Certification of Smoke Detection Systems in Aircraft

Challenges for standardisation

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Key Question

What smoke source for future smoke detector certification?

Or: How shall a reference smoke generation source for future smoke detector integration verification look like?

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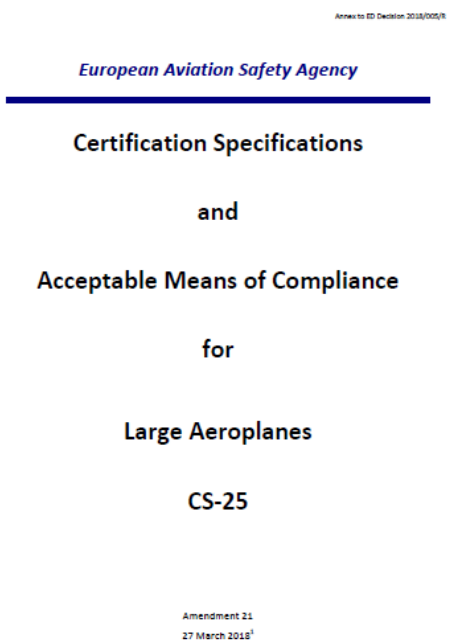
The “One – minute rule”


Annex to ED Decision 2018/005/R

European Aviation Safety Agency

Certification Specifications

and

Acceptable Means of Compliance

for

Large Aeroplanes

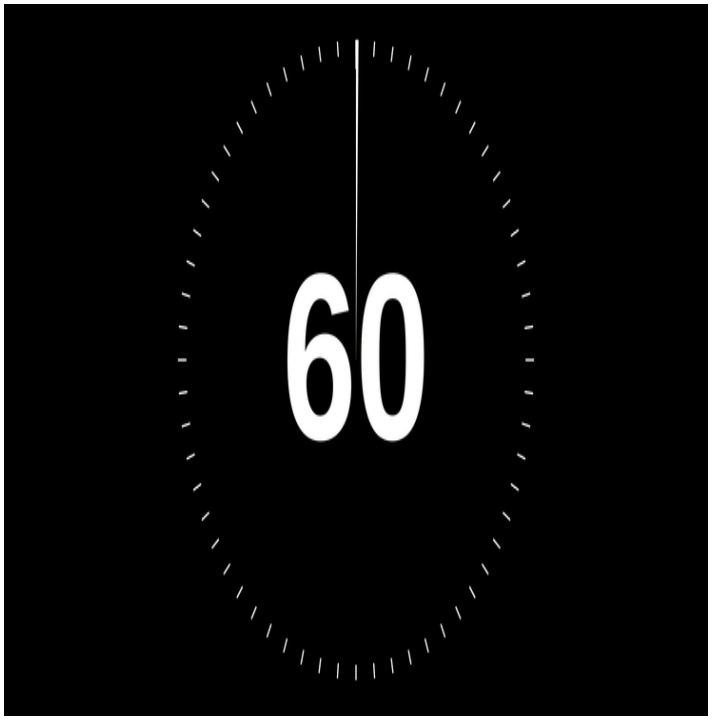
CS-25

Amendment 21
27 March 2018[1]

CS 25.858 Cargo or baggage compartment smoke or fire detection systems

If certification with cargo or baggage compartment smoke or fire detection provisions is requested, the following must be met for each cargo or baggage compartment with those provisions:

(a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.



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Motivation

What smoke to use to certify the latest Smoke Detectors?

1/6/94 AC 25-9A

a. Acceptable Smoke Generators for Smoke Detection Tests.

(1) Generators. An appropriate generator should be selected, e.g.,:

(i) Paper Towel Burn Box (see Appendix II);
(ii) Rosco Theatrical smoke generator [see 10a.3)];
(iii) Helium-injected Rosco Theatrical smoke generator;
(iv) A pipe or cigar;
(v) A Woodsman Bee Smoker; or
(vi) Any other acceptable smoke generator.

