



Defence
Safety Authority

DSA 03-OME Part 1 (JSP 520)- Defence Code of Practice (DCOP) and Guidance Notes for OME Acquisition

Defence OME Safety Regulator

DOSR



DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

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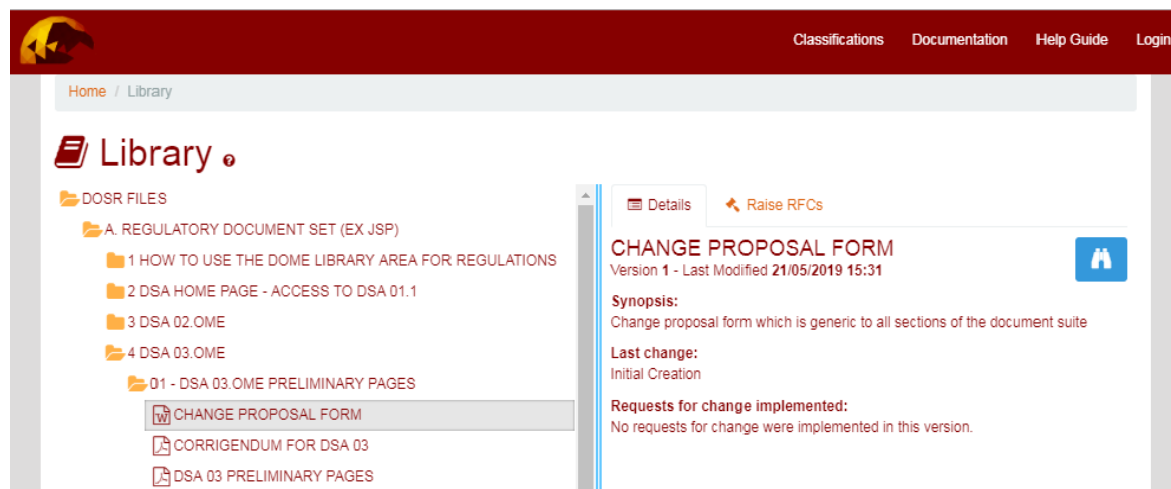


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1 Introduction

1. The MOD's Insensitive Munitions (IM) policy sets out to progressively reduce over time the vulnerability of the UK stockpile as technology matures and procurement opportunities allow. It seeks to balance the programmatic and technical costs and risks of improving the vulnerability of individual munitions, against the improvements to safety that can be achieved at munition level, in the context of the entire munitions inventory.

2. STANAG 4439¹ defines IM as “*munitions which reliably fulfil their performance, readiness and operational requirements on demand, but which minimize the probability of inadvertent initiation and severity of subsequent collateral damage to weapon platforms, logistic systems and personnel when subjected to selected accidental and combat threats.*”

Methodology

Munitions Stockpile

3. **Present Inventory.** In terms of stock levels, Hazard Division (HD) 1.1 munitions dominate the UK inventory and represent the majority of the key bursting and fragmenting munitions. Their operational importance apart, HD 1.1 munitions pose the greatest risk of catastrophic response to external stimuli and thus to individuals, platforms, the stockpile and the environment. Hence HD 1.1 munitions intrinsically attract a high priority for IM insertion. There are other factors to take into account, however, such as the carriage of munitions on ships as embarked military forces' stores. Most of these munitions, whether or not HD 1.1, have very few IM characteristics and pose a significant threat to the host platform.

4. **Future Inventory.** Most new munitions have been procured against MOD IM policy, but a large number of in-service munitions pre-date the policy². Munitions Project Teams (PTs) must remain proactive in the management of their munitions in order to improve the IM status of the munitions stockpile in accordance with the MOD IM policy. There are over 1000+ natures in the current munitions stockpile, many of which are IM non-compliant. In order to demonstrate that munition risks are either Broadly Acceptable or Tolerable and As Low as Reasonably Practicable (ALARP). Ordnance, Munitions and Explosives (OME) Project Team Leaders (PTL) must keep munitions under review in order to identify opportunities for IM insertion. Operational risks may well act as a driver for high priority IM insertion.

Financial Implications

5. The additional cost of using IM-compliant Energetic Materials (EM) in the production of new munitions is often minimal compared to their whole-life cost. For the

¹ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

² The Joint Capabilities Board endorsed the MOD IM Policy statement on 6 Sep 01.

older munitions, however, the costs of re-design and manufacture to achieve greater or full IM compliance are likely to be significant. However the costs of IM insertion need to be demonstrated to be disproportionate to the risk to justify a decision not to improve IM characteristics. Further, as IM offer operational, logistic and environmental benefits, analysis should be undertaken to quantify both through-life costs and associated benefits. Cost Benefit Analysis (CBA) tools are available to support through-life assessment and their use is strongly encouraged.

Benefits Of IM

6. IM offer compelling operational benefits including:
 - a. The flexibility to concentrate assets and thus employ a smaller logistic 'footprint.'
 - b. The retention of capability in face of hostile attack and accidents.
 - c. Reduced loss of people and assets following hostile attack and accidents.
 - d. Reduced site and stockpile defence demands.
 - e. More efficient use of logistics equipment and manpower.
 - f. Contribution to the maintenance of morale.
 - g. A more favourable public perception of OME safety.
7. IM policy compliant munitions offer other logistic benefits such as:
 - a. Reduced demand on commanders to put in place procedural risk mitigation measures (e.g. packaging and barriers).
 - b. Reduced through-life costs by means of more efficient use of storage facilities, more flexible movement and handling.
 - c. Reduced collateral damage in the event of an incident involving munitions (e.g. during storage and transportation).
8. Operational, transportation and storage benefits are realised through reduced hazard classification (HC) and PTs should endeavour to attain the most appropriate HC even if that requires additional testing. The testing burden can be minimised by combining IM and HC assessment requirements by merging IM Assessment Panel (IMAP) and Defence Ordnance, Munitions and Explosives Regulator (DOSR) data requirements.
9. These benefits may in turn lead to reduced operational, political, financial, health and safety and environmental consequences. Additionally, the latest IM Energetic Materials (EM) are more robust against mechanical ageing mechanisms and are at least as stable in chemical ageing as existing materials. Thus, system life using these energetic materials should be at least as good as that in mature in-service munitions.
10. The IM CBA studies have shown a prevalence of high risk situations during the operational phase of a munition's Manufacture to Target or Disposal Sequence (MTDS), i.e. munitions are much more likely to see an IM threat when deployed. The

findings of these studies are backed up by statistics on Allied catastrophic munition related events³. Therefore, it is likely that operational activities will be a factor in prioritising IM insertion. Specifically, IM compliance requirements should be carefully considered when undertaking Urgent Operational Requirement (UOR) IM assessment – the delivery timescale for UORs may lead to a lowering of the priority placed on IM. Munitions deployed to combat zones can expect significant exposure to combat threats which could affect operational effectiveness.

The Legal Obligation to Reduce Risk

11. The MOD has legal and moral responsibilities to its employees and to other people who could be affected by its activities; these are outlined in DSA02.OME. IM Policy has been developed to enhance MOD's ability to demonstrate, so far as is reasonably practicable, risks are either Broadly Acceptable or Tolerable and As Low as Reasonably Practicable (ALARP).

