Expired PDRM/WB15s left out in fleet; incident and preventive measures

06/27/2018

Background

- Parachute Deployment Rocket Motor (PDRM)
  - Subsystem of Navy Aircrew Common Ejection Seat (NACES), used on F-18C/D/E/F fighter, EA-18 Growler and T-45 trainer aircrafts
  - Responsible for the extraction of the main recovery parachute from the head box
  - The rocket motor recently self-initiated in two separate occasions

- WB15
  - Cartridge actuated initiator used in the modified NACES P3I ejection seat used on F-18 and T-45 aircrafts
  - The initiator is a gas actuated ballistic gas producing device and is used during the emergency egress ejection seat catapult phase to provide catapult separation

NACES

Main Parachute Headbox

WB15

PDRM

IMPORTANT

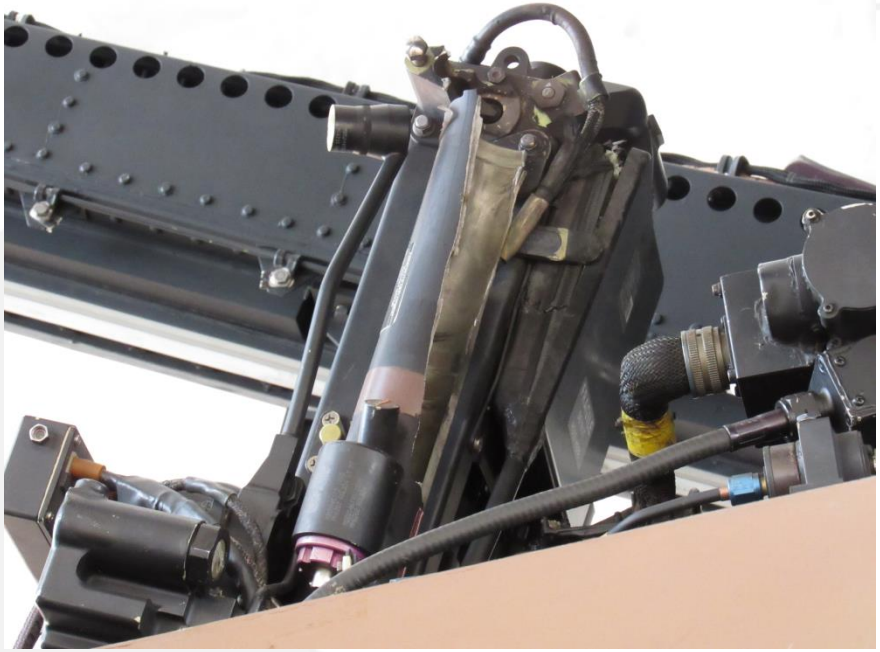
• Stabilizer (2-NDPA) eliminates nitrogen oxides that result from nitric acid ester decomposition, and inhibits autocatylitic decomposition

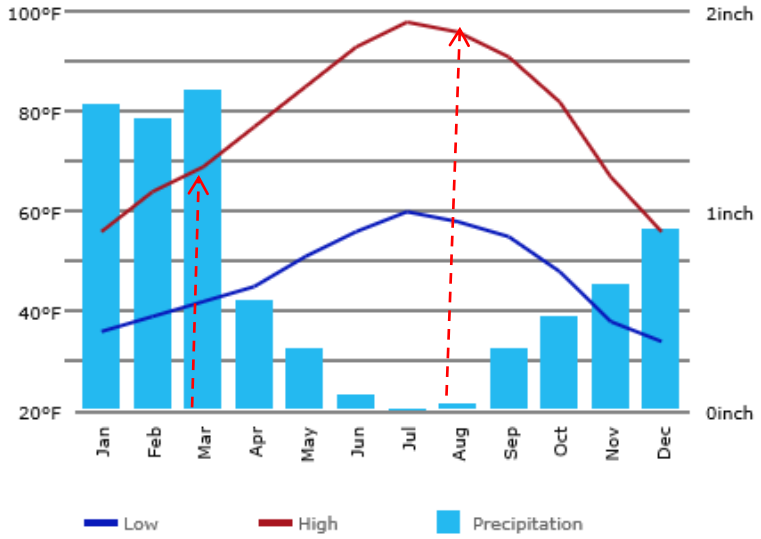
• Stabilizer (initially 2%) is gradually consumed over life of item