(2) Fuel. Representative materials should be selected, e.g.,:

(i) Plastic;
(ii) Rags;
(iii) Tobacco;
(iv) Burlap;
(v) Paper; or
(vi) Any other acceptable fuel

Alarm threshold for single optical SD	
	Light Obscuration
Aviator UL smoke generator	2.03%
Rosco smoke generator	2.67%

Alarm threshold for smart SD	
	Light Obscuration
Aviator UL smoke generator	3,27%
Rosco smoke generator	52,36%

It could make a difference depending on which smoke generator we use

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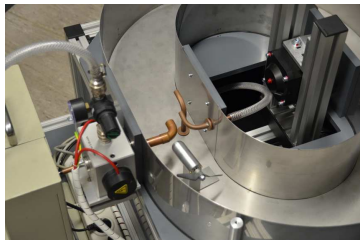
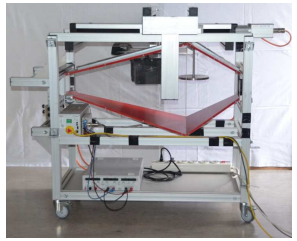
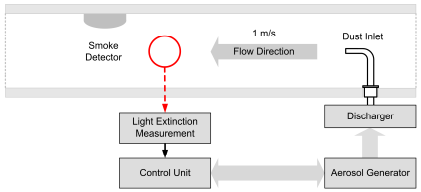
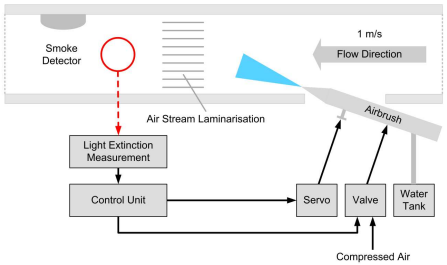
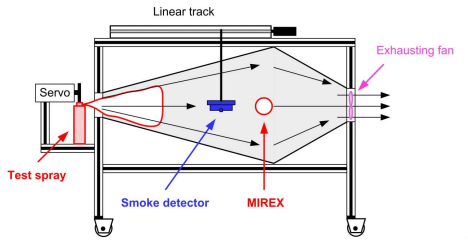
False Alarm immunity requirements

SAE AS8036 Standard

	Dust	Water Mist & Fog	Insecticides & Deo
Real world		 	
Test Apparatus			
Working principle			

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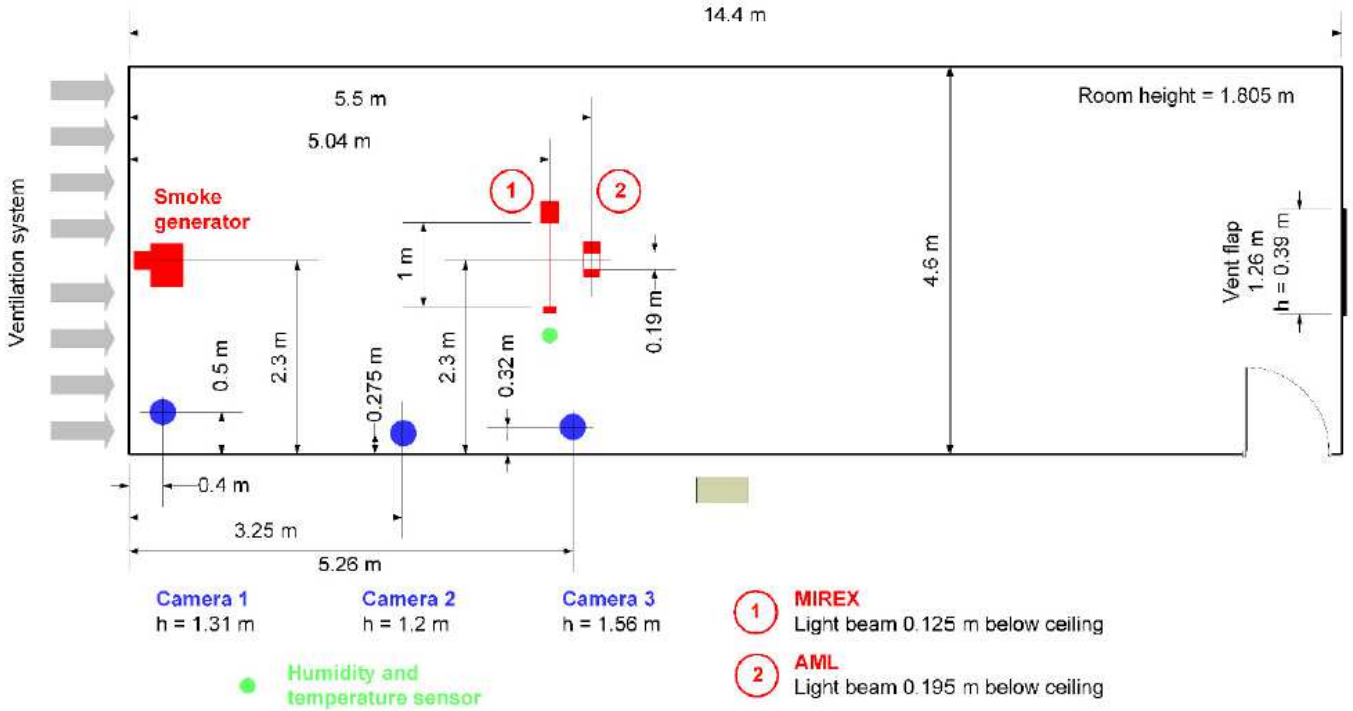
Today's standards

