

Vendor's Guide to Data Requirements for Weaponized UAS Safety Concurrence

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This guide has been developed by the Naval Surface Warfare Center, Indian Head Division (NSWC IHD) System Safety Division. It establishes the minimum data and documentation requirements for industry partners to support the U.S. Government's safety review and concurrence process for weaponized Unmanned Aerial Systems (UAS). Adherence to this guide is critical for ensuring that a complete and accurate data package is provided, which is the primary factor in facilitating a timely and successful safety assessment.

1. Introduction

To obtain the necessary safety concurrence for a weaponized unmanned aerial system (UAS), vendors must provide a comprehensive safety data package to the U.S. Government. This guide outlines the required documentation and data to ensure a thorough and efficient review. All efforts should be made to provide all the information below, however, packages must be delivered by the identified due date. If information is not available on time, it should be noted whether the data exists and will be provided later, does not exist or the appropriate status of the information.

Your submission will be the primary source of information for a formal Hazard Analysis (HA) and Mishap Risk Acceptance (MRA) process. Providing a complete and detailed package is the most critical factor in facilitating a smooth and timely safety review.

2. System Overview and Technical Specifications

Provide a complete technical data package for the entire system, including the air vehicle, control station, and all payload variants. This package should include user manuals, technical specifications, and any available test data. The following sections detail the required information.

2.1 Air Vehicle

Provide detailed specifications for the UAS airframe, including:

- Performance: Payload capacity, top speed, operational range (both with and without payload), and flight endurance.
- Physical Characteristics: Detailed diagrams with dimensions, weight, airframe materials, and specifications for the payload mounting system (e.g., strap pass-through locations, mounting hole patterns, maximum screw penetration depth).
- Components: A full list and description of all major components, such as antennas (e.g., Low Band, High Band, Video), camera systems (EO/Low Light/Thermal), and the propulsion system (motor and propeller specifications).
- Pre-flight & Assembly: Detailed, illustrated procedures for any required operator assembly, such as propeller installation, antenna mounting, and camera angle adjustments.
- Identify personnel standoff distance for each antenna (and location of antenna on vehicle)
- Identify all keep-out zones for take-off/launch to position personnel. Keep-out zones may be for launch failure or inadvertent warhead function

Note: Many systems are designed to supply initial arming logic power to an ESAD while the user is still holding the item or standing next to it (considered unsafe). What considerations are given for user egress?

- List the following, their purpose, their location on the vehicle
 - Explosive or pyrotechnic devices (squibs, EFIs, deflagrators, initiators, etc.) with:
 - Explosive materials and compositions by weight
 - Completed qualifications and characterization tests (ex. AOP-7, MIL-DTL-23659F):
 - Max no-fire current

- Max no-fire voltage at cold, hot, ambient (for in-line initiators)
 - hazardous springs
- Complete electrical interconnect schematic showing how all components within the vehicle are connected

2.2 Ground Control System (GCS)

Provide detailed specifications and illustrated operating procedures for the GCS, including:

- Components: A list and description of all GCS components, such as the pilot handset, virtual reality/display goggles, video/control link antennas, and any interface boxes.
- Setup and Operation: Step-by-step procedures for system setup, pre-flight checklists, antenna mast orientation for optimal signal, and any procedures for switching between control link frequency bands.
- On-Screen Display (OSD): A detailed guide and graphical layout of the OSD, defining all displayed symbology and information (e.g., Control Band, Link Quality, Video Transmitter Temperature, Altitude, Speed, Flight Duration, munition/payload status).
- Include any information about autonomous features, such as waypoint flight and safety features, such as geofence capability, lost link capability, etc.

2.3 Batteries & Charger

Provide a complete battery data sheet for all system batteries (air vehicle, GCS, handset, etc.).

The data sheet should include:

- Battery Specifications: Part Number, battery chemistry (e.g., Lithium-Ion), nominal/maximum/minimum voltage, cell configuration (e.g., 6S5P), capacity (Ah), Watt-Hours, specified charge/discharge rates, operating and storage temperature ranges.
- Charger Specifications: Detailed operating instructions for the provided charger, including descriptions of preset charging profiles and procedures for placing batteries into a safe, long-term storage charge.
- Provide description of Include any safety features within the battery
- Provide the battery datasheet. It will include all features listed plus max recommended current draw
- Provide description of known safety features in the battery charger.
- Provide test reports for any completed safety testing, such as NATO 38.1 and NAVSEA S9310, UN 38.3, or other independent lab testing.

2.4 Launcher Systems

- Provide the launcher and relevant subcomponents of the launch function

2.5 Laser Systems

Provide for any laser utilized in the system for any purpose (e.g., target designation, range-finding, altitude measurement, data transmission, etc.), you must provide a dedicated data sheet or an explicit statement detailing the following for each unique laser:

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- Purpose and Function: The specific role the command laser plays in the system.
- Laser Classification: The official hazard classification (e.g., Class 1, Class 3R, Class 4).
- FDA Approval Status: A clear statement on whether the laser product is approved by the U.S. Food and Drug Administration (FDA).
- FDA Accession Number: If FDA approved, you must provide the official FDA Accession Number for the product.

