Transportation Safety Board of Canada

Presentation at the
2011 Wheel Rail Interaction Conference

Heavy Haul Seminar

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Outline for Today's Presentation

- About the TSB
- TSB vs. NTSB
- Wheel/Rail Investigations
- Another Investigation of Interest
- TSB Watchlist

Object of the Board

- to advance transportation safety by:
  - Conducting independent investigations, if necessary public inquiries
  - Make findings as to causes and contributing factors
  - Identifying safety deficiencies
  - Making recommendations
  - Reporting publicly

Unique Features of TSB's Enabling Legislation

- The TSB is independent from any other federal department or organization
- The TSB reports directly to Parliament
- It is not the function of the Board to assign fault or determine civil or criminal liability

Unique Features of TSB's Enabling Legislation

- The Board shall not refrain from reporting fully because fault or liability may be inferred from findings

- The Board's findings are not binding on parties to any legal, disciplinary or other proceedings

TSB vs. NTSB

- The Chair and Board Members have no role in the fact finding portion of the investigation
- TSB produces findings as to causes and contributing factors vs. determination of proximate cause

TSB vs. NTSB

- Limited use of observers
- The IIC is the spokesperson for the investigation
- TSB is the keeper of rail occurrence data

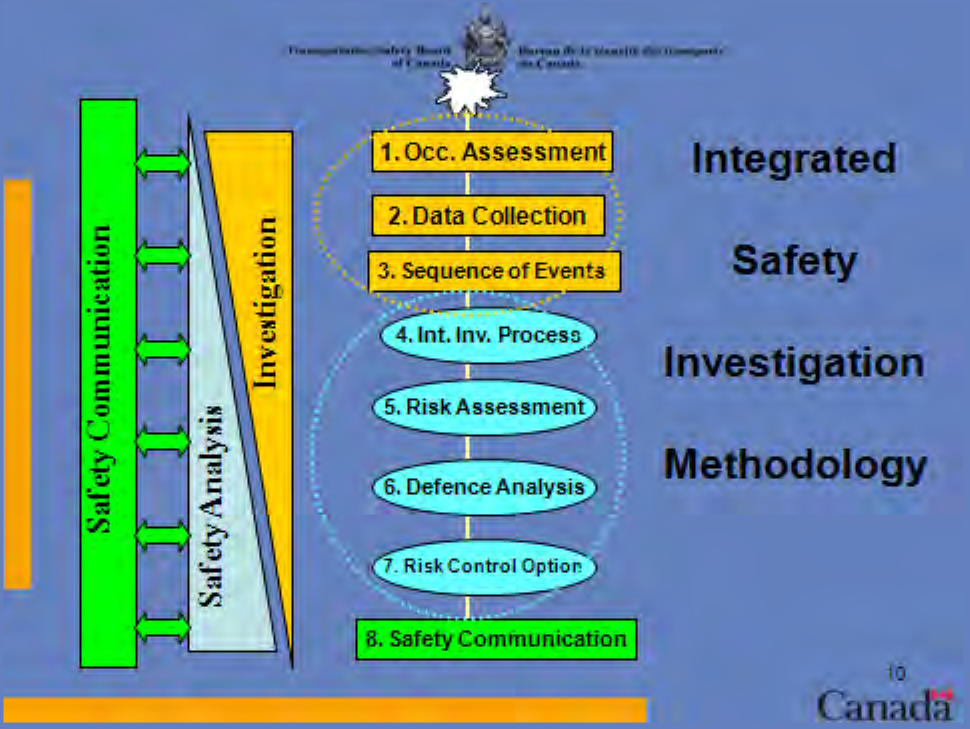
Protection of Information

- On-board voice recordings
- On board video recordings
- Witness statements
- Medical information
- Representation on the confidential draft
- The identity of persons making reports

The Rail Pipeline Investigation Branch

- RPIB – 25 Staff
- 13 Regional Investigators (…8 Regional Offices)
- 5 Head Office Investigators (…Specialists, Standards, Technical Co-ordinator)
- 1 Pipeline Investigators
- 3 Regions (…East, Central, West)

ISIM


Safety Communication
Safety Analysis
Investigation
1. Occ. Assessment
2. Data Collection
3. Sequence of Events
4. Int. Inv. Process
5. Risk Assessment
6. Defence Analysis
7. Risk Control Option
8. Safety Communication
Integrated
Safety
Investigation
Methodology
10
Canada