12. In meeting legal obligations, it is likely to become increasingly difficult to demonstrate a plausible case for not pursuing an IM-compliant solution either for new munitions or at a suitable insertion opportunity in the life of a mature in-service munition.

Insensitive Munitions Policy

13. MOD Policy requires that all new munition acquisitions must be procured to comply with IM policy and this must be reflected at Initial Gate as a Key User Requirement.

14. MOD Policy also requires that in-service munitions are kept under review to identify insertion opportunities (e.g. re-stocking, mid-life update, re-provisioning, etc.) to achieve full or improved levels of IM compliance. At the time of planning the acquisition, the procurement authority shall establish if an IM compliant solution is practicable; the IMAP will advise on the practicality of an IM compliant solution. Where full IM compliance is not possible, OME PTLs should strive to provide improved levels of IM compliance.

15. The OME PT shall seek agreement of their IM strategy from the appropriate Front Line Command (FLC) /Operating Duty Holder, and Safety and Engineering assurance from the relevant technical assessor; reporting progress in achieving IM compliance against the policy through both the internal DE&S Project review and Safety & Engineering Assurance review processes and the standard acquisition and approvals processes set out in the Acquisition System Guidance (ASG).

Insensitive Munitions Compliance

16. 'IM compliance' means that the munition in a particular configuration satisfies the criteria set out in STANAG 4439. These threats have been selected to encompass all

³ Munitions Safety Information and Analysis Centre (MSIAC).

credible hazard mechanisms that may be induced in munitions, and are set out in Table 1.

Table 1: Insensitive Munitions Threats and Response Requirements

Serial	Potential Threats	IM Response Requirement
1	Fast Heating (Magazine, Store, Aircraft or Vehicle fuel fire).	No response more severe than Type V (Burning)
2	Slow Heating (Fire in Adjacent Magazine, Store or Vehicle)	No response more severe than Type V (Burning)
3	Bullet Impact (Small Arms Attack)	No response more severe than Type V (Burning)
4	Fragment Impact (Fragmenting Munition Attack)	No response more severe than Type V (Burning)
5	Sympathetic Reaction (Most severe reaction of same munition in magazine, store, aircraft or vehicle)	No propagation of reaction more severe than Type III (Explosion)
6	Shaped Charge Jet Impact (Shaped Charge Weapon Attack)	No response more severe than Type III (Explosion)

17. For many new munition designs, the technology already exists to make IM compliance a reasonable and achievable objective. For older munitions, however, where there may be limited design flexibility, full IM compliance through the insertion of IM technologies may not be possible. This is not to say that improved IM signatures should not be pursued for all munitions, the overarching obligation to reduce risk to ALARP remains in force. For example, the achievement of a Type IV (deflagration) rather than a Type III (explosion) response, whilst not fully compliant with the MOD IM Policy, may well represent a significant and worthwhile reduction in risk. It should also be noted that risk reduction should follow a systems approach and may, therefore, include the use of procedural and other mitigation techniques and special packaging.

18. The majority of munitions will require IM assessment against the full range of threats. There may, however, be instances in which some threats may not be considered appropriate as it is considered unlikely that the munition will experience a particular threat. Thus, a Threat Hazard Assessment (THA) should be carried out to determine the potential threats to the munition throughout MTDS and to justify why any specific IM threat is deemed to be irrelevant. However, care must be taken in exercising this option. It is important to remember that the purpose of the IM THA is to capture all credible mechanisms that might induce a response in the munition. The absence of a specific threat such as fragment impact does not necessarily imply that the mechanisms induced by this stimulus could not be induced by other threats.

19. Should the THA demonstrate, to IMAP's satisfaction, that an individual IM threat is not pertinent to a particular munition in a specific configuration, IMAP can assess

the munition in that configuration to be IM compliant on these grounds, even if an assessment of the munition in that configuration against the threat stimulus specified in STANAG 4439⁴ would lead to an unacceptable response level.

20. It should be noted that currently few energetic materials are likely to offer an IM response better than Type II to a Shaped Charge Jet (SCJ) impact. The THA may well show, however, that SCJ remains a credible threat and, in these cases, mitigation should be considered.

Achievement of IM Compliance

21. IM compliance may be achieved by a range of methods, whether applied directly or indirectly. Preferably, it will be achieved through the use of low vulnerability EM that are tolerant of shock, impact and heat. Other measures may include:

- a. Munitions design and construction.
- b. Built-in mitigation such as stress raisers, fusible plugs, coatings and liners, venting systems and bore mitigants.
- c. Passive mitigation barriers, screens, or shielding to separate and protect individual or grouped munitions may offer a simple and cost-effective means of improving IM signatures.
- d. Packaging, either to protect the store from the threat or to contain the effects of an event.

22. AOP39⁵ gives guidance on design methodologies that may be employed to achieve IM through intrinsic compliance of the munition or external mitigations.

23. It is stressed that management of risk to either Broadly Acceptable or Tolerable and ALARP is required irrespective of whether or not full IM compliance has been achieved.

Additional IM Information

24. Beyond this JSP, the MOD's primary source of IM information is the Defence Ordnance Safety Group (DOSG). Contact details of International IM information sources, such as the NATO Munitions Safety Information and Analysis Centre (MSIAC) website and resources, are available through the DOSG.

⁴ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

⁵ AOP39 Guidance on the Assessment and Development of Insensitive Munitions (IM) Edition 3.

2 Roles and Responsibilities

Introduction

1. The management of MOD IM policy is shown at Figure 1, with further explanation of the outline roles and responsibilities of the main working groups:
 - a. IM Policy Implementation and Assurance.
 - b. Insensitive Munitions Assessment Panel.

