Hazardous Material Fires

FAA Technic Center Triennial International Fire & Cabin Safety Research Conference

Presented to: Battery Fires I
By: Janet McLaughlin
Date: December 3, 2013

Hazardous Material Transportation

- How and why was the hazardous material (hazmat) transportation system developed?
- What is the threat and risk to transporting hazmat in aviation today?
- What has changed to increase the threat and risk?
- What does the change mean to the risk for aircraft, its occupants and property?

Hazardous Materials

Hazardous material means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has been designated as hazardous under section 5103 of Federal hazardous materials transportation law…

Hazmat Regulation

- **The current Federal regulatory system governing the transportation of hazmat was developed before the last century.**
- **In 1866, the first Federal Law was passed regulating the transportation of hazmat, specifically explosives and flammable materials.**
- **Rail shipments of explosives during the civil war were addressed by contractual obligations between shippers and carriers.**

Hazmat Regulation

- **In 1887 the Interstate Commerce Commission (ICC) marked the beginning of a Federal effort of regulatory uniformity on all modes of transportation.**
- **They were first developed for rail transport.**
- **ICC was the primary regulatory agency with authority over hazmat transportation through 1966.**

Hazmat Regulation

- **In 1908, Congress passed a law that would govern hazmat transportation for more than six decades.**
- **The Explosives and Combustibles Act authorized ICC to issue regulations covering packing, marking, loading, and handling of explosives and other dangerous substances in transit.**

Hazmat Regulation

- **The Civil Aeronautics Board (CAB) in conjunction with safety officials from the Dept of Commerce developed the first regulations for transportation of hazmat by air in the early 1940's.**
- **In 1966, authority to regulate the transportation of hazmat was transferred from ICC, the Department of Treasury, and CAB to a new Federal Agency the Department of Transportation (DOT).**

Hazmat Regulation

- **Within DOT, separate modal administrations were retained to preserve organizational continuity.**
- **A separate entity, the Hazardous Material Regulations Board, was created to coordinate all hazmat activities within the DOT.**
- **Legislation in 1970 pertaining to hazmat imposed minimal requirements on DOT.**

Hazmat Regulation

- **Shortly after, the Secretary created the Materials Transportation Bureau (MTB) within the Research and Special Programs Administration (RSPA).**
- **In 1976 the MTB consolidated the Hazmat Regulations from CFR 14 (FAA) and CFR 46 (Coast Guard) with the highway and rail regulations.**
- **The format has essentially stayed the same since 1976.**

Deregulation

- **The Airline Deregulation Act in 1978 phased out the powers of the Civil Aeronautics Board which phased out the control over fares, routes and market entry of commercial airlines.**
- **The Act did not diminish the regulatory power of the FAA.**

Hazmat Regulation

- **Regulations issued by RSPA (PHMSA) covered shippers, carriers of hazmat by all four modes.**
- **A number of international regulatory bodies have established recommendations and standards affecting all modes of transport and especially in air and vessel became the regulatory framework of choice.**

Hazmat Regulation

- **Underlying DOT's current classification system are several assumptions, one being that most accidents involve fire.**
- **From the very first regulatory structure in 1866, flammable materials and explosives were the risks considered to present the most significant threat.**

Why the Concern

- **Accidents and Incidents caused by in-flight fires**
  - 2,864 fatalities had resulted from accidents and incidents caused by in-flight fires.
  - These were in-flight fires in all types of aircraft.
  - The last recorded information was March 2013.

Hazmat and Air Transportation

- **In 1999, the Volpe National Transportation Systems Center conducted a quantitative threat assessment to determine the probability that a life threatening incident would occur as a result of transporting hazmat in an aircraft cargo compartment.**
- **This assessment establishes a comparison point from 1999 to look at the change in 2012.**

Hazmat Transportation Evolution

- The basis for the regulations is the same.
- However:
  - What we transport
  - How much we transport
  - The risk hazmat presents
  - The threat of a catastrophic event
- Have all changed

Hazmat and Air Transportation

- **It was estimated in 1999 that 1-2% of total cargo was hazmat.**

- **Certain Air Carriers estimate today, that on some routes as much as 80 – 85% of their cargo load (freighters) is lithium batteries or related devices and equipment. This is hazmat.**

Hazmat in Air Transportation

Percentage of all Hazmat packages in 1999

- 30% were Class 9 most believed to be ORM
- 26% were flammable liquids
- 20% were Class 7

Hazmat in Air Transportation

- **There are more than 4 billion lithium ion cells manufactured annually as of 2012. Most are manufactured in Japan, China and Korea. This increases the RTM flown by each shipment.**
- **If only an estimated 60% are transported by air, that is over 2 billion.**
- **Lithium metal battery production is estimated to be another 25% of that total.**
- **Then the equipment and devices are transported once assembled.**

Aviation Safety Implications from Lithium Batteries

- **We have, and will continue to, see exponential growth of lithium batteries manufactured.**
  - In addition to more batteries, batteries are becoming more and more energy dense.

