Regulation No. 55
Mechanical Couplings –
Coupling Balls and Towing Brackets

S. Weiland

Fraunhofer Institute
Structural Durability
and System Reliability

Geneva - GRRF

January 31st, 2006
Contents

• Introduction

• Effects of loading on the durability assessment

• Comparison of 94/20/EC resp. ECE R 55.01 to CARLOS TC

• Summary
CARLOS TC (CAR LOading Standard, Trailer Coupling) Consortium Participants

Car OEMs:
Adam Opel AG
Audi AG
BMW Group
DaimlerChrysler AG
Ford-Werke AG
Porsche AG
Skoda AG
Volkswagen AG
Volvo Car

Suppliers:
AL-KO GmbH
Bosal Research
Karmann GmbH
MVG mbH
Oris Fahrzeugteile Hans Riehle GmbH
PD&E Automotive Solutions
Magna Steyr Fahrzeugtechnik AG & Co KG
Westfalia Automotive GmbH & Co KG

Technical Control Boards:
RWTÜV Fahrzeug GmbH, Essen
TÜV Automotive, München

Research Institutes:
Fraunhofer Institute for Structural Durability LBF (project manager)
KATECH
(Korea Automotive Technology Institute)
Introduction

- Trailer coupling devices (TCD) are safety-critical components

- Tests for the homologation of TCDs according to 94/20/EC are performed with
  - sinusoidal loading
    - 1-dimensional loading (1-D)
    - constant amplitudes (CA)
    - no mean load (R=-1)

- Fatigue relevant local stresses and strains on TCDs are depending on
  - service loads
    - 3-dimensional loading (3-D)
    - variable amplitudes (VA)
    - variable mean load (R≠-1)
Uni- & Multiaxial Load – Cycles to Failure

Uni- & Multiaxial Load:
- different cycles to failure with the same force amplitudes.
Constant Amplitude Testing – Type of Failure

CA-Testing:
- type of failure depends on load amplitude.
Mean Load - Cycles to Failure

Mean Load:
- different cycles to failure with same load amplitude
Currently used guideline 94/20/EC resp. ECE R 55.01

The 94/20/EC resp. ECE R 55.01 guideline:
- sinusoidal loading
  → 1-dimensional loading (1-D)
  → constant amplitudes (CA)
  → no mean load (R=-1)

→ Durability assessment is critical with respect to:
  - type of failure
  - cycles to failure

Possible Improvement:
A testing procedure oriented on 3-D service loads will lead to customer oriented type of failures resp. cycles to failure.
Derivation of a Testing Procedure based on Service Loads

**Input:**
42 verification tests / measurements from OEMs

**Signal analysis:**
verifications, normalizations, correlations, load spectra

**Derivation of 3 Modules:**
based on representative 22 load segments

**Testing Procedure:**
damage sums, duration (<150h), frequencies, max. amplitudes

**CARLOS TC:**
duration: ~92h, module mix: $10 \times (5 \times (10 \times M1 + M2) + M3)$
Current EC Homologation Test 94/20/EC (1-D, CA) and CARLOS Trailer Coupling (Realistic loading: 3-D, VA)

- Increasing of max. force amplitude
- Introducing Fy as further testing direction
- 3D-testing with variable amplitudes and mean load
→ More realistic testing procedure!
Multiaxial Test-Rig for Trailer Coupling Devices
The additional testing-direction $F_y$, may lead to additional failures.

→ Additional failure criteria in the guideline will be needed.
Summary

- Currently used testing procedure is representing a fictitious testing scenario.
- Proposed testing procedure CARLOS TC is representing customer oriented service loading.
- Proposed testing procedure leads to customer oriented failures.

The proposed testing procedure is oriented on 3-D service loads and represents the customer usage more closely.
Thank you for your kind attention!
current procedure – 1960‘s technology:
• hydropulse test bench, uni-axial loading
• coupling device rigid (?!?) mounted
• constant test force ±0,6*D under 15°
• 2 * 10^6 cycles for designs made of steel
• no lateral forces
• result: fatigue strength (Wöhler)
• ??? cycles for design made of light alloy
• car manufacturers must release permissible trailer mass, vertical static load and fitting points (see also EC directive “mass and dimensions“ 92/21/EEC including 95/48/EC)

• verification: harmonized car loading standard (CARLOS) for car bodies

• intention: use of CARLOS test also for A50-X devices and acceptation in ECE 55-01
new procedure – state-of-the-art:
• hydropulse test bench, multi-axial loading
• coupling device directly mounted at car body or directly at the test bench
• not constant test forces – load-time histories of the variable force components: Fx longitudinal, Fy lateral and Fz vertical
• test duration 92 hours
• designs made of steel and/or light alloy
• result: service strength (long life)
59th GRRF, item 6 ECE R55-01
optional test procedure for A50-X (p.5)

proposal for further approach:

Installation of an ad hoc group to study
and discuss the presented details quite
similar as previously done with main
discussion for ECE 55-01

time schedule for an ad hoc group meeting:
April 2006 or later