Standard OPS 001 Approval of firebombing delivery systems

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Review Due: November 2014

1. BACKGROUND

1.1. Given the range and variation between models of aircraft types and delivery systems available for firebombing, it is has been found necessary for NAFC's Members to approve each individual combination of aircraft type and delivery system.

1.2. Australian fire and land management agencies are currently cooperating to develop a common system for testing and approval of aircraft types and delivery systems for aerial firefighting. However, further research and development is required before this approach can be fully implemented.

1.3. In the interim this Standard aims to provide guidance to NAFC Members in approving aircraft type and delivery systems for firefighting and firebombing in Australia.

1.4. Any individual contract or agreement to purchase firefighting and firebombing services may include additional requirements to those listed here.

2. GUIDELINE

2.1. Prior to conducting any firebombing operation, aircraft are required to be equipped with a delivery system approved for that particular aircraft type. Delivery systems include firebombing tanks, belly tanks and underslung buckets. Any approval includes approval of the delivery systems' component parts including, but not limited to, doors, gates, valves, venting systems, suppressant injection systems, system controllers, and controller software.

2.2. Each combination of aircraft type and delivery system requires the specific approval of the relevant Member. In most circumstances, Members will endeavour to recognise the approval granted by another Member.

2.3. Levels of approval are:

a. **Approved** – the aircraft type and delivery system combination may be used in firebombing operations on behalf of the Member.

b. **Provisionally Approved** – the aircraft type and delivery system may be used in firebombing operations on behalf of the Member, subject to particular conditions specified by the Member. Provisional approval may also apply in a case where a Member has made a partial assessment of the aircraft type and delivery system combination, but further testing or assessment is required before the system is Approved.

c. **Not Approved** – the aircraft type and delivery system combination has been assessed but does not meet the requirements of the Member. The aircraft type and delivery system may not be used in firebombing operations on behalf of the Member.

d. **Not Assessed** - the aircraft type and delivery system combination has not yet been assessed for approval by the relevant Member.

2.4. In approving aircraft type and delivery systems for firebombing, particular attention will be given, where appropriate, to the design of the:

a. tank or bucket; and

b. firebombing door or valves; and

c. tank venting; and

d. system controller; and

e. ground distribution of retardant slurries and suppressant solutions.

2.5. Compliance with all requirements listed here will not necessarily result in approval as other factors can also influence the effectiveness of various aircraft type and delivery system combinations for firebombing.

2.6. Approval of a delivery system by the United States Interagency Airtanker Board (**IAB**) will not necessarily result in approval in Australia. However, delivery systems with full IAB approval will normally be recognised as meeting Australian requirements for flow rates, dump times, venting, and ground pattern and distribution of retardant and/or suppressant solutions.

3. APPROVAL CRITERIA

3.1. Capacity

a. Organisations proposing delivery systems for approval must provide certification from an independent authority (acceptable to the Member) of the maximum physical volume of water that may be carried in the tank.

b. The aircraft must be reasonably capable of carrying this volume, under the conditions defined in either *NAFC Standard PR001 Categorisation of rotary wing aircraft used for firebombing operations* or *NAFC Standard PR002 Categorisation of fixed wing aircraft used for firebombing operations*, as appropriate.

3.2. Flow Rates and Dump Times

a. The delivery system must have flow rates and dump times which have demonstrated ability under typical dropping conditions to provide an adequate on-the-ground distribution of both suppressant and retardant solutions as appropriate for the combination of aircraft type and delivery system (see clause 3.9 below).

b. During an on-ground static test with a full load of water, the delivery system must be able to produce a "full dump" or “salvo” with a minimum acceptable flow rate,

measured from the time at which the firebombing door starts to open to the time at which the substantive load has left the tank:

Aircraft Type	Minimum acceptable flow rate
Fixed Wing Tank	1000 litres / second
Rotary Wing Tank	500 litres / second
Rotary Wing Bucket	500 litres / second

3.3. Capabilities

a. All tanked delivery systems, and buckets with a capacity of greater than 1200 litres, must be capable of dropping a pre-determined amount of the load at the maximum flow rate, plus other flow rates (see clause 3.3(d)), and then closing and resealing the firebombing door or valve in flight, and then dropping a further part of the load in the same manner (i.e. be capable of "splitting" the load).

b. Where the predetermined amount of the load to be dropped in any one "split" is not continuously variable, an acceptable number of fixed options appropriate to the size of the firebombing tank must be provided. As a guide:

