ARE THERE DIFFERENT TEST METHODS FOR INSENSITIVE MUNITIONS BASED ON STANAG 4439?

WHAT PARAMETERS MATTER?

IMEMG's Expert Working Group Members on Test Procedures

Presented by Gerhard HUBRICHT – Yves GUENGANT

www.imemg.org

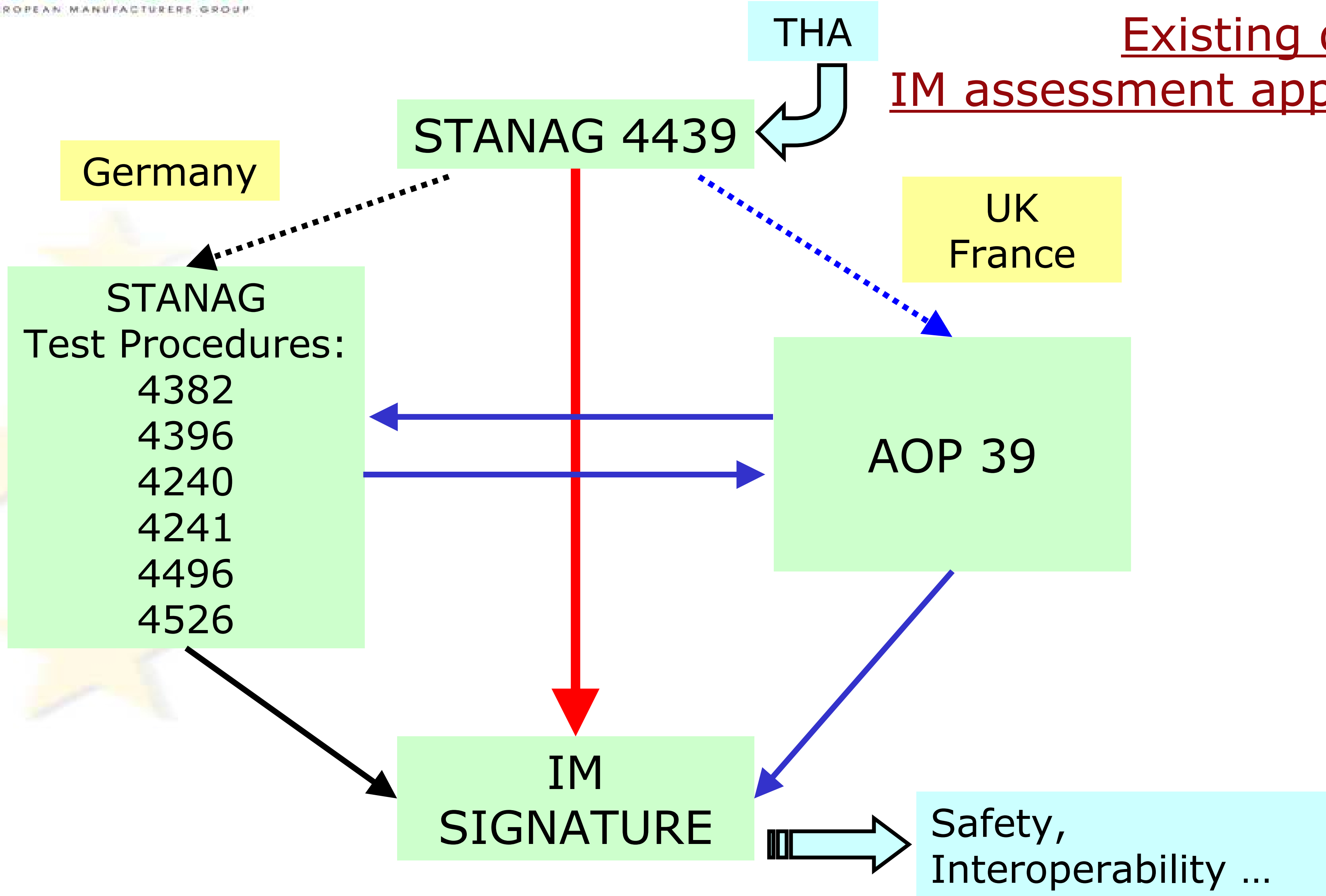
Context

- IMEMG is the European Organisation assembling leading armament groups working with IM technologies.
- It aims at expressing the viewpoint of the armament industry with regard to relevant transnational regulations and requirements.
- This paper is the result of common works carried out by the *Test Procedure Expert Working Group*:
  - It is based on industrial feed-back implementing Test Procedures, or STANAG,
  - This work is the continuation of the 2006's IMEMTS presentation,
  - It aims to point out difficulties and proposes possible improvements.

A status: Lack of accuracy in Test STANAGs

- Various procedures are proposed in STANAGs
  - FCO, SCO, BI, FI (procedure choice to be approved by each national authority).
- Test set up not specified in sufficient detail
  - FCO, BI, FI, SCI (i.e. restraint apparatus …).
- STANAGs Edition 2 are not fully harmonised with UN orange book
  - FCO, BI, SR (i.e. combustible nature, donor initiation …).
- Stimulus not always well defined
  - SCO, FI, SR, SCI (i.e. aiming point choice for impacts).
- Response and result subject to interpretation
  - FCO, SCO, BI, FI, SR (i.e. propulsion effect assessment).
- Acceptance criteria of the test results are not defined
  - FCO, SCO, BI, FI, SR, SCI (i.e. bullet incidence angle).

Existing different IM assessment approaches



National Approaches and Practices

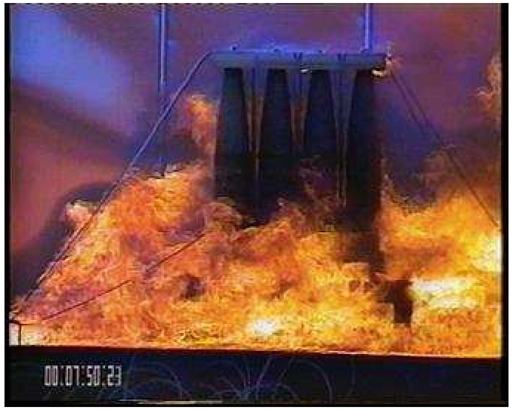
- Due to different procedures in STANAGs and the uncertainty of requirements, some significant differences for vulnerability tests have appeared between the practices of test centres,
- The STANAG and the AOP are considered at different level between Nations; i.e. In France and UK it is possible to demonstrate munitions responses through small scale tests and numerical simulations without full scale trials.
- As the description of the stimulus is not accurate enough, the trend is that each country defines its domestic procedure (e.g. for Sympathetic Reaction of non-detonative items and for Shaped Charge Impact).
- Other new constraints influence the application of the IM STANAGs: Transportation, Storage and Environmental Protection.

