Assessing the Spontaneous Combustion Potential of Hazardous Cargo on a Tarmac

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Federal Aviation Administration

FAA William J. Hughes Technical Center

Concern: Spontaneous Combustion of Chemical Disinfectant Cargo





Federal Aviation Administration



July 22, 2020 | Boeing 777F | Pudong Int'l Airport – Shanghai, P.R. China

Cause: chlorine dioxide disinfection tablets spontaneously combusted under high temperature and humidity

Ambient temp and humidity at time of combustion: 93°F (34°C) and 60% RH

Sulfate or bisulfate in effervescent tablets increases the risk of spontaneous combustion.



1000 tablets were packaged like this...100kg or 220lbs!





Testing and Outcome

This study will indicate the probability of autoignition of chemical disinfectant and/or Lithium-ion battery cargo on a hot tarmac and <u>the results may affect current FAA/IATA/ICAO hazardous goods regulations.</u>

Phase 1 Test Data will determine:

•Highest internal **temperature and humidity** of a typical cargo stack (rain-wrapped pallet or LD3) and the **duration** those values were sustained.

Data Analyzed

Phase 2 Test Data will determine:

•How chemicals and/or batteries in cargo respond to extreme heat and humidity conditions (observed in phase 1)

Test Plan in Progress



Phase 1 Setup

Simulated, full-scale cargo stacks

- 27 empty boxes stacked with thermocouples (measuring surface and air temperature), humidity sensors, and pyranometer at specific locations
- 2 Box types:
 - 4G UN HAZMAT double walled boxes
 - non-UN single walled boxes
- 2 wrapping types: LD3 vs. rain-wrapped pallet

31 Type-T TC 2 Omega HX94BV2 Humidity Sensors 1 SP-215-SS: Amplified 0-5 Volt Pyranometer





TYPE T TC – Center of box, air measurement



TYPE T TC – taped on center of box face, surface measurement

OMEGA Humidity Meter – Probe Mounted center of box, mid-air





Data Snapshot





Phase 1 Results

- Data was collected every 2 minutes over a period of 30 days
- Test articles were subject to a good mix of wind, rain, and sun
- Ambient data was collected using weather station sensors adjacent to the stacks



MAXIMUMS ACROSS 30-DAY DATA COLLECTION

			Ambient
RWP	MAX SURFACE TEMP	175°F	94°F / 94% RH
	MAX AIR TEMP	168°F	96°F / 95% RH
LD3	MAX SURFACE TEMP	151°F	98°F / 85% RH
	MAX AIR TEMP	121°F	98°F / 85% RH

MAX INTERNAL HUMIDITY 95% RH



Factors that effect Heat and Humidity





Global Heat & Humidity Records

2022

Hottest temp in Northern Hemisphere Shush, Iran on Aug 9	128.5°F
Highest avg. temp in Northern Hemisphere Makkah, Saudi Arabia	89.2 °F
Hottest temp in Southern Hemisphere Onslow, Australia on Jan 13	123.3°F
Highest avg. temp in Southern Hemisphere Surabaya Int'l Airport, Indonesia & Wyndham Airport, Australia	84.9°F
Hottest temp recorded during 30-day WJHTC test July 12, 2023	97.5°F
Highest avg. temp recorded during 30-day WJHTC test	87.3°F

1991-2021

Annual Avg. Humidity for Shush, Makkah, Onslow, and Wyndham ranges 37-46% RH; Surabaya at 84% RH; and Atlantic City at 70% RH



Phase 2: Chemical Response to Extrema

- Disinfectant product will be tested in an oven, one at a time
- Each test product will be subject to one high temperature level and 2 humidity levels (2 runs each); duration of test is TBD
- Temperature and humidity test levels were chosen based on global and local data
- Testing will determine if hazardous material combustion can occur on a tarmac in extremely hot global climates.



DOE: Input-Process-Output Diagram



- 7 disinfectant products were chosen from a variety of chemical classes, each with unique active ingredients. Solid and liquid-type products will be tested. Some products are not-regulated by ICAO and some are.
- Test samples will be weighed and photographed before and after test.



Phase 2 Set-Up

- Oven Set to 125°F
- UN 4G Hazmat Box with test product packed in its proper inner packaging (ICAO)
- 3 Type-K Thermocouples
 - touching bottom inside face of box
 - suspended approx. 1-in above product surface (inside inner packaging)
 - touching outside surface of box
- Omega HX94BV2 Humidity Sensor
- Containers of Saturated Solution
 - $Mg(NO_3)_2$ to achieve 85% RH
 - KNO_3 to achieve 45% RH
- PyroScience Fiber-optic Oxygen Meter



Potential Phase 3 – Chemical Spills

- Test conditions same as Phase 2
- Simulate spillage/mixing of different chemicals
 - Considering 49 CFR § 177.848 Segregation of hazardous materials



Test Predictions

 Expect solid disinfectants to be the most likely to cause a thermal event, especially if subject to moisture



Questions?

Contact Information:

Lindsey Anaya General Engineer, FAA Fire Safety Branch Lindsey.p.Anaya@faa.gov



