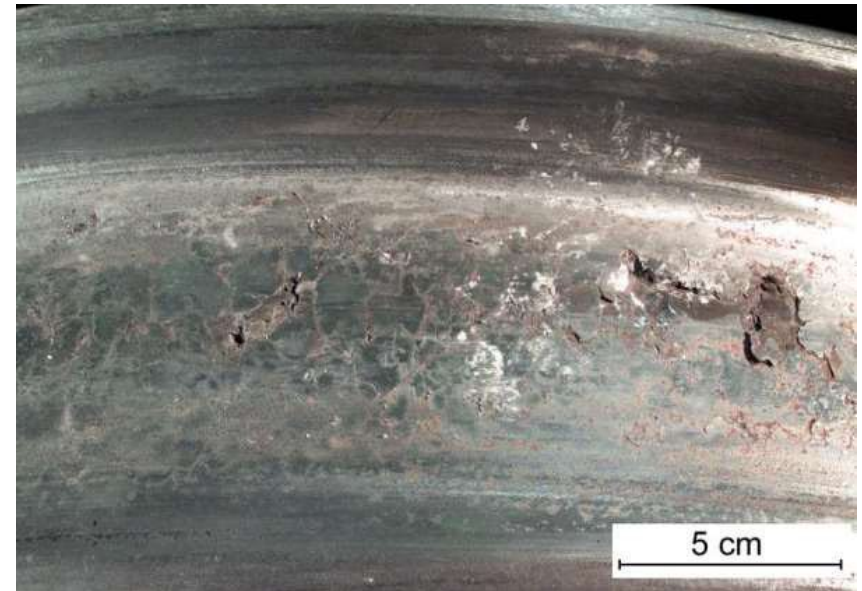
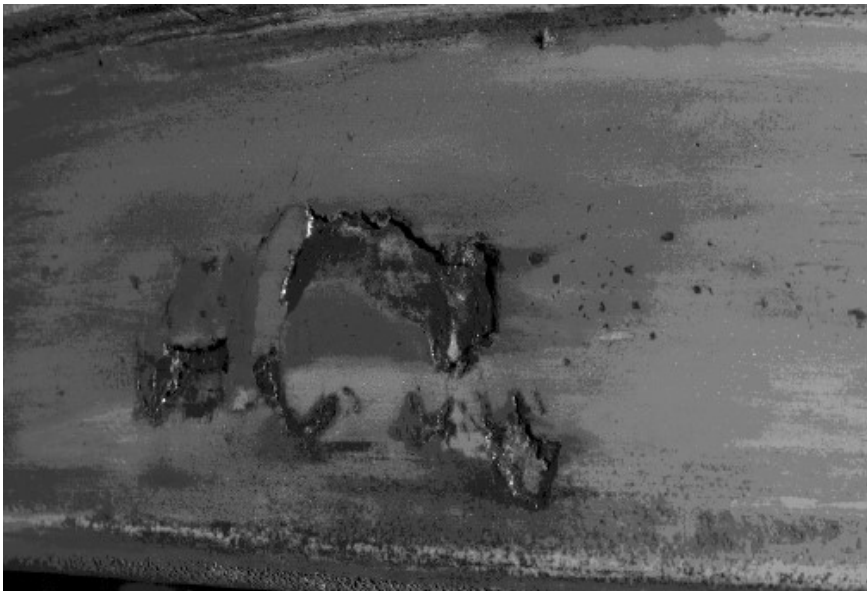




Wheel shelling

(mechanism, cause and preventive measures)



Generic wheel surface defects

- Shelling
- Spalling
- Flaking
- These terms have been used interchangeably to describe any surface defect associated with wheel tread (AND) track surface defects
- Spalling or Flaking is a surface phenomenon
 - It is shallow in depth and is associated with areas of very high contact stresses.
 - Usually, these defects do not progress deeply below the surface.
 - Instead, they progress about 0.030" below the surface. Spalling appears to be a surface fatigue condition related to high shear stresses as well as normal contact stressing
 - Chipping (subsequent to spalling) is known as flaking



All in one

Spalling



Flaking

Shelling

All in one

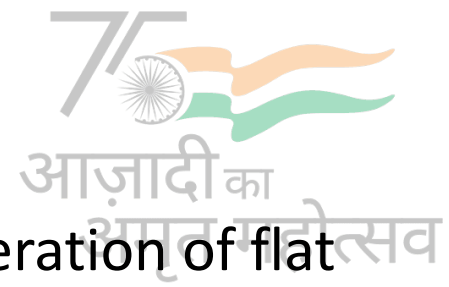
Spalling

Shelling

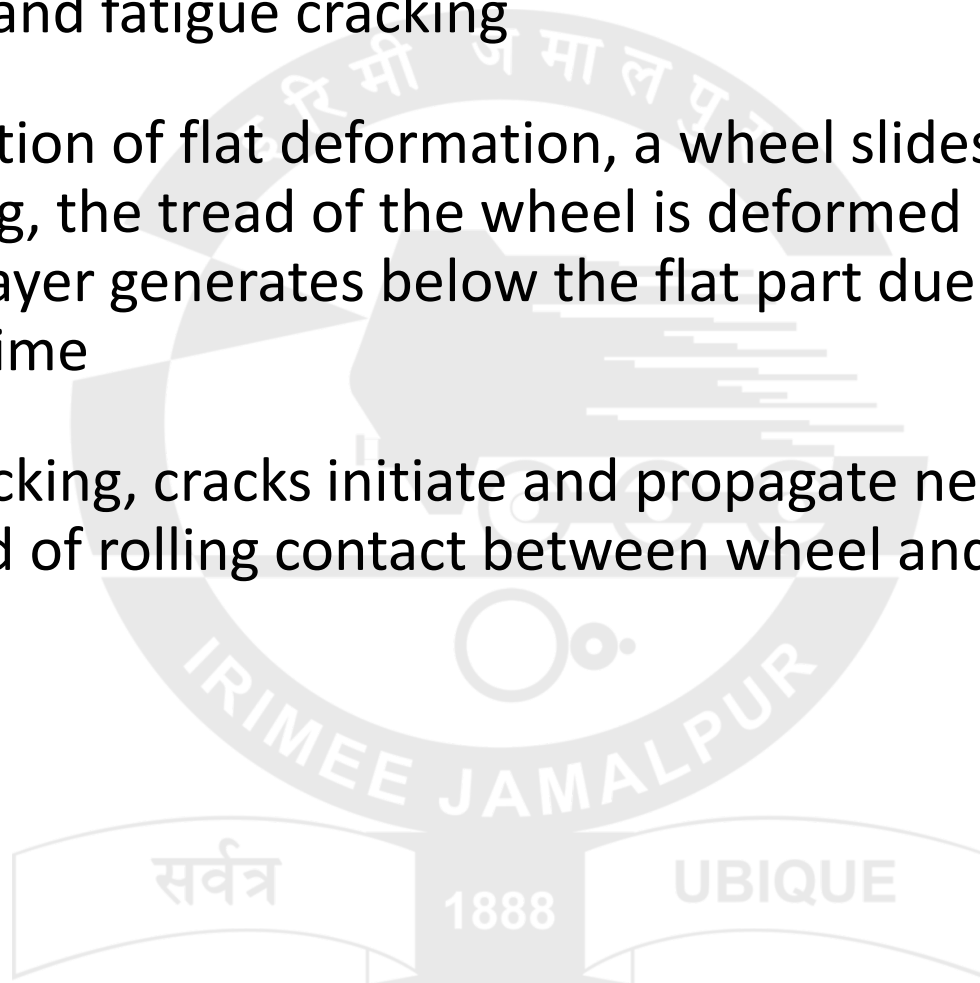
Flaking



Wheel Spalling

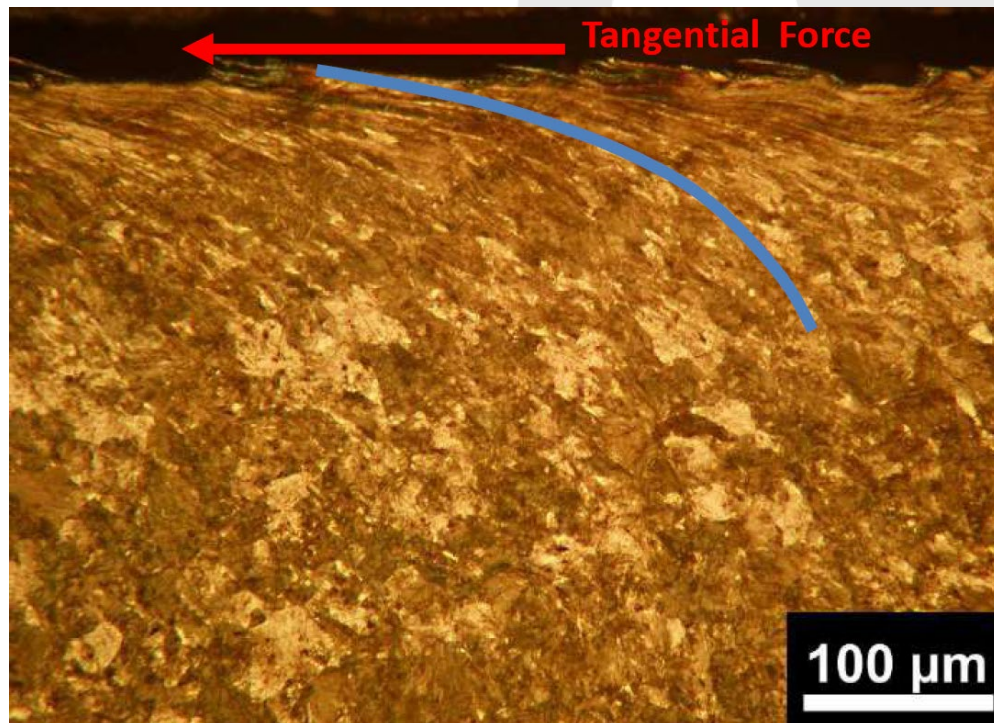


- Spalling generates during two stages, which are generation of flat deformation and fatigue cracking
- In the generation of flat deformation, a wheel slides on the rail during braking, the tread of the wheel is deformed into flat shape and a white layer generates below the flat part due to friction heat at the same time
- In fatigue cracking, cracks initiate and propagate near the flat due to long period of rolling contact between wheel and rail



What is Shelling

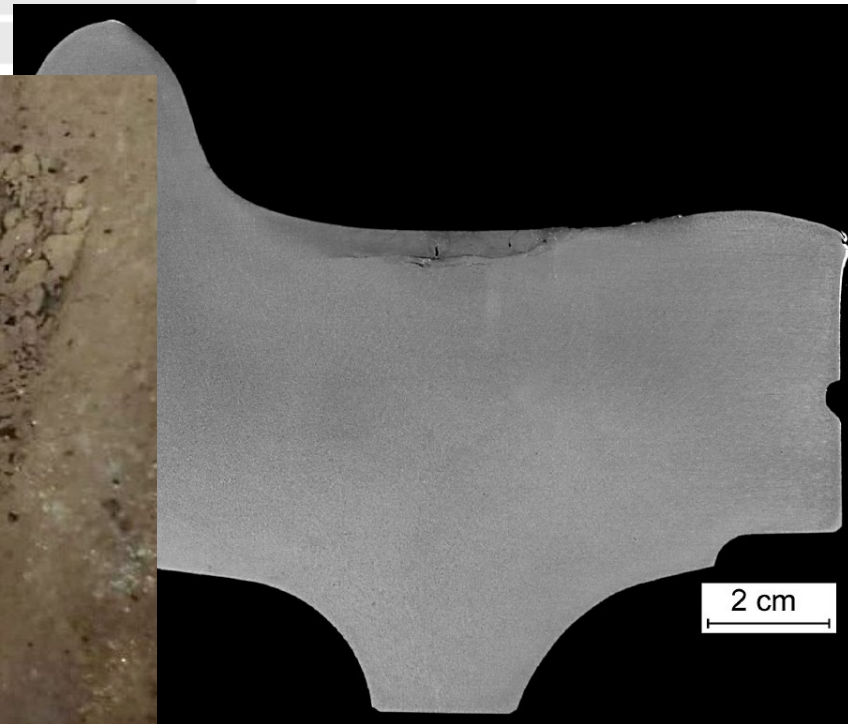
- Plastic flow of material
- Sub-surface cracks propagated to surface
- Shelling is a progressive internal separation that develops beneath the cold-worked region. Such a separation may propagate longitudinally along the tread