- **Almost all of these batteries are produced in Asia.**

- **In study commissioned by the FAA Tech Center, 4.1 battery-fire related freighter accidents were forecasted between 2012-2021. This study did not consider (Cherry):**
  - Passenger aircraft accidents

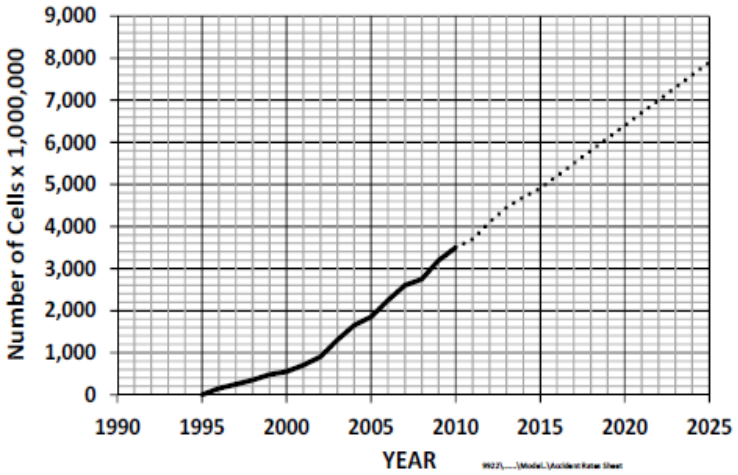
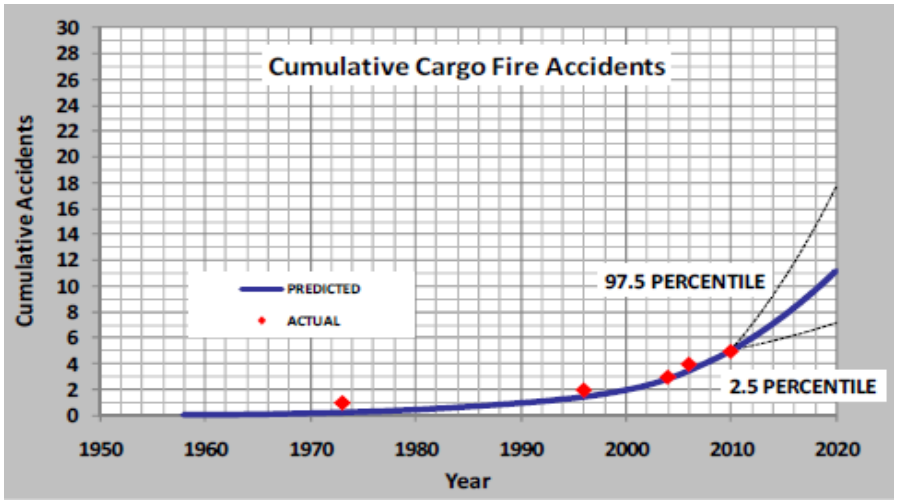


Figure 3. Estimated Annual Number of Secondary Lithium Battery Cells Produced Worldwide



Risk of Transporting Hazmat by Air in1999

- **In the Volpe assessment a “high threat” was considered one catastrophe expected per ten thousand cargo compartment flights.**
- **A “medium threat” was considered one catastrophe expected for between ten thousand and ten million cargo compartment flights.**
- **It was determined all of the selected hazmats that met the medium and high threat categories were already forbidden for air transportation by DOT regulations.**

Threat mitigation

- **Are we forbidding all of the high and medium threat hazmats today?**
- **The threshold for an acceptable level of safety is 10 to the minus 9. With the quantities and associated risks, are we meeting this acceptable level of safety?**
- **The threat of a catastrophic event is assessed to be as high as one freighter accident every two years.**
- **Do we have the technology to mitigate this risk and are we using it effectively.**

What risk is posed?

- **FIRE**
  - Lithium batteries can go into thermal runaway
  - Lithium batteries being involved in a fire caused by other sources may provide enough energy to cause a controllable event to turn into an uncontrolled event.
  - There is not a know suppression agent that controls lithium metal battery fires.
  - As large format cells are designed into large format batteries the risks may not be the same as the smaller lithium ion design.
  - Risks presented are fluid

Sequence of Events

- **When flammable materials were the risk presented, you needed several contributing factors to all be present for an uncontrolled event.**
  - The flammable material had to leak;
  - At the same time a random spark or initiation source had to be present;
  - Both had to be in the proximity of one another at the same time.

Aircraft Systems

- **Are aircraft systems designed prior to this risk designed to mitigate this risk?**
- **Are the aircraft systems failing during accident and incident conditions due to designs to mitigate a different threat condition.**
- **Since 1866 flammable materials have been regulated in transportation as the threat of fire is considered to be the basis of catastrophic accidents in transportation.**
- **Today Annex 8 still focuses on explosives and hazmat (dangerous goods).**

Developing Technologies

- **Air transportation and the global economy**
- **Lithium batteries and devices and equipment and the global economy**
- **The last year has seen developing technologies for cargo transportation**

Developing Technologies and Strategies

- **Hazmat packaging**
- **ULD suppression systems**
- **Aircraft suppression systems**
- **Quantity control**
- **Segregation**

Solutions

- **The transportation of energy devices and articles has to be a systematic approach to mitigation in aviation.**
- **There will not be a single solution to this complex risk as presented in aviation.**
- **We have to work collaboratively with all disciplines in aviation safety, aircraft system manufacturers, and the lithium battery industry to be effective in mitigation.**

Contact Information

Janet McLaughlin

Deputy Directory, FAA Hazardous Material Safety Program

202-385-4897 Office

202-437-7651 Cell

Janet.mclaughlin@faa.gov

Questions ?