Test report

Project No.	717502789
Principal	BLT Flexitank Industrial Co., Ltd 11F, Gold Light Tower, Hongkong Middle Road Qingdao, 266071 China
Contractor	TÜV SÜD Rail GmbH Testcenter Rolling Stock Gross-Berliner Damm 73D 12487 Berlin
Project Manager	Daniel Zingelmann Tel.: 03581 / 70 43 78 Fax.: 03581 / 64 28 92 E-Mail: daniel.zingelmann@tuev-sued.de
Document	**10_717502789_Report_A**
Title	**Rail Impact Test / COA Recommended Code of Practice**

Issue A Date 11.08.2010

Issue	Date	Author	Checked by	Certified by	Remarks
A	11.08.2010	DaZi	FrRe	KlHe	1st approved issue

The present issue A replaces all preceding issues.

Issue	Date	Name	Signature
Author	11.08.2010	Daniel Zingelmann Test Engineer	This document was created electronically and has informative character only.
Checked by	11.08.2010	Frank Reichstein Manager Testing Facility	
Certified by	11.08.2010	Dr. Klaus Hempelmann Manager Testcenter Rolling Stock	

Copy no.	Copy	Recipient
1		BLT Flexitank Industrial Co., Ltd
2		TÜV SÜD Rail GmbH Testcenter Rolling Stock Görlitz
Pdf	x	BLT Flexitank Industrial Co., Ltd TÜV SÜD Rail GmbH Testcenter Rolling Stock Görlitz

The results and observations contained in the test report exclusively rated to the test object mentioned in this report.

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Symbols and abbreviations used in this report

TR RT	TÜV SÜD Rail, Testcenter Rolling Stock
a_1,a_2 [g]	accelerations on container
a_{1F}, a_{1F} [g]	accelerations (filtered)
f [Hz]	frequency
T [°C]	ambient temperature
t [s]	time
v, v_{impact} [km/h]	impact velocity
SRS	Shock Response Spektrum

1 Summary

On 20.07.2010 Flexitank “3900829 20690” with Bulkhead have been subjected to rail impact tests inside a 20 ft container, serial no. MSKU 740 790-3. The tests have been performed according to COA Flexitank Code of Practice: Version 2, dated 1st January 2010, “With Proposed Clarifications”, dated 20th May 2010, Part 2 Section A: Flexitank/Container Combination Rail Impact Test Criteria, COA Test: Option A.

The following impact speeds have been attained: 5.0 / 9.7 km/h.

The Flexitank was leaking after impact speed at 9.7 km/h.

The maximum recorded wall deformations after each impact with the Flexitank being installed amounted up to 32 mm on side wall a, 28 mm on side wall b and 14 mm on end wall.

The maximum overall recorded wall deformations with the Flexitank being removed amounted up to 13 mm on side wall a, 12 mm on side wall b and 1 mm on end wall.

The maximum overall recorded Bulkhead movement amounted to 62 mm. The Bulkhead imposed pressure upon the doors.

The maximum recorded change in length of the diagonals on side wall corner castings caused by all impact tests amounted to 0 mm / 0 mm and 1 mm / 0 mm respectively on the sides of the container.

The permanent deformation on the door amounts to 9 mm.

2 Assignment

As commissioned by BLT Flexitank Industrial Co., Ltd, (written order dated 03.10.2009) a Flexitank system was to be subjected to impact tests inside a standard ISO marine container, including the provision of Time-Acceleration curves and SRS curves for any speeds at both ends of the container under test.

The tests were to be performed pursuant to the COA Flexitank Code of Practice: Version 2, dated 1st January 2010, “With Proposed Clarifications”, dated 20th May 2010, Part 2 Section A: Flexitank/Container Combination Rail Impact Test Criteria, COA Test: Option A. This guideline defines the general requirements and conditions applicable for the performance of the tests as well as for the surveying of the Flexitank system and the container.

3 Performing the test

3.1 General information

Test period	20.07.2010
Test site	Görlitz Test Facility, Germany
Test bench	Impact track no. 4
Measurement chain and test setup	See annex A
Wagon and container parameters	See annex B
Static buffer characteristics	See annex C, D
Temperature	18°C, dry weather
Impact speeds	5.0 / 9.7 km/h
Inspection agency	nonattendant

3.2 Flexitank system specification

Flexitank manufacturer	BLT Flexitank Industrial Co., Ltd
Flexitank type	3900829 20690
Flexitank size	24 m³
Flexitank specification	multi layer flexitank, 2 inner layer of 350 micron Polyethylene and 1 outer layer of 230g/m² woven Polypropylene 3" top and bottom butterfly valves
Bulkhead type	6 bars
Bulkhead specification	each 50x50x2.5 mm, plastic board behind the bulkhead, doorpacker
	additional 2 vertical bars on each inner side walls of container (50x50x3.0 mm, length 2370 mm)

3.3 Container specification

Container supply	Maersk Line
Container size	20 ft
Container serial no.	MSKU 740 790-3
Manufacturing date	03 / 2008
Side wall thickness	1.6 mm / 2.0 mm
End wall thickness	2.0 mm
Nominal tare weight	2,170 kg
Maximum gross weight	30,480 kg
Racking test load value	15,240 kg

3.4 Weight measurements

Tare mass test platform	22.2 t
Mass readily fitted container	2.4 t
Payload mass (Flexitank content)	24.0 t
Total test mass container wagon	48.6 t
Acceleration correction factor	0.96

3.5 Test methods and measurement programme

An open freight wagon (wagon type: Eas, total mass: 80 t) is accelerated and shunted by a V-22 locomotive. The impact wagon then runs into the specimen to be tested, i.e., an unbraked 4-axle container wagon (wagon type: Rs) standing freely on a straight track.