- As the shells propagate, they can turn to form a transverse separation, which is referred to as detail fracture from shelling, and may lead to long fracture on the wheel disk

What is Shelling

- The shelling process by which tread cracks form also starts as a result of a sliding event
- The process includes rapid heating and austenitizing of the tread surface during a slide followed by rapid cooling and transformation to untampered **martensite**



Levels of propagation



Consequential damages may be

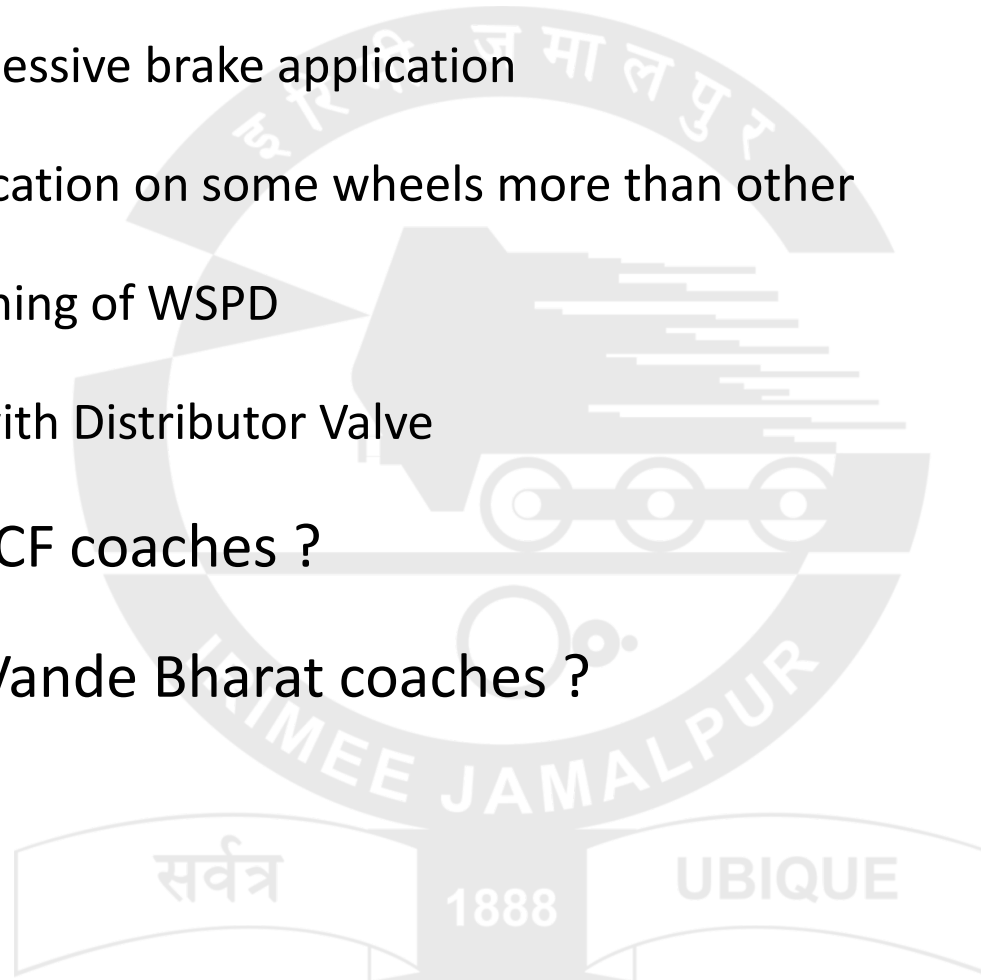
- Preexisting cracks in the area of a slide can grow from shallow and harmless cracks into cracks of greater significance due to high thermal and transformation stresses
- This propagation may lead to long fracture on the wheel disk



22533/Gorakhpur - Yesvantpur SF Express

Conditions for Shelling to occur

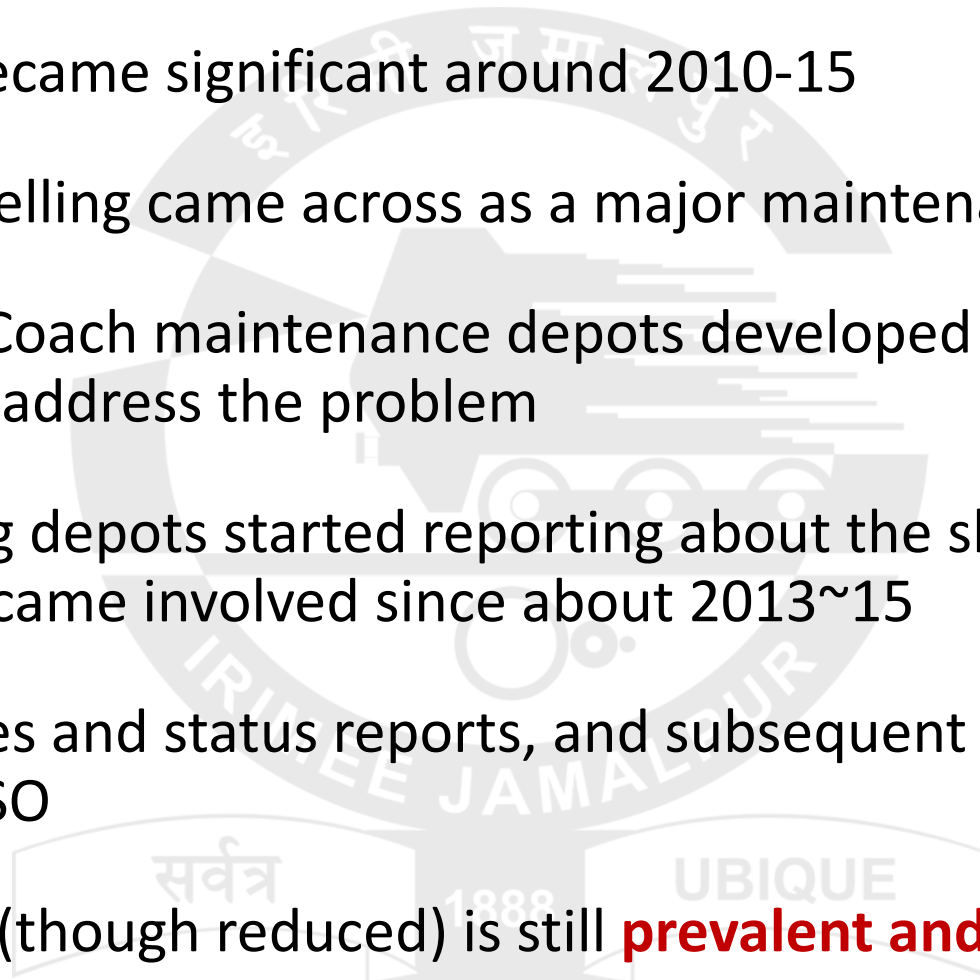
- Rapid heating AND cooling of localized portion of wheel tread
 - Sudden/excessive brake application
 - Brake application on some wheels more than other
 - Malfunctioning of WSPD
 - Problems with Distributor Valve
- What about ICF coaches ?
- What about Vande Bharat coaches ?



History of Wheel shelling

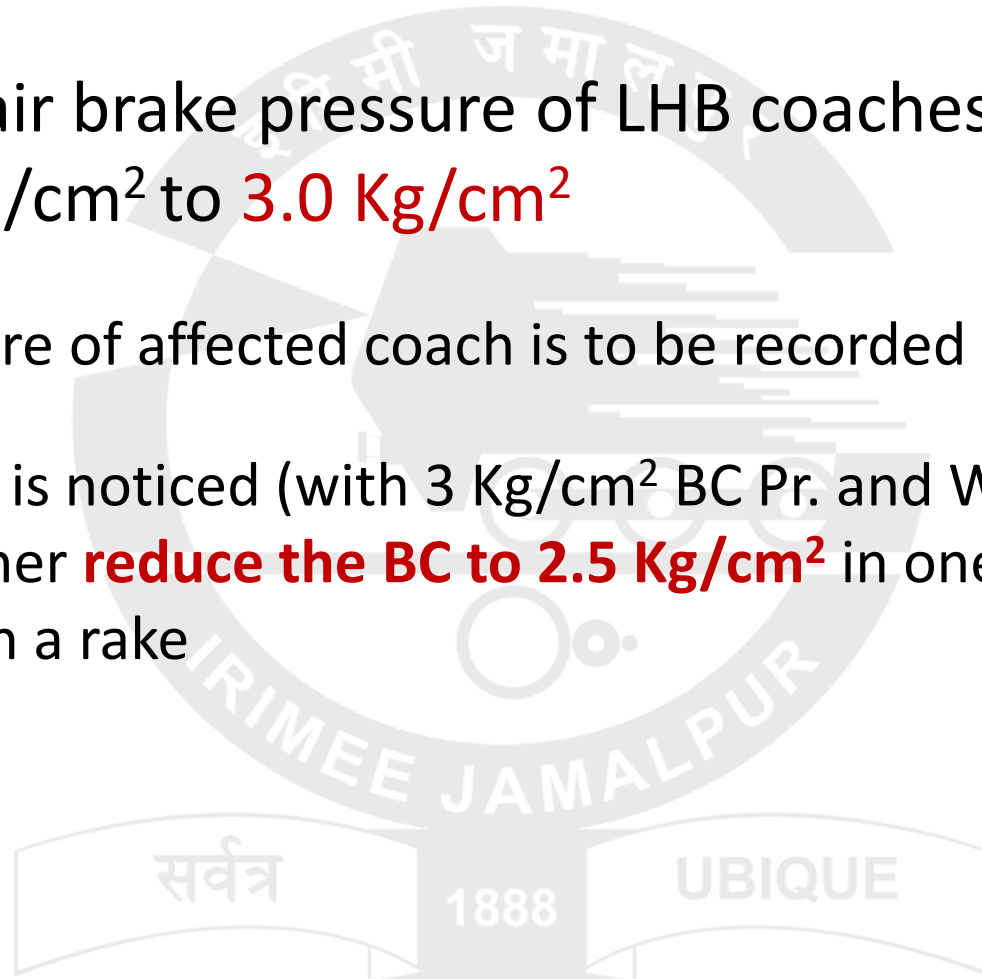


- LHB coaches were introduced in 1999
- Population became significant around 2010-15
- The wheel shelling came across as a major maintenance problem
- Some of the Coach maintenance depots developed their own procedure to address the problem
- Major holding depots started reporting about the shelling problem and RDSO became involved since about 2013~15
- Several studies and status reports, and subsequent guidelines were issued by RDSO
- The problem (though reduced) is still **prevalent and persisting...**



Initial remedy

- No.MC/LHB/Brake, dated: 18.12.2015
- Maximum air brake pressure of LHB coaches reduced from 3.8 Kg/cm² to **3.0 Kg/cm²**
 - BC Pressure of affected coach is to be recorded
 - If shelling is noticed (with 3 Kg/cm² BC Pr. and WSP working), then further **reduce the BC to 2.5 Kg/cm²** in one or two coaches in a rake