Recent Incident

An F/A-18F Rear Seat PDRM self-initiated while parked on ramp at NAS Lemoore, CA

- Occurred 1 August 2017
- Ambient temperature was ~95°F at the time of incident





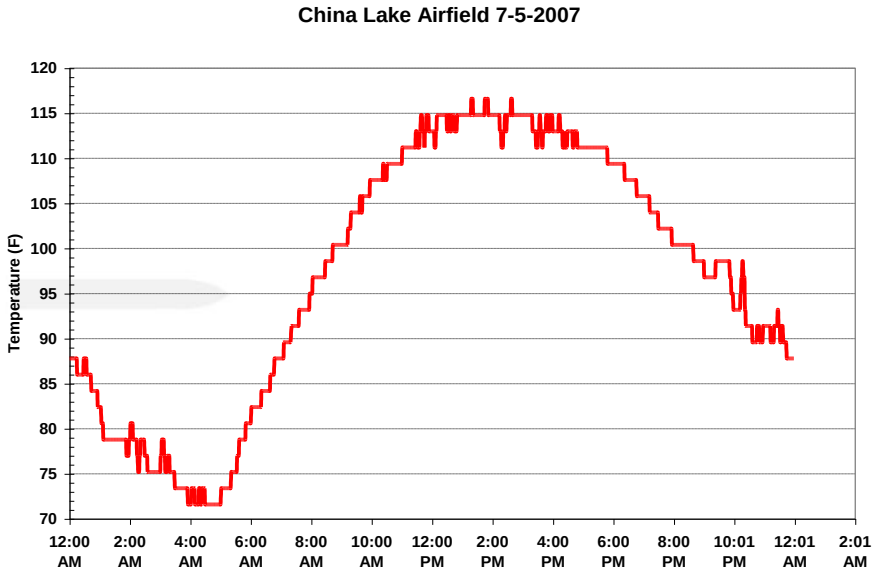
- Climate Data
  - Significant increase in temperature from end of install life till incident occurred

Note: WB15 did not self ignite

Previous Incident

An F/A-18D Rear Seat PDRM self-initiated while parked on ramp at China Lake, CA

- Occurred 5 July 2007, 1630PST
- Aircraft Parked, tied-down with canopy closed, for approx. 4 hours
- Ambient temperature was 112°F at 1630
- Peak Temperature was 116°F earlier that day



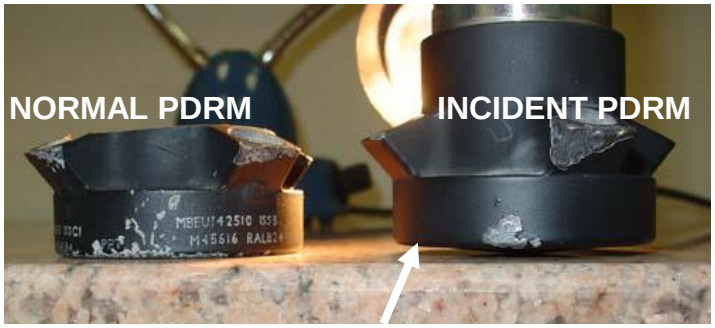
PDRM Physical Evidence
(2007 Incident)

- Aluminum outer body ruptured, section separated
- Steel rocket motor case ruptured from over-pressurization
- Nozzle top cap and upper motor tube section ejected from cockpit
- Residual propellant (green) spattered onto cockpit surfaces

