SALZGITTER MANNESMANN FORSCHUNG

Ein Unternehmen der Salzgitter Gruppe

JOINTEC

SZMF Experimental Testing

Hilgert, Zimmermann

Test Programm SZMF

SALZGITTER MANNESMANN FORSCHUNG
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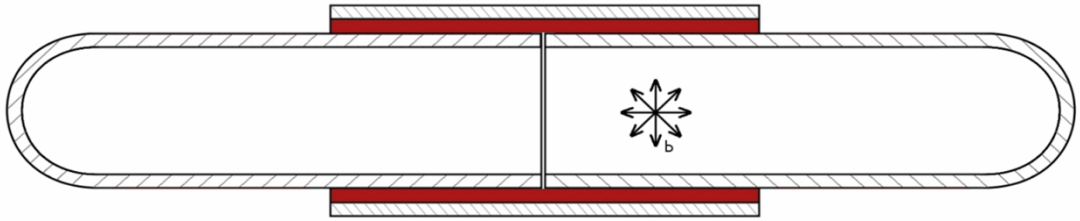
	No.	Pipe material D_a [mm]	t [mm]	Material	Testing Procedure [-]	sleeve length [mm]	Amount [-]	
Small-scale	A	168	7	S355	Internal static pressure	550	6	✓
	B				Internal cyclic pressure		1	✓
	C				Tensile Test		3	✓
Full-scale tests	D	508	9	X60	Internal static pressure	700	2	✓
	E				Internal cyclic pressure		2	running



Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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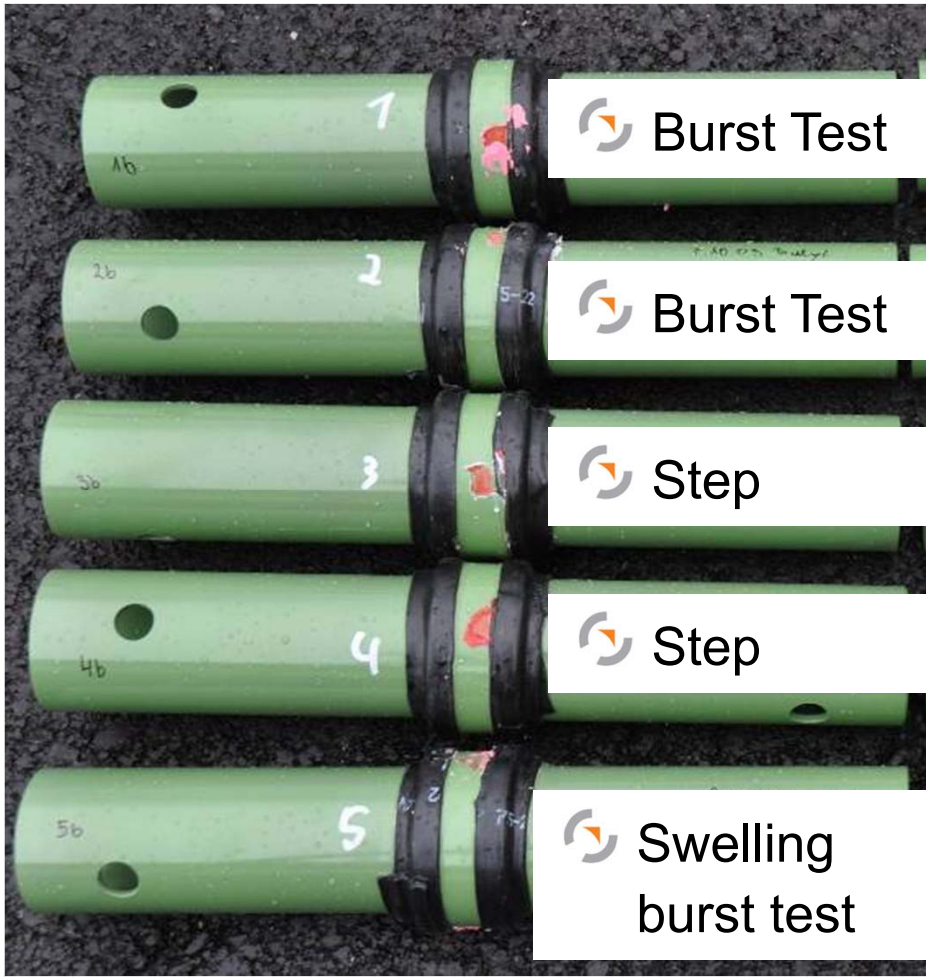
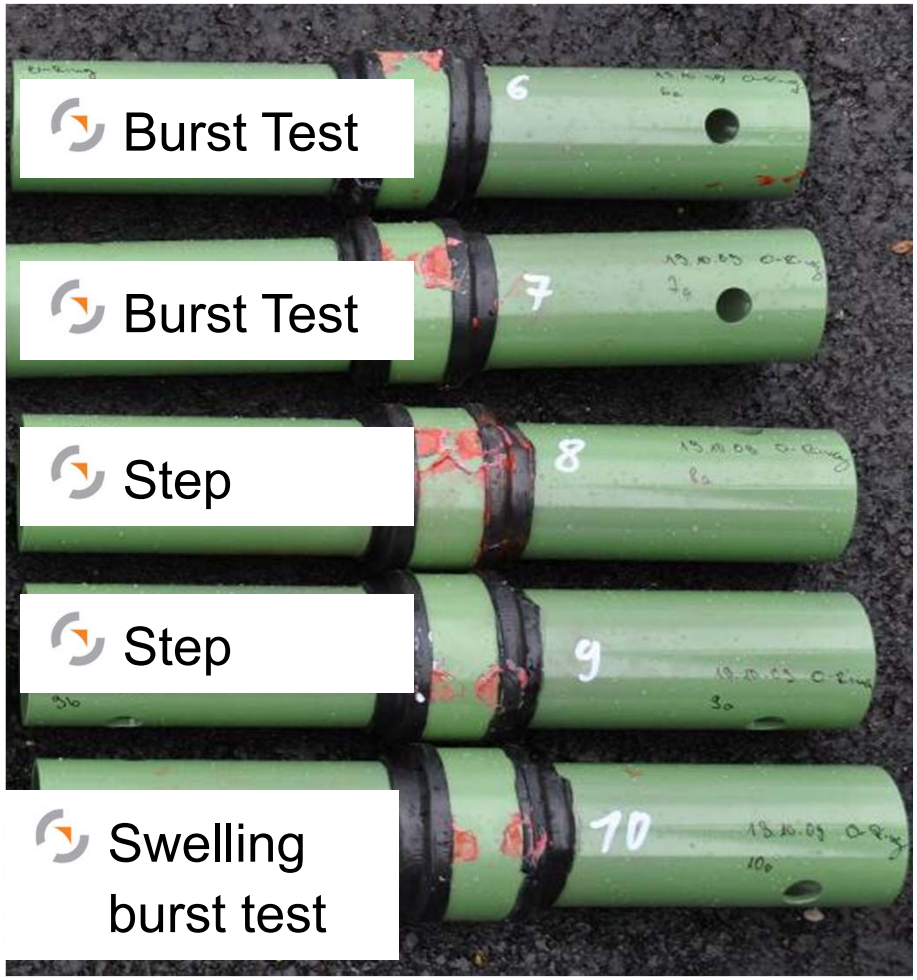
Butyl Ø50mm x 3mm O-ring