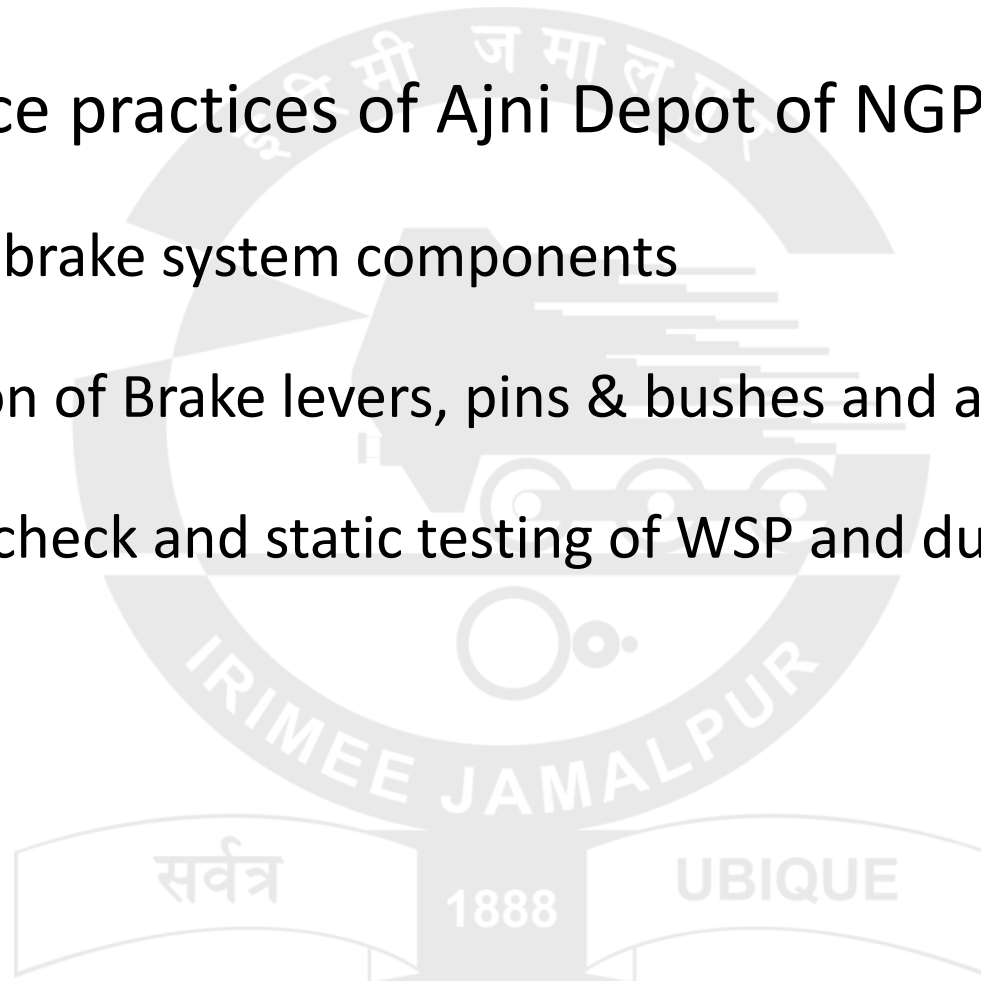
Initial remedy

- No.MC/LHB/Brake, dated: 10.11.2016
- Maximum air brake pressure of LHB coaches reduced from 3.8 Kg/cm² to 3.0 Kg/cm²
 - BC Pressure of affected coach is to be recorded
 - If shelling is noticed (with 3 Kg/cm² BC Pr. and WSP working), then further reduce the BC to 2.5 Kg/cm² in one or two coaches in a rake
 - **Interchange the bogies** of affected coaches with non-affected coaches



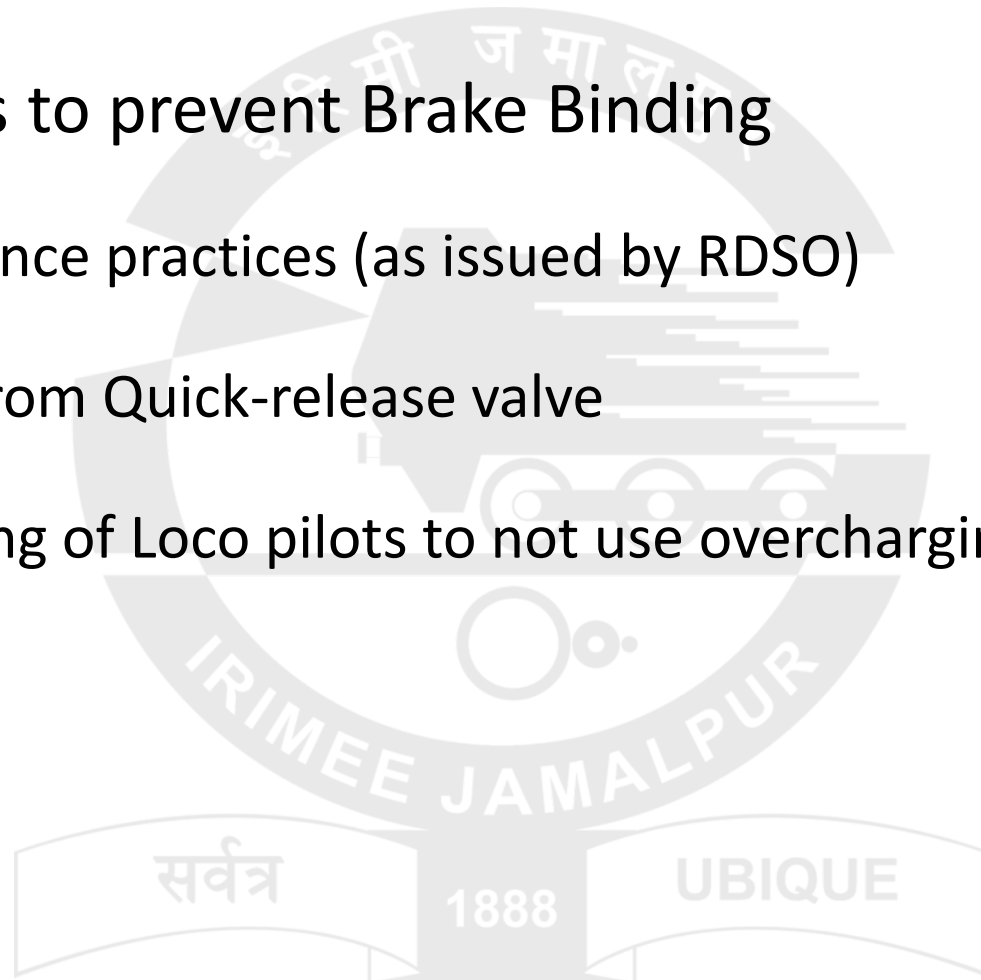
Initial remedy

- No.MC/LHB/Brake, dated: 19.01.2017
- Maintenance practices of Ajni Depot of NGP (checklist)
 - Health of brake system components
 - Lubrication of Brake levers, pins & bushes and all moving parts
 - Function check and static testing of WSP and dump valves

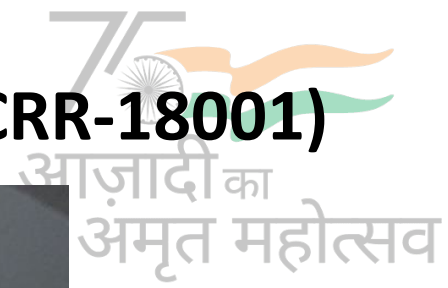


Initial remedy

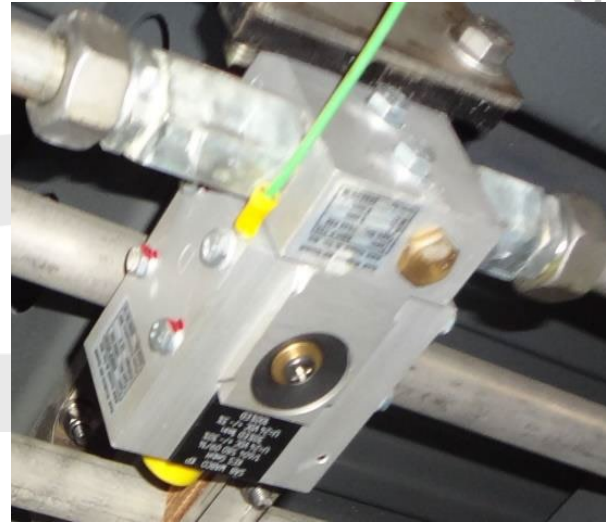
- No.MC/LHB/Brake, dated: 16.11.2017
- Instructions to prevent Brake Binding
 - Maintenance practices (as issued by RDSO)
 - Release from Quick-release valve
 - Counselling of Loco pilots to not use overcharging



Carriage Research Report (RDSO/CG/CRR-18001)



- No.MC/LHB/Brake,
dated: 28.03.2018



Brake System of M/s KBIL:

	Prescribed	With 7mm exhaust choke	With exhaust choke removed
Venting Time t_e	350 - 650 ms	790 ms	592 ms
Pressure build up time t_b	600 - 1000 ms	952 ms	956 ms
Factor t_b/t_e	1.3 – 1.6	1.2	1.6

Brake System of M/s FTIL:

	Prescribed	With 9mm exhaust choke	With exhaust choke removed
Exhaust Time	400-600 ms	592 ms	592 ms
Charging time	900-1200 ms	890 ms	902 ms

Carriage Research Report (RDSO/CG/CRR-18001)

- No.MC/LHB/Brake, dated: 28.03.2018
- Effect of choke size of Dump Valve on Wheel shelling



FTRTIL (9 mm, 6 mm)



KBIL (7 mm, 5 mm)

Carriage Research Report (RDSO/CG/CRR-18002)

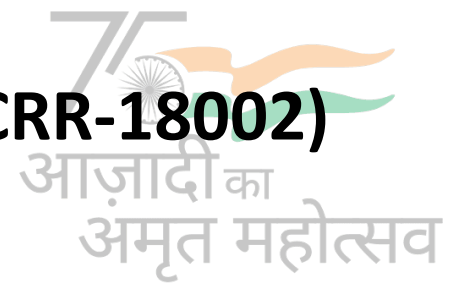
- No.MC/LHB/Brake, dated: 06.09.2018
- Use of polyamide self-lubricating bushes



