The Influence of Thermal Expansion on Package Tightness during Fire

Frank Koch[1] Claus Bletzer Jens Sterthaus

BAM Bundesanstalt für Materialforschung und -prüfung, Germany
[1]since 2009 ENSI Eidgenössisches Nuklearsicherheitsinspektorat, Switzerland

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Outline

- Introduction
- Parameters
- Evaluation of leak tightness
- Conclusions

Accident conditions of transport

Test conditions

- Drop test: 9 m drop on unyielding target
- Puncture test: 1 m drop on steel bar
- Fire test: 30 minutes at 800°C

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- Leak Tightness
- Shielding
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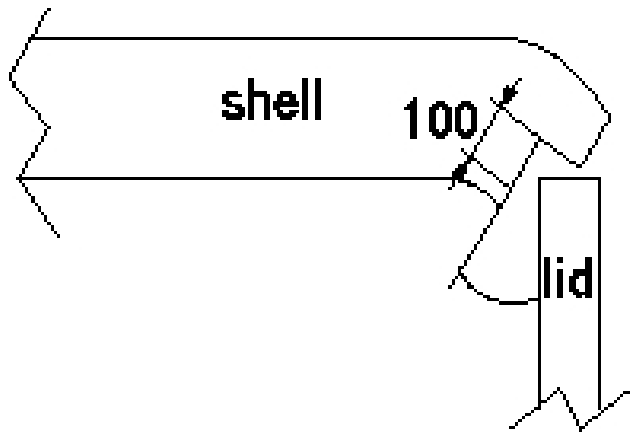
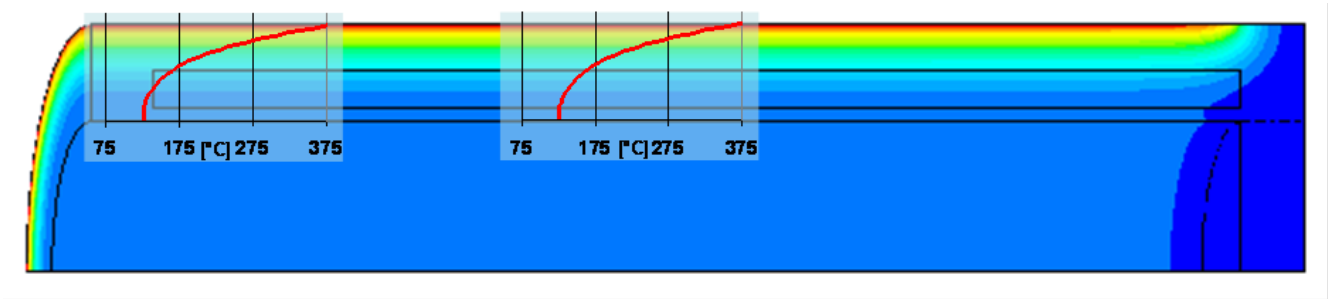


Fire test effects

Temperature gradients



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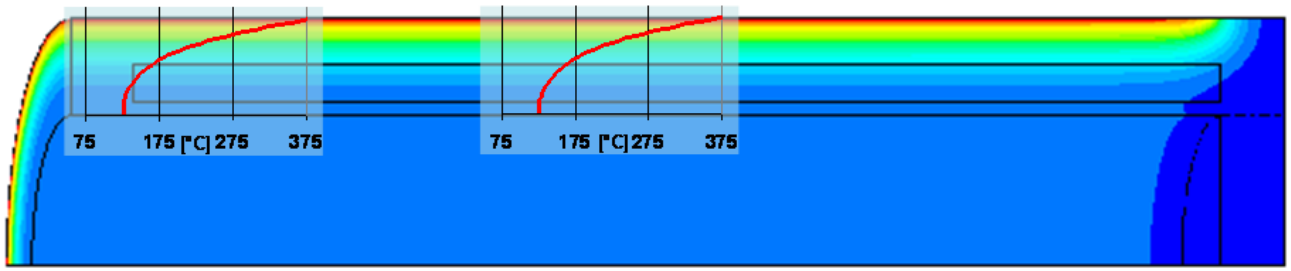
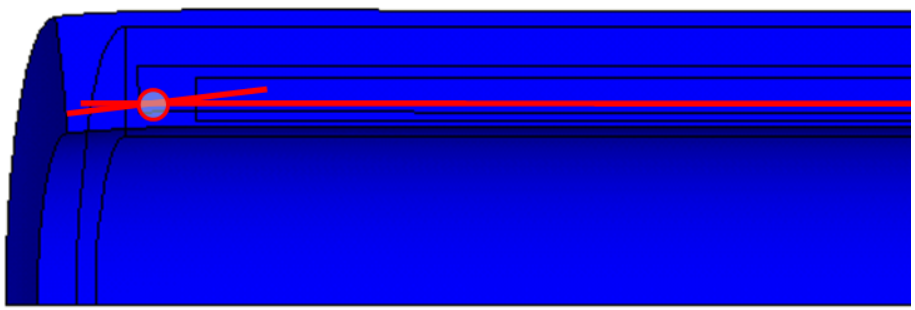


