Cargo MPS Task Group

11/19/2019
10:00 AM
WEBEX

Type of meeting: Task Group Meeting

Note taker: Dhaval Dadia

Attendees: Dhaval Dadia, Robert Ochs, Stephen Happenny, Calvin Ko, Enzo Canari, Doug Ferguson, Pat Baker, Nels Olson, David Shaw, Karsten Kirbach, Andre Freiling, Konstantin Kallergis, Mark Fazzio, Samir Tambe, Xavier Tiger.

Minutes

Agenda item: Meeting Minutes

Discussion:

The meeting minutes for this task group will be available on the Fire Safety Branch website at the link mentioned below.
https://www.fire.tc.faa.gov/Systems/Cargo/TaskGroup

Conclusions:

Have meeting minutes available on the Fire Safety Branch website.

Action items	**Person responsible**
✓ Update Meeting Minutes	Dhaval Dadia

Agenda item: Next Meeting

Discussion:

Next meeting will be a Webex on Dec. 17, 2019.

Conclusions:

Setup next Webex meeting for Dec. 17, 2019

Action items	**Person responsible**
✓ Prepare an agenda for the next meeting	Dhaval Dadia

Agenda item: Agenda for the meeting

Discussion:

Topics	Issue	
Next Meeting		19th Nov at 10 AM EST
Challenge Fire	Develop methods for Challenge Fire Scenario	Refer to Enzo
Halon Simulant Testing		
MPS Document	Status of MPS Document	

The items tabulated above were the topics of discussion at the meeting.

Conclusions:

Summary of the agenda items for the Webex meeting.

Action items	Person responsible	Deadline
✓ None	N/A	N/A

Test Method	Issue	Discussions	Status

Other Topics	Challenge Fire	Continue discussions regarding setup of the challenge fire.
		<<Material for new Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems_EASA.docx>>
		(see Appendix)
		• Test Setup
		  • Initiate thermal runaway with which cell
		  • WH of the cell
		  • Chemistry
		  • Must meet international standards
		  • Repeatability of the cells used for testing.
		  o Pre-test to make sure cells are similar
		  o UN38.3 - cells need to pass this to be shipped
		• 2 gallons of Ethanol
		  o Specify type of ethanol. (% of water/alcohol)
		  o https://www.airseacontainers.com/4g-1-x-1-plastic-jug-shipper-hazmat-un-boxes.html#page=page-1
		  o 1 according to IATA packaging
		  o 2nd to ignite
		• Test sequence
		  o More specific in explaining the thermal runaway process. What is identified as TR
		  o Rate of increase in temperature - determine from past data
		  • Heat it at the rate so that 1st TR is within 10 mins to get 10C/min
		  • Create conditions that are conducive to TR propagation
		  o Add more specific conditions
		  o Rate of heating of cells need to be defined.
		  o Appendix that provides different scenarios
		  o Add if this has not occurred yet to step 2.
		  o Don't have to wait for 3 TRs. Could prescribe a timeline to ignite ethanol.
		  o Put both ignition sources in box 5.
		  o Wait 60 sec or so until first TR. Then ignite ethanol.
		  o Agreed to put both ignition sources in one box.
		  o Timeline - 60 secs after 1st TR to ignite ethanol-agreed
		  o Think of the setup within Box 5. placement of batteries and ethanol.
		• Tests Conducted	

		○ 5 Tests ○ 180 mins for one test • Acceptance Criteria ○ Discharge of the high rate - make it more generic ○ Take out "no flames" - agreed • Enzo has concerns about overarching acceptance criteria - clarifying intent of running MPS tests. • Talk in the future meeting if we should keep the Bulk Load Fire test or not	
	Halon Simulant Testing		In Progress
	MPS Document		In Progress

Appendix

Special notes: Raw information used during discussions

Draft Material for new Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems

Proposal to include in the EXECUTIVE SUMMARY the following description of the Challenge Fire Test:

For the Challenge fire scenario, the acceptance criteria is no flames may be visible 1 minute after discharge of the high rate discharge bottle and the average of the five test peak temperatures shall not exceed 710°F (377°C). In addition, the average of the five test areas under the time-temperature curve shall not exceed 9850°F-min (4974°C-min). The test times when the average peak temperature cannot be exceeded and when the time-temperature area should be computed is the 28-minute interval from 2 to 30 minutes after the activation of the suppression system.

Commented [HS(1]: Note that the remainder of the acceptance criteria for the Challenge fire test should be identical to the acceptance criteria for the bulk-load fire test.

Commented [CE2]: It is my understanding that this implies conducting a baseline test with Halon for the Challenge fire scenario. Using the same baseline as for the bulk-oad fire test scenario may not be appropriate, because the baseline is developed with a different (shredded paper only) and less critical fire load.

Proposal to include in the body of the test the following description of the Challenge Fire Test:

Challenge Fire Test. The intent of these tests is to ensure that halon replacement agents/extinguishment mechanism can address a complex fire that could be present in today's cargo compartments. The fire load for the Challenge fire scenario consists of material that when combusted produces a complex fire (i.e., after ignition, the resulting fire consists of Class A surface burning, Class B flammable liquid fire, and combustion of some lithium batteries). These materials will be loaded in cardboard boxes and placed on a pallet, and the entire pallet will be completely covered with plastic rain wrap.

