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INTERNATIONAL CIVIL AVIATION ORGANIZATION

A UN SPECIALIZED AGENCY

Managing Safety Risks Associated with Transport of Lithium Batteries as Cargo

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International Civil Aviation Organization

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1 **ICAO**

Role in managing cargo safety risks

2 **Technical Instructions**

Role prescriptive provisions play in mitigating risks associated with dangerous goods, including lithium batteries

3 **Potential safety gaps**

Potential safety gaps revealed through challenges with transporting lithium batteries safely by air

4 **Addressing the safety gaps**

What ICAO is doing to help address potential safety gaps

5 **Multidisciplinary approach**

Holistic approach to the safe carriage of goods

6 **Questions**

Questions from the audience

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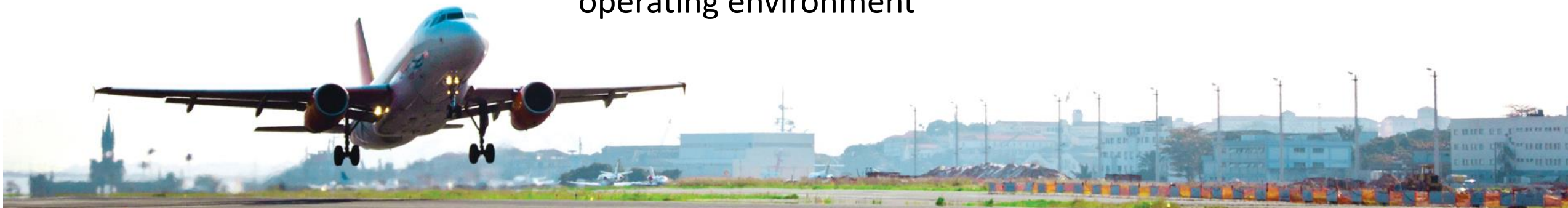
Role in Managing
Cargo Safety Risks

International Civil Aviation Organization (ICAO)

- United Nations specialized agency created in 1944
- Convention on International Civil Aviation
- Supported by Annexes containing Standards and Recommended Practices (SARPs)
- Developed and amended through consensus agreement among 193 Member States
- States incorporate SARPs into laws and regulations
- Industry develops policies and procedures to comply with State's laws and regulations
- Uniform implementation globally enables a seamless operating environment



Nineteen Annexes to Chicago Convention

- Annex 1 — *Personnel Licensing*
- Annex 2 — *Rules of the Air*
- Annex 3 — *Meteorological Service for International Air Navigation*
- Annex 4 — *Aeronautical Charts*
- Annex 5 — *Units of Measurement to be Used in Air and Ground Operations*
- Annex 6 — *Operation of Aircraft*
- Annex 7 — *Aircraft Nationality and Registration Marks*
- Annex 8 — *Airworthiness of Aircraft*
- Annex 9 — Facilitation
- Annex 10 — *Aeronautical Telecommunications*
- Annex 11 — *Air Traffic Services*
- Annex 12 — *Search and Rescue*
- Annex 13 — *Aircraft Accident and Incident Investigation*
- Annex 14 — *Aerodromes*
- Annex 15 — *Aeronautical Information Services*
- Annex 16 — *Environmental Protection*
- *Annex 17 — Security — Safeguarding International Civil Aviation against Acts of Unlawful Interference*
- Annex 18 — *The Safe Transport of Dangerous Goods by Air*
- Annex 19 — *Safety Management*

