

Future Vertical Lift (FVL) Capability Set #3

Request for Information (RFI) #2

24 Oct 2016

Synopsis

This Request for Information (RFI), issued in accordance with Federal Acquisition Regulation (FAR) 15.201(e), is issued for the preliminary planning for a potential acquisition and is not a Request for Proposals (RFP). A response to this notice is not an offer, and no offer can or will be accepted by the US Government to form a binding contract. If respondents submitted information under the previous solicitation, number W58RGZ-16-R-0170, please indicate this in your response and reference where the information was provided in your previous submittal. Should a formal RFP be issued in the future, any and all respondents and non-respondents will be eligible to compete for the acquisition. Submission of a response to this RFI is not required to submit a proposal in response to any RFP which may be released in the future or to be awarded any contract pursuant to the same.

1.0 Introduction

The Initial Capability Document (ICD) for the Future Vertical Lift (FVL) Family of Systems (FoS), dated 8 April 2013, established a need for a vertical lift capability to support the US Army (USA) and the US Marine Corps (USMC), recapitalizing their existing fleet of H-60 and H-1 aircraft (A/C). This new capability should have an Initial Operational Capability (IOC) in the 2030-2032 timeframe and support Army Assault missions and Marine Corps Attack and Assault/Utility missions with a common solution (or as common a solution as practical).

2.0 RFI Intent

The purpose of this RFI is to facilitate market research on the state of technology (e.g, technology maturity levels and availability) and related costs which could be incorporated into a potential Future Vertical Lift Capability Set 3 (CS 3) Utility and Attack material solution(s) in support of the FVL Analysis of Alternatives (AoA). Since the February 2016 RFI release, The USA and USMC have continued to refine the FVL concept in terms of requirements, acquisition strategy, and cost estimates leading to the 28 October 2016 Material Development Decision briefing (MDD). As part of the MDD process, the Office of the Secretary of Defense (OSD) Cost Assessment and Program Evaluation (CAPE) Office has released official AoA guidance. To improve the quality of the data input to the AoA, respondents are encouraged to address specific RFI questions by either updating existing submittals from the February 2016 RFI or submitting new responses.

The requested information is for internal planning purposes only and will not be publicly released outside the Government RFI Assessment Group. It is the intent of the US Government that industry responses to this RFI will be considered with respect to the development of a future RFP, should a decision be made to proceed with any particular acquisition phase.

The US Government intends to engage industry on their RFI submittals, via industry day(s) or other face-to-face engagements as determined by the US Government. The intent of these engagements is to conduct market research and specifically for respondents to discuss select technologies described in their RFI response, provide insights as to the challenges they face in developing rotary wing aircraft to meet USA & USMC requirements, provide results of capability or operational effectiveness analysis, and the risks associated with developing an executable moderate risk FVL acquisition program.

3.0 Capabilities

The aircraft should be capable of meeting the following needs, whether it is an upgraded legacy platform, an existing or modified commercial off-the-shelf/government off-the-shelf (COTS/GOTS) aircraft, a new-start aircraft, or other. Note this is a top-level summary and is not all-inclusive.

- 3.1.1. Shipboard compatible (lives on the ship; 100% ship suitable) for USMC variants and shipboard capable (lands, refuels/reloads, and takes-off; able to handle electromagnetic interference (EMI) and has manual folding) for USA variants on L-class (amphibious) ships, with the USMC variant having a folded spot factor equivalent/close to an Utility Helicopter(UH)-1Y.
- 3.1.2. Aerial refueling via standard North Atlantic Treaty Organization (NATO) probe and drogue refueling systems.
- 3.1.3. In all phases of flight, the aircraft shall exhibit Level I Cooper-Harper Rating Scale handling qualities within the operational flight envelope (Level I definition shall be in accordance with (IAW) a tailored Aeronautical Design Standard Performance Specification, ADS-33E-PRF for rotor-borne flight, meeting the requirements for an attack helicopter including Target Acquisition and Tracking. Level I definition shall also be IAW tailored Military Standard, MIL-STD-1797B handling qualities standards for other flight modes, as delineated by Air Vehicle Class IV).
- 3.1.4. Assault/Utility variants offer eight (USMC) to twelve (USA) crashworthy troop seats whose seat back height, seat pan depth and seat pan width are compatible with both unequipped and heavily equipped troops donned with body-borne mission equipment such as the Modular Lightweight Load-carrying Equipment (MOLLE) pack. Minimum seat width to provide the required accommodation is twenty-three (23) inches wide with a sitting platform that is eighteen (18) inches deep. Accommodation of mission equipment on the seat must also be compatible with maintaining aisle space for both general movement about the cabin and for emergency egress. Alternative cabin configuration should be compatible with accommodating six (6) litter patients or six (6) ambulatory patients with medical equipment.
- 3.1.5. The aircraft must be capable of operations in all weather (except the most severe weather, e.g. severe thunderstorms, turbulence, icing, hurricane force winds), night and degraded visual environment (DVE), moderate icing, Instrument Meteorological Conditions (IMC) and Instrument Flight Rules (IFR). This includes the ability to identify and engage threats in all manner of environmental/weather conditions.
- 3.1.6. Aircraft must be able to deploy to and from unimproved austere field sites/tactical assembly areas as well as rolling take-offs from L-class ships.
- 3.1.7. Conduct missions with the describe ground rules and payloads as specified in Appendices A and B.
- 3.1.8. Aircraft must be capable of the following limit g-loads: 1) During mission MT-2, Segment 7 – Positive 4.5 G to negative 1.5G (if wing-borne), Positive 3.5G to negative 1.0G (if rotor-borne) and 2) During missions A-1, A-2, A-3, Segment 6 – Positive 3.5G to negative 0.5G in applicable flight mode for segment.
- 3.1.9. Assault/utility variants will offer weapons with a near 360 degree coverage.
- 3.1.10. Aircraft must have ballistic protection for the pilots, crew, and troops, including transparencies.
- 3.1.11. Aircraft shall exploit capabilities of Manned Unmanned Teaming (MUM T) as well as being optionally manned. MUM-T Level 4 Control of Unmanned Aircraft System (UAS) (Level 5 Control for UAS Group 2 and smaller except for Medical Evacuation).

3.1.12. A data rights strategy.

4.0 Air Vehicle

4.1. Design Philosophy:

- 4.1.1. Given that the FVL CS 3 aircraft is intended to fulfill multiple roles related to utility and attack mission areas, describe the design approach utilized to meet the diverse mission set for the proposed aircraft and substantiate why it is the right approach.
- A. Is there a single design for both utility and attack variants? If so, what is the level of complexity, timeframe to reconfigure, and specialized support equipment needed to reconfigure between variants?
- B. Is there a dual design approach, one for utility and one for attack? If so, are there common components (engine, rotor, etc.) utilized in the different fuselages (i.e. H-1 approach)?
- 4.1.2 Regardless of the approach chosen, what would be the implications and impacts if the chosen design approach could not be used and the other had to be used? Provide data to substantiate the differences between the two options, including but not limited to groups weights, mission performance (using the information in Appendices A and B), and vehicle geometry and aero properties (including drag). Document the pros/cons of each approach across all aspects of the design.
- 4.1.3 Given there is the potential for multi-service use of the FVL CS 3 aircraft, describe the design approach to address both land and sea-based use of the aircraft (USA vs. USMC usage). What will be different between the aircraft used by the two services?
- 4.1.4 Describe the science and technology (S&T) needs for the design. Describe what specific systems/components need to mature in order to be utilized on the FVL aircraft. Provide current Technology Readiness Levels (TRLs), plan/roadmap/timeline for maturing each, and the plan for integrating all technologies into the overall aircraft.

4.2 Aircraft Modifications (if proposed solution is a derivative of an existing A/C):

- 4.2.1 If modifications are required to a baseline model, what are they and what are the impacts to weight and drag?
- 4.2.2 If modifications are required, what test and qualification efforts must be carried out?

4.3 Performance:

- 4.3.1 Using the mission profiles, ground rules, assumptions, and weight allocations provided in Figures 1-4 and Appendices A and B, estimate the following. The estimates should take into account (from a weight and performance standpoint) the key desired capabilities outlined above.
- 4.3.1.1 Mission Range (For each mission listed in Appendices A and B)
- A. What is the maximum range carrying the required weapons, payload or passenger load? Provide a range-payload diagram as part of the response.

B. What is the running gross weight of the aircraft throughout the mission to meet or exceed the required range?

C. For substantiation, provide a listing of mission segments including: fuel, power required, time, distance, speed, and weight, where applicable.

4.3.1.2 Minimum One Engine Inoperative (OEI) Speed

A. If wing-born flight, provide $1.2V_{stall}$.

4.3.1.3 Maximum Hover GW and Hover Torque Margin:

A. What are the maximum Hover Out of Ground Effect (HOGE) and Hover In Ground Effect (HIGE) Gross Weights using Maximum or Takeoff Rated Power and limiting factor (engines, transmission, max structural GW) at the following conditions?

- 1) Sea Level, 39.4°C (103°F)
- 2) 3000 feet PA, 33.1°C (91.5°F)
- 3) 4000 feet PA, 35°C (95°F)
- 4) 6000 feet PA, 35°C (95°F)

4.3.1.4 Performance Substantiation: Total aircraft power required is defined as the sum of main rotor(s), tail rotor, drive system, and accessory losses in terms of Engine Shaft Horsepower (ESHP). (Include airspeeds which encompass hover up to VNever Exceed. Other parameters should encompass the range of conditions encountered in the mission profiles.)

A. Upon what is the power required based? (i.e., flight test, model test, analysis, combination, etc.).

B. What is the isolated rotor hover figure of merit as a function of continuous time (CT)/Sigma for the anticipated range of hover tip Mach numbers?

C. What is the total aircraft power required? If in coefficient format, what is power coefficient (CP) as a function of μ , CW and Nr_{REF} ? If in referred format, what is HPREF as a function of true airspeed (TAS), reference gross weight (GWREF), and Nr_{REF} ?

D. For wing-born flight, provide total thrust and drag as well as coefficient of lift (CL) vs Alpha, CL vs coefficient of drag (CD), flaps delta CL, and provide power-to-thrust efficiency.

E. What is the hover in ground effect (HIGE) power required at a 10 ft. wheel height? If in coefficient format, what is CP as a function of CW and Nr_{REF} ? If in referred format, what is HPREF as a function of GW_{REF} and Nr_{REF} ?

F. What is the power available, including installation effects and losses based on? (i.e., flight test, model tests, engine manufacturer's cycle deck, etc.)

G. What is the installed spec power available in horsepower (HP) as a function pressure altitude, outside air temperature and airspeed at the following ratings: Maximum Continuous Rating, Intermediate (30 minute) Rating, Maximum or Takeoff Rating (and duration), and OEI or Contingency Rating (and duration)?

H. What additional losses need to be accounted for due to environmental control system (ECS), drive system, or accessories, which are not already accounted for in the power required and power available bookkeeping? Provide a detailed list of all losses.

- I. What is the installed fuel flow as a function of power, pressure altitude, outside air temperature and airspeed?
- J. What are the All Engines Operating (AEO) and OEI transmission ratings in HP and duration?
- K. What is the drag, in square feet (sq. ft.), of the aircraft? Provide a detailed listing, showing drag of each component as it builds up to the overall A/C drag. Call out drag variations between missions.
- L. What is the vertical drag (download) of the A/C as a percentage of rotor thrust? Provide calculations and substantiation to for the build-up to the overall number.
- M. What are the following key aircraft dimensional and specification parameters?
 - 1) Engine designation.
 - 2) Design Rotor Speed (100%), rate per minute (rpm).
 - 3) Normal Operating Rotor Speed, % or rpm and the flight condition each are used.
 - 4) Fuel system useable capacity, gallon (gal) or pounds (lbs).
 - 5) Reference indicated torque to horsepower value at 100% torque (Q) at 100% rotor rpm (Nr).
 - 6) Reference drag (equivalent flat plate area) of the power required data, sq. ft.
 - 7) Maximum Structural Gross Weight (GW), lbs.
 - 8) Minimum fuel on deck allowance, gal or lbs., this quantity being separate from mission reserves.

4.4 Aircraft Configuration:

4.4.1 For the FVL aircraft the following detailed information, if applicable, is requested:

4.4.1.1 Vehicle Description

4.4.1.1.1 Provide a precise description of the current production aircraft, modified/derivative production aircraft, or notional design. (Responses should include, but not be limited to these areas of interest: rotor system, number of engines, provisions for crew compartment environmental control, avionics overview and architecture description, minimum and maximum number of occupants, and landing gear configuration).

4.4.1.1.2 Document the external dimensions and spread attributes of the aircraft in the form of detailed three-view drawings. Specifically include (where applicable):

- A. Diameter of main rotor(s)
- B. Diameter of tail rotor/thruster
- C. Span and chord of wing
- D. Span and chord of horizontal and vertical tail
- E. Length overall, rotors turning.
- F. Minimum height of main rotor(s) at low RPM
- G. Minimum height of turning tail rotor
- H. Length of fuselage
- I. Width of fuselage
- J. Height to top of rotor hub
- K. Height overall
- L. Minimum ground taxi turn radius measured by arc of rotor system

- M. Wheel track
- N. Wheelbase
- O. Ground clearance (dry and fully loaded)
- P. Distance from rotor to landing gear (in hover)
- Q. Distance from center of lift to nose of aircraft
- R. Distance from ground to pilot's eye
- S. Center of gravity (both vertical and longitudinal) at Design Gross Weight and Maximum Take-off Weight (for missions listed in Appendices A and B)
- T. Sail area (unfolded)

4.4.1.1.3 Document the internal layout and attributes of the aircraft in the form of detailed drawings and supporting data. Specifically include (where applicable):

- A. Cockpit configuration
- B. Cabin configuration(s)
- C. Internal layout/location of systems (avionics, fuel tanks, engines, transmissions, drive shafts, ECS, flight controls, etc.)
- D. Describe the crashworthy troop seats to be used that offer the necessary protection

4.4.1.1.4 Describe the ship suitability attributes, including the folding method, for the proposed A/C. Utilize drawings and supporting data to capture the necessary attributes:

- A. Folding methods and folded dimensions
- B. Folded area (as a projection of area onto the deck) and compare it to a UH-1Y spot factor
- C. Sail area (folded)
- D. Location of tie-down attachment points.
- E. Needs for any unique support equipment
- F. Provide the time it takes for the rotor brake to stop the rotor during landing operations
- G. Identify any limitations and/or inspections related to shipboard operations.