Train Derailment

Ashcroft Subdivision

Near Lytton, British Columbia

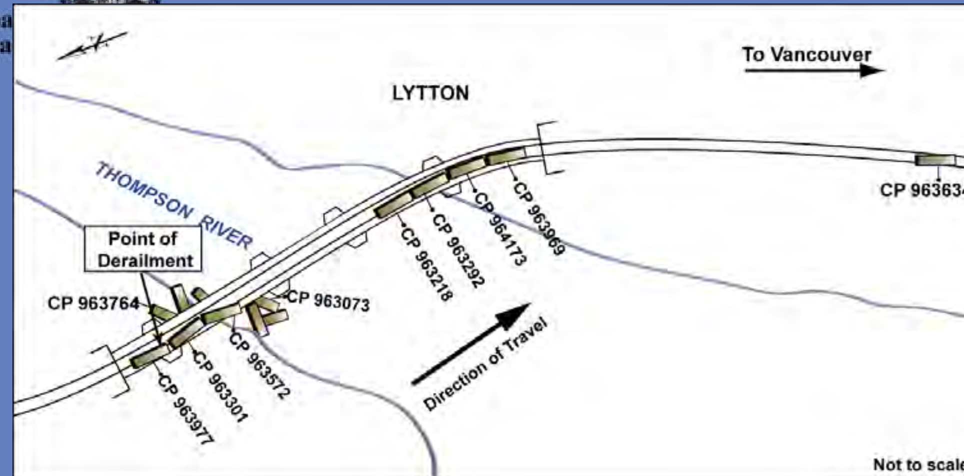
R06C0104

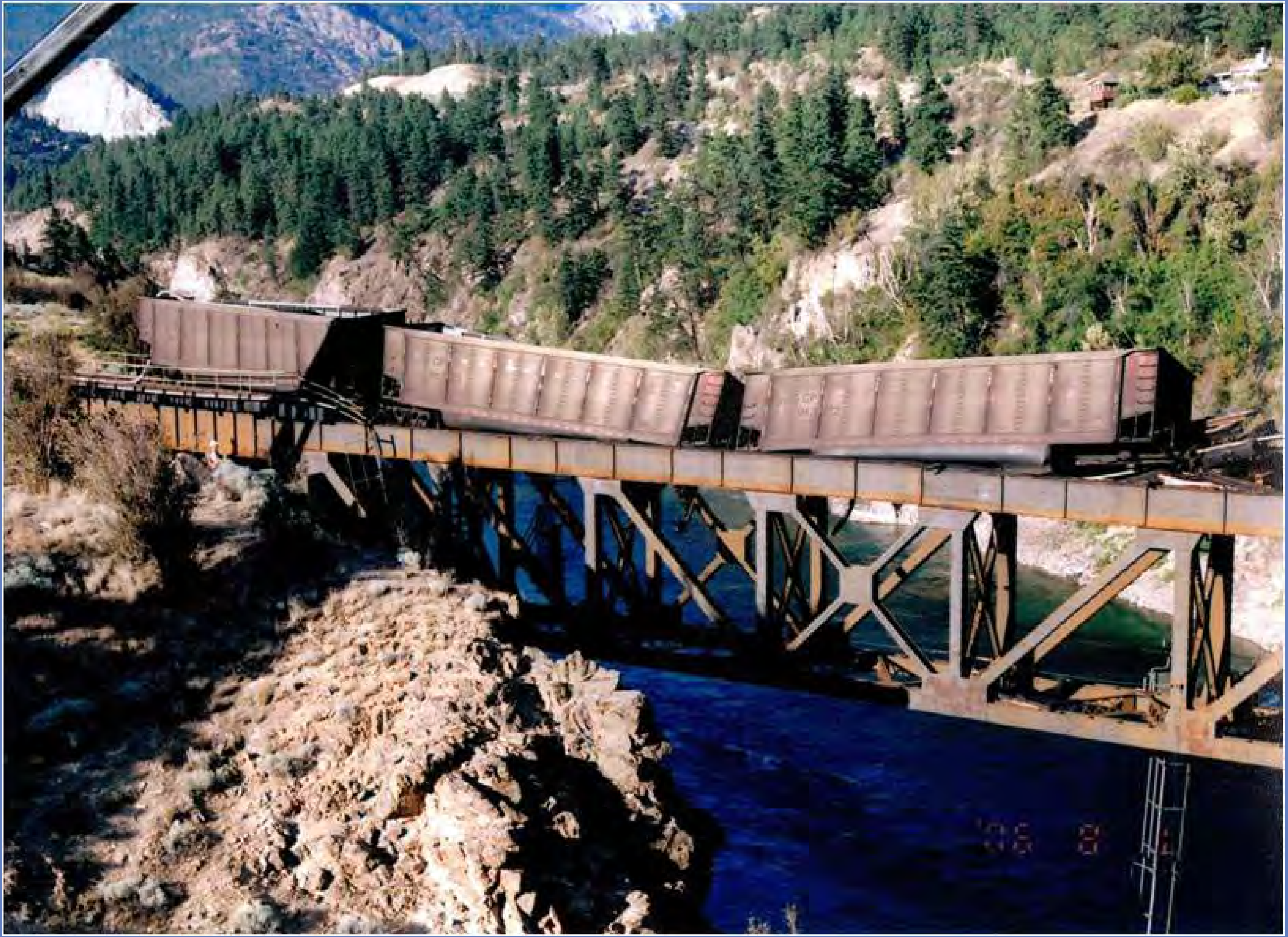
July 31, 2006

Derailment of a Coal Train (TSB occurrence R06C0104)

