BRAKES QUALITY REVIEW – 21MY UPDATE

Brakes Engineering
9th December 2021

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PTA 21MY 18" brakes
Executive summary

Purpose of the review :

- Update on E-PACE, Discovery Sport and RR Evoque Brakes Refinement Performance : 21MY introduction adversely affecting low TIS metrics.
- Review iQM Project status (Root cause, Escape point, ICA/PCA, next steps).

Expected outcomes :

- Share technical direction and next steps on timeline to recover Brake Refinement as soon as possible.

Executive Summary:

- Status – Brakes Refinement performance has deteriorated at 21MY for low TIS. Issues are split into two categories:
- 1) Noise when braking from moderate speed (grinding – iQM P342439).
- 2) Noise at end of abrupt stop (graunch – iQM P343739).
    - *These Refinement issues do not affect the brake system primary function*.

- Technical actions are in place and suppliers are involved to implement ICA and PCA asap.

Brakes Content

21MY – E-PACE, Discovery Sport, RR Evoque

21MY was a major change point for Brakes Systems, supporting US Legislation, vehicle efficiency and ADAS features;

- Roll-out of decoupled brakes – Integrated Power Brake (IPB)
  - Improved pedal feel, Actuation NVH, decoupled system supporting ADAS implementation.
- Introduction of Lightweight disc on E-PACE (previously implemented with New Front End on Discovery Sport and RR Evoque)
  - Reduced un-sprung mass, improved ride quality.
- Low-Cu compliant front pad material
  - Compliant with Jan-2021 US legislative requirement on Copper content.
- Zero-Cu compliant rear pad material
  - Compliant with Jan-2025 US legislative requirement.
- New CBI/Hitachi 18" front caliper with positive pad retraction, high roll-back seals on rear calipers
  - Caliper technology for low drag – improved efficiency, lower emissions, reduced pad wear.
  - *However – lower drag results in extended bedding-in period for friction components.*
- Auto-hold function
  - This is getting very positive customer feedback (eg JD Powers).

- Friction couple related issues are the outstanding challenges.
- Despite these model Open Projects, JLR overall remains in a Leadership position for Brake NVH (2021 JD Powers IQS data).
- Brakes NVH – Noisy/Vibrate/Shudder classed 2nd best attribute on 21MY Defender v Midsize Premium SUV.

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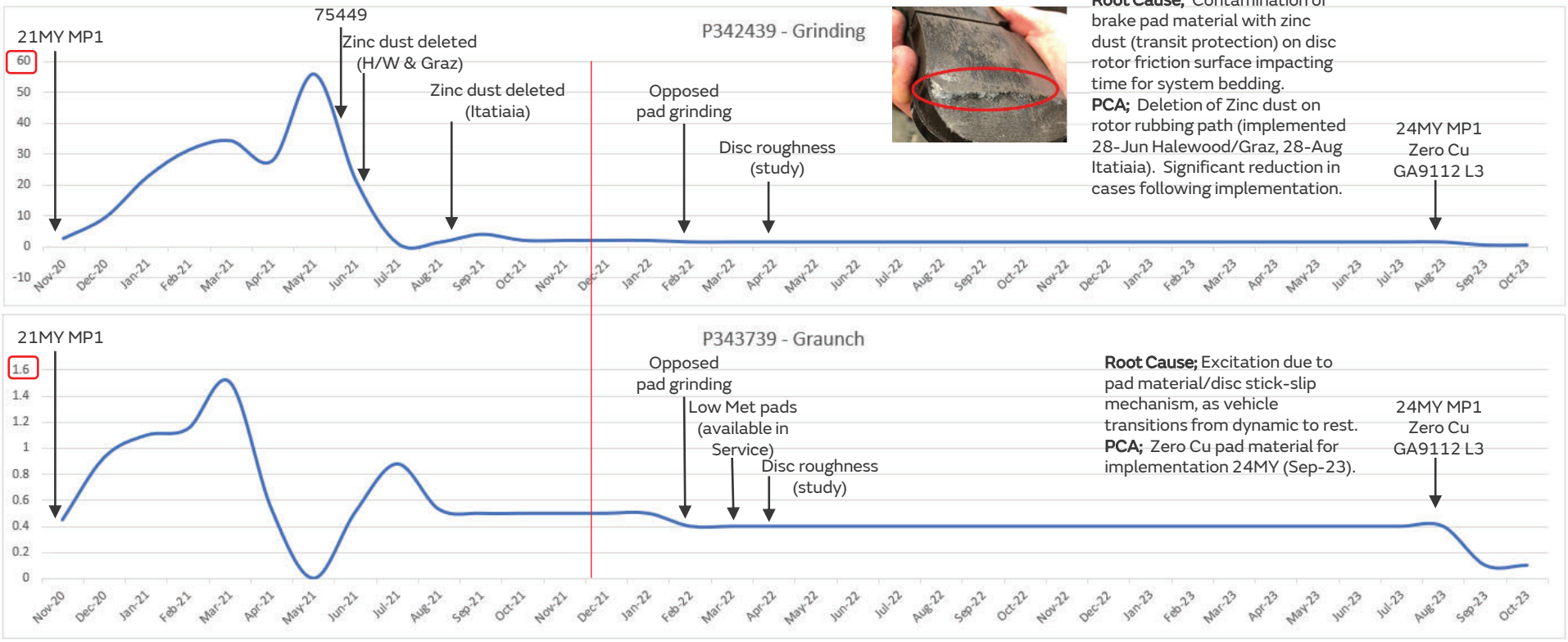
TIMELINE



