Electronic Flight Bag (EFB) Hazard Assessment

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Background

- EFBs are electronic devices used to replace the paper materials typically found in the pilot's Flight Bag.

- They are divided into three classes:
  - **Class I** – Portable electronic device (PED), Commercial off the Shelf (COTS) equipment, used as loose equipment and stowed during portions of flight

  - **Class II** – PED, can be COTS equipment, mounted and connected to aircraft power during flight for use and charging.

  - **Class III** – Considered installed equipment, these are not PED, or COTS equipment, but rather are pieces of equipment built and tested specifically for aircraft EFB use.

Background

- Class I EFBs are considered portable electronic devices (PEDs) and are not subject to airworthiness standards.
- Class II EFBs are also considered PEDs, and are not subject to airworthiness standards, however their mounting/charging connection hardware are.
- Class III EFBs are subject to airworthiness standards, as they are considered installed equipment.
- Responsibility for class I and class II EFBs falls under FAA flight standards
- This brief set of tests is aimed at assessing the potential hazard posed by class I and class II EFBs.

Test Facility & Equipment

- FAA Fire Safety 737
  - Flight Deck Volume - 129 ft^3
  - For current tests, 1 pack was running with gaspers in the flight deck closed. This configuration resulted in an air exchange rate of 60 s.



Test Facility & Equipment

- Laptop outfitted with a high capacity (7.2 Ah), 9 cell Li-Ion battery
- Battery has been modified to initiate thermal runaway:
  - Test 1 - replaced one of the battery cells with a small cartridge heater
  - Test 2 – replaced two of the battery cells with small cartridge heaters
- Laptop placed in the cockpit within a mesh cage to prevent any damage to aircraft. In addition, all flammable material (carpeting, seat cushions, etc) from the cockpit has been removed.
- Any sign of resulting fire was immediately extinguished for protection of the aircraft