4.4.1.2 **Mission Systems Description**

4.4.1.2.1 Sensors - Provide a precise description of the notional design, the external dimensions and positions of all the sensors on the air vehicle, including acquisition and tracking. Specifically include (where applicable):

- A. Size, weight, dimension
- B. Detailed three-view drawings
- C. Range for acquisition and tracking
- D. Designation capability (type, error/TLE)
- E. Field of view and field of regard

4.4.1.2.2 Stores - Provide a precise description of the notional design, dimensions and positions for the internal and external store stations (including pylon, rack and suspension equipment on the air vehicle. Specifically include (where applicable):

- A. Size, weight, dimension
- B. Detailed three-view drawings
- C. Rack, Pylon deployment/retraction (internal)
 - 1) Will the weapons bays have separate bulkhead when weapons are deployed at altitude?

- 2) Method and timing for extension/retraction (hydraulic, pneumatic, mechanical).
What is the reaction time and time to secure?
- 3) What is the release mechanism for the racks? (pneumatic, etc.)?
- 4) Will there be methodology for manual retraction in case of failure? Identify potential failure modes for internal suspension equipment.
- D. Clearance between weapon station/bay doors and aircraft aspects (nacelle/rotor, fuselage).
 - 1) Rocket motor plume/gun blast overpressure
 - 2) Safe separation clearances to airframe (MIL-STD-1289) for employment? For jettison?
 - 3) Separation clearance for store-to-store contact
 - 4) Need to understand/identify if there will be limitations to weapons employment throughout the air vehicle flight envelope
- E. Clearance between weapon station/bay doors and ground/ship deck.
 - 1) Launch and recovery (skids/flat tire/compressed strut)
 - 2) Aircraft Weapons Support Equipment (AWSE) to weapons bay for loading/downloading

4.4.1.3 **Isolated Rotor Performance:**

4.4.1.3.1 Provide the radial distribution of blade properties at sufficient resolution (number of blade stations) to adequately define piecewise linear or nonlinear distribution of:

- A. Chord
- B. Twist
- C. Airfoil
- D. Quarter chord locus with respect to blade pitch axis (chordwise and vertical offsets define local sweep and anhedral, respectively)
- E. Mass (alternatively supply blade mass outboard of, and first and second mass moments of flapping inertia about actual or equivalent flapping hinge)

4.4.1.3.2 Rotor airfoil section 2D aerodynamic lift, drag, and pitching moment coefficient data at full-scale Reynolds Numbers as a function of angle of attack and Mach Number over the full range of operation to be experienced by each airfoil. Tabular data in C81 airfoil deck format preferred.

4.4.1.4 **Weight and Balance:**

4.4.1.4.1 Use the following ground rules when providing the information:

4.4.1.4.1.1 Ensure weight and CG estimates are consistent with design descriptions and operational usage of the concept described throughout the RFI response.

4.4.1.4.1.2 Components that are installed for every mission and not removed/installed operationally should be included in Weight Empty or Basic Weight. Operational components that are only required for some missions should be reflected in Mission Weight Buildups as either Operating Weight items or Zero-Fuel Weight items.

4.4.1.4.2 For the FVL aircraft, the following detailed information, if applicable, is requested:

4.4.1.4.2.1 Provide a functional weight and balance report for the design concept that is compliant with needed capabilities reflected in this RFI. It is desired that the format and content be consistent with an Estimated Weight Report per SAWE Recommended Practice #7 (<http://www.sawe.org/technical/rp>). At a minimum, provide weight and longitudinal balance data for each functional weight group and provide as many other elements of the report as possible. If not already provided, provide graphic and narrative design descriptions of the concept by functional groups that correspond with the Estimated Weight Report.

4.4.1.4.2.2 In addition to the material weight breakdown for structural weight in the Group Weight Statement, provide subtotals of the material weight breakdown for each of the functional weight groups that make up Structure; Wing, Rotor, Empennage, Fuselage, Gear, Engine Section and Air Induction.

- A. List or group primary structural components and identify metal alloys used for each type of component.
- B. If composite materials are used for any primary structural components, identify the components and the materials used. Identify the mechanical properties for each composite material to include; fiber/resin constituents, resin content, fiber grade, mechanical properties of the composite (E1, E2, G12, nu, t0 and density), honeycomb (if applicable) and allowable strains for compression and tension and any environmental factors that apply.

4.4.1.4.2.3 Substantiate all weight and balance data to explain the methods, analysis and rationale for the values, which are expected to be accurate, complete, realistic and objective.

4.4.1.4.2.4 Quantify the portion of Weight Empty for the concept that requires development and the portion, if any, which exists and does not require development. Include an allowance for weight growth anticipated during development and substantiate the value. Recent NAVAIR experience is that derivative programs experience weight growth from Contract Award to Initial Operating Capability (IOC) that is, on average, 23.4% of the initial development portion. All-new development programs experience average weight growth of 12.6% over the same development period.

4.4.1.4.2.5 Derive and substantiate a recommended weight allowance to include at IOC, to ensure that the system delivered has some measure of built-in growth capacity at IOC.

4.4.1.4.2.6 Clearly identify the weight of each crashworthy seat and the center-of-gravity (CG) of each one in aircraft coordinates with a corresponding diagram of the seating arrangements in the aircraft.

4.4.1.4.2.7 Describe the design solution and capabilities that would “fit” within the armor weight allocation given in Appendices A and B. The armor solution should address, at a minimum, passive ballistic protection needs including seat armor, floor armor, and transparency armor. Discuss the weight and CG impacts of ballistic protection to include assumptions made and graphic depiction(s) of areas covered as well as the threat level of protection enabled by the solution.

4.4.1.4.2.8 Describe the design solution and capabilities that would “fit” within the Avionics and Instruments weight allocation given in Appendices A and B. The Avionics and Instruments solution should address, at a minimum, Communications, Navigation, Identification, Chaff/Flare dispensers, Radar detector, Missile Detector, Helmet-mounted display, Diagnostics, Wiring System, Thermal Imaging/Sight, and Digital Display System. Identify all avionics subsystems included to meet needed

capabilities. Include substantiated weight and balance data for all B-kit components and for A-kit integration components, separately, according to each subsystem.

4.4.1.4.2.9 Clearly identify and substantiate the weight and balance impacts due to aerial refueling. Identify the weight and CG for operationally-removable components, if applicable.

4.4.1.4.2.10 Identify the following frequencies, if applicable and as warranted:

- A. Flap Natural Frequency of rotor blades
- B. Wing beam-bending mode frequency
- C. Wing chord-bending mode frequency
- D. Wing torsion bending mode frequency

4.4.1.4.2.11 If applicable, explain the anticipated operational conversion steps necessary to change the aircraft from one mission scenario to another mission scenario, and include the weight and balance impacts of such conversions.

4.4.1.4.2.12 Quantify the weight penalties reflected in Weight Empty or Basic Weight for the following specific capability needs, at a minimum. Additional penalties should be identified as determined by the RFI respondent:

- A. Optionally Manned or Unmanned (MUM) – quantify and substantiate the system weight penalty for compliance with this capability need. Also quantify and substantiate any weight impact of possibly changing the needed capability to either Manned or Unmanned instead of Optionally-MUM.
- B. Shipboard Operations – quantify and substantiate the system weight penalty for compliance with this capability need.
- C. Electromagnetic Environmental Effects (E3) – quantify and substantiate the system weight penalty for compliance with this capability need.
- D. Aerial Refueling – quantify and substantiate the system weight penalty for compliance with this capability need.
- E. Weapons – quantify and substantiate the system weight penalty in order to meet weapons carriage capabilities; internal, external or both. Explain how capabilities drive the design solution recommended and, if possible, quantify the impacts of alternate design solutions or capabilities studied.
- F. High-altitude – quantify and substantiate the system weight penalty for compliance with this potential capability need. Also quantify and substantiate any weight impact of possibly changing the needed capability to either supplemental oxygen or pressurized cabin, as applicable.

4.4.1.4.2.13 Provide weight and balance impacts due to in-flight motion of system components including, but not limited to: extension/retraction/rotation of landing gear, refueling probe, doors, or other components, as applicable. Provide weight, center-of-gravity, and moment of moving components in the “before” state as well as in the “after” state, and the axis of rotation/translation, in order to substantiate the derivation of the moment-impact of each motion.

4.4.1.4.2.14 Provide weight and balance impacts due to “folding” of system components for shipboard handling. Provide weight, center-of-gravity, and moment of folding components in the “before” state as well as in the “after” state, and the axis of rotation/translation, in order to substantiate the derivation of the moment-impact of each fold operation.

4.4.1.4.2.15 Provide estimates and substantiation of weight, 3-axis center-of-gravity, 3-axis moment of inertia and 3-axis product of inertia for the Basic Weight configuration.

4.4.1.4.2.16 Provide estimates and substantiation of weight, 3-axis center-of-gravity, 3-axis moment of inertia and 3-axis product of inertia for the shipboard/folded configuration.

4.4.1.4.2.17 Provide mission loading, weight and CG estimates and substantiation for static tip-back and/or roll-over conditions to quantify limitations in loaded and unloaded conditions during shipboard.

4.4.1.4.2.18 Provide hoisting and jacking capabilities and limitations at each load introduction point.

4.4.1.4.2.19 Provide a complete accounting of weight, CG, volumes and any other data/analysis that substantiates buoyance/flotation capability.

4.4.1.4.2.20 Clearly identify the weight and CG of raft storage in the aircraft with accompanying diagram.

4.4.1.4.2.21 Identify weight, CG and moment data for unusable fuel and specify it in the functional weight report as a Weight Empty item or as a Basic Weight item in Mission Weight Buildups.

4.4.1.4.2.22 Provide weight, CG and moment data for usable fuel in each of the fuel tanks in the aircraft. Identify the geometric dimensions and CG of each empty fuel tank that corresponds with data reflected in the functional weight report. Provide usable fuel weight, CG and moment data tables for each of the tanks at a minimum of ten graduated conditions between empty and full.

4.4.1.4.2.23 Provide mission weight buildups that substantiate weight and CG estimates for each mission profile. Mission buildups should start with Weight Empty, as found in the Estimated Weight Report, and include weight and longitudinal CG subtotals for Basic Weight, Operating Weight, Zero-Fuel Weight, and Takeoff Weight conditions. Provide detail accounting for items included in each subsequent subtotal. For missions that include troops, weapons or ordinance, clearly identify the item, location, quantity, weight and CG of each item in aircraft coordinates. List expendable and non-expendable items separately. Clearly identify the weight and CG of any mission-specific/variable components (racks, launchers, mounts, etc.) necessary for suspension of weapons on the aircraft.

A. Figures 1-4 are offered as Mission Weight Build-ups for use with the missions in Appendices A and B for responding to the RFI.

4.4.1.4.2.24 Provide diagrams for each mission profile that depict the Mission Weight Buildup graphically along with operational weight and CG limitations to verify that limits are maintained for the loading conditions.

4.4.1.4.2.25 Identify any mission loading conditions that would result in weight and/or CG limitations, taking into account aircraft component movement, fuel usage, mission expendables and passenger/crew movement conditions. Expendables may or may not be expended in every operational mission so worst-case scenarios need to be investigated in order to determine if there would be any operational restrictions.

4.4.1.4.2.26 If the solution being proposed is based on modifications to an existing production or demonstration aircraft, then submission of the following detailed information is also requested:

- A. Provide a functional weight and balance report for the baseline aircraft. It is desired that the format and content be consistent with an Actual Weight Report per SAWE Recommended Practice #7 (<http://www.sawe.org/technical/rp>). At a minimum, provide weight and longitudinal balance data and actual weighing record. Provide as many other elements of the report as possible. If not already provided, provide graphic and narrative design descriptions of the baseline aircraft by functional groups that correspond with the Actual Weight Report.
- B. For each of the modifications, provide weight, longitudinal CG, and graphic/narrative description of components anticipated to be removed from the baseline aircraft to accommodate the modification. For items removed, the Actual Weight Report will clearly show that those items are reflected in the report.
- C. For each of the modifications, provide a separate list of components to be added to the aircraft to accommodate the modification and include weight, longitudinal center-of-gravity, and graphic/narrative description of the components to be added.
- D. Provide analysis data, rationale, and methods that substantiate the basis and accuracy of weight estimates of the added components. Identify whether each item added is an existing item, a non-developmental item (NDI) or if it would require development.