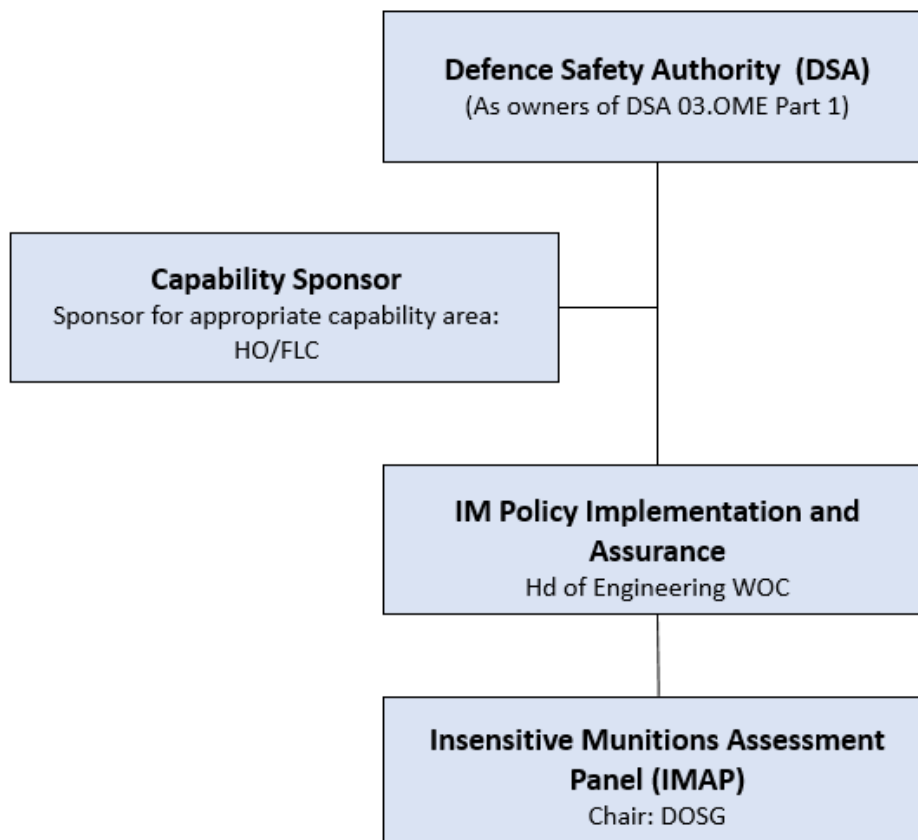


Figure 1: The Management of MOD IM Policy

IM Policy Implementation And Assurance

2. Head of Engineering (Hd Eng) within the Weapons Operating Centre (WOC) is responsible for assuring that OME PTs comply with DSA03.OME. This includes implementation of and compliance with the IM Policy. Hd Eng WOC is also responsible for monitoring UK MOD compliance against the IM Policy at an inventory level. The post is required primarily to:

- a. Bring together policy, technology, delivery and use.
 - b. Monitor progress towards compliance with IM Policy.
 - c. Identify technology gaps.
 - d. Influence IM research.
 - e. Inform investment decisions.
 - f. Provide a feedback opportunity for Industry.
3. Specifically, Hd Eng WOC will provide resource to:
- a. Assess the IM needs of munition programmes, focusing on the availability of IM technological solutions at likely insertion points.
 - b. Facilitate dialogue and best practice across the acquisition organisation, the Services and environments.
 - c. Report to Defence Ordnance Safety Regulator (DOSR) TL regarding achievement against the IM Policy with respect to the reduction of vulnerability of the UK OME stockpile.
 - d. Through the IMAP, maintain an IM database to record all IM assessments across the UK inventory.
 - e. Publish and present relevant papers.
4. Whilst the detailed project planning, costing of options, funding and balance of investment decisions remain the responsibility of the respective PT and appropriate capability area, Hd Eng WOC is able to:
- a. Inform the targeting of research to support IM insertion plans.
 - b. Offer guidance and broad options to stakeholders in support of acquisition and balance of investment decision making.
 - c. Support cost-benefit analysis and inform the development of associated methodologies.
 - d. Establish and maintain a centre of excellence in the knowledge, understanding and application of IM technology.

Insensitive Munitions Assessment Panel

5. IMAP's formal role is to act as the National Authority for IM signatures of OME. It is required to:
 - a. Provide an assessment of the IM signature of particular munition design standards in specific storage and transport configurations, in accordance with methodology set out in AOP39⁶.
 - b. Work with project teams to ensure that their proposed approach to IM assessment and the body of evidence to be provided will be both adequate to conduct an assessment, and appropriate for the particular stage in the design and development process.
 - c. Provide advice regarding trial plans and results.
 - d. Comment on the technical content of submissions for relevant internal DE&S and external capability area review, for the refinement of the IM Key User Requirement.
6. Composition. The IMAP comprises:
 - a. Core Members:
 - 1) Permanent Members.
 - 2) Subject Matter Experts (SMEs), selected from the OME community.
 - b. Attendees: as required and as appropriate to the subject munition(s) or technology to be discussed, for example the DOSG Safety Adviser (SA), PT, Capability desk officer, Industry or test facility representatives.
7. TORs. Chair IMAP reports to Hd Eng WOC. IMAP TORs are at Annex A.
8. IMAP Process. Guidance on the IMAP process, covering submission of test plans and evidence for IM assessment, is at Annex B.

Industry Perspective

9. UK Industry is working closely with MOD safety organisations and research establishments to develop technologies and capabilities in support of IM solutions. Available technologies include reduced-vulnerability explosives and propellants, mitigation techniques and attenuating packaging. A series of polymer-bonded explosives (PBX) has been qualified to UK and NATO standards, and is available now for a wide range of IM applications. IM manufacturing capability has been established in a succession of technology demonstration, development and manufacture programmes for shell, mortar, bomb and rocket/missile applications across the 3 military operating environments. Trials have shown that IM compliance may be met without degradation in performance or lethality. In short, UK industry has credible

⁶ AOP39 Guidance on the Assessment and Development of Insensitive Munitions (IM) Edition 3.

capabilities to meet full or improved IM signature requirements in line with the ALARP principle.

3 Implementation

Strategy for Identification of The IM Requirement

1. Any User Requirement for the procurement of OME by the Ministry of Defence must include a Key User Requirement to meet the UK MOD IM Policy as described in DSA03.OME. The requirement must be initiated as early as possible in the procurement cycle (Initial Gate or earlier), and be reviewed throughout the Concept, Assessment, Development, Manufacture, In-service, Disposal (CADMID) cycle.
2. The process allows for change of the required IM Signature of the OME from the requirements specified in DSA02.OME on grounds of cost, time, technical risk or military capability. This process requires the FLC/Operating Duty Holder concerned to agree the IM signature of the OME (to be incorporated in the procurement contract).
3. Any change of the final required IM Signature from the criteria specified in DSA02.OME must be covered by an evidence-based submission, prepared by the OME Project Team (PT), with support from IMAP, for the attention of the Front-Line Command (FLC/Operating Duty Holder) originating the requirement. Care must be taken to preserve a balance between operational imperatives, costs and risks. The FLC/Operating Duty Holder shall agree the final IM signature requirement.

Procedure for Applying the IM Policy To Any New Procurement

4. This guidance breaks down into four successive stages which may be adapted to the type of procurement and of OME considered:
 - a. Incorporation of the UK IM Policy in the initial User Requirement Document as a Key User Requirement.
 - b. Identification of a proposed **Target IM Signature** for the OME drawing on analysis of the risks throughout the MTDS and, if necessary, current IM technology which will then serve as a basis for further consideration by the OME PT and potential contractor consultations prior to Main Gate.
 - c. Identification of an agreed **Contractual IM Signature**, identifying and justifying, in consultation with potential contractors and FLC/Operating Duty Holder, any change from the Target IM Signature for reasons of cost, time, capability or technology maturity. This leads to an agreed Contractual IM Signature at Main Gate.
 - d. Review of Contractual IM Signature throughout the CADMID cycle.
5. A flow chart for this sequence of phases is given in Annex D.

Initial Statement of Requirements

6. For any new procurement, the originating FLC/Operating Duty Holder shall include the need to comply with UK IM Policy as defined in DSA02.OME as a Key User Requirement.
7. The OME PT shall support the FLC/Operating Duty Holder in specifying the IM requirement, with additional subject matter expertise being provided by the OME PT Safety Adviser and IMAP.

