



Rideau Transit Group
805 Belfast Road
Ottawa, ON K1G 0Z4

October 8, 2021

City of Ottawa
110 Laurier Avenue West
Ottawa, ON K1P 1J1

Our Reference:	RTG-OTT-58-0-LET-1293
RTM Reference:	RTM-RTG-00-0-LET-0170
Project Agreement Reference:	N/A

Attention: Michael Morgan
Director, Rail Construction Program

Subject: Derailment of LRV21 - 8D Summary

Dear Mr. Morgan:

Please refer to the attached correspondence from RTM which includes a copy of the Derailment of LRV21 8D Summary report.

Please note that we are providing a copy of this report as a courtesy at this time as RTM is currently in the process of reviewing the report for completeness and accuracy.

Should you have any questions, concerns, or require additional information please do not hesitate to contact us.

Regards,

Nicolas Truchon, CFA, MBA
Chief Executive Officer
Rideau Transit Group General Partnership

cc.: City: Lorne Gray, Troy Charter
RTG: Bruno Tremblay
RTM: Mario Guerra

Attachments: 1) RTM-RTG-00-0-LET-0170 - Derailment of LRV21 - 8D Summary



Rideau Transit Maintenance
805 Belfast Road
Ottawa, ON K1G 0Z4

October 8, 2021

VIA EMAIL TO

Mr. Nicolas Truchon
Chief Executive Officer
Rideau Transit Group
805 Belfast Road
Ottawa, ON K1G 0ZA

RTM Letter No:	RTM-RTG-00-0-LET-0170
Replying To:	None
Reference:	ALSMNT-RTM-0989 Ottawa Light Rail Transit Project Amended & Restated Maintenance Contract dated September 16, 2019, between Rideau Transit Group General Partnership, a general partnership established under the laws of Ontario (“ RTG ” and/or “ Project Co ”) and Rideau Transit Maintenance General Partnership, a general partnership established under the laws of Ontario (“ RTM ” and/or the “ Maintenance Contractor ”), the “ Maintenance Contract ”.
Action Required:	

Subject: Derailment of LRV21 - 8D Summary


Dear Mr. Truchon,

Please find attached letter ALSMNT-RTM-0989, including a copy of the Derailment of LRV21 - 8D Summary, received from the Maintenance Subcontractor. RTG is requested to circulate this letter and the enclosed 8D report to the City as a courtesy, RTM is currently in the process of thoroughly reviewing the document for completeness and accuracy.

RTM reserves all its rights under contract, at law and in equity.

Sincerely,

Rideau Transit Maintenance General Partnership



Mario Guerra, General Manager



Attachments: ALSMNT-RTM-0989 (Derailment of LRV21 - 8D Summary)

Cc.: Meaghan Walser, Bruno Tremblay – RTG
James Messel, Steve Nadon, Tania Seely – RTM



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Mr. Mario Guerra
Chief Executive Officer, Acting General Manager
Rideau Transit Maintenance General Partnership
805 Belfast Road
Ottawa, ON K1G 0Z4

Ottawa, October 07, 2021

Letter No.: **ALSMNT-RTM-0989**
In reply to: None
Action: RTM
Letter Ref.: None
Subcontract: Second Amended and Restated Maintenance Subcontract dated September 16, 2019
("Subcontract"); Article 7.3 of Attachment 50 – Interface Rights and Obligations

Subject: Derailment of LRV21 on the 19th of September 2021

Dear Mr. Guerra,

In relation to the derailment of LRV 21 on the 19th of September and further to Alstom letter ALSMNT-RTM-0978, please find attached the 8D summary.

Based on the available data, the gearbox hub failure was caused by the lack of torque on the gearbox hub retaining bolts. Repair data indicates that the retaining bolts were improperly torqued during the cartridge bearing assembly refurbishment.

Please be notified that Alstom presents this letter without waiving and with express reservation of Alstom's rights and remedies as may be available under the Maintenance Subcontract Agreement, any other contract, applicable law, rules or regulations whether at law or in equity. In no event shall this letter constitute nor be deemed to be a waiver by Alstom of any of its rights or remedies with regards to the above

Sincerely,

Richard France
Project Manager



Attachment(s): - LRV21 - Derailment - 8D summary

cc: James Messel, RTM
Karim Farran, Alstom



WITHOUT PREJUDICE
Ottawa Safety Alert
LRV21 Derailment
8D#218742

Last Update : 07/10/2021

Agenda

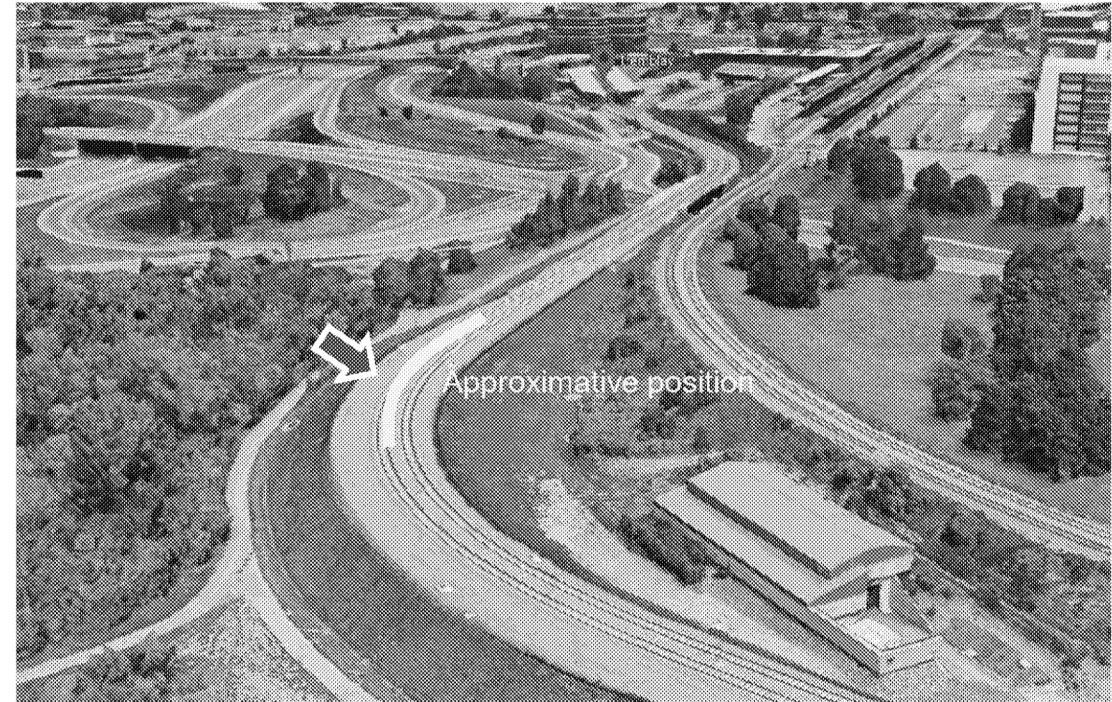
1. Incident Initial Observations
2. Incident Timeline
3. Containment Action & Safety Notice
4. Root Cause Analysis
5. General Information
6. 8D Summary

01

Incident Initial Observations

Incident Report

- Incident: Derailment
- Vehicle: LRV21
- Train Configuration running as the trailing car, with LRV38, in a 2 car multiple-unit train
- Location: moving in westbound direction, after switch 315 West of Tremblay station
- Date: 19/09/21, approx 12:05 PM

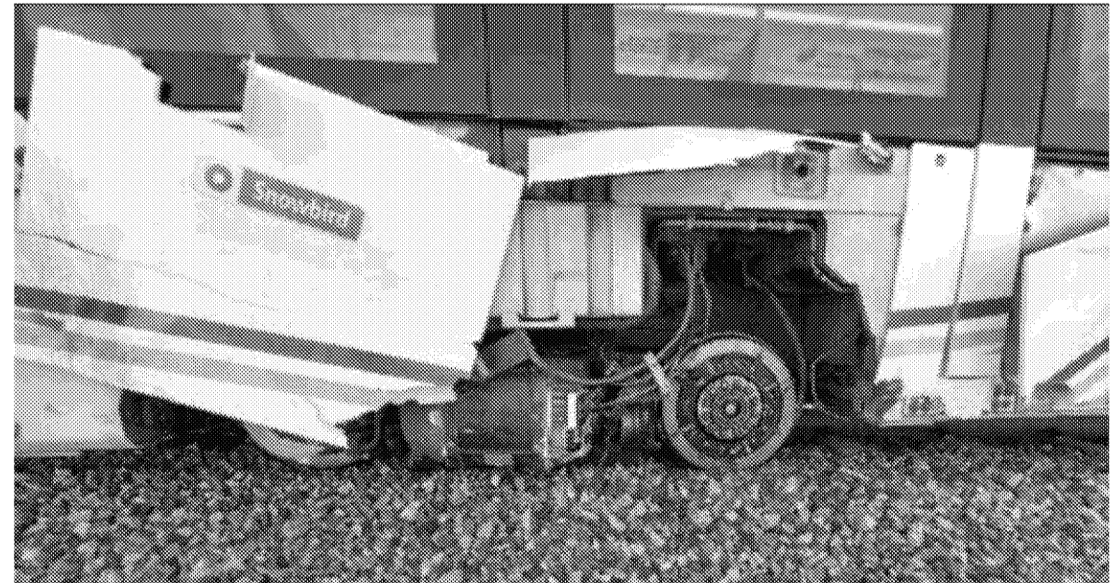


Incident Report

Initial damage assessment (based on vehicle summary inspection and complete right of way walk through):