The impacting 4-axle Eas wagon is an impact wagon according to ERRI with reinforced under-carriage and partitions according to ERRI drawing M0003-0081. The wagon is loaded with standard UIC ballast.

The container-under-test is positioned on the stationary test wagon in such a way that the doors face the impact and the door end bottom corner castings are in full contact with the solid barriers on the wagon in order to allow direct load transfer. The opposite bottom corner castings of the container have play in the longitudinal direction, restraining the container only vertically by a horizontal bolt.

The tests are performed at impact speeds at 5, 9.5 and 9.5 km/h (± 0.5 km/h) towards the container doors. Afterwards the container-under-test will be arrested at its end wall bottom corner castings and an impact at 9.5 km/h (± 0.5 km/h) will be performed towards the container end wall. For any impact speed, a Shock Response Spectrum analysis will be carried out. Evaluation includes the accelerations occurring 0.05 sec before and 2 sec after the impact at a 5-per cent damping and within a natural frequency range from 2 to 100 Hz.

The PCB 350B04 accelerometers (± 500 g) are attached to base blocks fixed to the lower corner fittings of the container-under-test in longitudinal direction toward the impacting end by Pattex Stabilit (a two-component methylacrylic adhesive). The accelerometer signals are filtered by an analogue low-pass filter for anti-aliasing (Low-pass 200 Hz Butterworth). The measuring frequency for the accelerations (to be captured unfiltered) is 10 kHz.

The impact speed is measured immediately before the impact.

After each test the Flexitank will be checked for leakage. Furthermore the change-in-shape of the doors, container side walls and end wall will be measured at equally spaced locations as per the Code of Practice as well as the movement of the bulkhead towards the doors. In addition the diagonals of the container side wall corner castings will be measured before and after testing.

Figure 1: Container barriers and acceleration sensors / view on Flexitank

4 Results

4.1 Overview

All mentioned values below are to be seen in reference to the first measurement (prior to filling).

Status	Leakage	Maximum recorded wall deformation			Bulkhead imposing pressure upon doors
		Side wall a	Side wall b	End wall	
After filling (acceptance criteria)	no (no)	32 mm (40 mm)	28 mm (40 mm)	14 mm (40 mm)	yes (no)
Impact towards container door end					
After impact at 5.0 km/h (acceptance criteria)	no (no)	28 mm (40 mm)	25 mm (40 mm)	14 mm (40 mm)	yes (no)
After impact at 9.7 km/h (acceptance criteria)	yes (no)	22 mm (40 mm)	19 mm (40 mm)	4 mm (40 mm)	yes (no)
After 3rd impact		No impact performed.			
Impact towards container end wall					
After impact reverse		No impact performed.			
Overall testing (acceptance criteria)	yes (no)	13 mm (8 mm)	12 mm (8 mm)	1 mm (7 mm)	yes (no)