Aircraft Type	Number of parts / splits
Fixed Wing with tank < 3000 litres	at least two parts
Fixed Wing with tank > 3000 litres	at least four parts
Rotary Wing Type 2 and 3	at least two parts
Rotary Wing Type 1	at least four parts

c. Tanked delivery systems with compartmentalised tanks with separate firebombing doors may be an acceptable alternative to splitting loads, provided that at least two compartments are provided and that each compartment is capable of carrying a minimum volume of water:

Aircraft Type	Minimum volume per compartment
Fixed Wing Tank	1000 litres
Rotary Wing Tank	500 litres

d. Tanked delivery systems must be capable of dropping all or part of the load at predetermined flow rates that are less than the maximum flow rate (i.e. be capable of restricted flow).

e. For tanked delivery systems where the predetermined restricted flow rate is not continuously variable, an acceptable number of fixed options must be provided. At least four "coverage levels" or options should be provided. (eg 500, 1000, 1500 and 2000 litres per second).

3.4. Construction and Design Features

a. Delivery systems and associated equipment must meet appropriate legislative requirements and aviation regulatory authority design requirements.

b. Delivery systems and associated equipment must not compromise the air worthiness or controllability of the aircraft.

c. Tanked delivery systems must have firebombing doors that are able to be fully closed in flight (fully retrievable) when the tank is empty (unless otherwise specifically approved)

d. Bucket delivery systems must include a means of being able to reduce the load carried according to prevailing conditions, without unduly affecting the operation of the bucket or the quality of the drop pattern. This is usually achieved by physically reducing the capacity of the bucket or by taking a partial load in the bucket.

e. All equipment must be well constructed and include effective seals to prevent any unacceptable leakage of tank contents. Acceptable losses are:

Aircraft / System Type	Full load, static test, 60 minutes	Full load, firebombing, 20 minutes
Fixed Wing Tank	<2 litres lost	<5 Litres lost
Rotary Wing Tank	<2 litres lost	<5 litres lost
Rotary Wing Bucket	<20 litres lost	<50 litres lost

f. Delivery systems must be mechanically reasonably simple, robust, reliable, and constructed from durable materials. Where practicable, delivery systems will incorporate redundancy which enables continued firebombing operations in the event of partial equipment failure.

g. Delivery systems will as far as possible, avoid the use of specialised parts and be "field maintainable".

h. Delivery systems must enable the aircraft to be operated safely. In this respect, particular attention must be paid to aspects such as:

   i. availability of an emergency dump or jettison;

   ii. ergonomics of operation - not requiring excessive strength or excessive movement by the pilot to dump or jettison the load;

   iii. ergonomics of operation - easy adjustment of settings and controls; and

   iv. avoiding large pitch excursions/movements or trim changes when dropping the load.

i. For rotary wing systems, the aircraft must be capable of landing or safely offloading crew or payload in remote or roughly prepared landing areas with the delivery system attached.

j. Any self-filling delivery system that incorporates a hover-fill snorkel or skimming snorkel or probe must have the capability to fly with the snorkel or probe "stowed"

or “retracted” during cruise flight and release them to the filling position without landing the aircraft.

k. Delivery system designs must avoid features within the tank or bucket that may cause part of the load to “hang up” or “burp” in the tank or bucket.

l. Doors and valves must be designed such that the open door or valve does not impede the load exiting the tank, and so that doors and valves do not flap or pulse the load.

m. Delivery system doors, tanks, buckets and valves must be designed as far as practicable to avoid any structural members, actuating mechanisms or other parts of the system from impeding flow from the tank or bucket, or causing interference patterns in the flow.

n. Unless otherwise specifically excepted rotary wing aircraft must be capable of a minimum cruising True Air Speed with the delivery system fitted:

Aircraft / System Type	Minimum TAS
Rotary Wing with tank empty tank, snorkel in filling position	100 knots
Rotary Wing with bucket full bucket on 30 meter long line	80 knots

3.5. Tank Venting

a. Tanked systems must be provided with effective venting such that the load may exit the tank without restriction caused by negative pressure in the tank or without pulsing or striping effects.

b. Tank venting must be constructed in such a way as to prevent the tank contents from escaping through any vents from a fully loaded tank during manoeuvring.

c. Generally it will be necessary to provide a vent sized to be at least 30% of the surface area of the firebombing door. There may also be a need to interconnect the firebombing doors and vents to prevent “pulsing”.

