# FUTURE OF FIRE FIGHTING FOAMS

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# Recent Testing and ICAO Concerns

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# 2012 Danish ICAO Testing

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| ICAO Level B Fire test Results - Denmark 2012 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Test Fuel:* ***Jet A1*** *;* *Premix:* ***Freshwater*** | | | | | | | | |
| **Test product** | **Nozzle** | **Exp. Ratio** | **25% DT (Mins: Secs)** | **90% control (secs)** | **99% control (secs)** | **Extinction (Min:Secs)** | **25% Burnback (Min: Secs)** | **PASS/FAIL** |
| Mfr 1- F3: Product A | UNI86 | 9.64 | 18m 26 | 35 | 45 | None | N/A | FAIL |
| | ***MMS*** | ***4.8*** | ***10m 56*** | ***30*** | ***45*** | ***1m 58**** | ***6m 45*** | FAIL |
| Mfr 1- F3: Product B | UNI86 | 9.6 | 16m 16 | 50 | 1m 05 | 2m 00 | 8m 30 | FAIL |
| | ***MMS*** | ***4.5*** | ***18m 38*** | ***50*** | ***1m 45*** | ***None*** | ***N/A*** | ***FAIL*** |
| Mfr 2- F3: Product C | UNI86 | 10.2 | 15m 07 | 40 | 45 | 1m 24 | 7m 50 | FAIL |
| | ***MMS*** | ***4.93*** | ***5m 35*** | ***35*** | ***55*** | ***None*** | ***N/A*** | ***FAIL*** |
| Mfr 3- F3: Product D | UNI86 | 8.5 | 22m 57 | 55 | 1m 05 | 1m 40 | 9m 50 | FAIL |
| Mfr 4- F3: Product E | UNI86 | 7.4 | 17m 00 | 40 | 55 | 1m 50 | 8m 05 | FAIL |
| Key: UNI86 - Standard test nozzle; ***MMS*** - Modified Military Specification nozzle. *= fuel & premix temps cooler. | | | | | | | | |
| *Source: Resource Protection International.* | | | | | | | | |

Reduced expansion ratios and drainage times from MMS, more closely represents typical nozzles used by most Airport Fire Services *(than high spec. UNI86 test nozzle).* Tests were conducted at ambient temperatures between 10.6˚C and 14.7˚C, when 60s extinction was required to PASS.

** = Fuel temps: 8.7-10.2˚C & premix temps: 8.9-10.5˚C.* ***Standard requires premix & ambient ≥15˚C.***

As ambient temperatures increase, …also expect any foam's quality to be decreasing.

***What about typical summer temperature performances at 30-40˚C?***

# 2016 -Spain testing
# More Comparisons F3 v ≤C6

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Spain 2016 Fire Testing:
Control Time Results **compared to C6 AFFF** showing:

***at 2.5L/min/m²***
F3 60% slower on Gasoline *(3 x F3 product failed to extinguish)*
F3 50% slower on Jet A1 *(all 5xF3 products failed to extinguish)*