AGPtEK
DC 11.1V 7200mAh/80Wh
Replace: JD634, TD175
CAUTION
VORSICHT

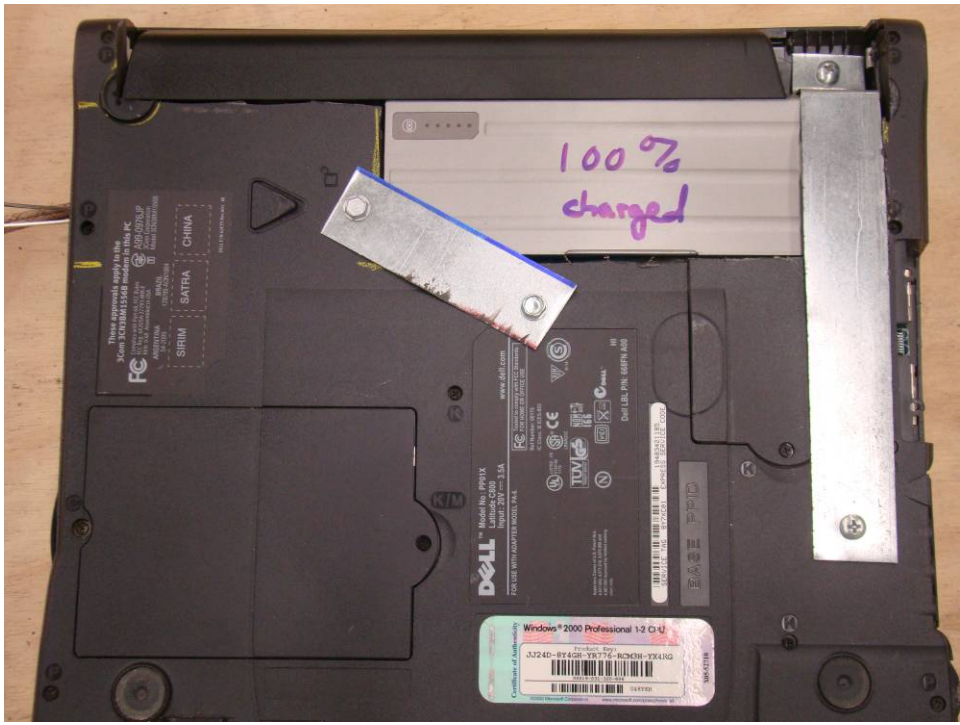


Instrumentation

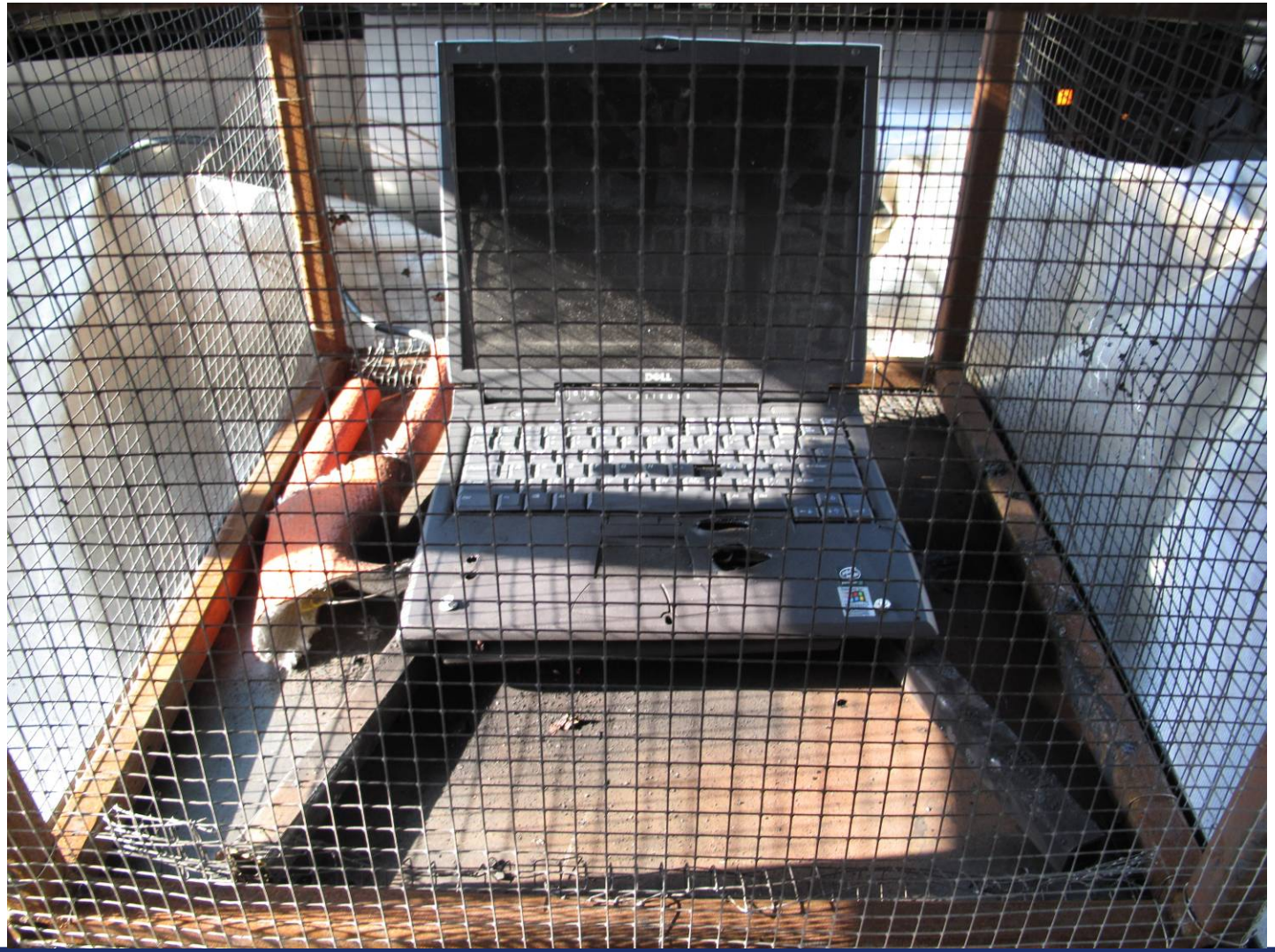
- Thermocouples placed on the cartridge heater(s), and one adjacent battery cell(s).
- Thermocouple to read ambient temperature in cockpit placed directly above laptop at 41″ height.
- Smoke meter placed at ‘eye-level’ (47.5″) across the pilot and co-pilot stations to measure ambient light obscuration within flight deck.
- Sample probes placed at ‘nose-level’ (41″) at both the pilot and co-pilot stations to monitor O_2, CO and CO_2 throughout test.

