Novel Slow Cook-off Test Method to Replicate Worst Case for Munitions Containing Internal Fuel

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Benjamin Blazek*, Jerry Webb

Naval Air Warfare Center Weapons Division

China Lake, CA USA

Impetus For This Work

- Several munitions subjected to SCO which contained flammable liquid fuels ignited into a fuel fire
- These munitions:
  - Contained live energetic components and fuel
  - Exhibited a reaction from something other than the main explosive which dispersed and ignited the internal fuel
  - This reaction sometimes launched energetic components
    - Varied landing location.
- Energetic components which landed or remained in the fuel fire
  - Fuel fire engulfs the already thermally damaged components
  - Reactions of energetics in this fire were more severe than those exhibited during standard FCO environment

Background

- Project Goals:
  - Design test to *consistently replicate* the worst case environment.
  - Design munition to pass worst case reaction environment.

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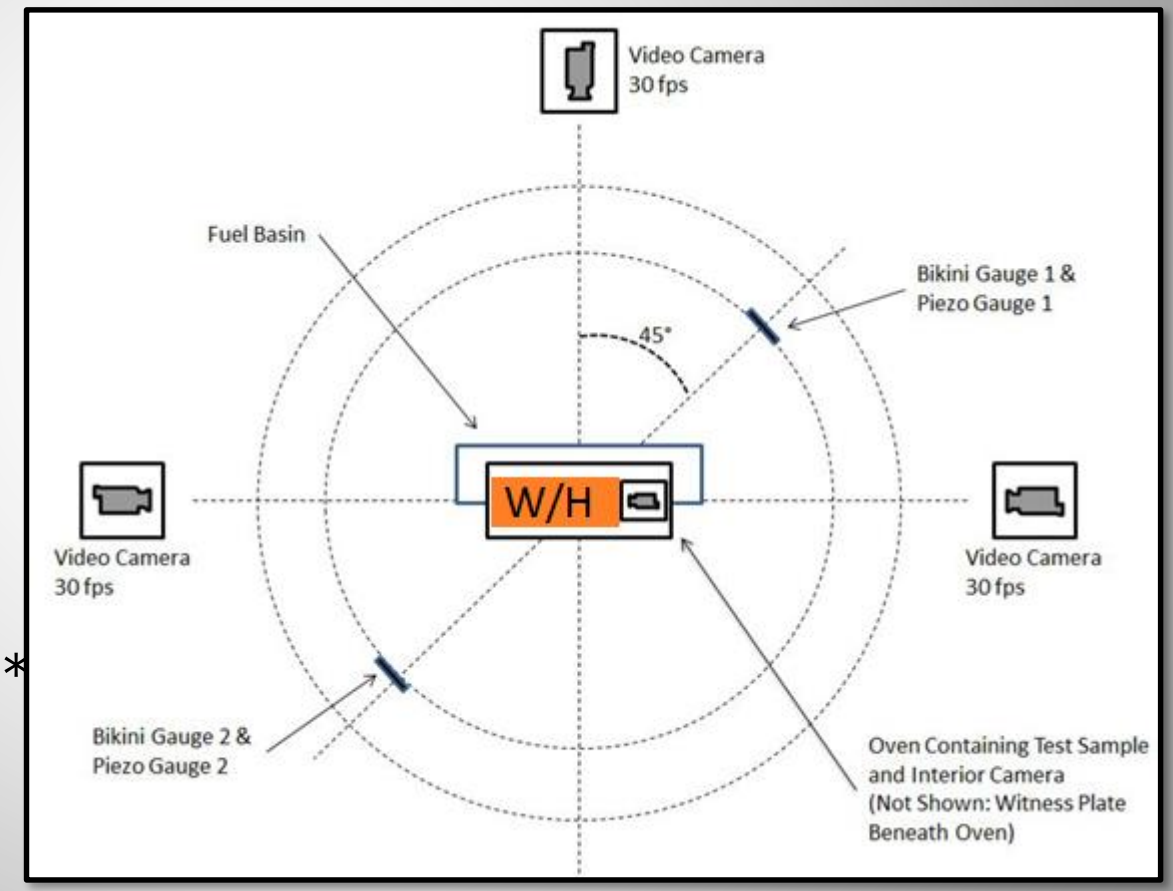
Test Design

- To extent possible, test met MIL-STD-2105D and STANAG 4382
- FCO test elements were used to replicate fuel fire (fuel pan, ignitors)

Design Features

- Fuel used in system
- "Clam-Shell" SCO Oven
- Fuel Pan beneath Oven
- Steel doors close pan
- Oven affixed to door
- Seams sealed for fumes
- Elec. winches open oven*
- Elec. ignitors for fuel*