STANDARDS AND RECOMMENDED PRACTICES (SARPs) IMPACTING CARGO SAFETY, INCLUDING DANGEROUS GOODS

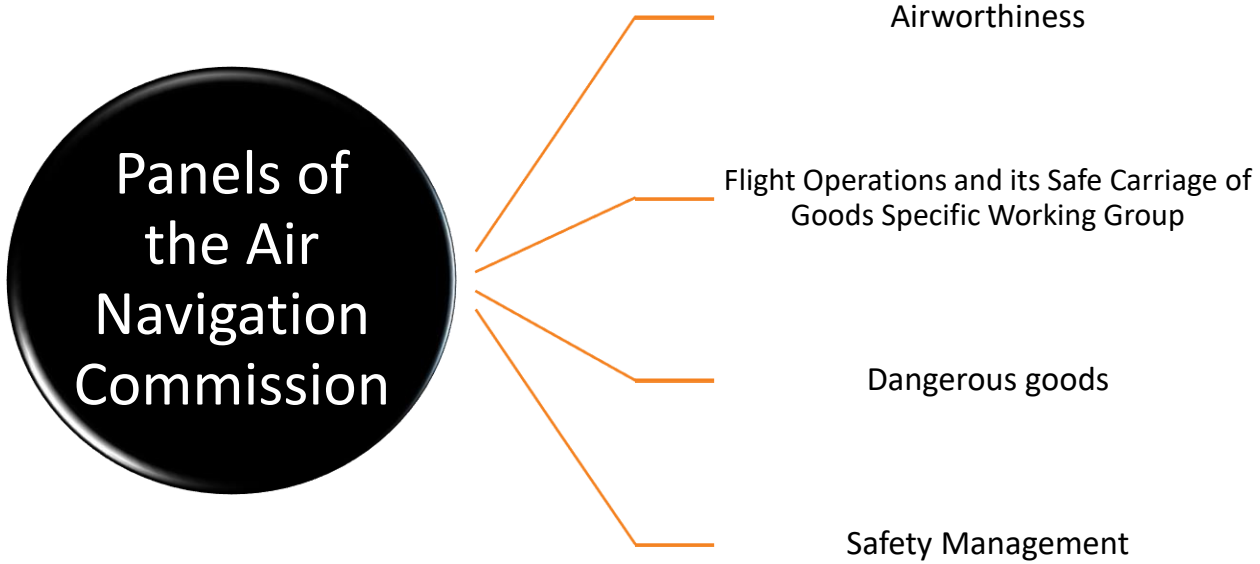
How ICAO works

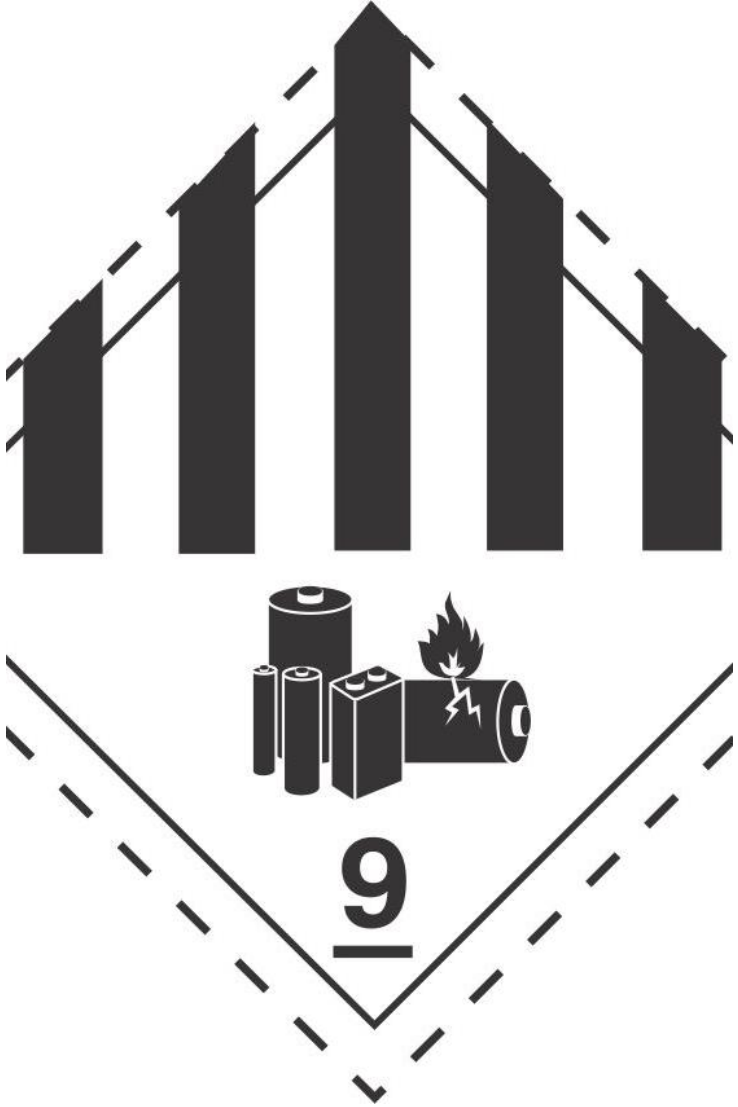
Assembly (193 Contracting States)

Council (36 Contracting States)

Air Navigation Commission

Secretariat





Lithium Batteries are Dangerous Goods

Subject to Annex 18

Articles or substances capable of posing a hazard to health, safety, property or the environment

Annex 18

The Safe Transport of Dangerous Goods by Air

Standards and Recommended Practices (SARPs) applicable to all international operations of civil aircraft