Test #1 – Pretest Photos





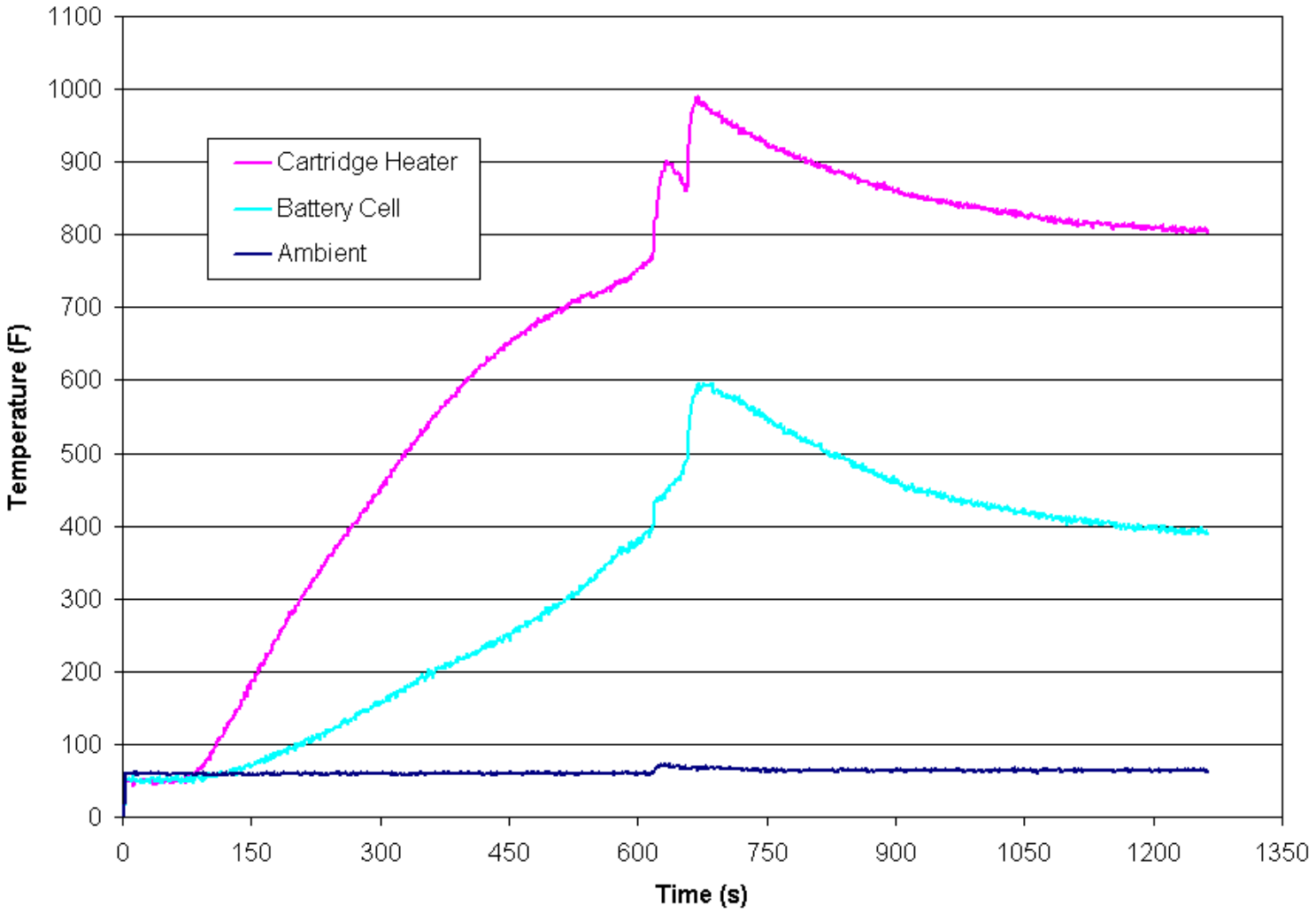
Test #1 – Post-Test Photos



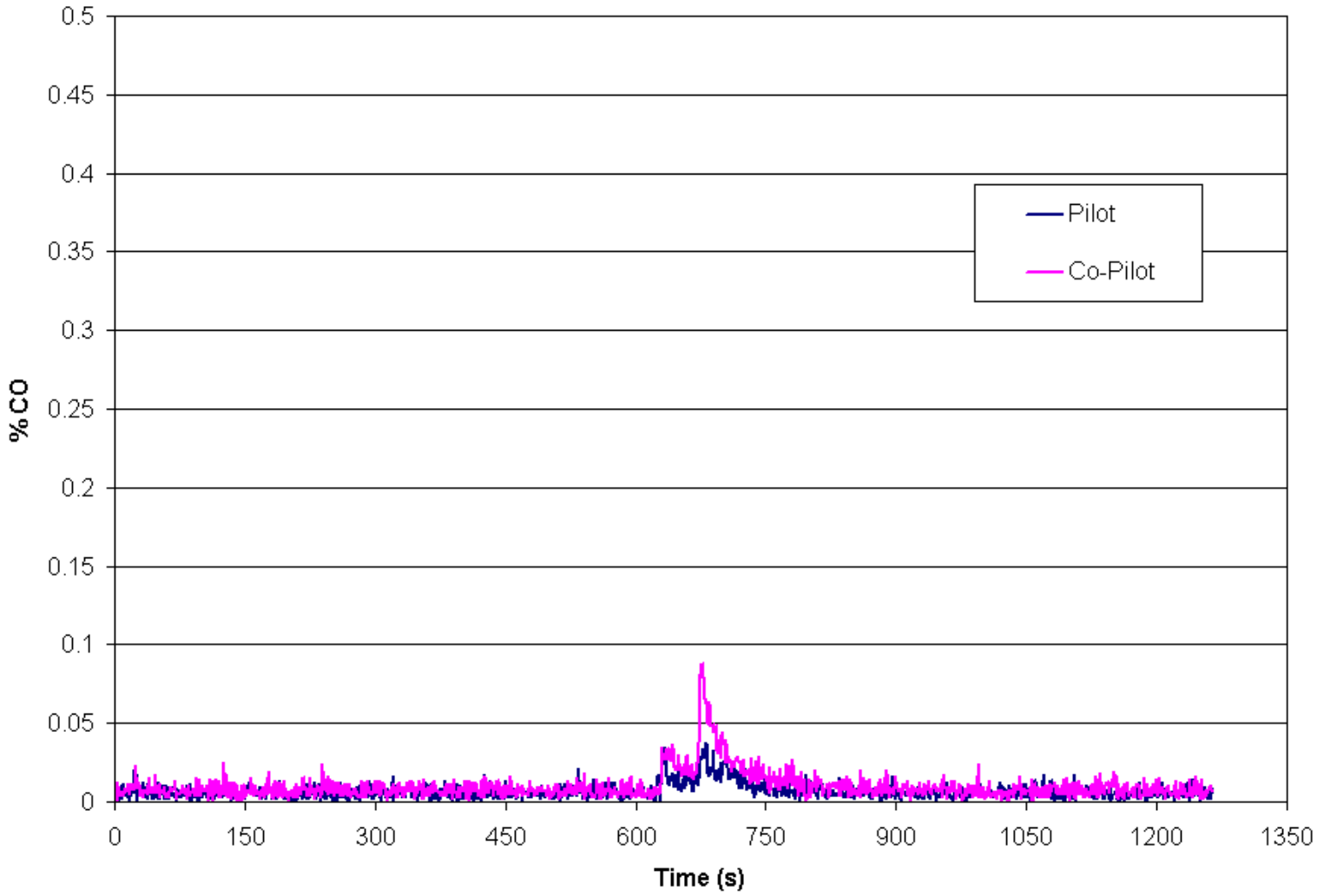
Test #1 – Post-Test Photos



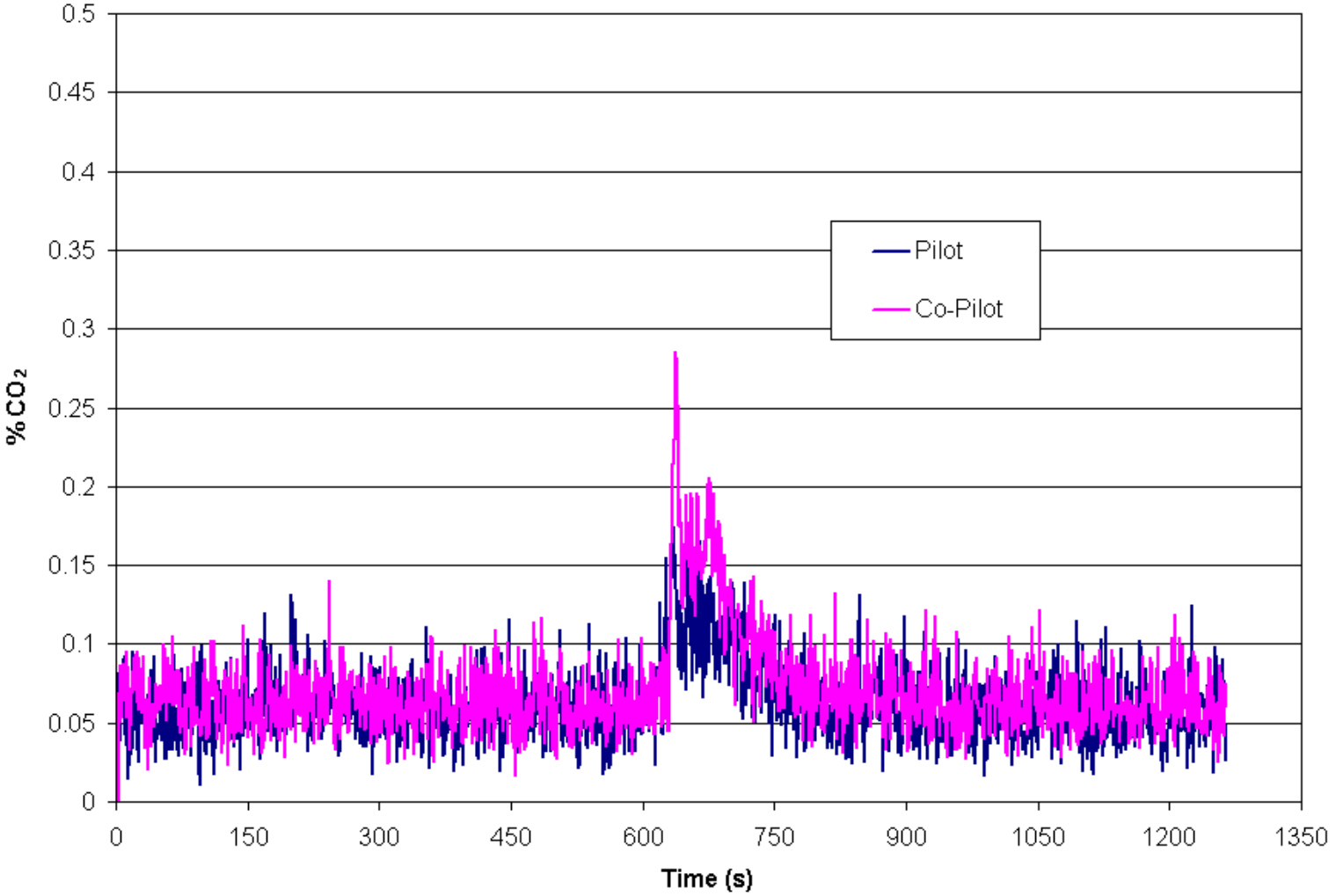
Test #1 Results – Temperature



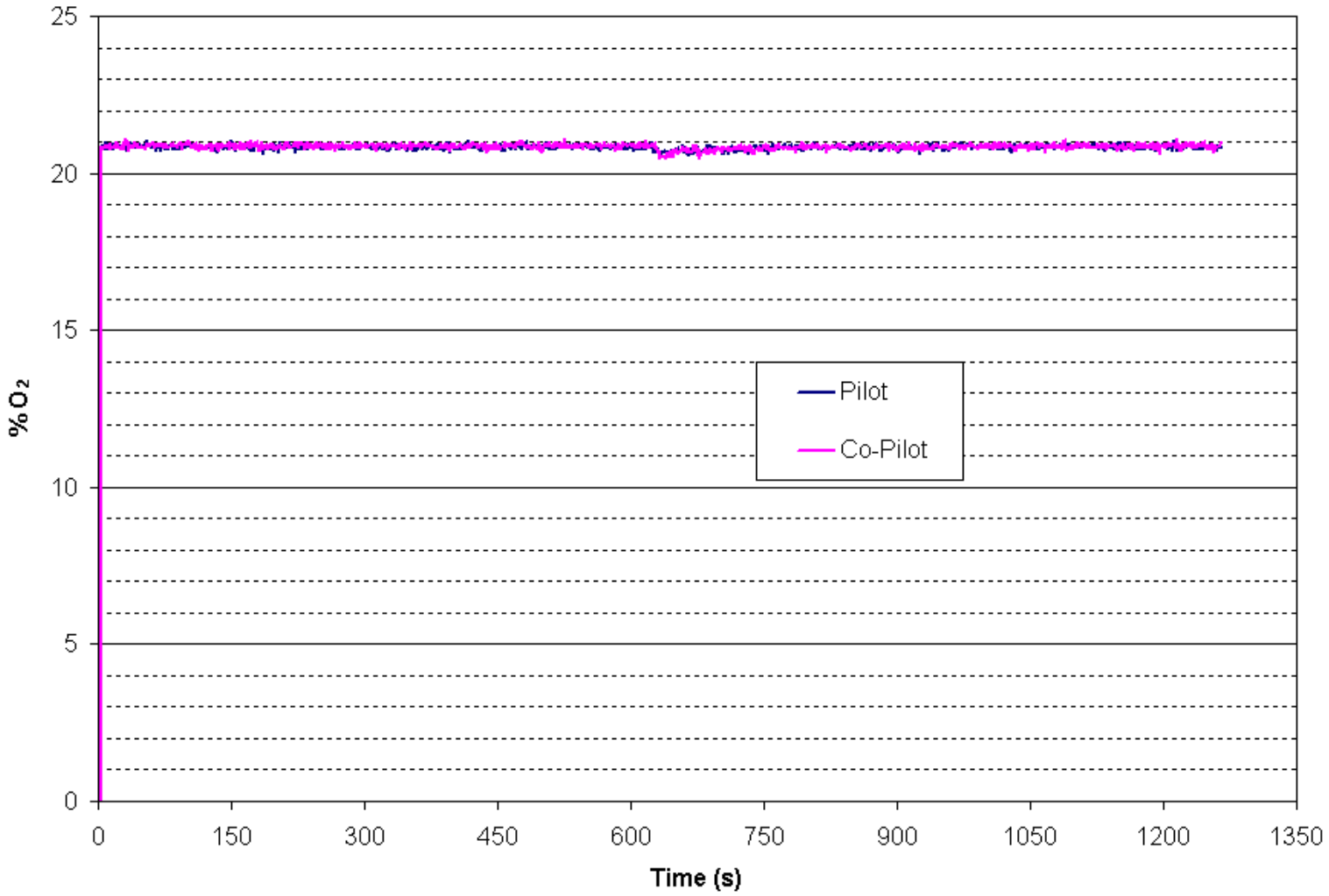
Test #1 Results – CO



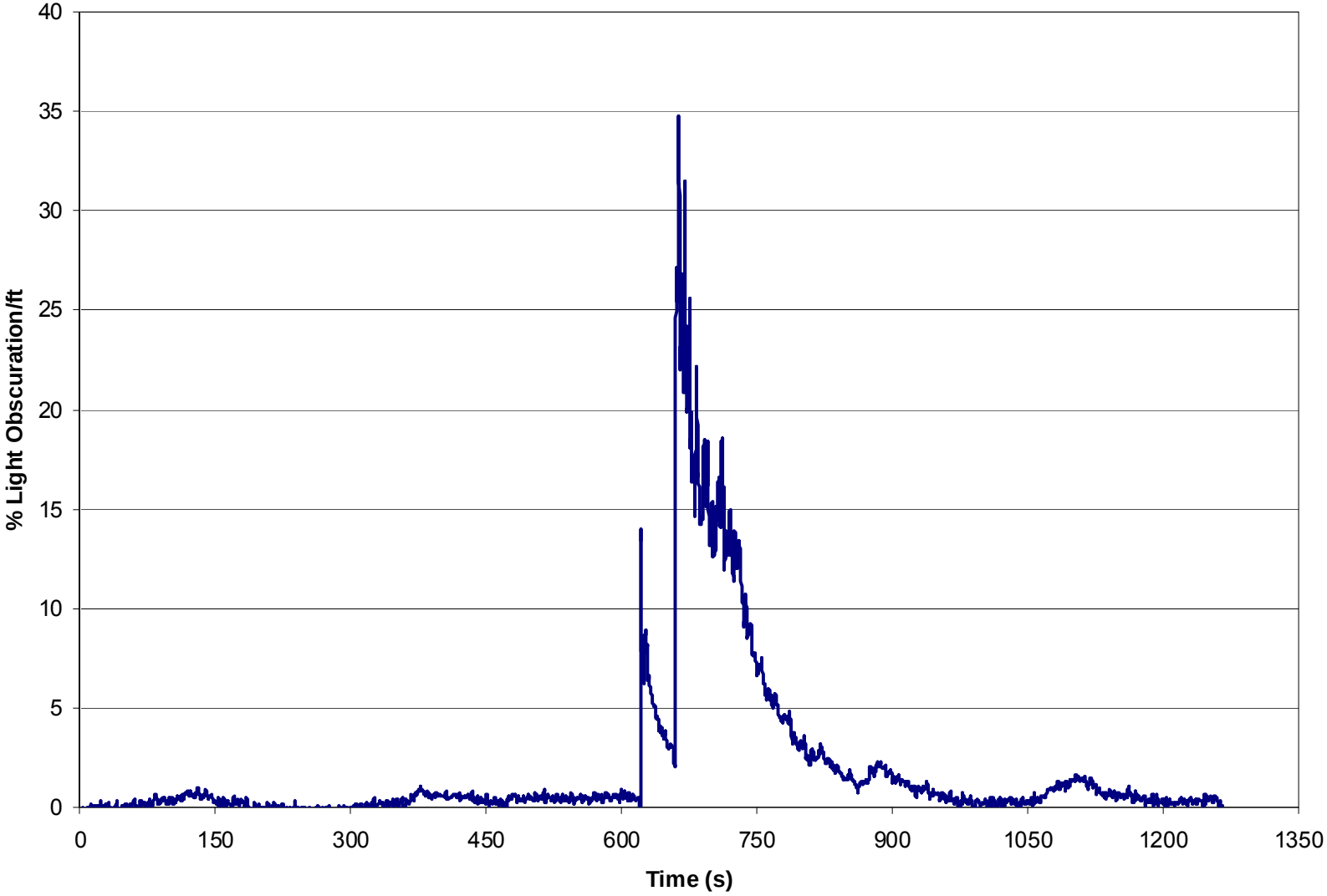
Test #1 Results – CO_2



Test #1 Results – O_2



Test #1 Results – Smoke Meter



Test #1 – Results Summary

- Two out of nine cells within the battery pack went into thermal runaway.
  - One had been replaced by cartridge heater
  - Three were isolated from event due to battery configuration
  - Heat was not great enough to affect other three batteries due to battery configuration and fire extinguishment.
- O_2, CO and CO_2 measurements showed negligible effects.
- Initial battery event occurred without warning (i.e. no visible smoke or audible event prior)
- Smoke meter showed greater than 10% light obscuration/ft for a period of ~1.5 minutes

