MSIAC
Munitions Safety Information Analysis Center

MSIAC
IM Technology
Gap Workshop

Gun Propulsion Technology

Emmanuel Schultz
TSO Propulsion Technology
e.schultz@msiac.nato.int
+32 (0) 2 707 5447

Tel: +32 (0) 2 707 5416
E-Mail: info@msiac.nato.int
Web: http://www.msiac.nato.int

MSIAC
Munitions Safety Information Analysis Center

IMTG Workshop

Reducing Munitions Response to Shaped Charge Jets, Fragments and Explosively Formed Projectiles

Dutch Defence Academy
The Hague, The Netherlands
20 to 24 June 2011
Open to MoD and Industry from MSIAC Nations

Contents

- Objectives
- Acknowledgements
- EFP vs. propelling charge
- Key factors affecting the propelling charge response to SJCI, FI and EFP impact
- Small Scale tests
- Large Scale tests
- General outputs

Workshop Outline

- **Topic**
  - Propelling charges are sensitive to attack by fragmentation warheads, shaped charge weapons and explosively formed projectiles (EFPs).



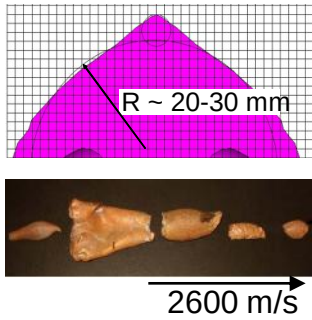
- **Objectives**
  - Identify
    - How to reduce the violence of reaction to these stimuli
    - Technology gaps and potential remediation options
    - Non technical hindrances

Acknowledgements

- Participants of the gun propulsion working group:
  - Wolfgang Stein, Rheinmetall (Chairman)
  - Pierre Archambault, MSIAC (Secretary)
  - Thelma Manning, US Army
  - Christine Michienzy, US Navy
  - Jean-Louis Paulin, Eurenco
  - Michael Ramin, Nitrochemie Aschau
  - Rutger Webb, TNO
  - Per Stensland, NDLO, Norway
  - Christ Van Driel, TNO
  - Duncan Watt, QinetiQ Australia
- 3 presenters:
  - T. Manning (US Army – ARDEC): *"The system level approach final assessment of Insensitive Munitions response of deterred double base propellant through optimized ignition and venting"*
  - P. Pelletier (GD-OTS Canada): *"Use of 84 mm Carl Gustav FFV 551 charge for SCJI tests at GD-OTS Canada"*
  - W. Stein (Rheinmetall): *"SCJI testing of propellants and propulsion charges"*