Deformations induced by thermal expansion



Parameters

Studied:

- Temperature and wall thickness
- Shell material
- Drop test result: shock absorber

Temperature gradient and wall thickness

Temperature gradient

Gradient K	*Thickness* mm	*Stress outside* MPa	*Stress inside* MPa
100	200	-175	205
200	200	-351	411
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Wall thickness

Gradient K	*Thickness* mm	*Stress outside* MPa	*Stress inside* MPa
300	100	-547	595
300	200	-526	616
300	300	-508	635

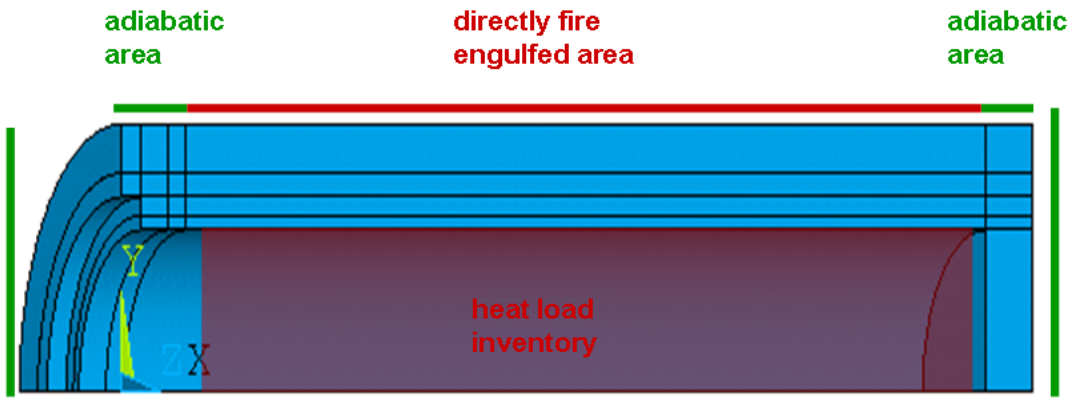
Shell material

Cast iron and steel

Gradient K	*Thickness* mm	*Stress outside* MPa	*Stress inside* MPa	*Material*
200	400	-209	282	cast iron
200	400	-324	437	steel