*Redundant pairs

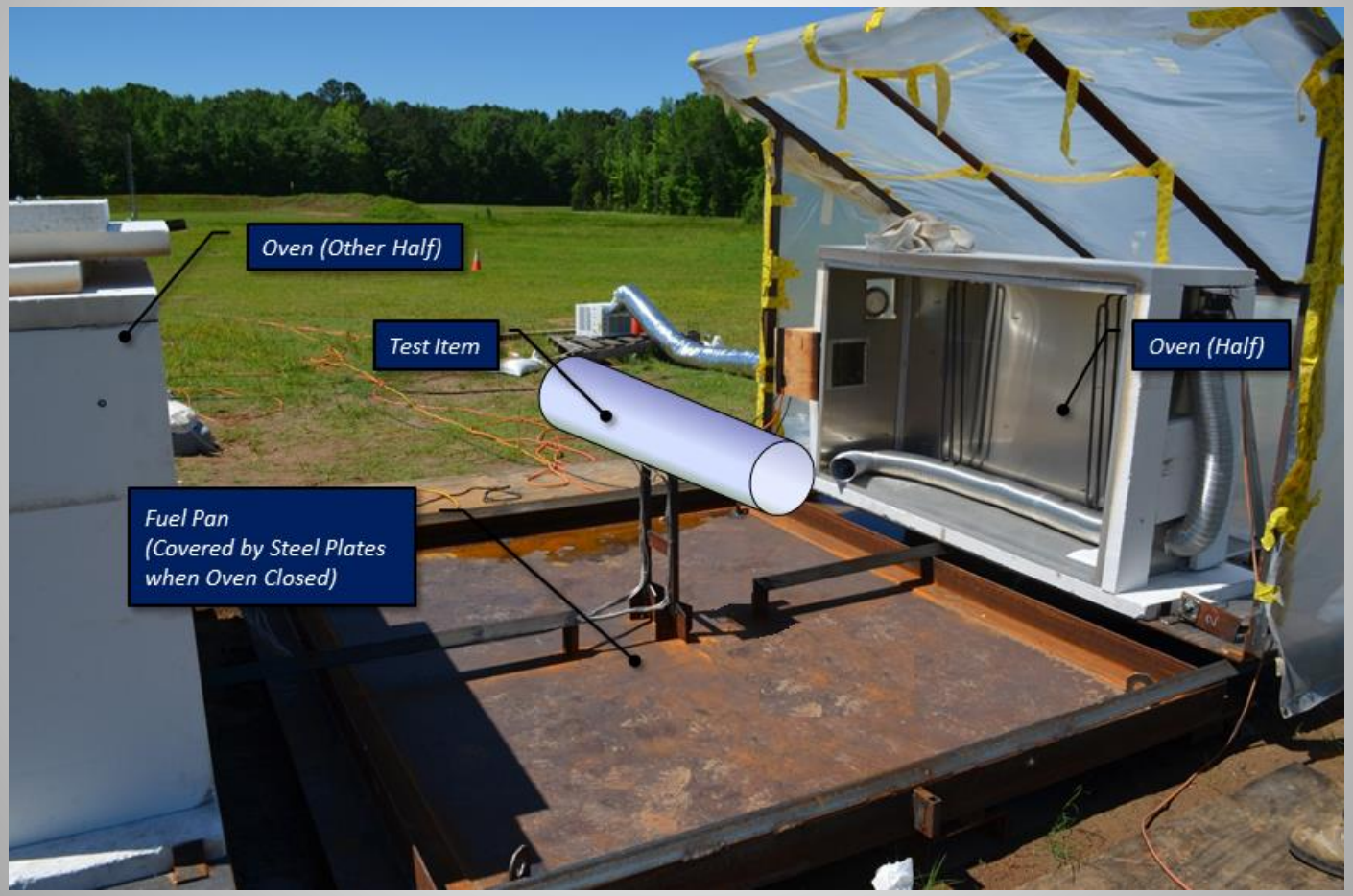


Test Design

- SCO Portion: Oven closed and sealed for SCO portion

Test Design

- Fuel Fire portion: Oven open, fuel pan uncovered, item exposed



Test Design

- Tent and "roof" around oven to protect against wind and rain
- Instrumentation:
  1. Internal cameras
  2. Thermocouples:
     - Air near item
     - Item skin
     - Routed to item stand so in place during entire test
  3. Blast Pressure Gauges

Test Conduction

Test Conduction

Test Conduction

Test Conduction

Test Conduction

Test Conduction

Test Results

Successes:

- SCO and Fuel Fire features functioned successfully
- Fuel fire similar as system test
- Instrumentation recorded successfully
- Seals prevented ignition issues
- New mechanism functioned as designed