ABENTLEY COLOUR SUMMARY – REVISED GRAUNCH ASSESSMENT

- During 'Characterisation' section, half of stops are done at 0.25g gauge and half done at 0.5g gauge.
  - •captures more data in event space of graunch issue (aggressive end of stop).
- 'Whole Vehicle Assessment' (WVA) done across a wider deceleration range to ensure more aggressive stops are captured.

	Release						End of Stop					
	Corroded		Hot		Cold		Corroded		Hot		Cold	
VER	Char.	WVA	Char.	WVA	Char.	WVA	Char.	WVA	Char.	WVA	Char.	WVA
GA9510 Baseline	<=5	<=5	>=8	>=8	>=8	>=8	>=8	6	<=5	<=5	<=5	<=5
GA9510 + Grease	<=5	<=5	>=8	>=8	>=8	>=8	>=8	<=5	<=5	<=5	<=5	6
GA9510 + 3M tape	<=5	<=5	7	>=8	>=8	>=8	>=8	<=5	<=5	<=5	<=5	<=5
GA9510 no springs	<=5	<=5	>=8	>=8	>=8	>=8	<=5	<=5	<=5	6	<=5	7
GA9510 L2	<=5	<=5	>=8	7	6	6	>=8	<=5	<=5	<=5	<=5	<=5
GA9510 50mm slot	<=5	<=5	>=8	>=8	>=8	>=8	>=8	<=5	<=5	<=5	<=5	<=5
GA9510 50mm pad	<=5	<=5	>=8	>=8	>=8	>=8	<=5	<=5	<=5	<=5	7	7
AMS2 (low-met)	6	<=5	<=5	<=5	<=5	7	>=8	<=5	7	7	7	6
GA8135	<=5	<=5	>=8	>=8	7	7	>=8	7	<=5	<=5	>=8	>=8
GA9112 (Zero Cu)	<=5	<=5	7	6	7	6	7	6	<=5	<=5	<=5	<=5
GA9112 L3 (Zero Cu)	<=5	<=5	>=8	>=8	>=8	>=8	>=8	<=5	>=8	6	>=8	6
GA9112 L4 (Zero Cu)	<=5	<=5	>=8	7	7	7	>=8	<=5	6	6	>=8	6
GA9112 L3 + sliding shim	<=5	<=5	7	6	>=8	>=8	>=8	<=5	6	6	>=8	7
GA9112 L3+ Monster anchor	<=5	<=5	>=8	7	>=8	>=8	7	<=5	7	7	>=8	>=8

- Vehicle test method developed to characterise Graunch along with Creep/Groan (Release)
- Vehicle testing of multiple graunch palliatives has been conducted;
  - Pad materials
  - Grease and shim changes
  - Caliper modification
- Optimum pad material for graunch is zero copper GA9112-L3, target introduction at 24MY.
- Testing has highlighted that disc corrosion is an influencing factor (eg - low vehicle usage during Covid restrictions).