- Flight tests are performed with different smoke generators
- The test programme is agreed in advance with airworthiness authorities
- Different aircraft manufacturers use different smoke generators and different modes of operation

Standardisation is required!

Velocity	Particle size	Refractive index	Ambient Temp	…

Smoke Generator assessment – the environment matters



Test environment to be reproducible and documented in detail

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Test Mock-Up with reference sensors

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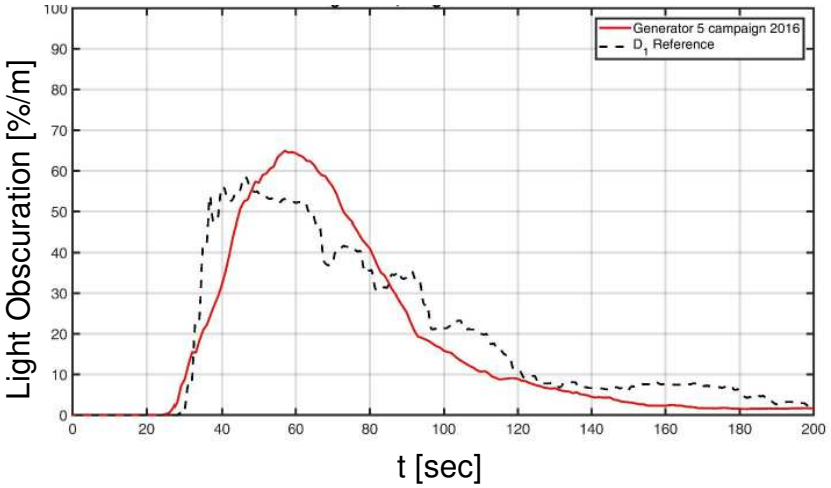
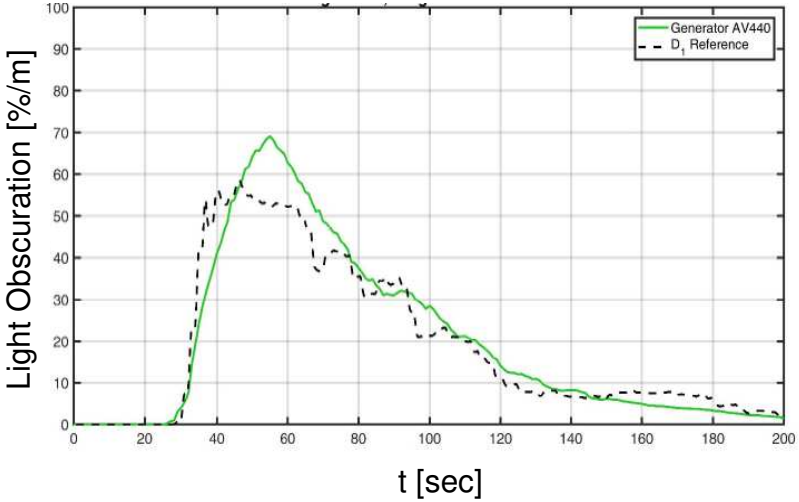
Recent studies