Mission Payload	Unit Weight	MT-1		MT-2		MT-3	
		Close Air Support		Deep Air Support		Armed Escort	
		Qty	Objective	Qty	Objective	Qty	Objective
	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>
Pilot (if applicable)	200	1	200	1	200	1	200
Gunner (if applicable)	200	1	200	1	200	1	200
Operating Weight Items			400		400		400
Gun Installation							
Gun (TBD)	154	1	154	1	154	1	154
Ammunition	0.57	1,200	684	1,200	684	1,200	684
Linkless Feed System (MAU-211)							
Ammunition Can	206	1	206	1	206	1	206
Flex Chute	30	1	30	1	30	1	30
Feeder	22	1	22	1	22	1	22
Precision-guided Munitions							
Small-diameter Bomb							
SDB II (GBU-53/B)	209	-	-	4	836	-	-
Joint Miniature Munitions Bomb Rack Unit (JMMBRU)	372	-	-	1	372	-	-
Air-Ground Missile							
JAGM/Hellfire (AGM-114K)	115	8	920	8	920	4	460
Hellfire Launcher (M299, 4-Rail)	146	2	292	2	292	1	146
Rockets							
2.75 inch Rockets (APKWS II w/M282 warhead)	36.9	38	1,402	-	-	19	701
Rocket Launchers (LAU-61 G/A)	201	2	402	-	-	1	201
Air-to-Air Weapons							
Air-to-Air Weapons (AIM-9X)	193	2	386	-	-	2	386
Air-to-Air Launchers	90	2	180	-	-	2	180
Defensive Countermeasures							
Chaff/Flare Cartridges	0.955	60	57	60	57	60	57
Zero-Fuel Weight Items			4735		3573		3227
Total Mission Payload Weight			5135		3973		3627

Figure 1 - Mission Payload Weights for MT-1, MT-2, and MT-3

Mission Payload	Unit Weight	MT-5		MT-6		MT-7	
		Utility		Troop Insertion		Self-Deployment (HADR)	
		Qty	Objective	Qty	Objective	Qty	Objective
	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>
Pilot (if applicable)	200	1	200	1	200	1	200
Copilot (if applicable)	200	1	200	1	200	1	200
Crew Chief (if applicable)	200	1	200	1	200	1	200
Gunner (if applicable)	200	1	200	1	200	1	200
Fast Ropes	100	2	200	2	200	2	200
Fast Rope Stanchions	24	2	48	2	48	2	48
Operating Weight Items			1048		1048		1048
Troops	335	-	-	8	2,680	-	-
Gun Installations							
Gun (TBD)	154	1	154	1	154	1	154
Ammunition (Linkless)	0.57	1,200	684	400	228	-	-
Linkless Feed System (MAU-211)							
Ammunition Can	206	1	206	1	206	-	-
Flex Chute	30	1	30	1	30	-	-
Feeder	22	1	22	1	22	-	-
Crew-served Weapons							
GAU-17 Machine Gun	119	1	119	1	119	-	-
GAU-17 Ammo Can (Empty)	88	1	88	1	88	-	-
GAU-17 Ammo Belts (100 Rnds, linked)	6.5	30	195	15	98	-	-
0.50-cal Machine Gun (TBD)	140	1	140	1	140	-	-
0.50-cal Ammo Can (Empty)	61	1	61	1	61	-	-
0.50-cal Ammo Belts (100 Rnds, linked)	29.5	6	177	3	89	-	-
Gun Mounts (removable components)	67	2	134	2	134	-	-
Precision-guided Munitions							
2.75 inch Rockets (APKWS II w/M282 warhead)	36.9	38	1,402	-	-	-	-
Rocket Launchers (LAU-61 G/A)	201	2	402	-	-	-	-
Auxiliary Fuel System (if applicable)							
Auxiliary Fuel Tanks (TBD capacity)	TBD	-		-		TBD	TBD
Auxiliary Fuel Kit	TBD	-		-		TBD	TBD
Ejector Rack (if applicable)	TBD	-		-		TBD	TBD
Mounts	TBD	-		-		TBD	TBD
Defensive Countermeasures							
Chaff/Flare Cartridges	0.955	60	57	60	57	-	-
Zero-Fuel Weight Items			3,871		4,106		TBD
Total Mission Payload Weight			4,919		5,154		TBD

Note: RFI Respondent to fill-in "TBDs".

Figure 2 - Mission Payload Weights for MT-5, MT-6, and MT-7

Mission Payload	Unit Weight	A-1	
		Attack/Recon	
		Qty	Objective
	<i>lbs</i>	-	<i>lbs</i>
Pilot (if applicable)	250	1	250
Gunner (if applicable)	250	1	250
Operating Weight Items			500
Gun Installation			
Gun (TBD)	85	1	85
Ammunition	0.57	1,000	570
Linkless Feed System (MAU-211)			
Ammunition Can	206	1	206
Flex Chute	30	1	30
Feeder	22	1	22
Precision-guided Munitions			
Small-diameter Bomb			
SDB II (GBU-53/B)	209	-	-
Joint Miniature Munitions Bomb Rack Unit (JMMBRU)	372	-	-
Air-Ground Missile			
JAGM/Hellfire (AGM-114K)	115	6	690
Hellfire Launcher (Individual rail)	36	6	216
Rockets			
2.75 inch Rockets (APKWS II w/M282 warhead)	36.9	38	1,402
Rocket Launchers (LAU-61 G/A)	201	2	402
Air-to-Air Weapons			
Air-to-Air Weapons (AIM-9X)	193	-	-
Air-to-Air Launchers	90	-	-
Defensive Countermeasures			
Chaff/Flare Cartridges	1	30	30
Survival Kits	15	2	30
Zero-Fuel Weight Items			3,653
Total Mission Payload Weight			4,153

Figure 3 - Mission Payload Weights for A-1

Mission Payload	Unit Weight	A-2		A-3		A-4	
		Air Assault		Assault Security		Strategic Self-Deployment	
		Qty	Objective	Qty	Objective	Qty	Objective
	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>	-	<i>lbs</i>
Pilot (if applicable)	250	1	250	1	250	1	250
Copilot (if applicable)	250	1	250	1	250	1	250
Crew Chief (if applicable)	250	1	250	1	250	1	250
Gunner (if applicable)	250	1	250	1	250	1	250
Operating Weight Items			1000		1000		1000
Troops	335	10	3,350	Fallout	Fallout	-	-
Gun Installations							
Gun (TBD)	85	1	85	1	85	1	85
Ammunition (Linkless)	0.57	300	171	500	285	-	-
Linkless Feed System (MAU-211)							
Ammunition Can	206	1	206	1	206	1	206
Flex Chute	30	1	30	1	30	1	30
Feeder	22	1	22	1	22	1	22
Crew-served Weapons							
M240 Machine Gun	51	2	102	2	102	-	-
M240 Ammo	0.065	1,000	65	1,000	65	-	-
Pintle Gun Mounts (removable components)	5	2	10	2	10	-	-
Precision-guided Munitions							
Air-Ground Missile							
JAGM/Hellfire (AGM-114K)	115	-	-	2	230	-	-
Hellfire Launcher (Individual rail)	36	-	-	2	72	-	-
Rockets							
2.75 inch Rockets (APKWS II w/M282 warhead)	36.9	-	-	14	517	-	-
Rocket Launchers (LAU-68 D/A w/fairing)	91	-	-	2	182	-	-
Munitions mounts	67	-	-	2	134		
Auxiliary Fuel System (if applicable)							
Auxiliary Fuel Tanks (TBD capacity)	TBD	-	-	-	-	TBD	TBD
Auxiliary Fuel Kit	TBD	-	-	-	-	TBD	TBD
Defensive Countermeasures							
Chaff/Flare	1	30	30	30	30	-	-
Survival Kits	15	4	60	4	60	4	60
Zero-Fuel Weight Items			4,071		1,970		TBD
Total Mission Payload Weight			5,071		2,970		TBD

Note: RFI Respondent to fill-in "TBDs".

Figure 2 - Mission Payload Weights for A-2, A-3, and A-4

4.4.1.5 Structures:

4.4.1.5.1 Provide views of the rotor hub and hinge, clearly indicating the type of hub, overall arrangement and number of blades, direction of rotation, hinge and bearing configuration, the method of rotor blade attachment, span wise cross sections, balance weights and tip areas for main and tail rotor systems.

4.4.1.5.2 Provide a structural description report that includes perspectives of the primary and secondary fuselage structure, including bulkheads, frames, longerons etc., major cutouts, fittings and splices, critical temperature areas with design temperatures indicated. Include major cutouts, weapons bays, store provisions, engine and drive system structural interfaces, rotor systems, control systems and landing gear supports.

4.4.1.5.3 Provide landing gear arrangement, structure, materials, design sink rate, attachment fittings, stroke length, tire sizes, tire types, pressures and footprint and skid dimensions (if applicable).

4.4.1.5.4 Identify the materials usage (e.g. Al, Ti, Composites) and applicable material conditions (heat treatment for metals) for primary and secondary structures and rotor components.

4.4.1.5.5 Identify the capability to carry internal and external payloads or weapons. Ensure payload/weapon capability is clearly defined and structural provisions to integrate are identified. Identify and describe functionality of systems for deploying internally carried stores. If internal carriage requires reconfigurable mission equipment, describe installation and removal methods.

4.4.1.5.6 Provide the basic structural design criteria (requirements (specifications, regulations, etc.) and verification methods) addressing, loads, crashworthiness, strength, fatigue and dynamics. Include the structural design weights, maneuvering and landing capabilities, design and landing speeds, design envelopes.

4.4.1.5.7 Provide the design fatigue life for the airframe and dynamic components as well as any technical basis (analysis, test, methodology).

4.4.1.5.8 Provide available dynamics analyses demonstrating the aircraft's structural dynamics behavior including forcing frequencies, modal behavior as well as flutter and mechanical and aeromechanical stability assessments.

4.4.1.5.9 If available, provide the operating limitations clearly defining the basis for each identified limitation.

4.4.1.5.10 What is the proposed structural certification methodology for the air vehicle?

4.4.1.6 **Propulsion Systems:**

4.4.1.6.1 Engine Description

4.4.1.6.1.1 Engine/Propulsion system description should include:

- A. Manufacturer (OEM provider)
- B. Major component (e.g. Starting systems/APU, Compressor, Combustor, Turbine) details
- C. Dimensions
- D. Weights (as a minimum): engine dry flange to flange, nozzle separate
- E. Stage count
- F. A description of the cooling scheme (i.e. modulated, cooled cooling air)
- G. Engine limitations
 - 1) Redline/max temperature limits (e.g. Max T3, Max T4, Max T41, Max T45)
 - 2) Durability (Component) Design Point and Aero Design Point (Flt Mach, throttle setting and Altitude)
 - 3) Physical/Mechanical/Other engine limits (e.g. Max Ng, Max Ngc, Max P3, Min P3, Max torque)
- H. Component maps (compressor, burners, turbine) from actual component tests and also the maps that are used in the submitted computer engine program if they differ from those submitted from component tests.
- I. If applicable, propeller maps in the following format:

- 1) For fixed-pitch propeller, give Coefficient of Power (C_p) vs Advance Ratio (J) and Coefficient of Thrust (C_t) vs Advance Ratio (J).
- 2) For variable pitch propeller, give Coefficient of Power (C_p) vs Blade Pitch Angle at a family of Advance Ratio (J) and Coefficient of Thrust (C_t) vs Blade Pitch Angle at a family of Advance Ratio (J).

4.4.1.6.1.2 Describe overall engine control methodology, including steady state and transient operating envelope limitations.

4.4.1.6.1.3 Describe the engine power setting structure (e.g. idle, max-continuous, and maximum power), its time limitations, and the associated limits.

4.4.1.6.1.4 Describe any advanced engine technologies and variable cycle features that will enable the engine to meet desired performance levels.

4.4.1.6.1.5 Describe the position of the engine intake as compared to the weapons rocket motor exhaust and gun gas path and any mitigation planned to prevent rocket motor ingestion/debris/spent casing damage.

4.4.1.6.2 Engine Performance:

4.4.1.6.2.1 Engine Cycle Model: Provide either source code or a customer thermodynamic engine cycle model (preferably in NPSS) that allows complete generation of uninstalled/installed performance data throughout the full mission envelope. The source code or customer model output should show all relevant component data (e.g. Flow station properties; P_t , P_s , T_t , W , W_c , 3rd stream flow; Performance parameters such as component pressure ratios, component adiabatic efficiencies, etc.). The model shall be capable of handling the following effects:

- A. Air Vehicle Inlet performance (Recovery vs. Corrected Airflow and Mach number)
- B. Engine bleed air usage
- C. Mechanical horsepower extraction (requirements)
- D. Exhaust/IR suppression losses (pressure-based measurements)
- E. If applicable: Inlet spill drag and afterbody drag uniquely defined from reference conditions between propulsion and aero, which are totally independent of any particular propulsion system.
- F. If applicable: Propeller Performance Model/Interface
- G. If applicable: Nacelle Air Management Model/Interface.

4.4.1.6.2.2 A detailed user manual shall be provided that describes all the inputs, outputs, Numerical Status Indicators, and engine model limits.

Where applicable, the digital data shall be incorporated into the engine model or instructions shall be provided as to how to integrate the digitized data into the engine model (e.g. component, propeller maps, installation tables, etc.).

4.4.1.6.2.3 Propulsion Model Verification: Provide detailed substantiation for how the uninstalled/installed power or thrust available was established and verified. (i.e., flight test, model tests, engine manufacturer's cycle deck, etc.)