- Gearbox
- Traction link
- Gearbox coupling
- Traction motor and components
- Multiple fasteners, brackets and clamps
- Side skirts
- Switch machine
- Switch heater
- Signaling post
- Several concrete ties at Tremblay station
- Scratch marks along the station platform and ballast projection were observed

Refer to slides 20-26 for details



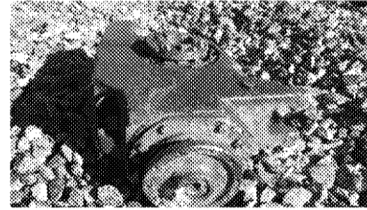
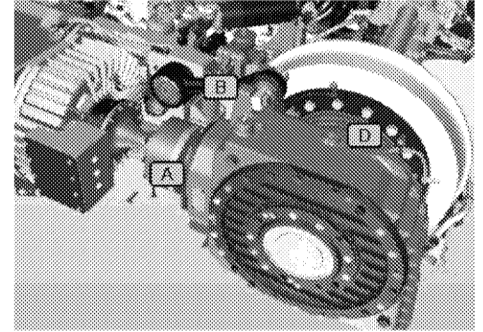
02

Incident Timeline

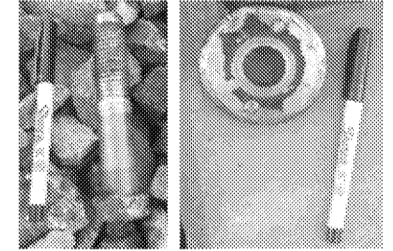
Most Probable Scenario

After logs review & track findings

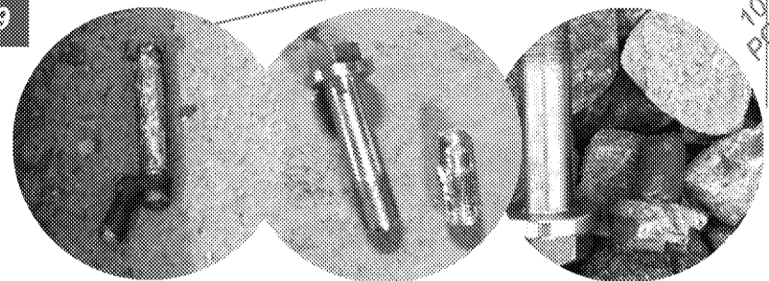
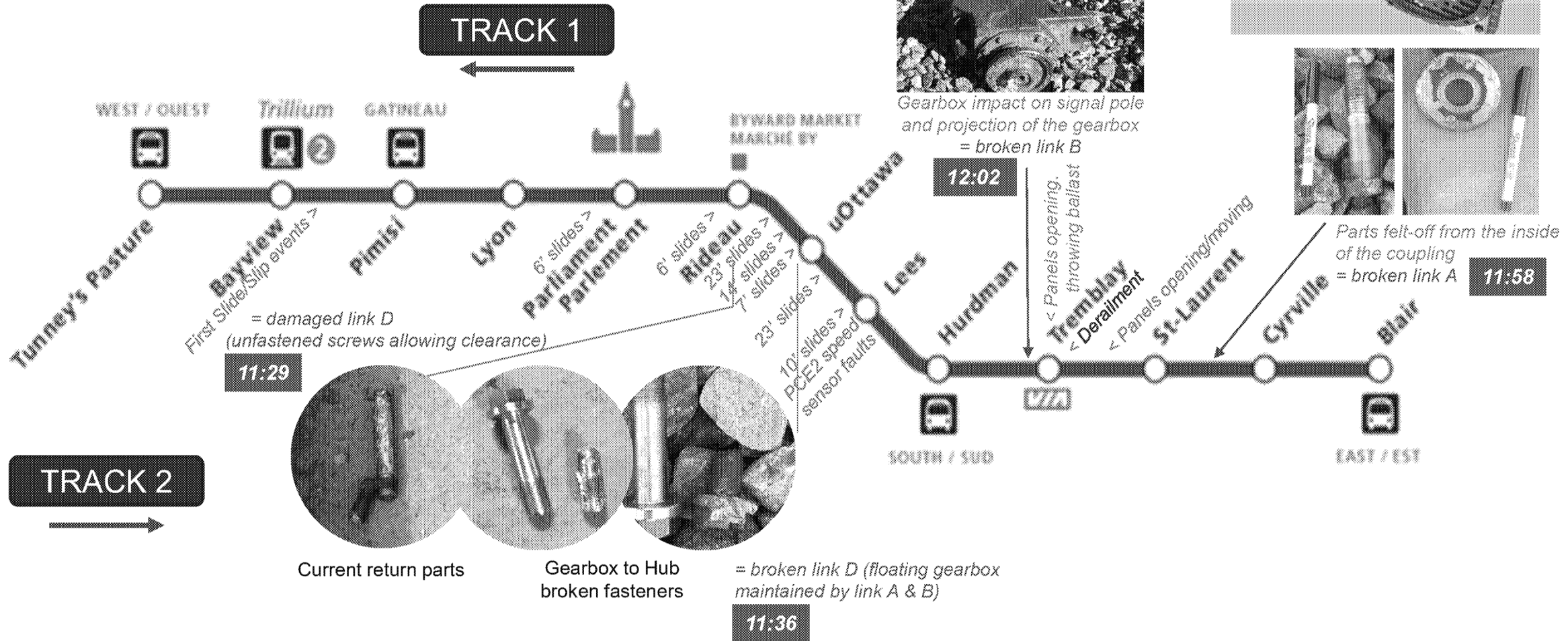
- A | Link between coupling & gearbox
- B | Link between the reaction rod & the gearbox
- D | Link between the gearbox hub and the axle



Gearbox impact on signal pole and projection of the gearbox = broken link B



Parts felt-off from the inside of the coupling = broken link A



Current return parts

Gearbox to Hub broken fasteners

= broken link D (floating gearbox maintained by link A & B)