National Approches and Practices

- LIQUID FUEL / EXTERNAL FIRE

FCO – FR

LPG Fire – GE

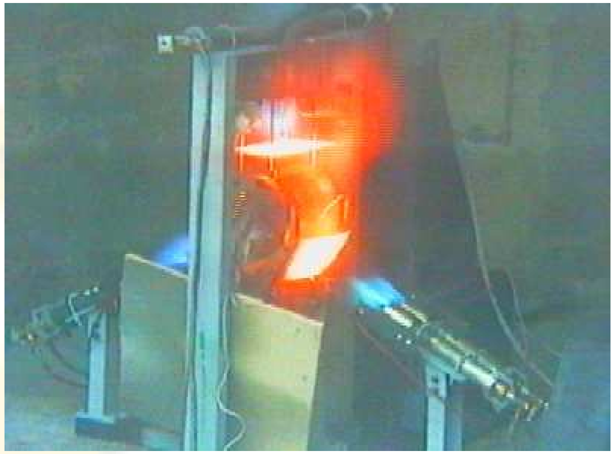


FCO – FR

FCO – UK

National Approches and Practices

- LIQUID FUEL / EXTERNAL FIRE



LPG Fire – FR

LPG Fire – GE

National Approches and Practices

- LIQUID FUEL / EXTERNAL FIRE
  - UK: Mini fuel fire sometimes accepted; 6 thermocouples normally used; The wind speed limit constraint is adapted with concrete wall.
  - GERMANY: Mini fuel fire sometimes accepted; 4 thermocouples normally used; LPG fire has been recently developed, but acceptance criteria still need to be defined; Cage around item can modify projections assessment.
  - FRANCE: Mini fuel fire not used; Mini LPG fire has been developed, but acceptance criteria to be defined.
  - NORWAY: Full scale fuel fire normally used; LPG fire is used when approved by the customer, so far mainly for civilian applications.

  Main questions:
  - *type of combustible (Kerosene, LPG) , thermal flux characteristics, scale effects, costs*