Gun propulsion and EFP

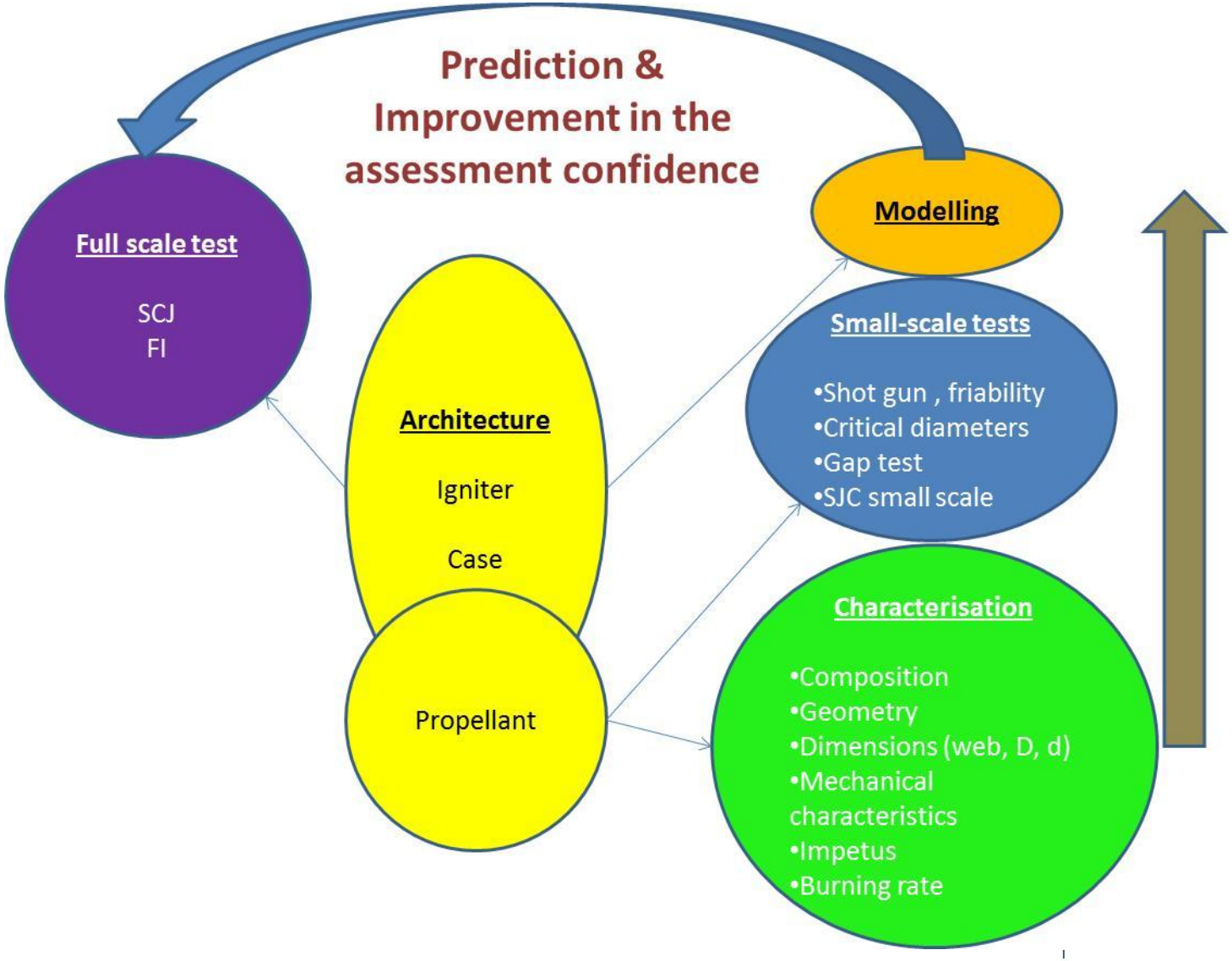
- The group agreed that:
  - EFP could be considered as a large slut hitting a large number of grains (where fragment and SCJ would only hit a small number of grains)
  - No data is readily available on the response of propelling charge against EFP
- There are similarities between:
  - The mono-slug IED (Improvised Explosive Device) EFP, and the French heavy fragment
  - Tip slug from multi-slug IED EFP and the NATO fragment
- Hindrances:
  - Data classification may prevent release of information on EFP
  - Resources to carry out tests may not be available



Key Factors & IM Technology

- After a review of the key factors identified during the IM design technology Workshop (2003), the following new key factors emerged from the discussion:
  - Critical diameters of the formulation, the grain and the bed
  - Impact of the process on mechanical characteristics
  - Impact of the surface coating and the crystal morphology & purity on sensitivity
  - Igniter and case contribution:
    - Not well taken into account or understood
    - Can increase significantly the violence of the response
    - The case may require venting as the loss of confinement created by the stimuli may not be sufficient to limit the increase of pressure

From the formulation to the full-scale test

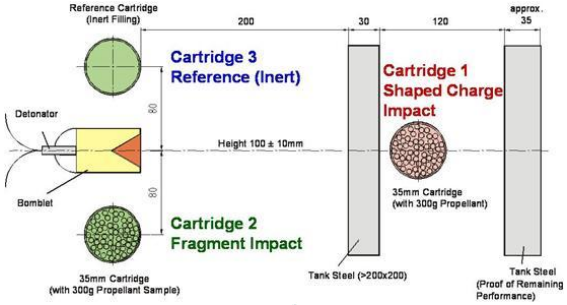


Small Scale Testing

- Critical diameters:
  - Critical formulation diameter is used to determine if the propellant will detonate and to put an upper limit of the grain diameter.
  - Critical grain diameter is to determine if the propellant will transition from deflagration to detonation (applicable only to small web) and to determine if the propellant with large web will detonate.
  - Critical bed diameter affects the likelihood of propagation to violent event at the propelling charge level

