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The purpose of this generic guidance is to provide a consistent and common communication link of technical terms and definitions and their use regarding aircraft aerial refueling fuel pressure and flowing systems in both steady state and dynamic conditions.

12. Does NAVAIR have primary release authority for this material?

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14. ABSTRACT
The purpose of this ARSAG document is to provide a consistent and common communication link of technical terms and definitions and their use regarding aircraft aerial refueling fuel pressure and flowing systems in both steady state and dynamic conditions. It is intended to assist in the technical assessments and evaluations in determining tanker/receiver aircraft fuel system compatibility, which employ the boom/receptacle and/or the probe/drogue method of aerial refueling. The technical compatibility assessment is a part of the tanker/receiver aircraft aerial refueling clearance process as defined in Aerial Refueling Clearance Process Guide, ARSAG Document # 43-08-04 dtd Aug ‘14 to ensure the safe transfer of fuel between the tanker and the receiver aircraft. In particular, this document should be used as guidance in completing the ARSAG document, Standardized Technical Data Survey, dated April 2014, ARSAG Document # 12-81-03R (previously termed, Performance and Interface Survey for Aerial Refueling, dated October 1981).

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See Document Abbreviations, Page 20
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ARSAG

AERIAL REFUELING SYSTEMS ADVISORY GROUP

Aerial Refueling Pressures Definitions and Terms, Design and Verification Guidance

Document Number 03-00-03R
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ARSAG is chartered in the US by the DOD as the Joint Standardization Board for Aerial Refueling Systems

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ARSAG DOCUMENT

FOR

AERIAL REFUELING

PRESSURE DEFINITIONS & TERMS

1.0 PURPOSE:

The purpose of this ARSAG document is to provide a consistent and common communication link of technical terms and definitions and their use regarding aircraft aerial refueling fuel pressure and flowing systems in both steady state and dynamic conditions.

2.0 SCOPE:

This document is intended to assist in the technical assessments and evaluations in determining tanker/receiver aircraft fuel system compatibility, which employ the boom/receptacle and/or the probe/drogue method of aerial refueling. The technical compatibility assessment is a part of the tanker/receiver aircraft aerial refueling clearance process as defined in ATP56; (NATO STANAG 3971) to ensure the safe transfer of fuel between the tanker and the receiver aircraft. In particular, this document should be used as guidance in completing the ARSAG document, Standardized Technical Data Survey, dated April 2010 (previously termed, Performance and Interface Survey, dated October 1981).

Any other use or implied use of this document for tanker and/or receiver aircraft design and test is not intended.

This document primarily addresses the minimum requirements for tanker/receiver aircraft compatibility assessment for safe aerial transfer of fuel between tanker and receiver aircraft.

3.0 AIRFRAME FUEL SYSTEM DEFINED

The airframe fuel system is that portion of the fuel system that deals with the handling of fuel up to the airframe/engine plumbing interface. This system includes ground refueling, aerial refueling, transfer (tank-to-tank), fuel dump, fuel tank containment and associated vent systems.

3.1 RECEIVING AIRCRAFT FUEL SYSTEMS TYPICALLY INCLUDE:

- 3.1.1 Transfer
- 3.1.2 Aerial Refueling Receiving System (Probe and/or Receptacle)
  - 3.1.2.1 Integrated Receptacle or Modular UARRSI
  - 3.1.2.2 Probe Nozzle and Probe Mast
- 3.1.3 Ground Refueling; Single Point and Gravity (Over-the-Wing)
- 3.1.4 Vent System
- 3.1.5 Fuel Tanks
- 3.1.6 Fuel Dump
- 3.1.7 Aerial Refueling Manifold/Lines
- 3.1.8 Pressure/Pressure Transient (Surge) Regulation
- 3.1.9 Instrumentation i.e.: Tank Fuel Quantity, Flow and Pressure Measurement (Steady State and Transients)
- 3.1.10 Fuel Tank Inerting
- 3.1.11 Fuel Level Control Valves
- 3.1.12 Pressure Disconnect Switches – Receptacle Method Only