11:36

TRACK 2 →

03

Containment Action & Safety Notice

/! Immediate Grounding of the Fleet !/

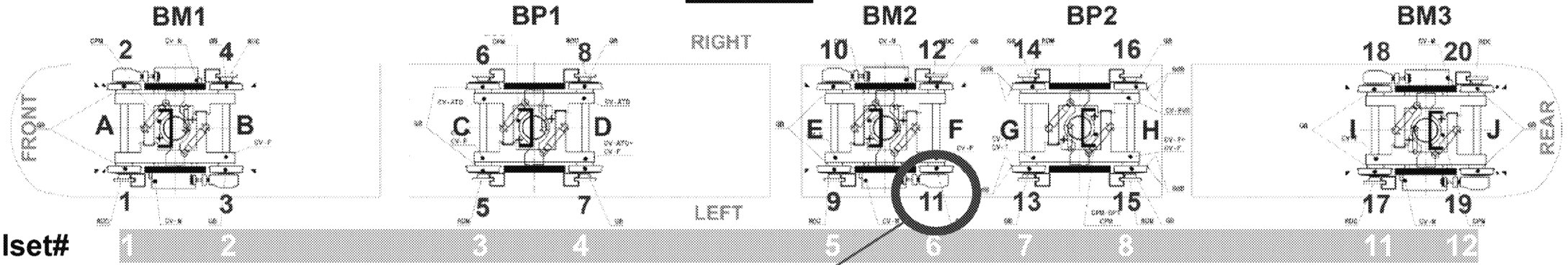
04

Root Cause Analysis

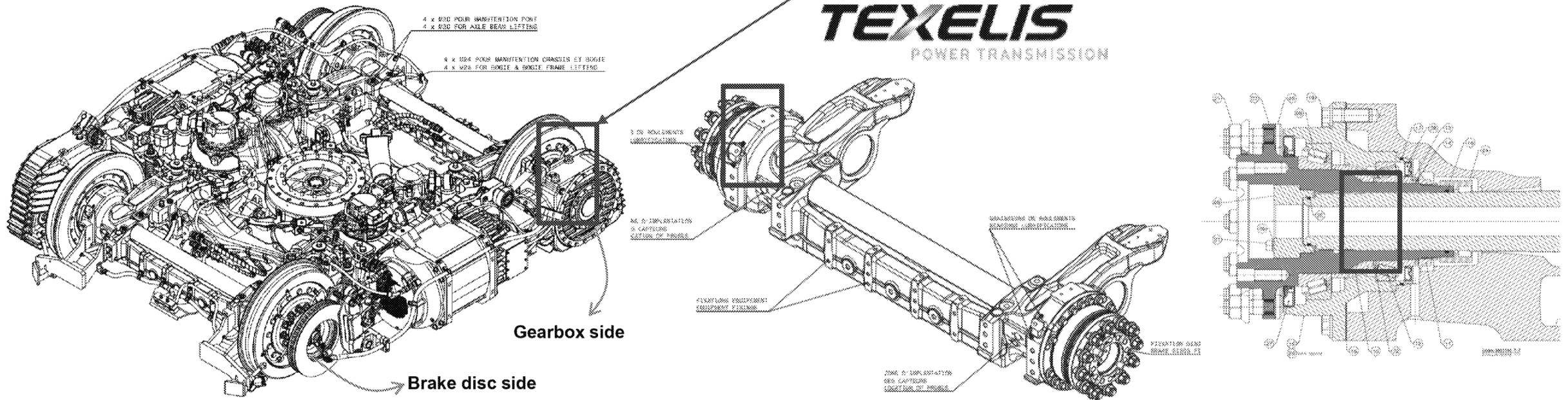
Terminology & Common References

BM: Bogie Moteur=Motor Bogie
 BP: Bogie Porteur=Trailer Bogie

LRV 21



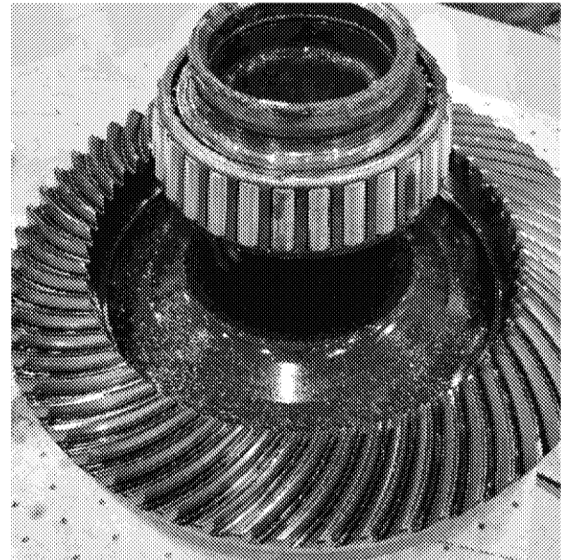
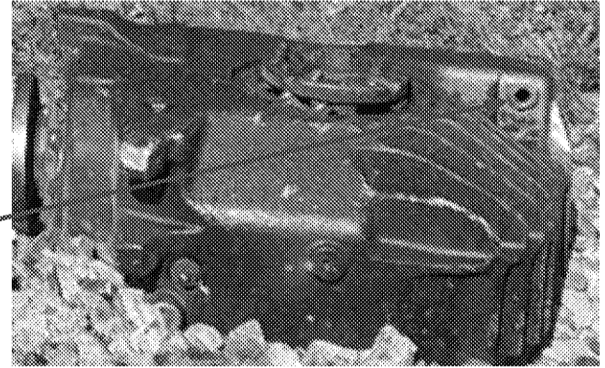
Wheelset#



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Root Cause Analysis *Investigation on Gearbox*

- External Inspection of gearbox disconnected from BM2
 - Gearbox damage on exterior showing multiple strikes
 - Missing gearbox oil screw
- Internal inspection of gearbox on BM2
 - All gears are in good condition
 - No trace of internal structural damage
 - Trace of something that looks like rocks in the remaining oil
 - No trace of rock damages on any pinions/gears
- Pre-incident inspection:
 - Gearbox was in good condition prior to the derailment
 - Free turning of all components



Gearbox is removed from the potential root cause

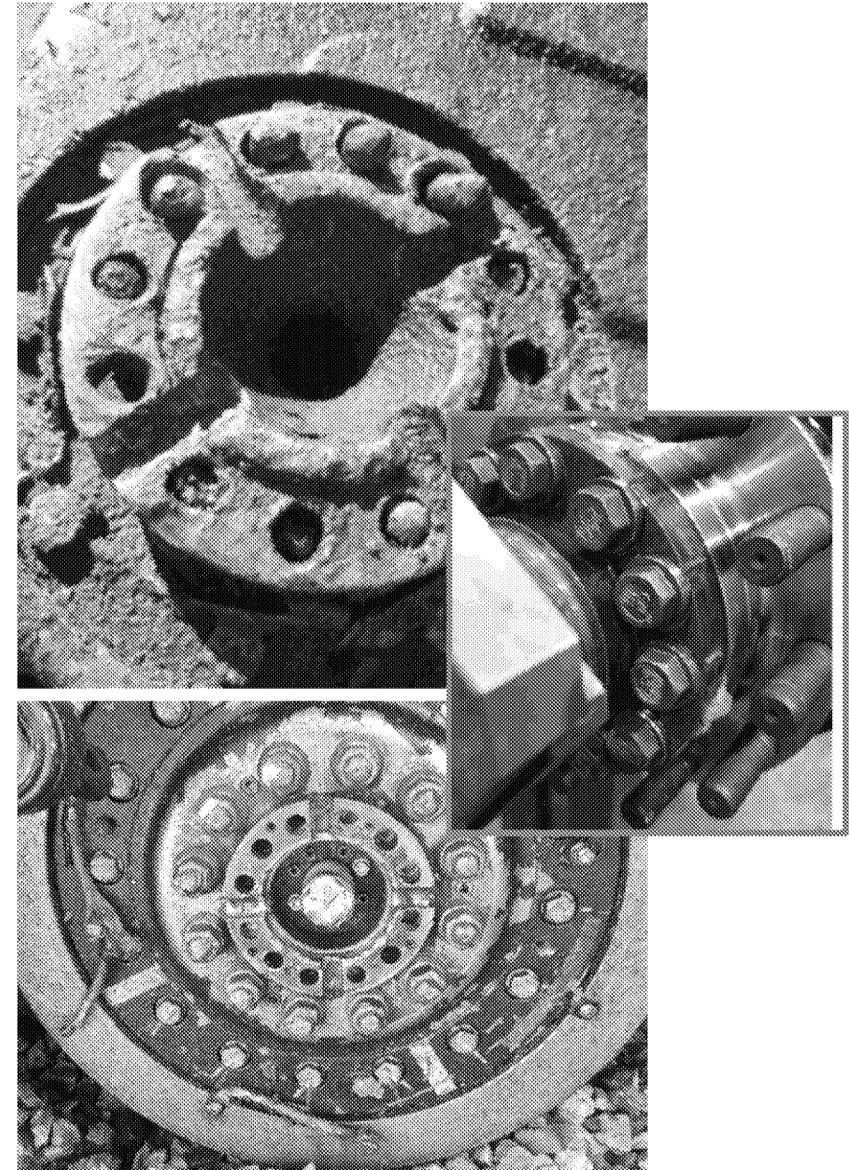
Root Cause Analysis

Investigation on Axle Assemblies

- The gap inspection and repair procedure (when needed) was introduced immediately following the derailment of LRV 19 on August 8th. The inspection and repair were new activities for the team.
- LRV 21 failed the gap inspection criteria on 3 axles (2 axles on BM3 and 1 axle on BM2). The 3 axles had to be repaired with new cartridge bearing assemblies and shafts. It was only the 6th time that a repair was needed.

43	BP1		BM2		BP2		BM3	
LRV ▾	Axle 3 ▾	Axle 4 ▾	Axle 5 ▾	Axle 6 ▾	Axle 7 ▾	Axle 8 ▾	Axle 11 ▾	Axle 12 ▾
21	OK	OK	OK	0.33mm	OK	OK	0.18mm	0.36mm
	OK	OK	OK	OK	OK	OK	OK	OK

Inspection Results on gap check leading to 2 bearing hub repairs on LRV21



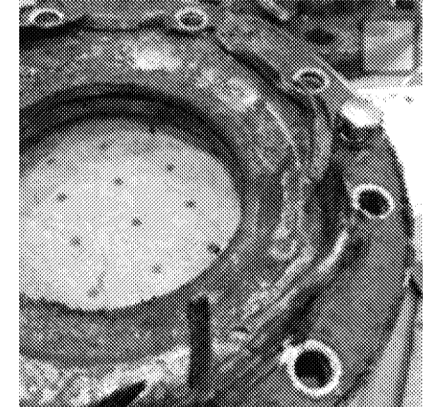
Root Cause Analysis

Investigation on Axle Assemblies

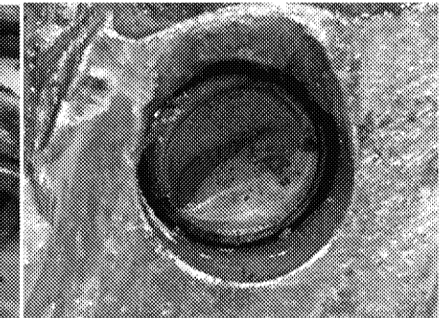
- Inspection of **BM3** from LRV21
 - Proper marking/torqueing of the 2 x BM3 gearbox hub
 - With Transportation Safety Board (TSB), torque was validated with 250Nm
 - All bolts tested and passed
 - Axles from BM3 confirmed officially torqued