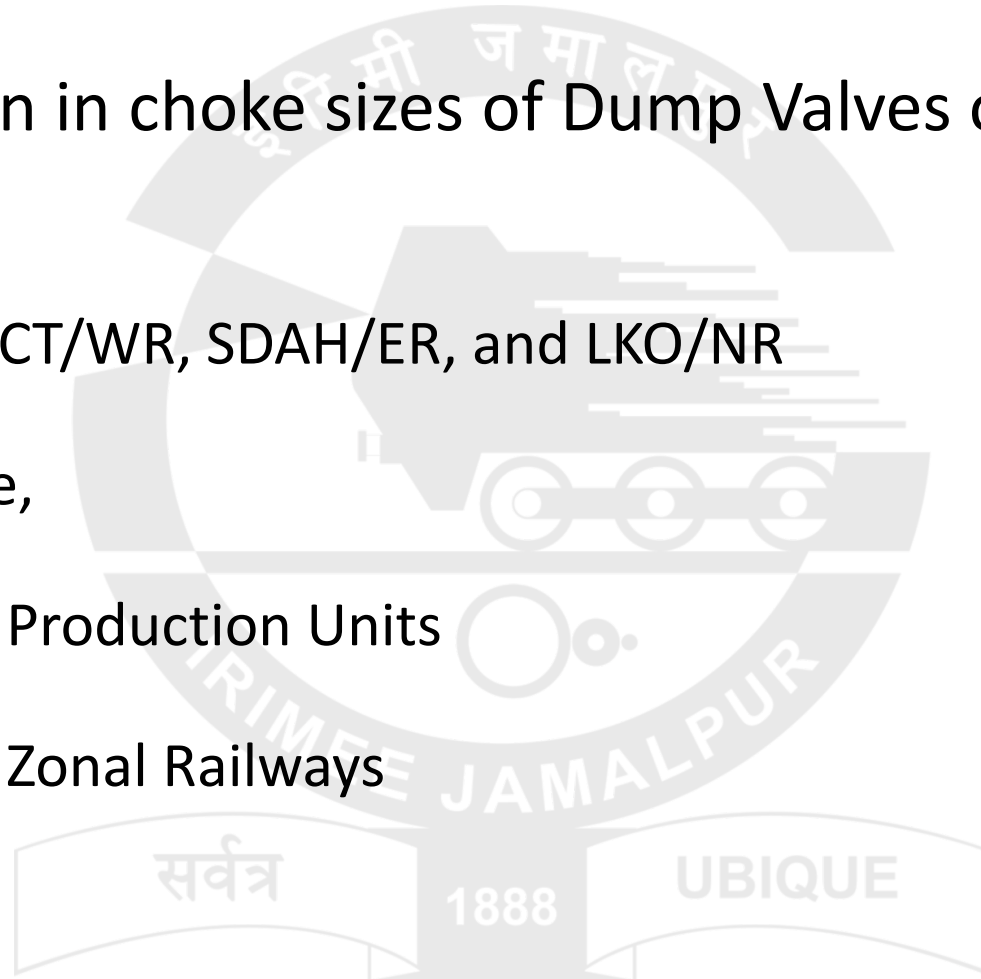
- KBIL has already been using nylon bushes – changed over to polyamide bushes
- FTRTIL was using metal bushes, that needed lubricant spray during disassembly – changed to polyamide bushes
- Polyamide bushes are self lubricating



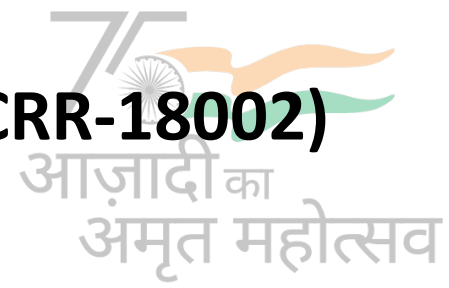
Carriage Research Report (RDSO/CG/CRR-18002)



- No.MC/LHB/Brake, dated: 27.09.2018
- Modification in choke sizes of Dump Valves of WSP system
 - Trials at BCT/WR, SDAH/ER, and LKO/NR
 - Choke size,
 - Action by Production Units
 - Action by Zonal Railways



Carriage Research Report (RDSO/CG/CRR-18002)



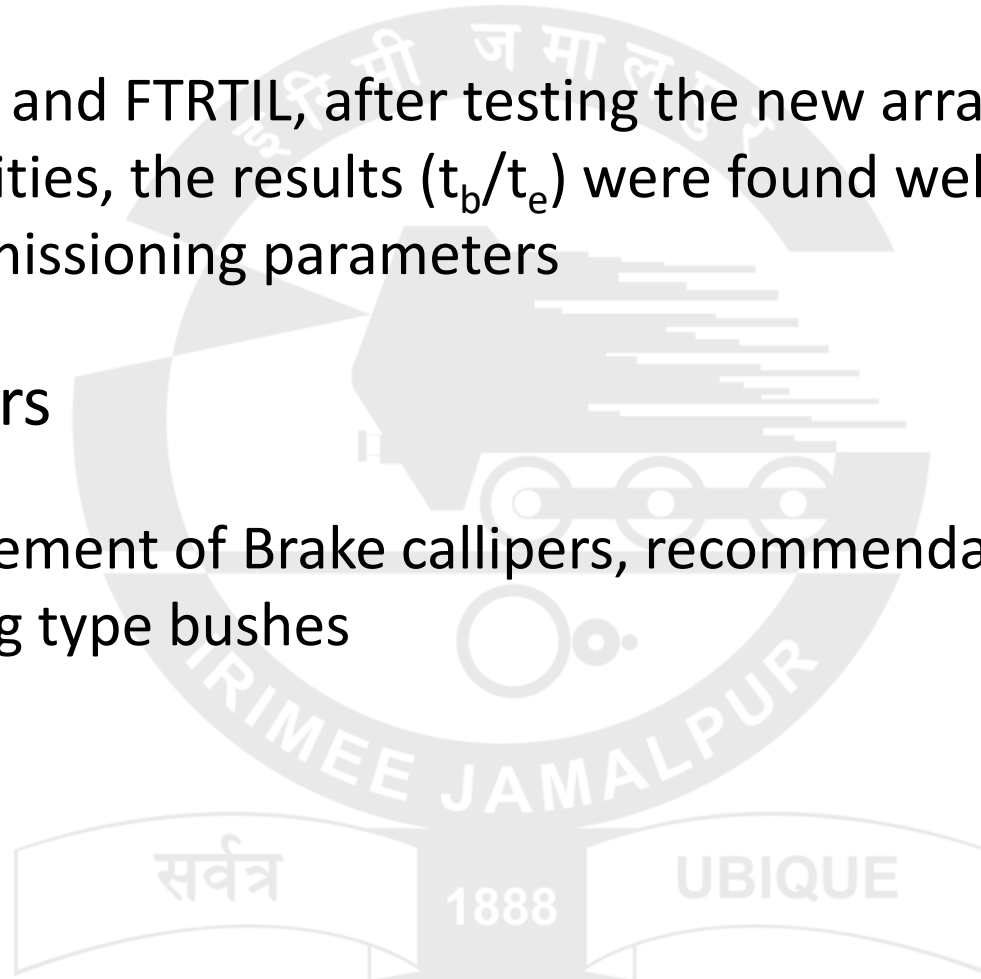
- Trials at BCT/WR, SDAH/ER, and LKO/NR
- 20 coaches in each depot, good health, WSPA
 - 10 coaches each of KBIL and FTRTIL, exhaust valve choke was removed and charging valve choke (5mm/6mm) retained
 - BCT/WR recorded 6 coaches with shelling, 3 with minor shelling
 - LKO/NR reported NO wheel shelling for 3 months
 - SDAH/ER reported shelling, trial extended, charging choke was enlarged to 9mm, 47 coaches were put under observation. The outcome was encouraging



Carriage Research Report (RDSO/CG/CRR-18002)



- Validation from brake system suppliers
 - Both KBIL and FTRTIL, after testing the new arrangements at their facilities, the results (t_b/t_e) were found well within design and commissioning parameters
- Other factors
 - Free movement of Brake callipers, recommendation of self-lubricating type bushes



Carriage Research Report (RDSO/CG/CRR-18002)

- Electrical connections



Missing WAGO Terminal



Damaged Junction Box



Damaged Connector



Damaged Connector



Modification in Choke sized of Dump valve

- No.MC/LHB/Brake, dated: 22.11.2018
- Approval by Railway Board
 - Charging choke size: 9 mm
 - Exhaust: No choke/open vent



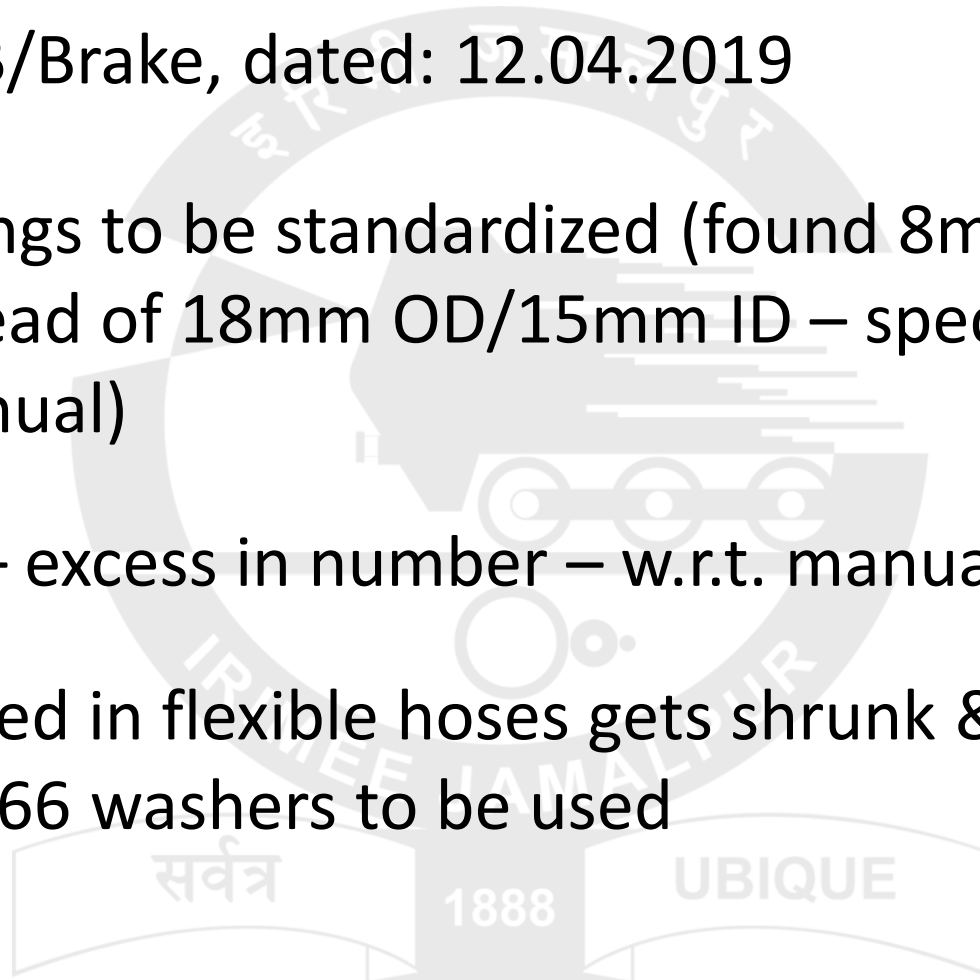
FTRTIL (9 mm, 6 mm)



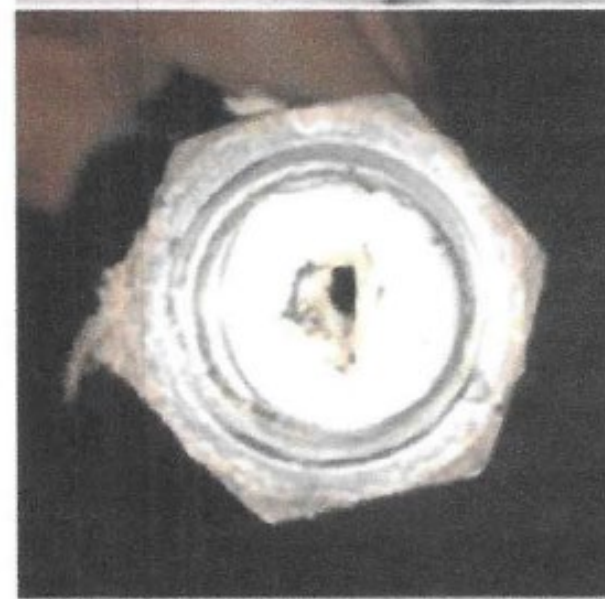
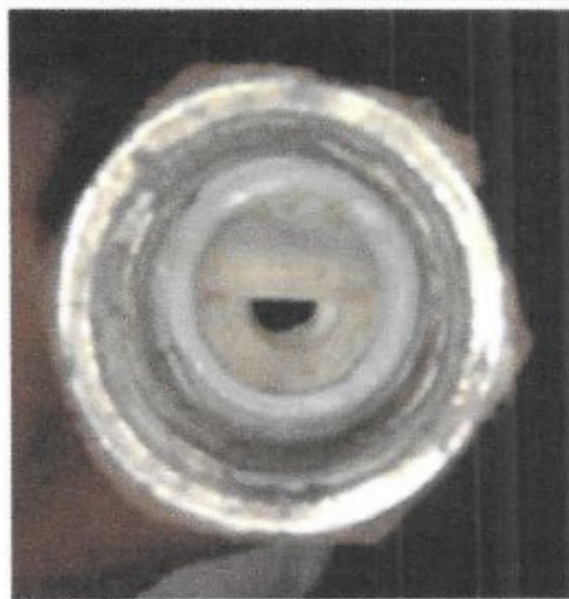
KBIL (7 mm, 5 mm)