3.2 TANKER AIRCRAFT FUEL SYSTEMS TYPICALLY INCLUDE:

- 3.2.1 Aerial Refueling Pumps and/or Transfer Pumps
- 3.2.2 Fuel Containment Tankage, Tankage Separation, Supply Tanks
- 3.2.3 Valves: Check, Line, Onload Level Control Valves, etc.
- 3.2.4 Pressure Regulation
- 3.2.5 Surge Suppression and Relief Valves
- 3.2.6 Aerial Refueling Manifold/Lines
- 3.2.7 Aerial Refueling Fuel Offload System (Boom and Hoses)
  - 3.2.7.1 Boom
  - 3.2.7.2 Nozzle
  - 3.2.7.3 Surge Protection
  - 3.2.7.4 Hose Reel Assembly
    - 3.2.7.4.1 Hose
    - 3.2.7.4.2 Coupling
    - 3.2.7.4.3 Drogue

3.2.7.4.4 Trunion (BDA Kit)

3.2.8 Cross Feed Manifold Connection/Regulation

3.2.9 Instrumentation i.e.: Fuel Tank Quantity, Flow and Pressure Measurement

3.2.10 Ground Refueling; Single Point and Over-the Wing

3.2.11 Fuel Intra Tank Transfer System

3.2.11.1 Gravity

3.2.11.2 Pump

3.2.12 Fuel Jettison (Dump)

3.2.13 Reverse Refueling Provisions

3.3 TANKER/RECEIVER AIRCRAFT FUEL SYSTEM INTERFACE PRESSURE (PRESSURE MEASUREMENTS)

The tanker aircraft fuel pressure delivered to the receiver aircraft at the interface measurement point. Typically, the value is 50 ± 5 psig under normal operating conditions. Other tankers may provide only 22 ± 2 psig.

3.3.1 Probe/Drogue interface measurement point: just downstream (≤ 6 inches) of receiver aircraft's probe nozzle.

3.3.2 Boom/Receptacle interface measurement point: just upstream (typically 18 inches) of the tanker aircraft's boom nozzle tip.

3.4 OPERATING (WORKING) PRESSURE

A maximum steady state pressure (no-flow and flowing conditions) that the fuel system can continually sustain throughout the life of the airframe without any external leakage, fatigue, failures or malfunction.

Receiver

Typical operating (working) pressure for receiver aircraft is 60 psig to ensure safe operation.

Tanker

Typical tanker AR subsystem operating (working) pressure is 120 psig to provide 55 psig maximum delivery pressure to the receiver aircraft interface. Pressures at leakage flow rates of less than 30cc/minute may be up to 65 psig.

3.5 PROOF (LIMIT) PRESSURE

A pressure in which the fuel system may function satisfactorily including pressure transients (surges) up to a value in which the aircraft can continually sustain throughout the life of the aircraft without any external leakage, failure and/or malfunction, or deformation. Proof pressures are typically two times greater than operating pressures. See Figure 1.

Receiver

Typical proof (limit) pressure values for US Navy aircraft are 120 psig. United States Air Force aircraft have typical proof pressures ranging from 120 psig (legacy receivers only) to 180 psig for fighters and small attack aircraft and up to 240 psig for larger bomber/tanker and transport aircraft that receive fuel at significantly higher flow rates (greater than 400 gpm).

Tanker

Typical AR tanker proof (limit) pressure values are 240 psig.

Note: To address fatigue issues, some airframe manufacturers establish an intermediate limit, "Maximum Operating Pressure," which is lower than Proof (Limit) Pressure. In this case, pressure transients are to remain below the Maximum Operating Pressure.

3.6 BURST (ULTIMATE) PRESSURE

A pressure that the fuel system can sustain without external leakage and/or rupture but may not function properly. Deformation without leakage is permitted. Burst pressures are typically 1.5 times greater than proof/limit pressures. See Figure 1.

Receiver

Typical burst pressure for US Navy aircraft is 180 psig. For US Air Force aircraft, typical burst pressures range from 180 psig to 240 psig. Typical burst (ultimate) pressure values for large tankers (as receivers), bombers and transports are 360 psig.