Table 1: Test result overview

4.2 Container wall deformation

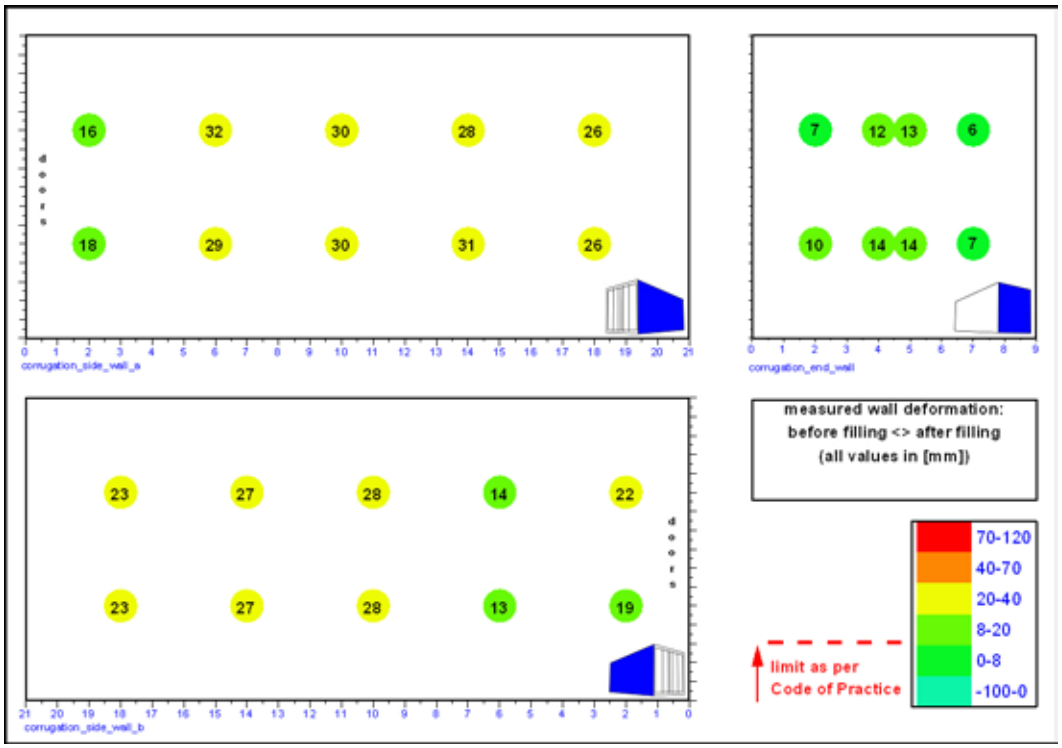

Figure 2: Wall deformation after filling

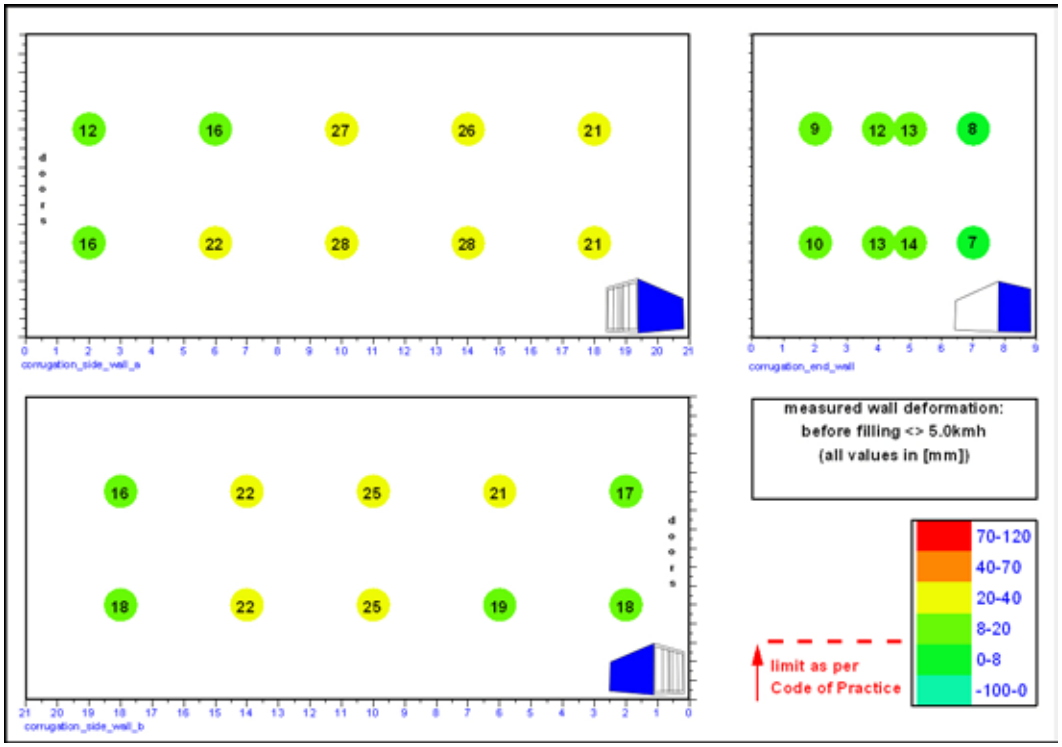

Figure 3: Wall deformation after impact at 5.0 km/h towards container door end

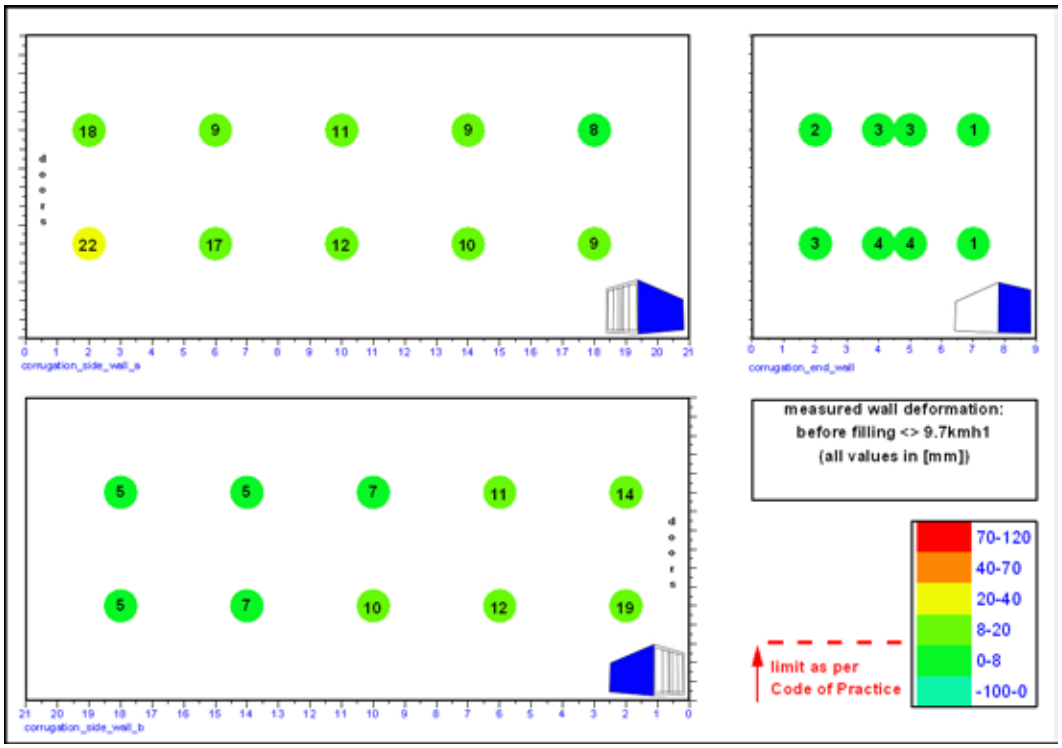

Figure 4: Wall deformation after impact at 9.7 km/h towards container door end

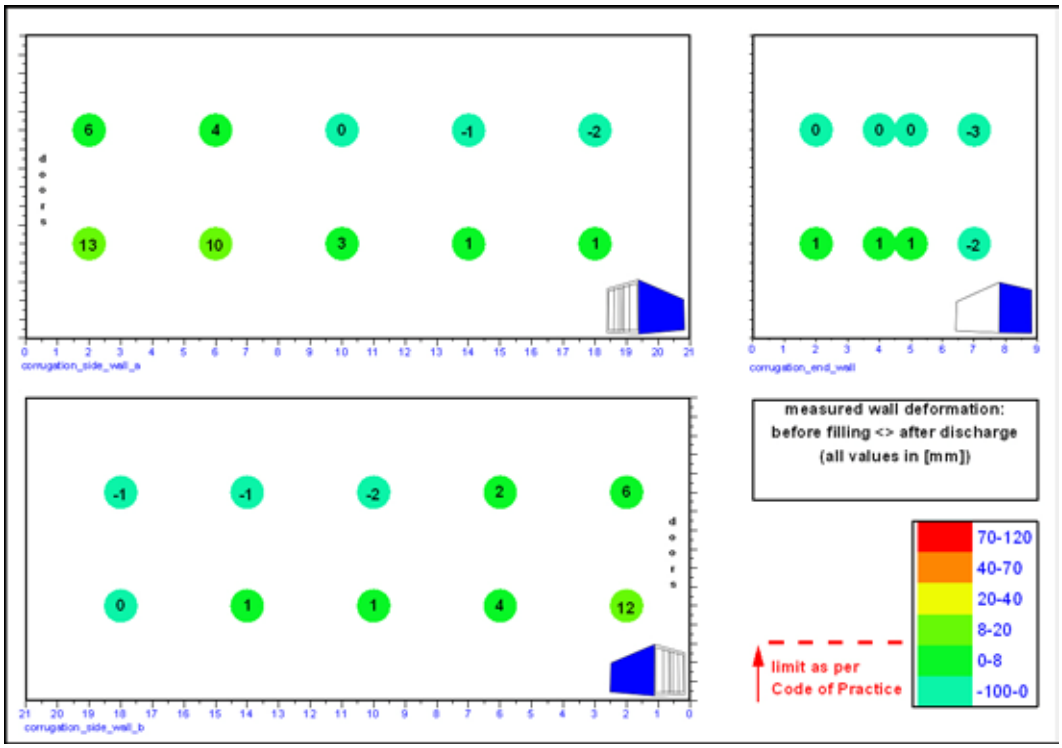

Figure 5: Total wall deformation (after discharge)

4.3 Bulkhead movement

All mentioned values below are to be seen in reference to the first measurement (prior to filling).

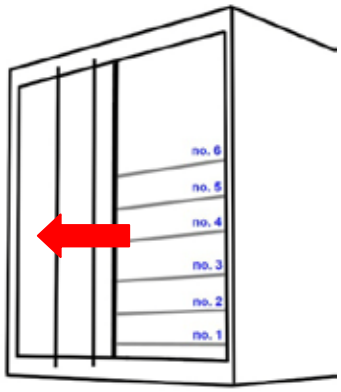

Figure 6: Bulkhead movement

Bar no.	After filling	After impact towards container door end at			After impact towards container end wall
		5.0 km/h	9.7 km/h	3rd impact	
6	8 mm	16 mm	No measur-ments taken. (too much pressure on the doors)	No impact performed.	No impact performed.
5	34 mm	62 mm			
4	35 mm	62 mm			
3	38 mm	59 mm			
2	37 mm	53 mm			
1	0 mm	3 mm			
Bulkhead imposing pressure upon doors					
	yes	yes	yes		

Table 2: Bulkhead movement

4.4 Diagonals of container side wall corner castings

The change in length of the diagonals on side a, measured before and after testing, amounted to 0 mm (ΔD3a) and 0 mm (ΔD4a).

The change in length of the diagonals on side b, measured before and after testing, amounted to 1 mm (ΔD3b) and 0 mm (ΔD4b).