Drop test: shock absorber

End shock absorber present



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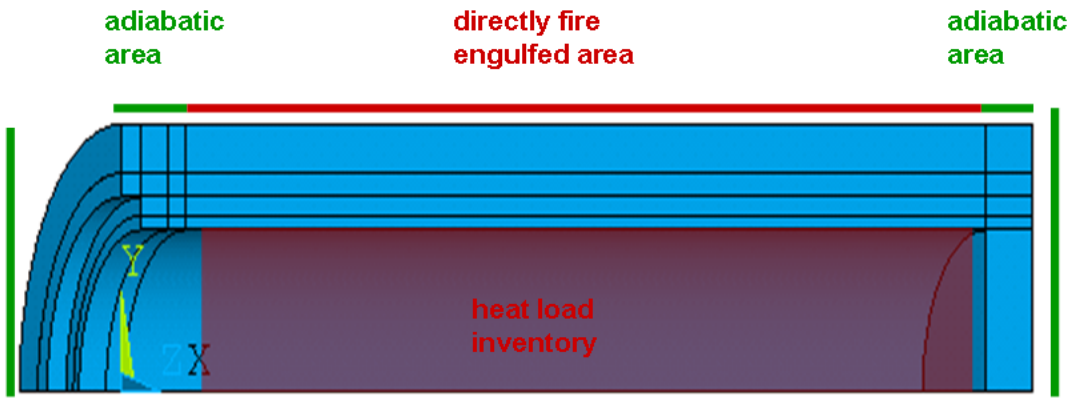
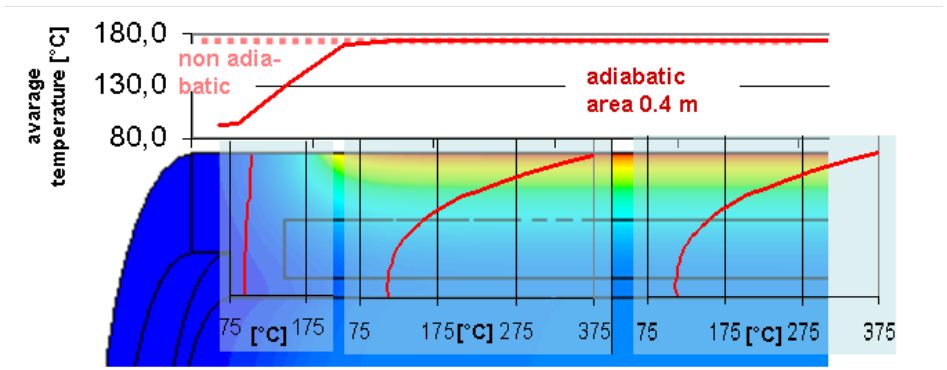
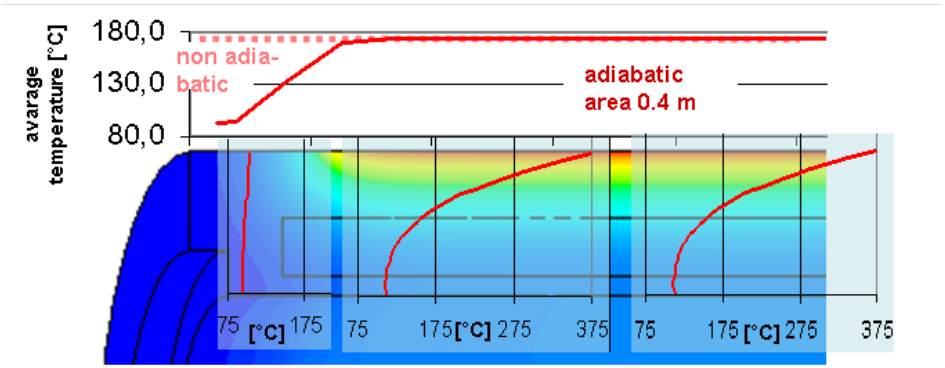


Effect



Drop test: shock absorber

Main parameter: length of adiabatic area



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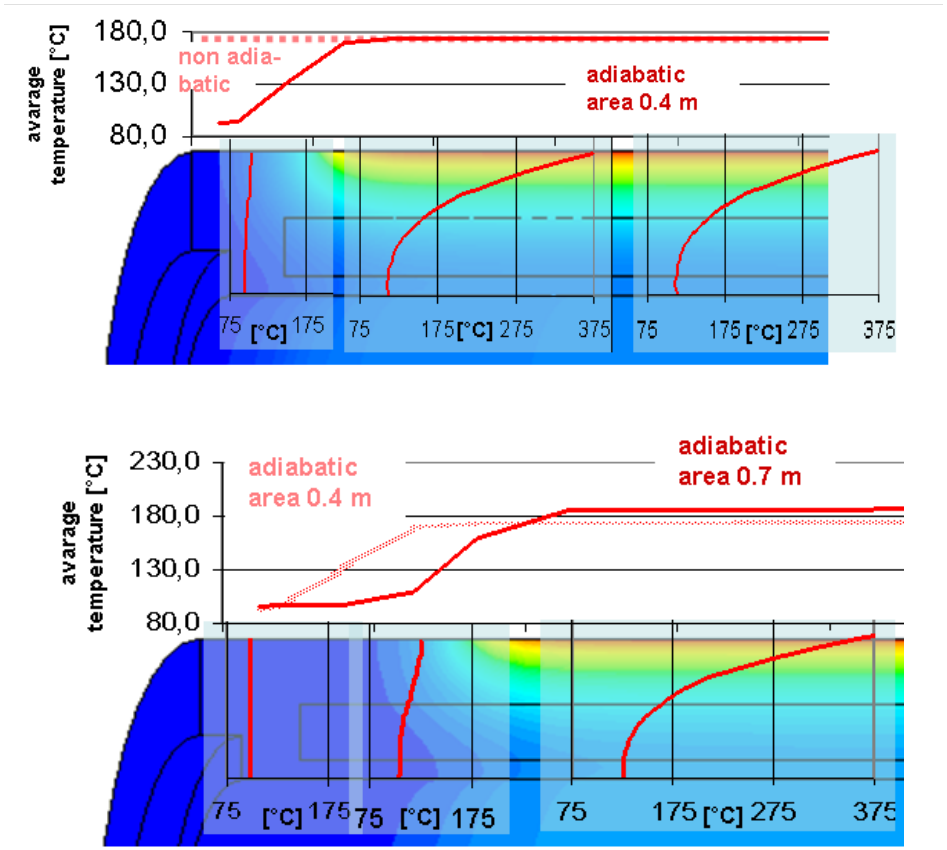