Tanker

Typical burst (ultimate) pressure values for tankers are 360 psig.

3.7 SURGE PRESSURE LIMITS & INTERPRETATIONS

Pressure transients occur as a result of an interruption of fuel flow, a perturbation of fuel flow or an abrupt change in flow velocity.

Pressure transients shall not exceed proof (limit) pressure in the aircraft. When exceptions do occur, a potential exists for system fatigue damage depending on the magnitude, frequency of occurrence and duration of the transient. When fuel flow interruptions/perturbations occur due to the conditions described in Paragraph 3.8 below, pressure transients can exceed limit/proof pressure. Evaluation of those pressure transients is important for determining whether system fatigue and/or system damage/leakage has occurred.

If, during developmental testing, it is determined that surge pressure values exceed the *design* proof pressure, the system must be evaluated to determine whether its *actual* proof pressure capabilities are adequate. A revised burst pressure (typically 1.5 times the revised proof) should be evaluated. If the *actual* proof pressure capabilities of the system are inadequate, the system should be redesigned to a proof pressure greater than the maximum surge pressure encountered during testing, and the burst pressure adjusted accordingly. See section 3.9 below. If transient pressure spikes are numerous and likely to occur over the life of the system, plumbing wall thickness or other issues of strength and durability must be addressed. Alternatively, the source of the pressure spike must be mitigated or reduced to eliminate excessive pressures.

A standard for evaluating the magnitude and duration of surge pressure has been recognized and in many existing systems established as a standard of 0.002 seconds (2 ms) response time. Instrumentation measurement capability between 250 to 600 Hertz is a minimum for existing aircraft.

3.7.1 Transient (surge) evaluations and in depth assessments (development and qualification sample rates may exceed the above values and be up to 3,000 Hz).

The proper transient (surge) response measurement instrumentation should include multiple pressure transducers at multiple locations using recording equipment with a sufficient response rate to capture the transient peaks. In some cases, up to 3K to 20K Hz response rates may be required.

The assessment of pressure transients for system damage should consider the magnitude (height), duration (width) and frequency of expected occurrences over the life of the system. See Figure 2. The effect of a short or long duration transient will determine if the spike is localized or system wide in nature.

A prediction of the quantity of spikes over the life of the system along with the predicted range of the peaks should be ascertained if possible. The distribution of cycles versus pressure magnitude then should be analyzed to determine the plumbing fatigue life or desired service life. This prediction then allows the design authority to substantiate all pertinent design features within the plumbing system for predicted failure times.

3.8 PRESSURE AND SURGE GENERATION FACTORS

3.8.1 Receiver Aircraft

Some conditions/factors that can produce receiving A/C system pressures including steady, state, flowing, surges/transients, to values over system proof (limit) pressure:

3.8.1.1 Rapid opening or closing of level control and inline shutoff valves

3.8.1.2 Simultaneous closing of level control valves, manually and via pre-check functions (ground and/or flight)

3.8.1.3 Last tank to fill shut off

3.8.1.4 Dead-end lines

3.8.1.5 Tanker pump startup; and/or Ram Air Turbine (RAT) AR startup

3.8.1.6 Flowing disconnects during reverse refueling

3.8.1.7 Failed tanker pressure and transient regulation systems

3.8.1.8 Inadequate design to accommodate all potential tanker flow and pressure conditions

3.8.1.9 Presence of air in plumbing system

3.8.1.10 Multiple receiver aircraft refueling simultaneously from a tanker which does not isolate the left/right/center dispensing systems with appropriate isolation valves.