Identification and Validation Of The Target IM Signature

8. The OME PT shall first define a Target IM Signature with support from their independent Safety Adviser (SA). This signature shall be developed from consideration of:
 - a. The level of response of the OME to the reference stimuli of STANAG 4439⁷ that could be achieved using technology available, or likely to be available, during the CADMID cycle and service life of the OME; balanced against.
 - b. The acceptability of any risks from the reaction of the OME in the different phases and configurations of its potential MTDS.
9. The Target IM Signature and supporting evidence is submitted to IMAP for validation and agreement of any changes from the IM requirements of DSA02.OME. The submission shall present the information that led to the identification of the Target IM Signature. In particular, it should show the signature derived from the IM assessment, and justify any modifications due to consideration of the current IM technology, and to analysis of cost or time pressures, impact on operational performance, achievable military capability, or technology risk. The submission shall describe the risk assessment carried out for the expected responses to the reference STANAG 4439 threats and potential MTDS and propose mitigation measures where anticipated risk levels are not Tolerable or ALARP. The OME PT shall send this submission and IMAP validation to the FLC/Operating Duty Holder for consideration and agreement.
10. The Target IM Signature is used when consulting potential suppliers.

Identification and Validation of The Contractual IM Signature

11. Consultation with potential suppliers may expose reasons for change from the Target IM Signature, because of additional cost or time pressures, impact on operational performance, achievable military capability, or technology risk. The OME PT shall analyse the risks resulting from any change from the Target IM Signature and, with support from their SA, explore possible mitigation measures necessary to compensate for the change. The information from this analysis, and the associated justifications, shall be submitted for validation and agreement by the IMAP of the

⁷ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

change from the Target IM Signature. The OME PT shall send the submission and IMAP validation to the FLC/Operating Duty Holder for consideration and agreement.

12. After agreement from the FLC/Operating Duty Holder a Contractual IM Signature will be incorporated into the contract at Main Gate.

Review of The Strategy

13. The PT is responsible for developing a strategy for achieving compliance with the Contractual IM Requirement. This strategy will be subject to review to ensure that:

- a. IM requirements are being addressed and managed properly.
- b. Hazards associated with areas of divergence from UK IM Policy are captured and mitigated in logs and safety cases.
- c. FLC/Operating Duty Holders are engaged throughout the life-cycle and accept any divergence from IM requirements and any residual risks associated with that divergence at Planning Assumption for Service Entry (PASE) and in-service.

14. Review and assurance of OME PT's IM strategy should be incorporated within normal acquisition management as part of relevant:

- a. Acquisition and approvals processes.
- b. Operating Centre Project Review processes.
- c. Safety and Engineering assurance processes.
- d. Independent OME safety advice from DOSG.
- e. Review and validation by IMAP.

Mid-Life Update

15. The mid-life update (MLU) of OME often involves replacement of energetic components (warhead, propulsion, fuze etc), presenting an opportunity to improve the IM Signature of that OME, should current risks and the current IM technology indicate that this is desirable.

16. The IM requirements for MLU, including development of Target, and if necessary, Contractual IM Signatures, shall be defined by applying the "Identification and Validation of the Contractual IM Signature" procedure.

17. This process is particularly important if no IM specification was required at the time of the OME's initial procurement. If the OME currently in service does not have an IM signature validated by the IMAP, an additional stage must be incorporated at the

beginning of the programme to produce an IM signature in accordance with DSA02.OME and STANAG 4439⁸.

18. Subsequently, when the MLU Target and Contractual IM signatures are established, the IMAP shall assess the evidence to ensure that there is no degradation of the levels of response relative to the IM signature of the OME to be upgraded.

Replenishment of Munitions

19. The OME PT must consider the IM Signature of OME at replenishment; balancing current risks with the present state of the art in IM technology. In many cases the application of the IM policy will be limited to verifying that any modification to the manufacture of the OME (due to obsolescence, etc.) does not lead to degradation in the IM signature of the OME. However, the OME PT shall consider the possibility of increasing the level of IM compliance by upgrade or replacement particularly if the state of the art in IM technology has advanced to a point where a significant risk presented by the OME could be mitigated or eliminated by adoption of that technology.

20. The OME PT shall consult IMAP on the desirability of upgrade or replacement instead of like-for-like replenishment. If IMAP advise that a significant risk could now be mitigated or reduced, the OME PT shall act on this advice through the regular safety and engineering risk management process.

⁸ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

4 Insensitive Munitions Assessment Process

Technical Methodology

1. The philosophy and methodology of IM assessment as applied by MOD and throughout the NATO nations are set out in AOP39⁹, which gives guidance on:
 - a. The methodology for carrying out an IM assessment.
 - b. The design techniques for developing an IM.
 - c. Best practice for conducting full scale tests, including interpretation of munition response.
 - d. The reporting of the IM assessment.
2. A detailed understanding of the reactive behaviour of EM is required along with an understanding of their interaction with hazard stimuli, hardware characteristics and full-scale configurations. The evidence required to underpin IM assessments can be determined by analysing the initiation and reaction mechanisms that the various stimuli are known to induce in the EM. In order to address the issues around both small and full-scale testing, and to make IM assessments more consistent and increase the level of confidence in them, the IMAP, comprising EM specialists, has been established to formalise this technical assessment process. It evaluates the likely response of a munition component to the IM threats specified in STANAG 4439¹⁰ and assesses whether the component complies with the IM requirements.
3. To assess the response/reaction level for each configuration of interest, the following factors will be considered:
 - a. Type and magnitude of the stimulus associated with the threat range.
 - b. Explosiveness and sensitiveness of the EM used in the munition.
 - c. Design of the munition.
 - d. Component interactions.
 - e. Selected configuration.
4. The process of assessing the response of the munition to the threats requires several inputs from the PT including munition configurations and the identification of the threats. Information that can be used to perform this assessment includes but may not be limited to:
 - a. Read across from similar designs.

⁹ AOP39 Guidance on the Assessment and Development of Insensitive Munitions (IM) Edition 3

¹⁰ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

- b. Modelling and analysis.
- c. Energetic materials characterisation.
- d. Laboratory scale test results.
- e. Small scale and component level test results.
- f. Full scale test results.

5. There are a range of approaches that can be applied to construct an IM Assessment that will conform to the whole body of evidence approach as laid down in AOP39. The specific requirements will vary from munition to munition and will be constrained and shaped by the extent of pre-existing evidence that can be called upon. Whilst the prospect may seem daunting, in practical terms the chosen assessment methodology must seek to achieve each of the following:

- a. Demonstrate sufficient characterisation of the explosiveness and sensitiveness of the energetic materials; by suitable charge scale explosiveness tests or read across from similar munition in order to make predications of likely munition response mechanisms.
- b. Demonstrate compliance with the IM threats and Requirements of STANAG 4439¹¹; by tests on all-up round, sub component read across from fragment impact or read across from a similar munition. The munition test configuration shall be advised by IMAP.
- c. Demonstrate engagement with IMAP throughout the assessment process.