Ruptured PDRM Body on Ejection Seat

Ruptured Motor Case

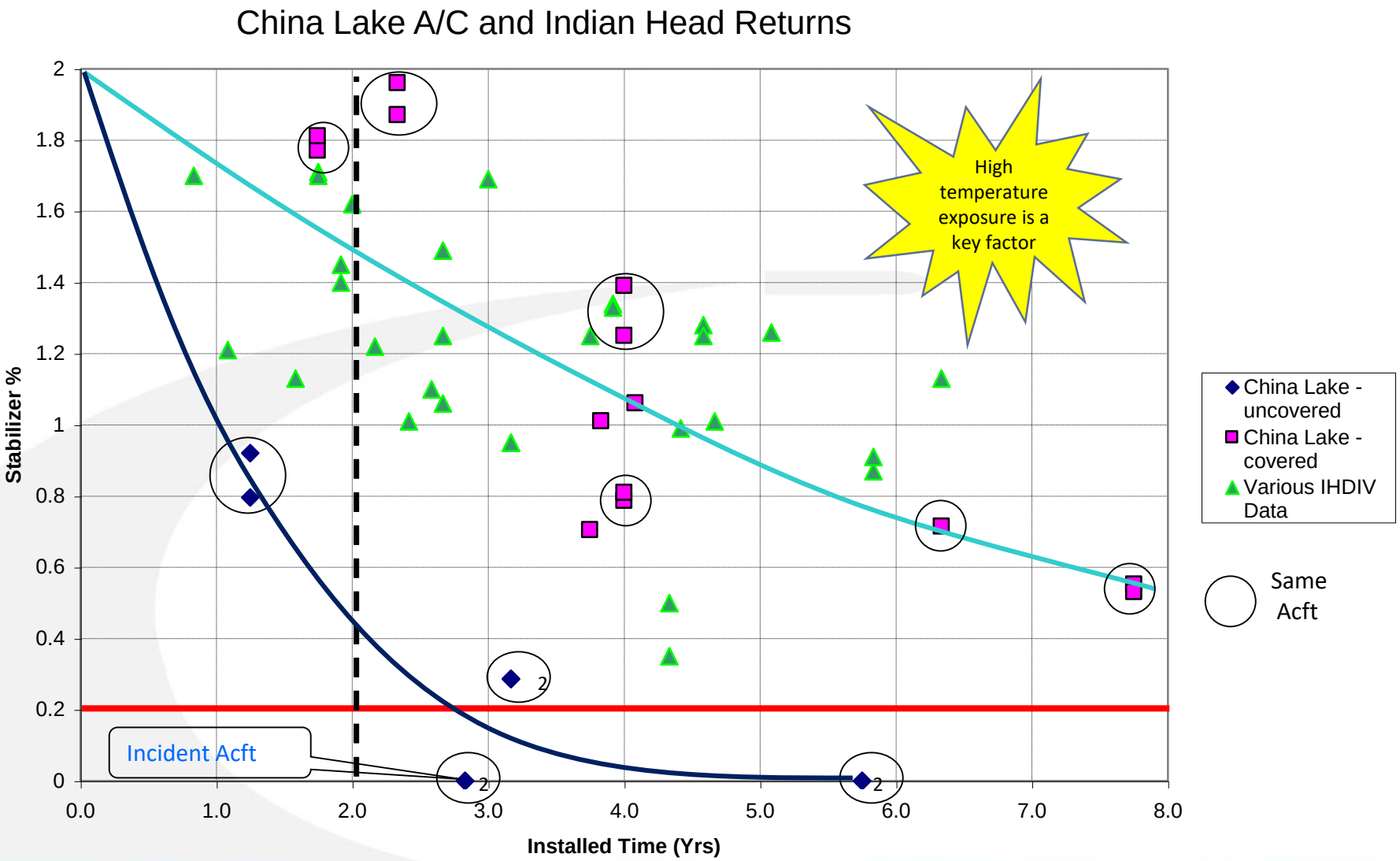
Recovered Propellant Fragment



Nozzle Cap distorted .070 in. “domed”

