



DANGEROUS GOODS PANEL (DGP)

TWENTY-NINTH MEETING

Montréal, 13 to 17 November 2023

Agenda Item 4: Managing safety risks posed by the carriage of lithium batteries by air (Ref: Job Card DGP.003.04)

REPORT OF THE DANGEROUS GOODS PANEL WORKING GROUP ON ENERGY STORAGE DEVICES (DGP-WG/ENERGY STORAGE DEVICES): BOWTIE ANALYSIS

(Presented by the Rapporteur of DGP-WG/Energy Storage Devices)

SUMMARY

This information paper presents a bowtie diagram developed by DGP-WG/Energy Storage Devices identifying the hazards, barriers, and consequences associated with thermal runaway of lithium batteries in an aircraft cargo compartment.

1. INTRODUCTION

1.1 The DGP-WG/Energy Storage Devices utilized the bowtie method as a risk assessment tool for its ability to visualize the hazard, the risk, the resulting consequences, and the reactive and proactive controls/measures designed to prevent unwanted outcomes. A copy of the diagram is shown in the appendix to this document.

1.2 The draft bowtie diagram depicts threats associated with two causal scenarios:

- 1) lithium batteries packed with equipment damaged at any point prior to loading on aircraft; and
- 2) lithium batteries contained in equipment damaged at any point prior to loading on aircraft.

The top event in this bowtie diagram is thermal runaway. The left side of the diagram depicts existing requirements contained in the Technical Instructions representing the active controls (or barriers) designed to prevent a thermal runaway event. The analysis also identified potential escalation factors that weaken the controls.

1.3 The right side of the diagram depicts consequences of a thermal runaway event (uncontrollable cargo compartment fire) and recovery controls that mitigate the consequences of a thermal runaway. Consequences and recovery measures are shown for:

- 1) an uncontrollable fire in a cargo compartment while the aircraft is in flight; and
- 2) an uncontrollable fire in a cargo compartment while the aircraft is on the ground, any point either before take-off or after landing.

The recovery controls assume traditional commercial air transport operations with larger aircraft and all controls may not be applicable to all aircraft or all operators. Generic escalation factors were included to identify cases in which a recovery control, e.g. active fire suppression, depressurization etc., is not present. Unique identifiers for Causal Scenario (CS), Preventative Controls (PC), Escalation Factors (EF), Recovery Controls (RC), and Hazardous Consequence (HC) were added for ease of identification and categorization.

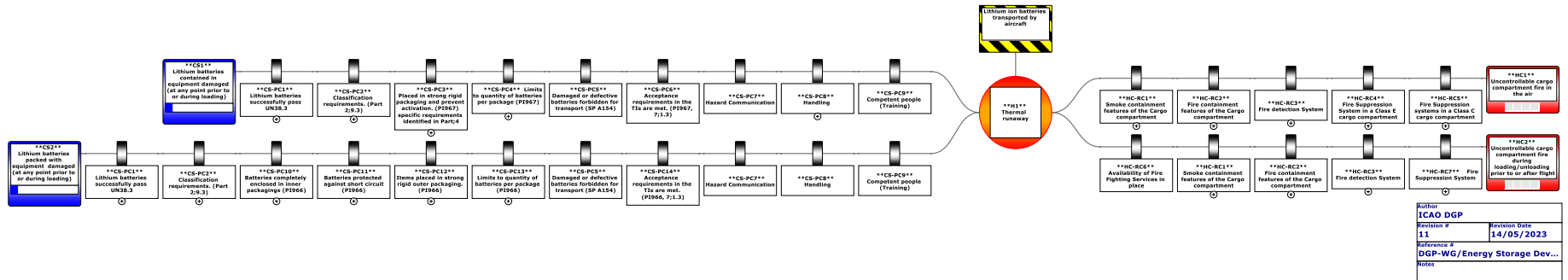
1.4 The diagrams in the appendix are best viewed electronically. Use the zoom or magnify function to make the text clear.