4.4.1.7 Drive System:

4.4.1.7.1 Describe the overall Drive System and all its subsystems.

4.4.1.7.2 What is the Gearbox Power Rating?

4.4.1.7.3 What are the power requirements placed on the drive system?

4.4.1.7.4 What are the life limits for Gears and Bearings?

4.4.1.7.5 Describe the required Lubrication System.

4.4.1.7.6 Will the system have a loss of lubrication capability? If so, describe it.

4.4.1.7.7 What are the Vibration limits and how will they be maintained?

4.4.1.7.8 What are the Torsional Stability needs?

4.4.1.7.9 What are the Environmental Conditions the drive system will need to handle?

4.4.1.7.10 What are the Torque Measurement requirements?

4.4.1.7.11 What are the Transmission and Gearbox Ratings?

4.4.1.7.12 Will component standardization and standard parts be a capability?

4.4.1.7.13 What materials will be used for castings, forgings, shafts, coating, and finishes?

4.4.1.7.14 How is the Rotor Brake/Gust Lock implemented?

4.4.1.7.15 What type of sensors will be used (debris monitoring, pressure, temperature, vibration)?

4.4.1.7.16 What are the design needs for Drive Shafting (couplings, bearings, disconnect)?

4.4.1.7.17 Provide all documented analysis/substantiation for the drive system design (drive system description analysis, torsional stability, lubrication, load/life, etc.).

4.4.1.7.18 What testing will be needed for development (oil flow, jet targeting, attitude, gear development, gear load distribution, etc.)?

4.4.1.7.19 What Qualification and Acceptance tests will be needed (component, filters, heat exchangers, blowers, etc.)?

4.4.1.7.20 What is needed for Bench Tests, Tie-Down Systems Tests, and Ground/Flight Testing related to the drive system?

4.4.1.8 Handling Qualities:

4.4.1.8.1 Describe the ground operations envelope (takeoff, landing, etc.); describe the low/high speed design flight envelope, operational/service flight envelope (if applicable) as defined by aircraft parameters and environmental conditions that shape the envelope. Describe air vehicle configuration changes required in order to transition between envelopes. Describe reasons for any restrictions or limitations to the ground or flight envelopes due to handling qualities issues.

4.4.1.8.2 Provide the tailored ADS-33E-PRF and MIL-STD-1797B specifications used for the design of the proposed aircraft, with rationale for tailoring choices. Provide a comprehensive description of the simulation models and/or analyses utilized to generate handling qualities data, including all assumptions and simplifications. Provide the predicted handling qualities performance for all tailored ADS-33E-PRF and MIL-STD-1797B specifications.

4.4.1.8.3 Describe the air vehicle characteristics for OEI and AEI conditions.

4.4.1.8.4 Describe how the air vehicle will operate in the maritime environment. Discussion should include (but not be limited to): launch/recovery (within ship deck motion of +/-3 degrees of pitch and +/-8 degrees of roll), holding, HIFR, VERTREP, and required transitions into and out of those conditions. Describe compliance to Level 1 Handling Qualities Standards (DIPES 1 or 2) within a Wind Over Deck (WOD) envelope which extends to +/-45 degrees off the nose out to 45 kts in Useable Cueing Environment 3 (UCE 3) as defined in ADS-33E.

4.4.1.8.5 Describe the mechanical and electronic flight control system from pilot input to rotor blade response. Describe flight control laws including control modes, inner loop, outer loop, autopilot, and flight director. Identify how the system will handle (respond to) GPS-denied scenarios. All flight control system documentation is to be presented in paragraph form as well as Simulink block diagrams (as appropriate).

4.4.1.8.6 CONOPS-level description of how automation will be utilized to reduce pilot workload especially in Degraded Visual Environments (DVEs).

4.4.1.8.7 Describe any handling issues/concerns with off balance loading of external store stations. Describe impact to handling qualities with deployment of internal store stations (sides or belly).

4.4.1.8.8 Describe the nacelle/rotor position and weapon engagement flight profiles including how the platform would execute combat maneuvers during 30 min combat segment, 100 ft. AGL to 6000 ft. AGL to support hover, 40-80 kts, 80-150 kts and 150+ kts airspeed. Provide time to conversion (if needed) and conceptual flight profiles to support guided/unguided weapons delivery and dynamic/evasive maneuvers (high pitch angle, diving/running fire (15-30deg), pullouts(700'-150'AGL), pop-ups, elevation gain). How would the rotor/nacelle downwash potential affect weapon deployment/trajectory (aerial ballistics of fin/spin stabilized projectiles)? What, if any, offset would be needed to employ forward quadrant munitions to prevent damage to airframe and loss of sensor coverage?

4.4.1.8.9 Are there any concepts for turreted or multi-directional launcher racks for employing munitions?

4.4.1.9 **Flight Controls:**

4.4.1.9.1 What is the design-to Probability Loss Of Control (PLOC)? What is the basis for establishing PLOC? How is PLOC substantiated?

4.4.1.9.2 Describe the flight control system architecture. Flight Control System (FCS) should include all components from command inputs to aerodynamic surface response, and all required sensors for piloted, autopilot, and autonomous control laws.

4.4.1.9.3 Describe the flight control law concept for piloted flight and autonomous operation. Include a description/figure of the flight control law architecture. Include a description of the top level modes, autopilot modes, flight director modes, and navigation and guidance modes. Provide the approach for inner loop control law design and analysis including expected basis for Plant models.

4.4.1.9.4 Quantify the anticipated performance characteristics of the FCS in a hover condition including, but not limited to, response to step commands, maximum roll rate, maximum pitch rate. Describe methodology for arriving at these values.

4.4.1.9.5 Describe any artificial rate limitations imposed by any FCS subsystems.

4.4.1.9.6 Describe the general approach for handling system faults through input signal management and system reconfiguration. Include your standard mitigation techniques or philosophies, redundancy management schemes, etc. as necessary.

4.4.1.9.7 Describe the contingency mode concepts for autonomous operations including onboard failures and loss of critical sensors or data links.

4.4.1.9.8 What sensors, displays, and automation will be available to support a DVE capability in zero visibility?

4.4.1.9.9 What FCS items are COTS/NDI, what items are new developments? For non-COTS/NDI, what is the basis for the cost and weight estimate provided?

4.4.1.9.10 For any existing or COTS/NDI components or systems, what qualification testing has been completed?

4.4.1.9.11 What physical architecture and software functionality is included in the cost and weight provided? If applicable, what modifications to the existing system are included in the cost and weight provided?

4.4.1.9.12 Have other system configurations been considered to improve PLOC, reduce maintenance, or provide other benefits? Have trade-studies been completed or planned to substantiate system architecture choices, subsystem/component choices, etc.?

4.4.1.10 Fuel Containment:

4.4.1.10.1 What type of fuel cells does the aircraft use (i.e. bladder or structural) and where are they located? If bladder, is there a secondary barrier around the fuel cell?

4.4.1.10.2 Does the aircraft provide features for crashworthy and self-sealing fuel systems including fuel bladders?

- A. To what standards do these features comply (ex: MIL-DTL-27422F, MIL-STD-1290A, MIL-T-18847C)?
- B. Will all fuel cells be completely ballistic tolerant or just the lower third?

4.4.1.10.3 What is the total fuel capacity including usable and unusable fuel?

4.4.1.10.4 How many fuel tanks (permanent and auxiliary) will be required to meet the needed range?

4.4.1.10.5 What new technologies are you employing, if any, for fuel bladders?

4.4.1.10.6 Is your aircraft employing an automated fuel balancing system for efficiencies?

4.4.1.10.7 Provide a fuel system diagram.

4.4.1.11 Aerial Refueling:

4.4.1.11.1 What experience does your company have with aerial refueling equipment and integration of fuel management during aerial refueling?

4.4.1.11.2 Is the aircraft aerial refueling capable?

- A. Has the aerial refueling system been qualified in accordance with MIL-A-19736A, MIL-HDBK-516, JSSG-2009?
- B. Provide a description of the aerial refueling probe. Include location, material, length, weight, etc.
- C. What tankers are certified to refuel the aircraft?
- D. What fuel delivery pressures and flow rates can the aircraft accept from the tanker?
- E. Provide a schematic of the aerial refueling fuel system.

4.4.1.11.3 Have you ever designed a retractable probe? If so, provide examples.

- A. Is the probe hydraulically or electrically driven?
- B. Does the probe installation meet the clearance requirements of STANAG 3447?
- C. Can the probe, its attachment to the airframe structure, and the structure surrounding the interface withstand the loads experienced during the aerial refueling process (engagement, disengagement, and fuel transfer) with the tanker without being damaged or creating FOD?

4.4.1.11.4 Is your company familiar with surge pressures encountered during aerial refueling and the requirements to keep surge pressures below the proof pressure of the fuel system?

4.4.1.11.5 How do you intend to meet the “MUM T/optionally manned” for the Aerial Refueling capability?

4.4.1.12 Electrical Power:

4.4.1.12.1 The following detailed information, if applicable, is requested:

4.4.1.12.1.1 Describe the Primary Electrical Power sources of the aircraft:

A. Main Generators

- 1) AC or DC output
- 2) Rating
- 3) Overload capabilities
- 4) Mounting locations (Engine, gearbox, etc.)
- 5) Number of units
- 6) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL-STD-810/461/464)
- 7) Other aircraft applications where used
- 8) Cooling method
- 9) Weight of the component

B. Main Generator Control Unit

- 1) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL- STD-810/461/464)
- 2) Protective functions
- 3) Other aircraft applications where used
- 4) Weight of the component

4.4.1.12.1.2 Describe the Secondary Electrical Power and Backup or Emergency Power sources of the aircraft:

A. Converters or Inverters

- 1) AC or DC output
- 2) Rating
- 3) Overload capabilities
- 4) Number of units
- 5) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL-STD-810/461/464)
- 6) Other aircraft applications where used
- 7) Cooling method
- 8) Weight of the component

B. Batteries

- 1) Chemistry
- 2) Rating

- 3) Number of units
- 4) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL-STD-810/461/464)
- 5) Other aircraft applications used on
- 6) Weight of the component

4.4.1.12.1.3 Describe the Engine Starting capabilities of the aircraft:

- A. If APU Engine/Generator, describe the Generator and GCU system:
 - 1) AC or DC output
 - 2) Rating
 - 3) Overload capabilities
 - 4) Mounting locations (Engine, gearbox, etc.)
 - 5) Number of units
 - 6) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL-STD-810/461/464)
 - 7) Other aircraft applications where used
 - 8) Cooling method
 - 9) Weight of the component
- B. If Hydraulic or Pneumatic, describe the role of the Electrical Power System
 - 1) Is battery required
 - 2) Is External Electrical Power required

4.4.1.12.1.4 Describe the External Electrical Power capabilities of the aircraft:

- A. Compatibilities
 - 1) Connection type
 - 2) Power rating
- B. External Power Monitor
 - 1) MIL qualified or COTS – for component performance, environmental and EMI/EMC (i.e. MIL-STD-810/461/464)
 - 2) Other aircraft applications where used
 - 3) Weight of the component

4.4.1.12.1.5 Describe the Electrical Power Distribution System of the aircraft:

- A. Is the Electrical Power Distribution System designed to provide MIL-STD-704F quality power to all utilization equipment?
- B. Explain how Electrical Power is distributed throughout the aircraft Electrical Power bus architecture with any and all combinations of provided Electrical Power sources
 - 1) Battery Power
 - 2) External Power
 - 3) APU Power
 - 4) Main Generator Power

C. Explain the capabilities of the Electrical Power Distribution System in case of loss of power source

1) Reconfiguration of Primary and Secondary Power bus architecture

a) Is it automatic or is crew action required?

b) Does reconfiguration retain as many electrical buses as safely possible?

2) Protection against power source and/or bus “door-belling”

D. Does the wiring system all meet the requirements of SAE AS50881

1) Is the wiring sized appropriately to safely handle the electrical loading demand?

2) What is the expected weight of the electrical power distribution system including relays, connectors, wiring, terminal boards, associated hardware, etc.?

4.4.1.12.1.6 Describe the aircraft’s electrical loading

A. What is the baseline electrical power demand of the aircraft?

1) Is there an Electrical Loads Analysis (ELA) per MIL-E-7016?

2) Does ELA cover all operation conditions including power source failures?

3) Provide an itemized list of power usage by system (flight controls, weapons, comms, nav, ASE, anti-ice, etc.).

B. Do both the primary and secondary systems have the capability to provide the required power with additional power to supply added weapons systems?

1) Are you considering MIL-STD-1760 interface for the weapons stations? If so, what type of interface class?

C. How much growth margin is factored into primary and secondary systems?

4.4.1.12.1.7 Does the electrical power system have prognostic and diagnostic capabilities?

4.4.1.12.1.8 What is the power type/capacity provided to the internal/external stations? How is it controlled/regulated? What is the planned electrical interface to the stations?

4.4.1.13 **E3:**

4.4.1.13.1 The following detailed information, if applicable, is requested:

4.4.1.13.1.1 Air Vehicle

A. What is the aircraft made of? (aluminum, composite, mixture?)

B. Has any shielding been added to the aircraft for EMI protection? If so, what are the specifications of the shielding?

C. Have any considerations been made for lightning protection for the aircraft? What are they? What testing has been performed? What testing is planned?

D. What antennas will be installed on the baseline configuration? Where will they be located? Has a location analysis been performed?

E. What other equipment will be mounted externally on the baseline configuration?

F. In regard to Air Vehicle, what E3 (EMI, EMC, EME, ESD, Lightning, P-Static, Bonding, TEMPEST, EMCON, HERP) has already been performed? To what pedigree has the

equipment been tested (MIL-STD-461, DO-160, MIL-STD-464, etc.)? Is there any planned testing?