- Hardware of **BM2** from LRV21
 - Shape of the broken screws on the BM2 gearbox hub
 - Broken at different lengths
 - Bending of the parts observed
 - Rubbing on the gearbox frame observed
 - No signs of plastic deformation as a consequence of having been torqued

After only 800 km of travel following axles refurbishment, evidence points to the gearbox disconnecting from the axle due to its fasteners loosening and breaking (ductile rupture) caused by the in-service gearbox loads and vibrations



Global view of the broken bolt of LRV21 Axle #6



Root Cause Analysis

Investigation on Repair Activities

- Records of the torqueing actions are logged by the automatic torqueing tool (Atlas Copco)
- The refurbishment records should show 3 brake disk torque applications and 3 gearbox hub torque applications
- Records show data for only 2 gearbox hub torque applications

Date	Reduce hub	Brake disk	Car in MSF2/Planning	Hub data missing	Brake data missing	Car Texelis documents	Texelis changes	Bogie	SN	Axel
10-sept	0	3	21				0			
09-sept	2	0	21	x		21	3	BM3 BM2	21	12, 11 6

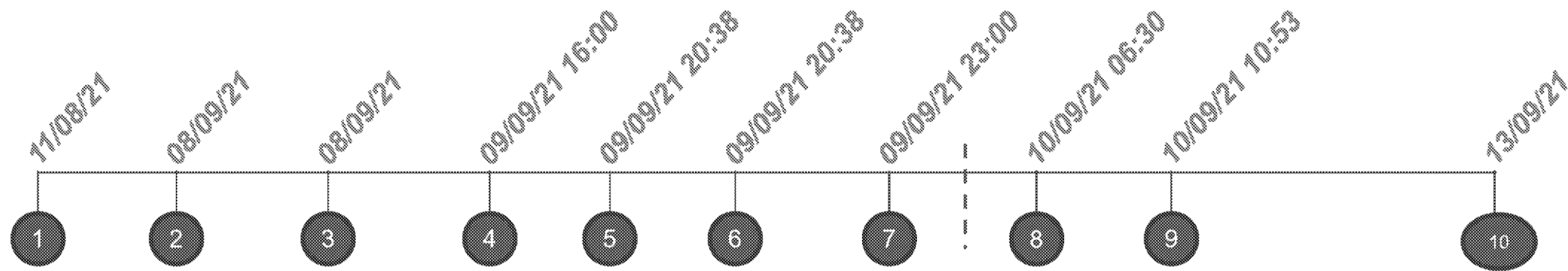
Data summary and dataset from torqueing tool

Virtual station name	VIN	Date and time	Batch sequence name	Date	Brake disk done	Axels done	Batch sequence count	Batch count	Status	Status info	Tightening program/Multistep r
BOGIE RETROFIT	WOR005WOR0021BRAKEDISCTI	09/10/2021 10:53:06	1 BRAKE DISC	10-09-2021	1		1	12	Tightening OK	Tightening OK	8.1 BRAKE DISC TIGHTENING
BOGIE RETROFIT	WOR006BM3-0251BRAKEDISCTI	09/10/2021 09:22:32	1 BRAKE DISC	10-09-2021	1		1	12	Tightening OK	Tightening OK	8.1 BRAKE DISC TIGHTENING
BOGIE RETROFIT	WOR005BM2-0251BRAKEDISCTI	09/10/2021 06:20:07	1 BRAKE DISC	10-09-2021	1		1	12	Tightening OK	Tightening OK	8.1 BRAKE DISC TIGHTENING
BOGIE RETROFIT	WOR007BM3-0251REDUCER-HUB	09/09/2021 20:38:56	1 REDUCER HUB	09-09-2021		2b	2	12	Tightening OK	Tightening OK	16.REDUCER HUB 150 ANG
BOGIE RETROFIT	WOR007BM3-0251REDUCER-HUB	09/09/2021 20:34:17	1 REDUCER HUB	09-09-2021		2a	1	12	Tightening OK	Tightening OK	15.REDUCER HUB 150
BOGIE RETROFIT	WOR007BM3-0251REDUCER-HUB	09/09/2021 18:54:53	1 REDUCER HUB	09-09-2021		1b	2	12	Tightening OK	Tightening OK	16.REDUCER HUB 150 ANG
BOGIE RETROFIT	WOR007BM3-0251REDUCER-HUB	09/09/2021 18:48:45	1 REDUCER HUB	09-09-2021		1a	1	12	Tightening OK	Tightening OK	15.REDUCER HUB 150

Operations 3a and 3b (12 batch count) are not present in the torqueing tool dataset

Root Cause Analysis

Investigation on Repair Activities



Repair Activity Timeline – LRV21 Cartridge Bearing Assembly Refurbish

1. Hub inspection failure
2. Bogies removed from car
3. Axles dismantling
4. Texelis (COH) hub change
5. Torqueing of axles
6. Self inspection (application of torque mark)
7. End of the shift
8. Start of the new shift
9. Torqueing of the brake disks
10. Car released from repair

Root Cause Analysis

Investigation on Repair Activities

Context

- The investigation and refurbishment activities were conducted on an expeditious basis within a climate of intense pressure from all stakeholders. The pressure on the team was constant and was flowed down systematically by way of multiple site visits to our assemblers working on the vehicles as there was a need to return the fleet to full service levels.
- The refurbishment operation was a newly introduced repair activity, following LRV19 derailment (Aug 8th) and not performed often (only when the gap inspection failed). It was only the 6th time that the repair operation was done.
- The missed torqueing happened during a transfer of shift with one crew ending without the work done but not clearly expressed to the following crew.

Based on the above, and the supporting repair data, conclusion is that the 12 bolts retaining the gearbox hub on BM2 position 11 were improperly torqued and not adequately verified.

Root Cause Analysis

Conclusion

Based on the available data, the gearbox hub failure was caused by the lack of torque on the gearbox hub retaining bolts. Repair data indicates that the retaining bolts were improperly torqued during the cartridge bearing assembly refurbishment

There is no evidence to suggest that the vehicle design is at fault

At this juncture, although the hub replacement on LRV21 was initiated as an outcome of the containment actions for the LRV19 derailment, the root cause of both events are completely different.

They must be treated separately regarding containment & corrective actions.

Strong countermeasures in relation to the identified root cause shared in this document have already been partially implemented and will be shared in the next days. All countermeasures will be included in the re-introduction to service plan.

05

General information

Data analysis of the Axles (Torque)

Équipement					
Type	Nom				
PONT TEXELIS	Iponam 5122890				
Train:	21				
Modèle:	5122890				
PONT TEXELIS	Iponam 5122813				
Train:	21				
Modèle:	5122813				
PONT TEXELIS	IPONAM 5123117				
Modèle:	189018				
No série:	5123117				
Feuille de temps					
Nom	Date	Début	Fin	Durée	Activité
Joel Cristofaro	2021-09-09	06:30	08:30	2:00	En route
Jimmy Vaudrin	2021-09-09	06:30	08:30	2:00	En route
Joel Cristofaro	2021-09-09	08:30	16:00	7:30	En cours
Jimmy Vaudrin	2021-09-09	08:30	16:00	7:30	En cours
Joel Cristofaro	2021-09-09	16:15	18:45	2:30	En route
Jimmy Vaudrin	2021-09-09	16:15	18:45	2:30	En route
Signature Employé		Signature Client			
Joel Cristofaro					