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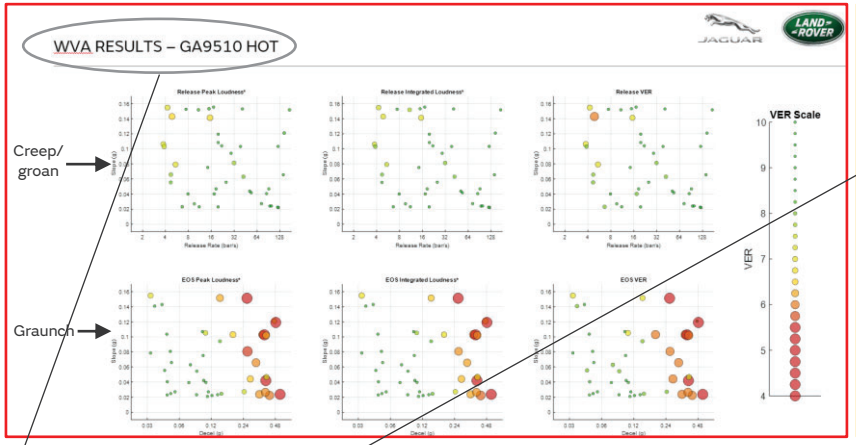
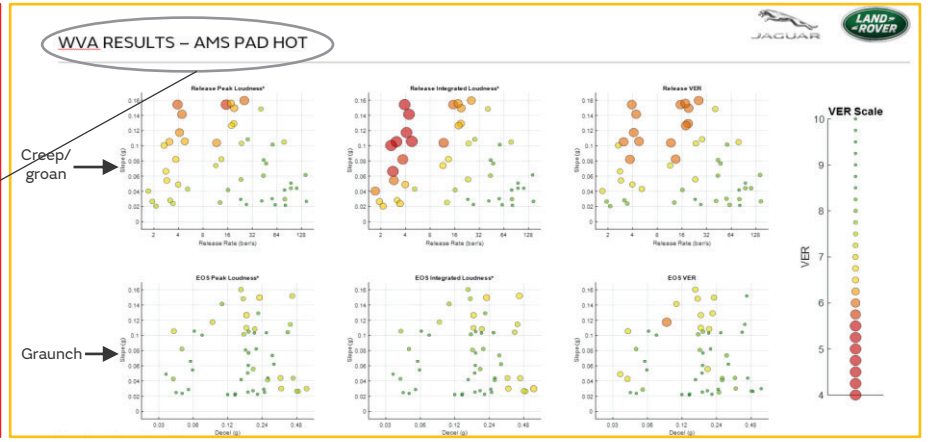
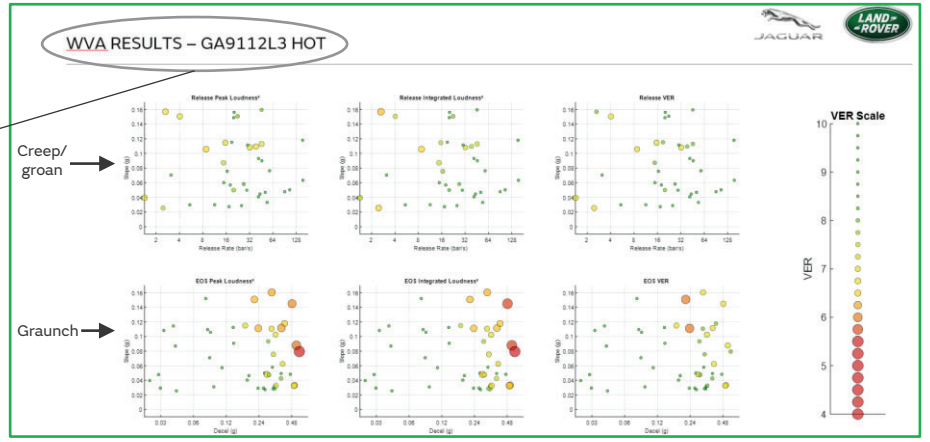
VEHICLE TESTING – GRAUNCH SUMMARY







Current production pad material (GA9510) performs well for release noise (creep/groan) but exhibits end of stop graunch.