National Approches and Practices

- SLOW HEATING



SCO - FR

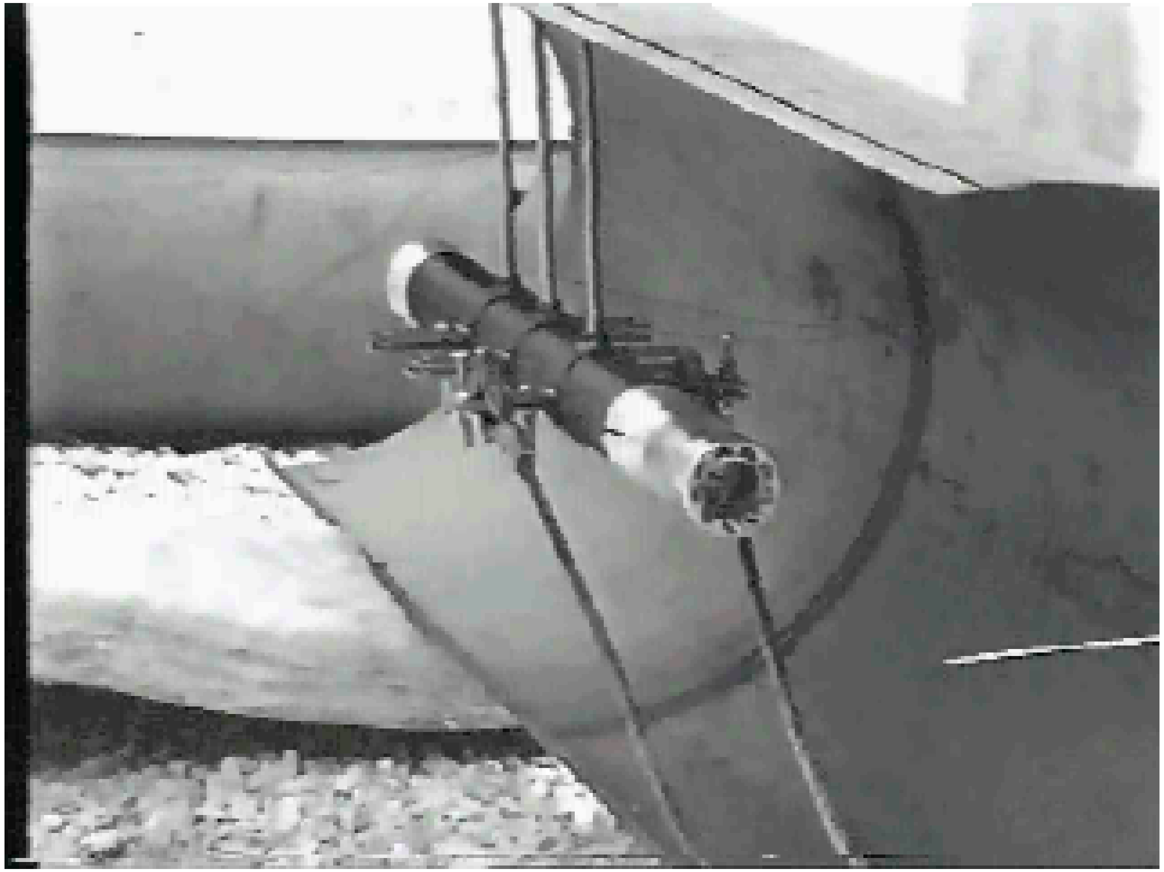


National Approches and Practices

- SLOW HEATING

SCO - FR

SCO - GE



National Approches and Practices

- SLOW HEATING
  - UK: Usually absence of THA; Then 3,3°C/h is used and number and position of thermocouples can vary.
  - GERMANY: generally 3,3°C/h used depending on the ammunition, air exchange is illustrated with a diffuser, blast gauges not always possible.
  - FRANCE: invariably 3,3°C/h, according to an important data base: various thermal exchanges (forced or natural convection), various item directions (vertical or horizontal), various thermal casing (metal, wood)…
  - NORWAY: Strictly according to STANAG.

  ↳ *Main questions:*
    - » *About Reaction Effects, risk of distortion for analysis between countries and test centres,*
    - » *Convection exchange characteristics would be better defined,*
    - » *Recorded blast overpressures are strongly influenced by heating device,*