Data sheet from Texelis

LRV21 Derailment

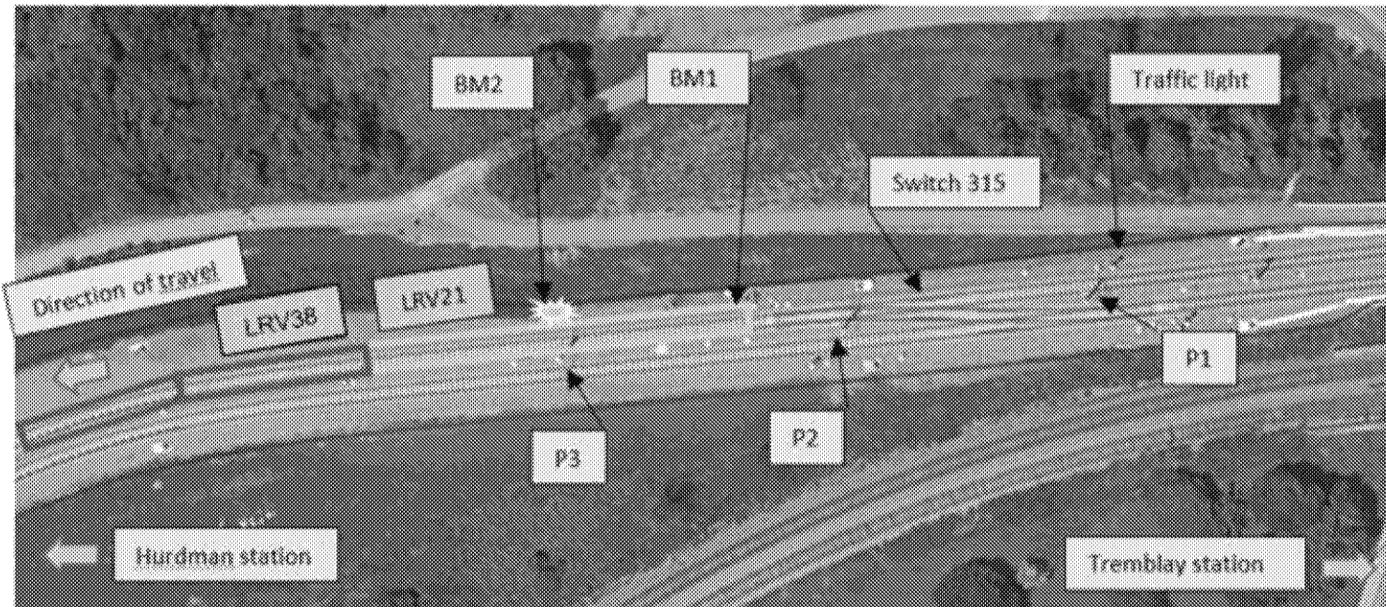
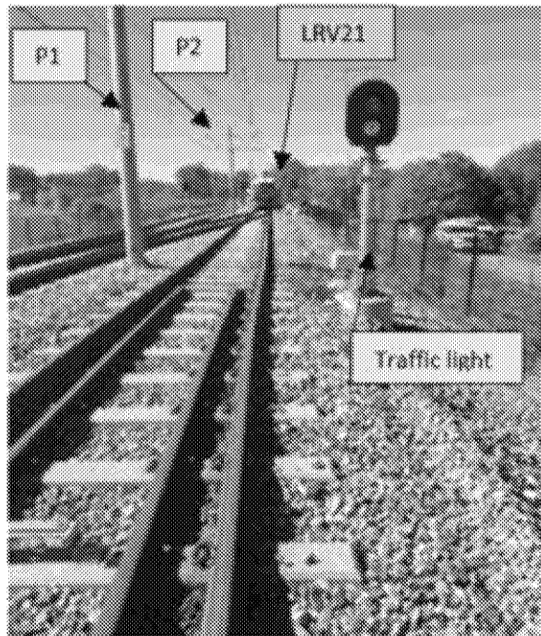
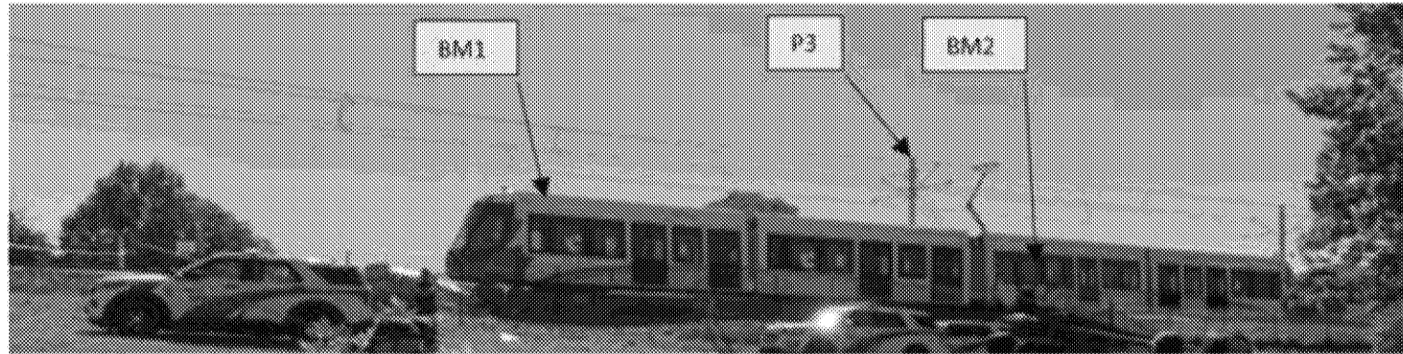
Information on LRV21

- Distance travelled since axle hub replacement: 753 km

MeasDoc.	Func. Loc.	Date	Measurement position	MeasRdg in entry unit	*Cntr..	Differen..
38359101	CAOTT-1121	01.09.2021	ODOMETER_READING	229068	229068	0
38405685	CAOTT-1121	02.09.2021	ODOMETER_READING	229068		0
38455116	CAOTT-1121	03.09.2021	ODOMETER_READING	229068		0
38494764	CAOTT-1121	04.09.2021	ODOMETER_READING	229068		0
38540536	CAOTT-1121	05.09.2021	ODOMETER_READING	229068		0
38583169	CAOTT-1121	06.09.2021	ODOMETER_READING	229068		0
38626557	CAOTT-1121	07.09.2021	ODOMETER_READING	229068		0
38672032	CAOTT-1121	08.09.2021	ODOMETER_READING	229068		0
38720345	CAOTT-1121	09.09.2021	ODOMETER_READING	229068		0
38807203	CAOTT-1121	11.09.2021	ODOMETER_READING	229068		0
38851129	CAOTT-1121	12.09.2021	ODOMETER_READING	229068		0
38897229	CAOTT-1121	13.09.2021	ODOMETER_READING	229068		0
38944357	CAOTT-1121	14.09.2021	ODOMETER_READING	229079	229079	11
38987156	CAOTT-1121	15.09.2021	ODOMETER_READING	229151	229151	72
39034286	CAOTT-1121	16.09.2021	ODOMETER_READING	229178	229178	27
39081774	CAOTT-1121	17.09.2021	ODOMETER_READING	229257	229257	79
39125781	CAOTT-1121	18.09.2021	ODOMETER_READING	229821	229821	564

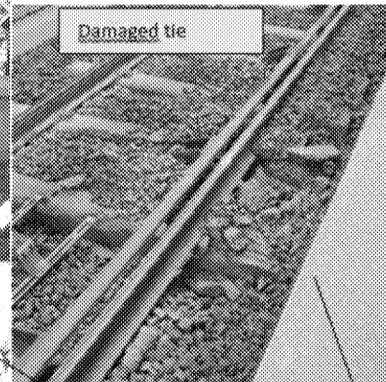
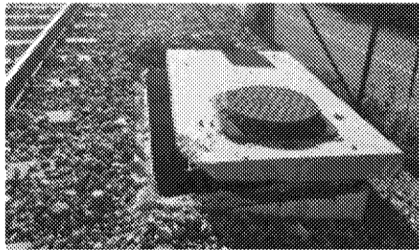
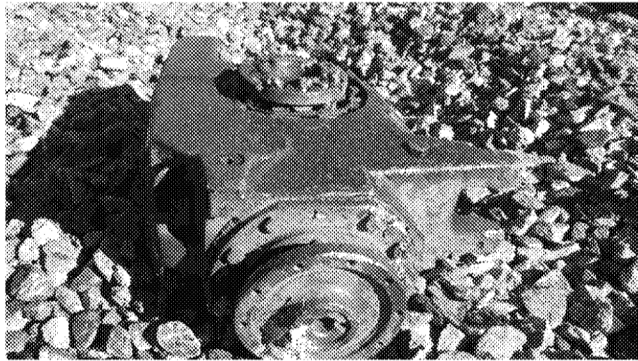
LRV21 Derailment