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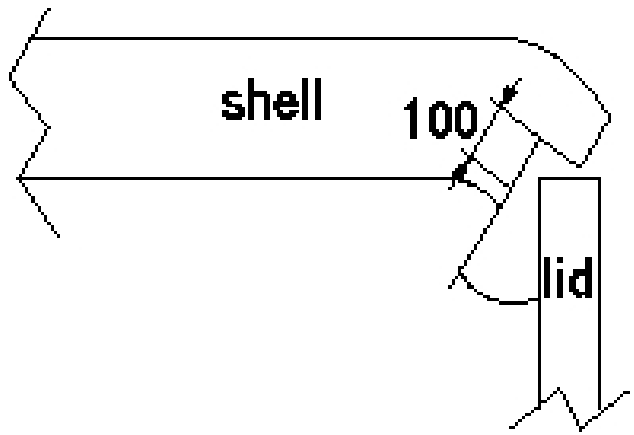

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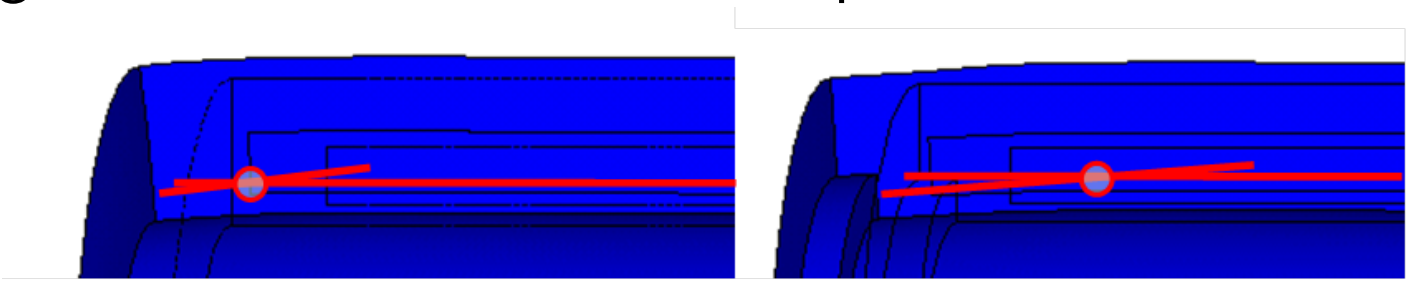
Length of adiabatic area: rotation point