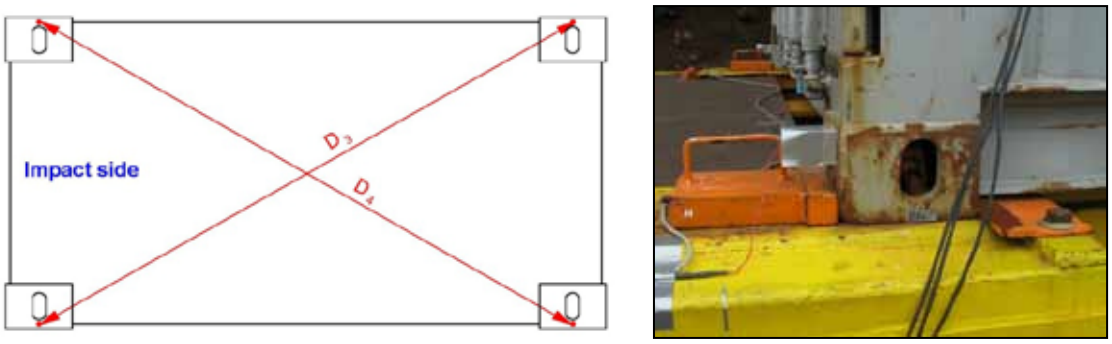

Figure 7: Distance between marks on the diagonally opposite corner castings

4.5 Time-Acceleration curves and Shock Response Spectrum

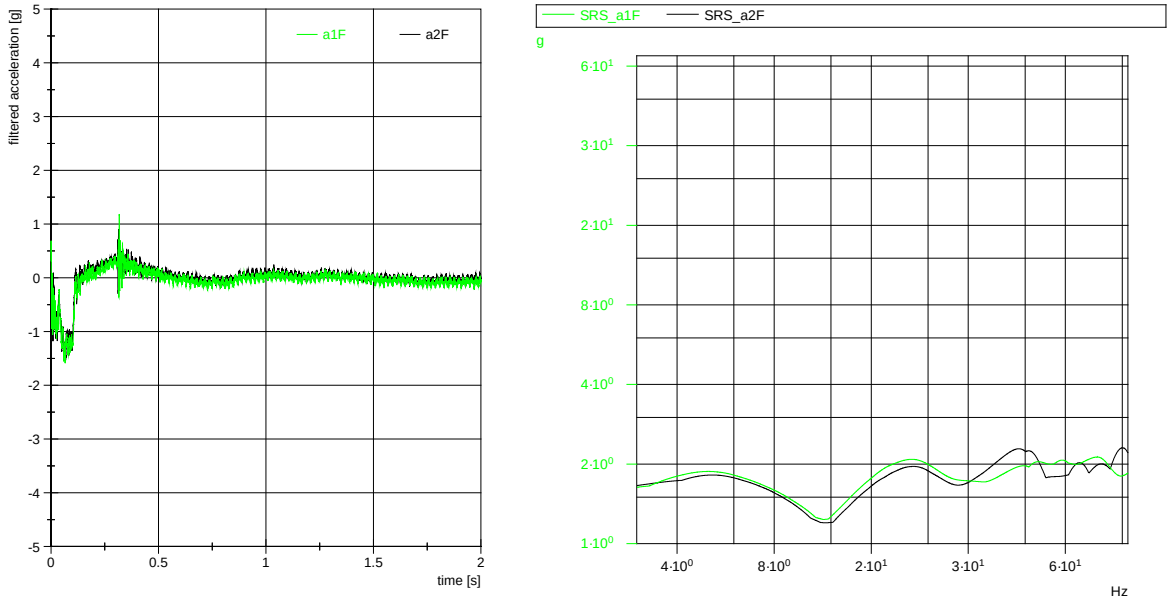

Figure 8: Time-Acceleration curve and SRS for impact at 5.0 km/h towards container door end

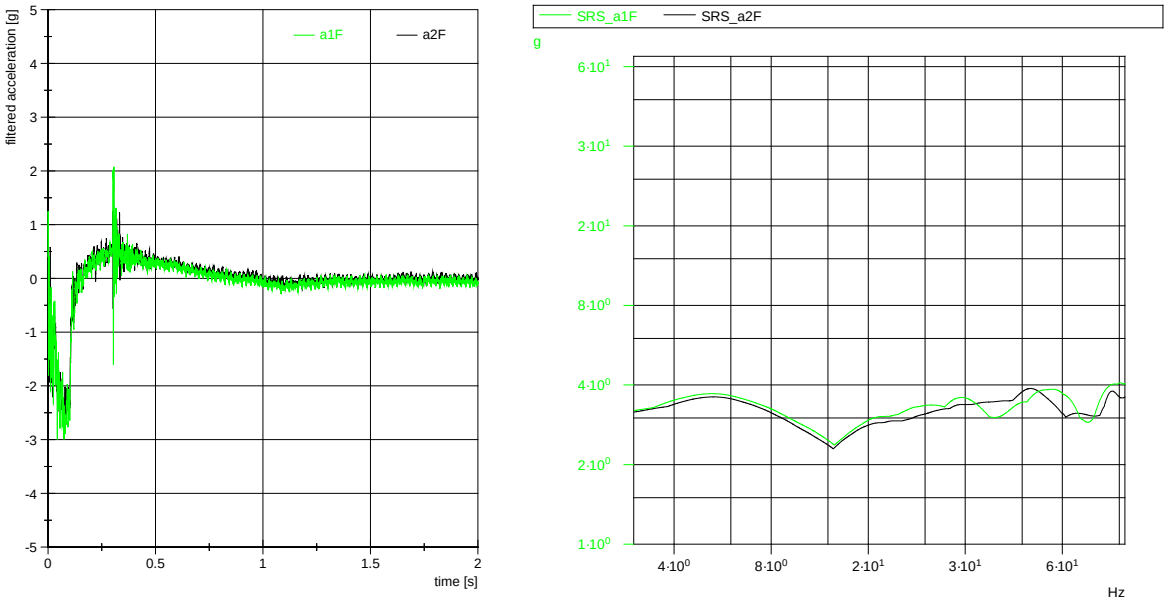

Figure 9: Time-Acceleration curve and SRS for impact at 9.7 km/h towards container door end