First Observations from Le Creusot (France) – Train position



LRV21 Derailment

Focus on the gearbox

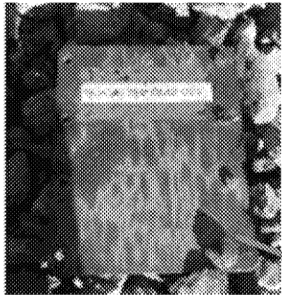


LRV21 Derailment

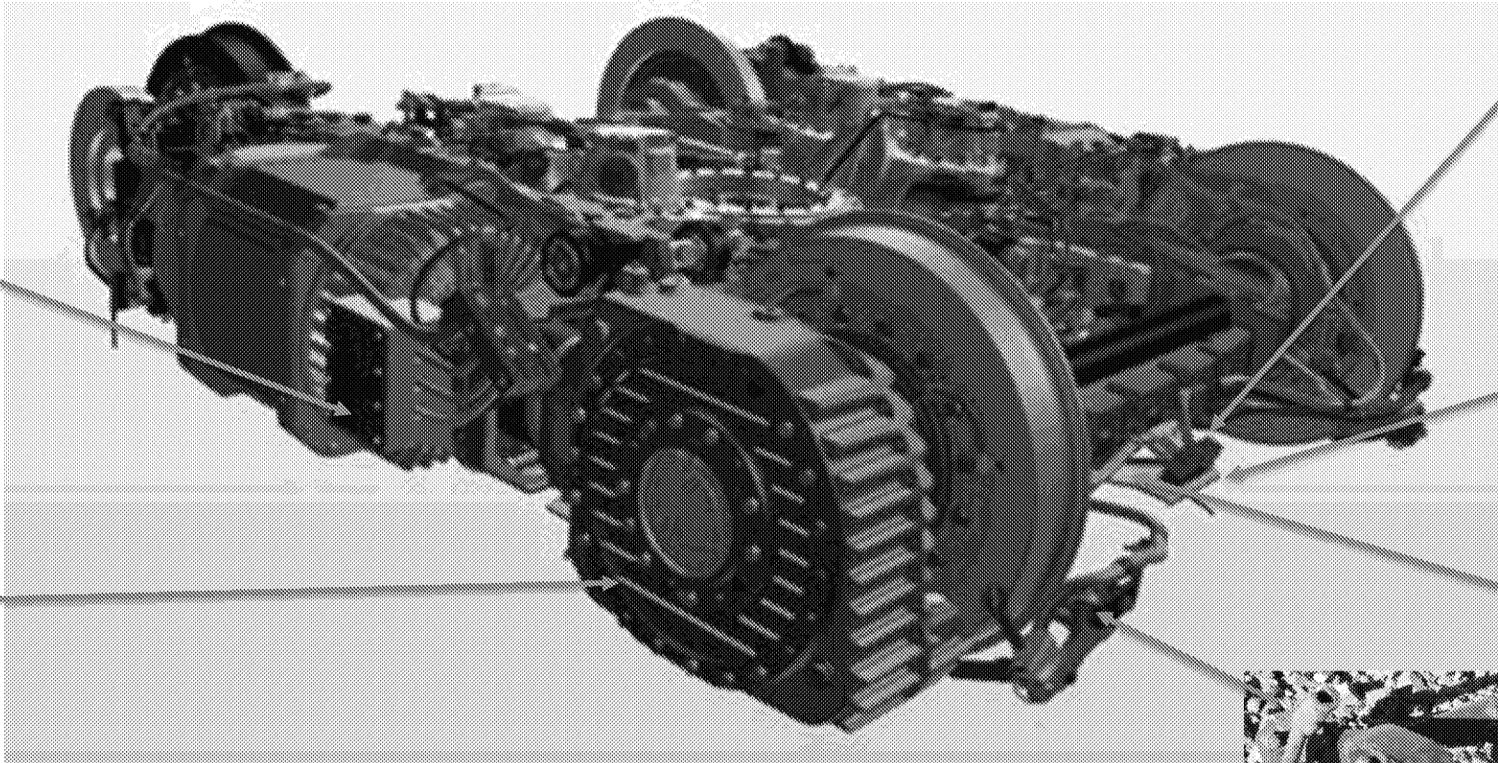
Identification of parts found on track

BM2 bogie

Cover of traction motor connection box



Gearbox



Low tension clamp 176066



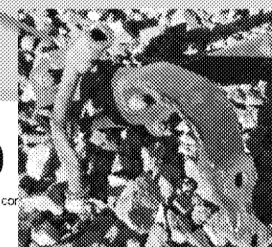
Low tension clamp support 178686



Spacer 183648



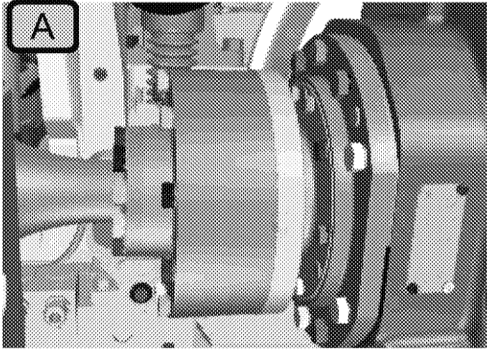
Equipment bracket 236080



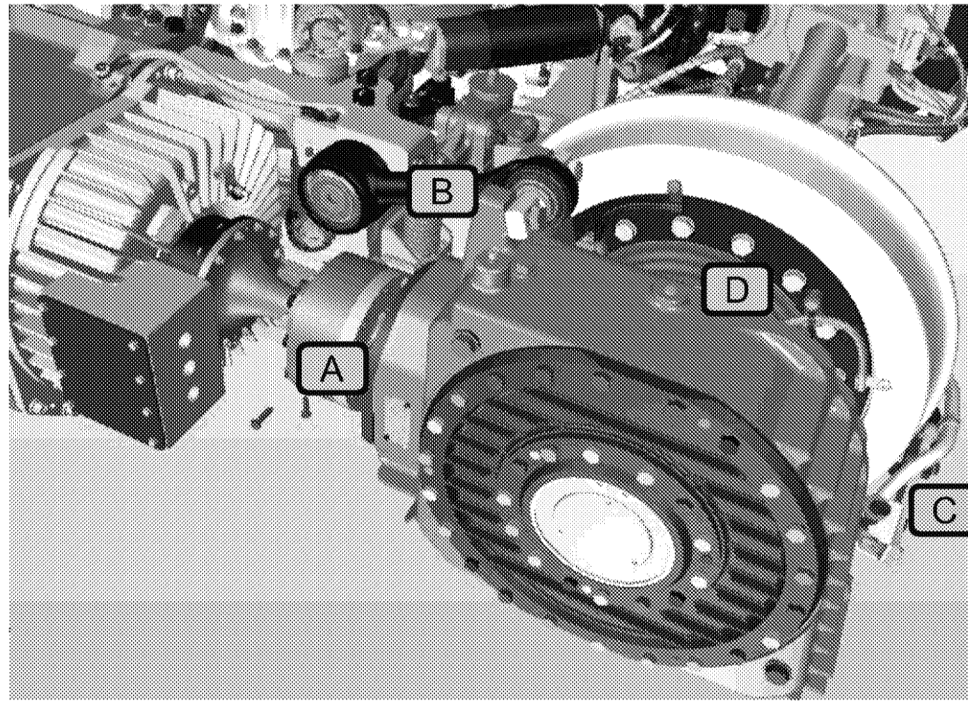
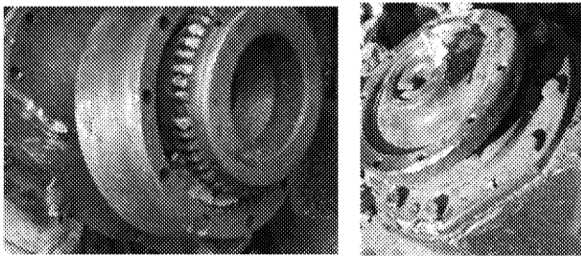
LRV21 Derailment

Identification of broken mechanical links

Gearbox/coupler
Screw M10x90 H head

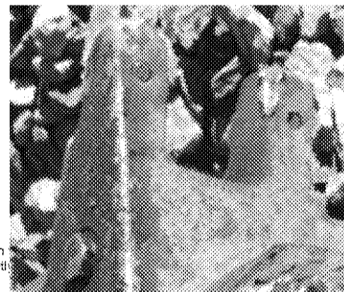
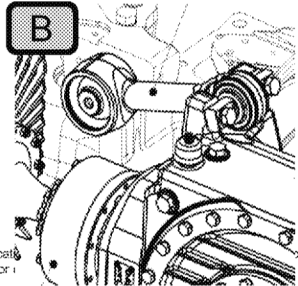


Coupling side Gearbox side

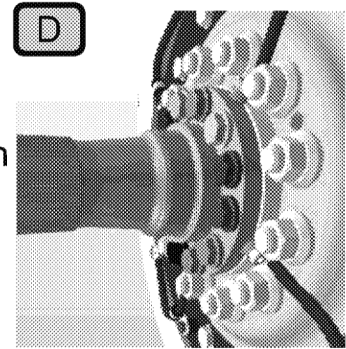


Gearbox/reaction rod
Screw M16x70 H head

Gearbox side

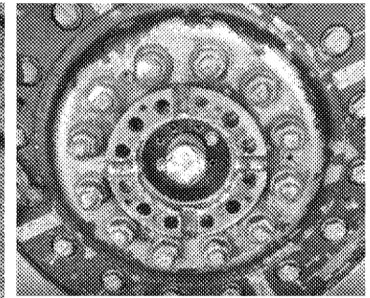
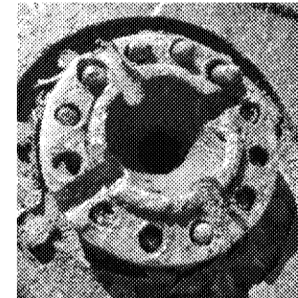