Internal Hydrostatic Pressure Tests

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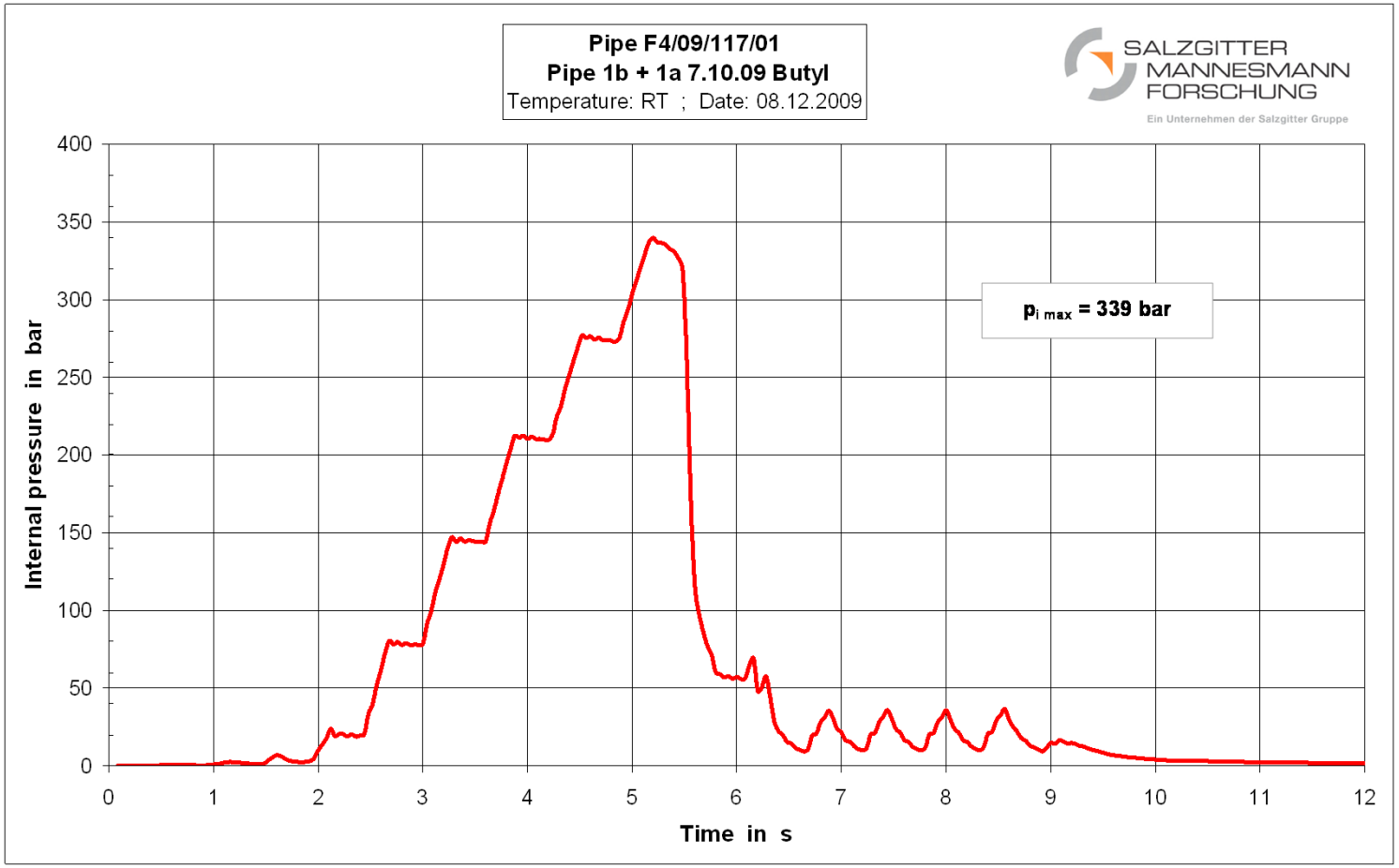
Butyl Sealing, max. internal pressure



Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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Butyl Sealing, max. internal pressure

p_{max}=340 bar

p_{max}=338 bar

Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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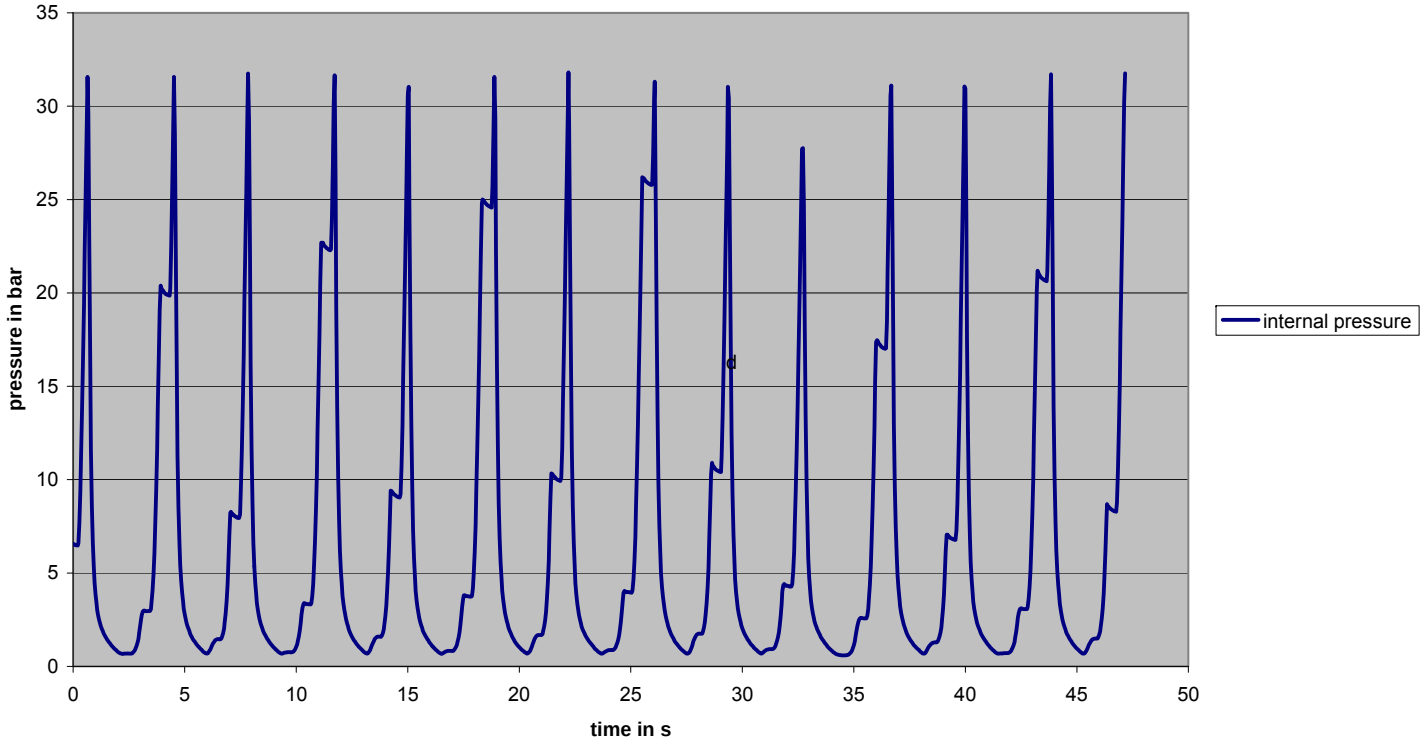
Butyl Sealing

- swelling 1000 cycles @ 32 bar, 10,000 cycles @ 160 bar
- max. internal pressure



Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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- Butyl Sealing
  - swelling 1000 cycles @ 32 bar, 10,000 cycles @ 160 bar
  - max. internal pressure

p_{max}=219 bar

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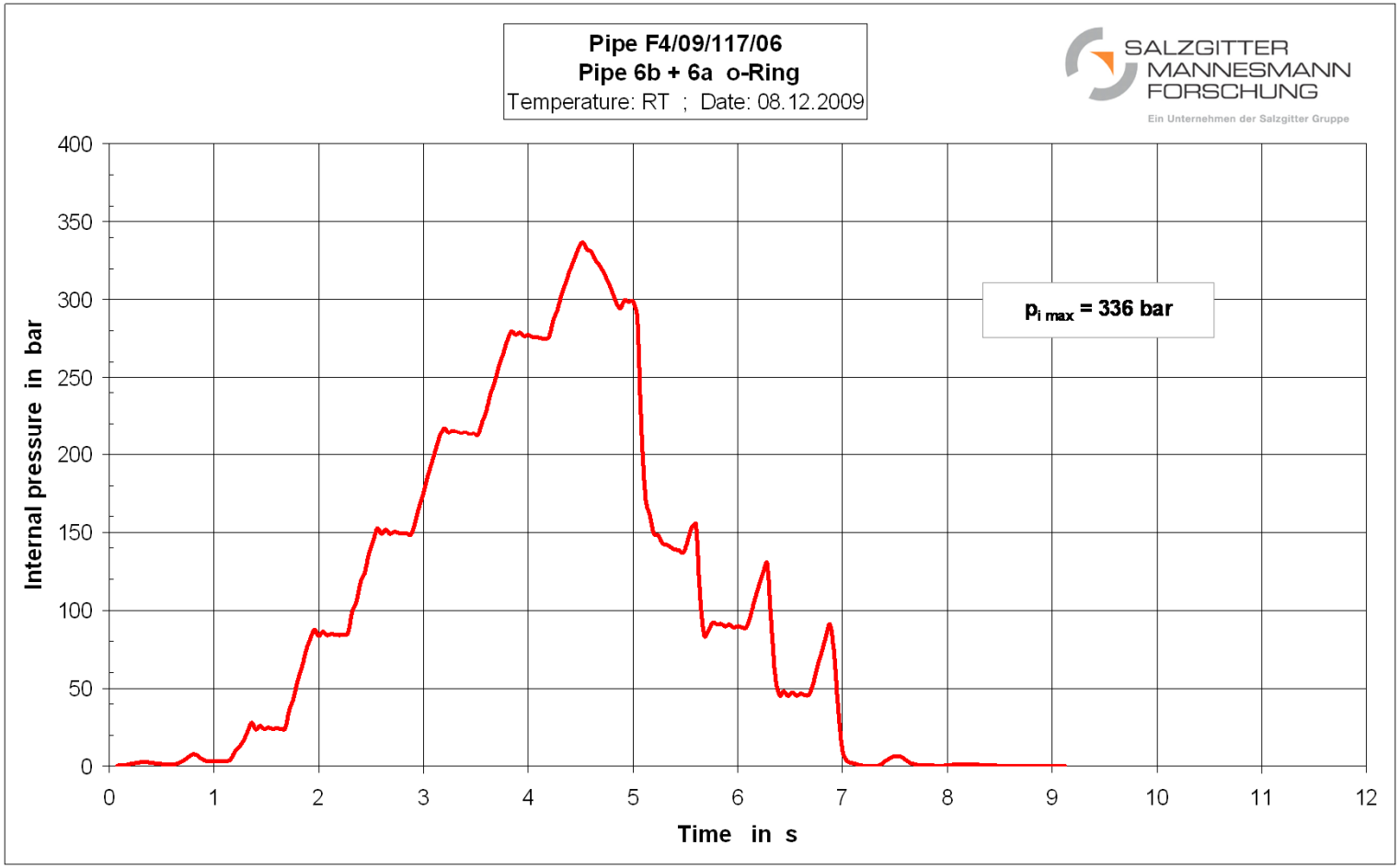

Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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O-ring sealing, max. internal pressure

p_{max}=337 bar

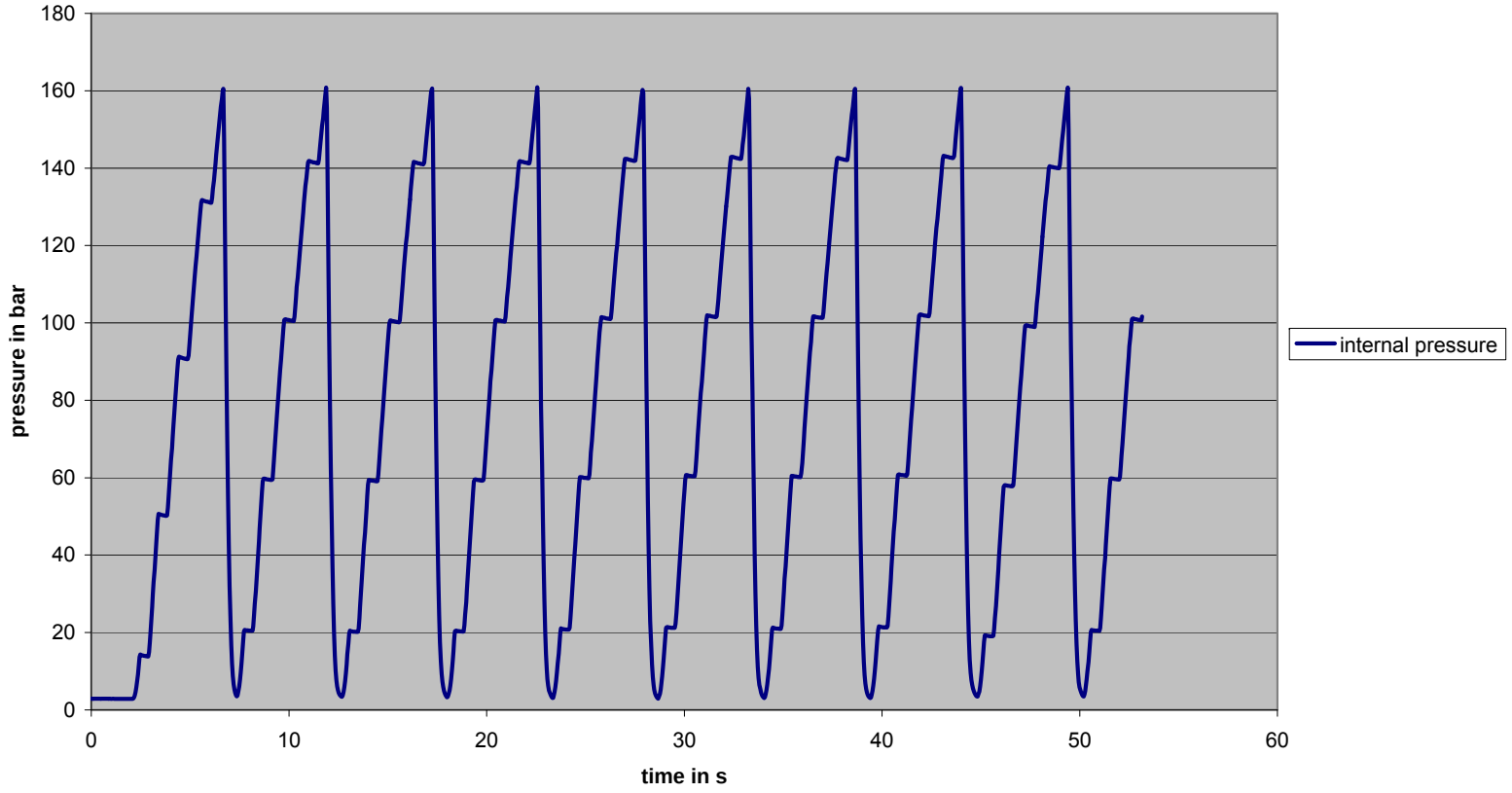
p_{max}=237 bar

Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
Ein Unternehmen der Salzgitter Gruppe

O-ring sealing

- swelling 1000 cycles @ 32 bar, 10,000 cycles @ 160 bar
- max. internal pressure