6. It is important to recognise that full scale testing involves a small number of tests that may not provide adequate characterisation of the likely response of a munition. It is now well known that some common EM such as TNT based melt casts of RDX and HMX exhibit widely varying responses to hazard stimuli, and that therefore the results of full scale tests on munitions containing these materials do not provide reliable information. It is this that leads to the requirement to demonstrate reproducibility of the explosiveness of warhead EM before considering component or system level factors.

7. Shaped Charge Jet (SCJ) attack is identified in STANAG 4439 (and expanded in STANAG 4526¹²) as one of the IM threats. Of all the IM threats, it has proven to be the most difficult to address for two main reasons:

- a. Threat Variability. The threat stimuli's characteristics vary significantly depending on the characteristics of the shaped charge used. Recent operational experience has demonstrated that it is a credible threat for many munitions.
- b. Test Failure. Most munitions fail SCJ attack and an assessment of a fail can often be delivered without the need for full scale testing. Indeed, shaped charges are often used to initiate detonation in donor charges in sympathetic reaction trials.

¹¹ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

¹² STANAG 4526 Edition 2: Shaped Charge Jet, Munitions Test Procedure.

8. However, continuing developments in IM technology have the potential to deliver solutions. Assessment of compliance with the IM requirement, Type III explosion response, should be based on a sound understanding of the response mechanism through small scale testing and modelling supplemented by full-scale testing (STANAG 4526¹³).

9. It is the case that endorsement is not required if a munition fails the SCJ attack test but meets the remaining IM requirements. This situation will be reassessed as and when solutions start to become more available to meet this threat. To reiterate, SCJ is a credible threat for which there is an IM requirement.

IM Signatures

10. The assessment process culminates in the generation of the IM signature for the munition in the given configuration. For a complex munition with a number of components containing EM, there will be more than one IM signature; commonly, there will be one for the rocket motor, the warhead and the all-up round. The format of the IM signature is shown and explained in Annex J of AOP39¹⁴.

11. It should be noted that all cases submitted for endorsement of IM Compliance and OME Safety Case Reports submitted to OME Safety Review Panel (OSRP) are required to include an IMAP assessed IM signature.

Agreement of IM Compliance

12. The purpose of attaining agreement of level of IM Compliance (whether Full, Target or Contractual) is to provide a clear audit trail demonstrating that the reasons for procuring a solution, which may range from full compliance to non-compliant, have been identified, assessed and justified, and that deviation from MOD Policy has been endorsed by the appropriate areas both within DE&S and FLC/Operating Duty Holders.

- a. In the case of new munitions requirements this is particularly important where the selected procurement strategy would result in a Non-IM Compliant solution.
- b. For in-service munitions this is particularly important for the re-provisioning activity, if improving the IM signature is practicable but where for time, cost or performance reasons it is not reasonable to pursue an IM solution.

13. The submission for agreement will demonstrate to IMAP and the appropriate FLC/Operating Duty Holder that the risks have been identified, that they are ALARP and Tolerable, and describe the operational impact. In drafting the submission, the PT should:

- a. Specify the shortcoming(s) against MOD's IM policy.

¹³ STANAG 4526 Edition 2: Shaped Charge Jet, Munitions Test Procedure.

¹⁴ AOP39 Guidance on the Assessment and Development of Insensitive Munitions (IM) Edition 3

- b. Identify the reason(s) for non-compliance.
- c. State the results of any cost benefit analysis.
- d. Assess the safety implications for the system, the munition, and its environment throughout its life cycle.
- e. Identify the operational impact, including any special handling or operating procedures and any mitigation measures required to reduce to ALARP the risks associated with IM non-compliance.
- f. Include the Platform PTs and the Users in the risk management process and provide supporting evidence that they have implemented the mitigations and can operate the weapon system within the constraints imposed by the mitigations.
- g. Identify future opportunities or a planned timescale for improving the shortcoming(s) against the MOD IM Policy.

14. Agreements of IM Compliance are to be recorded in the OME Safety Case and will be reviewed as part of the evidence provided for OME Safety Review Panel (OSRP).

15. It should be noted that the robustness of the supporting evidence¹⁵ shall be proportionate to the residual risks¹⁶ arising from the non-compliances against the STANAG 4439¹⁷. For example, for a small store, which almost achieves full IM compliance against the goals set out in STANAG4439, it might be appropriate to provide a short submission concentrating on a limited area. Generic endorsements of IM Compliance may be appropriate for small arms and pyrotechnics stores. For a larger store, where the risk of collateral damage is much greater for a given response type, it would be appropriate to give a more detailed explanation. The overall aim is to recognise efforts to achieve IM compliance, not to impose staffing effort for little real gain. Equally, it is entirely appropriate to expand on successful measures taken to implement IM for the munition as well as address the non-compliances. The balance of the argument should be at the discretion of the Project Manager (PM) and must be justified and recorded.

16. The respective PM is responsible for producing the submission for agreement of level of IM Compliance. As for all other aspects of S3 advice and support, the relevant DOSG SA is available to assist, including eliciting IMAP support as required. In preparing the submission the PT is required to consult widely, including with the user community, Platform projects and Naval Authority (Explosives) (for embarked stores on naval vessels) and any other key stakeholders to ensure they are aware of the risks and concur with the mitigation actions being proposed. Much of this would normally

¹⁵ For example, avoid discounting the threat from Slow Heating (SH) based on time to reaction in the specified test with a prescribed heating rate. In reality, any heating rate less than Fast Heating (FH) that allows the energetic material to warm to near its ignition temp could lead to a reaction much quicker than that witnessed in a test.

¹⁶ For small non compliances, with low residual risk and little collateral damage potential, it may be appropriate to expand with minimal amplification.

¹⁷ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

be undertaken through the Project Safety Panel. The submission must include evidence of such engagement and agreement to the risks and mitigations.

17. The need for agreement of level of IM Compliance may become apparent at any stage of a project, from the initial Concept stage where a potential solution to the requirement may be an IM non-compliant EM, through completion of IM testing in Assessment and Demonstration phases, to refurbishment, mid-life update or re-procurement. The submission should be made ahead of key decision points such as Initial Gate, Main Gate, ISD, or before contracting for re-procurement. In all cases, however, submissions should be made as early as practicable, in order that the proposed submission may be assessed as early as possible in the acquisition process. A schematic showing the through-life process of a munition's engagement with IMAP is at Annex C.

Urgent Operational Requirement – Insensitive Munitions Assessment

18. One of the tenets of UOR procurement is to reduce as far as possible the staffing effort whilst following Departmental policy in order to focus on the speedy delivery of equipment capability; the staffing of a submission for endorsement of IM Compliance should not delay this delivery, commensurate with the ALARP principle. If possible, the endorsement should be provided prior to system acceptance but, if necessary, the submission may be staffed retrospectively. It may be deemed to be unnecessary for UOR munitions with limited in-service life and operational deployment. Advice in all cases should be sought from the relevant DOSG SA and an IMAP assessment obtained.

19. IM policy must be applied in full if a UOR is to be brought into core, as part of the normal process of justifying, endorsing and fulfilling the core capability requirement.