Critical diameter of	Influencing factor
The formulation	Composition, particle sizes, process
The grain	Composition, perforations, web size
The propellant bed	Composition, bed homogeneity, loading density

- No small scale FI and SCJ tests other than
  - SCJ German Combination test
  - US SCJ pendulum test
  - UK DERA SCJ test

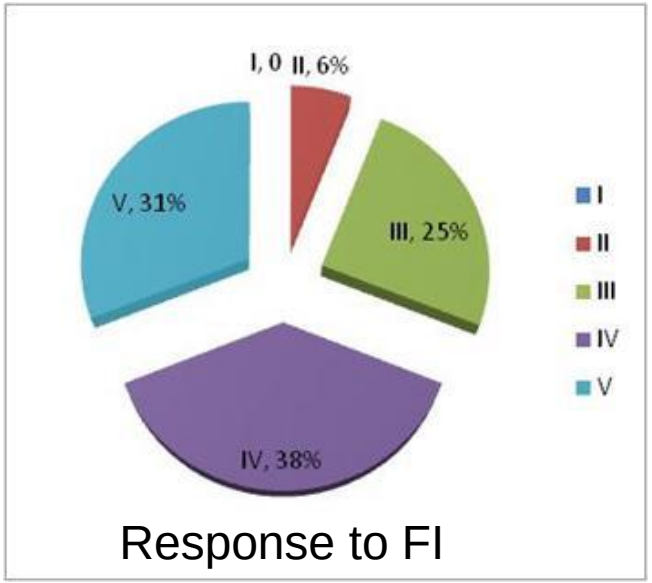


Small Scale Testing

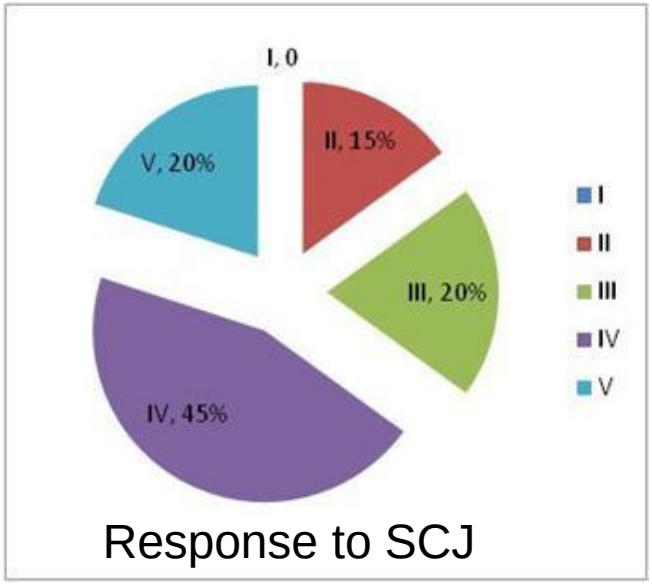
- **Shortfalls**
  - Analysis (comparison) of data has not been carried out because data among nations has not been shared
  - No standard on small-scale testing
- **Hindrance**
  - These data could be seen as vulnerability data.
- **Recommendation**
  - MSIAC should create a new database on these tests (critical diameters, SCJ small scale test): collect data and analyze them to establish trends, correlation and ability to predict the large scale response

FI & SCJ full scale test

- Statistical representation of responses of munitions that already include IM technologies (PASS not taken into account for SCJ):



Response to FI



Response to SCJ

- Most frequent response: deflagration (type IV)

FI & SCJ

- **Shortfalls**
  - FI & SCJ data is difficult to compare due to multiple test configurations used in the past and even now
  - No data on aged propellant
  - Lack of data at extreme temperatures
  - Statistical significance of testing
  - Testing
    - Lack of data sharing on FI test instrumentation (gun charge and sabot)
    - Reproducibility & accuracy of impact point/orientation of the fragment
    - Large number of possible Shaped Charges authorized for testing in the STANAG

FI & SCJ

- **Recommendations**
  - Exchange of FI & SCJ (and EFP if available) test configurations, instrumentation and testing issues on gun propellants for small scale and STANAG testing
  - Modelling response of propellant and ignition powder should be pursued to better understand the reaction mechanisms and increase confidence in the test results.
  - SCJ test score should be reported according to the response level described STANAG 4439, not just as pass or fail.
  - The STANAG on SCJ should be reviewed