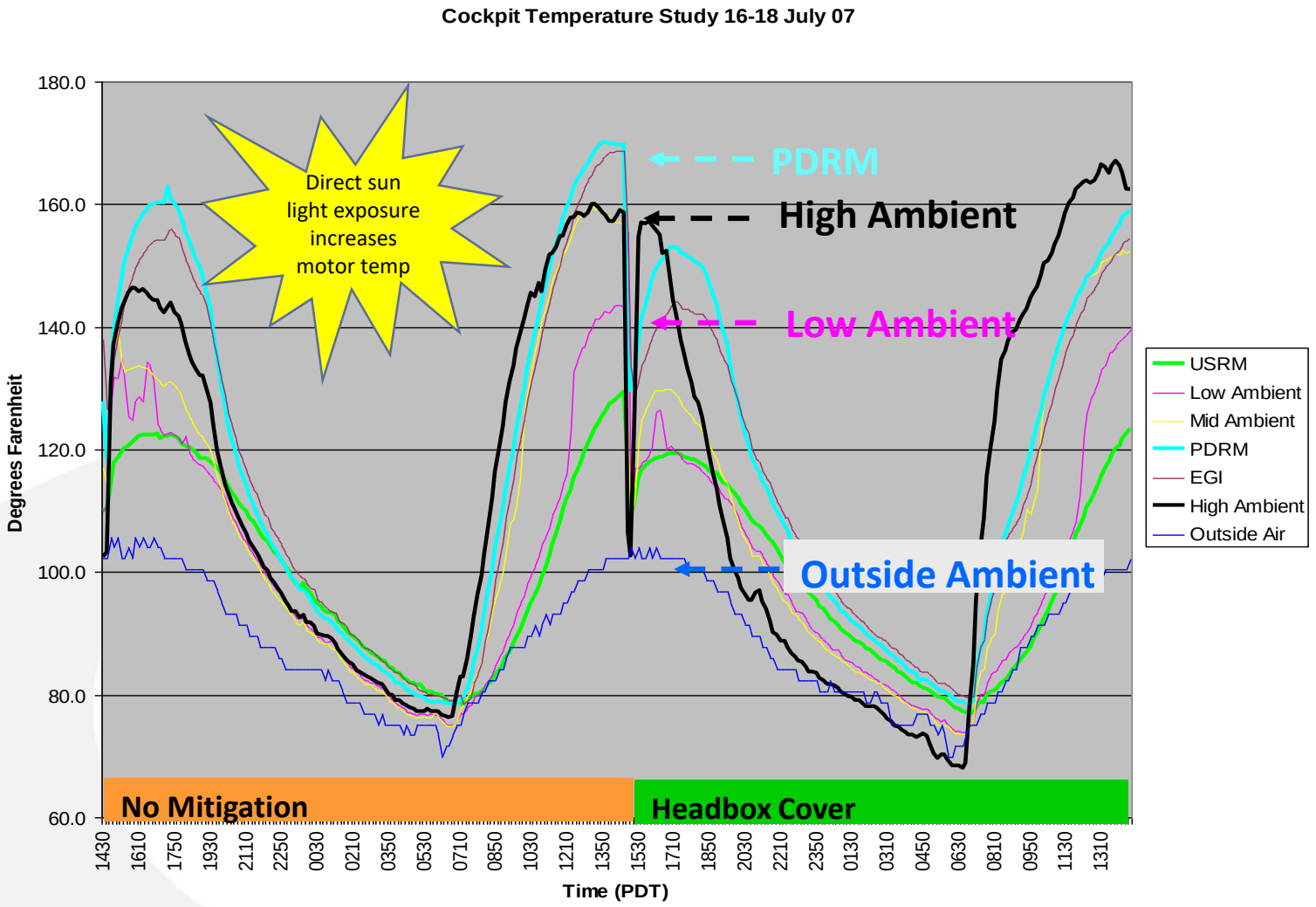
Stabilizer Depletion Test Results

(2007 investigation)