20. Where UOR munitions which already have an FLC agreement of IM Compliance, but which, on re-provisioning, have had changes to their design or other sub assembly, a submission for re-agreement can be covered by a Routine Letter to the respective FLC covering:

- a. The changes to the munition.
- b. A statement that the overall risk has not increased (or has decreased).
- c. Request that the FLC note the addition of the new munitions to the current agreement of IM Compliance for the duration of the UOR.

21. The criteria to be applied for munition UOR re-provisioning are as follows:

- a. Munition has an extant agreement of IM Compliance.
- b. The IMAP assess the changes and agree that the impact of the changes to the munition fall within the munitions' extant IMAP IM sentence, i.e. the IM signature is unchanged or improved compared to that of the original procurement.
- c. Risks are not increased.

Annex A: Insensitive Munitions Assessment Panel (IMAP) – Terms of Reference

Purpose

1. The IM assessment process must assure compliance of IM assessment procedures with relevant standards and guidance and review all supporting evidence in reaching a decision on IM compliance. In the event of non-compliance, the assessment process must also inform the justification for, and the preparation of, a submission for endorsement of IM Compliance. An MOD IM Assessment Panel (IMAP) was set up to provide a formal, structured IM assessment process.

Scope

2. The IMAP exists to provide technical advice and guidance to DOSG and PTs on the suitability of IM designs and the appropriateness of energetic materials for the munition's intended use. IMAP will provide technical advice on submission for endorsement of IM Compliance, but it has no authority over the decision-making process.

Tasks

3. The IMAP's tasks are:
- a. To provide advice on the assessment and achievement of IM compliance at any stage of a munition programme.
 - b. To agree IM assessment plans before assessment takes place.
 - c. To categorise the results of IM full-scale tests in accordance with the IM Response Descriptions in the form of an IM signature.
 - d. To review the scientific and technical aspects of submissions for endorsement of IM Compliance.

Responsibilities

4. The IMAP has the following responsibilities:
- a. Provision of advice on assessment and achievement of IM compliance to the PTL at any stage of the OME CADMID cycle. This may include assessment based on evidence from read across, energetic materials characterisation, laboratory and small-scale charge testing, modelling and analysis.
 - b. Review of proposed IM proving methodologies, before assessment is carried out.
 - 1) The IMAP will review evidence already available from, or to be gathered from, read across, energetic materials' characterisation, laboratory and small-

scale testing, modelling and analysis, to confirm that it will contribute to the full body of evidence approach to assessment.

2) Where component level or full-scale testing is proposed, the IMAP will confirm that the tests are meaningful, and that test procedures, test configurations, instrumentation and test facilities meet the requirements and objectives of the test and will advise the PTL of any corrective action required before testing takes place.

c. The IMAP is to categorise the results of IM assessment in the form of an IM signature.

c. Where a munition is assessed to have failed to achieve IM compliance, the IMAP will advise the PTL whether there are valid scientific and technical grounds for a submission for endorsement of IM Compliance and offer a technical opinion on the way forward.

d. The IMAP is to review the scientific and technical aspects of submission for endorsement of IM Compliance.

e. The IMAP is to engage with the PT through the project OME Safety Advisor in the first instance.

Reporting

5. The IMAP reports to Hd Eng WOC. Chair IMAP is to submit an annual report to Hd Eng WOC to inform the report to DOSR TL.

6. Guidance on the application of the IMAP Process is at Annex B.

Membership

7. IMAP membership comprises Core Members and attendees as required. Core Members are permanent IMAP members, appointed for their scientific knowledge by the IMAP Chair with approval of the WOC Science and Technology Team Leader (ST TL). Each Panel meeting will also include a number of invited attendees, relevant to the particular munitions under review.

Core Members

8. Core Members ensure the provision of consistent expert judgment in the assessment of IM test results and provision of advice to PTLs across the tri-Service munitions inventory. The Chair will be a subject matter expert in Insensitive Munitions technology and will be appointed by WOC ST TL. Chair IMAP's responsibilities include the maintenance of a list of the core IMAP members, who are subject matter experts from MOD and industry in the WOME domain whose expertise lies in at least one of the following areas:

- a. Warheads.
- b. Rocket Motors.

- c. Propellants.
- d. Fuzing systems.
- e. Pyrotechnics.
- f. Policy.

Attendees

9. Attendees are invited as necessary to provide additional information to the Panel. Attendees Members and may include:

- a. DOSR.
- b. PTL or Representative.
- c. DOSG Safety Adviser.
- d. Design Authority.
- e. Test Authority.
- f. Sponsor Representative (Capability sponsor for munitions under review).

Quorum

10. A quorum comprises the Chair and 3 Core members. Unanimous decisions should be sought wherever possible but, in order to reach a majority decision in the event of a disagreement, the Chair holds the casting vote.

Evidence

11. The PT is to provide copies of IM test plans, IM evidence (eg. read across, energetic materials characterisation, laboratory and small-scale testing, modelling and analysis) and IM full scale test results to the IMAP Secretary at least 3 weeks before the planned IMAP meeting. The IMAP Secretary is to circulate this data to the Core Members for consideration before the meeting.

12. Following its consideration of the body of evidence, IMAP is to propose to Secretary DOSR its prediction of the munition's likely Hazard Classification Code.

Minutes

13. A record of decisions, including a summary of the argument in each case, is to be circulated within 10 working days to:

- a. Core Members of IMAP.
- b. Attendees.
- c. Project Managers and DOSG Safety Advisers of all Projects reviewed by the meeting.

14. The IMAP decisions may be released before the formal release of the minutes but in such cases the IMAP sentencing is to be regarded as provisional; the formal decision is that contained within the IMAP minutes. The IMAP Secretary is to maintain a record of all IMAP minutes, meetings and related correspondence.
15. The IMAP is to maintain a searchable record of all IM signatures that it publishes and relevant supporting evidence.

Frequency

16. The IMAP will meet approximately 6 times in a calendar year (forecast at least 6 months in advance). Issues may be taken out of committee, but such decisions will be formally recorded at the next IMAP meeting.

Annex B: The Insensitive Munitions Assessment Panel (IMAP) Process – Guidance on Application

Advice To The OME Project Team On IM Compliance

1. The IMAP is able to provide advice on assessment of IM compliance to the PTL at any stage of the munition CADMID cycle. This may include assessment based on evidence from read across, energetic materials characterisation, laboratory and small scale charge testing, modelling and analysis. It is important that the potential inability of a munition to meet one or more of the IM requirements be identified as early as possible so that the implications can be evaluated and options for remedial action identified. In general terms, PTs should seek the IMAP's endorsement of their proposed assessment methodology before implementing their assessment plans.

The IM Assessment Methodology

2. The STANAG 4439¹⁸ recognises that All-Up Round (AUR) scale testing is not always the most effective way of assessing the IM status of a munition. Issues with AUR test results that may lead to the need for an analytical assessment include repeatability and reproducibility, statistical significance and representation of the threat. In forming a judgement of the IM status of a munition, it is essential to consider evidence from all relevant sources.