3.8.1.11 Failure modes i.e.: level control valves, line separation and software

3.8.1.12 Excessive fuel tank pressures (tank bottom pressure) due to:

1. an aerial refueling line separation (line rupture or coupling coming apart) within a tank
2. level control valve failure with inadequate vent line sizing when tanker delivery pressures exceed the receiver aircraft operating pressure, typically over 60 psig

3.8.1.13 Inadequate fuel tank venting

Figure 1

TYPICAL DESIGN PRESSURE CHART

Pressures	***Receivers***		***USAF Tankers & Large Receivers***
	Navy	***USAF Tactical***	
Operating / Working	60 psig	60 psig	120 psig
Proof / Limit (1)	120 psig	120 (3) - 180 psig	240 psig
Burst / Ultimate (2)	180 psig	180 - 240 psig	360 psig
Surges ≤ Proof	120 psig	120 (3) - 180 psig	240 psig

Note 1: Proof Steady State – no leaks, no deformation – verified by actual aircraft level tests (five (5) minute minimum hydrostatic test)

Note 2: Burst Steady State – no leaks, deformation acceptable – verified by analysis at the aircraft installation level. Components and manifolds should be tested to burst during the design and qualification test program.

Note 3: Some legacy aircraft (including rotary wing a/c) may be in inventory at 120 proof pressure.

Best Design Practice: To minimize impact from potential failure modes, the tanker and receiver aerial refueling systems should be designed to the same pressure limits above. This will preclude a single level failure mode, like a regulation system failure, from creating a potential hazardous over pressure event, steady state or transient surge, in either the tanker offload or receiver onload system.

Figure 2

Typical examples of:

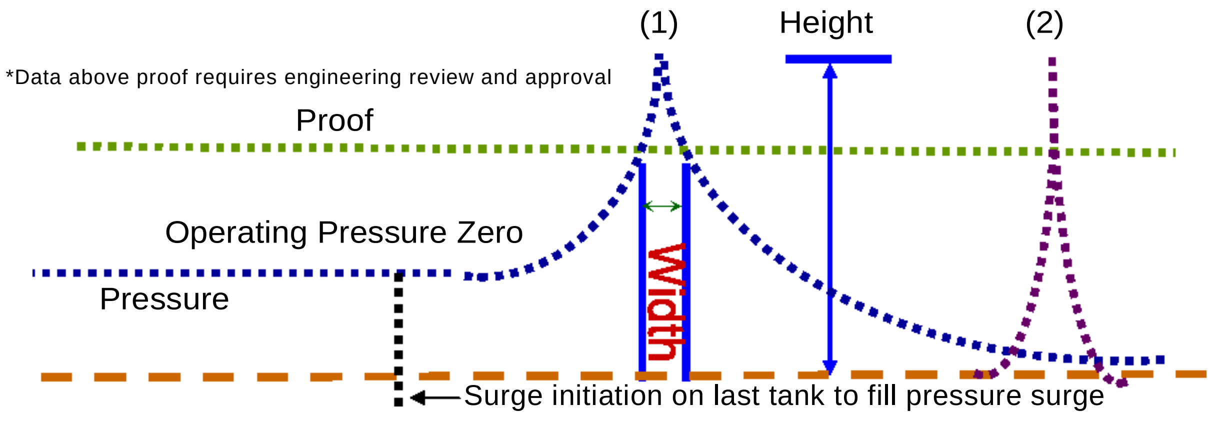
A) Potentially damaging system fatigue fuel transient (surge)

B) Low energy pressure spikes

Fuel Pressure Transients

1) High Energy Surge Spikes Exceeding Design Proof Pressure (Potential System Short/Long Term Damage)

2) Low Energy Surge Spike Exceeding Design Proof Pressure (Long Term Fatigue Concern)



May be localized pressure spike (TIME DEPENDENT FUNCTION)