Internal Hydrostatic Pressure Tests

SALZGITTER MANNESMANN FORSCHUNG
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- O-ring sealing
  - swelling 1000 cycles @ 32 bar, 10,000 cycles @ 160 bar
  - max. internal pressure

p_{max}=318bar

Internal Hydrostatic Pressure Tests

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- Butyl and O-ring sealing
  - step control
  - start pressure: 100 bar, holding time 24h
  - every 24h pressure increase by + 50 bar

p_{max} = 250 bar

4 steps to failure

96h resistance

Internal Hydrostatic Pressure Tests

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Butyl

No.	experiment	pressure
1	max. pressure	339 bar
2	max. pressure	338 bar
3	step control	250 bar
4		
5	swelling + max. pressure	219 bar

O-ring

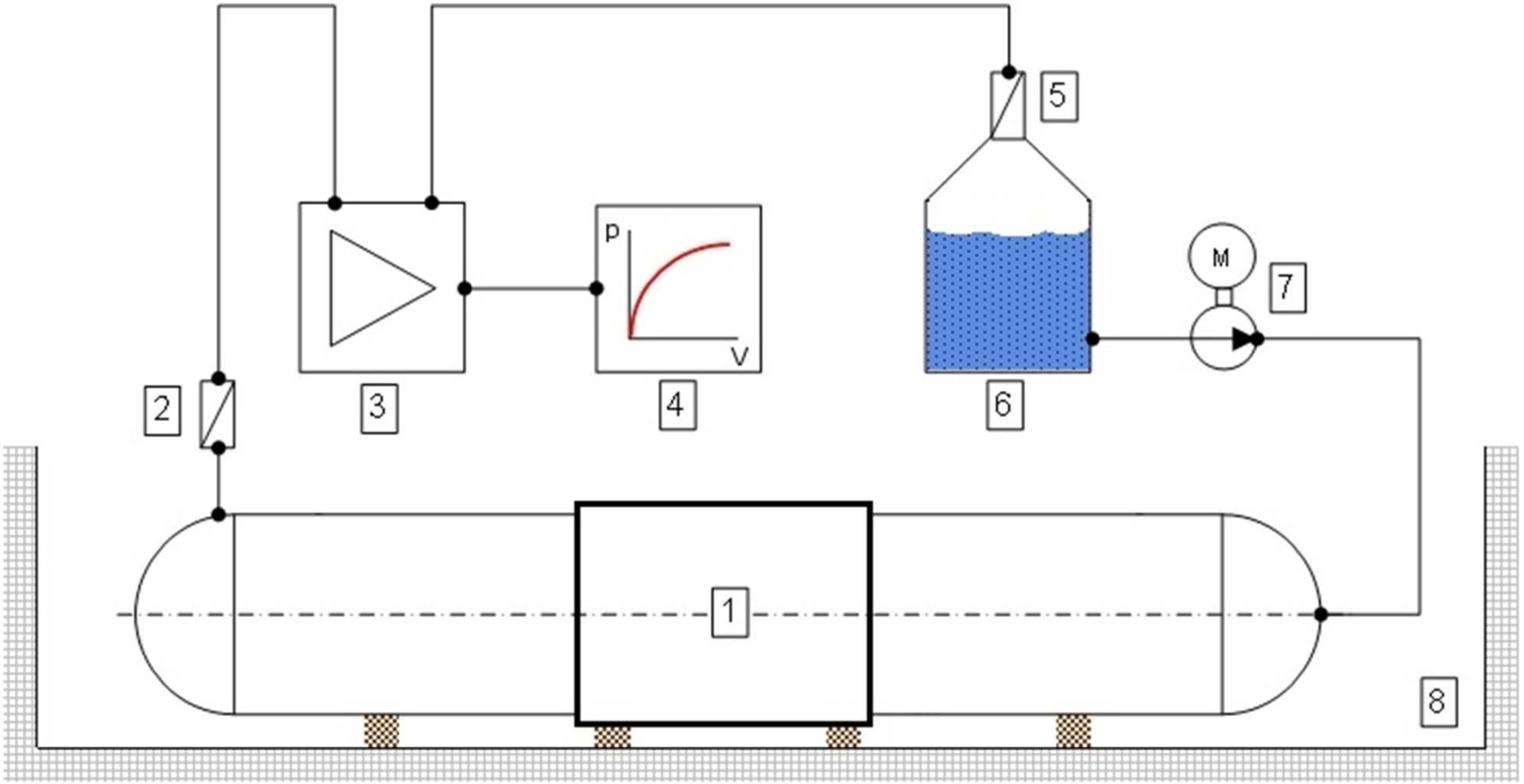
No.	experiment	pressure
6	max. pressure	336 bar
7	max. pressure	237 bar
8	step control	250 bar
9		
10	swelling + max. pressure	318 bar

Internal Hydrostatic Pressure Tests: Full-scale

	No.	Pipe material D_a [mm]	t [mm]	Material	Testing Procedure [-]	sleeve length [mm]	Amount [-]
Small-scale	A	168	7	S355	Internal static pressure	550	6
	B				Internal cyclic pressure		1
	C				Tensile Test		3
Full-scale tests	D	508	9	X60	Internal static pressure	700	2
	E				Internal cyclic pressure		2

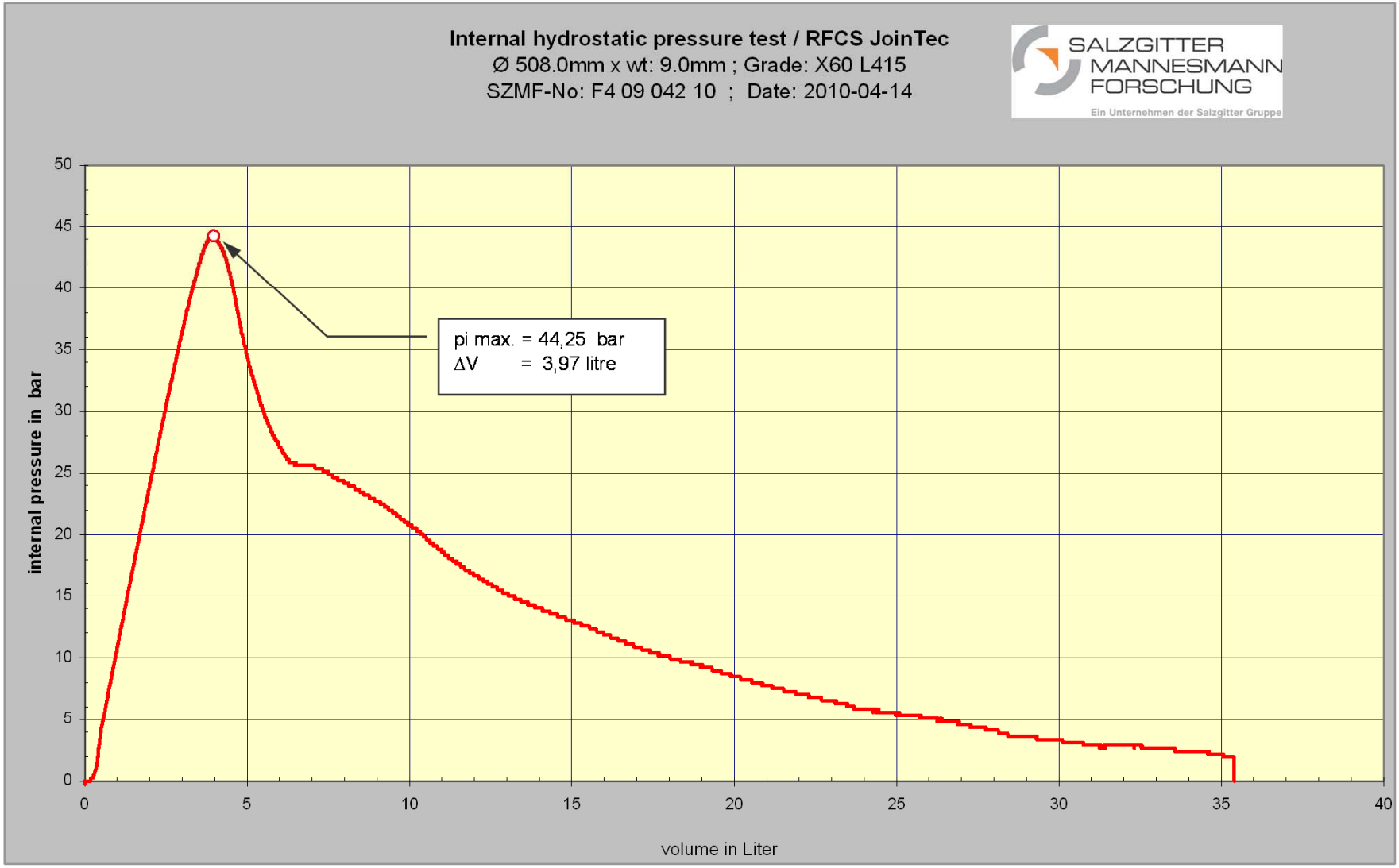
No sealing used!