Test #2 – Pretest Photos





Test #2 – Post-Test Photos



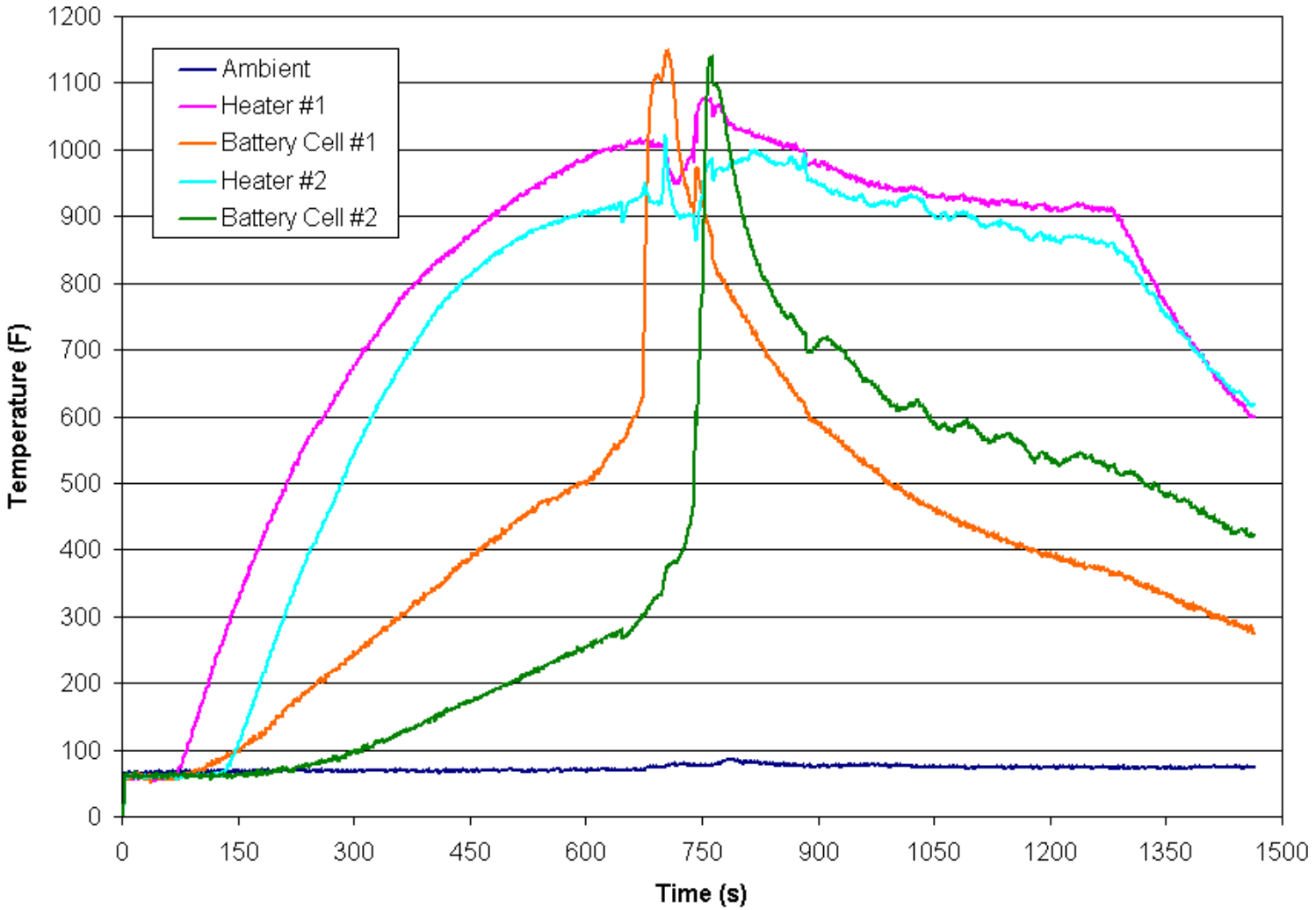
Test #2 – Post-Test Photos