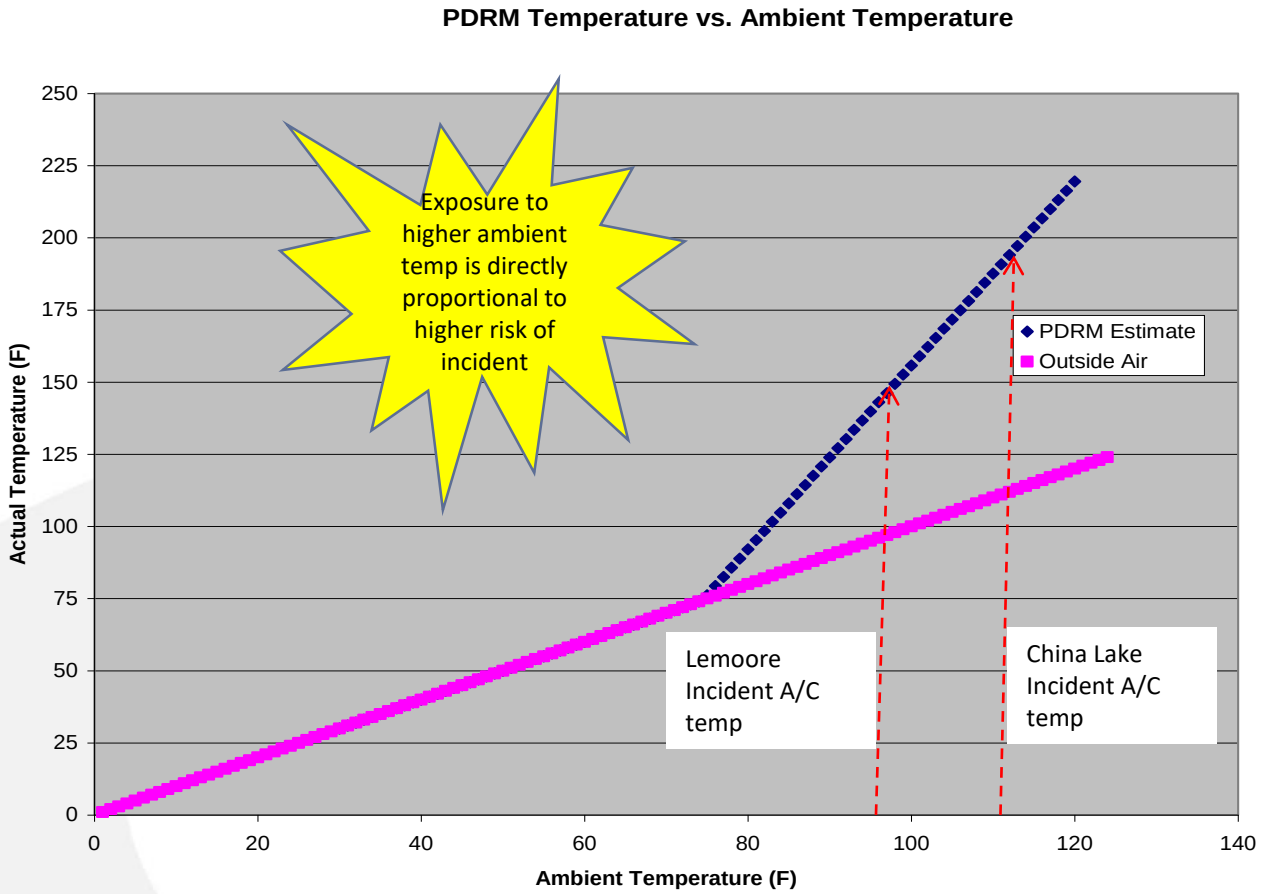
Cockpit Temperature Study

16-18 July 2007



Cockpit Temperature Study

16-18 July 2007 Cont.