Issues:

- Fuel fire ignition took longer than desired
- Wind did influence fuel fire

Potential improvements:

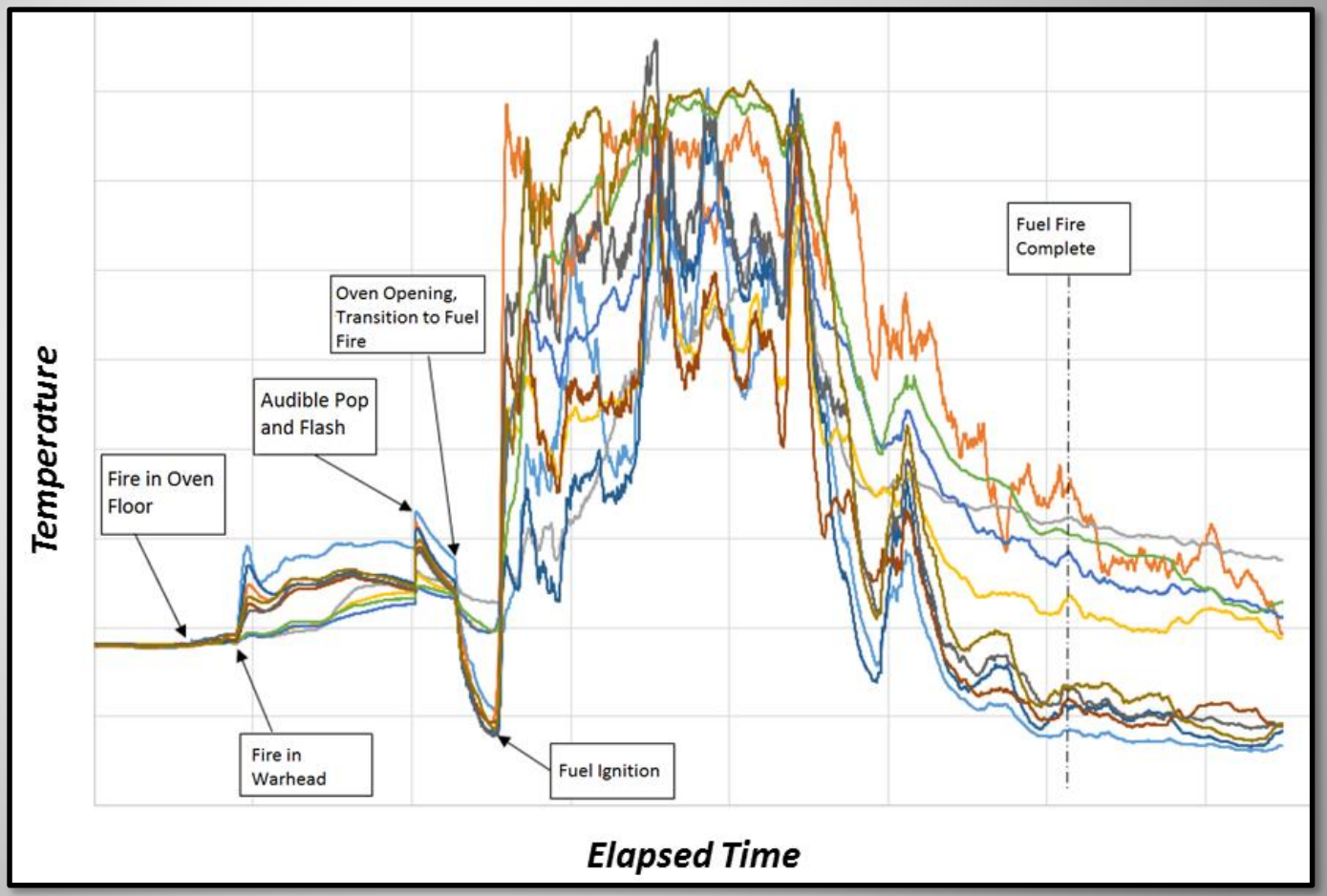
- Send ignition command same time as oven opening
- Improve wind barriers on sides not obstructed by oven halves

Test Results

- Thermocouple data captured entire event

Fuel fire ignited 83 seconds later than system response

Low consequence but room for improvement



Summary

- Designed a novel test which replicated the worst case SCO environment of a system with internal fuel
- Novel test successfully replicated a SCO with subsequent fuel fire
  - Reliability provided through redundant systems
  - FCO features increased repeatability of environment
  - Reduced cost and tests
  - Similar environment

- Test successfully assessed design solutions
- Have identified improvements, particularly for the fuel fire transition
- Item configuration and some test setup should be tailored to system of interest

Acknowledgements

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