Reliable Precision Munitions- Providing the Decisive Edge on the Battlefield

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Introduction

- **Precision munitions have proven themselves many times over on the battlefield during the past two decades**

- **Formerly used by exception, precision weapons are now the weapon of choice or a hard requirement**

- **Services and weapons developers continue to adapt munitions to meet the needs of the warfighter**

- **Effectively stating reliability requirements for these weapons early in the documentation process is vital to ensuring weapons can perform their intended mission**

Reliability impacts collateral damage, friendly fire, timely delivery of fires, and the volume of fires

Evolving Capability Challenges

- **Complex target environments**
  - Urban Environments
    - Collateral damage implications (CNN effect)
  - Hard and deeply buried targets
  - Time sensitive targets (theater and global)
  - Anti-access threats driving increased standoff ranges
  - Realistic Camouflage Concealment and Deception (CCD)
  - Mobile/re-locatable targets

- **Operational life attributes**
  - Weapons exposed to extended carriage times
    - Sustained cruise/cold soak times (internal heating, external cold)
  - Sand, dust, static discharge, moisture, open storage, vibration
  - Severe launch environment (i.e. Excalibur)

Increasing Weapon Complexity

- **Both air and surface delivered munitions have evolved on parallel paths**
  - Inertial guidance, laser guidance, imaging seeker, GPS and data-linked weapons
- **Next generation weapons combine precision delivery with:**
  - Data-links
  - Sophisticated and/or multiple sensors
  - Complex software
  - Standoff ranges and long time of flights
  - Signature reduction

Combined with challenging environmental factors

Other Considerations

- **Submunitions**
  - DoD policy requires <1% UXO from cluster producing weapons
  - What can we do to replace this required area munition capability?
- **Fuze Reliability**
  - Highly reliable fuzes
  - DoD S&T fuze effort
- **Political influence/constraints on weapons use**
  - What is the next land mine or cluster munition treaty?
- **Internal carriage constraints, collateral damage concerns, and increased range requirements driving smaller warheads**
  - Increasing requirement for precision
- **Simplicity – must be able to quickly employ in heat of battle**
  - CAS or other time-sensitive targets

Irregular warfare: Every bomb, bullet and mortar (and malfunction) can have strategic implications

Documenting Reliability in JCIDS

- **JCIDS Manual requires a Sustainment KPP (Availability) and two mandatory supporting KSAs for ACAT 1 programs**
  - **Availability (Mandatory KPP):** Two components (Materiel Availability and Operational Availability)
  - **Reliability (Mandatory KSA):** Must support the warfighting capability needed and support both Availability metrics
    - Most important measure for singe shot systems
    - Is the proposed reliability value consistent with the intended/expected operational use of the system?
    - Is the proposed reliability value consistent with the sustainment approach as presented in the operational availability metric?
    - Has the reliability metric been established at the system level?
  - **Ownership Cost (Mandatory KSA)**

For single shot systems the warfighter relies on munitions reliability to get intended effects on target

Defining and Measuring Reliability with Rigor

- **System-wide reliability metrics can mask munition reliability**
  - Reliability measures which include the supporting weapon system (platform or fire control system) often mask the capability of the munition itself (NLOS-LS)
- **Measures of Effectiveness (MOEs) can also disguise the true reliability of a weapon**
  - **Scenario Weapons Effectiveness (SWE) describes how a weapon will achieve a minimum Probability of a Single Shot Kill (PSSK) when averaged over a range of target types** (SDB-II KPP)
    - Weapons Effectiveness (WE) combines reliability, lethality and functionality (SDB-II KSA)
    - If lethality and accuracy are high, how much reliability can be traded?
  - **Missile Mission Effectiveness (MME) combines reliability, survivability and lethality** (JASSM KPP)
    - If survivability and accuracy are high, how much reliability be traded?