Gearbox/axle beam connection
Screw with flange M16x63

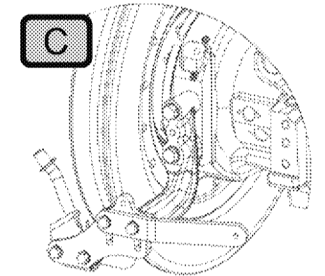


Gearbox side

Axle beam side

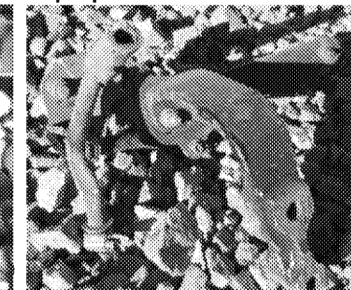
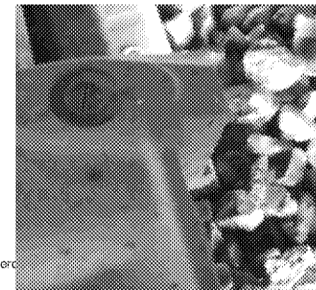


Axle beam/Equipment
bracket connection
M16x80 H head



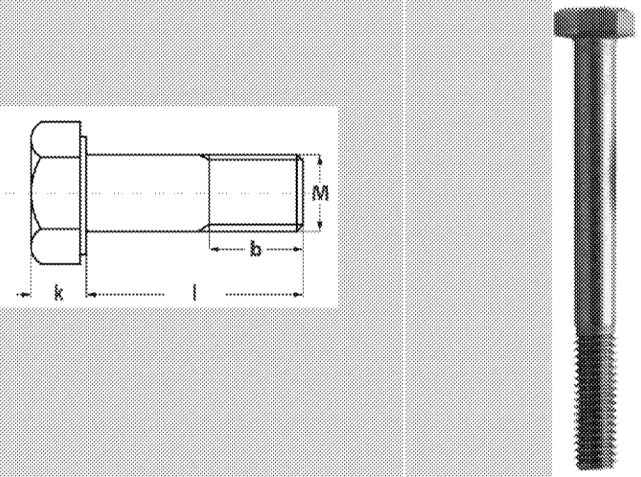
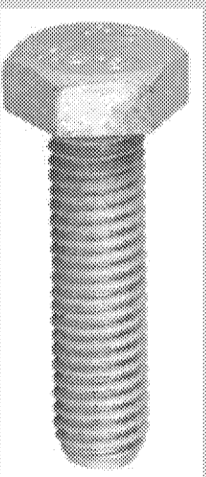
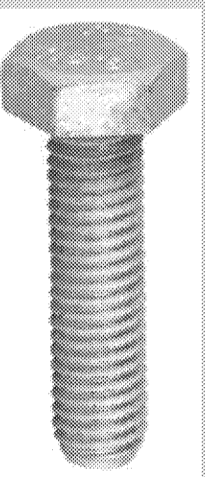
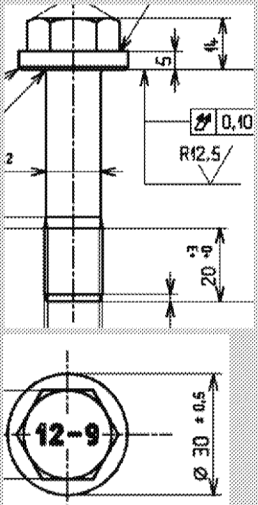
Axle beam

Equipment bracket



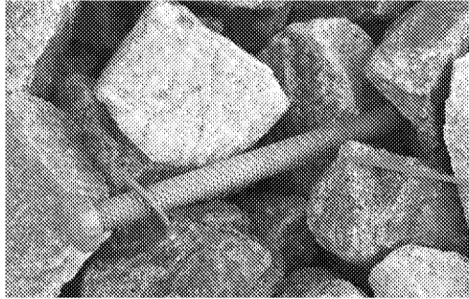
LRV21 Derailment

Identification of broken mechanical links – Focus on fasteners

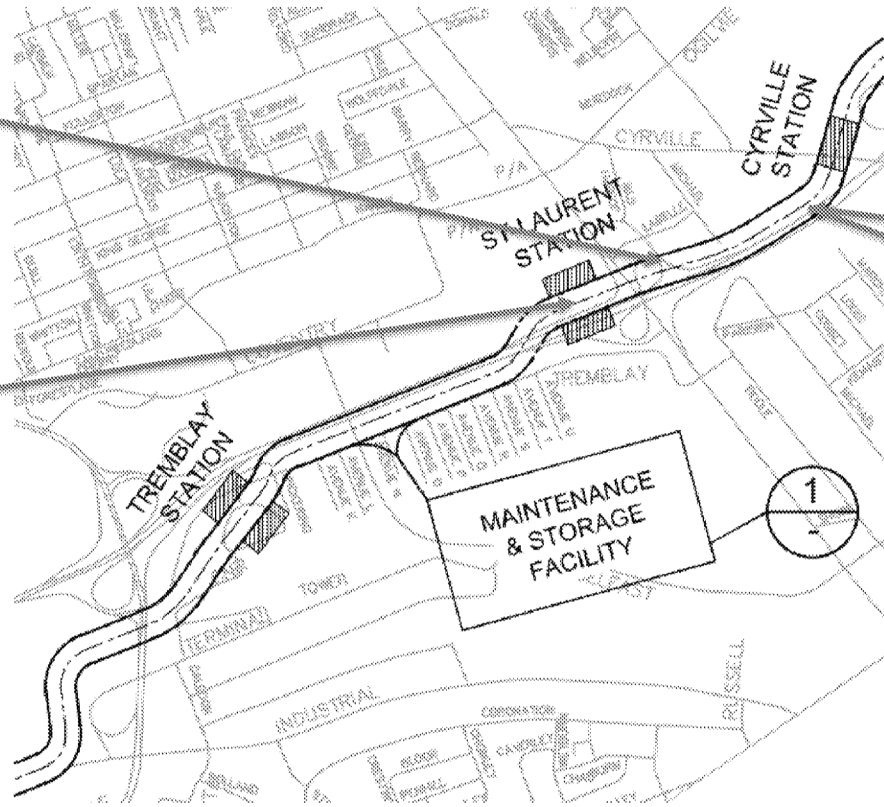
Link	A. Gearbox/coupler	B. Gearbox/reaction rod	C. Axle beam/Equipment bracket	D. Gearbox/axle beam
Fastener description	Screw M10x90 H head	Screw M16x70 H head ISO4017 8.8	Screw M16x80 H head ISO4017 10.9	Screw with flange M16x63
Part number	Supplier scope	DTR0009907909	DTR0009908005	DTR0000203980
Illustration	<p>$l = 90 \text{ mm}$ $b = 26 \text{ mm}$</p> 	<p>Class 8.8 on the head of the screw $l = b = 70 \text{ mm}$</p> 	<p>Class 10.9 on the head of the screw $l = b = 80 \text{ mm}$</p> 	<p>$l = 63 \text{ mm}$ $b = 20 \text{ mm}$</p> 

LRV21 Derailment

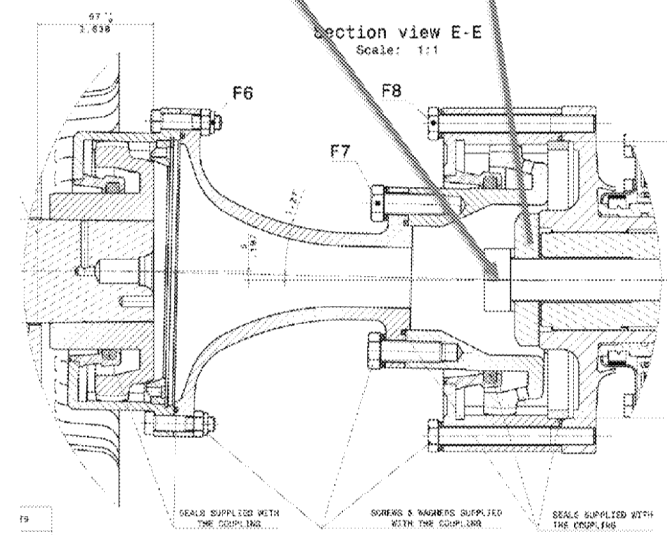
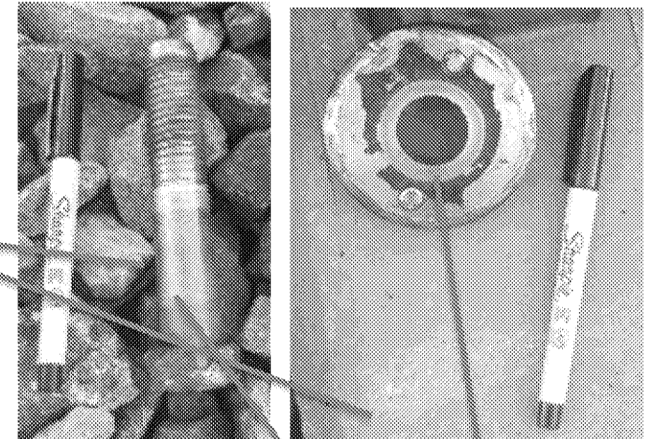
Positioning of parts found on track