- Main-track train derailment on July 31 2006 at mile 97.4 of the Ashcroft Subdivision at Lytton, British Columbia
- Train 803 was operating on another class one railway westward from Kamloops to Vancouver, British Columbia, on a directional running agreement.
- Train consisted of 2 locomotives and 124 loaded coal hopper cars (17400 tons)

- 20 loaded coal cars derailed while travelling across the bridge over the Thompson River
- 12 cars fell off the bridge, spilling about 1400 tons of coal into the river
- Extensive damage to the track and bridge

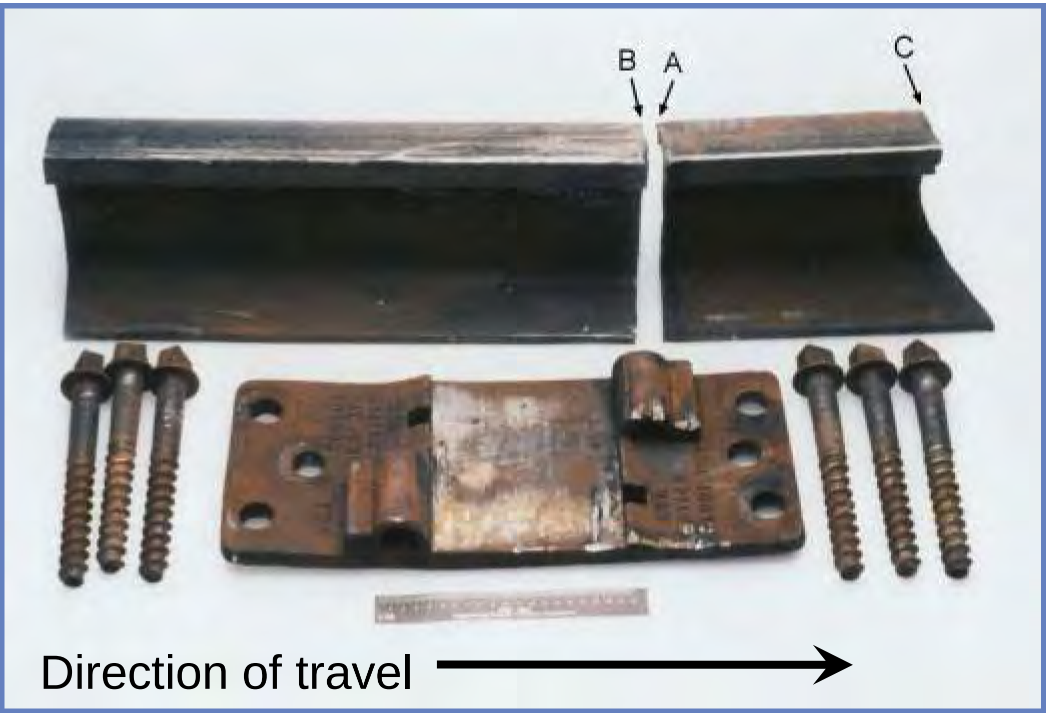




Canada

Recovered Rail Pieces and Fastenings

- Point of derailment was a broken rail on a tie plate
- Located 67 feet west of the east abutment (about 1 car length) on the north (high) rail and in the entry spiral of an 8-degree left-hand curve