***at 1.25L/min/m²***
F3 100% slower on Gasoline
F3 100% slower on Jet A1

***at 3.75L/min/m²***
F3 50% slower on Heptane
F3 25% slower on Gasoline
F3 10% slower on Jet A1

***Why were none of the five F3 agents able to extinguish Jet A1 fuel?***

**Table: All ≤C6 AFFFs PASS ALL fuel fire tests at 2.5L/min/m²**
*(1,3,4 = C6s; 2&5 = C8s)*

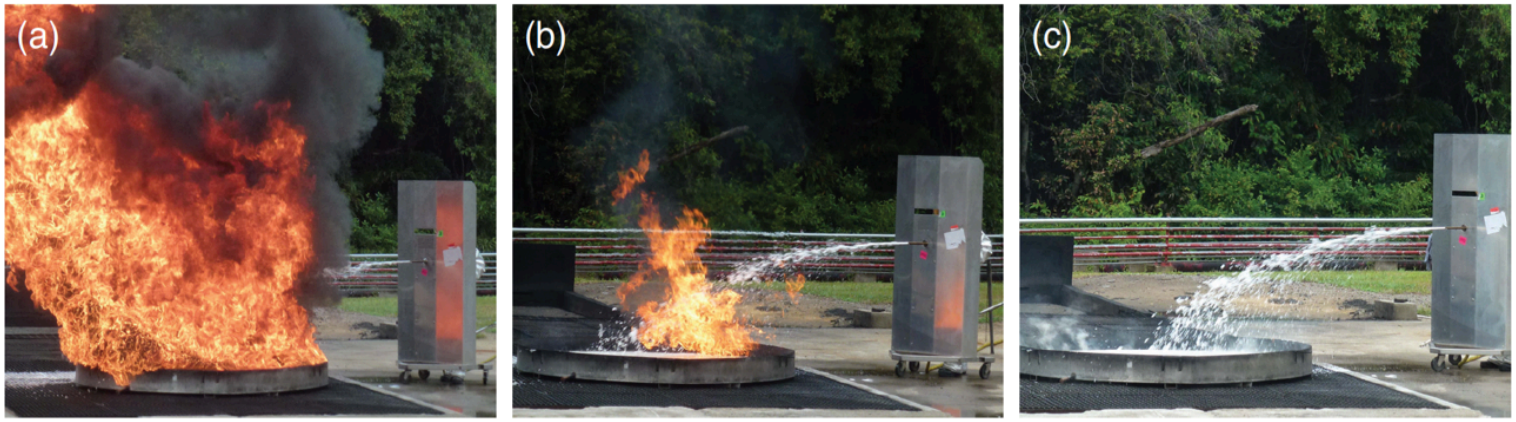
| | FFF (F3) | | | | | AFFF | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test/Fuel | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Gas. 95O | YES | NO | NO | NO | Late | YES | YES | YES | YES | Late |
| Heptane | YES | NO | NO | YES | Late | YES | YES | YES | YES | YES |
| Jet A1 | NO | NO | NO | NO | NO | YES | YES | YES | YES | YES |
| Diesel | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |

NB: 1-5 above represent five unique, commercially available AFFFs and F3 foams

**Differences increased with:**

- lowering application rates
- more volatile fuels
- tougher conditions

# 2016 Singapore F3 replaced by C6 AFFF



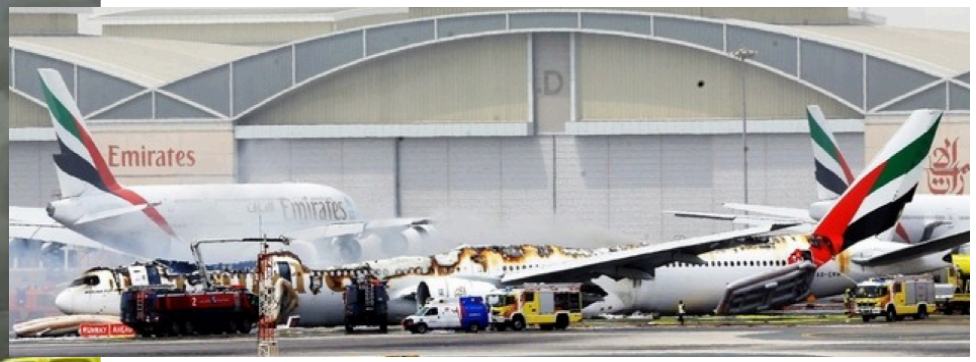

ICAO Level B Fire test demo in Singapore, 2016.
(a) pre-burn; (b) ≤C6 AFFF fire control; (c) ICAO Level B ≤C6 AFFF extinguishment

An F3 agent intended to be Conference highlight by showcasing its effectiveness. Had to be replaced by ≤C6 AFFF last minute because …***"too many environmental factors were not under our control to do F3"!*** ie it was too hot at 32°C for F3 to be effective (Such fire tests are usually conducted at 15-20 °C).

Twice the day before at 32°C, the same fire was unable to be extinguished using F3 agents, …and reportedly caught the training facility's fuel separator alight.

***A demo can be cancelled…REAL EMERGENCIES cannot!***

# 2016 Dubai
# B777 plane burned out




- Boeing 777 crashed (Aug 16) during "attempted go-around" , 48 °C heat with wind-shear conditions.
- All 300 passengers and crew safely disembarked, despite fuel fire developing.
- Foam applied to suppress the fire.
- A brave firefighter tragically lost his life when fuel tank exploded, 9 mins after crash.
- Extensive foam application to the fuselage continued… ***full control not achieved until 16 hours after impact! …Plane destroyed - apparently first ever in Emirates fleet.***
- Final investigation not yet concluded.
- Cause of firefighting failure, ...whether foam or very high ambient temperatures contributed, not yet known - Remains a possibility… ***Need to know - Why did it burn out?***