“Each Contracting State shall take the necessary measures to achieve compliance with the detailed provisions contained in the Technical Instructions”
(Standard 2.2.1)

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Technical Instructions

How they contribute towards mitigating risks associated with dangerous goods, including lithium batteries

Requirements aimed at

Identifying hazards

- Criteria developed by a committee of the UN ECOSOC for all modes of transport

Mitigating risks associated with the hazards at package level through quantity limitations, packing and packaging requirements

Communicating hazards down the supply chain to the operator

Shipper

Mitigating risks associated with the hazards by reducing the likelihood and severity an incident through:

- Operator acceptance, loading and stowage procedures
- Emergency response procedures specific to the dangerous goods on board determined through information provided to the pilot-in-command about the dangerous goods loaded on the aircraft.

Operator

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3

Safety Gaps

Potential safety gaps revealed through challenges with transporting lithium batteries safely by air

Technical Instructions

Assumptions

Hazards are accurately identified

Package level mitigation is sufficient

Aircraft safety systems and containment equipment can mitigate against a severe outcome

Compliance with prescriptive regulations and reaction to incidents is sufficient for safety

Lithium batteries

Reality

- Hazards classified as miscellaneous dangerous goods
- “Miscellaneous” does not describe actual hazard, which may vary depending on cell or battery type
- Some cells or batteries my be very benign, others too hazardous for air transport

- Packaging mitigation does not prevent propagation of thermal runaway to adjacent packages
- Quantity in cargo compartment increases risk

- A fire involving lithium batteries can overwhelm cargo compartment and containment equipment protection features

- Increasingly complex supply chain, cargo growth, changing battery technology, increased energy density outpace prescriptive SARPs
- Deliberate and non-deliberate compliance
- Reaction may be too late

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Addressing Safety Gaps

What ICAO is doing to help address potential safety gaps

Addressing the gaps

Three pillars for safe lithium battery transport by air system

Ban on transport of lithium batteries without equipment on passenger aircraft and need for cargo operators to assess ability to manage risk

- ICAO Council based on input from DGP, AIRP, and FLTOPSP
- Applicable 1 January 2015 for lithium metal and 1 April 2016 for lithium ion

Appropriate hazard communication

- UN lithium battery working group
- In progress: Presentation by G. Kerchner

Performance-based package standard

- SAE G27 Committee
- In progress: Presentation by D. Ferguson, G27 co-chair

Safety risk assessment provisions: Operator

- ICAO Flight Operations Panel
- Adopted specific safety risk assessment requirements in Annex 6, Chapter 15

Cargo compartment safety SARPs in Annex 6

- Cargo compartment safety
  - Policy and procedures that address items to be transported in the cargo compartment including specific safety risk assessment
  - Cargo compartment fire protection capabilities in the aeroplane flight manual or other documentation supporting the operation of the aeroplane
  - Policies and procedures to ensure, with reasonable certainty, that a fire involving items in cargo compartment can be detected and sufficiently supressed

Addressing the gaps

Ban on transport of lithium batteries without equipment on passenger aircraft and need for cargo operators to assess ability to manage risk	Safety risk assessment provisions: Operator	Appropriate hazard communication	Performance-based package standard	Technical Instructions: simplifying, clarifying, and strengthening
ICAO Council based on input from DGP, AIRP, and FLTOPSP	ICAO Flight Operations Panel	UN lithium battery working group	SAE G27 Committee	ICAO Dangerous Goods Panel (DGP)
Applicable 1 January 2015 for lithium metal and 1 April 2016 for lithium ion	Adopted specific safety risk assessment requirements in Annex 6, Chapter 15	In progress: Presentation by G. Kerchner	In progress: Presentation by D. Ferguson, G27 co-chair	In progress

Three pillars for safe lithium battery transport by air system

Prescriptive regulations

Simplifying, clarifying and strengthening

Continued efforts by Dangerous Goods Panel to simplify, clarify, remove ambiguity

- New amendments applicable 1 January 2023

Removal of exceptions for lithium ion and lithium metal batteries packed on their own

- Applicable 1 January 2023

Modification to current state of charge limit

- Replace existing requirement for batteries packed without equipment to be offered for transport at a state of charge not exceeding 30 per cent of their rated capacity with a requirement for them to be offered at the lowest state of charge practical
- DGP Working Group on Electronic Storage Devices to consider over next biennium