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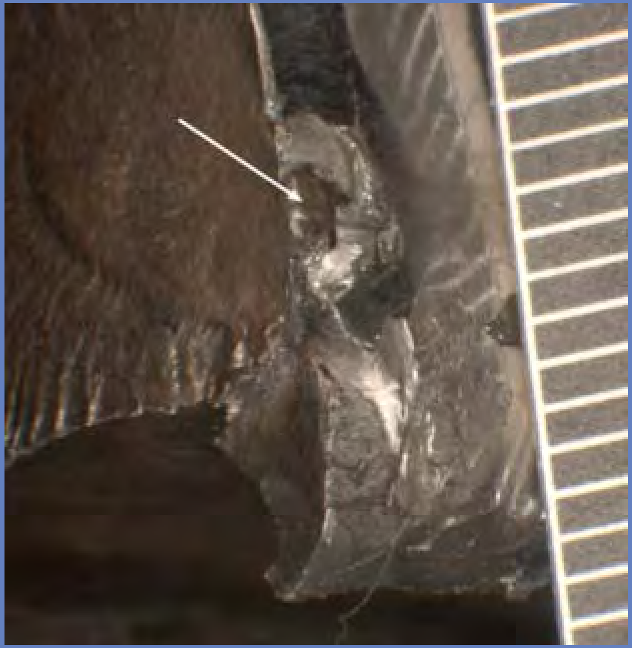
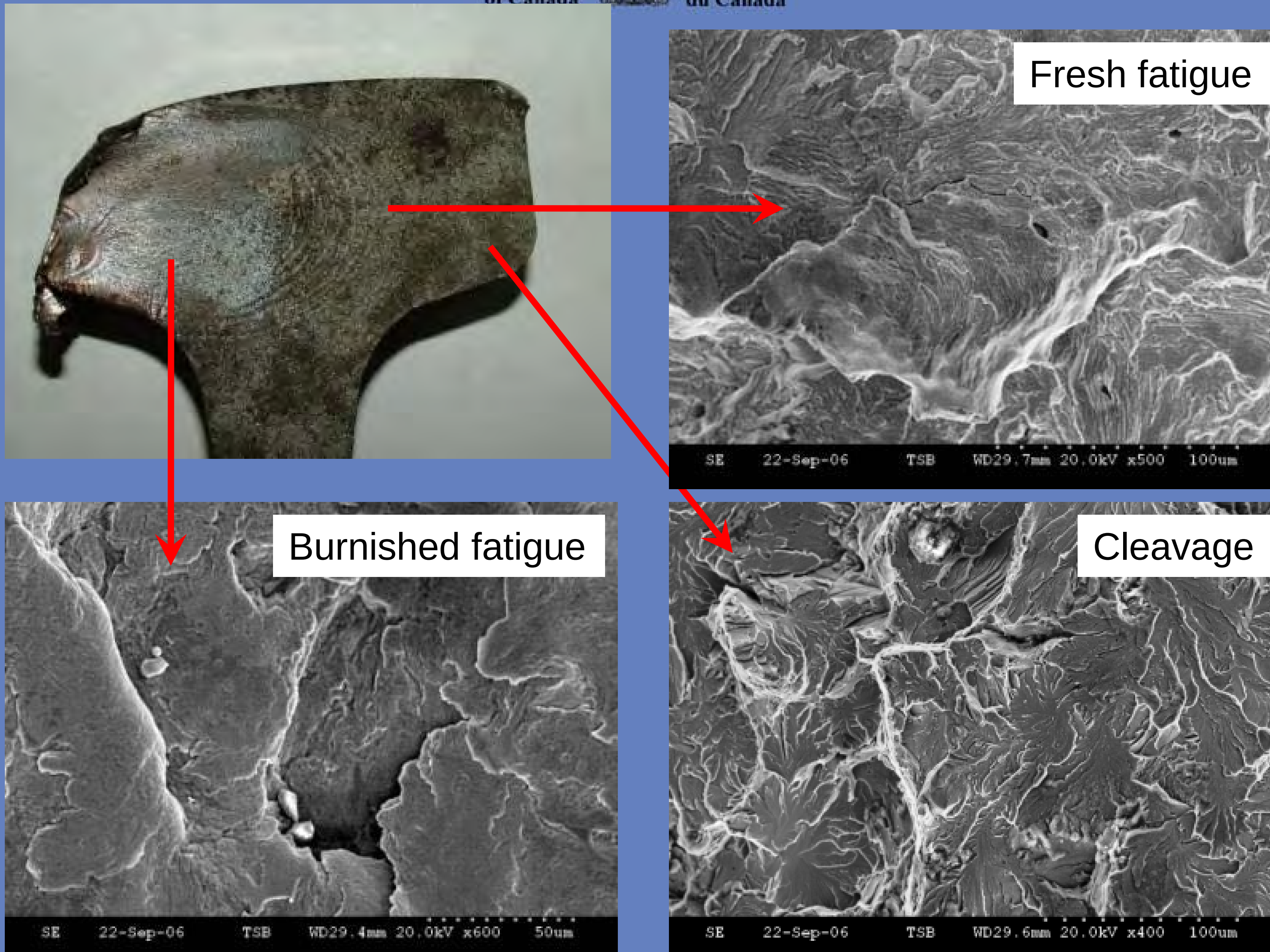
Fracture Face A

Beach marks in the fatigue crack region

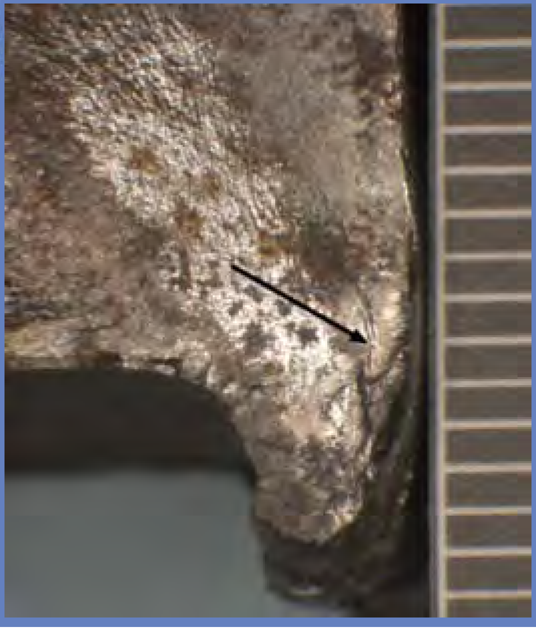
Fracture Face B



- Fractures A and B matched
- More battering on fracture B
- Crack initiated from a shell at the lower gauge corner.
- Lip created by plastic metal flow caused by wheel/rail contact overstress.