    - » *Slow heating rate is always 3.3°C/h, alternative procedure is not really justified.*

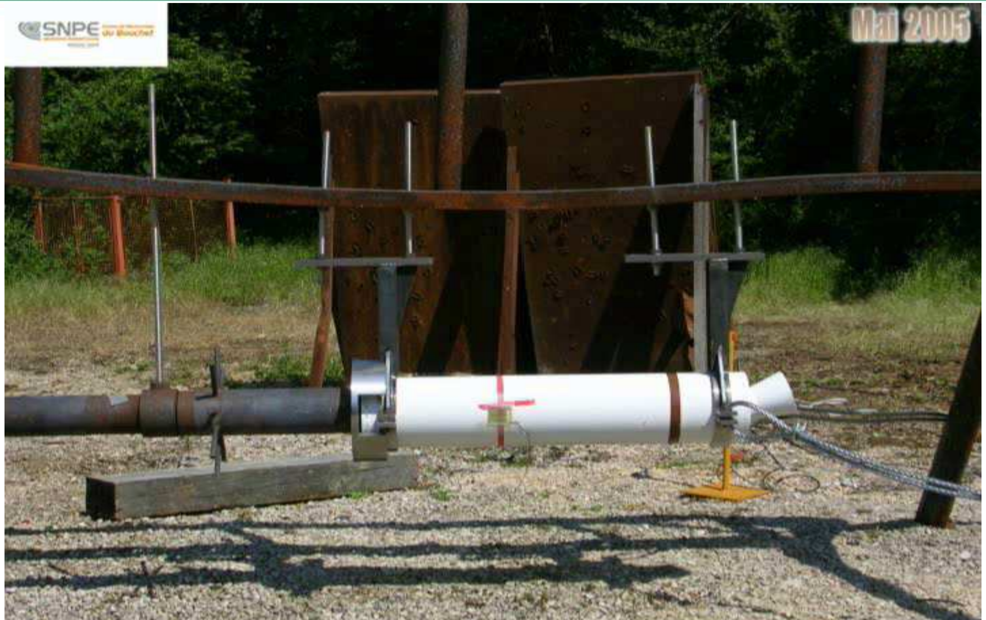
National Approches and Practices

- BULLET IMPACT

BI - FR

BI - UK

BI –GE


SNPE
Mai 2005

National Approches and Practices

- BULLET IMPACT
  - UK: 0.5” AP Ammunition used. Usually lack of THA; so procedure 1 is normally followed, all trials carried out involve single shot.
  - GERMANY: 0,5" AP Ammunition with 2 weapons (because of the rate of fire and precision of impact); Problem: bullet velocity and circle of target area are critical .
  - FRANCE: Procedure 1 with single shots is mainly used; For procedure 2, the velocity of the bullet is determined as the worst case; Item can be put in vertical orientation, different bullet type can be used.
  - NORWAY: Both procedures 1 and 2 are used according to customer requirements.
  - *Main questions:*
    - *Shot number: 3 bullets required,1 bullet currently used.*
    - *Aiming point: main charge usually targeted*