2.6 Autonomous Capabilities

Provide a detailed description of all autonomous or semi-autonomous features integrated into the system. This includes, but is not limited to, functions such as automatic target recognition, target tracking, autonomous terminal guidance, navigation without continuous operator input (e.g., GPS-waypoint navigation), automated return-to-home/base, automated takeoff and landing, and collision avoidance.

For each autonomous feature, the following details are required:

- Functional Description: A clear explanation of what the feature does and what its intended purpose is during a mission.
- Activation and Deactivation: The specific sequence of operator actions required to enable and disable the feature.
- Operator Override: A detailed description of the methods available for a human operator to interrupt, abort, or manually take control scheme for commanding launch from the autonomous function at any point during its operation.
- System Inputs: The sensors, data links, or other inputs the feature relies on to operate (e.g., EO/IR camera feed, GPS, LiDAR, etc.).
- Failure Modes: A description of the system's behavior if the autonomous function fails or if its required inputs are lost (e.g., loss of GPS signal during autonomous navigation).

3. Payloads & Fire Control Module (FCM)

A detailed data package is required for all payloads, including kinetic warheads and inert training systems.

3.1 Fire Control Module (FCM) / Electronic Safe and Arm Device (ESAD)

The FCM data package must include:

- Overview: A functional overview with clear diagrams identifying all user-interactive components (e.g., Safety Pull Pin, Detonator Connector, Status LEDs, Mode Selection Switches).
- Safety Features: A detailed description and analysis of all safety-critical features, such as:
 - Pull-Pin retention mechanisms that prevent accidental removal.
 - The specific number and sequence of distinct user actions required to arm and fire the system.

- The architecture of all fire-energy inhibits (e.g. static and dynamic switches), clearly identifying areas where a single component controls multiple fire-energy inhibits.
- Any time-windowed and sequenced order of operations required for arming.
- The presence and function of shunted detonator output relays.
- Any built-in operational end-of-life timers that disable the system.
- If arming requires environmental sensing, list the environmental conditions (type, amplitude, duration, etc.)
- If arming requires environmental sensing, list the environmental conditions (type, amplitude, duration, etc.)
- Provide the explosive energy train as part of Section 2.1 list.
- Identify features to bleed down firing capacitor voltage
- Time required to bleed down charge on firing capacitor(s) if the flight battery is still connected will full charge and if the flight battery is dis-connected

NOTE: When arming source power comes directly from the system battery, if you have a dud/impact after arming, unless the arming path from the battery was disconnected at impact (which cannot be assumed unless qualified to safety standards), the wait time will be the time associated with the dissipation of the ENTIRE system battery, plus the wait time provided by the bleed paths of the HV cap.

- To accomplish this, define:
 - (a.) the capacity of a fully charged battery in Ah (which is already listed as a requirement)
 - (b.) the dissipation rate of the system when in idle (all systems functioning/communicating, but the UAS not yet flying)
 - (c.) the dissipation rate of the system when in flight (at the lowest power flight settings)
 - (d.) the dissipation rate of the system if ONLY the ESAD were powered (worst-case scenario assuming that after impact, all other systems have become compromised and are no longer drawing current)
 - (e.) the worst-case wait time associated with the built-in bleed paths in parallel to the HV cap.
- Operational Features: A description of all selectable fuzing and trigger modes, including:
 - Command Detonation.
 - Impact Initiation.
 - Proximity/Height of Burst (HOB) Initiation, including full specifications for any sensors used (e.g., LiDAR operational range).
- Status Indicators: A complete guide to all LED status codes or other indicators for every system state (e.g., Start-up, Idle, Safety Pin Removed, Enabled, Armed, Triggered, Error).
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- Schematics: A complete, detailed electrical schematic with reference designators and part numbers.

For each warhead variant (e.g., Anti-Personnel, Anti-Materiel, Explosively Formed Projectile), provide:

- Description & Intended Effect: The design purpose and expected tactical effect of the warhead.
- Configuration:
 - Explosive type and Net Explosive Weight (NEW).
 - Fragmentation data: number of fragments, average size, material, and any available penetration data (e.g., into Ballistic Gelatin or RHA steel).
 - EFP data: projectile diameter, material, and modeled or validated penetration capability against relevant targets.
- Safety Danger Zone data/test reports if conducted
- Initiation Method: The specific type of detonator required for initiation.
- Technical Drawings: Detailed mechanical drawings with dimensions for all warhead and trainer variants.