Extension of state of charge limit beyond batteries packed without equipment

- Extend state of charge limit to batteries packed with or contained in equipment and to battery-powered vehicles.
- DGP Working Group on Electronic Storage Devices to formulate recommendation based on safety risk assessment conducted under guidance of safety management expert
- Addendum to be recommended if considered necessary

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Addressing the gaps

Ban on transport of lithium batteries without equipment on passenger aircraft and need for cargo operators to assess ability to manage risk	Safety risk assessment provisions: Operator	Appropriate hazard communication	Performance-based package standard	Technical Instructions: simplifying, clarifying, and strengthening	Clarifying responsibilities: States
ICAO Council based on input from DGP, AIRP, and FLTOPSP	ICAO Flight Operations Panel	UN lithium battery working group	SAE G27 Committee	ICAO Dangerous Goods Panel (DGP)	ICAO Dangerous Goods Panel
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Three pillars for safe lithium battery transport by air system

Annex 18

Clarification of States' responsibilities

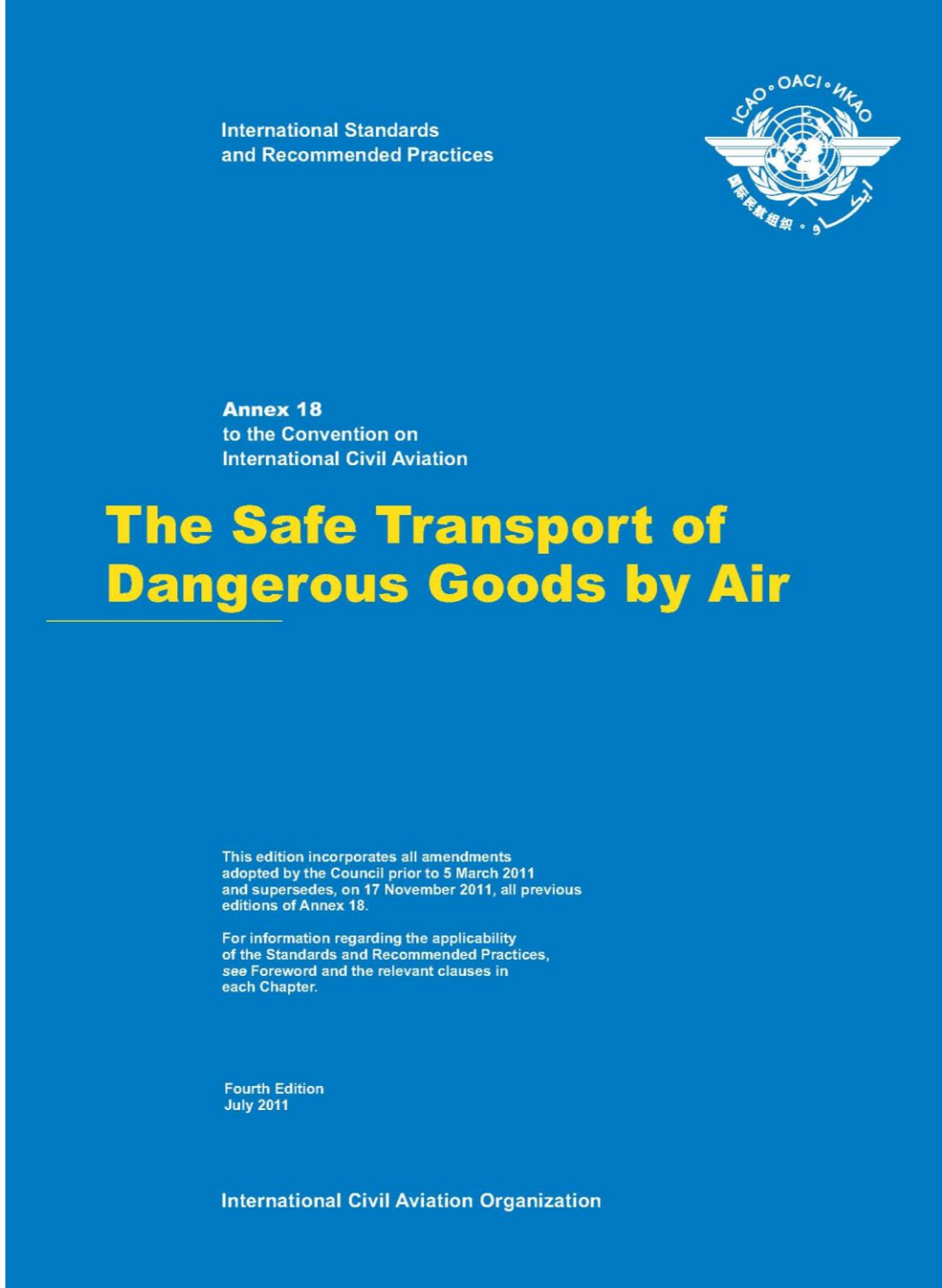
Amendment to SARPs and addition of supporting guidance material