Total transient energy = w x h = ___ psi – sec

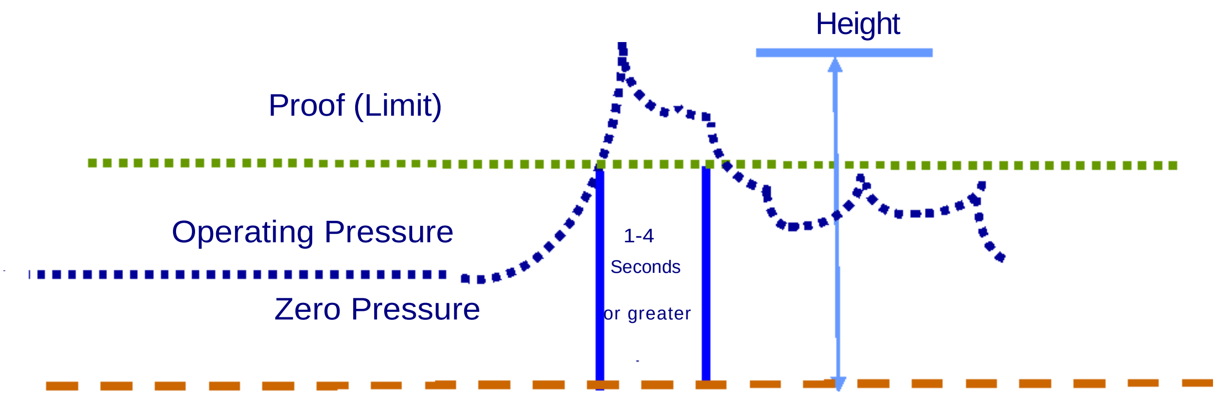
Percent above limit pressure = w x h x % = ___ psi – sec

Events that cause pressures exceeding limit must be evaluated and authorized by the aircraft design authority.

Figure 3

C) Unsatisfactory pressure regulation example

The whole system may see this pressure and damage to the system will likely result.



3.8.2 Tanker Aircraft

Conditions that can initiate damaging pressures and transient surges for aerial refueling tanker fuel dispensing systems are:

3.8.2.1 Flowing disconnects from tankers' hoses equipped with MA-2/-3/-4 couplings (tanker pump pressure at inlet to the coupling as the receiver aircraft's probe separates from the tanker coupling)

3.8.2.2 Dead end lines

3.8.2.3 Receiver aircraft valve closures

3.8.2.4 Tanker pump(s) startup and/or Ram Air Turbine (RAT) store pump startup

3.8.2.5 Stiff boom operations; Receiver aircraft receptacle toggles failed open, boom nozzle within receptacle by telescoping extension force pressure on the boom (rapid make/break of nozzle contact with receptacle)

3.8.2.6 Rapid tanker valve closures

3.8.2.7 Faulty tanker pressure regulation and relief valves

3.8.2.8 Air in lines

3.8.2.9 Pumps in series or in parallel

3.8.2.10 Multiple receiver aircraft refueling simultaneously from a tanker which does not isolate the left/right/center dispensing systems with appropriate isolation valves

3.8.2.11 Failure modes i.e.: Fuel level control valve, line separation and software

3.8.2.12 Excessive fuel tank pressures (tank bottom pressure) due to an aerial refueling line separation (line rupture or coupling coming apart) within a tank

3.9 PRESSURE REGULATION

Pressure regulation devices are primarily installed to protect receiver aircraft from high pressures generated by tanker aerial refueling pumps. Typical unregulated tanker values range from 80 to 120 psig steady state pressure. In some cases, tankers steady state flow/no flow pressures may exceed 120 and up to 240 psig (see Figure 3). This is especially true with transfer and AR boost pumps in series. Ram Air Turbine directly coupled to AR store boost pumps may exceed this pressure. In all cases, regulation devices need to be checked periodically (both primary and back-up regulation) to avoid tanker and/or receiver aircraft line and fuel tank rupture. Most tanker and receiver aircraft fuel tanks/vent systems are not protected against the pressure that may exist should fuel line separation occur within the fuel tank. Redundant tanker pressure regulation should be provided. In the absence of a redundant tanker pressure regulation system, an in flight tanker operator detection method device should be provided.

3.9.1 Receiver Aircraft

In some special cases receiver aircraft may require in-line regulation or restriction orifices installed downstream of the aerial refueling connection or installed within the inlet to the level control valves.

In receptacle-equipped receiver aircraft, pressure disconnect switches may provide receiver aircraft protection due to tanker unregulated delivery pressure. Pressure disconnect switches may react too fast (1 second or less) and thereby cause premature receiver aircraft disconnects. Too high pressure disconnect settings and/or too slow pressure disconnect switch actuation may not provide adequate over-pressure protection should the receiver aircraft level control valve be inoperative. The design of pressure disconnect switches must be verified by careful attention to the system pressure transients and over-pressure factors. Both analytical and fuel system simulators are necessary to insure proper pressure setting and delay time. If a failure detection method is not provided, the disconnect switch must be periodically tested to avoid latent failures.