Pencil size : 5,6 inches / 14,2 cm



Chainage 108-566



Most Probable Scenario

After logs review & track findings

#	Time	DIR.	Location	Observation	Interpretation
1	11:29	Going Eastbound	BAY-E > PIM-E	Beginning of slip/slide event cluster on LRV21 CC-M (logs)	Link D is severely damaged Freeplay in the connection (loosen screws / bent screws)
2	11:35		PIM-E > RID-E	Several short slip & slide (max 6 sec) (logs)	Freeplay in the connection Every torquing of the connection continue to damage the remaining screws
3	11h36		RID-E > UOT-E	Long slip / slide detection up to 23 sec (logs)	Link D is broken Total disconnection between the hub of the gearbox and the axle
			RID-E > UOT-E	Broken screws and earth current debris found on the track (track obs.)	The gearbox is maintained on the bogie by the reaction rod but mostly by the coupling
4					
5	11h59	Going Westbound	CYR-W > STL-W	Train departs from STL-W with panel opening/moving as if being tapped from inside on LRV21 (CTV) Parts from the inside of the coupling found on the track (track obs.)	Link A is broken Total disconnection of the coupling to the gearbox. The coupling to do not limit the gearbox movement anymore. Gearbox is retained by the reaction rod
6	12h02		TRE-W	Contact on platform basement Shocks on the cross tie Skirt opening & ballast throwing away (CTV)	Gearbox is dragged by the reaction rod with no vertical retention infringing the lower gauge and touching the track & ballast
7	12h02		TRE-W	Wheel lines on top of rail	Derailment generated by the ground contact of the gearbox
8	12h02		TRE-W > HUR-W	Loss of the sand equipment / Ejected gearbox Shocks on a pile + Track deformed	Gearbox infringed the lateral gauge being schocked along the track. Reaction rod screws get broken while impacting the signal pole
9	12h03		TRE-W > HUR-W	Cross switch 135 / Impact on the switch	-

01

8D summary

218742 NAMSER OTTAWA - Derailment of LRV21

K1S - Canada - RTG-Ottawa ? Citadis Spirit Maintenance 30y

Problem Description

What: Derailment of LRV21

Where : Ottawa confederation line at Tremblay Station on SW315.

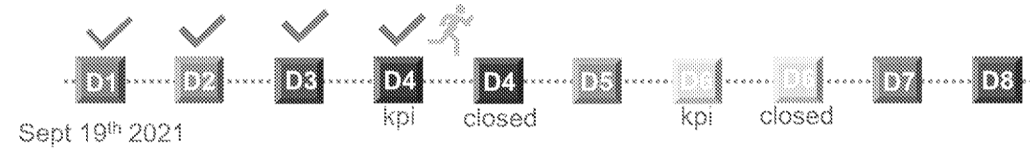
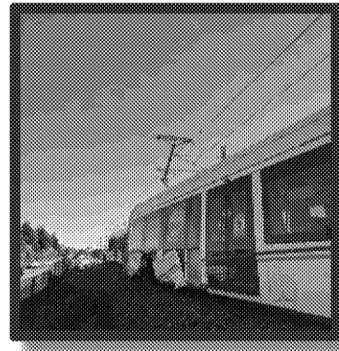
How: Known damages are:

- Gearbox
- Traction link
- Gearbox coupling
- Traction motor and components
- Multiple fasteners, brackets and clamps
- Side skirts
- Switch machine, Switch heater, Signaling post
- Several concrete ties at Tremblay station

When: On September 19th, 2021 approximately 12:05

Impact

Cannot operate the train along the line
Could lead to fatalities



D4 : What does the containment consist of?

Fleet is grounded until root cause is identified

Complete inspection plan and return to service plan to be deployed once root cause is identified

D4 : Progress/results/next step for deployment

Sept 19th Start of the containment process

Sept 22nd: Car was brought back to MSF depot after TSB approval to access

Sept 23rd: From review of data and LRV in MSF, it was discovered some bolts were not correctly torqued. Measurement on BM3 will need to be completed

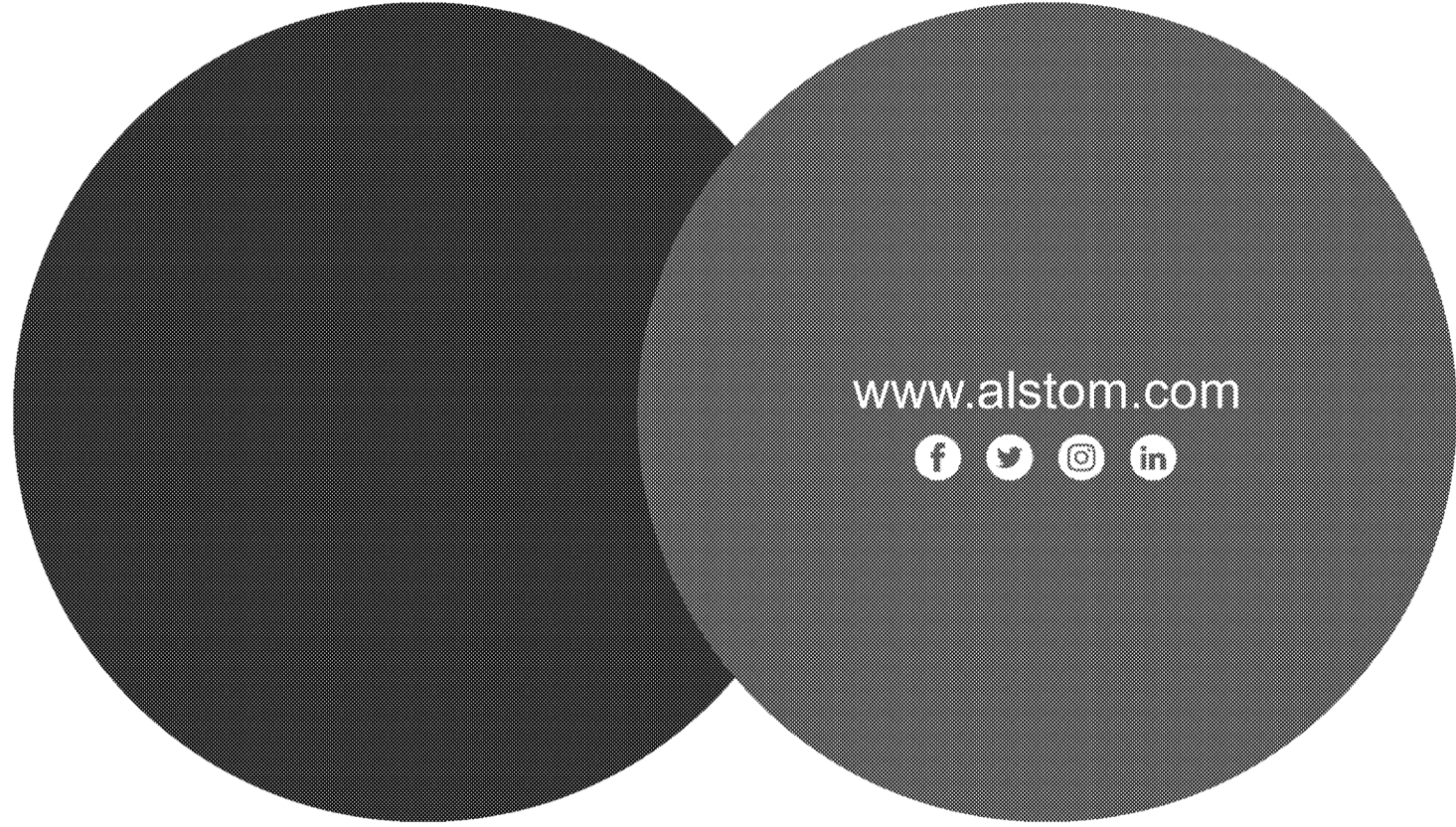
Sept 27th: Confirmation from the Atlas Copco data expert that one set of torquing sequence is missing for car 21. Axle not torqued could be 2 from BM2 and 2 from BM3.

Sept 29th: All measurement completed with TSB on site and dismantlement of Gearbox. Gearbox interior was looking in good and operable condition. BM3 bolts were confirmed to be torqued, confirming BM2 axle bolts were the ones not torqued

Oct 7th: Root cause identified

D5.1 : Progress/results/next step for deployment

- From all the available information, only 3 elements are kept as potential root cause (Gearbox, gearbox oil bolt and gearbox hub improperly torqued)
- From the analysis on the floor with TSB that occurred between Sept 27th to Sept 29th



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