Fresh fatigue
SE 22-Sep-06 TSB WD29.7mm 20.0kV x500 100um
Burnished fatigue
SE 22-Sep-06 TSB WD29.4mm 20.0kV x600 50um
Cleavage
SE 22-Sep-06 TSB WD29.6mm 20.0kV x400 100um

Fracture Face C



Crack origin at a shell in the lower gauge corner

Beach marks in the fatigue crack region

Scuffing and tearing on gauge face

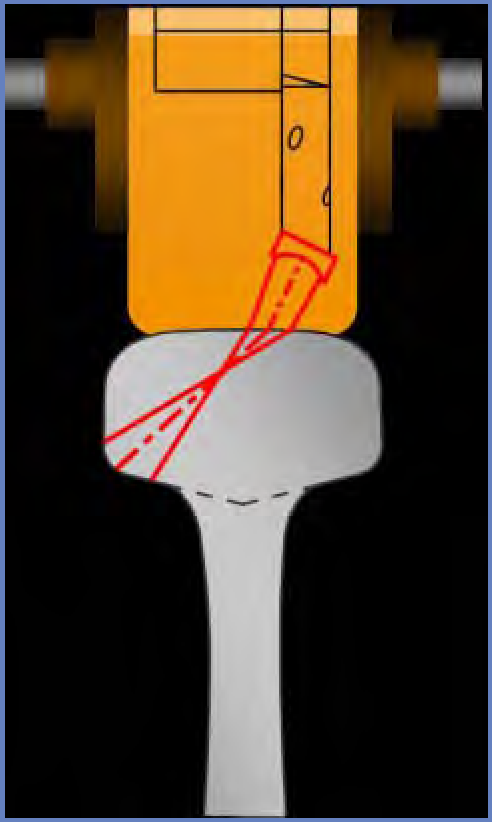
- Fine head checking, minor spalling, no visible evidence of shelling or corrugation.
- Rail showed 12 mm head wear and 6 mm flange wear.
- Rail did not exceed the specified limits for wear loss.

Rail Maintenance

- Grinding:
  - Remove surface damage such as corrugations, head checking, shells
  - Restore correct head profile, thereby correcting the contact geometry and relieving contact stress
  - Limitations of grinding equipment (cannot remove lip on lower portion of gauge face)
- Lubrication:
  - Wayside flange and top-of-rail lubricator system
  - Monitored by visual inspection
  - No monitoring of lubrication effectiveness by measurement of coefficient of friction at the wheel/rail interface

Rail Testing

- Transport Canada requires Class 3 track to be tested for internal defects at least once per year.
- Ashcroft Subdivision was being inspected 9 times per year.
- Sperry rail flaw detection car was run on 29 June 2006 (1 month before derailment).
- 12 probe Ultrasonic and induction-testing capability were conducted.
- No known defects in the curve at the time of the derailment.
- Next UT test was scheduled for mid-August, 7-10 days after the derailment.



Rail Testing

- Laboratory analysis concluded defects were present for some time
- June 2006 UT showed an indication near the location on the bridge where the rail broke
- Indication was attributed to a thermite weld upset/finish
- Shells and other defects can mask detail fractures (the UT signal reflects off the shell)
- Action taken:
  - Testing frequency was further increased
  - Indications interpreted as weld must be confirmed visually
  - All suspect indications are hand-tested