Clarify existing prescriptive oversight responsibilities

- Align with eight critical elements of a State safety oversight system required by Annex 19 — *Safety Management* and link to Annex 6 — *Operation of Aircraft*

Incorporate proactive strategy to managing safety

- Incorporate proactive elements of a State safety programme required by Annex 19 — *Safety Management*



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Incorporate proactive strategy to managing safety

- Incorporate proactive elements of a State safety programme required by Annex 19 — *Safety Management*

1. Legislative provisions to empower State authorities to oversee entities in the supply chain
2. Promulgation of dangerous goods regulations
3. Establishment of authorities with sufficient and qualified personnel and adequate financial resources to manage dangerous goods safety
4. Maintaining qualified technical personnel to perform safety management functions
5. Providing guidance, tools and safety critical information
6. Making sure operators can safely perform dangerous goods operation
7. Making sure operators can continue to safely perform dangerous goods operations
8. Resolving dangerous goods safety issues

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Incorporate proactive strategy to managing safety

- Incorporate proactive elements of a State safety programme required by Annex 19 — *Safety Management*

1. Setting up a State safety programme supported by a system description (including identification of interfaces)
2. Safety management systems obligations
2. Safety investigations
3. Hazard identification and safety risk management
4. Management of safety risks
5. State safety performance
6. State safety promotion

5

Multidisciplinary approach

Holistic approach to the safe carriage of goods

Safe Carriage of Goods Specific Working Group of the Flight Operations Panel (FLTOPSP/SCG-SWG)

- Multidisciplinary group that integrates the expertise of many disciplines to deliver a holistic approach to the safe carriage of goods
  - Operation of Aircraft
  - Airworthiness
  - Cargo safety (including dangerous goods)
  - Safety and risk management
  - Security and facilitation

- Established in 2019 following the identification that several expert groups had been working on different aspects of the safe carriage of goods by air

- First meeting in 2021

SCG-SWG


IATA
ICCAIA
EASA
European Aviation Safety Agency
ICAO
I·F·A·L·P·A
The Global Voice of Pilots
IAOPA

SCG-SWG Work Programme

Task (Job Card)	
1	Structure of the dangerous goods provisions
2	Dangerous goods risks introduced by entities in the cargo supply chain
3	Procedures for preventing and responding to incidents involving lithium batteries carried by crew, passengers and the operator aboard the aircraft

Task 2. Dangerous goods risks introduced by entities in the cargo supply chain

- **Action 1** Review whether provisions related to safety of the supply chain, cargo and mail, are adequate in reducing undeclared and mis-declared dangerous goods in the cargo compartment of an aircraft

- **Action 2** Review whether Annex 18 proposed provisions are adequate in reducing undeclared and mis-declared dangerous goods in the cargo compartment of an aircraft

- **Action 3** Explore how screening methods can support detecting dangerous goods including lithium batteries in addition to security threats

- **Action 4** Based on the outcome of Actions 1, 2, 3, develop provisions as necessary

Task 2 (Cont)

Progress Summary

- Gap analysis to identify current security screening methods that could also be used to detect dangerous goods (including lithium batteries)
  - Visual Screening / Manual Search
  - Detection System (without Algorithm) X-ray and CT-scan
  - Detection System (with Algorithm) X-ray and CT-scan
  - Metal Detection Equipment
  - Explosive Trace Detectors
  - Canine Detection

- Need to collect data specially from States with large volumes of traffic to have a global perspective of the problem

Task 3. Procedures for preventing and responding to incidents involving lithium batteries carried by crew, passengers and the operator aboard the aircraft

- Anything taken on board by the crew or passengers as carry-on or checked baggage, in the cockpit, in the cabin, or in the cargo compartment (including lithium batteries)

- **Action 1** Develop provisions for preventing and responding to incidents from lithium batteries

- **Action 2** Develop guidance on procedures for preventing and responding to incidents from lithium batteries in the aircraft

Task 3 (Cont)

Project Plan

1. Discuss and identify the risks and mitigations related to lithium batteries going into thermal runaway on board aircraft

2. Identify the current operations procedures already within the Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) documentation in ICAO