A Measurement chain and test setup

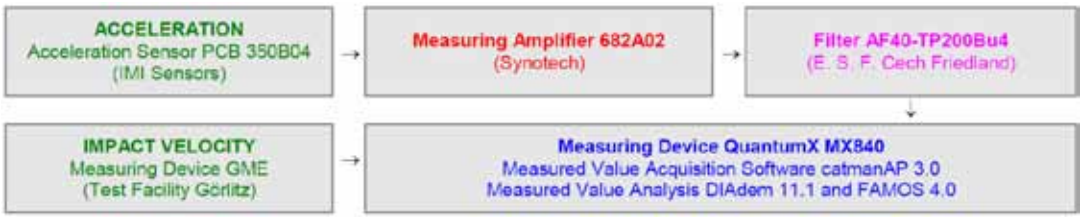

Figure 10: Measurement chain for rail impact test

Measurement frequency: 10 kHz

Filtering the accelerations: Low-pass 200 Hz Butterworth

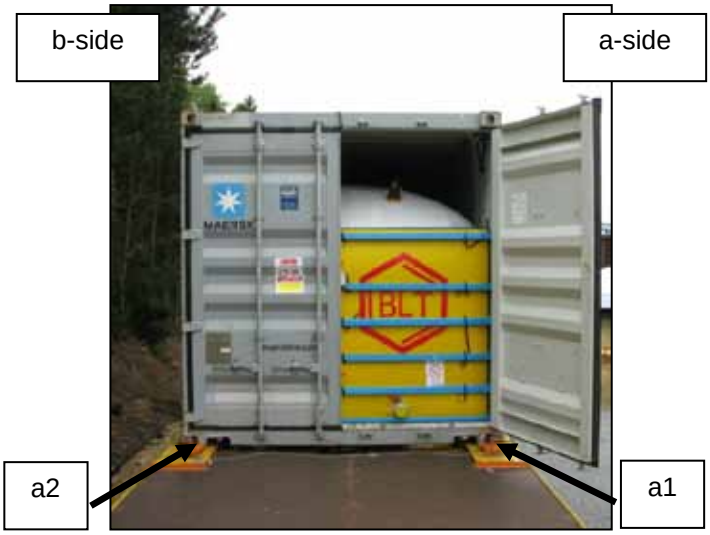

Figure 11: Allocation of measurement points

Figure 12: MSKU 740 790-3 container for testing

B Impact wagon and container wagon parameters

Wagon parameter	Stationary Wagon	Impacting Wagon
Wagon type	Rs	Eas (impact wagon according to ERRI)
Wagon number	21	14
Length over buffers	20.220 m	14.040 m
Empty weight	22.2 t	21.9 t
Total weight	48.6 t	80.0 t
Cargo	Container MSKU 740 790-3	Standard UIC ballast
Buffers	Class A buffers (ring spring) No. 101 and 102 (door end) No. 105 and 108 (end wall)	Class A buffers (ring spring) No. 144 and 147 (door end) No. 156 and 157 (end wall)

Figure 13: Impact wagon according to ERRI, no. 14 (80 t) loaded with standard UIC ballast

Figure 14: Container MSKU 740 790-3 on Rs type container wagon

C Static buffer characteristics (door end impact)

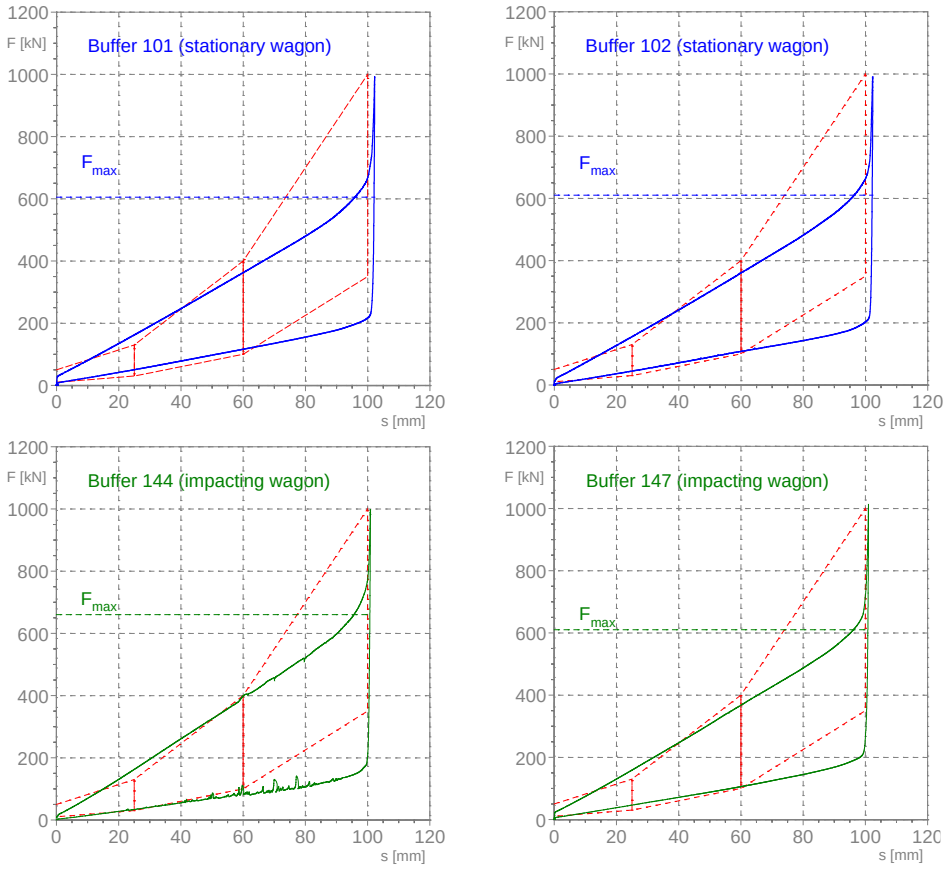

Figure 15: Static characteristics of used buffers

Static parameters		Buffers on the stationary wagon		Buffers on the impacting wagon	
		No. 101	No. 102	No. 144	No. 147
Maximum force	[kN]	605	610	660	610
Stroke	[mm]	102.3	102.4	101.0	101.1
Preload force	[kN]	28	19	14	22
Energy absorption	[kJ]	32.8	32.4	34.0	32.0
Energy dissipation	[kJ]	22.1	22.7	26.4	22.3
Damping	[%]	67	70	78	70
Test conditions					
Date		09.07.2008		20.03.2008	
Ambient temperature		22 °C		5 °C	
Stroke velocity		100 mm/min			
Load		1			
Remarks		-			

D Static buffer characteristics (end wall impact)