3.6. Foam Injection

a. Delivery systems of greater than 500 litres capacity must be fitted with a reservoir and suppressant concentrate injection system capable of injecting a measured amount of concentrated fire suppressant chemical (eg foam and water enhancing polymer gels) into the firebombing tank or bucket.

b. The suppressant concentrate reservoir shall have a minimum capacity according to the table below. All capacities are defined as percentages of the maximum load of water that may be carried when firebombing.

Aircraft / Delivery system Type	Minimum capacity
Fixed Wing - ground reloading	1.2%
Fixed Wing - self filling (scooping)	6%
Rotary Wing - with tank	5%
Rotary Wing - with bucket	6%

c. Unless otherwise approved by the relevant Member, rotary wing aircraft with buckets with a capacity of greater than 1200 litres the suppressant concentrate reservoir must be on-board the aircraft, and deliver suppressant concentrate to the bucket via a suitable hose with a breakaway connection.

d. Any reservoir on-board an aircraft must be capable of being filled in such a way as to minimise manual handling of heavy fire suppressant concentrate containers. A stand alone system that employs an electric pump on board the aircraft that draws concentrate from containers positioned on the ground and delivers it to the on-board reservoir is preferred. This process should be pilot activated from the cockpit with the fire suppressant concentrate fill point located in in a safe position in view of the pilot, for fixed wing aircraft this would normally be in close proximity to the firebombing tank fill point.

e. Any in-bucket fire suppressant concentrate reservoir must be capable of being filled in a manner that minimises risks associated with manual handling of heavy containers and eliminates high manual lifting of heavy concentrate containers.

f. The concentrate injection system for the fire suppressant concentrate must be capable of injecting a pre-set measured amount of concentrate to an accuracy of plus or minus 5% of volume. (ie if set to inject 20 litres, the actual injection of concentrate is between 19.0 and 21.0 litres)

g. The concentrate injection system will be capable of being operated by the pilot with the single action of a button or switch.

h. The concentrate injection system will incorporate the means to ensure that the concentrate is well distributed in the tank or bucket contents. (eg a distribution manifold)

i. The design of the delivery system and concentrate injection system will ensure that excessive foaming is not created within the tank or bucket during filling or flight.

3.7. Filling Requirements

a. Fixed wing aircraft:

i. the tank must be capable of being ground filled without restriction through at least one external 80mm (“3 inch”) diameter “Camlock” male fitting. For Single Engined Airtankers this fitting must be located on the left hand side of the aircraft behind the wing, and fitted with an integral stop valve with the “on” and “off” positions clearly marked; and

ii. the plumbing, fittings, fixtures and any other associated systems for filling the tank shall not contain components measuring less than 75mm internal diameter; and

iii. single Engined Airtankers must carry and have immediately available an approved adaptor fitting to reduce from the 80mm male “Camlock” to 50mm (“2 inch”) male “Camlock” external filler port.

b. Rotary Wing aircraft with tank or bottom fill buckets

i. the tank or bucket must be capable of being hover-filled, unless specifically exempted by the relevant Member. Hover-fill times to a full tank or bucket under ISA conditions at Mean Sea Level must not exceed 70 seconds; and

ii. hover fill pumps must be capable of operating without undue restriction on duty cycles. As a guide, any hover fill pump must be capable of providing 20 complete fills per hour of operation without restriction; and

iii. hover fill systems must be equipped with filtering designed to prevent clogging or ingestion of items liable to damage the pump or other delivery system components; and

iv. hover fill systems must be capable of filling the tank or bucket with fresh or brackish water without restriction. (Note that this is a minimum requirement for basic approval – some contracts may specify that the aircraft tank/bucket combination must also be capable of self-filling with salt water without impediment); and

v. hover fill systems must be capable of filling the tank or bucket with retardant from a suitable dip tank; and

vi. tanked systems must be capable of being ground filled without restriction through an external 80mm (“3 inch”) “Camlock” male fitting located in a safe position on the side of the aircraft.

c. Rotary wing aircraft with any bucket

i. The bucket must be capable of being hover-filled; and

ii. Some buckets may be capable of “bottom filling”. This refers to the ability of the bucket to be filled or partially filled through the dump valve by the action of pumps and/or flapper valves. This capability is not an approval requirement but may be specifically required in some contracts; and

iii. Buckets must be able to be filled with fresh, brackish or salt water or fire retardant without restriction.