3.9.2 Tanker Aircraft

Typical tanker pressure regulation devices include:

3.9.2.1 Aerial refueling couplings used for the probe and drogue method with pressure regulation include MA-3 with single regulator and MA-4 with redundant pressure regulators

3.9.2.2 Boom tanker pressure regulators upstream of the boom nozzle, within the tanker aerial refueling offload system

3.9.2.3 Gate valve (feedback driven by pressure sensors & venturi)

3.9.2.4 Pressure sensing pumps

3.10 SURGE PRESSURE SUPPRESSION PROTECTION AND REDUCTION

Typical examples of receiver/tanker surge mitigation are described below:

3.10.1 Receiver Aircraft

3.10.1.1 Slow closing valves (considering ullage and venting factors), metered, reopening; valves should be redundant and checked on an adequate basis

3.10.1.2 Low AR fuel line velocities (i.e. larger diameter pipes)

3.10.2 Tanker Aircraft

Surge suppression is typically to protect receiver aircraft. In many cases surges can develop in the tanker due to the aforementioned as well as reflected pressures from receiver aircraft valve closures

3.10.2.1 Slow closing valves

3.10.2.2 Pressure regulating devices, see Paragraph 3.9 above for mitigating factors

3.10.2.3 Surge boots

3.10.2.4 Accumulators

3.10.2.5 Hose elasticity

3.10.2.6 MA-3, -4 pressure regulated couplings with latching toggles (tanker/receiver latching device) for probe/drogue aerial refueling

3.10.2.7 Omission of aerial refueling pump check valve (provides for soft system i.e. no reflection point for surge)

3.10.2.8 Fast acting pressure relief valves (surge suppression characteristics)

3.10.2.9 Slow start-up of Ram Air Turbine.

3.11 Pressure Requirements Usage

In the application of pressure design limits, there are different criteria for design, test, minimum, maximum, working, maintenance action, etc.

3.11.1 In the application of a pressure design limit, it shall be expressed as a hard requirement. Example, “The design proof pressure of a system shall be 240 PSIG.”

3.11.2 In the case of test it shall be expressed as a minimum. Example, “The proof pressure of a system shall be a tested to a minimum of 240 PSIG.”

3.11.3 In the case of a surge pressure test it shall be expressed as a maximum. Example, “The surge pressures during worst case testing shall not exceed a maximum of 240 PSIG.”

3.11.4 During field operation, the pressure limits shall be expressed, as a maintenance action in the event that the proof pressure is exceeded. Example, “If the maximum proof pressure of 240 PSIG is exceeded, the following maintenance action is required.”

3.11.5 In the case of operating pressure, it shall be expressed as a minimum, maximum or range. Examples:

3.11.5.1 “The operating pressure shall be a minimum of 20 PSIG.”

3.11.5.2 “The operating pressure shall be a maximum of 120 PSIG.”

3.11.4.3 “The operating pressure shall be a minimum of 20 PSIG and a maximum 90 PSIG.”

3.11.5 In the case of interface pressure, it shall be expressed as a range of the tanker and receiver interface limits. Example, “The discharge pressure shall be 50 ± 5 PSIG at the inlet to the boom nozzle.”

3.12 Simplified Pressure Factors

Operating (working)	X PSIG
Proof (limit)	2 * X
Surges	≤ 2 * X (Proof)
Burst (ultimate)	3 * X (1.5 * Proof)

If Surges are greater than Proof, the Proof Pressure shall be raised accordingly and the Burst Pressure shall be raised to 1.5 times the new Proof.

4.0 TEST AND VERIFICATION, TYPICAL METHODS FOR TANKER & RECEIVER A/C

Conduct the following test and verification methods to minimize the risk of fuel system incompatibility due to fuel pressures exceeding design values.

