INTEROPERABILITY CONSIDERATIONS

Considerations to be examined when aerial refueling is being planned for retrofit or new aircraft.

I. OPERATION AND USE

A. Mission (Specific)

1. identify mission requirements dictating aerial refueling
2. Do mission requirements and planned usage dictate the type of system (boom/receptacle, probe/drogue or both systems)?
3. What are the intended methods of AR?
    a. deployment - transportation to theater of operation
    b. employment - operations within theater of operation combat air patrol pre/post strike
    c. training
4. What tankers and/or receivers are planned for refueling operations?
    a. AR hardware compatibility
    b. airspeed/altitude envelope
5. What are the fuel off-load requirements?
6. What is the impact on crew task and work load? What is acceptable?
7. Define rendezvous plans and equipment to accomplish rendezvous
    a. tanker/ receiver compatible equipment.
    b. special purpose rendezvous equipment which requires changes in tanker/receiver equipment
    c. rendezvous distance, etc.

B. Mission Flexibility (General)

1. Are multi-role requirement(s) indicated, (i.e., tanker and cargo)?
2. Do allied, tactical, and/or strategic plans impact your aerial refueling system and operations?
3. What aerial refueling equipment is necessary for basic mission, potential uses, interservice, special purpose, and international interoperability? Is a special AR hardware location required to meet multiple role requirements such as ground conversion, aerial conversion, and simultaneous/multiple receiver refueling?
    a. receptacle/UARRSI
    b. probe
    c. fuselage boom
    d. fuselage drogue
    e. multiple booms (wing/fuselage) with aerial conversion to provide for multiple drogues (wing/fuselage)
4. Is there a requirement for aerial conversion between boom and drogue systems, particularly to accommodate a mixed multiple receiver aircraft mission (probe and receptacle)?

5. Is there a dual role mission suggesting a receptacle to probe conversion?
    a. single or dual aerial compatibility
    b. future conversion provisions may be indicated by foreign military sales.
6. Is operational redundancy of off-load AR mechanisms required?
7. Are accommodations/provisions for future installations required?
    a. external AR store
    b. fuel lines
    c. hydraulic lines
    d. wing structural hard points and wing installations required?

C. Basing, Logistics Support and Operating Locations
1. What type of basing is the aircraft to operate from?
    a. runway lengths, maximum weights, etc.
    b. base operations
    c. forward basing, etc.
    d. fast base escape
2. ground support equipment required
3. logistics support required
4. training required

D. Environmental Conditions: What environmental conditions are expected?
1. external lighting required (natural lighting, twilight, night dark night, day)
2. altitudes (low level to 45K ft. or greater)
3. low/high temperatures
4. turbulence levels (use of FAA definitions)
5. lightning strikes

E. Threats
1. Do Generated environmental potentials exist?
    a. EMI
    b. EMP
    c. ECM
    d. ECCM/IRCM/lethal systems
    e. nuclear, biological, chemical (NBC)
    f. combat, hostile fire, survivability and vulnerability
    g. probabilities of threat encounter (PE)
    h. paint schemes (camouflage)
2. What external light emissions are permissible in special mission environments? Also, is consideration being give for night vision goggles compatibility?
3. Will radio silence conditions be required? If so, are tanker/receiver communications required during radio silent conditions? After hook-up? Prior to hook-up? Distance required in all coordinates?
4. Any external forms of transmission

II. SYSTEM DESIGN, PERFORMANCE AND INTEGRATION

A. What standards, specifications, and/or regulations apply to AR system, fuel system, lighting, ground support equipment communications, avionics, fuels, EMI, etc.? List the applicable parts.
   1. USAF
   2. DoD
   3. International Standards (STANAG's)
   4. MoD
   5. FAA
   6. SAE (other)

B. When appropriate AR equipment is incorporated onto the aircraft, what integration assessments are necessary to assure full compatibility of the AR system and other aircraft technical discipline/hardware?
   1. engine air inlet duct
   2. antennas, angle-of-attack vane, pitot tube, aerodynamic control installation
   3. canopy
   4. windshield
   5. avionics, electronics (fuel ingestion)
   6. air-conditioning scoops (fuel ingestion)
   7. crew station visual reference
   8. electrical load analysis, hydraulic/pneumatic load analysis, air conditioning/cooling analysis, mass properties analysis (leads, stress, structural dynamics)
   9. aerodynamics analysis (drag, climbout, range)
   10. fuel spill/material compatibility

C. What power requirements are necessary for smooth engine speed adjustments? Are automatic provisions required?
   1. auto controls
   2. auto throttle
   3. auto hook-up, etc.