PDRM exposure temperature limit is 150°F

Temperature Study – Data Collection

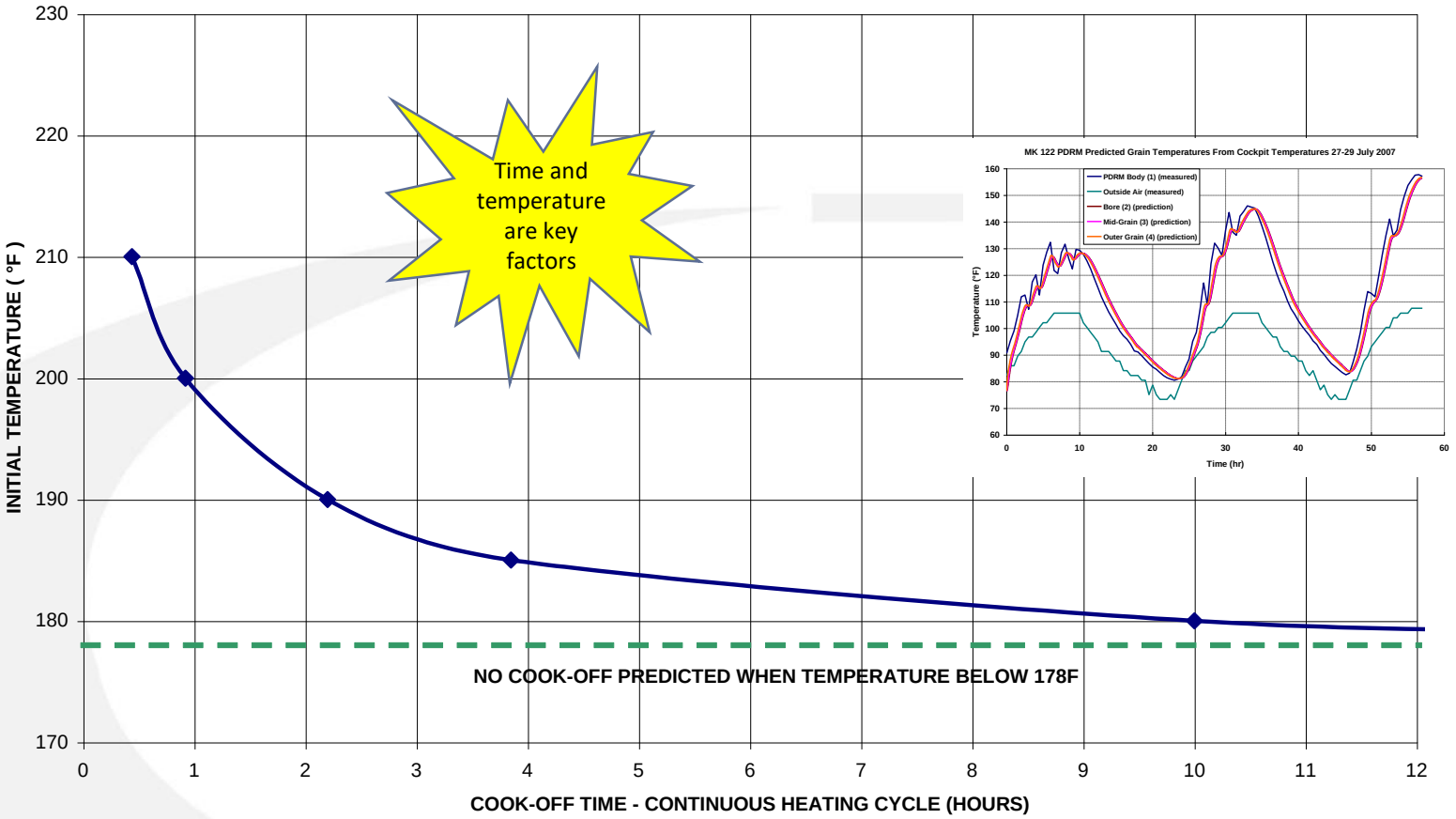
(2007 investigation)

Mitigation Concepts:

- Directing the fleet to keep aircraft indoors or shaded was not practical for F-18 squadrons.
- As a ground rule any temperature mitigation techniques had to use equipment available to the fleet. Minimizing maintenance impact was also a primary consideration.
  - Open Canopy
  - Use existing locally manufactured headbox covers
  - Use commercially available Canopy sun shield.
- T-45 squadrons were able utilize recommended temperature mitigation concepts such as the use of canopies

Modelling Cook-off Prediction

FEM PREDICTED COOK-OFF TIMES FOR PDRM
USING PROPERTIES OF KU PROPELLANT WITH 0.35% STABILIZER REMAINING
(MOST CONSERVATIVE THERMOKINETIC VALUES FROM GLASS CAPILLARY DSC TESTS)