Conclusions

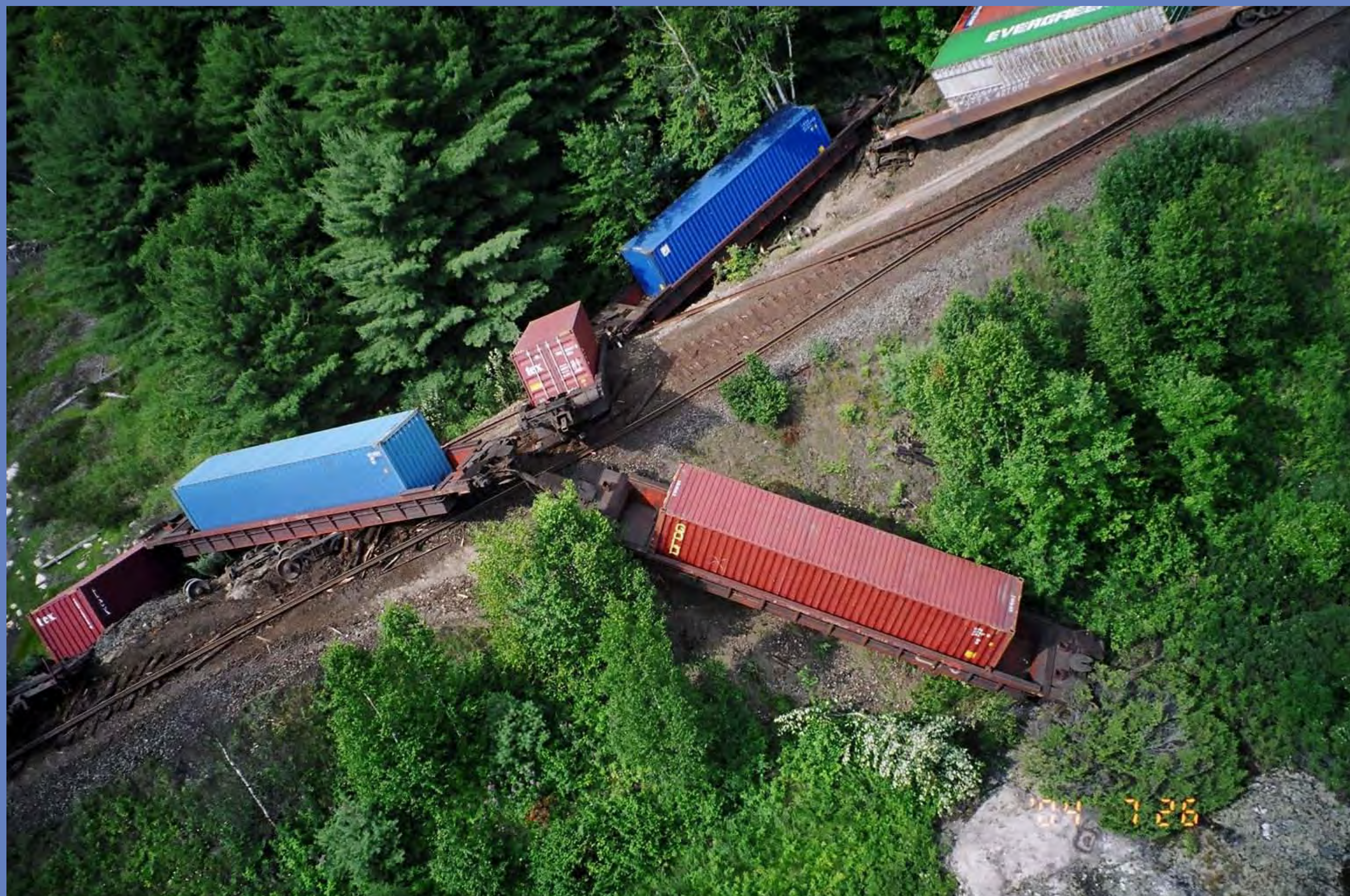
- The train derailed when a pre-existing detail fracture defect grew to a critical size leading to the rail breaking under the train.
- The detail fracture defect grew from a shell at the lower gauge corner at a lip created by plastic metal flow caused by wheel/rail contact overstress.
- The rail material met the requirements of the applicable specifications.
- Neither the train operation, the condition of the rolling stock, fastenings nor the bridge timber under the rail break were considered contributory to the accident.

Conclusions

- The detail fracture defects grew quickly, consistent with the heavy loading experienced by the track section*.
- Contributing factors to the derailment:
  - Difficulty of detecting these types of defects using UT
  - Rapid unpredictable growth rate of the defects
  - Ineffective rail lubrication program

Train Derailment
Bala Subdivision

Near Burton, Ontario
July 25, 2004



CAUSE(S)

- The 15th car, DTTX 750219, an articulated five-platform intermodal container car, was most likely the first car to derail
- The car generated a high lateral force and rolled the low rail on the five-degree portion of the right-hand compound curve
- After the train had begun to derail, both rails rolled over, leading to rail breaks due to torsional instantaneous overstress rupture in the high and low rails

Five Contributing Factors

- Car Design
- Rail Lubrication
- Wheel Conicity
- Track Fastening System
- Track Geometry

Car Design

- Simulation determined that under the single-platform car condition, the high impact force and large angle of attack for the leading truck disappeared
- The articulated car produced higher dynamic response than a similar single-platform car under the similar conditions at the derailment site

Rail Lubrication

- The absence of lubrication on the gauge face of the high rail resulted in increased flange/gauge friction
- This made truck rotation difficult leading to high lateral forces