D. Do safety/operations require direct window viewing, night vision goggles (NVG). TV low/level (night and color), field of view adjustments to field of view/voice communication requirement prior to and after hook-up and under radio silence conditions?

E. What total time is allotted for the refueling operation?
   1. rendezvous
   2. hook-up
   3. fuel transfer

III. AIRCRAFT SYSTEM DESIGN VERIFICATION

A. What standards, specifications, and/or regulations apply to the AR, fuel/vent systems, communications, avionics, and lighting systems?

B. What are the mission and/or AR hardware verification requirements?
   1. specific profile test case verification
   2. general mission requirement/verification
   3. AR mission flexibility

C. Determine adequacy of fuel tank vent outlet location with failed fuel level control valve in flight. Access fuel impingement on/into critical areas of aircraft, i.e., engine exhaust, engine air inlet ducts, air inlets, bays with ignition sources.

IV. COMPATIBILITY/DETERMINATION (TANKER/RECEIVER)

A. What considerations are being given to tanker/receiver compatibility in the following areas?

1. fuel system
    a. pressures (designs)
    b. pressure regulation (normal and failure modes)
    c. fuel flow control (normal and failure modes)
    d. fuel tanker vent system (normal and failure modes)
    e. line/coupling separation within fuel tank
    f. reverse refueling
    g. stiff boom refueling
    h. fuel tank vs. fuel isolation for various fuels, i.e., JP-4, JP-5, JP-7, JP-8, JP-8 + 100, JPTS, etc.
    i. pressure disconnect switch (pressure setting, response time)
    j. manual boom latching
    k. override AR modes
    l. status lights
    m. fuel pressure surge control and pressure regulation response
2. formation aids
3. boom interphone communications
4. AR procedures and AR manuals
5. separate upper/lower rotating beacon/strobe controls to avoid operation distractions, i.e., separate controls upper/lower with full voltage dimming control
6. radio communications (HF, UHF, VHF, etc.)
7. effects of EMI on fly-by-wire controls (booms and aircraft) as may be affected by HF radio transmissions
8. tanker-pilot director lights (location and visibility of receiver pilot)
9. external airframe platform lighting and full voltage dimming control
10. viewing system
    a. IR
    b. UV
    c. NVG
11. tanker down wash effects
12. receiver bow wave effects
13. airspeed altitude envelope (tanker/receiver overlap)

B. What are the normal and special aircraft configurations?
   1. ferry
   2. external tanks
   3. booms/special pods
   4. external weapon system
   5. engine out performance
   6. autopilot configurations
   7. yaw damper
   8. control surface configuration (flaps L.W., T.E., etc.)
   9. modulated afterburner
   10. speed breaks

C. Other tanker/receiver compatibility factors should be obtained from the performance and interface survey (prepared by ARSAG) dated Oct. '81.
   A copy may be requested from D. H. Kalt, ARSAG Chairman

D. Determine adequacy of AR hardware probe/receptacle location in view of fuel spillage in flight. Access fuel impingement in relationship to critical areas of aircraft, i.e., engine exhaust, engine air inlet ducts, air and/or air conditioning inlets, bays with ignition sources, cockpit air inlet ducts and non-pressurized cabins/cockpits

E. Failure modes and effects
   1. equipment separation
   2. unstable equipment due to damage
   3. emergency tanker inputs

V. COMPATIBILITY VERIFICATION

A. Are simulated laboratory tests required?

B. Are ground tests required?
   1. individual airframe tests
   2. tanker and receiver and/or simulated (see flight test items below)
   3. instrumentation

C. Are flight tests required?
   1. tanker configurations (external/internal)
   2. tanker weights
   3. receiver configurations (external/internal)
   4. receiver weights
   5. altitude/airspeed optimum and envelope determination
   6. restrictions identified
   7. fuel flow rate and pressure verification and instrumentation as required
   8. fuel spray and impingement onto aircraft critical areas assessment
   9. evaluation of redundant systems i.e., back-up systems, redundant fuselage, hose reels, hose guillotine, etc.
   10. tanker/receiver aircraft physical spacial clearance and associated AR envelope
   11. tanker/receiver flow field effects

12. multipod AR receivers
    a. pressure transients, interaction tanker/receivers
    b. formation/position/rotation
13. flowing fuel disconnects
14. receiver AR system shutoff
15. hose drogue/boom stability (no receiver)
    a. air turbulence
    b. tanker
        1. rudder doublet
        2. elevator doublet
        3. side slips
16. hose/drogue stability (receiver)
    a. turbulence (air)
    b. drogue drag/design

VI. AERIAL REFUELING TRAINING, REQUIREMENTS AND CURRENCY

A. International; contact
B. US DoD