Assessment of “reference curve” in unventilated wooden cargo compartment mock-up



Siemens Smoke Generator

Aviator Smoke Generator

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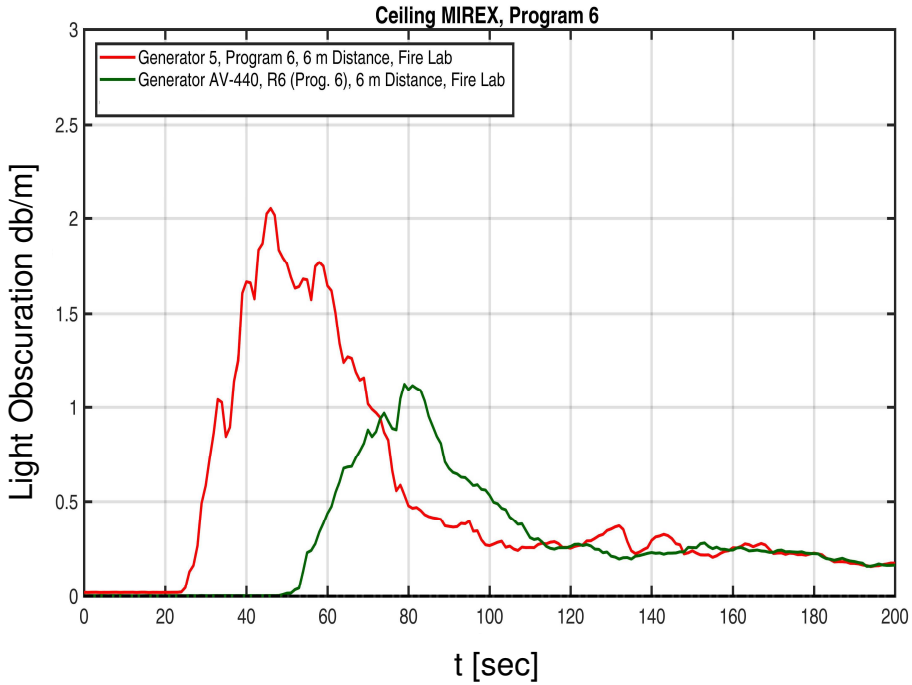
Smoke Density Measurements in EN54 room environment

- In a different environment (EN 54 room), the results of smoke density measurements differ between the 2 generators.
- Smoke dynamics and spreading becomes visible as influencing factor in the enlarged room with higher dilution