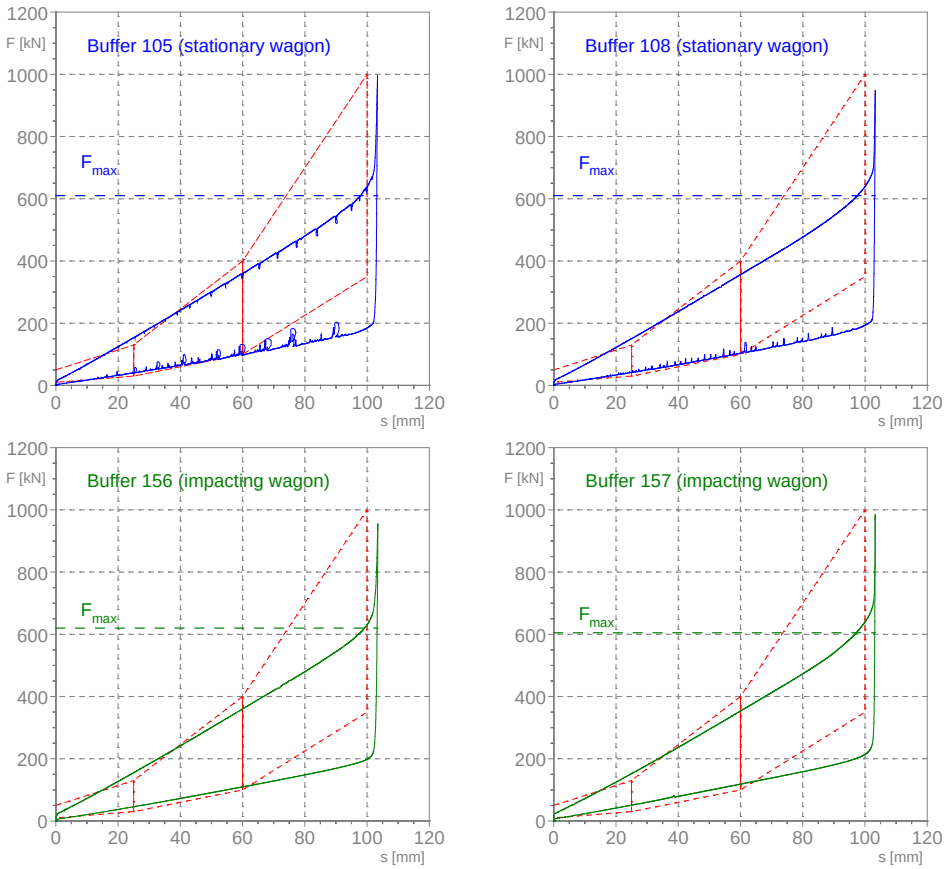

Figure 16: Static characteristics of used buffers

Static parameters		Buffers on the stationary wagon		Buffers on the impacting wagon	
		No. 105	No. 108	No. 156	No. 157
Maximum force	[kN]	610	610	620	605
Stroke	[mm]	103.4	103.3	103.5	103.3
Preload force	[kN]	15	15	20	22
Energy absorption	[kJ]	32.8	32.5	32.9	32.4
Energy dissipation	[kJ]	23.1	22.7	22.6	21.4
Damping	[%]	70	70	69	66
Test conditions					
Date		09.07.2008		10.07.2008	
Ambient temperature		22 °C		15 °C	
Stroke velocity		100 mm/min			
Load		1			
Remarks		slight chatter marks			

E Test facility approval for railway specific test

Translation from the German Language
[Translator's notes given in italics and in square brackets]

Eisenbahn-Bundesamt **Central Office**
[German Federal Railway Authority]

Approval Certificate

for

TÜV SÜD Rail GmbH
Prüfstelle Schienenfahrzeuge (Railmotive)
[Rolling Stock Test Center]

Groß-Berliner Damm 73 d
12487 Berlin

with locations at

Görlitz and Delitzsch *[Germany]*

as

Test Center

for

Railway Specific Tests on Rail Vehicles

in the following fields of testing:

Strength tests on buffing and draw gear, Running behaviour tests, Derailment safety tests on distorted track and on curved crossings, Determination of the roll centre and of the vehicle flexibility coefficient, Determination of the minimum longitudinal compressive force that a vehicle is capable of withstanding without derailment, Impact tests, Braking tests, Inside and outside noise measurements.

Identification Number: EBA – 007 / 04 / 10 –

This Certificate is based on the written approval granted on 21 April 2010 -3.126 Gp 007/10- and on the conditions specified therein. The railway specific tests covered by this approval are described in detail in the aforesaid written approval.

This approval is valid until **30 June 2013**, and is subject to withdrawal.

[signature]
Dr-Ing Thomasch

[round seal:]
Eisenbahn-Bundesamt
12 12
Central Office

Bonn, 23 April 2010

I, Dr Kerstin Lehmann, a duly sworn interpreter and certified translator for the courts and notaries of the State of Saxony in the Federal Republic of Germany, registered with the Oberlandesgericht Dresden, do hereby certify that the above and foregoing is a true, correct and complete translation - consisting of 1 page - of the 1-page German document entitled "Bescheinigung über die Anerkennung", of which I have seen a facsimile copy.
Witness my hand and seal in Görlitz, Germany on this 17th day of May, 2010

Dr. Kerstin Lehmann
Deutsch-Ossiger Weg 19
02827 Görlitz

F Test laboratory accreditation according to DIN ISO/IEC 17025

Translation from the German Language
[Translator's notes shown in italics and in square brackets]

DGA Deutsche Gesellschaft für Akkreditierung mbH
[DGA German Association for Accreditation]

Signatory of the Multilateral Agreements of the EA *[European co-operation for Accreditation]* and ILAC *[International Laboratory Accreditation Cooperation]* on Mutual Recognition

Represented in the

Deutscher AkkreditierungsRat
[German Accreditation Council]