4.4.1.13.1.2 Avionics

- A. What transmitters will be installed on the baseline configuration of the aircraft?
- B. What Comm/Nav equipment will be installed on the baseline configuration of the aircraft?
- C. What other avionic equipment will be installed on the baseline configuration of the aircraft?
- D. In regard to Avionics, what E3 (EMI, EMC, EME, ESD, Lightning, P-Static, Bonding, TEMPEST) has already been performed? To what pedigree has the equipment been tested (MIL-STD-461, DO-160, MIL-STD-464, etc.)? Is there any planned testing?

4.4.1.13.1.3 Mission Systems

- A. What Electrically Initiated Devices will be installed on the baseline configuration of the aircraft? Has a HERO analysis been performed? What consideration has been made to the event of an unintentional firing WRT the Cargo Hook System as well as other EID based systems that could cause harm to the aircraft or personnel?
- B. In regard to Mission Systems, what E3 (EMI, EMC, EME, ESD, Lightning, P-Static, Bonding, TEMPEST, HERF, HERO) has already been performed? To what pedigree has the equipment been tested (MIL-STD-461, DO-160, MIL-STD-464, etc.)? Is there any planned testing?

4.4.1.13.1.4 Flight Controls

- A. Does the aircraft use a (fully or partially) fly-by-wire system? If so, in what areas of the aircraft is the system implemented?
- B. Is there a FADEC installed on the aircraft?
- C. In regard to Flight Controls, what E3 (EMI, EMC, EME, ESD, Lightning, P-Static, Bonding, TEMPEST) has already been performed? To what pedigree has the equipment been tested (MIL-STD-461, DO-160, MIL-STD-464, etc.)? Is there any planned testing?

4.4.1.13.1.5 T&E

- A. What Instrumentation equipment has been identified for use during testing? To what level has the equipment been qualified?

4.4.1.14 **Survivability:**

4.4.1.14.1 From a survivability standpoint, what future threat capabilities have been considered in the development of this concept aircraft?

4.4.1.14.2 From a survivability standpoint, what unique capabilities and performance does this aircraft concept offer in terms of mission effectiveness?

- A. Was mission effectiveness modeled?
- B. What M&S tools were utilized?

- 4.4.1.14.3 What susceptibility reduction features are envisioned for the aircraft?
- A. Will the Aircraft Survivability Equipment (ASE) be fully integrated into this platform and interoperable with other platforms? How will threat information be displayed, shared and acted on by an ASE (ASE–aircraft systems interface), associated countermeasures and on/off-board weapon systems?
 - A. Will the aircraft incorporate any threat avoidance automated flight control capability?
 - B. Will ASE systems be constrained in sensor and countermeasure coverage and performance due to airframe design obstructions or exhaust flow?
 - B. Is open architecture a consideration in the design of this ASE system? Will the architecture be compliant to any standards e.g. FACE? What are the benefits?
 - C. Will threat (guided/unguided) response (active/passive) involve or be coordinated with other aircraft (e.g. wingmen, drones, other platforms) and will there be cooperative detection, engagement and defeat of threats?
 - D. On the battlefield, to what effect is multispectral sensor information collected and fused?
 - 1) What is the expectation for improved operator situational awareness? What capabilities can be brought to the platform in terms of operating in degraded visual environments?
 - 2) What networking capability is envisioned? What data products can be moved to and from this aircraft and shared amongst wingmen and other platforms? How can such data sharing capabilities be used to increase survivability?
 - E. What levels of aircraft signature (acoustic, visual, IR, RF, others) suppression are envisioned?
 - 1) What signature reduction technologies can be incorporated and what are their respective Technology Readiness Levels?

4.4.1.14.3 What Vulnerability Reduction features are envisioned for the aircraft?

- A. For critical flight systems and components, what technologies and materials can be incorporated into the design to decrease vulnerability?
 - 1) Describe redundancy and separation of critical flight systems included in the aircraft concept design.
 - 2) Describe the ability of the flight control system to adapt/optimize to mitigate the effects of ballistic damage.
 - 3) Describe the use of other features such as self-sealing fuel system, dry-bay fire suppression, fuel tank explosion protection, leak mitigation, hydrodynamic ram mitigation, etc.
 - 4) Are there technologies and materials capable of improving survivability (reduce vulnerability) of dynamic rotating components such as drive shafts, drive couplings, bearings, swashplates and rotor blade control components?
 - 5) Are gear boxes designed for ballistic impact, can they continue to operate with fly-home capability?
 - 6) Describe gearbox design features for maintaining fly-home capability when a loss of primary lubrication occurs.
 - 7) What technologies and design features will be used to protect the flight crew and passengers from small arms and other threats to the aircraft? Can ballistic protection (e.g. armor) be integral to the airframe?
 - 8) Due to aircraft speed needs, are there unique challenges associated with weapons carrying capability and are there integration concerns?
 - 9) Does a weapons-carrying capability pose any vulnerability concerns?

- 10) Describe any specific design features (e.g. health monitoring system) that aide pilots in identifying real time threat induced damage to flight critical components and/or structure.
- B. Based on existing designs, previous testing of existing airframes and new technologies envisioned for FVL, what Live Fire Testing should be conducted in compliance with Title 10 US Code 2366 requirements?

5.0 Mission Systems

5.1 Avionics Suite:

- 5.1.1 Describe the avionics architecture
 - A. Are the avionics components connected via a digital data bus?
 - B. Does the architecture utilize any Wave Division Multiplexing technology? If so, describe.
 - C. Describe your use of fiber optics cabling and switching technology for increased mux signal speed and bandwidth and decreased weight.
 - D. Describe the redundancy of the architecture.
 - E. Is any portion of the avionics system architecture FACE conformant?
- 5.1.2 Communications System
 - A. Describe the aircrafts communications suite. List installed radios and current functionalities.
 - B. Is Beyond Line-of-Sight communications possible. If so describe the system in detail.
 - C. List and describe associated antennas and interconnects.
- 5.1.3 Navigation System
 - A. Describe the aircrafts navigations system
 - B. Describe any aircraft unique capabilities for navigation in a GPS denied environment.
- 5.1.4 Identification Friend or Foe
 - A. Describe the aircrafts IFF transponder and available modes.
- 5.1.5 Mission Computer or Equivalent
 - A. Describe the mission computer system in detail.
- 5.1.6 Displays
 - A. Describe the planned aircrafts' display systems, architecture should a display fail, and any use of advanced technology in this area.

5.2 Sensors:

- 5.2.1 What portion of available size, weight, and power (SWAP) is estimated to be allocated to RF, multispectral (EO/IR), or other sensors?
- 5.2.2 Describe the general concept for RF sensor antenna/aperture placement(s) on the platform to achieve the need for 360 degree air to surface and air-air target detection, tracking, and identification.
- 5.2.3 Describe the positioning of the installed sensors. Describe the targeting capability for the sensors. Describe the concept for geo/spatial location by the sensor to support targeting.
- 5.2.4 Describe how aircraft sensors will provide targeting/tracking information to weapons (i.e. fused tracking, laser designation, RF targeting, etc.).
 - A. How many active/passive tracks will the platform be capable of?
 - B. What is the field of view (FOV) of the sensor?
 - C. What is the field of regard (FOR) of the sensor?
 - D. What is the planned resolution/range for each type of sensor? At various altitudes?

- E. What is the TRL of the sensor suite?
- F. What types of technology are being planned/investigated to support the platform?
- G. How many targets can be designated simultaneously?
- H. Is the sensor slew rate/tracking capability capable of handling air-to-air engagements?
 - I. How will the sensor address battlefield obscurity? (smoke, defilade, low visibility)
 - J. How will the EO/IR suite address day/night and thermal crossover?
- 5.2.5 Describe how off-board targeting/track files will be transmitted/relayed to sensors/weapons.
- 5.2.6 Describe the structure for mounting. Describe plans for mitigating operational/flight environment conditions (specifically aircraft vibration, high altitude freezing, moisture intrusion).
- 5.2.7 What types of helmet mounted display/heads-up display systems are being proposed for interfacing with the sensor suite?

5.3 Weapons/Stores:

- 5.3.1 What portion of available size, weight, and power (SWAP) is estimated to be allocated to Weapons and Store Stations? Does the SWAP include gun/sensor turret or is that allocated to air vehicle?
- 5.3.2 Describe the general concept for weapons/stores placement(s) on the platform to achieve the need for 360 degree air to surface and air-air target engagement.
 - A. Describe the weapon types planned for integration (lethal and non-lethal). Show a diagram of the Weapon Engagement Zones (WEZ) and effective range for the weapon loadout for each mission with respect to the aircraft for various altitudes. Describe additional store types that would be supported by the platform (i.e. auxiliary tanks, training pods, electronic warfare (EW), etc. Trade study analysis for weapon/store types that demonstrate combination effects (range coverage, capability, effectiveness, lethality, etc. as applicable)
 - B. Identify any areas of Seeker blinding that could prevent Lock-on Before Launch (LOBL) or area coverage/suppression type engagements in the weapons/sensor field of regard. For example if the pylon is too close to the airframe, the effective radiation/seeker aperture may be blocked for various weapons/EW/sensor pods. Nacelle position may inhibit port/starboard field of fire for crew-served weapons.
 - C. Describe weapon/store station position that would support the combat/weapons engagement profiles identified in Appendices A and B. Identify how internal/external stations could be loaded and deployed to support the mission profiles.
 - D. What are the pitch/roll/yaw angles of the pylons relative to the aircraft? How does the aircraft pitch angle change at various airspeeds? Do the pylons articulate to enable long range and/or off-axis engagement or are they fixed?
 - E. Estimates for Weapon Delivery Accuracy and Target Location Error based on employment scenarios depicted in Appendices A and B.
 - F. Several of the current Rotary Wing weapon variants have airspeed employment limitations at 150kts (APKWS, Hellfire, JAGM) and gun system accuracy is affected by the delivery profile. How does this affect the weapons implementation on the proposed aircraft design? Would the FVL need to consider fixed wing variants as well as rotary wing variants IOT accomplish the mission sets described in Appendices A and B? Does the nacelle/rotor transition mode support the lower speed employment and still provide combat maneuverability? Several weapons have min/max elevation limitations (i.e.

SOPGM, CSW). How are these limitations being considered with respect to flight envelope?

- G. Describe how/which weapons will be capable of employment on the ground? Perimeter defense during load/unload troops/cargo? (Yankee/V-22 RMWS) How will CSW be stowed in-flight to perform high elevation flight profiles and HAAR?

5.3.3 Describe the weapon/store station interfaces to the platform

- A. Describe in detail the wiring/connectors/umbilicals and interface for each station and how wiring harnesses will be secured/protected inflight during weapons employment and jettison. (i.e. 1760/UAI, Ethernet, 28VDC rocket umbilicals)
- B. Describe in detail any additional interface features for the internal/external stations to support future weapons integration (optics, cooling, NET enabled, data link, directed energy weapons)

5.3.4 Describe the general concept for weapons/stores handling, loading/downloading, arming/dearming on the platform. (include where applicable)

- A. Support/test equipment/tooling/carts/hoists
- B. Ground/operator clearance for maneuvering to load/download including shipboard and FARP environments
- C. Emergency/non-routine procedures for hung stores/suspension equipment
- D. Need to understand the level of effort required to reconfigure the aircraft for different mission types (i.e. CAS/Attack, Escort, Troop deployment)

5.3.5 Describe the general concept for configuring the aircraft for mission conversion and periodic maintenance including pylon, rack, suspension equipment, gun mounts/turrets on the platform.

- A. Reliability predictions/Maintenance concept/Manpower Supportability
- B. Support/test equipment/tooling/lifts/hoists
- C. Ground/operator clearance for maneuvering to install /remove
- D. Level of maintainer/manpower/time
- E. Need to understand the level of effort required to reconfigure the aircraft for different mission types (i.e. CAS/Attack, Escort, Troop deployment)

5.3.6 Describe the structure/load that the internal/external pylons and suspension equipment will be designed to support (Mil-Std-8591). Normal flight profiles? Fatigue? Crash loads?

5.3.7 Provide Concept of Operations recommendations and description for weapons loadout/inventory to support the mission described in Appendices A and B to include number of engagements, range, suppression vs precision attack, min/max altitude for engagement (based on weapons type).

5.3.8 Describe the design/block diagram for the fire control system/stores management system.

Provide a functional description if applicable including:

- A. Architecture (centralized or distributed, digital/analog interface, DI, sensors, avionics, link interface)
- B. Subsystem hardware (store management computer, station control units, power control modules, etc.)
- C. Inventory management
- D. Built-in Test
- E. Suspension/release equipment control

- F. Fusing/Arming/safety interlocks
- G. Release consent
- H. Operator interface/controls/displays
- I. Off-board command and fire control

6.0 Cost

6.0.1 This portion of the RFI will focus on, by appropriation, general cost ground rules, assumptions and historical basis for the elements of cost for the various concepts available. In addition to cost-specific information, this portion of the RFI also focuses on soliciting ideas and inputs regarding affordability initiatives and cost reduction/mitigation techniques which can be applied to the 2032 and beyond associated capabilities. Areas of interest include changes to Concept of Operations (CONOPS)/tactics of current and future systems; identification of cost drivers for system design, testing, production and sustainment; recommendations on training, maintenance, support activities, Department of Defense (DoD) business policy (how requirements and oversight potentially drive cost and schedule), with the goal of reducing or mitigating those costs. Fundamentally, the government is looking to plan affordability potential into integrated warfare capability while filling capability gaps associated with the sundown and retirement of the H-60 and H-1 airframes to become better informed of future alternatives.