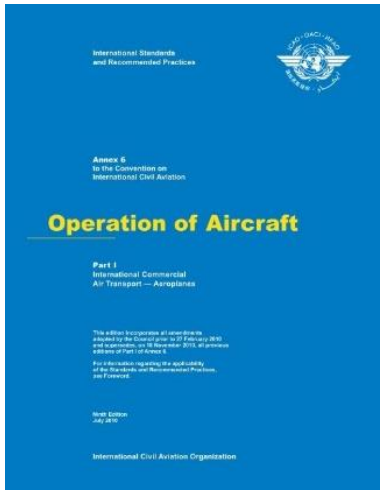
3. Determine if existing PANS-OPS (or other) guidance needs modification

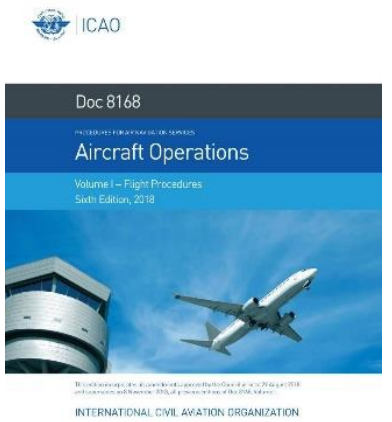
4. Identify what additional equipment is required on board the aircraft to support the new procedures

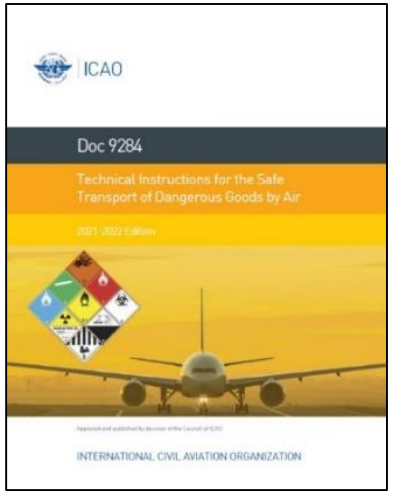
Task 3 (Cont)

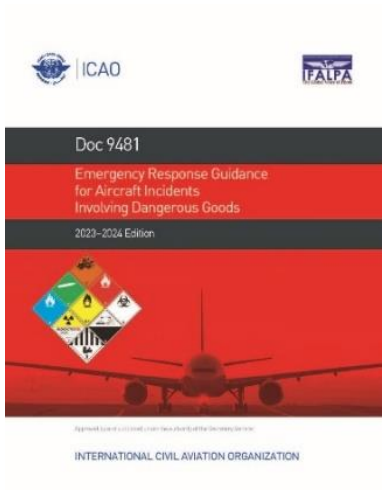
Progress Summary

- Review of Annex 6, PANS-OPS, and FLTOPSP/5 Report
  - Flight deck remains a primary concern
- Began a review of guidance, SARPs and reports mentioned in Task 3 to:
  - Understand how they are inter-connected, identify issues and gaps
  - Support Bowtie/Risk Analysis
- Review of Doc. 9284 “Technical Instructions for the Safe Transport of Dangerous Goods by Air”
- Review of Doc. 9481 “Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods”
- Review of ICAO DGP/26 Meeting October 2017









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Task 3 (Cont)

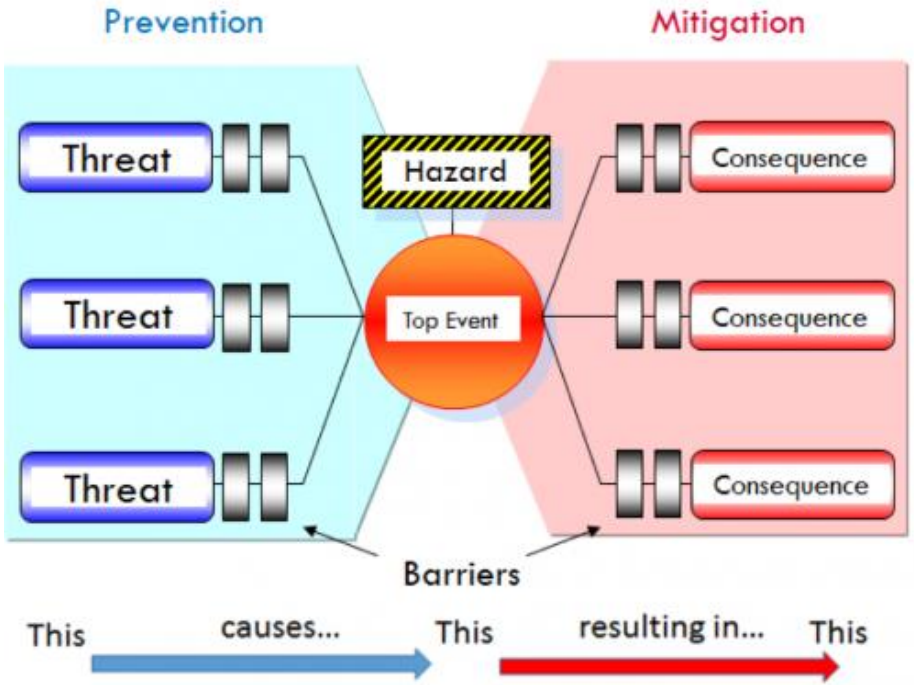
Several topic-focused meetings to assist with the Project Plan steps