3. The IMAP will consider how a munition is likely to respond to the threats laid down in STANAG 4439. These responses to the threats will be tabulated as an IM signature as follows (where '✓' indicates IM compliance and 'X' indicates IM non-compliance):

Stimulus Response		Fast Heating	Slow Heating	Bullet Impact	Fragment Impact	Sympathetic Reaction	Shaped Charge Jet Impact
		None	-	✓	✓	✓	✓
Burning	V	✓	✓	✓	✓	✓	✓
Deflagration	IV	X	X	X	X	✓	✓
Explosion	III	X	X	X	X	✓	✓
Partial Detonation	II	X	X	X	X	X	X
Detonation	I	X	X	X	X	X	X

¹⁸ STANAG 4439 Policy for Introduction and Assessment of Insensitive Munitions (IM).

4. In assessing the IM status of a munition, the IMAP will consider in turn how the following factors affect the response of the munition to these threats:
- a. The explosiveness and sensitiveness of the energetic materials used in the munition.
 - b. The design of the munition.
 - c. Sub component interactions.
 - d. Tactical packaging.
 - e. Logistic packaging.
 - f. Storage and transport configuration.
 - g. The operational environment.

Review of Proposed Assessment Methodology

5. In order to assess the validity of the IM assessment process proposed by the PT, the IMAP will need information on the munition design and deployment, the THA and any pre-existing evidence. Thus, the PTL should provide, through the DOSG SA:
- a. Brief description of munition, to include:
 - 1) Design and construction.
 - 2) Components.
 - 3) Energetic materials.
 - 4) Outputs from Threat Hazard Assessment relevant to IM assessment.
 - 5) Munition life cycle (including storage, handling, modes of transport, packaging, deployment, platform, operational and training use).
 - b. Pre-existing information:
 - 1) Read across from similar designs.
 - 2) Modelling and analysis.
 - 3) Energetic materials characterisation.
 - 4) Laboratory scale test results.
 - 5) Small scale and component level test results.
 - c. Proposed IM proving methodologies, to include:
 - 1) Evidence to be gathered from read across, EM characterisation, laboratory and small-scale testing, modelling and analysis.
 - 2) Component level testing.
 - 3) Full-scale testing proposed.

6. The IMAP will confirm that:
 - a. The methodology and body of evidence proposed will allow a robust IM assessment suitable for the stage in the acquisition cycle which the munition has reached.
 - b. Test procedures, configurations, instrumentation and facilities meet the requirements and objectives of the test.

Assessment of Full Scale Test Results

7. In order to categorise the results of IM full-scale tests, the IMAP will need the information listed in, "Review of Proposed Assessment Methodology" for the review of test plans together with all trials evidence, for example video recordings, pressure gauge readings, debris patterns and the detailed test reports. It is important that the attendees to the IMAP include personnel who have witnessed the relevant tests, so that the reasons for any deviations from the test plan or unusual circumstances can be explained.
8. The relevant test STANAGs identify the minimum data to be recorded. Information required by the IMAP will always include:
 - a. Description of the facility and how it conforms to the requirements of the STANAG.
 - b. Size and construction of test arena.
 - c. Test item configuration (eg packaging, inert components, inert stores).
 - d. Test item location, suspension, restraint, orientation.
 - e. Test item temperature pre-conditioning.
 - f. Number and location of thermocouples and blast pressure gauges.
 - g. Location, orientation, size and construction of witness plates.
 - h. Details of any other instrumentation used (eg thermal flux gauges, sound recording).
 - i. Location of video or film cameras.
 - j. Video/film, with audio, of the complete test, including pre- and post- views of the test site.
 - k. Wind velocity and direction.
 - l. Description of the events and sounds observed.
 - m. Blast overpressure.
 - n. Still colour photography of the test site and set up, the test item remains, debris, cratering, burn spots and unreacted energetic material.
 - o. Debris map indicating location, size, weight, type, identification and number of debris items, where specifically required by the IMAP.

- p. Total recovered weight of debris, recovered weight as percentage of test item weight.
9. Additional information will be required for specific IM tests, for example:
- a. Fast Heating
 - 1) Size.
 - 2) Depth and construction of fuel fire hearth.
 - 3) Quantity and specification of fuel used.
 - 4) Method of suspension and any thrust measurement devices.
 - 5) Thermocouple traces.
 - 6) Duration of fire.
 - 7) Time for flame temperature to reach 1000°F.
 - 8) Average flame temperature.
 - 9) Time to reaction of test item.
 - 10) Wind direction and velocity.
 - 11) Distances to any protective wall or enclosure.
 - 12) Opportunity to link IM tests to Classification tests (for storage and transportation): UN Test Series 6(c) Bonfire Test from the UN Manual of Tests and Criteria is a very similar test to the Fast Heating test but has a requirement for witness screens.
 - b. Slow Heating
 - 1) Oven construction.
 - 2) Heat source and output.
 - 3) Air circulation method.
 - 4) Internal oven air pressure relief.
 - 5) Duration of test.
 - 6) Preconditioning details
 - 7) Measured heating rate.
 - 8) Time to reaction
 - 9) Oven air temperature at reaction
 - 10) Test item temperature at reaction.
 - c. Bullet Impact
 - 1) Calibre and type of bullet
 - 2) Method of measuring velocity
 - 3) Aim point.

- 4) Projectile velocity.
 - 5) Number of sighting shots and velocities.
 - 6) Witness screen arrangements to determine projectile egress direction and distance.
- d. Fragment Impact
- 1) Description of fragment projector.
 - 2) Number
 - 3) Size
 - 4) Type of fragments
 - 5) Method of measuring velocity, aim point,
 - 6) Number of fragments impacting the test item.
 - 7) Average fragment velocity.
- e. Sympathetic Reaction
- 1) Rationale for packaging and configuration used (THA).
 - 2) SR mitigation barriers (if used).
 - 3) Method of donor initiation.
 - 4) Donor and acceptor item numbers
 - 5) Orientation and configuration.
 - 6) Simulated components, including dummy components to provide confinement.
 - 7) Velocity measurement and witness screen arrangements and results.

IMAP Meetings

10. The DOSG SA has a key role in the process as the link between the PT and the IMAP. The SA should:

- a. Inform the PT of the requirement to submit IM assessment methodologies, experimental plans, simulation strategies, test plans and to the IMAP at appropriate points.
- b. In conjunction with the PT, prepare a pack ahead of the IMAP meeting with the key documents (flagged as necessary) and other evidence such as video recordings.
- c. Support the PTL in presentation of the evidence to the IMAP.
- d. Provide feedback to the PT of any assessment or advice from IMAP.

11. At the meeting, the IMAP review of a munition will commence with a presentation by the PM or his representative. The Members of the IMAP will have read the information provided in advance by the PM and the PM's presentation should therefore

be limited to a résumé of the key points. The presentation should include a brief overview of:

- a. The munition programme.
- b. The munition design.
- c. The operational life cycle (storage, transport, deployment and use).
- d. The results of the munition THA.

12. The meeting will then consider the evidence to support the claimed response for each of the IM threats in turn. The PM should provide a short summary of the relevant evidence which will always include video or film evidence where such evidence is available, plus still photographs, debris maps, instrumentation traces and any other evidence which will assist the Panel in determining the level of response.