Wheel Conicity

- Wheels on car the suspect car had been changed recently and were in nearly new condition
- Wheel/rail frictional forces are at their highest with newer profile wheels due to their reduced conicity compared with the conformal profile of a worn wheel.
- The newer profile, low conicity wheels would have contacted the rail head closer to the centreline of the rail and likely contributed to the unusually high dynamic responses

Rail Fastening System

- The high lateral stiffness of elastic fasteners on the high rail produced higher dynamic responses than more flexible fasteners with lesser stiffness.
- The conventional fasteners on the low rail provided insufficient counterbalance resistance to the high lateral forces on the high rail to prevent the low rail from rolling over.
- The simulation scenario of spikes on both rails resulted in reduced angle of attack and lateral forces, and consequently, reduced dynamic response.

Rail Fastening System Cont’d

- If elastic fasteners had been installed on both rails, the high rail likely would have still produced higher dynamic forces but the increased strength of the elastic fasteners on the low rail would have provided increased resistance to the lateral force
- The installation of elastic fasteners in curves on one rail only and/or on only a portion of the curve increases the risk that excessive lateral force will be transferred to the rail with conventional spike and plate fastenings, leading to rail breaks and/or rollover.

Track Geometry

- The simulation determined that the small gauge and alignment variations were necessary triggers for the unusually high dynamic responses
- The deviations likely caused the leading truck to contact the high rail at a very large angle of attack, jarring the truck aggressively into the low rail and increasing the lateral curving forces enough to roll over the less-restrained low rail

Train Derailment
Mactier Subdivision

Buckskin, Ontario
January 31, 2006

Canada

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Cause and Contributing Factors

- The car derailed at Mile 114.65 when the L1 wheel became loose while traversing a curve and migrated inboard, causing both wheels to drop between the rails.
- While in service between October 2004 and the derailment date, undetectable brinelling, micro-movement and fretting at the wheel bore/axle seat interface progressively loosened the reconditioned L1 wheel until a combination of lateral and rotational forces displaced the wheel inboard.

- In 2000, loose wheels began to occur on a coal rail car fleet.
- By fall 2001, the railway had traced the problem to a modified wheel boring process that had been used in the assembly of 36-inch wheel sets at its wheel shop between April 1998 and February 2001 (approximately 43 800)
- The modified boring process resulted in wheel sets with a 60% reduction in contact area between the wheel bore and axle wheel seat.
- The reduced contact area led to higher contact stresses causing fretting that progressively loosened the interference fit resulting in wheel sets to have a high susceptibility to loosen, particularly in heavy-curvature territory.