Internal Hydrostatic Pressure Tests

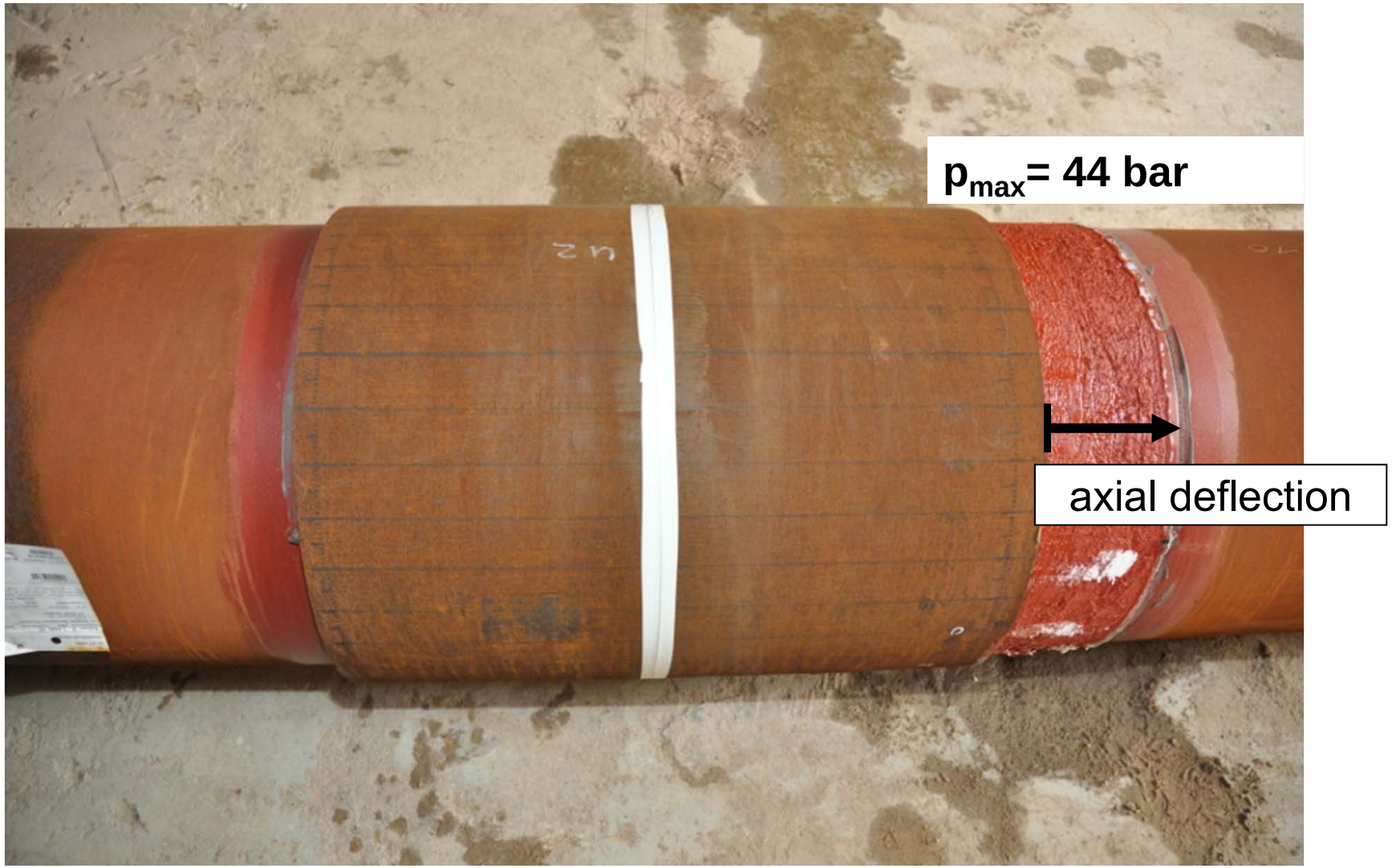


1 Specimen
2 Pressure transmitter
3 Signal converter
4 Signal output
5 Scales
6 Water reservoir
7 Hydraulic pump
8 Pit

Internal Hydrostatic Pressure Tests



Internal Hydrostatic Pressure Tests



Internal Hydrostatic Pressure Tests

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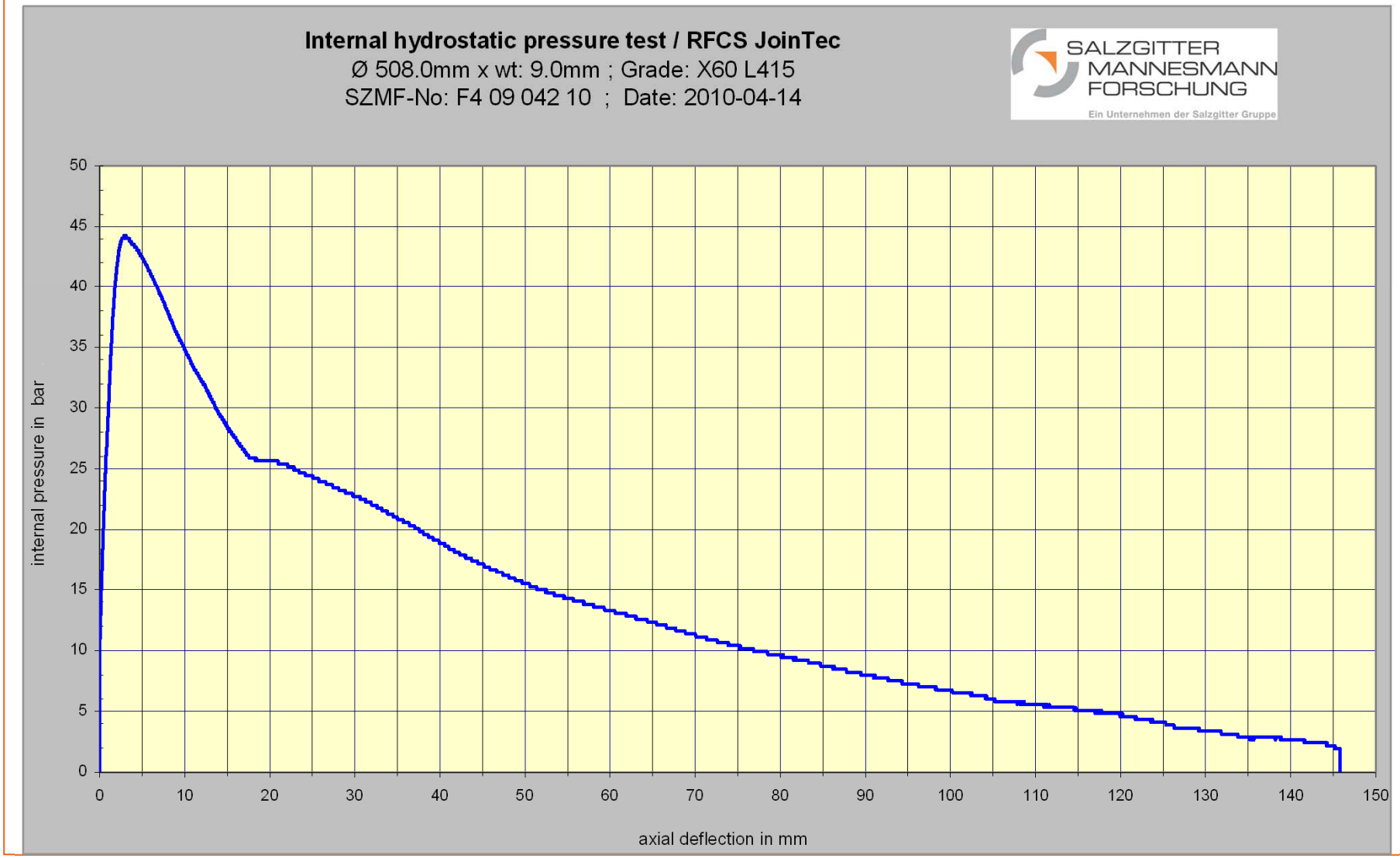