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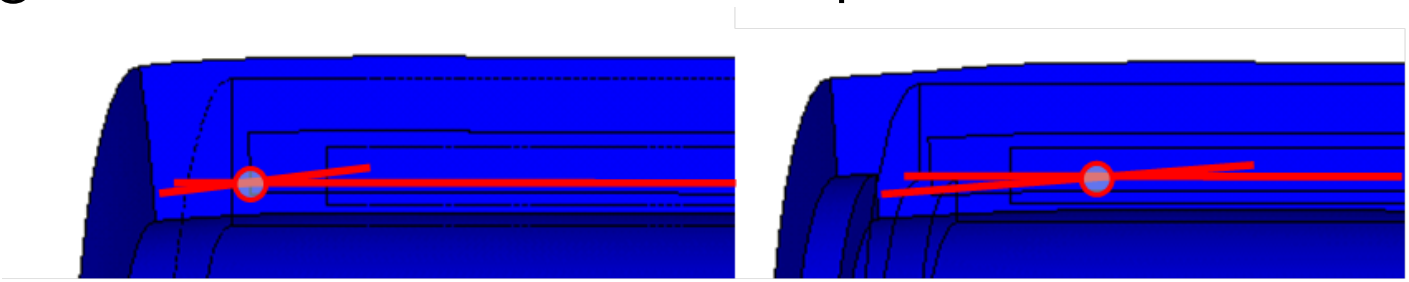
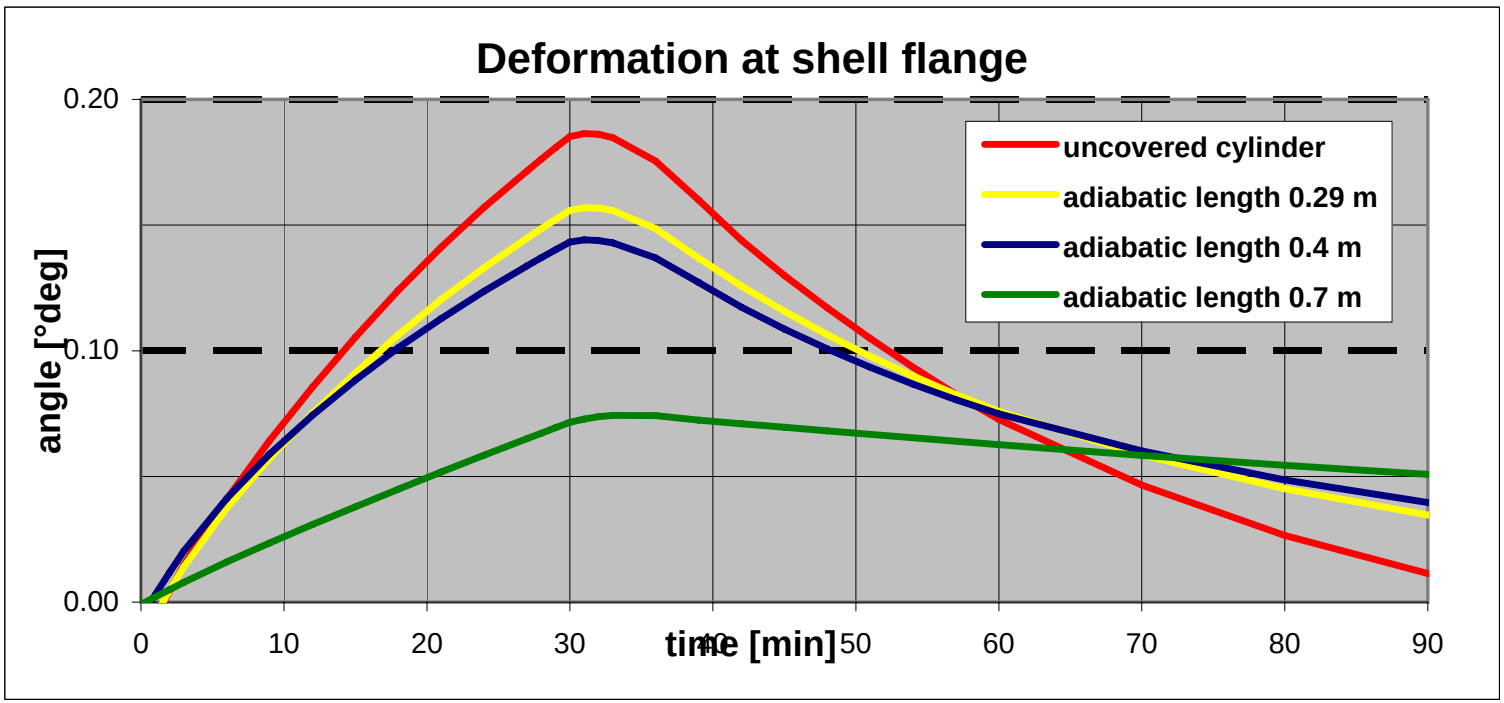


Angles and gaps

Case	*Angle*	*Gap at seal position*
Non-adiabatic area	0.186°	0.325 mm
Adiabatic area of 0.4 m	0.143°	0.250 mm
Adiabatic area of 0.7 m	0.073°	0.127 mm

Evaluation of leak tightness

Time influence



Conclusions

Investigated issues

- Thermal expansion during fire test (ACT) is studied
- Identified parameters:
  - Temperature gradient
  - Wall thickness
  - Shell material
  - Shock absorber presence after drop test
  - Shock absorber design

Conclusions

Consequences

- Shell/lid deformations (angle)
- Increased shell/lid gap at seal area
- Potential release of radioactive material
- Situation lasts minutes in opposite to short-time drop event
- . . . results in a significant safety issue