Safety Action Taken

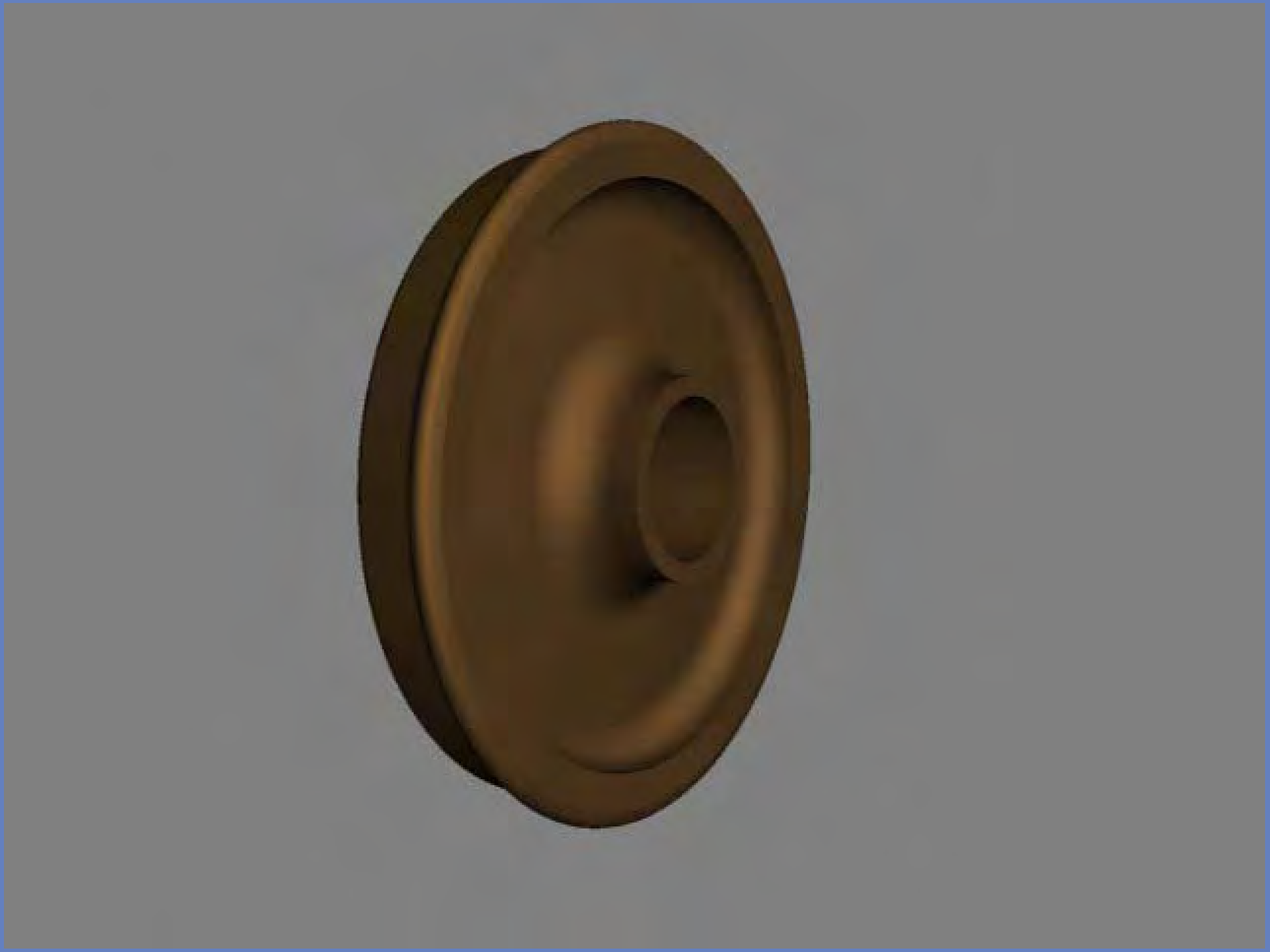
- On 31 July 2006, the AAR issued Circular C-10343 which contained MA 74 Supplement 1 (MA 74-S1) instructing railways to continue looking for cars with the company’s wheel shop wheel sets with locking plate mount dates between April 1998 and December 1999
- On 23 October 2006, the AAR issued Circular C-10377 implementing changes to AAR’s G-II Manual Rule 1.3.5 to define minimum finish bore limits for wheels.
- On 28 November 2006, the AAR issued AAR Circular C-10415, which contained MA 74 Supplement 2 (MA 74-S2) providing a new expiration date for the removal of the wheel sets and expanded the date range for the suspect wheel sets to include the full manufacturing window (April 1998 to February 2001)

Safety Action Taken

- The railway installed wheel profile detectors (WPDs) that provide back-to-back wheel set gauging and automatically measures brake shoe wear on each car
- The AAR, through its Transportation Technology Center, Inc. (TTCI), is actively pursuing the use of radio frequency identification (RFID) tags to track railroad components.

TSB Recommendations

- The Department of Transport ensure that all the 36-inch wheel sets assembled at this company's shop, between April 1998 and February 2001 be removed from cars operating in Canada.
- The Department of Transport ensure that railways adopt procedures and technologies to track all wheel sets.



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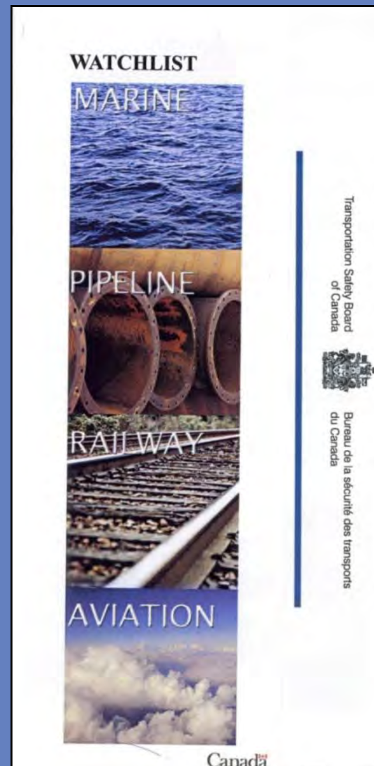
WATCHLIST

- Fishing vessel safety
- Emergency preparedness on ferries
- Passenger trains colliding with vehicles
- Operation of longer, heavier trains
- Risk of collisions on runways
- Controlled flight into terrain
- Landing accidents and runway overruns
- Safety Management Systems
- Data recorders



Canada

WATCHLIST

<u>**Rail issues**</u>

Passenger trains colliding with vehicles

Operation of longer, heavier trains

Derailed Canada psgr train following crossing accident, Mackay, AB

Aerial photo of derailed cars, Cobourg. ON

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WATCHLIST

Multi-modal issues

Safety Management Systems

Data recorders

Derailed locomotive, Lillooet, BC

Touchdown short of runway, Bombardier Global 5000, Fox Harbour, NS

Voyage data recorder (marine)

Destroyed locomotive event recorder, Lillooet,

Flight data recorder (air)

Canada

Thank You

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