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APPLICATION OF OZONE-SAVING FIRE SUPPRESSIVE AGENT

HALON 37 ***FOR CHARGING HAND-HELD ONBOARD EXTINGUIHERS***

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1. GENERAL

The materials of Montreal Protocol UN of September 16, 1987 specify the list of agents which, coming into the atmosphere, destroy the ozone layer of the Earth.
This list, in particular, includes Halon 1211.
Currently Halon 1211 is widely used on boards of the civil aircraft as fire suppressive agent (FSA) in:

- onboard hand-held extinguishers of different capacity;
- onboard stationery fire suppressive systems for protection of fire risk zones and other aircraft compartments;

Currently the majority of domestic civil aircraft types are equipped with onboard hand-held extinguishers of OP1 and OP2 type (OP stands for "hand-held extinguisher" in Russian alphabet) using Halon 1211 as FSA.

That is why the necessity to replace Halon 1211 with the other – ozon-saving fire suppression composition, used for application in OP1 and OP2 types extinguishers with their minimum construction developments occurred.

The fire suppressive agent Halon 37 was chosen as an **ozone-saving** for a replacement of Halon 1211 in onboard hand-held extinguishers.

To determine the fire suppressive effectiveness of Halon 37 the rig fire tests were performed for OP1 and OP2 extinguishers charged with Halon 37. The methodology of the rig fire tests and the tests results will be described further in Section 3.

The onboard hand-held extinguishers are intended for fire suppression of the incipient fire at crew cockpit, passenger cabin, cargo and baggage compartments of the aircraft.

See below technical requirements to onboard hand-held extinguishers being the subject of the given report [1]:

- capacity of the hand-held extinguishers, engaged with one hand, should be not more than 3 litters, and those engaged with two hands should be not more than 8 litters; the extinguishers engaged with two hands should have an oblong hose with different kinds of heads to spray the fire-suppressive agent;

- extinguishers based on Halon 1211 and Halon 1301 application, as well as other types of halons or their compositions are intended for extinguishing of flammable materials, used for furnishing and design of aircraft cabins and for electrical wiring and electrical components;
- the time of operation of the hand-held extinguishers should be not less than 15 seconds and the distance of the spraying (at the ambient temperature = 20ºC) should be not less than 3 meters. The OP extinguisher with halon should be operable within the temperature range from -60ºC to +60ºC.

2. COMPARATIVE CHARACTERISTICS OF HALON 37 AND HALON 1211

The fire suppressive agents – Halon 37 and Halon 1211 - are chemical compounds of the one and the same class of the halogen-containing substances.
Halon 37 – C_3F_7H does not contain in its compound the atoms of Bromine and Chlorine and that is why may be considered as an inert chemical compound related to the ozone layer of the Earth.
Halon 1211 – CF2ClBr, contrary, does contain in its compound the atoms of Bromine and Chlorine which define its ozone-destructive action.

Table 1 provides the phisical-chemical properties of Halon 37 and Halon 1211 considered during designing of the hand-held extinguishers.

Table 1

MAIN PROPERTIES of HALON 37 AND HALON 1211 [2-4]

	Halon 37	**Halon 1211**
	Colorless gas	Colorless gas
Relative molecular mass	170	165,4
Melting temperature, ºC	-131	-159
Boiling temperature, ºC	-18,3	-3,8
Liquid density at 20ºC, kg/m	1410	1830

Minimum volume extinguishing concentration, %	6,2	4,3
Vapor pressure in balance at 20ºC, KPa	420	234

As one can see from the data provided in the Table 1 the density of Halon 37 in liquid condition is 23% less than of Halon 1211 and the minimum volume extinguishing concentration is 44% higher that of Halon 1211.
Based on the analyses used to reach one and the same extinguishing effectiveness the amount of Halon 37 used should be 1,8 times higher than of Halon 1211.

3. EVALUATION of Halon 37 FIRE-EXTIGUISHING EFFECTIVENESS

As was already mentioned before, to determine the fire-extinguishing effectiveness of Halon 37 the OP1 and OP2 types extinguishers, charged with Halon 37 OP1-2,0-32-48 with capacity of 2 litters and OP2-6,0-32-48 with capacity of 6 litters, were subject to the rig fire tests.
The OP1 and OP2 extinguishers charged with Halon 1211 in due order were subject to the full scope of the prescribed tests and fully comply with Airworthiness Standards and Aviation Regulations in part of requirements to aircraft fire protection.

While testing the OP extinguishers charged with FSA Halon 37, it was necessary to determine the types of fires, for allocation of which it is possible to use the extinguishers of this type, the distance of the effective fire-suppression and to determine the specific features of application of OP extinguishers with the new FSA.