General outputs

- **Hindrances**
  - Lack of funding to pursue basic research
  - Lack of wide spread use of IM technology because of development, production & qualification cost
  - Easy access to waiver
    - Faster
    - Cheaper
    - Lower risk for the PM than developing IM technology
  - Lack of funding for IM technology development
  - Lack of awareness of the
    - Benefits & availability of IM technologies amongst PM & users
    - Consequences of not doing IM amongst PM & users

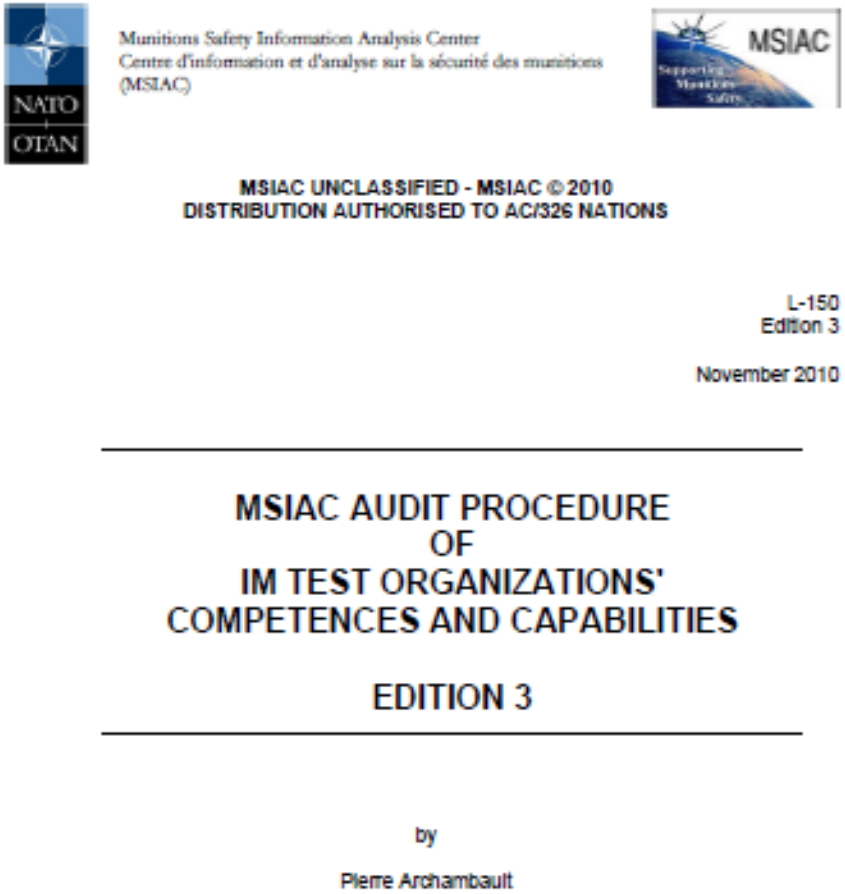
General outputs

- Recommendations
  - Coordinate approach to IM propelling charge development and industrialization given that all nations faced similar challenges in:
    - Building and maintaining capabilities
    - Sharing development cost
    - Collaboration between governments & industrial organizations

- Short and long term remediation strategy:
  - Replacing sensitive propellant by less sensitive ones
  - Introducing in-service less sensitive igniter
  - Introducing non-chemical ignition
  - Developing venting on metallic case and packing

- All the details are on the report available on request to individuals from MSIAC nations.

Test center audit procedure



Munitions Safety Information Analysis Center
Centre d'information et d'analyse sur la sécurité des munitions
(MSIAC)

MSIAC UNCLASSIFIED - MSIAC © 2010
DISTRIBUTION AUTHORISED TO AC/326 NATIONS

L-150
Edition 3

November 2010

MSIAC AUDIT PROCEDURE
OF
IM TEST ORGANIZATIONS'
COMPETENCES AND CAPABILITIES

EDITION 3

by

Pierre Archambault

- Guidance for carrying out a self-audit
- Help the test centers in assessing their IM/HC testing capabilities and competences
- Useful to identify:
  - Strengths
  - Weaknesses
  - Deficiencies
  - Recommendations for improvement
- Already used by WTD-91, Bofors Test Center and Nammo Raufoss