3.8. System Operation

a. Unless otherwise specifically approved by the relevant Member, delivery systems must be operated by electrical, pneumatic or hydraulic means, that permit the pilot to:

i. determine in advance the amount of the tank contents to be dropped; and

ii. for tanked systems, determine in advance the flow rate or coverage level; and

iii. activate the dump with a single action of a button or switch mounted on the control column or throttle quadrant or cyclic; and

iv. operate the dump system manually in the case of failure of the primary delivery system.

b. In approving delivery systems, with respect to the design of electrical, hydraulic or pneumatic actuation, particular attention will be paid to :

i. capabilities offered; and

ii. robustness and reliability; and

iii. simplicity and maintainability; and

iv. redundancy - ie the ability to satisfactorily continue a firebombing operation, even on a manual basis, in the event of partial failure of the delivery system; and

v. weight and drag, if aircraft performance will be significantly affected.

c. Unless otherwise specifically approved by the relevant Member the Firebombing Delivery System must provide an interface compatible with the AFAMS tracking and event logging system.

3.9. Ground Pattern and Distribution

a. The combination of aircraft type and delivery system must be capable of producing on the ground a distribution of retardant slurry or fire suppressant solution that is acceptable to the Member.

b. The ability to drop and distribute a load on the ground according to the required patterns is a key criteria for approval of delivery systems.

c. The “dispersal” characteristics of water, various fire suppressant solutions, and retardant slurries are different. It is important to be able to achieve satisfactory drop patterns for each. Fixed wing delivery systems must produce an adequate ground distribution of retardant. Rotary wing delivery systems ideally should be able to achieve adequate ground distribution of retardant.

d. For tanked delivery systems firebombing doors must operate quickly. In effect doors need to be able to “snap” to the appropriate position and “snap” closed again. This is particularly important when splitting loads.

e. For the purposes of these standards a standard drop is defined. This standard drop is designed to define the minimum acceptable retardant or suppressant coverage level and distribution on the ground, it is expected that most firebombing delivery systems would exceed these minimum requirements:

i. a standard drop is defined as:

Parameter	Value
Drop door or valve	Fully open or maximum setting
Aircraft height - Rotary wing	75 feet AGL
Aircraft height - Fixed wing	75 feet AGL or minimum safe height
Aircraft speed - Rotary wing	40 knots
Aircraft speed - Fixed wing	minimum safe drop speed
Terrain	flat
Conditions	ISA at sea level, nil wind.

ii. the effective zone of a standard drop is where the concentration of retardant or suppressant on the ground is:

Type	Minimum concentration
Retardant	0.81 litres / square metre
Suppressant	0.2 litres / square metre

f. During a standard drop the aircraft must be able to produce a pattern of retardant or fire suppressant on the ground which:

i. is reasonably rectangular, as far as practicable; and

ii. has an effective zone width of:

Aircraft / System	Effective zone width
Fixed Wing Tank	between 15 metres and 20 metres
Rotary Wing Tank	between 10 metres and 15 metres
Rotary Wing Bucket	n/a

iii. is without excessive variation in width over the effective length (the width of the effective zone should vary by no greater than + or - 20% along its length i.e. a 15 metre wide pattern would have no areas less than 12 metres wide and none greater than 18 metres wide); and

iv. for fixed wing aircraft the length of effective zone that will depend on the amount dropped, but in any case not less than 40 metres; and

v. within the effective zone, has a distribution of retardant or suppressant that must be as even as practicable, ideally varying by no greater than 20% in level of concentration in the effective zone; and

vi. has no “striping” or gaps in coverage.

g. Outside of the effective zone there will be as little retardant or suppressant as possible, ideally no greater than 15% of total load reaching the ground should be outside the effective zone.

h. When splitting the load, the same criteria as in clause 3.9(f) apply, only the length of effective pattern should vary.

i. When restricting the load (ie operating at lower coverage levels) - the same criteria as in clause 3.9(f) apply, only a reduction in width of effective pattern may be allowable (to no less than 10 metres wide).

3.10. General

a. Where the particular substance is approved for the Aircraft type, delivery systems must be capable of effectively delivering water and foam and retardant and water enhancing polymer gel solutions.

b. Delivery systems must at all times when used for aerial firefighting or firebombing be clean and free of any chemical other than those prescribed by Members as being appropriate to the operations.

c. Self-filling tanked aircraft (including scoopers and sea snorkel equipped aircraft) must, in addition to their self-filling ability, meet the retardant carrying capacity and other capabilities outlined in this standard.