Modified guidelines

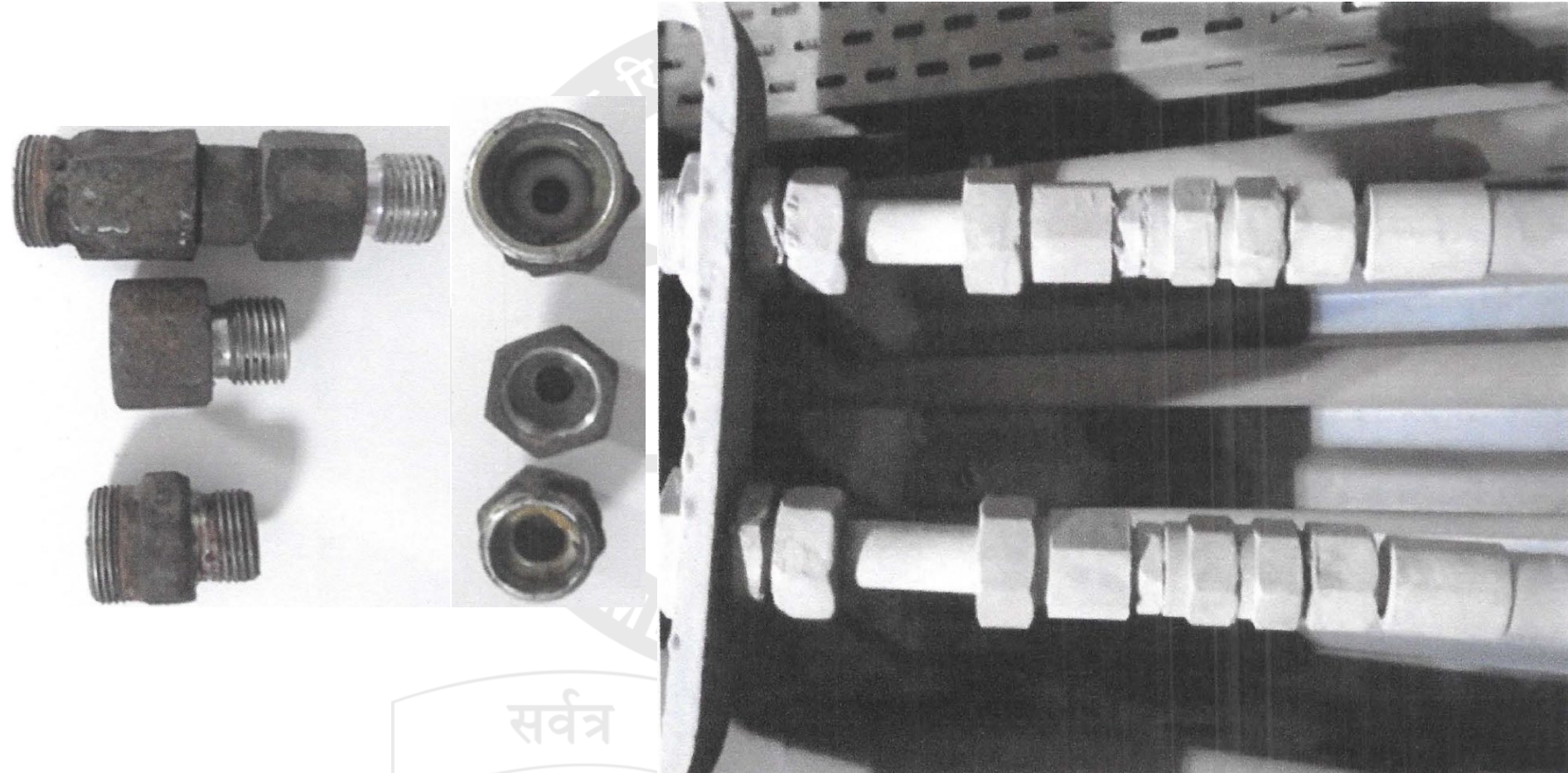
- No.MC/LHB/Brake, dated: 08.03.2019
- No.MC/LHB/Brake, dated: 12.04.2019
- BC line fittings to be standardized (found 8mm, 9mm, 12mm instead of 18mm OD/15mm ID – specified in Alstom manual)
- Bite joints – excess in number – w.r.t. manual
- Washers used in flexible hoses gets shrunk & perished – only Nylon-66 washers to be used



Obstructions in the BC hoses



Restricted airflow due to end fittings



सर्वत्र

Excessive end fittings

Choke sizes for AEFG2 model of WSP (FTRTIL)

- MC/LHB/Brake, Dated: 10.06.2019

- Upgraded UIC approved AEFG2 WSP model
- Dump Valve (type DV12)

Brake System Make/Model	Exhaust Choke Size	Charging Choke Size
FTRTIL (Model AEFG2)	6 mm choke	4mm choke

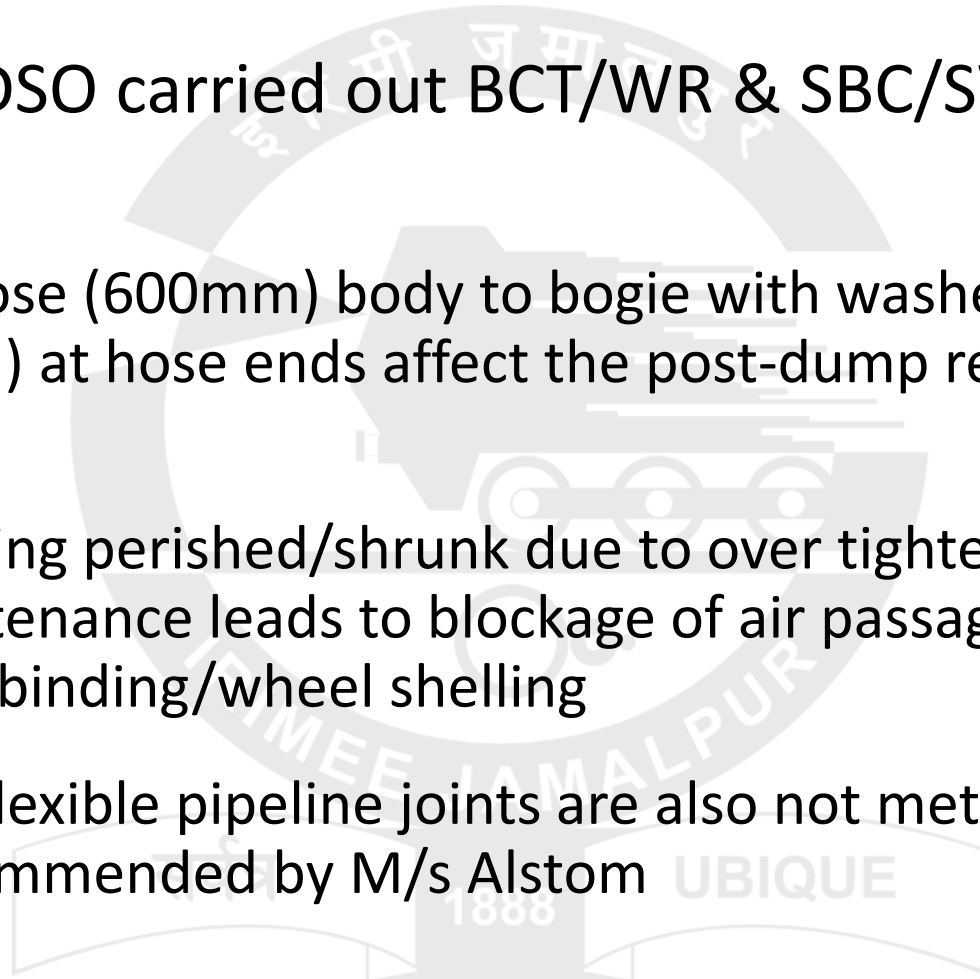
1888



Modification in AB pipeline & fittings

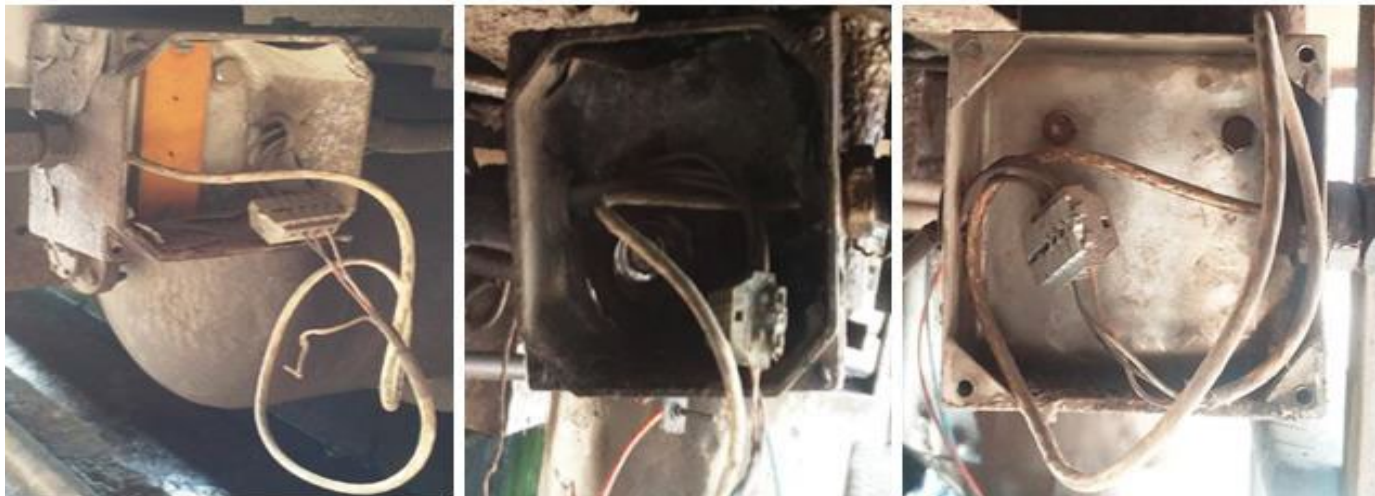


- No.MC/LHB/Brake, dated: 24.06.2019
- Study by RDSO carried out BCT/WR & SBC/SWR on wheel shelling
- Flexible air hose (600mm) body to bogie with washer (Nylon/Teflon) at hose ends affect the post-dump release time by upto 300ms
- Washers getting perished/shrunk due to over tightening and routine maintenance leads to blockage of air passage and thus causes brake binding/wheel shelling
- The existing flexible pipeline joints are also not metal-to-metal joints as recommended by M/s Alstom