National Approches and Practices

- FRAGMENT IMPACT

FI - FR

FI - UK

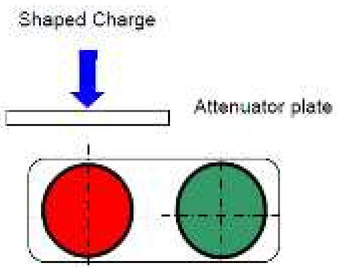
FI - UK

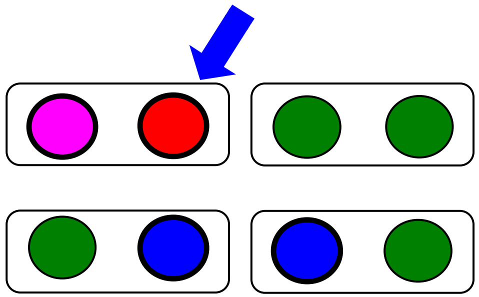
National Approches and Practices

- FRAGMENT IMPACT
  - UK: Procedure 1 Projectile velocity (2560 m/s) is performed by only one test center; STANAG doesn't state that tests should be carried out on separate munitions, UK use separate munitions.
  - GERMANY: As defined in this STANAG, the generation of fragment high velocity is expensive and they are not a threat for artillery ammunition.
  - FRANCE: Procedure 2 Projectile velocity (1830 m/s) is performed, highest velocity isn't possible yet; a lot of experience using the 250g steel sphere up to 2200m/s; high strength steel used for fragment.
  - NORWAY: A capability to perform both procedures 1 and 2 is being established and will be operational next year.

  ➯ *Main questions:*
    - *Reliability of stimulus (angle of incidence, aiming point, variability in hardness steel of fragment),*
    - *Difficulties with Procedure 1,*
    - *THA aim to demonstrate that pertinent stimulus is procedure 2*

- SYMPATHETIC REACTION





SR - FR

SR - FR

SR - FR


Banc EB1
M01_MURAT

National Approches and Practices

- SYMPATHETIC REACTION
  - UK: Munitions usually initiated by L2A1 detonator onto booster pellet.
  - GERMANY: Test configuration like in storage. It depends on type of munitions and their requirements.
  - FRANCE: The worst configuration in terms of safety, a single test is performed.
  - NORWAY: According to STANAG and/or customer requirement dependent on product to be tested.

  Main question:
  - *Selection of a representative donor initiation for non explosive munitions*
  - *Tested munitions configurations are primarily importance on response.*

National Approches and Practices

- SHAPED CHARGE JET IMPACT

SCJ - FR

SCJ - FR

National Approches and Practices

- SHAPED CHARGE JET IMPACT
  - UK: Land Systems have used IBL 755 (50mm) rounds but are now moving to M42 (MLRS bomblet; approx 34mm); THA not always available.
  - GERMANY: Bomblet DM 1383 is used; if necessary with shielding. Shell in configuration with booster/fuze.
  - FRANCE: France performs the test with a 62 or a 89 mm diameter shaped charges without shields; Domestic standardisation is ongoing for 62 mm diameter shaped charge dedicated to standardised tests.
  - NORWAY: Will probably use M72 and/or RPG7 in the future.