Accreditation Certificate

The **DGA Deutsche Gesellschaft für Akkreditierung mbH** hereby certifies that

TÜV SÜD Rail GmbH
Prüfstelle Schienenfahrzeuge / TR-RT
[Rail vehicles test center]

Groß-Berliner Damm 73 d
12487 Berlin

with locations at

Karl-Marx-Straße 39
04509 Delitzsch

Maxim-Gorki-Straße 25
02827 Görlitz

is qualified according to DIN EN ISO/IEC 17025:2005 to perform tests in the fields of

Testing and analysis of rail vehicles in terms of running behaviour, capability to operate under geometrical limit conditions of track layout *[referred to as "preliminary approval tests" in EN 14363:2004 , translator's note]***, and running safety, including studies of the kinematic gauge of rail vehicles and the determination of the centre of area and of the centre of mass of vehicle bodies; Braking tests of rail vehicles;**
Rail vehicle strength tests;
Testing of buffing and draw gear including crashworthy components;
Dynamic testing of tank containers (SRS shock response spectrum).

See also the Annex forming part of this certificate and consisting of seven pages.

The Accreditation is valid from **2009-11-30** until **2014-11-29**.

DAR Registration Number: **DGA-PL-3866.99**
Berlin, 2009-11-30

[p.p. signature]
Univ.-Prof. Dr.-Ing. habil. K. Ziegler
Managing Director

[round stamp:]
Deutsche Gesellschaft für Akkreditierung mbH
DGA
Member of EA, IAF, and ILAC

See the notes on the back of this document.

DEUTSCHES AKKREDITIERUNGSSYSTEM PRÜFWESEN GMBH
DAP-PL-3866.99

DGA Deutsche Gesellschaft für Akkreditierung mbH
Ernst-Augustin-Strasse 15
12489 Berlin

with locations at

Ernst-Augustin-Strasse 15
12489 Berlin

Gartenstrasse 6
60594 Frankfurt am Main

The DGA is a signatory of the Multilateral Agreement for Testing Laboratories (MLA) of the European co-operation for Accreditation (EA) and of the Mutual Recognition Arrangement (MRA) of the International Laboratory Accreditation Co-operation (ILAC). The EA has also concluded further bilateral agreements on mutual recognition of test laboratories. The signatories of these agreements mutually recognize their accreditations of test laboratories.

For the current membership status please refer to the respective internet pages:
EA: http://www.european-accreditation.org
ILAC: http://www.ilac.org

Accreditation is granted on the basis of an assessment performed, and on the basis of the agreement concluded with the accreditation body on the accreditation of a test laboratory in accordance with the regulations and procedures of the German Accreditation System, according to the standards DIN EN ISO/IEC 17025:2005 and DIN EN ISO/IEC 17011:2005.

The test laboratory fulfils the material and personal requirements according to DIN EN ISO/IEC 17025:2005 for the fields of testing specified in the Accreditation certificate as well as for the methods described in the Annex to the Accreditation certificate.

Further information on the scope of accreditation (fields of testing, procedures and methods, specifications) is given in the Annex to this Accreditation certificate.

Said annex, as well as the documentation submitted and filed in connection with the accreditation procedure, form part of this Accreditation. Any changes or amendments must be made in writing.

This Accreditation is subject to revocation at any time, should the prerequisites specified in the Agreement and in the Annex to this Accreditation certificate not be satisfied any longer.

I, Dr. Kerstin Lehmann, a duly sworn interpreter and certified translator for the courts and notaries of the State of Saxony in the Federal Republic of Germany, registered with the Oberlandesgericht (Higher Regional Court of Appeal) Dresden, do hereby certify that the above and foregoing is a true, correct and complete translation - consisting of 2 pages - of the 2-page German document entitled "Akkreditierung", of which I have seen a facsimile copy.

Witness my hand and seal in Gorlitz, Germany on this 15th day of January, 2010

Kerstin Lehmann

Dr. Kerstin Lehmann
Deutsch-Ossiger Weg 19
02827 Görlitz

G Certificate of Registration Transport Canada

Transport Canada / Transports Canada

Certificate of Registration

Pursuant to its application on file with Transport Canada, to the Transportation of Dangerous Goods Regulations, and to paragraph 7.2.2 of National Standard of Canada CAN/CGSB-43.147-2005, Construction, Modification, Qualification, Maintenance, and Selection and Use of Means of Containment for the Handling, Offering for Transport, or Transporting of Dangerous Goods by Rail,

TÜV SÜD Rail GMBH
Maxim-Gorki-Strasse 25
02827 Görlitz Germany

is granted this Certificate of Registration as a test facility registered to perform dynamic longitudinal impact tests on tank containers, subject to the following conditions:

1) Testing shall be carried out in accordance with procedure Pst_51_100, Issue G dated 2009-02-13 on file with the Director and Appendix E of CAN/CGSB-43.147-2005 Amendment No.1;

2) A copy of all official test results must be sent to the Director. These results must include accelerometer and SRS data in electronic format suitable for analysis; and

3) Not later than twenty days after any change occurs in the information on file at Transport Canada supporting the application for registration, the applicant shall advise the Director, Regulatory Affairs Branch of any such change.

This Certificate of Registration shall expire on the date shown below unless revoked earlier. The Director may revoke this Certificate of Registration if the Director is satisfied that the facility is not capable of or is not complying with the applicable requirements.

Dated: **10 February 2009**
Expiration Date: **31 July, 2011**

Certificate No. ASD 4067-31-37A

Signature:
Jacques Savard, Director
Regulatory Affairs Branch
Transport Dangerous Goods Directorate

Canada

16-0037E (0504-03)