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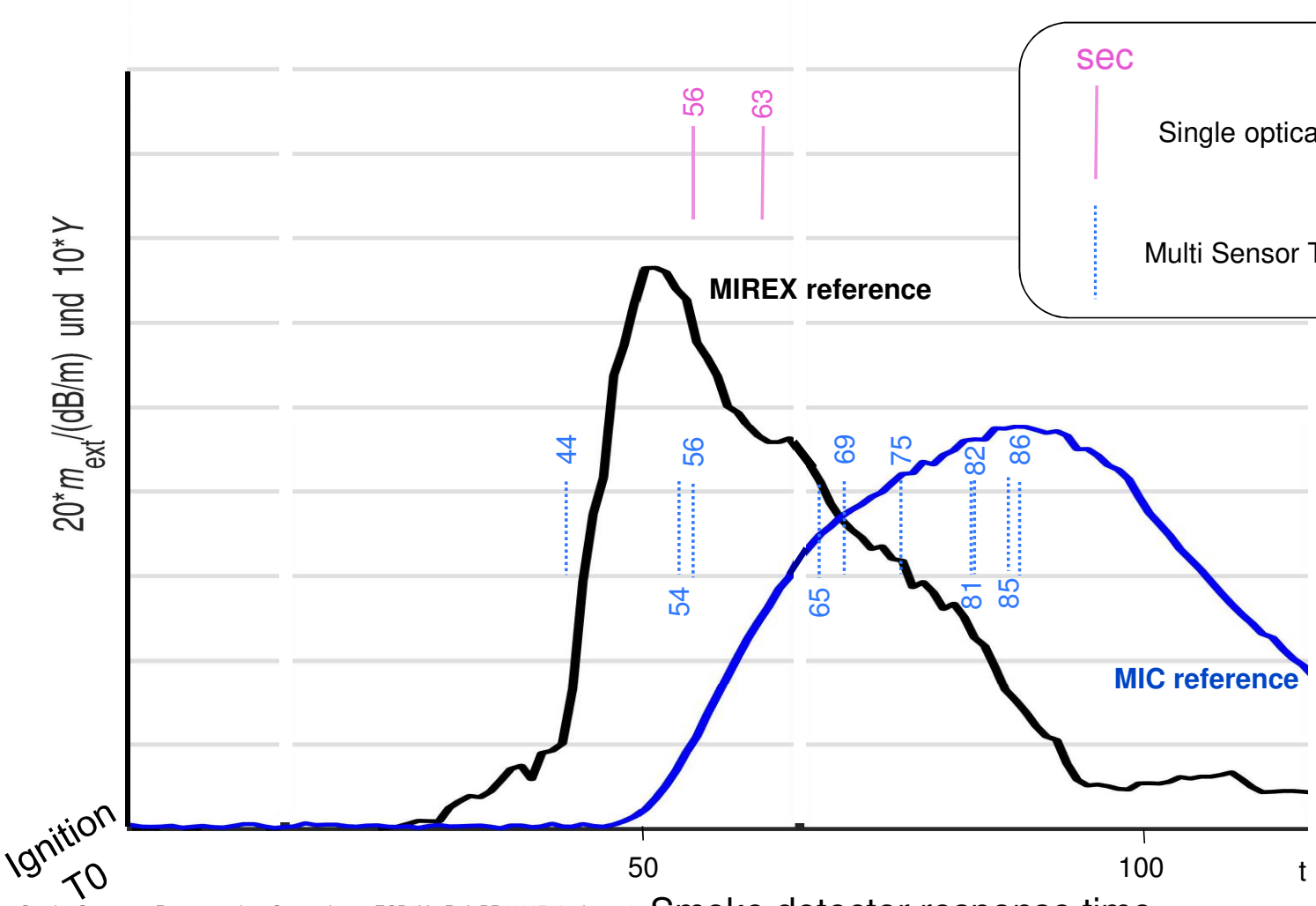
Smoke Generator test

Siemens Smoke Generator Program 5 in EN54 test environment



- Multisensor smoke detectors respond differently to artificial smoke
- The Siemens smoke generator generally useable to certify multisensor smoke detectors