4.1 COMPONENT LEVEL

4.1.1 Test each component to proof pressure (should be sustained by test, a minimum of 5 minutes)

4.1.2 Qualification test to system design pressure limits (See Figure 1)

4.2 SUBSYSTEM LEVEL

4.2.1 Test to proof pressure (should be sustained by test, a minimum of 5 minutes)

4.2.2 Test for conceivable failure conditions

4.2.3 Demonstrate redundancies

4.2.4 Test with air in lines

4.3 AIRCRAFT INSTALLED SYSTEM LEVEL

4.3.1 Test tanker and receiver aircraft hydrostatically to design proof pressure (minimum sustained for 5 minutes). Component qualification is not an acceptable substitute since aircraft line routing and clamping of all components will impact results.

4.3.2 Tanker/Receiver aircraft or simulator and fuel/de-fuel source test:

- 4.3.2.1 Fuel pump
- 4.3.2.2 All fuel pumps
- 4.3.2.3 Failure modes
- 4.3.2.4 Flowing disconnects (during manual pump operation and at 10 ft/sec separation velocity of receiver aircraft)
- 4.3.2.5 Test air in lines
- 4.3.2.6 Portable test units (PTUs) that provide simulated level control valves, which can close within 0.2 seconds (linearly) thereby simulating worst case receiver aircraft shut off valves.

4.4 GROUND TEST (TANKER/RECEIVER AIRCRAFT COUPLED)

4.4.1 Account for head pressures

4.4.2 Adjust the test article or aircraft for the correct flight attitude (pitch, roll, etc.) This is crucial in those cases where the receiver's valve closure sequence can be affected by orientation

4.4.3 Instrumented assets

4.4.4 Failure modes (failed regulators/suppressors)

4.4.5 Real time data

4.4.6 Minimize or eliminate use of elastic materials such as rubber hoses between boom nozzle and receiver aircraft receptacle. Elastic materials such as rubber hoses act as surge suppressors.

4.4.7 Provide adequate ground support equipment drive motors simulating RAM Air turbines, equivalent to aerial refueling flight conditions and also provide simulations of simultaneous receiver aircraft aerial refueling conditions

4.4.8 Conduct all conditions as listed in Paragraphs 3.8.1 and 3.8.2 herein

4.5 TEST PROGRESSION:

Real time data should be used for progressions from most benign to worst case conditions

4.5.1 Steady state

4.5.2 Single tank top offs

4.5.3 Simultaneous top offs

4.5.4 Line valve closure with and without air in lines

4.5.5 Flowing disconnects

4.6 ANALYTICAL MATH MODEL

Analytical math models should be initiated at the component and installation level and refined to the results of component, systems and installed system tests for both ground and flight.

4.7 FLIGHT TEST VERIFICATION OF GROUND TESTS:

Flight test spot checks of ground test data should confirm ground tests data and/or analytical math model test data. Flight test conditions, which cannot be duplicated on the ground, shall be conducted in-flight with appropriate fuel pressure and flow instrumentation, i.e.: Ram Air Turbine/fuel pump startup time and receiver aircraft flight orientations.

4.8 TANKER/RECEIVER INSTRUMENTATION:

Instrument the tanker and receiver at the following locations (mount pressure transducers on bottom of fuel lines and bleed any trapped air).

4.8.1 Receiver aircraft instrumentation and pressure transducers:

4.8.1.1 Level control valves (as close to inlet as practical)

4.8.1.2 Dead end lines

4.8.1.3 In-line valves upstream and downstream

4.8.1.4 Downstream probe nozzle and UARRSI receptacle (see Interface paragraph 3.3 for location)

4.8.1.5 Fuel tank pressure

4.8.1.6 Fuel quantity gauges all tanks (existing A/C instrumentation)

4.8.2 Tanker aircraft pressure and fuel flow instrumentation

4.8.2.1 Fuel AR/transfer pump outlets

4.8.2.2 Boom/hose inlet

4.8.2.3 Pressure regulators/surge suppressors (up- and downstream)

4.8.2.4 Boom/hose outlet (see Paragraph 3.3 for interface of boom nozzle)

4.8.2.5 MA-2/-3/-4 coupling (upstream)

4.8.2.6 Internal to Wing AR Stores

1. Store inlet
2. AR pump outlet
3. Hose inlet
4. Hose outlet / up-stream MA-2/3/4 coupling
5. MA-3/4 coupling down-stream of pressure regulator(s)