6.02 Cost and Schedule:

6.0.2.1 Ground Rules and Assumptions

- A. Provide any/all updates since the original February RFI responses
- B. Provide all inputs in an Excel workbook
- C. Where cost values are provided, submit as a value in Constant Year FY18\$.
- D. If inflation factors are used for cost normalization, use 2016 OSD inflation indices.

6.0.2.2 Schedule

- A. Formulate a theoretical program schedule that considers development and qualification timelines to achieve certification, and is consistent with recent acquisition reform and guidance contained within the most recent DoD5000.02 (Technical Demonstration and EMD phases, Milestone A or B insertion, etc.). Include engineering and design reviews (SETR events) such as SRR, SFR, PDR and CDR. At a minimum, the notional schedule should contain the following phases and associated timelines:
 - 1) TMRR Phase, if applicable
 - a) Preliminary Design Timeline
 - b) Timeline to first prototype delivery
 - 2) Engineering and Manufacturing Development (EMD) Phase
 - a) Critical Design Timeline
 - b) Timeline to First Flight
 - 3) Production and Deployment Phase
 - a) Lot delivery timelines
 - b) Full Rate production Decision

6.0.2.3 Cost

- A. Provide cost projections for the following areas, in accordance with your schedule, and document the assumptions; specifically identify the cost methodology used in determining costs and identify specific items where cost is based on actual costs incurred.

Provide your cost information, to a level 4 indenture, in a Mil-STD-881C WBS format. The WBS should also be accompanied by a WBS Dictionary for mapping purposes. The following is included as an EXAMPLE of an acceptable WBS format:

1.0	FVL CAPABILITY #3 EFFORT
1.1	AIR VEHICLE (AV)
1.1.1	AIRFRAME
1.1.1.1	FUSELAGE
1.1.1.2	TAILBOOM AND EMPENNAGE
1.1.1.3	ROTOR SYSTEM
1.1.1.4	DRIVE SYSTEM
1.1.1.5	ELECTRICAL SYSTEM
1.1.1.6	ANCILLARY PROPULSION
1.1.1.7	OTHER AIRFRAME (Specify)
1.1.1.8	INTEGRATION, ASSMBLY, TEST, AND CHECKOUT
1.1.2	PROPULSION
1.1.3	AV APPLICATIONS SOFTWARE
1.1.4	AV SYSTEM SOFTWARE
1.1.5	COMMUNICATIONS/IDENTIFICATION
1.1.5.1	****
1.1.6	NAVIGATION/GUIDANCE
1.1.6.1	****
1.1.7	CENTRAL COMPUTER
1.1.7.1	MISSION COMPUTER
1.1.7.2	AIR DATA COMPUTER
1.1.8	FIRE CONTROL
1.1.9	DATA DISPLAY AND CONTROLS
1.1.9.1	****
1.1.10	SURVIVABILITY
1.1.10.1	****
1.1.11	RECONNAISSANCE
1.1.12	AUTOMATIC FLIGHT CONTROL CENTRAL INTEGRATED
1.1.13	CHECKOUT
1.1.14	ANTISUBMARINE WARFARE
1.1.15	ARMAMENT
1.1.16	WEAPONS DELIVERY
1.1.17	AUXILIARY EQUIPMENT
1.1.17.1	****
1.1.18	CREW STATION SYSTEMS ENGINEERING/PROGRAM
1.2	MANAGEMENT
1.2.1	NON-ILS SYSTEMS ENGINEERING
1.2.2	ILS SYSTEMS ENGINEERING

	NON-ILS PROGRAM
1.2.3	MANAGEMENT
1.2.4	ILS PROGRAM MANAGEMENT
1.3	SYSTEM TEST & EVALUATION
	DEVELOPMENT TEST &
1.3.1	EVALUATION
	OPERATIONAL TEST &
1.3.2	EVALUATION
1.3.3	MOCKUPS
1.3.4	TEST & EVALUATION SUPPORT
1.3.5	TEST FACILITIES
1.4	TRAINING
1.4.1	EQUIPMENT
1.4.2	SERVICES
1.4.3	FACILITIES
1.5	DATA
1.5.1	TECHNICAL PUBLICATIONS
1.5.2	ENGINEERING DATA
1.5.3	MANAGEMENT DATA
1.5.4	SUPPORT DATA
1.5.5	DATA DEPOSITORY
1.6	PECULIAR SUPPORT EQUIPMENT
	TEST AND MEASUREMENT
1.6.1	EQUIPMENT
	SUPPORT AND HANDLING
1.6.2	EQUIPMENT
	INITIAL SPARES AND REPAIR
1.7	PARTS
1.8	COMMON SUPPORT EQUIPMENT
1.9	OPERATIONAL/SITE ACTIVATION
1.10	INDUSTRIAL FACILITIES

6.0.2.4 RDT&E, Total Research Development Test and Evaluation (RDT&E) Costs (BY18\$) - Broken into Recurring & Non-Recurring (Assume two prototypes for Technology Demonstration Phase and four production representative articles for Engineering and Manufacturing Development Phase) Note: provide rationale if you believe the program can be executed with moderate risk by entering at Milestone (MS) B or with fewer prototypes per phase.

- A. Provide staffing profiles (average “Full Time Equivalents” or FTEs per year) by fiscal year to support your development schedule and group into the following: Air Vehicle, Avionics & Mission Systems, SE/PM, Logistics, Test & Evaluation, and Security.
- B. Describe software of existing system and how it potentially will be modified to meet FVL system concept. Provide the Source Lines of Code (SLOC) values and software language for each existing system and estimate the projected new, modified, and reuse SLOC values for the FVL system concept. Provide information (i.e. analogous/actual information) and a brief description of your strategic approach to system software development to assist with understanding estimate basis.

- C. Provide drawing counts and associated productivity metrics for existing system and projected drawing count of FVL system concept.
- D. Identify unique GFE/GFI items required to support development of FVL system concept.
- E. Describe a concept for Contract Logistics Support (CLS) for a system fielded for development/operational test activities of approximately thirty months in duration. Provide cost ROMs associated with CLS concept.
- F. Provide a brief description of your concept's anticipated test program to be employed.
- G. Provide the current TRL levels associated with the technologies included in each WBS element of your concept
- H. Describe the Information Security capabilities of your products and what standards they meet. What implications to overall system cost do you anticipate as a result of these Information Security Capabilities?
- I. What is the anticipated cost associated with the data rights strategy previously listed in the summary capability needs section above under bullet #12?

6.0.2.5 Procurement

- A. Identify your calculation assumptions for "Number of Procurement Lots," "Lot Quantity," as well as "Total Aircraft Buy."
- B. Identify the single shift minimum sustaining yearly production quantity.
- C. For each system being described, provide the following cost information with the associated limitations:
 - 1) Total Procurement Costs (BY18\$) - Broken into Recurring & Non-Recurring (Based on 349 air vehicles at the minimum sustaining yearly qty stated above)
 - 2) Fly away cost (BY18 \$) (Based on 349 air vehicles at the minimum sustaining yearly qty stated above)
 - 3) Unit Recurring Flyaway Cost (BY18\$) - Expand recurring unit fly-away cost value into typical Navy Budget Exhibit P-5 sheet elements: Air Vehicle, Propulsion, Avionics, IAT&CO, SEPM, and ECOs. Provide detailed substantiation information (i.e. analogous/actual cost information) to assist with estimate rationale and basis.
- D. Describe the Production strategy associated with each conceptual design to include the following:
 - 1) Production line- stand-alone or share with other TMS's
 - 2) Production tooling requirements and associated cost (assumptions for number of procurement lots, lot quantity, and total aircraft buy should be consistent with your calculation assumptions for recurring unit fly-away cost above.
 - 3) Production rate that can be achieved with tooling requirements
 - 4) Identify any potential teaming arrangements for major subcontractors
 - 5) Identify what items, if any, are to be procured and provided as GFE
 - 6) Identify the projected labor and material mix for end item cost
 - 7) Identify assumed aggregate improvement and quantity curves for identified production quantities through the production cycle, identifying breaks if appropriate
- E. Describe and identify typical (or average) annual costs in a production environment for: tooling, support equipment, publication updates, and initial sparing.

6.0.2.6 Operating and Support Cost

- A. Describe the maintenance and support approach for your concept.
- B. Provide total O&S cost estimates of the FVL concept to support your production buy assumptions and include the following assumptions:
 - 1) 25 year service life
 - 2) ~255 average yearly flight hours (Operational aircraft must fly 22 hours per month)
 - 3) Assume 255 hours per year with 1.5 hour mission time per sortie
 - 4) Provide total costs as total O&S, cost per aircraft per year, and cost per flight hour.
 - 5) Categorize into the structure provided below. Provide substantiation information (i.e. analogous/actual cost information) to assist with estimate rationale and basis.
 - 6) Provide targeted system reliability

WBS Total
1.0 UNIT-LEVEL MANPOWER
1.1 OPERATIONS
1.2 UNIT-LEVEL MAINTENANCE
1.3 OTHER UNIT-LEVEL
2.0 UNIT OPERATIONS
2.1 Operating Material
2.1.1 Energy (POL, Electricity)
2.1.2 Training Munitions & Expendable Stores
2.1.3 Other Operational Material
2.2 Support Services
2.3 Temporary Duty
3.0 MAINTENANCE
3.1 Organizational Maintenance And Support
3.1.1 O-Level Consumables
3.1.2 O-Level Repair Parts
3.1.3 O-Level DLRs
3.1.4 Contract Maintenance Services
3.1.5 Other Unit Maintenance
3.2 Intermediate Maintenance
3.3 Depot Maintenance
3.3.1 Government Depot Repair
3.3.2 Contractor Depot Repair
3.3.3 Other Depot Maintenance
4.0 SUSTAINING SUPPORT
4.1 System Specific Training
4.2 Support Equipment Replacement
4.3 Operating Equipment Replacement
4.4 Sustaining Engineering and Program Management
4.5 Other Sustaining Support
5.0 CONTINUING SYSTEM IMPROVEMENTS
5.1 Hardware Modifications or Modernization
5.2 Software Maintenance & Modifications
6.0 INDIRECT SUPPORT
6.1 Installation Support
6.2 Personnel Support
6.3 General Training and Education

- C. Identify proposed personnel requirements for operating and maintaining system concept.
- D. Identify repair capability of overall and/or specific dynamic systems (OEM, Gov't depot, other).
- E. Identify proposed publications philosophy (paper, electronic, combination), page counts and maintenance level for each type of technical manual.

- F. For each system concept, what are the projected annual software maintenance costs? Provide information (i.e. analogous/actual information) to assist with understanding estimate basis.
- G. Describe sparing levels of existing system (for engines, PSE, training equipment) and how levels would adjust for FVL system concept.
- H. For each Aircraft system/subsystem being described that is currently in the DoD supply chain, provide NIIN, P/N, and CAGE of the top 25% highest cost parts. (i.e. GE engine, ARC-210 Radio).
 - I. Describe unique PHS&T considerations for the system.
 - J. What is the Support Equipment required to operate and maintain existing systems, and what is the percentage of CSE?
 - K. Describe your DMSMS and obsolescence management program.
 - L. Describe concepts, materials, and equipment (courseware, simulators, training aids, mock-ups) required to adequately train operators and maintainers to operate the FVL system concept.
- M. Describe special facilities required for the development, production, testing, training, storage and maintenance of the FVL system concept.

6.0.2.7 Affordability

6.0.2.7.1 Affordability¹ has always been a priority; however its emphasis considering the US Governments options is paramount given the fiscal outlook from which upfront investment would be required. Given that some candidate concepts are at early technology readiness levels (TRL) levels of maturity, the US Government team is interested in understanding the risk areas that your organization predicts will challenge cost and schedule predictions/assumptions and realization of those estimates. We ask you to provide background on past program experiences, including the major obstacles, risks, issues and variables associated with design and development of systems that may provide insight into cost and schedule drivers to allow planned avoidance of such pitfalls while introducing new ways to affordably acquire capability.

6.0.2.7.2 Responses are encouraged from industry and should provide data regarding affordability and cost reduction/mitigation techniques. When providing details of the cost reduction techniques, provide cost data and relative complexity that shows both the costs associated with and without the technique applied.

6.0.2.7.3 The following is a list of specific areas of interest (in no specific order or priority) for each respondent concept. If there are additional costs saving measures not identified below, provide adequate background, data and applied methodology in your response.

- A. Cost-saving modifications/adaptations to CONOPS/tactics of current and future systems.
 - 1) Additional information:
 - a) Baseline systems should be considered to include current operational systems.
 - b) CONOPS/tactics changes should consider not only rotary wing assets but the enabling systems as well. These systems may include weapon improvements (both on and off board), space assets, networks, sensors, etc.
 - 2) Specific question(s):

¹ Achieving affordable programs (affordability): Conducting a program at a cost constrained by the maximum resources the Department can allocate for a capability. These resources include funding, schedule and manpower. What is better buying power? <http://bbp.dau.mil/>, 26 November 2013.

