Prospective Study into Harmonised Train Accident Precursors Analysis and Management

Train Accident Causal Trees

Introduction

This document contains causal trees for the following train accidents:

- Train to train collisions
- Trains striking objects
- Rolling stock fires
- Passenger and freight train derailments
- Level crossing accidents
- Train movement accidents

The train accident causal trees are a structural representation of the relevant contributory precursors. These have been identified by making reference to train accident risk models from European railway establishments. The data available to populate the fault trees included accident data from ERA and UIC, and precursor information from European models made available in confidence to inform this project. The causal trees have been developed using Isograph Reliability Workbench 11.0 (formerly Fault Tree+) and uses standard fault tree Boolean notation. The following symbols are used in the development of the causal trees.

Where colour coding is used to indicate relative levels of risk it should be noted that the results are intended to very general values and are not specific to any particular rail network. This colouring is based on the data made available to the project team, from existing rail risk models and rail accident databases as described above, combined with the statistical expertise available within the project team. Populating the trees with country or network specific data would result in more meaningful figures given there are likely to be substantial differences between different countries and/or parts of the network. While the colour-coding should be considered as indicative only, providing exact figures at this stage is therefore likely to be misleading. Note that colour-coding show how the risk lower events contribute to the higher event shown on each page.
Train Collision Causal Tree

Key:
Red = 20% or more of risk
Yellow = between 5 and 20% of risk
Green = 5% or less of risk
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Train Collision Causal Tree

Driver Error leading to train train collision

DRIVER ERROR

- Driver anticipates change of aspect
- Driver fails to check aspect of signal past CP
- Driver fails to locate signal past CP
- Driver fails to react to caution signal past CP
- Ignorance of rules
- Violation of rules
- Driver misreads signal
- Driver reads wrong signal
- Driver misjudgement - braking / environment
- Unknown / uncategorised driver error
- ERTMS / ATP / APC data entry error

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Train Collision Causal Tree

Operational staff
- Signaller error leading to train collision

Signaller Errors

Operational staff
- Signaller sets the wrong route

Misroute

Operational staff
- Signaller operational error

Operational

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Train Collision Causal Tree

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Train Collision Causal Tree

Rolling Stock Fault

ROLLING STOCK

Brakes failure
ERTMS /ATP/APC Odometry Error
Traction control failure

BRAKE FAILURE
ERTMS ODO
TRACTION

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Passenger Train Derailment Causal Tree

Key:
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- Derailment due to human error
  - D1
  - Page 2
- Derailment due to Track Faults (Superstructure)
  - D2
  - Page 3
- Derailment due to faults on switches and crossings
  - D3
  - Page 4
- Derailment due to rolling stock faults
  - D4
  - Page 5
- Derailment due to running into obstructions
  - D5
- Derailment due to structural failures (Substructure)
  - D6
  - Page 6
- Derailment due to other causes
  - D7
  - Page 7
- Developed elsewhere
  - EV1

Note: In keeping with CSI definitions this is included in collisions
Freight Train Derailment Causal Tree

Key:
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- Track buckle
- Track twist
- Broken rail
- Rail fastenings and joints
- Gauge spread
- Cyclic top
- Miscellaneous track faults

TF1
TF2
TF3
TF4
TF5
TF6
TF7
Collision with Object Causal Tree

Train collision with object on the line or within the Kinetic Envelope

COLL OBJECT

Collision with trees or animals
- COLL BIO
  - Page 2

Collision with rolling stock parts either attached to or fallen from trains
- COLL ROLL STOCK
  - Page 3

Collision with other objects
- COLL OTHER
  - Page 4

Collision with damaged infrastructure
- COLL INFRAS
  - Page 5

Collision with maintenance materials and equipment
- COLL MAINT
  - Page 6

Collision buffer stops
- COLL BUFFERS
  - Page 7

Collision with items left on the line by vandals
- COLL VANDALS

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Collision with Object Causal Tree

Collision with rolling stock parts either attached to or fallen from trains

Collision with object thrown up by passing train
Collision with object due to defective rail vehicle
Collision with objects/debris fallen from trains
Collision with an out of gauge item on a passing train (e.g. loading error)

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Collision with Object Causal Tree

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Level Crossing Causal Tree

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Level Crossing Causal Tree

- Failure of the level crossing equipment causes a collision
- Crossing Control
  - Crossing equipment fails to detect approaching train resulting in a collision
  - Lights and/or barriers fail to operate resulting in a collision
  - Staff fail to operate manual crossing control resulting in a collision

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Level Crossing Causal Tree

Road vehicle failure causes collision

RV FAILURE

Road traffic accident on crossing leads to collision

RTA

Broken down road vehicle on crossing leads to collision

FAILURE

Long wheel based vehicle is grounded on level crossing leading to collision

GROUNDING

Road vehicle brake failure on approach to crossing results in collision

BRAKE FAILURE

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Rolling Stock Fires

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Rolling Stock Fires

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Rolling Stock Fires

Fires inside passenger trains

INTERIOR FIRE

- Fire due to electrical equipment failures
  - ELECTRICAL EQUIP
- Fire due to mechanical equipment failure
  - MECHANICAL EQUIP
- Fire due to human error / carelessness
  - HUMAN ERROR
- Interior train fire due to other causes
  - OTHERS
- Fire due to vandalism
  - VANDALS

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Rolling Stock Fires

Fires affecting freight trains only - cargo related

Freight Cargo

Fire of dangerous goods

DANGEROUS

- Radioactive
- Toxic
- Flammable
- Explosive
- Miscellaneous

Fire of non dangerous goods

NON DANGEROUS

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Train Movement Injury

Person injured by rolling stock in motion

RS IN MOTION

Injury to person on platform

Injury to person lineside

Injury to person on train

PLATFORM

LINESIDE

ON TRAIN

Page 2

Page 3

Page 4

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Train Movement Injury

Injury to person on platform

Fall from platform and hit by train
- Alcohol or drugs contributes to fall from platform
  - SLIP (ALCOHOL)
- Accidental slip / fall onto tracks
  - SLIP (OTHER)
- Attempting to retrieve item or cross tracks (not suicide)
  - DELIBERATE
- Overcrowding results in a fall from platform
  - OVERCROWD
- Injury from leaning into the path of the train
  - LEAN INTO
- Struck by a protruding train part off train e.g. open door
  - PROTRUDING PART
- Injury as a result of train turbulence
  - TURBULENCE
- Injury from leaning on train whilst train moving
  - LEAN ONTO

Caught in doors and dragged

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Train Movement Injury

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