Integrity of Electrical Components

- MC/LHB/Brake, dated: 27.09.2019
- One time drive to ensure vibration resistant electrically secured connection in WSP wiring
- SSE/JE made responsible to ensure that fault counter readings for WSP should not repeat
- Proper trouble-shooting of recorded faults – repair to loose/damaged electrical connections

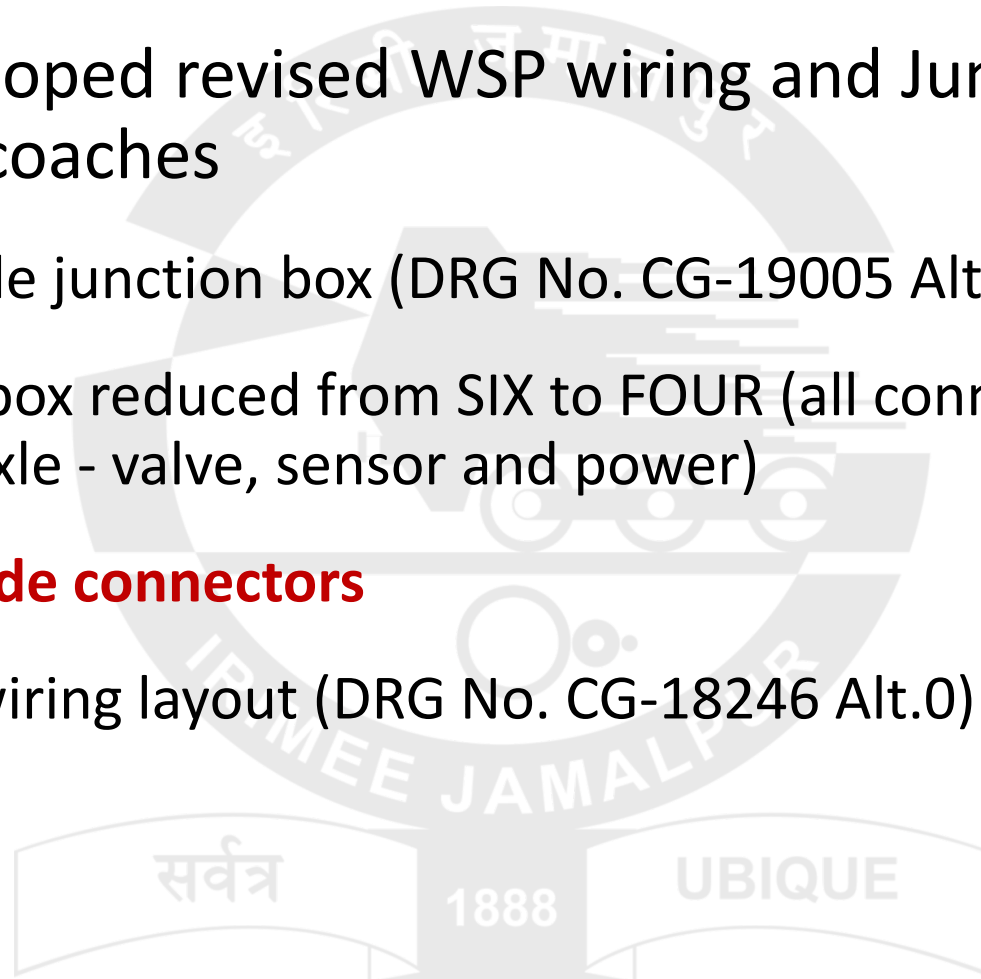


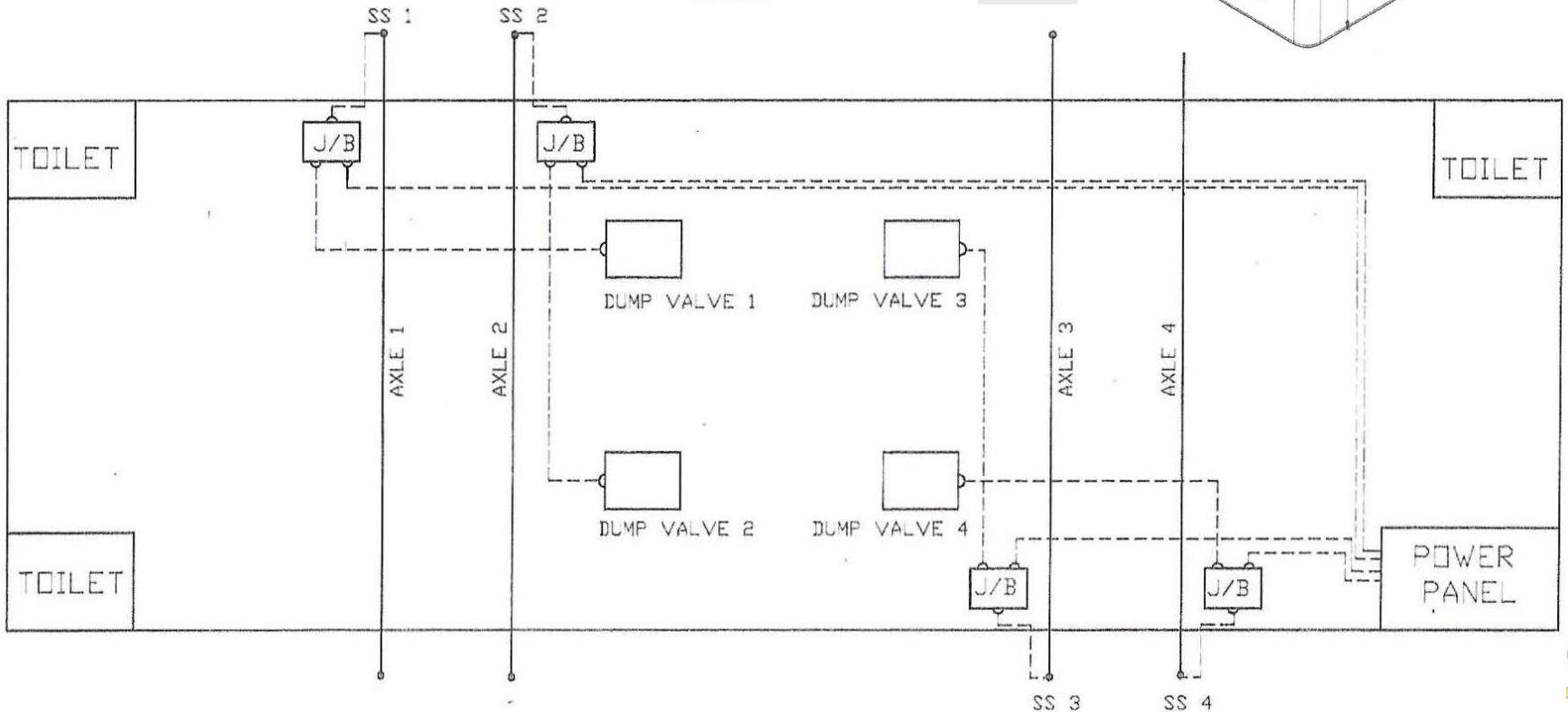
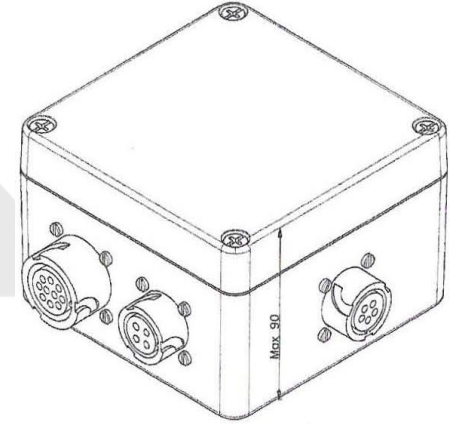
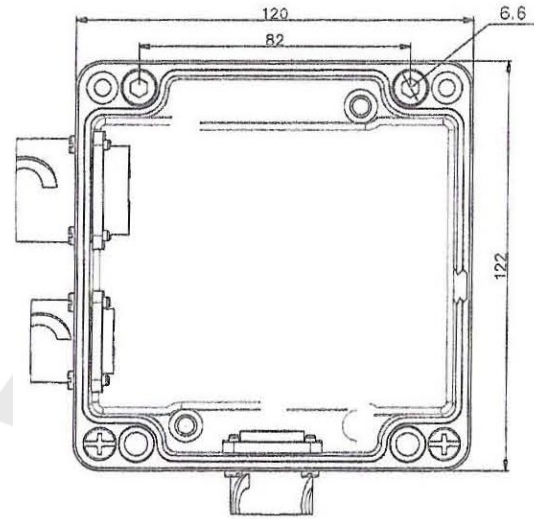
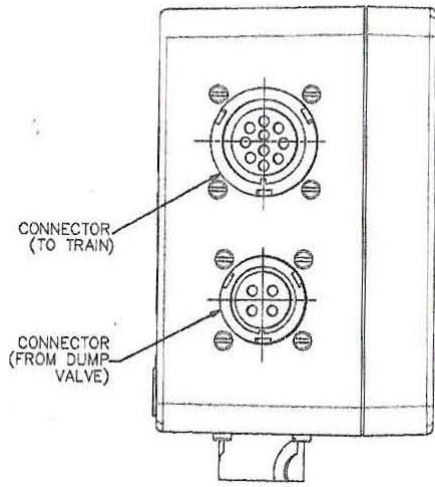
Damaged Speed Sensor Junction Box

Revised wiring scheme for WSP system



- MC/LHB/Brake, dated: 27.02.2019
- RDSO developed revised WSP wiring and Junction Box – for all LHB coaches
 - IP 67 grade junction box (DRG No. CG-19005 Alt.1)
 - Junction box reduced from SIX to FOUR (all connections in one box per axle - valve, sensor and power)
 - **MIL – grade connectors**
 - Revised wiring layout (DRG No. CG-18246 Alt.0)

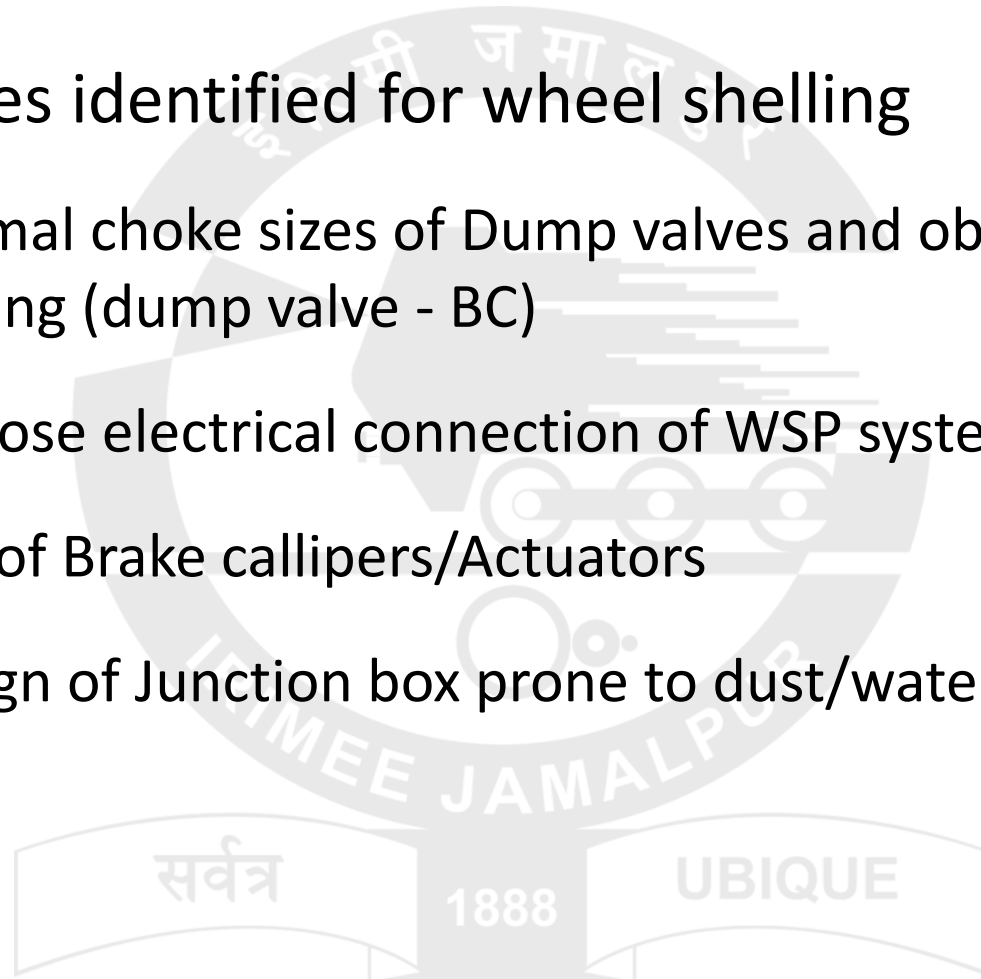




Consolidated instructions by RDSO



- No. MC/LHB/Brake Dated: 15.04.2019
- Major causes identified for wheel shelling
 - Non-optimal choke sizes of Dump valves and obstructions in air brake piping (dump valve - BC)
 - Wrong/loose electrical connection of WSP system
 - Jamming of Brake callipers/Actuators
 - Poor design of Junction box prone to dust/water ingress