- a) Can these changes increase/maintain system effectiveness while reducing cost or what degradations in effectiveness would be realized versus the cost savings?
 - b) Is there a way to modify CONOPS/tactics to save fuel cost?
- B. Cost drivers of system design, testing, production, sustainment and how to reduce or mitigate those costs.
 - 1) Additional information:
 - a) Historically, system procurement prices have increased resulting in reduced procurement quantities.
 - 2) Specific questions(s):
 - a) From an Industry perspective, what drives increases in system design, testing, production, sustainment, etc.?
 - b) What changes would be recommended in the early system design process that would lead to decreased cost in all program phases?
 - c) How would your organization leverage such a change to realize cost savings?
 - d) Are there any revolutionary production techniques (i.e. 3D printing of parts) that could reduce production cost? To what portions of the aircraft could this production technique be applied (i.e. non-structural only)?
 - e) Are there commercial or military maintenance, information technology and supply chain management techniques and technology that could reduce the life cycle cost of future platforms?
 - f) What are cost saving drivers/strategies for the Government to affordably access or own technical data associated with operational and maintenance functionality?
 - g) Identify any cost savings/drivers associated with the ability to upgrade and maintain software for the Government, to include but not limited to Government ownership of the software, ease of upgrade and sustainment, ability to change/enhance software while keeping firmware/hardware in place, and how the software's ability to interoperate with other platforms could be leveraged.
 - h) How can open system architecture be achieved while incentivizing contractors? Where should open architecture boundaries be planned for the greatest effect?
 - i) How can we design systems to bring down the life cycle cost after fielding, i.e., manpower, flying hours, sustainment, infrastructure, disposal, etc.?
 - j) What are the total cost implications of designing to a longer or shorter service life than the requested 25 years?
- C. Cost drivers associated with Training, Maintenance and Support and how to mitigate these costs.
 - 1) Additional information:
 - a) Lifecycle costs far exceed procurement costs. Weapon system operating and support (O&S) costs including costs for repair, parts, maintenance and personnel have historically accounted for a significant portion of a weapon system's total costs.
 - 2) Specific questions(s):

- a) What changes could be made based on commercial aircraft training, maintenance and support practices, advances in training systems, health monitoring and design to reduce cost and extend the life of aircraft and subsystems?
 - b) Can we modify training techniques to still maintain superiority but also save on fuel cost? What does that investment look like?
- D. Cost drivers for capabilities and how changes can greatly influence overall cost.
 - 1) Specific question(s):
 - a) From an Industry perspective is there a “knee-in-the-curve” where small increases in performance would come at rapidly increasing costs? Where are those “knees” given your understanding of system capabilities required to meet the 2030 and beyond threat?
- E. Cost and schedule drivers regarding DoD business policy, requirements, and oversight.
 - 1) Specific question(s):
 - a) How do government-imposed factors (DoD Policy, Navy Policy and Public Law) drive increases in both cost and schedule?
 - b) How can changes to government factors (DoD Policy, Navy Policy and Public Law) streamline schedules and reduce costs create a better end product?
 - c) What causes DoD to realize increased cost and schedule relative to similarly developed commercial products?
 - d) How can we write contracts that incentivize Industry to achieve the lowest development and production costs?
- F. Cost savings by use of upgrades to existing and currently funded rotary wing systems.
 - 1) Specific question(s):
 - a) How could upgrades to any and all other currently deployed platforms realize cost savings that could benefit a FVL replacement capability (estimates of the amount of savings are encouraged)?
 - b) What distributed operations, open architecture, or other contributions can be made to the FVL capability and/or capacity to provide for better future affordability?
- G. Cost saving strategies to incorporate a new system aboard aircraft carriers
 - 1) Specific questions(s):
 - a) What considerations/strategies may be applicable for a new system to be operational, maintainable, and logistically supportable aboard aircraft carriers?
- H. Cost reduction options for aerial refueling.
 - 1) Specific question(s):
 - a) What options may reduce costs associated with force structure or infrastructure while maintaining warfighting effectiveness for FVL Capability?
 - b) How would the aforementioned options realize cost savings (estimates of the amount of savings are encouraged)?
- I. Cost savings by use of Joint systems.

1) Specific question(s):

- a) How could commonality between technologies and/or subcomponents with other Services' unique systems provide science and technology (S&T) development efficiencies, economics of scale, logistics efficiencies, etc., realize cost savings (estimates and the amount of savings are encouraged)?

7.0 RFI Respondent Instructions

7.0.1 All final responses should be submitted to the address below no later than 1600 (4:00) CST, 04 January 2017.

7.0.2 Proprietary information should be clearly marked. No classified documents shall be included in your response. Please be advised all information submitted in response to the RFI becomes the property of the US Government and will not be returned.

7.0.3 US Government support contractors will assist in the review of any data provided by respondents to this RFI. A non-disclosure agreement (NDA) has been signed by the support contractors with the US Government that precludes them from disclosing any data outside of the US Government. Accordingly, respondents are asked to provide concurrence in their submissions that the data submitted may be reviewed US Government Support Contractors. All information will be handled by US Government and Support Contractor personnel as procurement sensitive information subject to the protections, restrictions and requirements set forth in FAR 3.104.

7.0.4 The US Government requires one (1) electronic copy (compact disc) of the RFI response. There is no page limit for the RFI responses. The electronic copy of your response must be in Microsoft Office 2010 or Adobe Acrobat XI readable formats. Please provide your firm/company's name and address, point of contract with telephone number and e-mail address.

7.0.5 Any questions on this RFI must be directed to the Lead Contract Specialist, Billy Gravitt via email at billy.r.gravitt.civ@mail.mil or the Contracting Officer, Janine Cowling, via email at Janine.l.cowling.civ@mail.mil, no later than 15 days after the RFI announcement. No question will be accepted telephonically nor will any responses to questions be provided telephonically.

The mailing address for questions and responses to the RFI is:
Army Contracting Command - Redstone
Attention: CCAM-BH-C, Janine Cowling, Contracting Officer
5304 Martin Rd., Second Floor (Room 4249)
Redstone Arsenal, AL 35758

- A. Hand delivery of the requested RFI responses is acceptable. If hand delivered, please contact the Lead Contract Specialist to make the necessary arrangements as to time and date of delivery. Delivery must be made by the response date/time to the address below:

Army Contracting Command - Redstone
Attention: CCAM-BH-C, Janine Cowling, Contracting Officer
5304 Martin Rd., Second Floor (Room 4249)

8.0 RFI Discussions:

8.0.1 Respondents are requested to identify their interest in participating in technical discussions between US Government representatives from multiple government organizations to include NAVAIR; PEO Aviation; Aviation Development Directorate; Army Material Systems Analysis Activity; TRADOC Analysis Center – Fort Leavenworth; TRADOC Capabilities Manager; and USMC Capabilities Development and Integration Directorate. The purpose of these discussions would be to incorporate industry inputs into addressing specific AoA study question listed below:

- A. How much do next generation or otherwise increased capabilities affect operational outcomes compared to the baseline? What are the impacts of accepting capabilities above the current baseline but below the identified capability requirements?
- B. Which key attributes (range, speed, high/hot, reliability/availability/maintainability) contribute the most to effectiveness? Which key attributes contribute the most to cost?
- C. What are the implications of self-deployable and/or aerial refueling capability?
- D. What are the implications and tradeoffs of optionally manned capabilities of FVL CS3?
- E. What are the tradeoffs of fielding one CS3 alternative for each Service as opposed to fielding one CS3 alternative for the Army, Marine Corps, and SOCOM? For cases where two CS3 alternatives are fielded (e.g., Army and SOCOM with one, Marine Corps with another)?
- F. If one or more new development alternatives are chosen, what are the operational, sustainment, and cost implications considering commonality of maintenance, supply chain management, operator and maintainer training, sustaining engineering and other FVL logistics elements?
- G. What are the affordability impacts of developing a high-speed, long-range rotorcraft that has sufficient reliability and low enough operating costs to have commercial applications?

8.0.2 In addition to discussing specific data elements in support of the AoA, the US Government would like to engage in discussions to obtain data concerning the challenges of developing rotary wing aircraft to meet US Government requirements, and the risks and challenges associated with developing an executable moderate risk AAS acquisition program. Specific areas of interests identified to date include examination of technology, design, development and manufacturing risks associated with the following:

- A. Airframe
- B. Engines
- C. Powertrain systems (transmission, drive shafts, power/accessory gear boxes, etc.)
- D. Rotor(s)/propeller(s)/prop rotor
- E. Flight control systems
- F. Software
- G. Fuel systems
- H. Environmental control systems
- I. Electrical power supply and distribution systems
- J. Auxiliary power systems
- K. Hydraulic and pneumatic systems
- L. Aircraft and mission systems

- M. Open System Architecture/backbone to enable common mission systems (e.g., sensors effectors, communications, navigation, etc.).
- N. Mission equipment (avionics, sensors, armament, etc.).

Appendix A: USMC Mission Ground Rules and Profiles

Performance Ground Rules:

- A. General
 - 1) Standard Day lapse rates; MIL SPEC 3013 Hot Day Atmosphere definition
 - 2) Specified altitudes are Pressure Altitude
 - 3) Zero Wind for all segments
- B. Weights
 - 1) Minimum Fuel on Deck (MFOD) quantity defined to be 10% Total Fuel Quantity
 - a. MFOD is separate from Mission Reserves
 - 2) Performance Operating Weight Build-up varies with each mission (see Figure 1, Figure 2, and weight allocations below)
- C. Propulsion System
 - 1) Fuel Heating Value 18,300 BTU/lbm
 - 2) Jet Fuel Defined as JP-5 with a value of 6.8 lb/gal
 - 3) Fuel Flow increased by 5.0% for unknown/anticipated installation effects (per MIL-SPEC 3013)
 - 4) Allow for accessory losses to cover electrical system power needs, at a minimum to carry a load of 80kW AC and 500-600A DC, plus allowances for growth.
- D. Hover Performance
 - 1) Torque margins are applied to hover power required to takeoff for:
 - a. Land-based, 5% Margin
 - b. Ship-based, 10% Margin
- E. Cruise Performance
 - 1) All Engines Operating (AEO)
 - 2) Speed for Long Range Cruise (VLRC) is at 99% maximum specific range

Mission Profile Acronyms and Abbreviations:

CAS Close Air Support
DAS Deep Air Support
HADR Humanitarian Aid Disaster Relief
HIGE Hover In Ground Effect
HOGE Hover Out of Ground Effect
IRP Intermediate Rated Power
KCAS Knots Calibrated Air Speed
KTAS Knots True Air Speed
MCP Maximum Continuous Power
MRP Maximum Rated Power
NM Nautical Mile
PA Pressure Altitude

SL Sea Level pressure altitude

STO Short Takeoff

V_{BE} Speed for Best Endurance

V_{BROC} Speed for best rate of climb

V_{LRC} Speed for Long Range Cruise (= speed for 99% of maximum specific range)

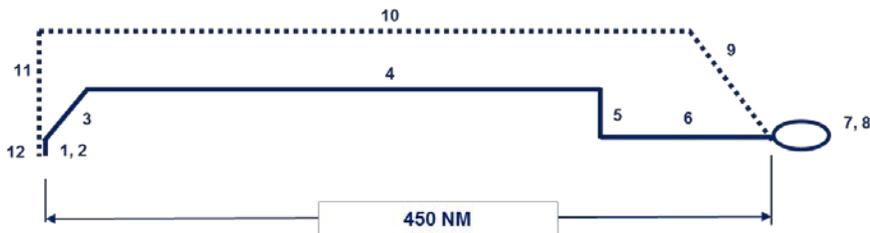
V_{MCP} Speed at Maximum Continuous Power

$V_{90\%MCP}$ Speed at 90% of Maximum Continuous Power

VTO Vertical Takeoff

USMC V-22 Armed Escort Mission Profile (MT-3):

*Use weights from Figure 1 and weights allocations below

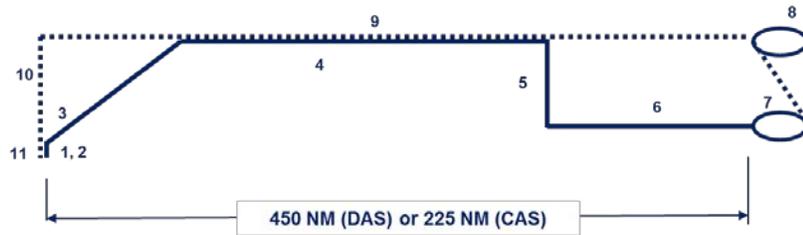


Entire mission at MIL-STD-3013 Hot Day conditions

1. Warm-up for 10 minutes at Idle Power at SL / 39.4°C.
2. VTO to HOGE for 1 minute at MRP.
3. Climb at IRP at V_{BROC} to 10,000 Ft PA.
4. Cruise for 400 nm at 230 KCAS (277 KTAS).
 - Must be able to dash ahead at 253 KCAS (304 KTAS) at IRP, prefer 265 KCAS (318 KTAS)).
5. Descend to 300 Ft PA (no fuel / time / distance credit).
6. Cruise for 50 nm at 240 KCAS (251 KTAS).
 - Must be able to dash ahead at 264 KCAS (276 KTAS) at IRP, prefer 276 KCAS (288 KTAS)).
7. Combat, 5 minutes at V_{IRP} (at max available IRP), 25 minutes at V_{BE} .
8. Off load 80% expendable ordnance, retain launchers.
9. Climb at IRP at V_{BROC} to best range altitude.
10. Cruise back at V_{LRC} at best range altitude.
11. Descend to SL (no fuel / time / distance credit).
12. Land with reserves (greater of 10% of initial mission fuel or fuel for 20 minutes at V_{BE} at SL).