- FAA - “The History of Cargo Compartment Fire Protection in Transport Aircraft”
  - Regulation changes over the years lessons learned from various accidents
- Underwriter Laboratories (UL) - “The Development of the Standard for Battery Fire Containment Products, UL 5800.”
- France - CAA and DGA Aeronautical Systems
  - Overview of their PED tests
- ICCAIA - Discussion on Electronic Flight Bags
  - Power banks use with EFBs, and the uncertainty they introduce when allowed to be used without clear requirements and oversight
- ICAO Cabin Safety Group (ICSG)
- Alaska Airlines
  - Overview of three events and lessons learned involving lithium batteries in the cabin

Task 3 (Cont)

BowTie (Hazard/Risk Analysis Tool)

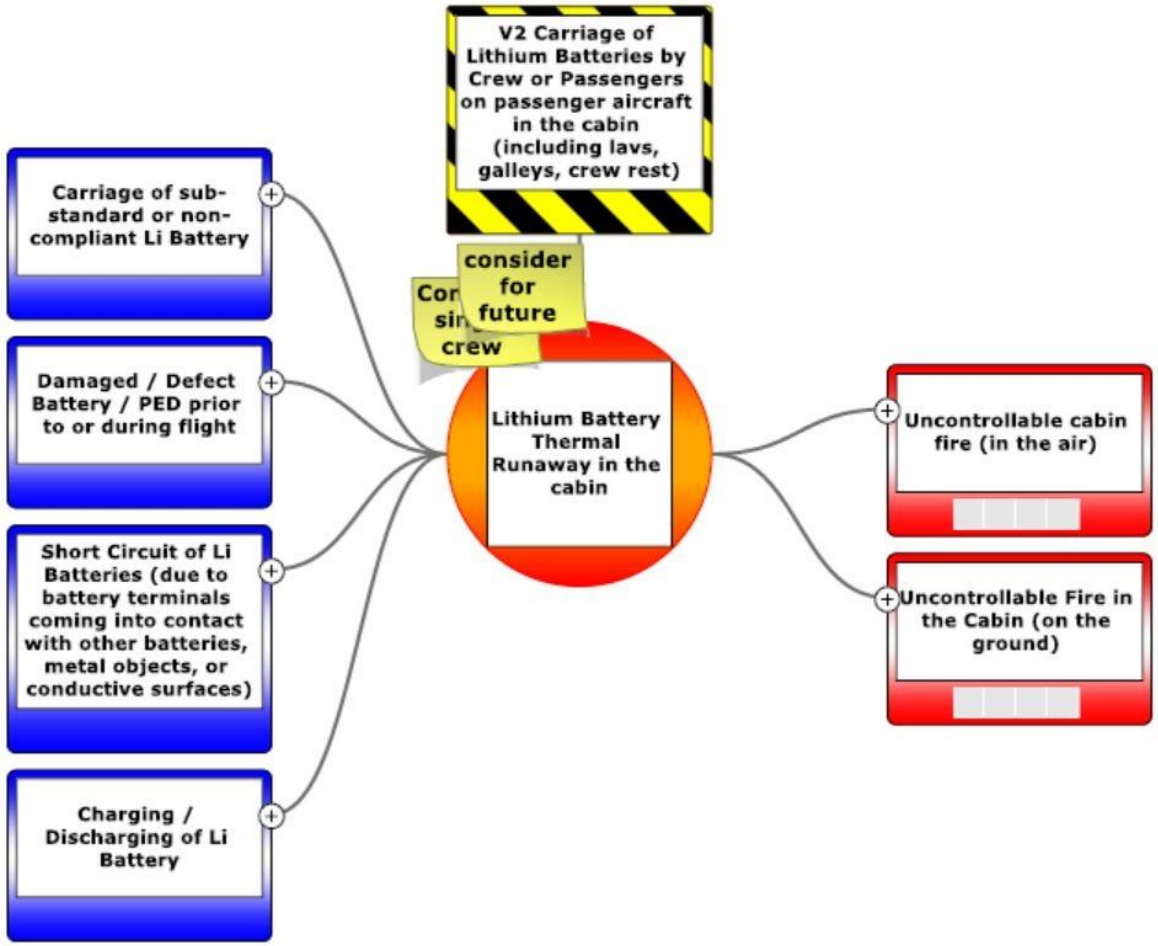
- Carriage of Lithium Batteries by Crew or Passenger in the Cabin (Multiple Configurations) (Current)
- Carriage of Lithium Batteries by Crew in the Cockpit (Multiple Configurations)
- Carriage of Lithium Batteries by Crew or Passenger in Checked Baggage
- Additional



