Engine/APU Halon Replacement Industry Consortium – Release Altitudes of Fire Extinguishing Agents

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Where do Engine/APU Fire Extinguishing Discharges Occur in the Air Column?

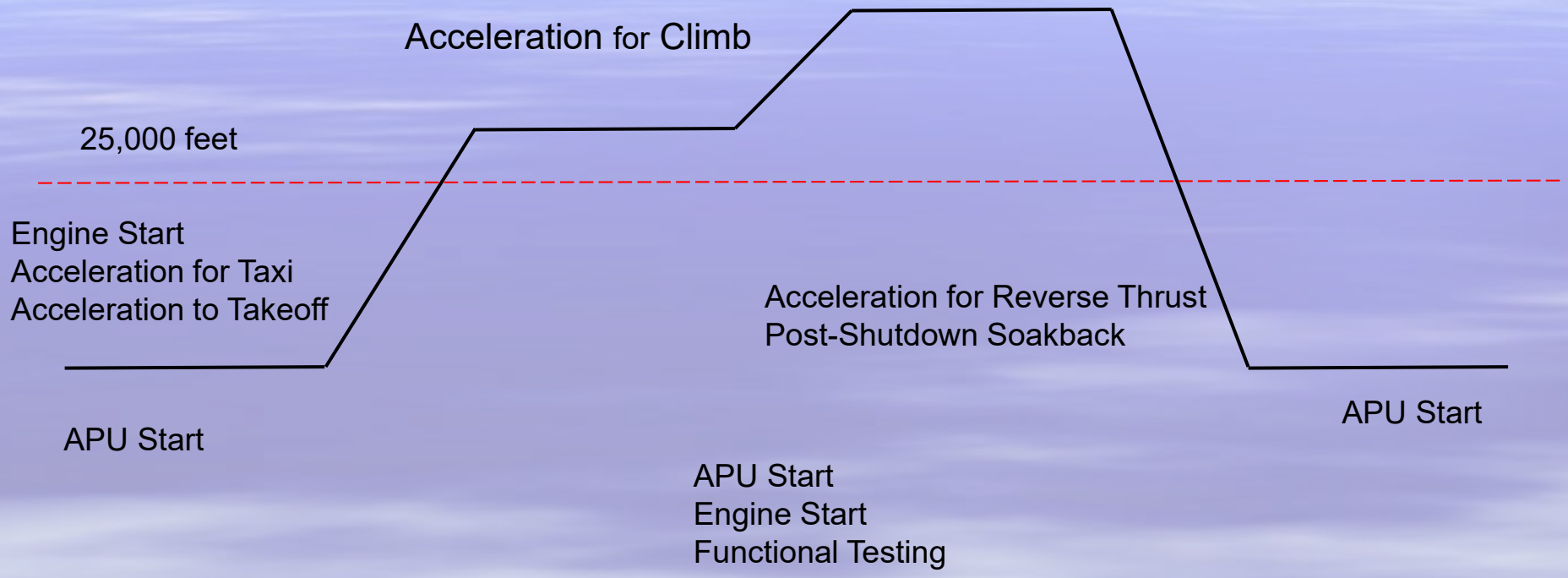
Why does this matter?

- Halon replacement candidates have varied atmospheric lifetimes and decomposition mechanisms
- Some candidates are predicted to have greater or lesser ozone depletion or global warming potential based on altitude of release
- Understanding likely altitudes of discharge/release can impact selection criteria

How should this be studied?