Simulation laying conditions

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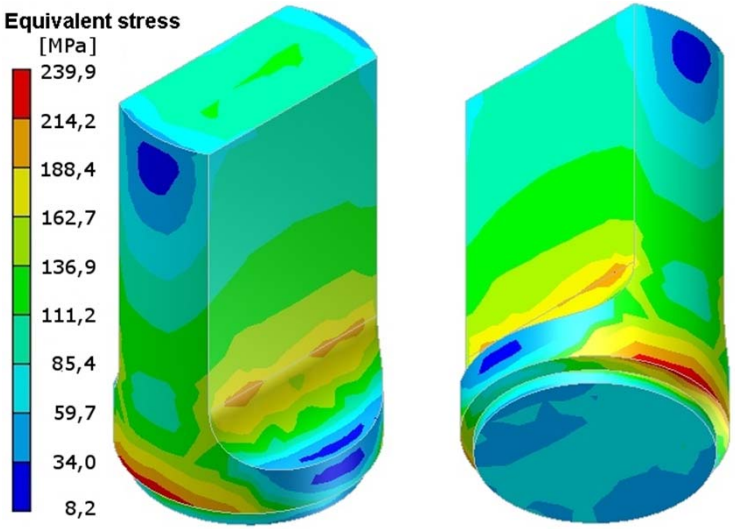
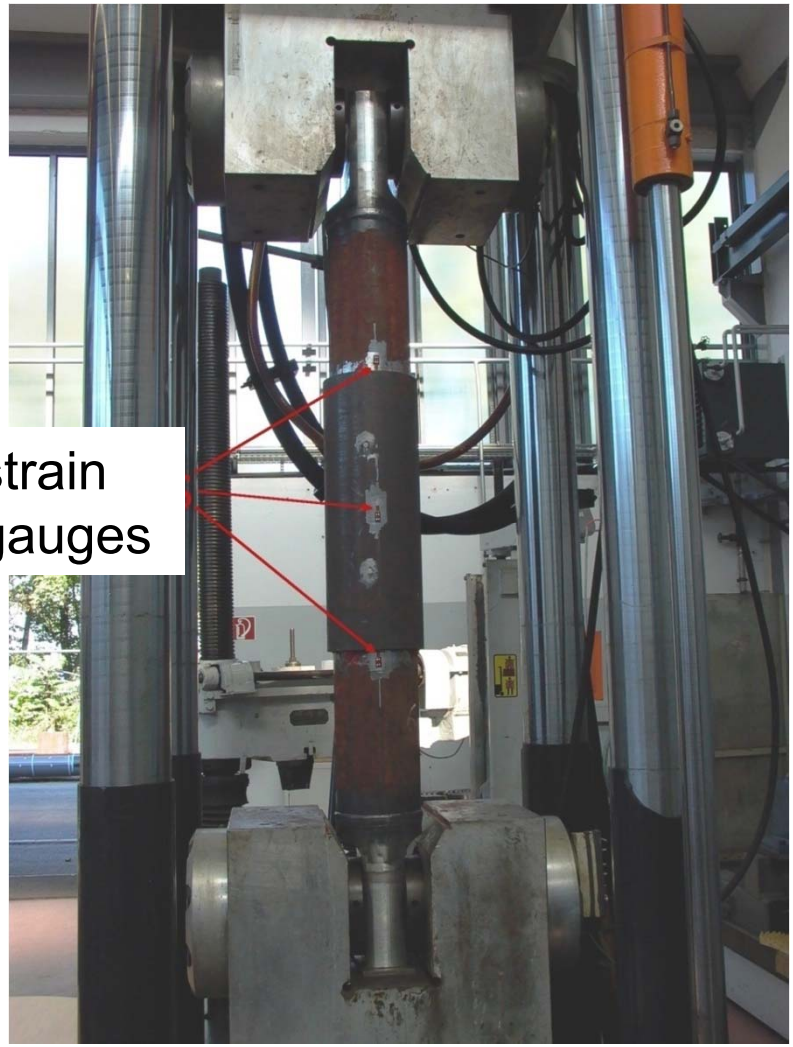
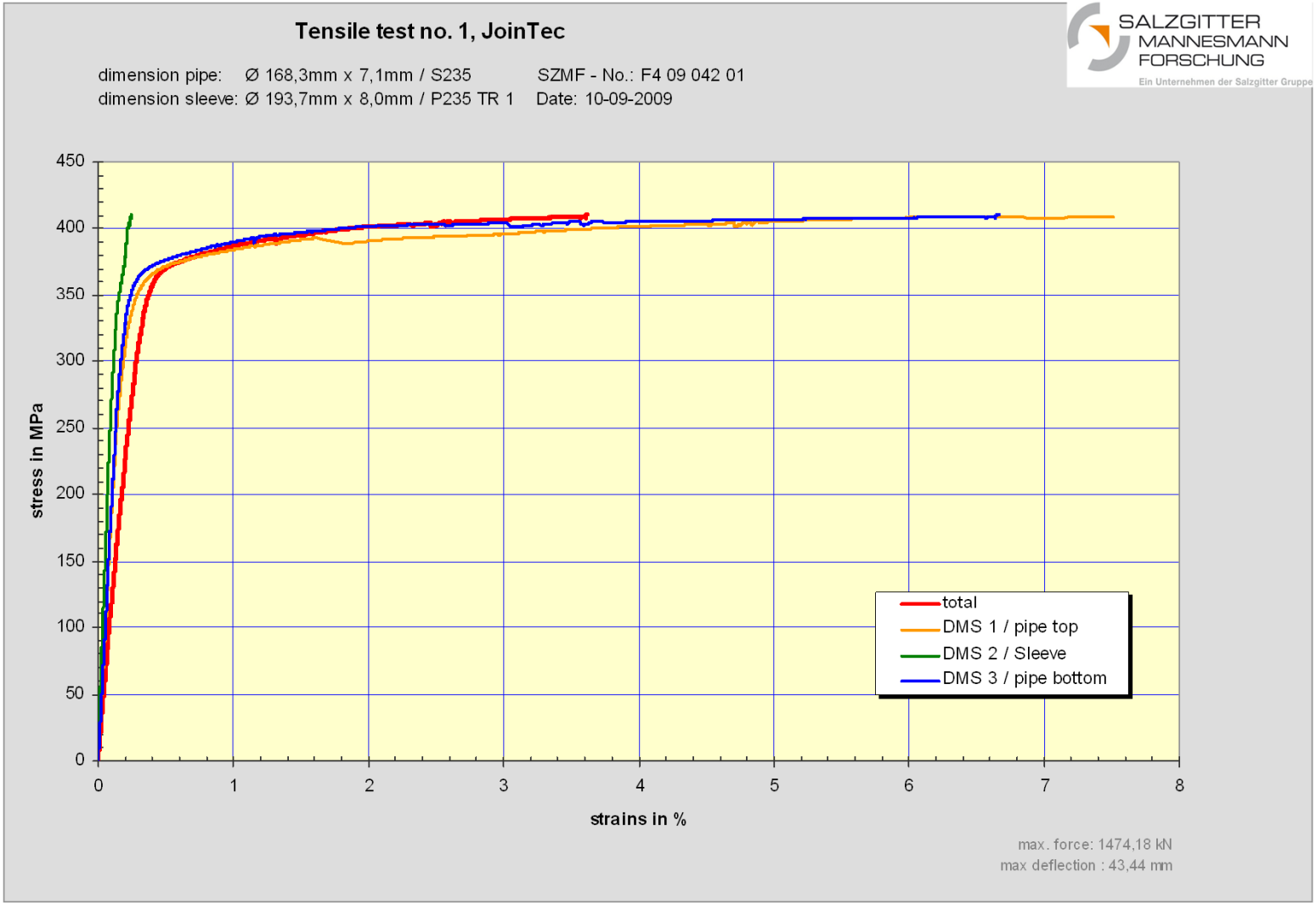
Tensile test