2. **DISCUSSION BY THE DGP-WG**

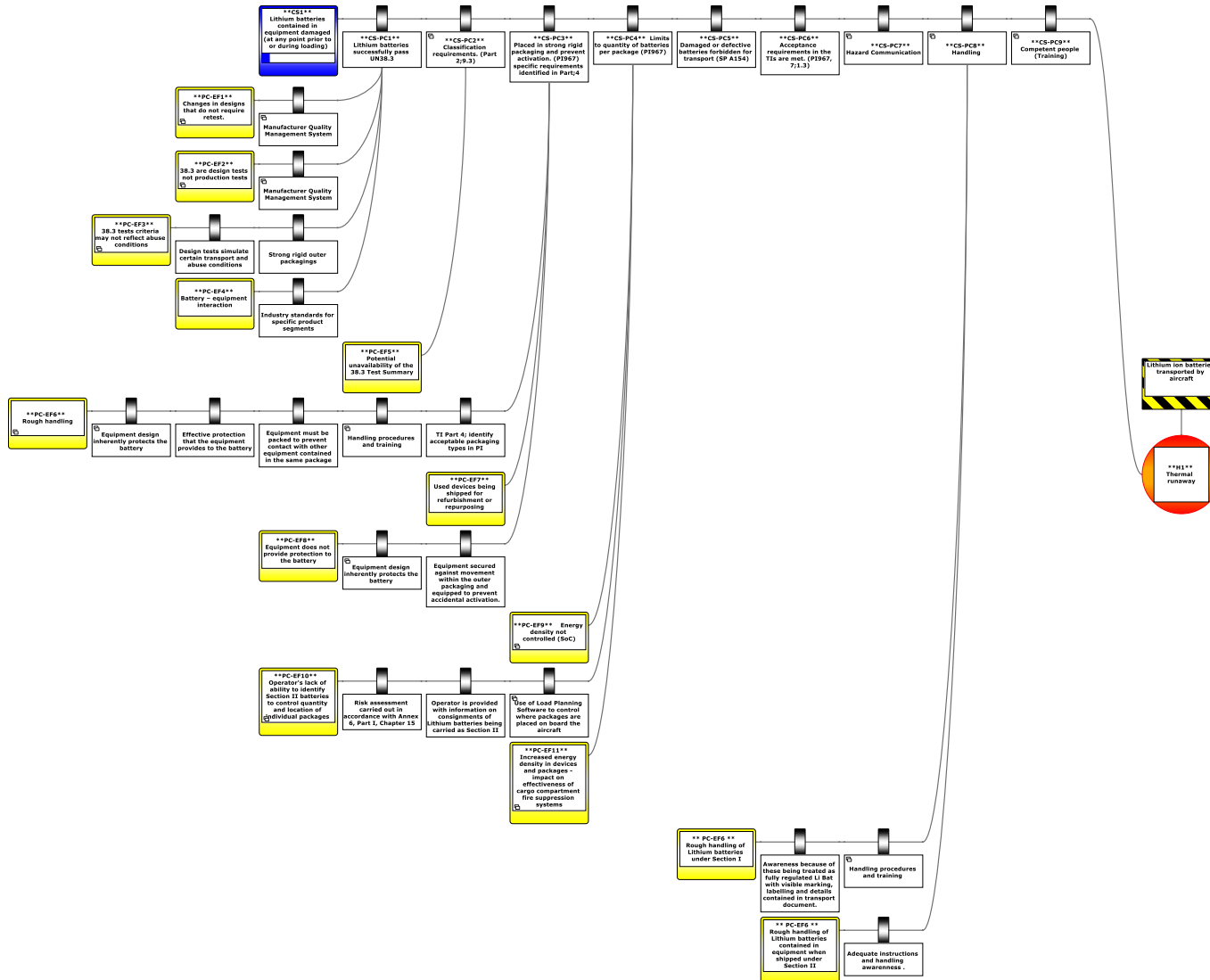
2.1 The DGP is invited to review the bowtie diagram in the appendix to this information paper and to consider the impacts of escalation factors and effectiveness of existing controls.