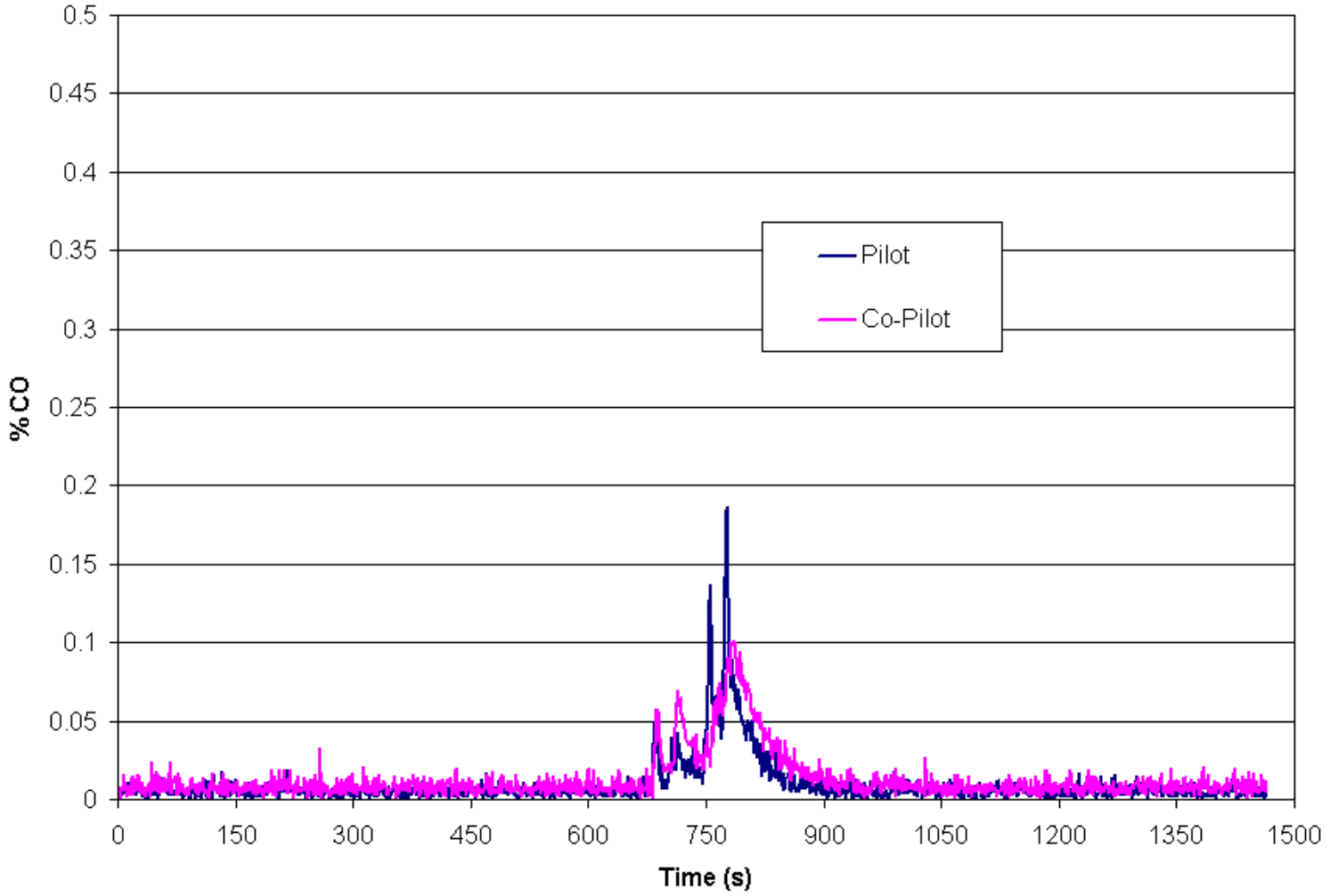
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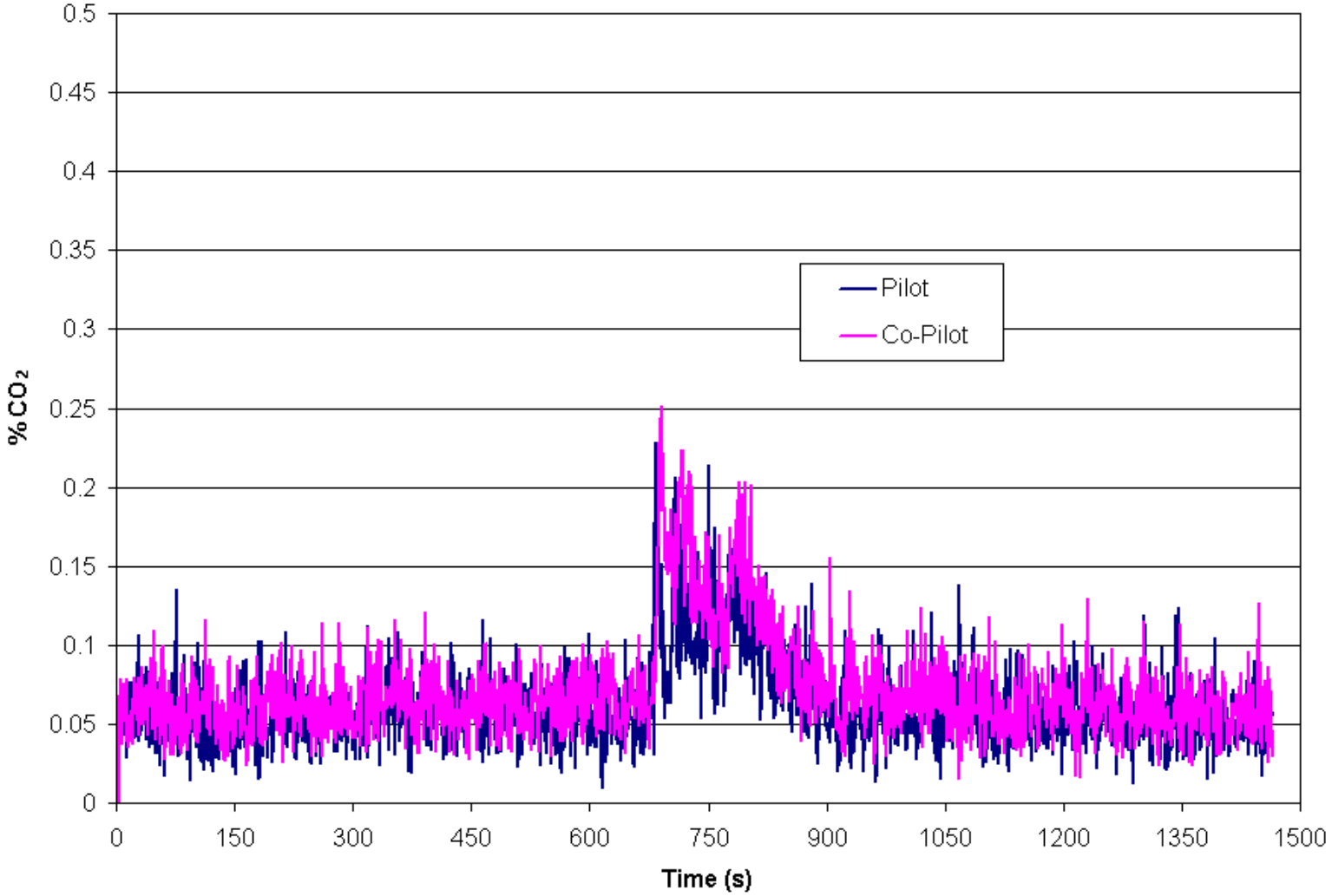
Test #2 Results – Temperature