4.8.2.7 Fuel flow, fuel totalizer (existing aircraft system indication system)

4.8.2.8 Fuel tank quantity gauges (existing aircraft system indication system)

4.8.2.9 Verify aerial refueling design pump power (hydraulic/electrical) is within design requirements

4.8.3 Instrumentation frequency response and accuracy

Historically, instrumentation sample rates of 250 – 600 Hz are used. Lower rates may lose important short duration surge information. Some airframe manufacturers are using sample rates up to 3 kHz; while some component vendors are using sample rates up to 20 kHz. These sample rates are generally used during development and qualification tests.

4.8.3.1 Pressure transducers 250 to 600 Hz, 0.5 psi resolution

4.8.3.2 Pressure recording 250 to 600 Hz, 0.5 psi resolution

4.8.3.3 When recording and transducer equipment have response frequencies over 600 Hz they may pickup high frequencies of other systems or fuel dynamic factors (noise) thereby clouding valid transient (surge) pressures necessary to assess the legitimate pressure measurements. When these cases occur, lower values of response frequency or filtration of noise may be necessary.

5.0 MAINTENANCE INSPECTIONS

Maintenance, inspections, and test verification methods of critical aerial refueling equipment, and inspections and test of all tanker and receiver aircraft aerial refueling systems / components should be performed on a scheduled basis throughout the life of the aircraft by use of ground support equipment. Failure of critical aerial refueling equipment can result in serious fuel line failure, fuel tank rupture and uncontrolled fuel spillage. Critical aerial refueling components include: tanker fuel pressure regulators, surge suppression devices, receiver aircraft pressure disconnect switches, and shut-off and level control valves. Failure of these devices may not affect the tanker or receiver aircraft normal flying performance but will seriously impact aerial refueling fuel transfer operation and safety.

6.0 Abbreviations

6.1	GPM	Gallons per minute
6.2	PSIG	Pounds per square inch gauge
6.3	A/C	Aircraft
6.4	Hz	Hertz (frequency cycles/second)
6.5	UARRSI	Universal Aerial Refueling Receptacle Slipway Installation
6.6	K	Thousand
6.7	ARSAG	Aerial Refueling Systems Advisory Group
6.8	MS	Milliseconds
6.9	MA-2,-3,-4 Coupling	Used by tanker aircraft drogue systems to couple hose to receiver aircraft probe nozzle (MA-2)
6.10	MA-2 Nozzle	Used by receiver aircraft to couple probe mast to tanker coupling hose connection
6.11	Boom Nozzle	Tanker coupling to receiver aircraft
6.12	Receptacle (UARRSI)	Receiver coupling to tanker aircraft
6.13	Stiff Boom	Method to secure nozzle / receptacle connection when receiver aircraft receptacle toggle failures occur
6.14	BDA	Boom to Drogue Adapter

7.0 References

7.1 ATP-56 (NATO STANAG 3971) Air To Air Refuelling

7.2 STANAG 3447 Ed. 3 “Aerial Refueling Equipment: Probe-Drogue Interface Characteristics”

7.3 Aerial Refueling Probe / Drogue Guide Number 04-05-09WD

7.4 STANAG 7191 Ed #1 “Aerial Refueling Equipment: Boom-Receptacle Interface Characteristics” Draft

7.5 ARSAG Document 20-08-09WD “Aerial Refueling Boom / Receptacle Guide

7.6 JSSG 2006 & 2009 appendix F Joint Service Specification Guide

7.7 Performance and Interface Survey dated 1981 ARSAG Document

7.8 Standardized Technical Data Survey dated January 2010 ARSAG Document

7.9 MIL-T-83323 Test, Universal Receptacle, Aerial Refueling

7.10 Tester, Boom Nozzle P/N 81018 (NSN 4920-01-183-3039)

7.11 Tester MA-2,3,4 Coupling P/N: 81015, NSN: 4920-01-186-5820

7.12 MIL-H-4495, Hose Assembly, Rubber, Air Refueling