Modification in AB pipeline and fittings



- No.MC/LHB/Brake, dated: 24.06.2019
- RDSO finalized standard piping layout with OEMs

S.No.	DRAWING/PART NO.		
	M/s Knorr-Bremse	M/s Faiveley Transport	M/s Escorts
A.	Flexible Hose (650mm) – for body to bogie		
	KP0274893	FT0052512-001	1J112000031
B.	Flexible Hose (500mm) – for Brake Actuators		
	KP0313153	FT0052512-002	3EB9942

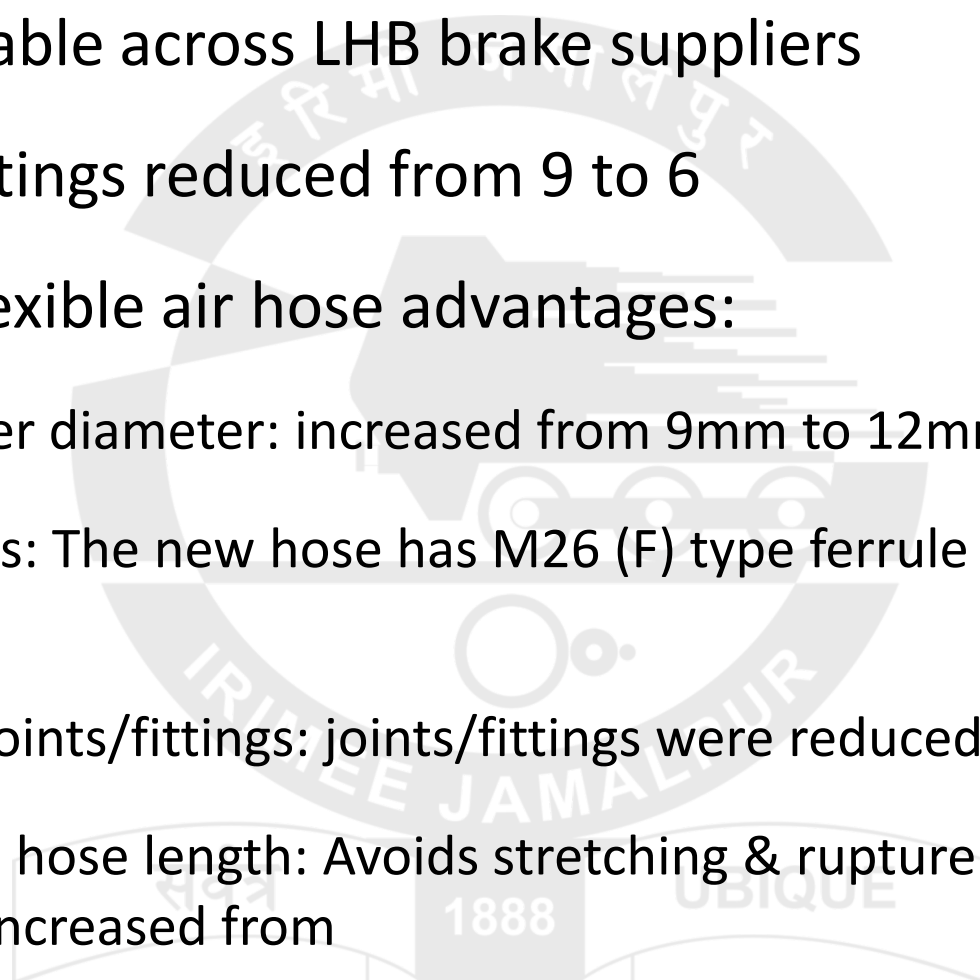
Note: The upgraded flexible hose should only be procured from RDSO approved sources for Axle Mounted Disc Brake system to ensure quality of this critical item.



Modification in AB pipeline and fittings

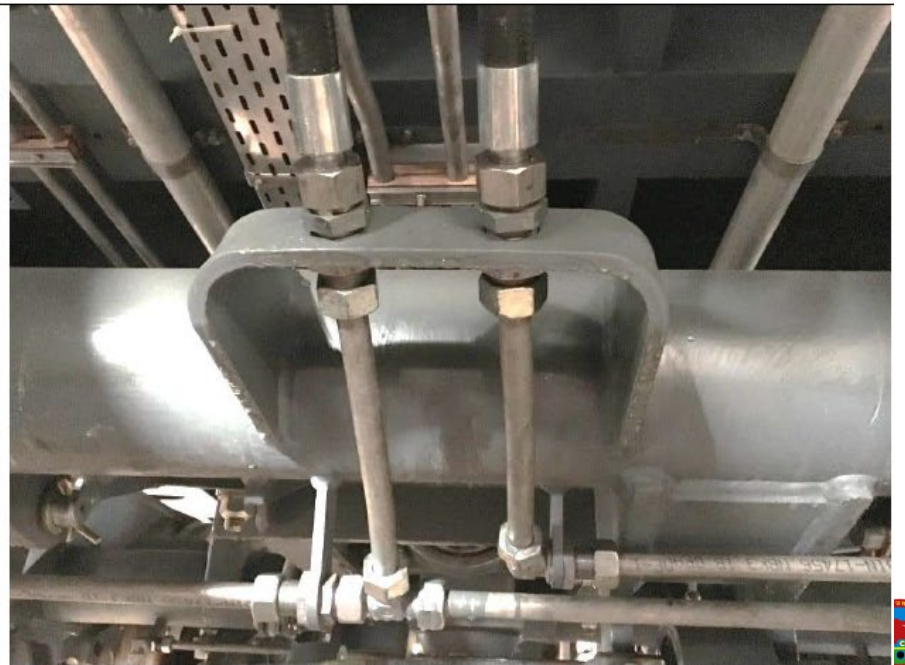


- RDSO standardized design of flexible hose (Drg.No.CG-19036) interchangeable across LHB brake suppliers
- Pipe joint fittings reduced from 9 to 6
- Upgraded flexible air hose advantages:
 - Bigger Inner diameter: increased from 9mm to 12mm
 - No washers: The new hose has M26 (F) type ferrule arrangement at both ends
 - Less pipe joints/fittings: joints/fittings were reduced from 9 to 6 nos
 - Increase in hose length: Avoids stretching & rupture - The length of hose was increased from 600 to 650mm, as in original Alstom design





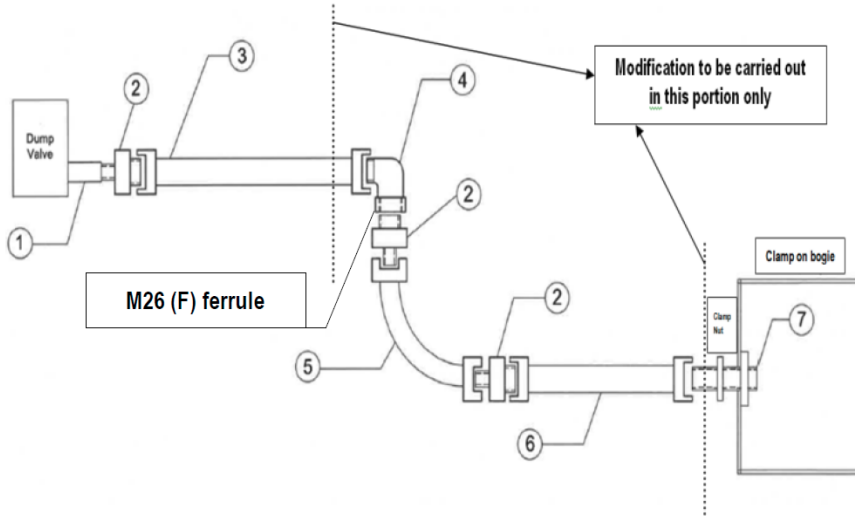
Existing piping arrangement



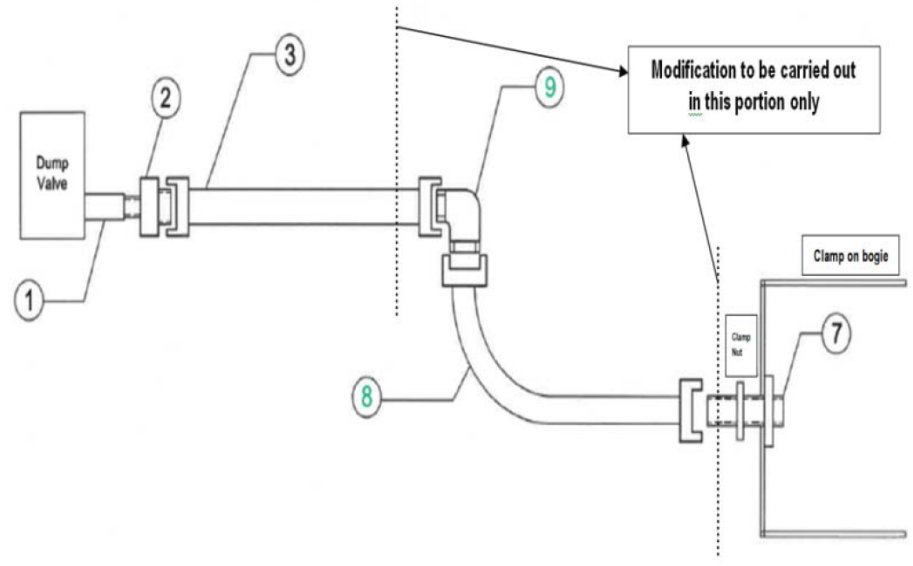
Modified piping arrangement with reduced joints and modified hose