- maximum transferable force
- stresses in pipe and adhesive
- behavior of adhesive bond under tension





Tensile test



F_{max}=1455 kN

Stresses

steel pipe:

σ_{max}= 404 MPa

adhesive:

τ_{max}= 9.9 MPa

Resistance:

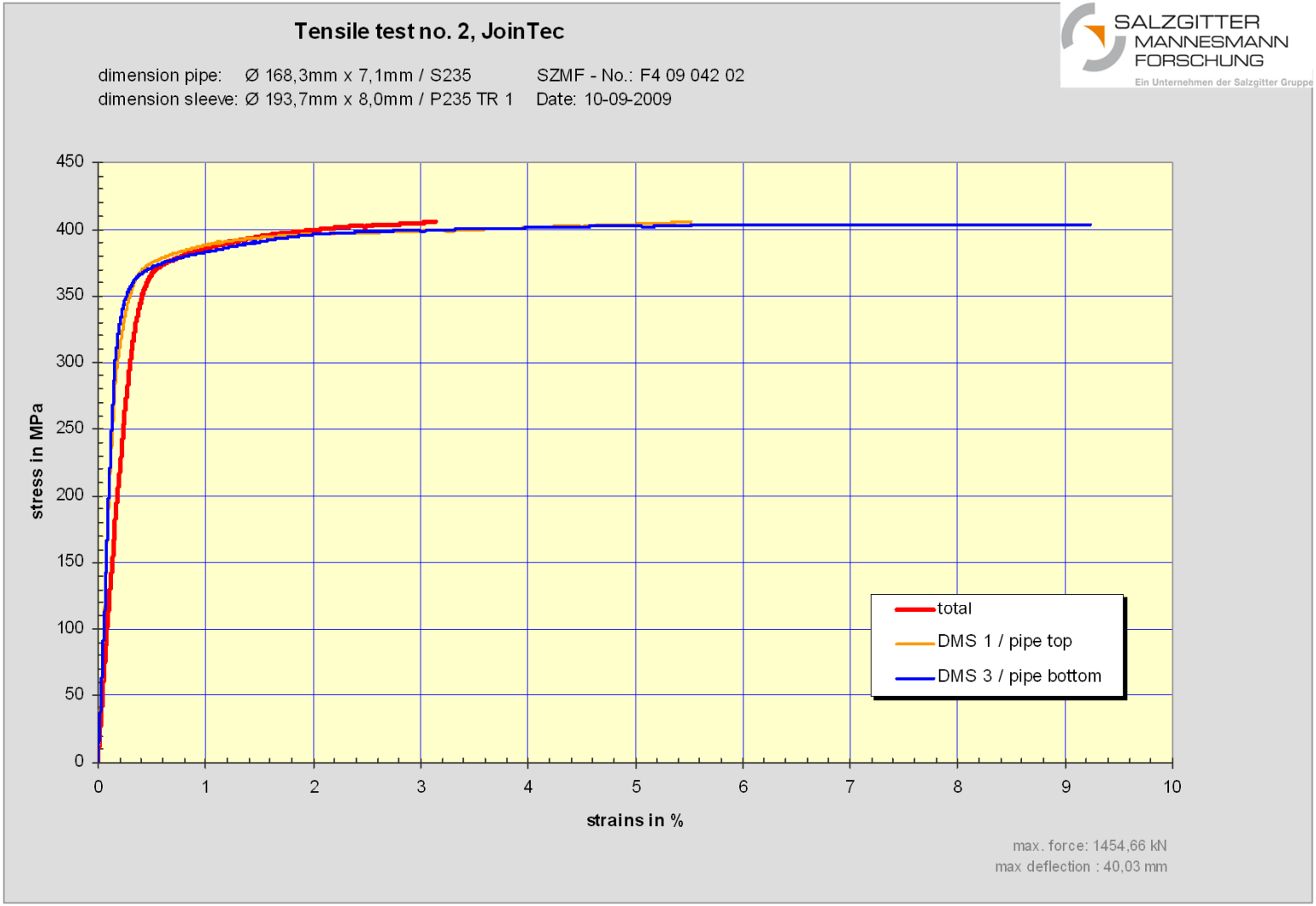
steel pipe:

F_{max}= 1503 kN

Adhesive (τ = 15 MPa):

F_{max}= 2181 kN

Tensile test



F_{max}=1474 kN

Stresses

steel pipe:

σ_{max}= 405 MPa

adhesive:

τ_{max}= 10 MPa

Resistance:

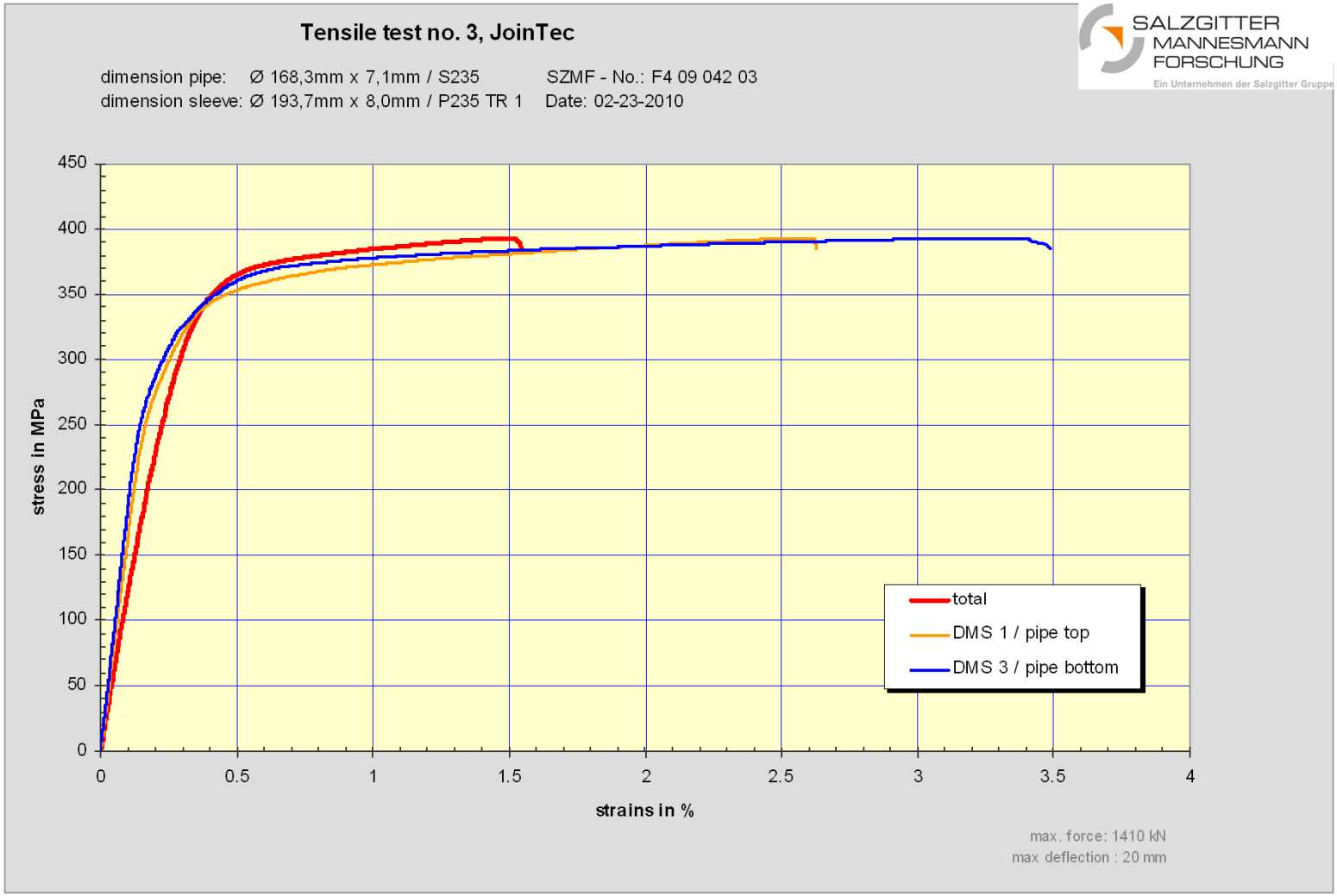
steel pipe:

F_{max}= 1503 kN

adhesive:

F_{max}= 2181 kN

Tensile test



F_{max}=1410 kN

Stresses

steel pipe:

σ_{max}= 393 MPa

adhesive:

τ_{max}= 9.7 MPa

Resistance:

steel pipe:

F_{max}= 1503 kN

adhesive:

F_{max}= 2181 kN

Conclusions

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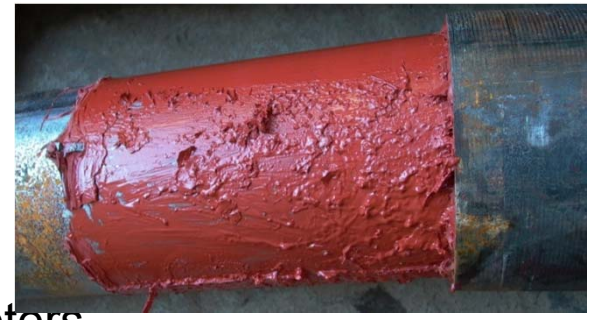
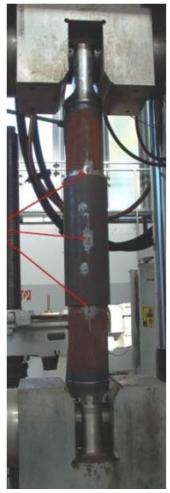
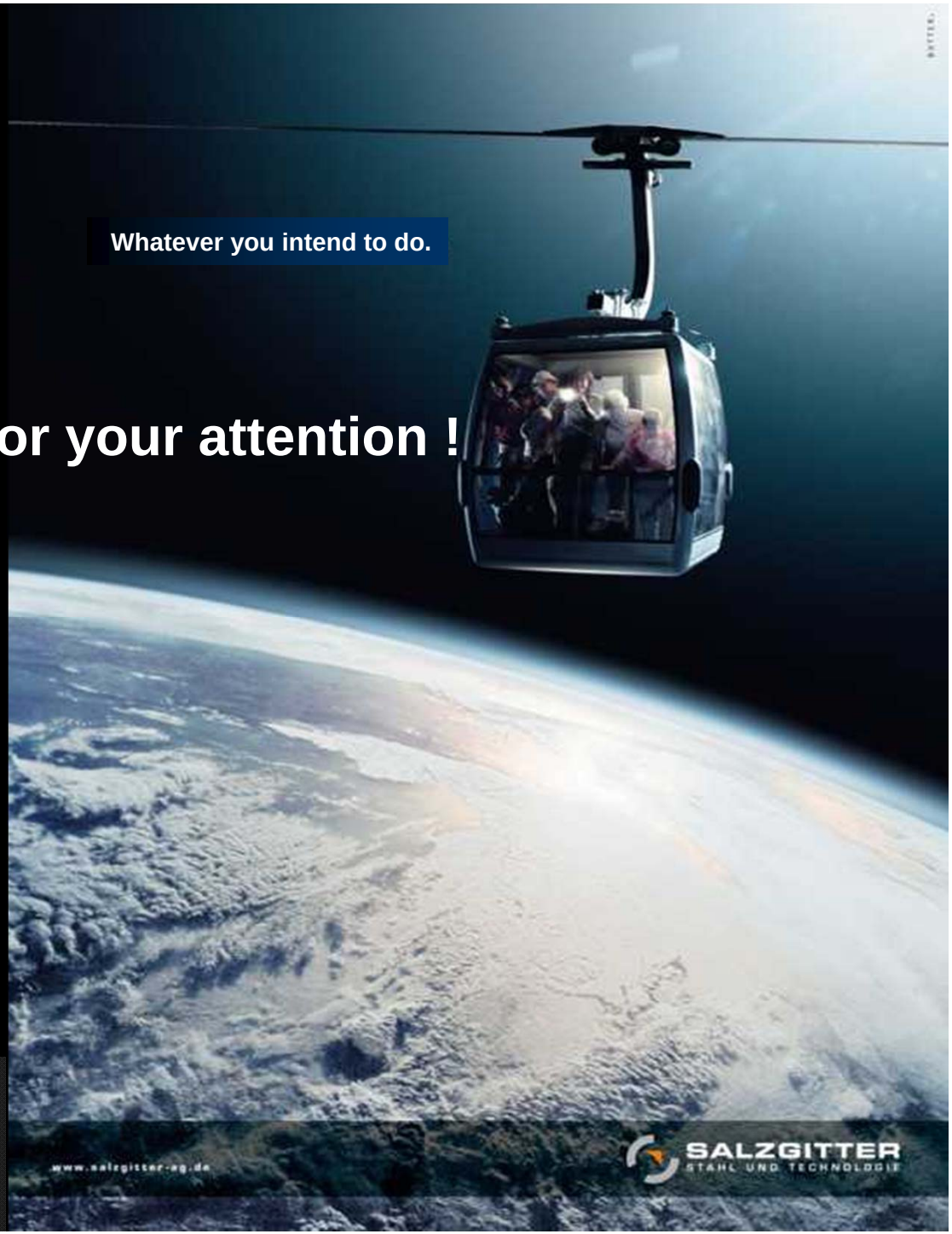




- Findings from internal hydrostatic pressure test
  - seal improves tightness (needs to be developed)
  - leak-proof up to approximately 30 bar
  - behavior under cyclic load still unknown for large diameters
- Findings from the tensile test
  - pipe laying possible due to good axial resistance
  - adhesive strength sufficient to cause steel pipe yielding
- General knowledge
  - for low pressure pipelines (≤ 5 bar: water supply) already applicable (p_{min}> 38 bar)

Thank you for your attention !



Salzgitter Mannesmann Forschung GmbH
Ehinger Str. 200
47259 Duisburg
www.szmf.de