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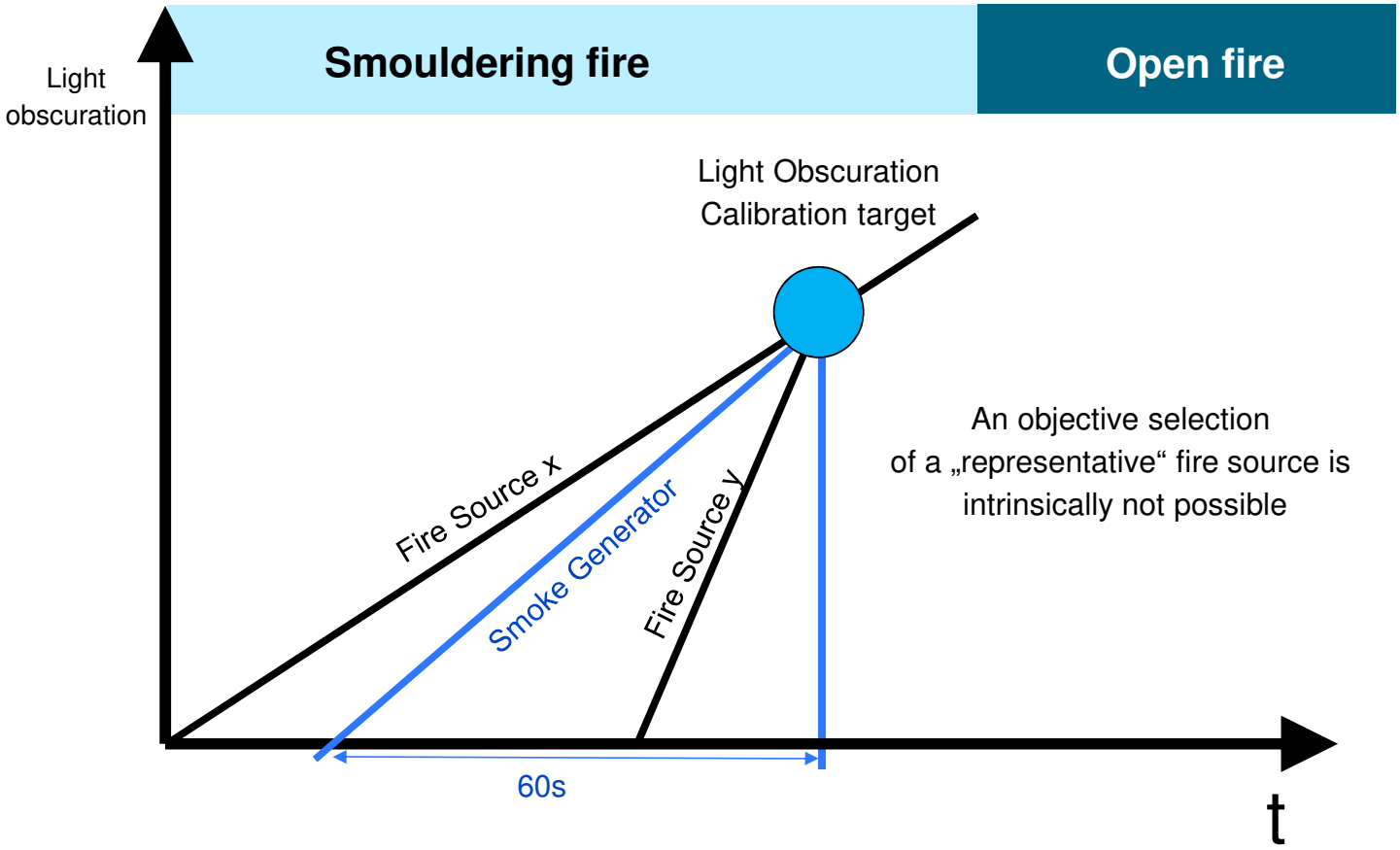
One possible way to the reference



An objective selection of a „representative“ fire source is intrinsically not possible

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(a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.

(b) The system must be capable of detecting a fire at a temperature significantly below that at which the structural integrity of the aeroplane is substantially decreased.

The transition point from smouldering to flaming could be used
- with an agreed and justified scenario and margin –

to estimate the smoke density reference.

Smoke Generator Response time Comparison - ECD1Y - Ref. PR1809703 - Issue 1

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Summary

- Siemens and Aviator smoke generators show good match in unventilated wooden aircraft cargo compartment mock-up
- Different results for Siemens and Aviator Smoke Generator occur in a different environment (EN54 room)
- Smoke Detector responses to the same smoke generator differ

Next steps

- Discussion on parameters / ranges / tolerances of a standardized smoke generator calibration approach
- International agreement on reference
- Investigations on in-flight changes of smoke generator application (cabin pressure, cargo door leakage, etc.)

Acknowledgements

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Thank you

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