# ICAO Concerns: Test Changes

*ICAO Level B fire test showing F3 edge flickers after 60seconds foam application*

**2013 ICAO Fire test Changes:**

- Fuel **was Jet A1** (Avtur) (Flash Pt. 38˚C, Freezing -47˚C).
- Now **Kerosene** also permitted (Flash Pt 37-65˚C freezing -40˚C or below).
- Level B test ***changed from 60 seconds to 120 secs extinction***… allows edge flickers for 60 secs! = Lower quality AFFFs & F3s previously excluded now PASS! ***Why?***
- ARFF application rates (L/min/m2) typically double test rates (Level B at 2.5 and Level C just 1.56)! …***Is that enough to ensure life safety under such changes?***
- ***Do we risk more foam for longer = potentially more harm to life & environment?***
- ***Surely 15˚C ambient temp. is unrealistic for Australia ..why not test at 40˚C?***

# Why are temperature and Fuel so Important?

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**ICAO fire test requires**

- Ambient and foam solution temperatures ≥15°C required for testing
- Jet A1 and Kerosene fuels are not close to their flashpoints for testing (but are in Australia!)
- Flammable vapours not delivered at ignition point, takes time for fuel to warm up during preburn, so **easier to control and extinguish**
- Does this adequately reflect summer temperatures in most of the world? ***No.***
- Does the safety margin allow for this between test application rate (2.5L/min/m2) and ARFF application on fires at around 5L/min/m2 on all foams? Maybe... Who knows? ***Has F3 been used in anger on major fire in Australia or UK? …Apparently Not!***
- Nothing says fuel cannot also be cooled ...no rule prevents making the test easier?

**Australian airports conditions**

- Airport ambient temperatures around 35-40°C much of year - across much of Australia
- Jet A1 is main aircraft fuel (flashpoint 38°C), fuel more volatile, vapourising at ignition point as flashpoint regularly exceeded - so **harder to control and extinguish**
- Fuel cannot be easily cooled below flashpoint
- Foam blanket stability drops as ambient temperature increases
- Fuel volatility increases with increased risk of fuel pickup into foam blanket - unless contains fuel shedding additives

ALL foams F3 & C6 used at Australian airports, should pass ICAO level B at 40°C AND 15°C with Jet A1 fuel to ***ensure sufficient safety margin to protect life safety …year round***

# ICAO Concerns: Life Safety

**Life Safety Concerns:**

- Seems to contradict 2014 Airport Services Manual Pt 1 -requires control of any fire occurring (not necessarily extinguishing) ...**before** rescue begins ...***isn't reliable, fast, effective, fire control critical? Are sudden unpredictable flashbacks OK?***
- ***Do we risk extricating passengers into areas still vulnerable to sudden & unpredictable re-involvement in flames - increased risk in summer?***
- ARFF Response - fire crews practice to ensure typical 3 min survivable atmosphere inside fuselage ***achievable***. ...***Is it still?***
- ***What impacts do such changes have on travelling public's safety?***... most airports exceed 32°C in summer, & most of year across N Australia, Asia & Middle East? ***Are we safe enough?... ICAO Level B doesn't currently tell us!***

# Conclusions

**Most agree:**

- **≥C8s** (PFOS, PFOA and PFHxS) = **undesirable legacy issues & should be banned/restricted**
- **All fire types can pollute**: especially firewater runoff/fuel alone …. Even without any foam use!
- **F3 can bring problems** – flashbacks, slower control, diminished life safety, escalation, fuel emulsification, increased foam use + more runoff + more overflows
- **Fuel repellency and fast spreading seem critical** to deliver key performance objectives, *when* more environmentally benign (NOT Bioaccumulative, NOT Toxic)
- **Careful risk assessment of whole incident** critical to protecting life safety, minimising escalation & reducing environment impacts
- **Reducing risks, liabilities and exposures** facilitates best practice, …without always re-engineering existing fire systems

**Most ≤C6 agents achieve** fire performance & environmental performance objectives: **fast, reliable, effective , efficient fire control… with reduced runoff, less overflow, less BOD etc.**

**BUT …does F3?**

***Most realistic conclusion*:**
**Fast; efficient; robust; effective; reliable; environmentally responsible incident control *is still needed for good MHFs fire protection.***

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