APPENDIX
BOWTIE DIAGRAM

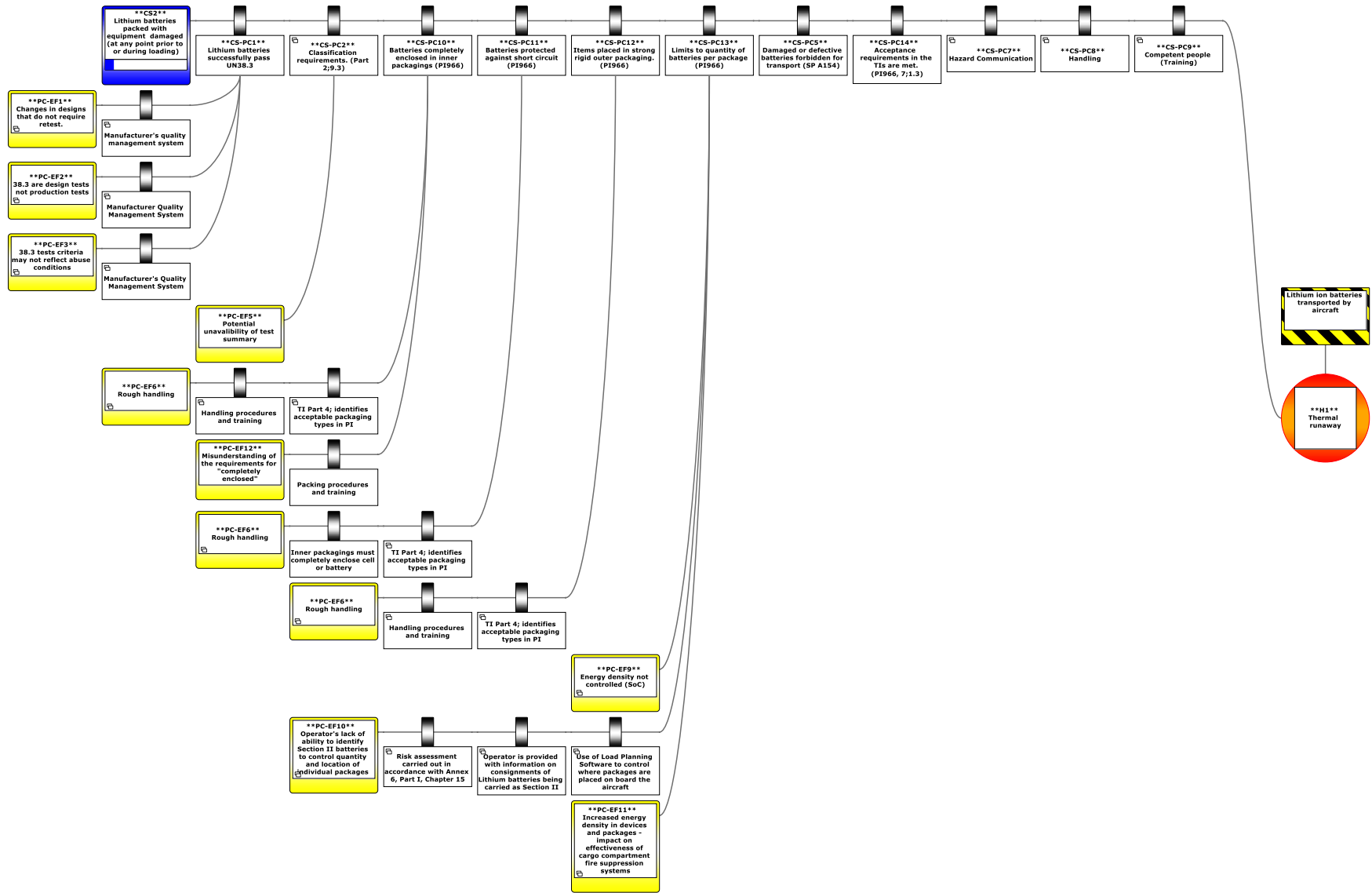
VIEW #1 — BOWTIE CS AND HC



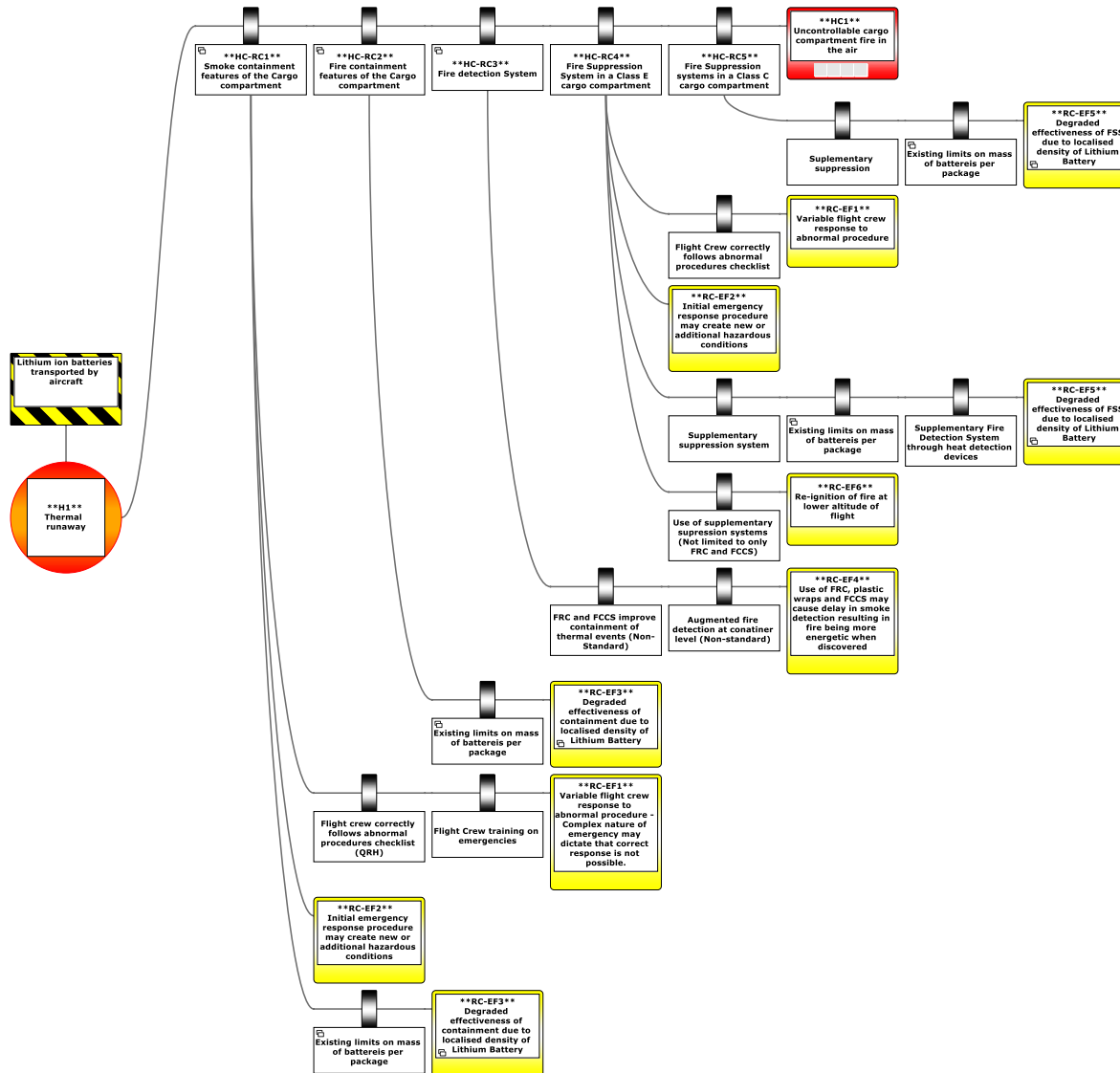
VIEW # 2 — THREATS AND CONTROLS CS1



VIEW #2 – THREATS AND CONTROLS CS2



VIEW #3 – CONSEQUENCE HC1



VIEW #5 – FULL BOWTIE