Modified hose

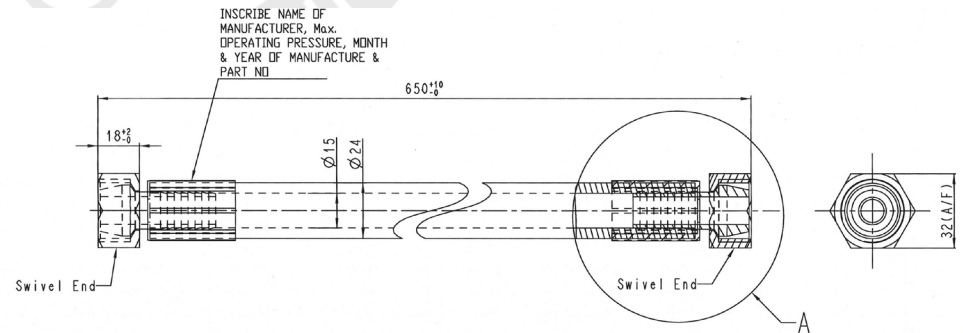
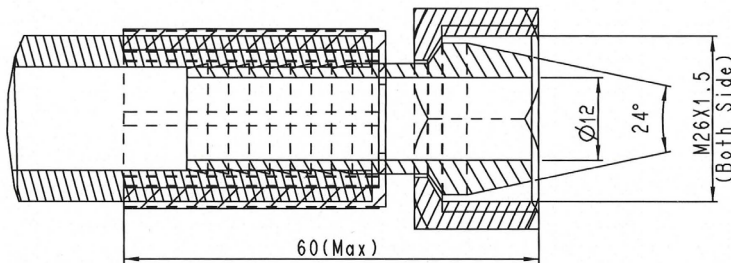
Existing Arrangement (Fig 1)



Modified Arrangement (Fig 2)



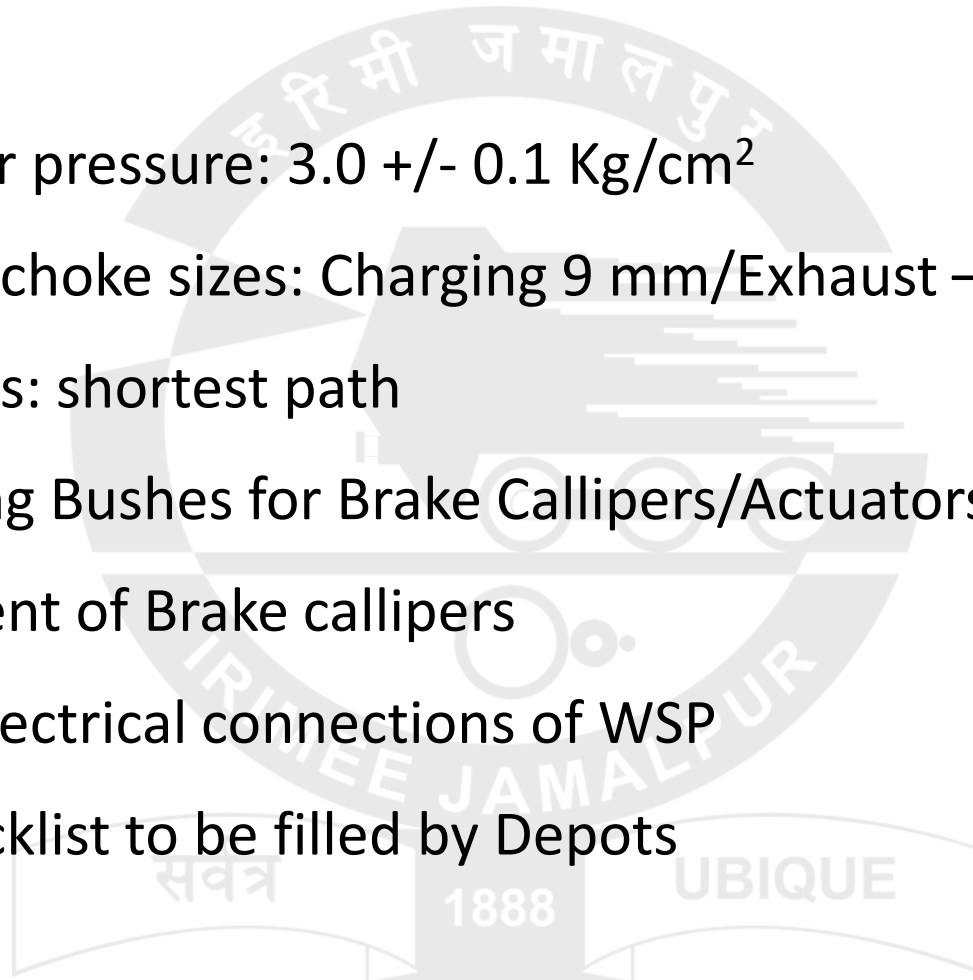
A



Consolidated instructions issued by CAMTECH



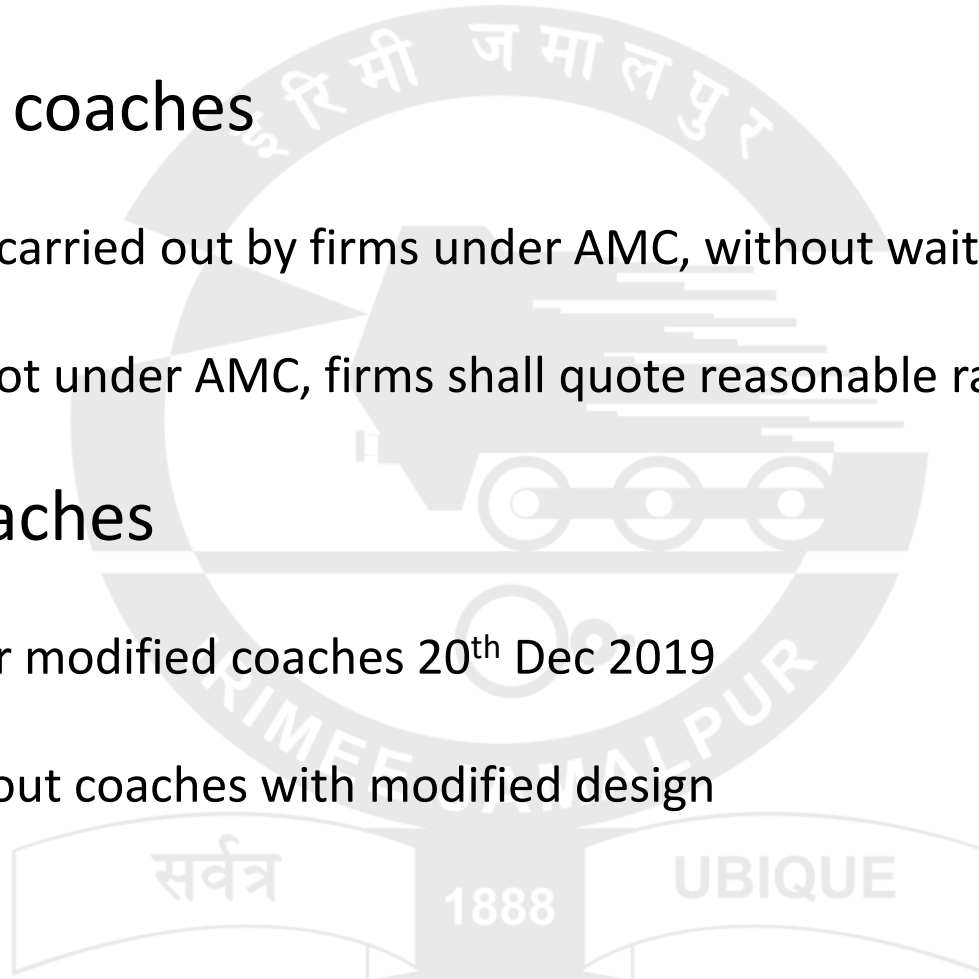
- IRCAMTECH/GWL/M/LHB, Dated: 08.07.2019
- Brake cylinder pressure: $3.0 \pm 0.1 \text{ Kg/cm}^2$
- Dump Valves choke sizes: Charging 9 mm/Exhaust – open vent
- Pipe & Fittings: shortest path
- Self lubricating Bushes for Brake Callipers/Actuators
- Free movement of Brake callipers
- Integrity of electrical connections of WSP
- 23 items checklist to be filled by Depots



Modification in AB pipes and fittings



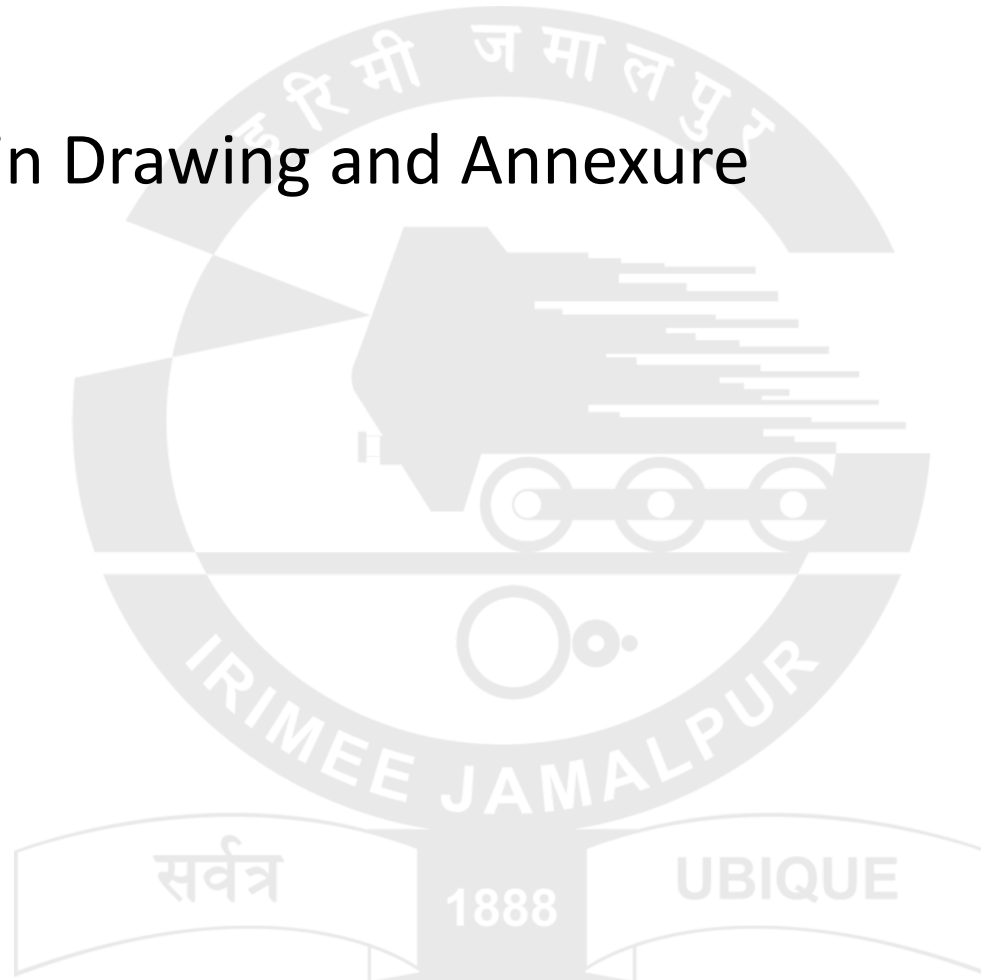
- No.MC/LHB/Brake, dated: 17.12.2019
- For existing coaches
 - Change to be carried out by firms under AMC, without waiting for schedule
 - For coaches not under AMC, firms shall quote reasonable rates
- For new coaches
 - Cut-in date for modified coaches 20th Dec 2019
 - PU shall turn out coaches with modified design



Modification in AB pipes and fittings



- No. MC/LHB/Brake, dated: 04.08.2020
- Correction in Drawing and Annexure



Current status

- The wheel shelling is reduced to a large extent, however NOT eliminated
- MIL standard junction box and connections are not standardized in old/existing coaches as it needs complete changeover of wiring harness as well – costly
- AMC in most of the depots are going to be expired, and in-house maintenance/knowledge needs to spruced up

