STANAG 4382
Slow Heating Survey and Historical Review

Insensitive Munitions and Energetic Materials Technology Symposium
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• Background
• Process / Questionnaire
• Analysis
• Test Setup Photos
• Historical Events Review
• In 2015, MSIAC initiated a survey of STANAG 4240 (Fast Cook-off Test) that led to a list of recommendations to update the document.

• NATO AC/326 SG/B has tasked MSIAC to initiate the same type of survey for STANAG 4382 (Slow Heating Test).

• MSIAC was subsequently tasked to review actual events heating rates and durations.

Stated aim of the test

Determine the reaction of munitions to the slow application of heat which is in contrast to that occurring during fast cookoff tests. Although not necessarily intended as such, this slow heating may result from indirect exposure to fire.
Procedure

- MSIAC has written a survey related to the Slow Cook-off Test
- The survey was reviewed by the custodian of STANAG 4382 (USA)
- The survey was sent to the nations
- After reception & analysis of the answers and other related documents, MSIAC is summarizing the results in a report.
Origin of the answers

- 34 responses from 11 nations.
- 62/38 government / private

**Answers by nations**

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<th>Country</th>
<th>Organisation</th>
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**THANK YOU**

for the number and the quality of your answers
To provide an extreme heating rate different from the FCO.

To characterize the munition being tested.

To simulate a real life accident scenario.
Do you conduct your SCO tests as required by the STANAG 4382 primary test procedure?

- Yes, 31
- No, 3

Germany: WTD91-320
France: AFNOR NF T70-515

Do you have a nationally approved test procedure to carry out the slow heating test?

- Yes, 2
- No, 1

NAWCWD: code 47300D
NSWC Crane: CR-JXRN-RD-P-1196E
Heating Rate

Should the slow heating rate be changed?
- Yes, 17
- No, 12
- Unknown, 3
- Depends, 2

Should item size be a consideration in defining a slow heating rate?
- Yes, 10
- No, 21
- Unknown, 2
- Depends, 1
Do you have equipment to force the airflow?

- Yes, 17
- No, 2

Do you provide protection for any energetic material exuded out of the item being tested?

- Yes, 10
- No, 15
- Unknown, 1
Should we standardize the oven design?

- Different munition types require different considerations.
- Differing sizes of munitions required different sized ovens.
- Some items need to be restrained to prevent flight in case of a strong propulsive reaction.

At least recommendations and guide to a well designed oven to avoid blast wave absorption, fragment location into the oven and secondary fragments.
Many different designs!
Do you precondition at 50°C for 8 hours?
- Yes: 28
- No: 4

Should a melt cast energetic be pre-soaked differently from a non-melt cast material?
- Yes: 7
- No: 15
- Unknown: 7
- Depends: 1

Should the requirement to precondition be changed in any way?
- Yes: 11
- No: 9
- Unknown: 4
- Depends: 4
Should we recognize the benefit of having a higher reaction temperature?

- Yes: 7
- No: 17
- Unknown: 2
- Depends: 3

Should a maximum temperature be defined as defined by Hazard Classification Tests?

- Yes: 9
- No: 18
- Unknown: 2
Melting and Propulsion

Should the melting of energetics during a test affect the testing requirement?
- Yes, 4
- No, 23
- Unknown, 3
- Depends, 1

Do you restrain the test item in case of risk of propulsion?
- Yes, 12
- No, 14
- Depends, 4
Do you have any information on duration or rates of actual slow heating incidents?
During the AC/326 SG/B SH CWG meeting, 10-11 April 2017, MSIAC was asked to obtain and share any available historical information from the MSIAC safety database regarding real-life slow heating events and potential thermal threats.


A search of MAD-X provided no applicable information.

A report search resulted in a large number of references.

K. Hunt from OSD provided further references.

Dr. David Hubble from NSWCDD, USA did a similar study, along with supporting fire modeling. He had very similar results and conclusions.
Historical Duration Data

Real world durations have relatively short durations - 5 events identified to be longer than 1 day

UK Navy statistics related to ship fire duration (1989)

US truck transport statistics related to fire duration (1969)

US rail transport statistics related to fire duration (1969)


there exist a wide variety of heating rates
these rates depend on many factors
  • direct exposure: fire size
  • indirect exposure: adjacent compartment size
Order of magnitude of the maximum temperature and the heating rate

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<td>Regime</td>
<td>Fast Cookoff (FCO)</td>
<td>Intermediate Cookoff (ICO)</td>
<td>Slow Cookoff (SCO)</td>
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<td>Temperatures (Order of magnitude)</td>
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<td>100 to 300 °C</td>
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<td>Heating rates (Order of magnitude)</td>
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<td>1 to 20 °C/sec</td>
<td>25°C/hr to 50 °C/min</td>
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NATO AC/326 SG/B Slow Heating Custodial Working Group is using this information as part of the process to update STANAG 4382
Backup Information

- Backup
References

“2.75-Inch rocket system slow cookoff heating rate”, H. Gokee, NAVY IM/Shipboard fire protection workshop (1995)
“Preliminary analysis of the heating of ordnance in ship magazines due to a fire in an adjacent compartment”, J. Mansfield, NAWCWPNS TP 8186 (1996)
“Standoff distance effect on cookoff of ordnance stowed in MDCS ship cargo holds”, O. Heimdahl, L. Bowman, Twenty-ninth DoD Explosives Safety Seminar (2000)
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“CFAST, the consolidated model of fire growth and smoke transport”, Richard D. Peacock, Glenn P. Forney, Paul A. Reneke, Rebecca M. Portier, Walter W. Jones, National Institute of Standards and Technology Technical note 1299
“Modeling of Buildings, houses... fires”, http://UoC-Fire Engineering.htm
“Recent Explosive Events in Ammunition Storage Areas,” a report of 137 incidents released in June 2007 by the South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (http://www.seesac.org).

Acknowledgment: Thanks to Kathryn Hunt, US OSD for further information and references on fire events.