*Coordination with DGP Electronic Storage Devices WG

BowTie (Carriage of Lithium Batteries in the Cabin)

View #1 – Threats and Consequences



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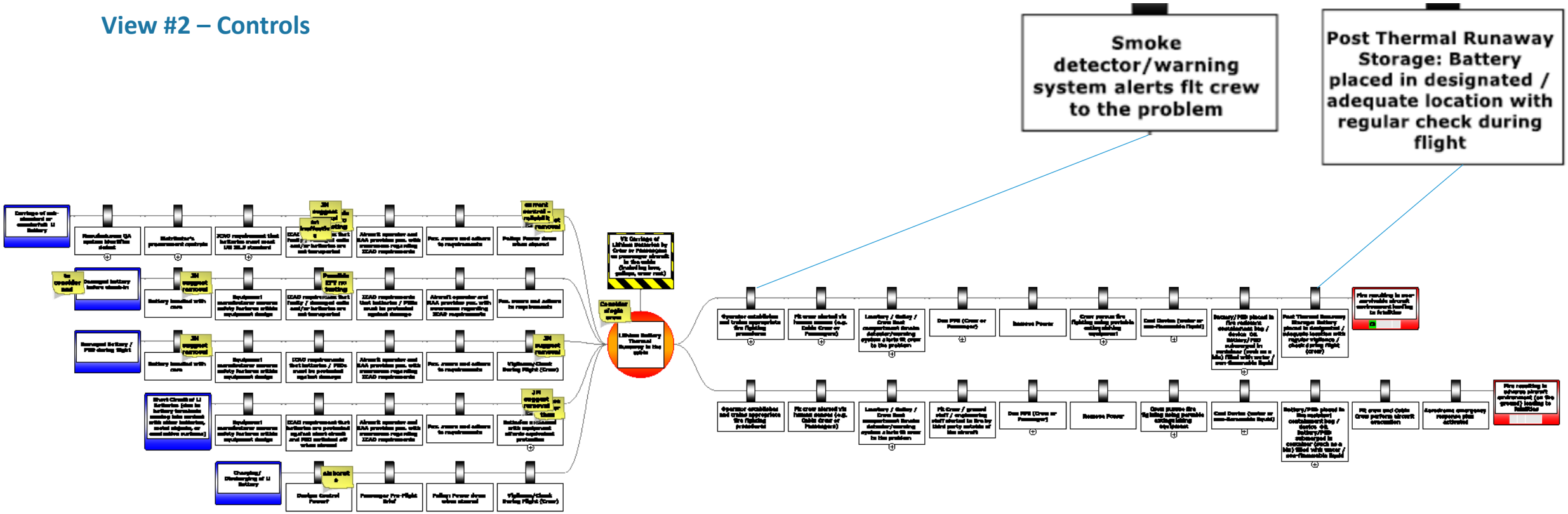
BowTie (Carriage of Lithium Batteries in the Cabin)

View #2 – Controls



Task 3 (Cont)

Future work

- Review of current common practices in flight crew and flight attendant emergency procedures
  - IFALPA and FAA gathering data
- Electronic Flight Bags – Unique risks given the environment
  - Continue collaboration with EASA (they have a 36-month research project underway to characterize the hazards presented by personal devices)
- Fire Containment Bags
  - Collaboration with Underwriter Laboratories, EASA, end users
- Continue collaboration with the ICAO Cabin Safety Group
  - Preview the Working Group analyses with them
  - Discuss Cabin Crew Safety Training Manual (Doc. 10002)
- Complete Bowtie(s)
- Begin work on Cockpit and attain Pilots perspectives (IFALPA)

6

Questions

Questions from the audience

Thank You!

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