Multi variable MOEs can allow a weak variable to be masked

Adverse Effects of Reliability Requirements

- **Eliminating trade space drives cost and limits options/competition**
  - Producing highly reliable, low cost munitions will likely require an incremental approach
- **Reliability requirements also affect testing**
  - Integration
  - Captive carry (internal and external)
  - Number of test events
  - All drive cost/schedule

Conclusion

- **Current precision munition systems are demonstrating high reliability requirements under challenging conditions**
  - JDAM, GMLRS and Excalibur are recent examples in today's fight
- **JCIDS requirements documents must adequately address weapons reliability**
  - Must define reliability requirements early for complex weapon systems with demanding operational and test requirements
  - Precision munitions capabilities must balance requirements for both IW and high-end combat
- **Defining munitions reliability requires early and extensive collaboration between Services, JCS, OSD, acquisition and test communities**

Background

Sustainment KPP (per JCIDS Manual)

Sustainment consists of three key factors: Availability, ***Reliability***, and Ownership Cost. The Sustainment KPP (Availability) and two mandatory supporting KSAs (Reliability and Ownership Cost) will be developed for all ACAT 1 programs. For ACAT II and below programs, the sponsor will determine the applicability of the KPP. During the CBA, the relevant sustainment criteria and alternatives will be evaluated to provide the analytical foundation for the establishment of the sustainment KPP and KSAs.

(1) Additional guidance on the sustainment KPP is provided in Appendix B to this Enclosure and reference O.

(2) Exemptions. For ACAT II and below programs, the sponsor who determines the Sustainment KPP does not apply will include rationale in the CDD/CPD explaining why it is not appropriate. ***For a designated KPP to be considered as such within a CPD for a system at MS C, it must first have been required in the CDD at MS B.*** The sponsor must still identify the associated production sustainment metrics in the CPD for the system based on expected performance of the system whether the KPP existed in the CDD or not.

Availability KPP

(1) Availability will consist of two components: Materiel Availability and Operational Availability. The components provide availability percentages from a corporate, fleet-wide perspective and an operational unit level, respectively. The Operational Availability metric is an integral step to determining the fleet readiness metric expressed by Materiel Availability. The following provides guidance for development of both metrics:

(a) Materiel Availability. Materiel Availability is a measure of the percentage of the total inventory of a system operationally capable (ready for tasking) of performing an assigned mission at a given time, based on materiel condition. This can be expressed mathematically as number of operational end items/total population. The Materiel Availability addresses the total population of end items planned for operational use, including those temporarily in a non-operational status once placed into service (such as for depot-level maintenance). The total life-cycle timeframe, from placement into operational service through the planned end of service life, must be included. This is often referred to as equipment readiness. Development of the Materiel Availability metric is a program manager responsibility.

(b) Operational Availability. Operational Availability indicates the percentage of time that a system or group of systems within a unit are operationally capable of performing an assigned mission and can be expressed as (uptime/(uptime + downtime)). Determining the optimum value for Operational Availability requires a comprehensive analysis of the system and its planned use as identified in the CONOPS, including the planned operating environment, operating tempo, reliability alternatives, maintenance approaches, and supply chain solutions. Development of the Operational Availability metric is a requirements manager responsibility.

(2) Reliability KSA. ***Reliability is a measure of the probability that the system will perform without failure over a specific interval***. Reliability must be sufficient to support the warfighting capability needed. Considerations of reliability must support both Availability metrics. Reliability may initially be expressed as a desired failure-free interval that can be converted to a failure frequency for use as a requirement (e.g., 95 percent probability of completing a 12-hour mission free from mission-degrading failure; 90 percent probability of completing 5 sorties without failure). Specific criteria for defining operating hours and failure criteria must be provided together with the Reliability. ***Single-shot systems and systems for which other units of measure are appropriate must provide supporting analysis and rationale***. Development of the Reliability metric is a requirements manager responsibility.

Reliability Review Criteria

Has the reliability metric been established at the system level? Is it traceable to the ICD, CDD, other JCIDS analysis, or other performance agreement?

Does the analysis clearly provide criteria for defining relevant failure?

Does the analysis clearly define how time intervals will be measured?

Does the analysis identify sources of baseline reliability data and any models being used? Is the proposed value consistent with comparable systems?

Is the proposed reliability value consistent with the intended operational use of the system (i.e., the CONOPs)?

Is the proposed reliability value consistent with the sustainment approach as presented in the operational availability metric?

Is the proposed reliability value consistent with the performance of existing or analogous systems?

For single-shot systems and systems for which units of measure other than time are used as the basis for measuring reliability, does the package clearly define the units, method of measuring or counting, and the associated rationale?