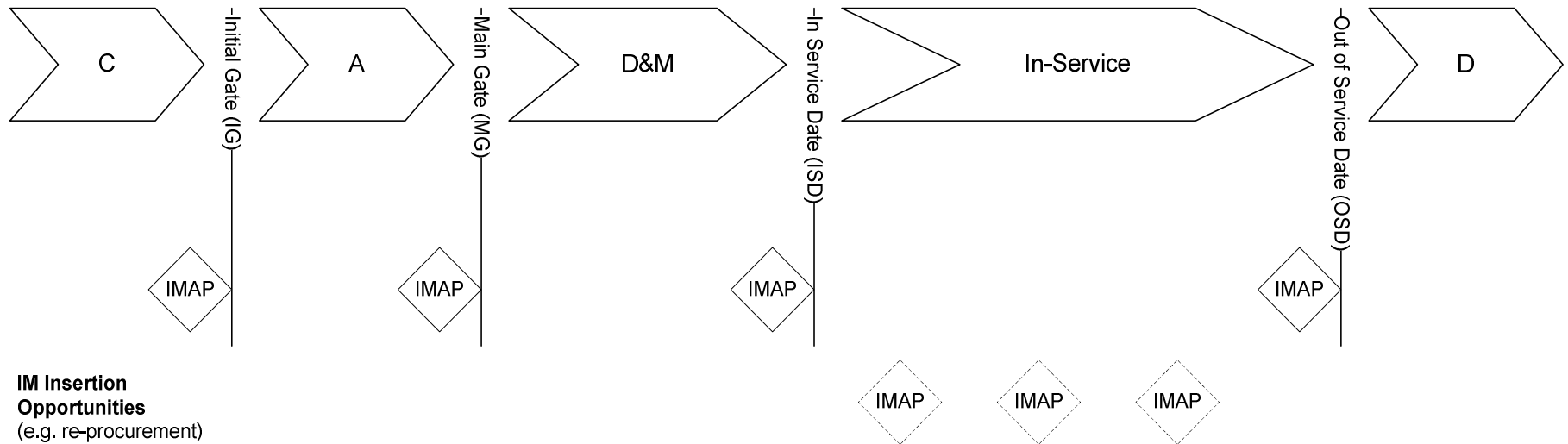
13. The PM should forward data for consideration by IMAP to the IMAP Secretary no later than 3 weeks prior to the meeting.

Submission for Endorsement of IM Compliance

14. Where a munition is assessed to have failed to achieve IM compliance, the IMAP will advise the PM whether there are valid scientific and technical grounds for a submission for endorsement of IM Compliance and offer a technical opinion on the way forward. The basis for the IMAP's advice will be the information supplied by the PM above. Where additional information or evidence is required the IMAP Chair will advise the PM.

15. The IMAP will conduct a review of all submissions for endorsement of IM Compliance raised by the PM, either in committee or ex-committee. The purpose of this review is to confirm that the submission has a sound technical justification. The IMAP, as a scientific and technical body, is not able to address the broader aspects of justification of the submission, such as risk, tolerability and satisfaction of the ALARP principle.

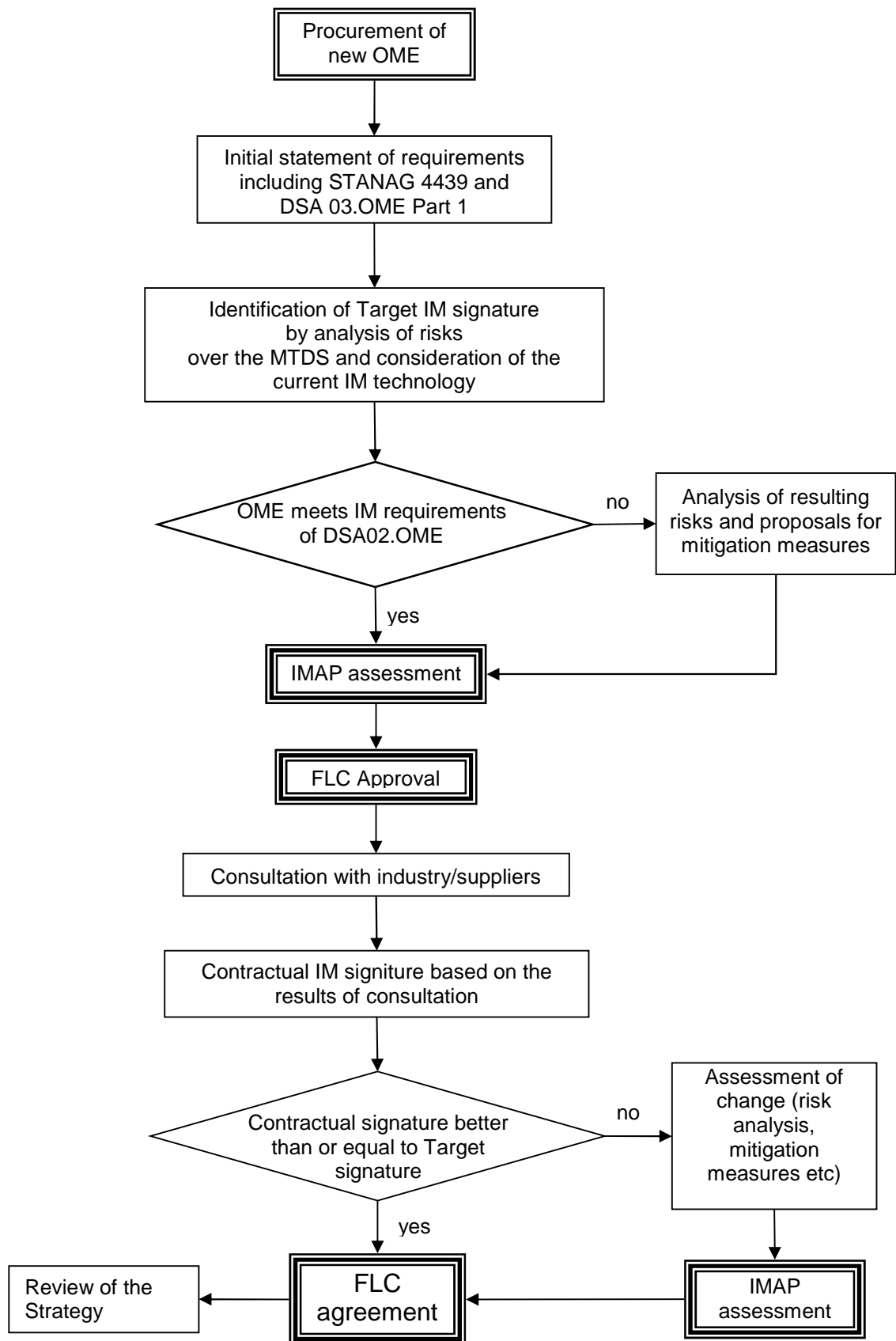
Annex C: Indicative Assessment of a Munition by IMAP Through Life



Notes:

1. **IMAP.** Solid lines indicate the minimum level of engagement with IMAP that is likely. Dotted lines indicate other possible engagements, e.g. where IM insertion opportunities have been identified.

Annex D: Applying the IM policy



NOTE:- Bold boxes represent decision points