↳ *Main question:*

- *Lack of defined shaped charge and clear definition (V^2d and/or Penetration Depth and/or Charge Diameter),*
- *Diversity of shaped charges according to THA and/or munitions size.*

Concerns for the IM stakeholders

- UP TO NOW THE LACK OF ACCURACY IN ALL TEST PROCEDURE STANAGS REFERENCED BY STANAG 4439 PREVENTS A COMMON ASSESSMENT AVOIDING AN INTERPRETATION.
  - Impossible to benchmark precise IM signature of various munitions, difficulties for mutual agreements of IM Signature:
    - » Possible IM assessment without whole full scale tests (advanced approach, coherent with AOP39, admitted only in few countries),
    - » Various stimuli according to different procedures,
    - » Trend to develop domestic standards (FCO, SR, SCI),
    - » Need to repeat vulnerability test results to improve confidence,
    - » Test centres have not the same level of competency,
    - » Munitions Responses subjected to interpretation according to sophistication of measurements and their interpretation,
    - » Propulsion event assessment is not precise enough,
    - » Test set-up not described with accuracy in the test report.

Concerns for the IM stakeholders

» Waste of money due to:

- duplication of tests in various countries: IM Tests and UN Orange Book tests are not really harmonised,
- unrealistic stimuli which create expensive tests :
  - Bullet impact test with three shots,
  - 18.6g fragment impact at 2530 m/s velocity, when 1830 m/s seems to be more pertinent and justified.

– Potential differences in the level of safety and consequently problems for interoperability.

Conclusions

- HOW TO GAIN THE MAXIMUM BENEFIT FROM IM TESTING IS A QUESTION OF INTERNATIONAL CONCERN BUT TO GET THIS BENEFIT REQUIRES A COMMON MEANS OF ANALYSIS,
- IMEMG SUGGESTIONS ARE :
  - To define stimuli avoiding several procedures for identical munitions,
  - To specify a list of test acceptance criteria (boundary conditions for test/stimuli parameters),
  - To describe the test arrangement precisely in the test report to avoid misinterpretation of results,
  - To make precise records and measurements in accordance with AOP 39, adapted to the expected reaction (eg propulsion)
  - To avoid costly, unrealistic or unnecessary stimuli :
    - » bullet impact (3 shots) or fragment impact (18,6g @ 2530m/s).

Conclusions

- To consider if it would be an improvement to take into account munitions size for IM assessment through test procedure,

- Munitions size is not considered as an important factor on descriptors which are examined response (e.g. large Missile versus Medium Calibre Ammunition),

- Munitions architecture is not clearly taken into account (e.g. fragmentation analysis is defined for steel cases, then aluminium or composite case have different behaviour),

- To Identify the difficulties of observing the tested item response when the initial stimulus has relatively large impulse.

Propositions

- TO FACILITATE FULL INTEROPERABILITY, AC 326 AND WORKING GROUPS PARTNERS (MSIAC) ARE REQUESTED TO IMPROVE IM TEST PROCEDURES:
  - Resolution of inconsistency in test procedures,
  - Sharing of domestic procedures, applying the test procedures in the same way
  - Ensure each result is really representative of the munitions behaviour versus a threat well identified,
  - The STANAGS have to be written in a such way that the test leads to the same result from one test centre to another.
- IMEMG IS ABLE TO BRING All ITS EXPERIENCES IN DEVELOPING MUNITION WITH IM GOALS AND CAN CONTRIBUTE TO THE EFFORT
  - Test Procedure Expert Working Group is available to share industrial feed-back in developing a munition with the highest level of IM.

Authors

- AWE
  Mike TILL
- BAE SYSTEMS - GCS
  Charles MARSHALL
- EURENCO
  Yves GUENGANT
- MBDA.F
  Michel VIVES
- MBDA.UK
  Peter MILNER
- NAMMO
  Quoc Bao DIEP
- NEXTER Munitions
  Régis AUMASSON
- RHEINMETALL W&M GmbH
  Dr. Gerhard HUBRICHT
- ROXEL SAS
  Laurent BONHOMME
- TDA Armements SAS
  Joël FERRON