Summary of Study

- Incident was as a result of accumulated high temperature exposure in cockpit (above 165°F)
- Consistent stabilizer data from installations on same aircraft reinforces environment as cause
- Resulting complete stabilizer depletion enabled thermal self-heating to lead to autocatalytic decomposition reaction
- 150°F exposure temperature limit determined by analysis to provide adequate safety margin for interim operations
- PDRM and WB15 are the most affected units due to the location of the assets on the seat relative to direct sunlight exposure
- Other cartridges when OA tested are checked for stabilizer content to determine there hazard level and currently, there is no hazard identified

Required Safety Mitigations

- Technical manual 11-100 requirement for PDRM & WB15
  - Overaged assets shall be removed from parent aircraft within 30 days of expiration of the original service life
  - The ideal storage temperature range for this device is 60 °F to 90 °F
- Fleet disposal requirement for overaged PDRM & WB15
  - Handling these items in a reduced temperature regime (120°F or less)
  - Storing these items in a reduced temperature regime (120°F or less)
  - Transporting these items in a reduced temperature regime (120°F or less)
  - Assets that weren't removed within 30 days of expiration are considered unsafe for storage per Notice Ammunition Reclassification (NAR)
  - NAR requires the affected assets to be protected from exposure to direct sunlight

Required Safety Mitigations Cont.

- As a result of the PDRM auto-ignition incident on F/A-18D at NAS Lemoore on 01 Aug 2017:
  - Risk Criteria Recommendation for Overaged PDRM and WB15 Assets was issued to determine high and medium risk assets for immediate disposal at the request of the Navy Designated Disposal Authority (DDA)
  - Based on assigned risk levels, the assets can be issued condition code Victor (CC/V) in support of an urgent Notification of Ammunition Reclassification (NAR) for each DODIC
  - The high risk units should be disposed in place, utilizing EOD teams to complete the handling and disposal within 60 days of issuing NARs 0118-2018 and 0119-2018
  - The Medium risk units could safely await packaging and transport to US Army Joint Munitions Command (JMC) for disposal

	PDRM	WB15
Total Assets Impacted	168	175
Total High Risk Assets	128	134
Total Medium Risk Assets	40	41
Total Assets Not Accounted For	25	74
Total High Risk Not Accounted For	20	60
Total Medium Risk Not Accounted For	5	14

Preventative Measures

Short Term

- Based on propellant study conducted, both PDRM and WB15 install lives changed
  - F-18 install life was reduced to 2 years
  - T-45 install life was reduced to 4 years
  - Fleet tech manual 11-100 revised to add important safety instruction
    - End user must acknowledge expired PDRM and WB15 when logging into Virtual Fleet Support (VFS) TRACE
    - VFS TRACE notifies the TYCOMs with a monthly report of installed PDRMs and WB15s 30 days past their expiration

Long Term

- Develop and implement digital twin predictive software tool
- Design and qualify a replacement composite propellant

Digital Twin Predictive Tool

- Digital twin
  - Software tool based on a chemical kinetic model to predict the stabilizer concentration based on temperature exposure of the item
    - Develop cockpit temperature prediction model
    - Collect actual aircraft temperature
    - Validate model against collected data
    - Integrate the double base stabilizer kinetic model with the temperature prediction model
    - Install a data logger to measure the cockpit temperature around the PDRM and WB15 location
    - Develop and implement digital twin predictor in commercial software package
    - Provide user training

PDRM MOD 1 Status

- PDRM MOD 1 is fully qualified with composite propellant that is designed to withstand temperatures up to 200^{o}F with no concern for auto ignition
- Type II service lease approved
  - Allows initial production of MOD 1 rocket motors to begin
- Type III service release pending approval
  - Allows the release of MOD 1 production rocket motors to the fleet
- Engineering Change Proposal (ECP) to add PDRM MOD 1 to the current NACES seat technical data package (TDP) has been submitted to the program office and currently pending approval
- Initial production of 350 PDRM MOD 1 rocket motors is currently underway at NSWCIHEODTD with an estimated service release date of FY 20

Conclusion

- Do what you can to minimize temperature exposure
- Adhere to published lives
- Remove/dispose of promptly at end of life
- Make sure you don't have any of the PDRMs/WB15s
- CAD/PAD Program working to provide long-term solutions (Mod 1, Digital Twin, etc…)