REDUCING THE OCCURRENCES AND IMPACT OF FREIGHT TRAIN DERAILMENTS

D-Rail dissemination Meeting 12th November (STOCKHOLM)

WP 3 – Derailment analysis and prevention

WP Leader: Michel PINEAU (SNCF)
Speakers: Michel PINEAU (SNCF) & Anders EKBERG (CHALMERS)
WP OVERVIEW

1. Introduction
2. Participants & Roles
3. Deliverables
4. Results
## INTRODUCTION

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<th>WP number</th>
<th>Lead beneficiary number</th>
<th>Estimated indicative person-months</th>
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PARTICIPANTS & ROLES

- VUT Technische Universität Wien
- CHALM Chalmer Tekniska Hoegskola AB
- POLIM Politecnico di Milano
- MMU The Manchester Metropolitan University
  replaced since July 2012 by
  HUD Huddersfield University
- LUCC Lucchini RS SPA
- DB Deutsche Bahn AG
- HARS Harsco Rail Limited
- SNCF Société Nationale des Chemins de fer Français
PARTICIPANTS & ROLES

Task 3.1 – Analysis of derailment causes, impact and prevention assessment schemes
• Leader: VUT
• Participants: HARS

Task 3.2 – Analysis & mitigation of derailment related to wheel/rail interaction
• Leader: POLIM
• Participants: DB, (MMU) HUD, CHALM, SNCF

closely integrated D3.2 and D3.3 (guideline)

Task 3.3 – Analysis & mitigation of derailment due to material fatigue & fracture
• Leader: CHALM
• Participants: LUCC, SNCF

“top–down”

“bottom–up”

all WP3 deliverables are public
Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

D-RAIL

Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]
Project Start Date: 01/10/2011
Duration: 36 Months

D3.1
Report on analysis of derailment causes, impact and prevention assessment

Due date of deliverable: 31/07/2012
Actual submission date: 30/05/2013

Work Package Number: WP3
Dissemination Level: PU
Status: Final F2

Leader of this deliverable:
Prepared by:

Name: Schöbel Andreas
Schöbel Andreas
Zarembski Allan
Palese Joseph
Maly Thomas

Organisation:
VUT
VUT
HARSCO
HARSCO
VUT

Verified by:
Mark Robinson

UNEW
D3.1 Analysis of derailment causes, impact and prevention assessment schemes

- **Cause-consequence chains** of different derailment causes

- Identification of **potential mitigation measures** including estimation of application level

- Overall **evaluation approach** for mitigation measures to make a cost-benefit-analysis for the implementation of on-board and wayside train monitoring systems.
showcases for mitigation measures for derailment cause
axle rupture

T - trackside
V - vehicle side (in general)
R - vehicle side (recording car)
Y - (shunting) yard
W - workshop

a - widely known/used measures
b - already known measures, but not widely applied
c - measures, which might be relevant for the future

1...9 - technology readiness level (TRL)
Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

**D-RAIL**

**Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]**
**Project Start Date: 01/10/2011**
**Duration: 36 Months**

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**D3.2**

Analysis and mitigation of derailment, assessment and commercial impact

Due date of deliverable: 31/03/2013
Actual submission date: 03/06/2013
(15/11/2013 rev after int & ext review)

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**D3.3**

Guidelines on derailment analysis and prevention

Due date of deliverable: 31/03/2013
Actual submission date: 03/06/2013
(15/11/2013 rev after int & ext review)

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Main European derailment causes:

• Poor track geometry
  – excessive track width
  – excessive track twist
  – track height/cant failure

• Poor vehicle conditions
  – skew loading
  – spring & suspension failure

• Failures
  – axle ruptures
  – wheel failure
  – rail failures

Major causes and key parameters!
Well-founded operational limits!

*Monitor the right things at the right levels*
Implementable results from WP3 (as compiled in D7.1)

- 37 potential modifications ranked (low, moderate, high) in terms of cost of implementation
- 29 means of influencing the risk of derailments

Examples of “not-too-high” hanging fruit

- Improved regulations (elaborated in the UIC-led HRMS project)
- Integrated prediction of crack growth in wheel load sensors to aid planning and maintenance
- Improved design / approval guidelines for wheels and running gear
- Improved and harmonized reporting guidelines and follow-up routines based on key parameters
RESULTS – RAIL BREAKS

Influencing parameters
- impact load
- temperature
- vehicle speed
- track
- sleepers
- impact type

...
RESULTS – ALARM LIMITS FOR RAIL BREAKS

Impact load limits *versus* rail crack size

**Load types:**
- Bending from impacting wheel flat
- Tension from thermal loading
RAIL BREAKS – CRACK GROWTH

EXAMPLE:
Foot crack – nominal “bad case” scenario
Measured load magnitudes (average or peak for each wheel)

Equivalent “average” load

Increased growth due to cold temperature
RESULTS – FLANGE CLIMBING

Some key parameters

• wheel/rail friction
• suspension characteristics
• track twist
• side bearer vertical bump stop clearances
• geometry of isolated track defects

Some current derailment related regulations

• GM/RT 2141 (tentatively too severe)
• EN 14363 (tentatively too lenient)
RESULTS – ALARM LIMITS FOR RAIL CLIMB

Flange climbing
- axle
- longitudinal

Chassis twist (tare)
- diagonal
- 1:1.7 – stop
- 1:1.3 – maintenance
RESULTS – SLOSHING

Influence of sloshing

• increases risk of rollover (not flange climbing)
• S-curves and ~50% fill levels are worst cases
• <20% increase
Why don’t we derail today?

Measured load distribution (horizontal shift of CoG)

Mainly skewed axially or longitudinally

limits:
\[ \Delta x_{\text{lim}} = \frac{a}{2} \]
\[ \Delta y_{\text{lim}} = \frac{b}{9} \]
RESULTS – WHEEL DESIGN

Some key findings for web cracks

• Very slow growth in depth direction.
• For the crack to grow in the depth direction, it must be very extended circumferentially.

Fatigue sensitivity

• Increase of vertical loading
  – **straight track**: minor increase of fatigue
  – **curving and negotiation of points and crossings**: substantial increase in fatigue stresses.

• Low-stress wheels
  – better for thermal load resistance
  – more sensitive to mechanical fatigue especially due to wheel flats away from the rolling circle.
WP3 – Final remark

- The Guideline D3.3 is extensively backed by background details in D3.2

- Recommendations and suggested limits are scientifically based. This means:
  - Background assumptions and analyses are documented
  - The analyses can be extended to new and/or altered operational scenarios
  - The consequence of any deviations to recommendations can be quantified

  This promotes a sound technical discussion to obtain consensus

- The working group included representatives from across Europe (and USA), which aids in obtaining a broad view
Thank you for your kind attention