USMC Attack Mission Profile (CAS MT-1, DAS MT-2):

*Use weights from Figure 1 and weights allocations below

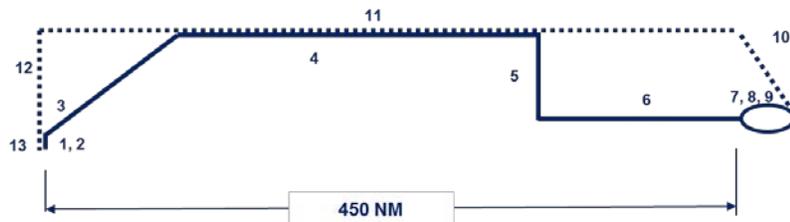


Entire mission at MIL-STD-3013 Hot Day conditions

1. Warm-up for 10 minutes at Idle Power at SL / 39.4°C.
2. VTO to HOGE for 1 minute at MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude
4. Cruise to 350 nm (or 175 nm for CAS) at $V_{90\%MCP}$.
5. Descend to 300 ft (no fuel / time / distance credit).
6. Cruise to mission radius at $V_{90\%MCP}$.
7. Combat, 5 minutes at V_{IRP} (at max available IRP), 10 minutes at V_{BE} . Climb to best endurance altitude, 15 minutes at V_{BE} .
8. Off load expendable ordnance, retain launchers.
9. Cruise back at V_{LRC} at best cruise.
10. Descend to SL (no fuel / time / distance credit).
11. Land with reserves (greater of 10% of initial mission fuel or fuel for 20 minutes at V_{BE} at SL).

USMC Utility Mission Profile (MT-5):

*Use weights from Figure 2 and weights allocations below

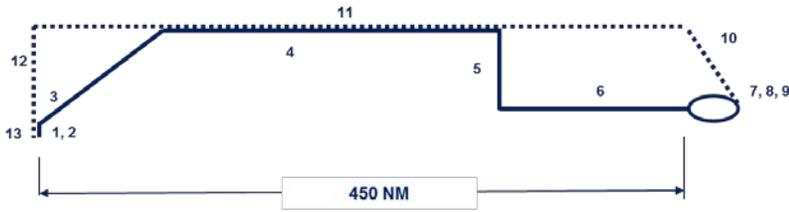


Entire mission at MIL-STD-3013 Hot Day conditions

1. Warm-up for 10 minutes at Idle Power at SL / 39.4°C.
2. VTO to HOGE for 1 minute at MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude.
4. Cruise to 350 nm at $V_{90\%MCP}$.
5. Descend to 3,000 ft PA (no fuel / time / distance credit).
6. Cruise to mission radius at $V_{90\%MCP}$.
7. Combat, 5 minutes at V_{IRP} (at max available IRP), 10 minutes at V_{BE} .
8. Off load expendable ordnance, retain launchers.
9. Land at 3,000 Ft. PA, at flight idle for 10 minutes and load 8 troops.
10. Climb at IRP at V_{BROC} to best cruise altitude.
11. Cruise back at V_{LRC} at best cruise.
12. Descend to SL (no fuel / time / distance credit).
13. Land with reserves (greater of 10% of initial mission fuel or fuel for 20 minutes at V_{BE} at SL).

USMC Troop Insertion Mission Profile (MT-6):

***Use weights from Figure 2 and weights allocations below**

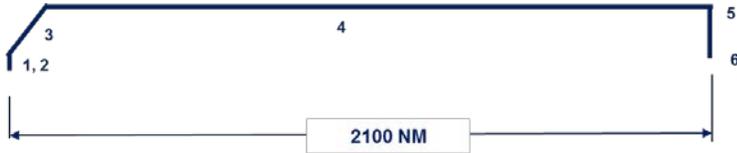


Entire mission at MIL-STD-3013 Hot Day conditions

1. Warm-up for 10 minutes at Idle Power at SL / 39.4°C.
2. VTO to HOGE for 1 minute at MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude.
4. Cruise to 350 nm at $V_{90\%MCP}$.
5. Descend to 3,000 PA ft (no fuel / time / distance credit).
6. Cruise to mission radius at $V_{90\%MCP}$.
7. HOGE for 5 minutes at 3,000 Ft PA at MRP.
8. Offload 8 combat equipped troops via fastrope.
9. Loiter for 30 minutes at V_{BE} (weapons expended at end of segment; retain launchers).
10. Climb at IRP at V_{BROC} to best cruise altitude.
11. Return at V_{LRC} at best cruise altitude.
12. Descend to SL (no fuel / time / distance credit).
13. Land with reserves (greater of 10% of initial mission fuel or fuel for 20 minutes at V_{BE} at SL).

USMC Self-Deployment (HADR) Mission Profile (MT-7; can use 1 refueling via tanker, no more than 2):

***Use weights from Figure 2 and weights allocations below**



Entire mission at MIL-STD-3013 Trop Day conditions

1. Warm-up for 10 minutes at Idle Power at SL / 32.1°C.
2. STO or VTO to HIGE for 1 minute at MRP.
3. Climb at IRP at V_{BROC} to optimum cruise altitude.
4. Cruise to maximum range at V_{LRC} at best cruise altitude.
5. Descend to SL (no fuel / time / distance credit).
6. Land with reserves (greater of 10% of initial mission fuel or fuel for 20 minutes at V_{BE} at SL).

Weight allocations for each mission (to be used in all missions):

In lieu of calculating weights for the aircraft’s Avionics and Instruments Weight Groups as well as for the structural/transparency armor, use these for all missions when calculating performance: 1) Avionics Weight Group – 1,190 lbs., Instruments Weight Group – 164 lbs., and Armor Weight – 1,186 lbs.

NOTE: Weigh allocations need to be provided to cover Store Provisions (such as structural hard points, jettison systems, release or launch, mounts and supports, electrical and controls), turret/gun drive/fairing/gun sight & control/mounts/supports/electrical provisions (everything needed for the gun called out in Figure 1 and Figure 2), and any additional pylon supports or installation provisions.

Appendix B: Army Mission Ground Rules and Profiles

Performance Ground Rules:

A. General

- 1) Standard Day lapse rates
- 2) Specified altitudes are Pressure Altitude
- 3) Zero Wind for all segments unless specified

B. Weights

- 1) Performance Operating Weight Build-up varies with each mission (see Figure 3, Figure 4, and weight allocations below)

C. Propulsion System

- 1) Jet Fuel Defined as JP-8 with a value of 6.7 lb/gal
- 2) Fuel Flow increased by 5.0% for unknown/anticipated installation effects (per MIL-SPEC 3013)

D. Hover Performance

- 1) Torque margins are applied to hover power required to takeoff for:
 - a. Land-based, 5% Margin
 - b. Ship-based, 10% Margin

E. Cruise Performance

- 1) All Engines Operating (AEO)
- 2) Speed for Long Range Cruise (V_{LRC}) is at 99% maximum specific range (high side)

Mission Profile Acronyms and Abbreviations:

HIGE Hover In Ground Effect

HOGE Hover Out of Ground Effect

IRP Intermediate Rated Power

KCAS Knots Calibrated Air Speed

KTAS Knots True Air Speed

MCP Maximum Continuous Power

MRP Maximum Rated Power

NM Nautical Mile

PA Pressure Altitude

SL Sea Level pressure altitude

V_{BE} Speed for Best Endurance

V_{BROC} Speed for best rate of climb

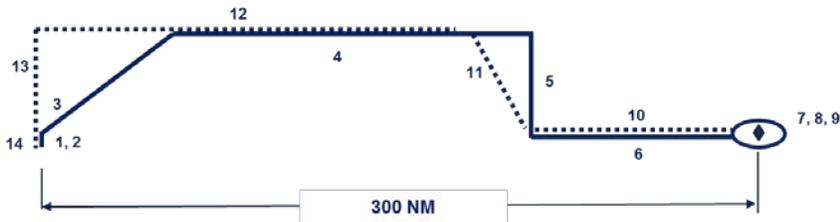
V_{LRC} Speed for Long Range Cruise (= speed for 99% of maximum specific range, on the high side)

V_{MCP} Speed at Maximum Continuous Power

VTO Vertical Takeoff

US Army Attack/Recon Mission Profile (A-1):

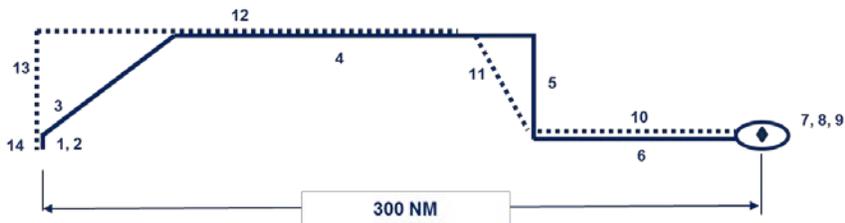
***Use weights from Figure 3 and weights allocations below**



1. Warm-up for 5 minutes at Idle Power at 6,000 ft / 95°F.
2. VTO to HIGE for 1 minute at ≤95% MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude, limit to ≤18,000 ft (range credit).
4. Cruise to 225 nm at V_{LRC} .
5. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
6. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
7. HOGE for 1 minute at 6,000 ft / 95°F at ≤95% MRP.
8. Loiter for 30 minutes at V_{BE} .
9. HOGE for 1 minute at 6,000 ft / 95°F at ≤95% MRP.
10. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
11. Climb at IRP at V_{BROC} to best cruise altitude, limit to ≤18,000 ft (range credit).
12. Return at V_{LRC} .
13. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
14. Land with reserves (greater of 10% of initial mission fuel or fuel for 30 minutes at V_{BE} at 6,000 ft / 95°F).

US Army Air Assault Mission Profile (A-2):

***Use weights from Figure 4 and weights allocations below**

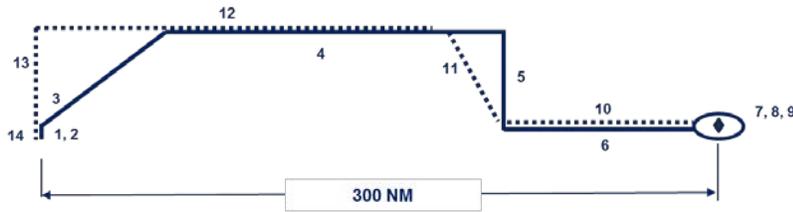


All weapons carried externally

1. Warm-up for 5 minutes at Idle Power at 6,000 ft / 95°F.
2. VTO to HIGE for 1 minute at ≤95% MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude, limit to ≤18,000 ft (range credit).
4. Cruise to 225 nm at V_{LRC} .
5. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
6. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
7. HOGE for 1 minute at 6,000 ft / 95°F at ≤95% MRP.
8. Loiter for 30 minutes at V_{BE} , expend weapons.
9. HOGE for 1 minute at 6,000 ft / 95°F at ≤95% MRP.
10. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
11. Climb at IRP at V_{BROC} to best cruise altitude, limit to ≤18,000 ft (range credit).
12. Return at V_{LRC} .
13. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
14. Land with reserves (greater of 10% of initial mission fuel or fuel for 30 minutes at V_{BE} at 6,000 ft / 95°F).

US Army Assault Security Mission Profile (A-3):

*Use weights from Figure 4 and weights allocations below

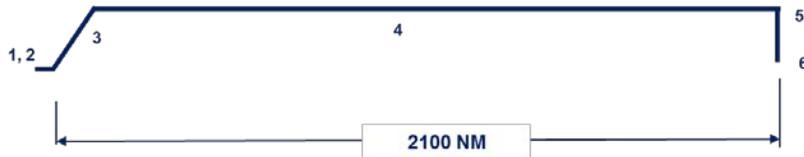


All weapons carried internally until needed

1. Warm-up for 5 minutes at Idle Power at 6,000 ft / 95°F.
2. VTO to HIGE for 1 minute at $\leq 95\%$ MRP.
3. Climb at IRP at V_{BROC} to best cruise altitude, limit to $\leq 18,000$ ft (range credit).
4. Cruise to 225 nm at V_{LRC} .
5. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
6. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
7. HOGE for 1 minute at 6,000 ft / 95°F at $\leq 95\%$ MRP.
8. Loiter for 60 minutes at V_{BE} , expend weapons.
9. HOGE for 1 minute at 6,000 ft / 95°F at $\leq 95\%$ MRP.
10. Dash to 75 nm at $V \geq 200$ KCAS (230 KTAS) (90-100% MCP).
11. Climb at IRP at V_{BROC} to best cruise altitude, limit to $\leq 18,000$ ft (range credit).
12. Return at V_{LRC} .
13. Descend to 6,000 ft / 95°F (no fuel / time / distance credit).
14. Land with reserves (greater of 10% of initial mission fuel or fuel for 30 minutes at V_{BE} at 6,000 ft / 95°F).

US Army Strategic Self-Deployment Mission Profile (A-4):

*Use weights from Figure 4 and weights allocations below



1. Warm-up for 5 minutes at Idle Power at SL / 103°F.
2. 2.5G rolling takeoff, 90% MRP at SL / 103°F.
3. Climb at IRP at V_{BROC} to optimum cruise altitude (range credit).
4. Cruise to maximum range at V_{LRC} at best cruise altitude.
5. Descend to SL / 103°F (no fuel / time / distance credit).
6. Land with reserves (greater of 10% of initial mission fuel or fuel for 30 minutes at V_{BE} at SL / 103°F).

Weight allocations for each mission (to be used in all missions):

In lieu of calculating weights for the aircraft's Avionics and Instruments Weight Groups as well as for the structural/transparency armor, use these for all missions when calculating performance: 1) Avionics Weight Group – 1,190 lbs., Instruments Weight Group – 164 lbs., and Armor Weight – 1,186 lbs.

NOTE: Weight allocations need to be provided to cover Store Provisions (such as structural hard points, jettison systems, release or launch, mounts and supports, electrical and controls), turret/gun drive/fairing/gun sight & control/mounts/supports/electrical provisions (everything needed for the gun called out in Figure 3 and Figure 4), and any additional pylon supports or installation provisions.