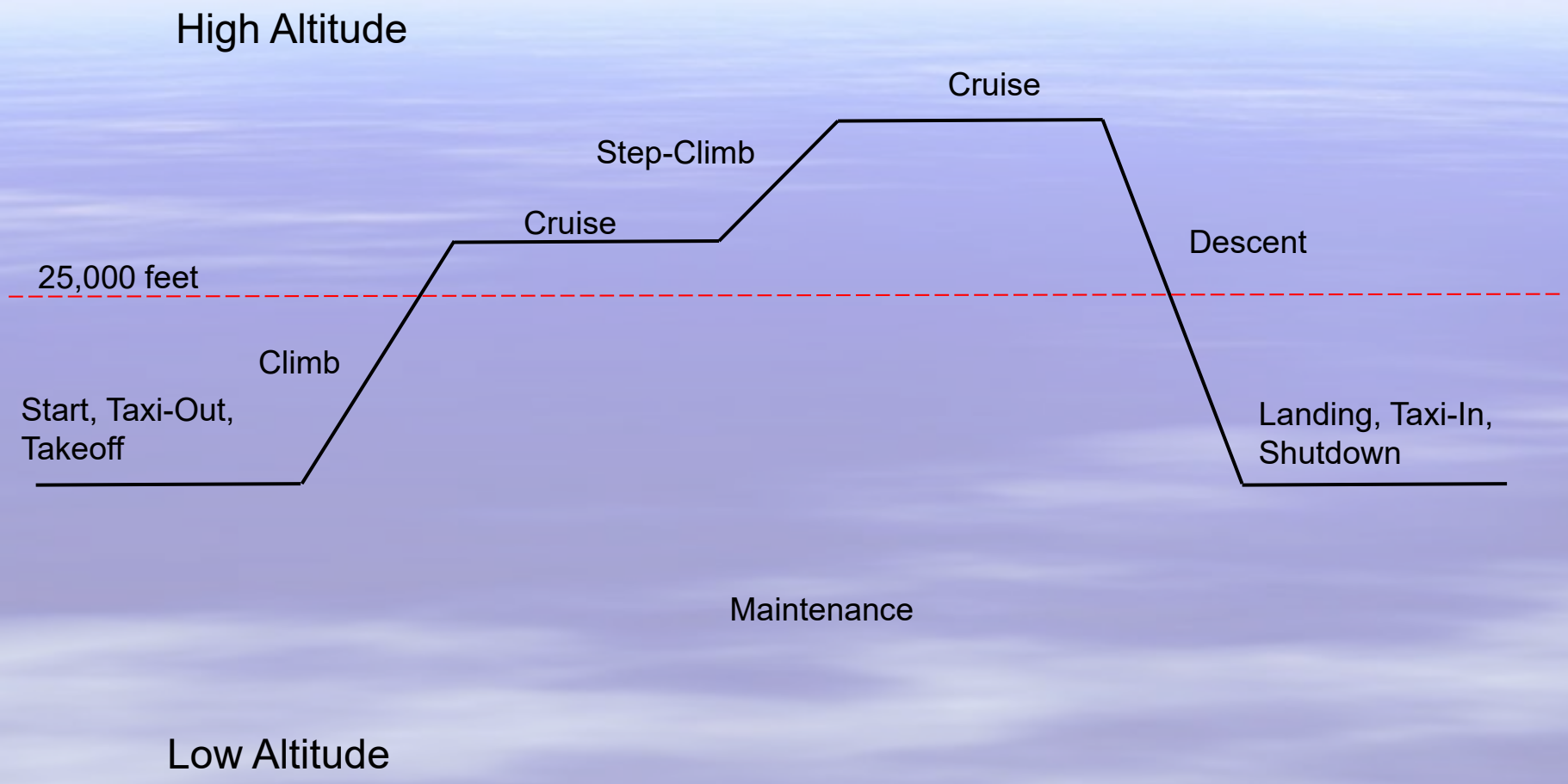
- Safety Agency and regulator report databases may not provide full information
  - Maintenance discharges often not captured
  - Some low-level events, such as a false warning on APU startup, not collected
  - Bottle leaks generally not recorded
- Logbook reports, on the other hand, can be used, with some limitations
  - Difficult to share raw data due to customer sensitivity
  - Skilled specialist needed to pull reports
  - Individual reports will record bottle(s) involved, as well as circumstances of discharge
  - Aggregate of years of reports can be used to provide useful insights

Aren’t discharges evenly distributed across flight times?



How were reports classified?

- Four airplane models reviewed via logbook extracts (internal proprietary databse)
  - Covered 20-year service period
  - All four models in production at time of data collection
  - Incidents represent 180M+ flight hours, and nearly 60M departures
  - Included not-reported events such as maintenance discharges and commanded discharged in non-fire scenarios
- Reports separated into three categories
  - Ground
    - Maintenance
    - Start/shutdown
    - Taxi-in/Taxi-Out
    - Takeoff Roll
    - Landing rollout
  - Low Altitude
    - Takeoff (after liftoff)
    - Initial Climb
    - Approach/Late Descent
  - High Altitude
    - Cruise
    - Top of climb or descent
    - Unknown in-flight categorized as “high”



Results

Type of Event	Number of Events	Percentage of Engine/APU Total	Percentage of Overall Total	Rate per Flight Hour	Rate per Flight Cycle
Engine Ground	131	72%	26%	7.1E-7	2.2E-6
Engine Low Altitude	34	19%	7%	1.9E-7	5.7E-7
Engine High Altitude	18	10%	4%	9.8E-8	3.0E-7
APU Ground	300	91%	59%	1.6E-6	5.0E-6
APU Low Altitude	7	2%	1%	3.8E-8	1.2E-7
APU high Altitude	21	6%	4%	1.1E-7	3.5E-7
Totals	511	100%	100%	2.8E-6	8.5E-6

95% of discharges at low altitude or on the ground

Observations and Conclusions

- Discharge events are not evenly distributed
- Majority of events happen on or close to the ground
- More APU than engine events
  - May be driven by ground crew caution
  - APUs tend to run on ground more than in air, and longer on ground than engines
- Maintenance activities are a significant source of unintended discharges
- A number of operators discharge bottles during an evacuation, regardless of fire indications

Thank you!