3.3 Ordnance & Energetics Data

Provide any existing official data sheets, test reports, or qualification letters for all energetic materials used in the system, including primary explosives and detonators. Include Explosive Ordnance Disposal procedures or considerations.

4. Concept of Operations (CONOPS) & Standard Operating Procedures (SOP)

A comprehensive CONOPS and a detailed, step-by-step SOP are required. These documents should be practical, illustrated guides for operators in the field, formatted similarly to a "Battle Drill."

Your submission should include:

- **Phases of Operation:** A clear definition of all lifecycle phases, including Storage, Transport, Pre-Launch, Operational Use, and Disposal/Dud Procedures.
- **Crew Roles & Responsibilities:** Clearly define the specific actions, responsibilities, and required communications for each team member (e.g., GCS Crew, Payload Crew).
- **Step-by-Step Procedures:** Provide detailed checklists and illustrated procedures for:
 - Pre-operation system checks for the air vehicle and FCM.
 - FCM built-in-test and functions check.
 - Payload priming, handling, and loading procedures.
 - The complete launch sequence (e.g., "Initiate Safety Pin", "Launch Drone").
 - The complete post-launch arming sequence.
 - Triggering procedures with specific notes and considerations for each mode (Impact, HOB, Command Detonate).
 - All emergency and abort procedures.
 - The standard landing and recovery procedure.

5. Lifecycle Environmental Profile (LCEP) and Testing

Provide all available data regarding the system's ability to withstand and operate within the environmental conditions expected throughout its lifecycle (from factory to disposal). This information is critical for understanding the system's robustness and operational limits.

- Environmental Limitations: Clearly define the documented operational and storage limits for conditions such as:
 - Temperature (high and low).
 - Altitude/Pressure.
 - Humidity, water immersion, and salt fog.
 - Sand and dust exposure.
 - Vibration and shock (during transport and operation).
 - Thermal Shock
 - Maximum verified no-damage handling-drop distance
- Environmental Testing: Provide any and all reports, data, and certifications from environmental testing that the system or its key components (airframe, Personnel Electrostatic Discharge (PESD), avionics, payload, FCM) have undergone. This includes, but is not limited to, tests for vibration, shock, thermal cycling, and water ingress.
- Environmental Assessments: Submit any formal analyses or assessments that document the expected environmental service conditions the system is designed to meet, often referred to as a Lifecycle Environmental Profile (LCEP) to include Electromagnetic Environments.

6. Hazard Analysis & Risk Assessment Data

The vendor is encouraged to perform and document a thorough hazard analysis.

6.1 System Hazard Analysis (HA)

For each identified hazard across the system's lifecycle, document the following:

- Hazard Description: (e.g., "Loss of command and control," "Inadvertent warhead detonation on the ground").
- System/Subsystem Involved: (e.g., Munition, Controller, Warhead).
- Mode of Operation: (e.g., Operational Use, Transportation, Storage).
- Causal Factors: The potential root causes of the hazard (e.g., Software failure, operator error, hardware defect, EMI).
- Effects/Mishaps: The potential outcome of the hazard (e.g., Injury to personnel, loss of munition, collateral damage).
- Mitigations: All recommended actions, procedures, and design features that reduce risk (e.g., "Follow checklist procedure," "Proper Training," "BIT checks," "System fail-safe modes").

6.2 Software Functional Hazard Analysis (FHA)

For systems with software-controlled safety-significant functions, a detailed FHA is required. This analysis should include:

- Functional Breakdown: A hierarchical list of all system and sub-system functions (e.g., Power Up, Fault Processing, Flight, Engage Target).
 - Functional Failure Analysis: For each function, analyze the effects of potential failures (e.g., "Fails to operate," "Operates incorrectly," "Operates inadvertently").
 - Hazard Description & Causal Factors: Link the identified functional failures to specific system-level hazards.
 - Existing Mitigations & Software Controls: Detail how the software architecture, by design, prevents or mitigates hazards.
 - Software Criticality: Provide all necessary data to help the government assess a Software Criticality Index (SwCI) for safety-significant software functions, including clearly identifying safety-compliance to known software safety standards/processes (ex. MIL-STD-882E and AOP-52).
- 6.3

6.3 Safety Authority Reviews and Certifications

Provide a history of any relevant or analogous Safety Reviews from DoW, Joint, Service or other national Safety authorities. (e.g. JSWSR, WSESRB, AWSSRB, NNMSB, FISTRP, AFSRB, JS-FISSA, SSSTRP, JS-SSA)

6.4 Autonomy

- If any autonomous features are included, provide details of the functionality

7. Conclusion

Assembling this comprehensive data package is a critical step in the path to fielding your system. A thorough and well-organized submission demonstrates a commitment to safety and significantly streamlines the government's review and concurrence process. Please ensure that all documentation is clearly written, well-organized, and supported by empirical data where applicable.

8. References

Military Standards 882, 810, 1316, 1901, 1911, 331, 2105, 464