Description of the Challenge Fire Test Fire Load:

For the Class A fire material, single-wall corrugated cardboard boxes, with nominal dimensions of 18 by 18 by 18 inches (45.7 by 45.7 by 45.7 cm) are used. The weight per unit area of the cardboard is 0.11 lb/ft$_2$ (0.5417 kg/m$_2$). The boxes are filled with 2.5 pounds (1.1 kg) of loosely packed standard weight office paper shredded into strips (not confetti). The final weight of the box and shredded paper is 4.5 ±0.4 pounds (2.0 ±0.2 kg). The boxes are conditioned to room standard conditions. The flaps of the boxes are tucked under each other without using staples or tape. The boxes are stacked in two layers in the cargo compartment in a quantity representing 30% of the cargo compartment empty volume. For a 2000-cubic-foot (56.6-m$_3$) compartment, this requires 178 boxes. The boxes touch each other to prevent any significant air gaps between boxes. The fire inside the ignition box is started by applying 115 volts alternating current (VAC) to a 7-foot (2.1-m) length of Nichrome wire. The wire is wrapped around four folded (in half) paper towels. The resistance of the Nichrome igniter coil is approximately 7 ohms. The igniter is placed into the center of a box on the bottom outside row of the stacked boxes. Several ventilation holes are placed in the side of the box to ensure that the fire does not self-extinguish. Ten 1.0-inch (2.5-cm) -diameter holes have been shown to be effective.

Commented [HS(3]: Note that the description of the Class A fire material should be identical to the MPS Bulk-fire load test describing the cardboard boxes and shredded paper.

For the Class B fire, two containers of ethanol (95% purity) are used. These consist of 500 ml of ethanol placed in a balloon in one box with lithium batteries present; and, 1 gallon (4546 ml) of ethanol in an IATA approved plastic container in a box with lithium batteries. Ignition will be achieved in the box with the 500 ml of ethanol via the use of a Nichrome wire.

For the lithium ion battery fire, 150 lithium ion batteries Tenergy (18650-type) in groups of 15 batteries each will be placed in 10 boxes. The batteries will be packed together without any separators. Each box will have 5 batteries at 30% state-of-charge (SOC); 5 batteries at 60% SOC; and 5 batteries at 100% SOC. Ignition will be provided in one box (Box #4) of 15 batteries via the use of a film heater placed on a corner cell with a 5-10°F/minute rate of heat generation. Ignition will also be provided in one box (Box #5) of 15 batteries and the balloon with 500 ml ethanol via the use of Nichrome wire and electrical current. The 1 gallon of ethanol in a plastic container will be located in one box (Box #8) with 15 batteries.

Commented [CE4]: We will need a figure showing how to place the batteries in the box.

Additional instrumentation required for this test will consist of the following:

1 Thermocouple on the battery with the film heater (Box #4)

3 Thermocouples on 3 adjacent batteries (Box #4)

1 Thermocouple in the box above the balloon with 500 ml ethanol (Box #5)

Ignition Sources:

a) Ignition of lithium batteries in box #4 initiated by film heater
b) Ignition of flammable fluid in box #5 initiated by Nichrome wire and electrical current

The procedure for conducting the challenge fire test is as follows:

1. Initiate thermal runaway of batteries in box #4
   - Wait for thermal runaway and venting of 3rd battery in box #4
2. Then ignite flammable fluid in box #5
3. Wait for first ceiling thermocouple to reach 200°F (similar to MPS bulk load test sequence), if this has not occurred yet
4. Wait additional one minute (similar to MPS bulk load test sequence)
5. Initiate suppression system (similar to MPS bulk load test sequence)
6. Test Length - 30 minutes from start of suppression

Commented [CE5]: It may be too subjective. Maybe we could specify a temperature limit (400°F) to be exceeded.

Challenge Fire Test Acceptance Criteria:

The acceptance criteria for the Challenge fire scenario is that no flames may be visible 1 minute after discharge of the high rate discharge bottle and that the average of the five test peak temperatures shall not exceed 710°F (377°C), starting 2 minutes after the suppression system is initially activated until the end of the test. In addition, the average of the five tests areas under the time-temperature curve of the compartment thermocouples shall not exceed 9850°F-min (4974°C-min). The area is computed for the 28-minute interval between 2 and 30 minutes after the activation of the suppression system.)

Commented [CE6]: It may be difficult to detect flames due to the presence of smoke and the selected cameras locations. We need to specify at least the number of cameras, their type and their location in the MPS chamber.

Commented [HS(7]: Note that criteria beyond no visible flames after 1 minute discharge of HRD bottle should be identical to the MPS Bulk-fire load test criteria.

Figure TBD, Challenge Fire Load Setup[1]

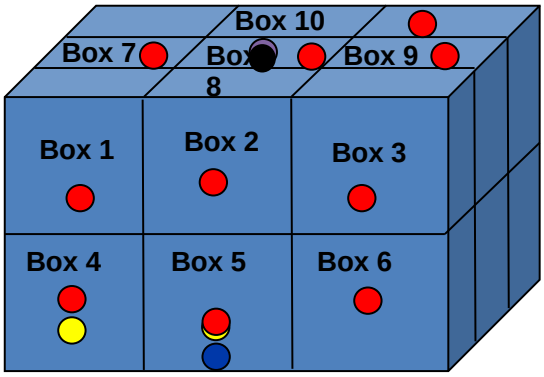
Pallet Configuration (18 boxes)

150 18650 Li-Ion batteries in groups of 15 batteries per box
1/3 at 30% SoC
1/3 at 60% SoC
1/3 at 100% SoC

500 mL ethanol

1 gallon (3.8 L) ethanol

Ignition Source



18 Standard MPS boxes (total)

- Temperatures in boxes #4, #5, #6
- Oxygen concentration (2 locations)
- Carbon monoxide concentration (2 locations)
- Carbon dioxide concentration (2 locations)
- Total Hydrocarbon Concentration (1 location)
- Hydrogen concentration (2 locations)

[1] Plagiarized from "*Minimum Performance Standard Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems Testing – Challenge Fire Test*", presented to the International Aircraft System Fire Protection Working Group, by Karsten Kirbach & Dhaval Dadia, May 8-9, 2018.