Evaluation of effectiveness of the OP type onboard hand-held extinguishers of different capacity, charged with Halon 37, was made during suppression of the following types of modeling fires, corresponding to classification [5] and [6]:

"A" class modeling fire – burning of the non-metallic constructions and decorative-finishing materials like cloth, rubber, plastic, paper etc

Two types of burning are possible:
"A1" – open flame burning
"A2" –glow

"B" class modeling fire – burning of liquid fuels, lubricating materials and special fluids.

For "A" class modeling fire a package of 450x300x45mm size, containing several layers of ПС-4 foam plastic and porous P-29 rubber is used having in its lower part a through hole of 30mm diameter to locate a fuse moist with aviation kerosene.

The compiled package was installed at the open platform in the vertical position on the support and the fuse was set on fire.
Suppression was made by OP1-2,0-32-48 extinguisher.

For “B” class modeling fire a pan of standard size 1400x700x100mm is used, half of the square of which is filled with the pieces of ПС-4 foam plastic of 15 mm width. Four or five liters of aviation kerosene are poured in the pan and set on fire. Suppression starts in one minute after kerosene is set on fire, that is how the task of suppression of the incipient fire of aviation fuel is being solved.
Suppression of the class ”B” fire was performed using OP-6,0-32-48 extinguisher charged with Halon 37.

Based on the results of the rig fire tests the following Halon 37 characteristics have been established:

a) Halon 37 fueling and weighting characteristics are so that no difficulties occur during charging of OP types extinguishers. The procedures and equipment does not need any essential changes but for some specification of the operational documentation for the hand-held extinguisher.

b) The Halon 37 length spray coming from the OP type extinguisher nozzle with necessary fire-extinguishing concentration is not more than 1,5-2,0 m.

c) “A” class modeling fire was extinguished within several seconds from 1,5m distance without any difficulties. In real life the obstacle for fire suppression may be only access to its fire point, as the length of the Halon 37 spray is not more than 1,5-2,0 meters.

d) It was impossible to suppress “B” class modeling fire with the extinguisher filled with Halon 37. The halon spray becomes less intensive starting from 1,5 meters, dissipates and at the distance of more than two meters practically fail to suppress the extensive burning flame. Besides, due to high heat generation of the burning flame it is impossible for the operator not wearing special protective cloths and holding the extinguisher to approach the fire point closer than 3 meters, it means that in this particular case the fire point is inaccessible for suppression with the hand-held extinguisher fcharged with Halon 37.
It is possible to suppress “B” class modeling fire by the extinguisher charged with Halon 37 only if it is the OP2 type extinguisher used on the open area at the initial stage of burning, when the flame is not such intensive and it is possible for the operator to approach closer to the fire point, not more than 1,5-2,0 meters.

e) The result of weighting identify that the extinguishers exhausts completely – the time of complete Halon 37 exhaust from the OP1 extinguisher of 2 liters capacity is 23-25 sec, and from OP2 extinguisher of 6 liters capacity is 72-76 sec.

3. LIMITATIONS AND RECOMMENDATIONS FOR Halon 37 USEAGE

Demonstration of Halon 37 fire-suppressive effectiveness as well as the analyses of its phisics-chemical properties showed the principled possibility for its application in onboard hand-held extinguishers for suppressing the initiated fire on board the aircraft.
For this purpose the aircraft Designer at the design of fire protective means should take into account the following Halon 37 peculiarities:

As for its fire extinguishing possibilities the ozone-saving Halon 37 is less effective than Halon 1211. It is required that the amount of Halon 37, necessary for provision of the same fire-extinguishing ability should be twice as much than for Halon 1211.

The onboard hand-held extiguishers filled with Halon 37 are applicable for suppression of class “A1” and class “B” modeling fires only when they are at their initial stage, when the heat generation of the fire point is not as much and it allows the operator with an extiguisher to approach to the necessary distance of 1,5-2,0 meter.

The onboard hand-held extiguishers, filled with Halon 37 are effective for suppression of the glowing modeling class “A2” fire from the distance not more than 1,5-2,0 meters.

Application of the OP1 and OP2 extinguishers, charged with Halon 37 to provide fire protection of the cargo compartments of “B” class is possible under condition of the the design changes should be performed minimizing a probability of occurrence of the open flame when baggage/cargo is set on fire, for example, use of fire-blocking case, covering baggage/cargo all around.

The onboard hand-held extiguishers charged with Halon 37 are used to suppress the fire when electrical wiring, aviation and radio electrical equipment which are under current are set on fire.

In some cases, based on the aircraft design and peculiarities of the aircraft operation, it is possible to use onboard hand held extinguishers, charged with Halon 37, without increasing their amount, but for this it is necessary to increase the number of the extinguishers, charged with water-etilenglicol composition.

5. LITERATURE

1. Airworthiness Standards (NLGS-3)
2. *Barabanov V.G., Belevtsev E.G., Zotnicov V.S.*…Halogen-containing fire-suppressive agents, “Teza”, SPb, 1999
3. TU 2412-049-00480689-96
4. TU 6-02-1103-82
5. GOST 27331-87
6. ISO 3941-77