
benefit:

- Variability of the input data (exposure, threat probability, munition reaction probability, consequence probability)
- Monte Carlo Runs



Min. Rate of Return  
IM Investment:  
> 75 %

Probability of  
IM Benefit:  
95.5 %

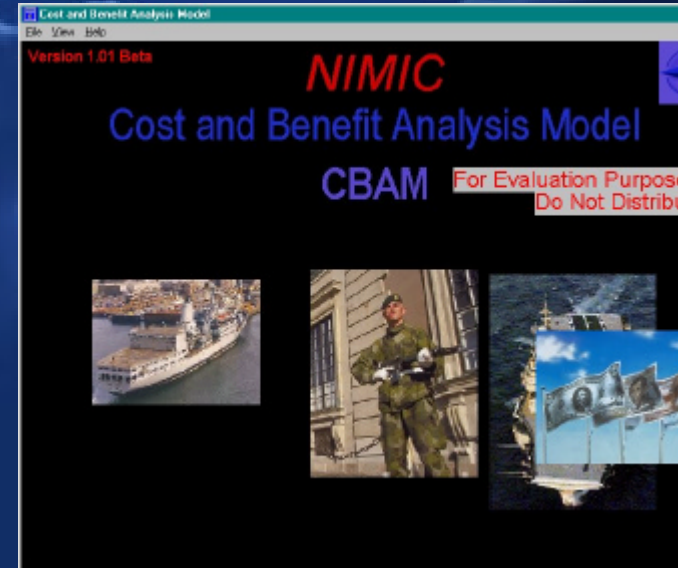


# CBAM/CBA Studies: Capabilities & Limitations

- **Too many uncertainties may give a meaningless result**
- **Some IM benefits are not financial:**
  - The increased flexibility in operations
  - The reduced logistics
  - Some consequences of accidents, such limited access to zones where UXOs have been spread
  - Operational, Health & Safety, Environmental and Political Benefits

# Future of CBAM

- Any comments, recommendations, requirements for the Model are welcome
- Future ?
  - Tool development and testing is now completed
  - A beta-version has been released early March 2003 to a limited number of testers
  - Additional improvements before distribution:
    - life saving probability
    - Direct difference cost calculation (IM and non-IM version)
  - CBAM 1.0: May 2003







# Conclusions

- **Storage benefits:**
  - Peacetime: very limited
  - Conflict or Crisis: medium to high
- **Transport benefits:**
  - Munition dependent
  - Nation dependent (exposure factor)
- **Benefits in operations (crisis or conflict)**
  - Reduced platform vulnerability
  - Reduced ground base vulnerability
- **Transport accident: political consequences?**

# Any Questions?



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