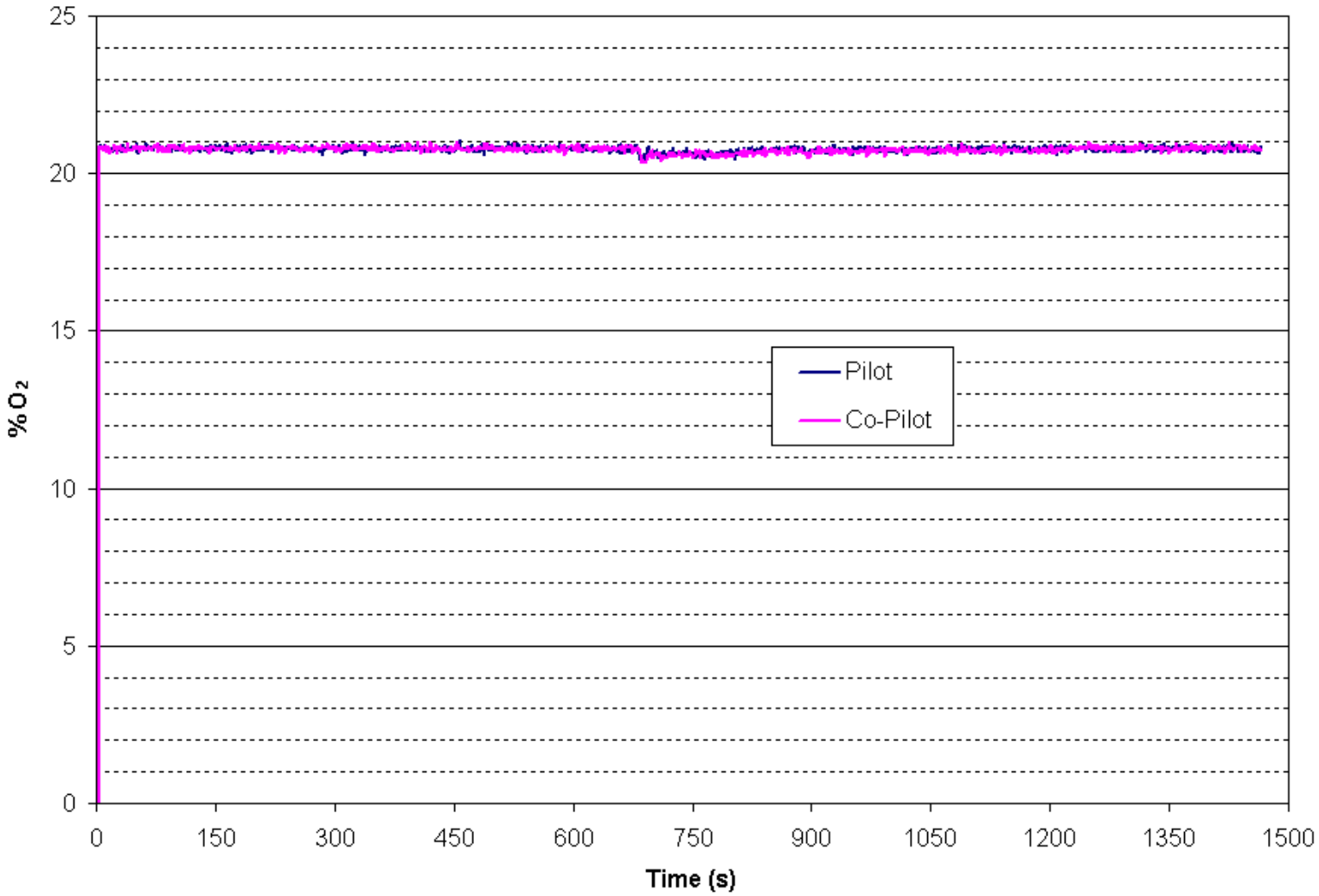
Test #2 Results – CO



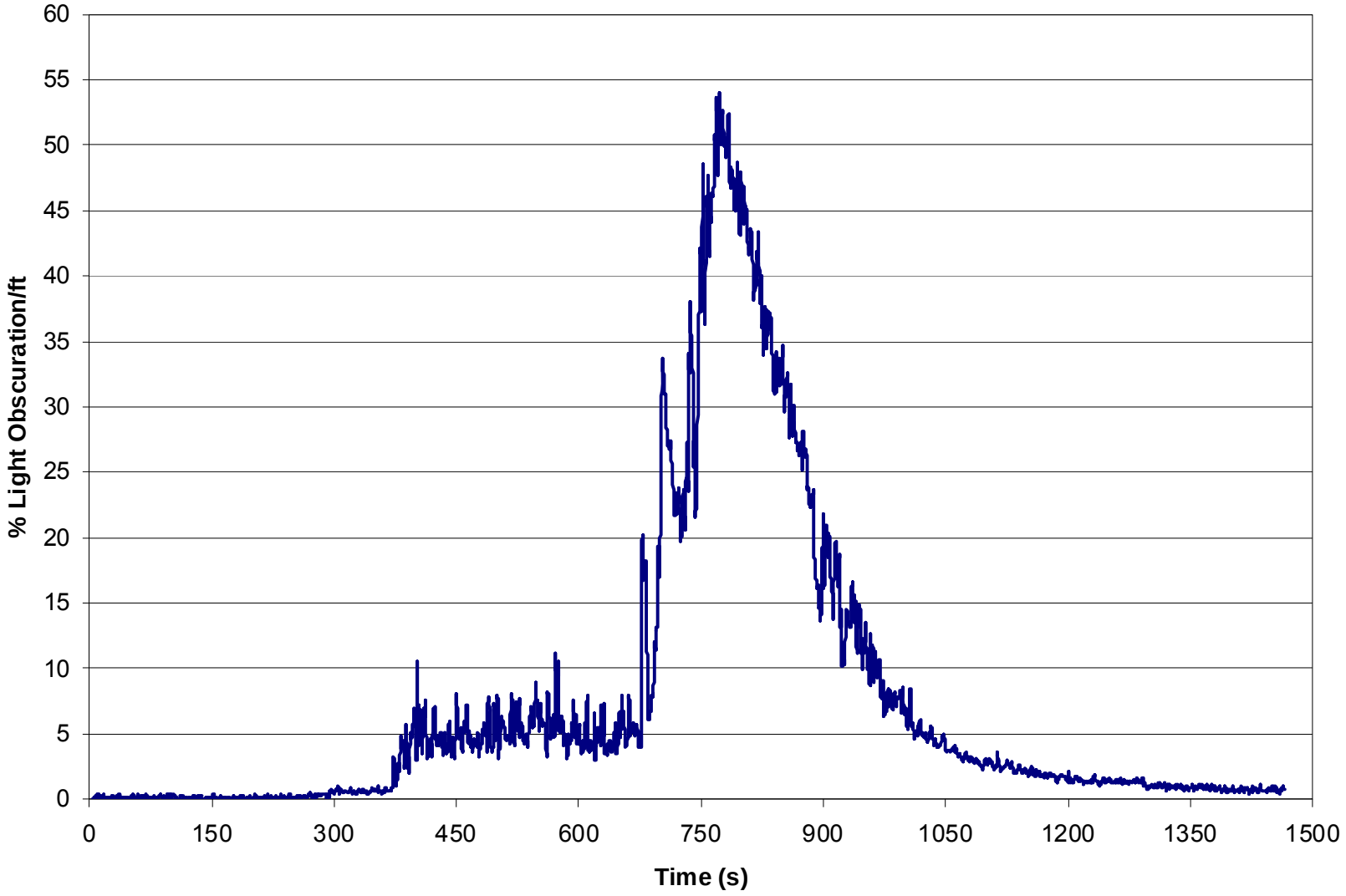
Test #2 Results – CO_2



Test #2 Results – O_2



Test #2 Results – Smoke Meter



Test #2 – Results Summary

- Four out of nine cells within the battery pack went into thermal runaway.
  - Two had been replaced by cartridge heaters
  - Three were isolated from event due to battery configuration
- O_2, CO and CO_2 measurements showed negligible effects.
- Smoke meter showed greater than 10% light obscuration for a period of ~5 minutes
- During one of the battery cell events, the pressure was great enough to forcefully push open the cockpit door (door was not latched).

Conclusion

- Tests have shown that even with a very high ventilation rate (1 air exchange/minute), a typical COTS Li-Ion battery could pose a significant hazard within the flight deck environment and could potentially present a catastrophic risk.