Performance pad (AMS2) material demonstrates improved end of stop graunch, at the expense of increased potential for release noise. Proposed as a Service Fix for critical customers (fix on fail).

Optimum material for graunch is zero copper GA9112-L3, target introduction at 24MY.

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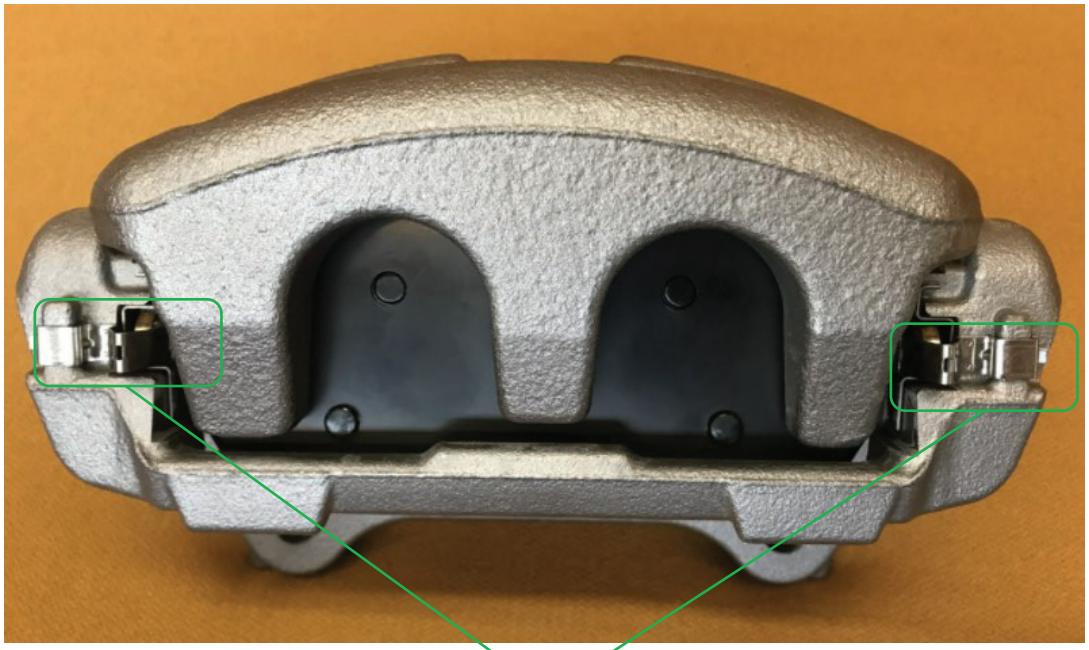
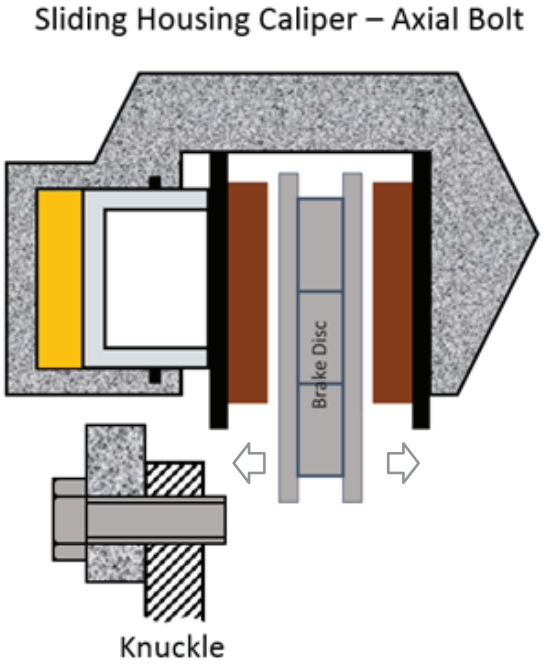
PTA 21MY 18” FRONT CALIPER





Positive retraction springs pull pads clear of disc when off-brake;
Reduces mean drag from 5.25Nm (19MY) to 2.5Nm.
This have a positive effect on fuel consumption and C02 emission but impacting bedding time

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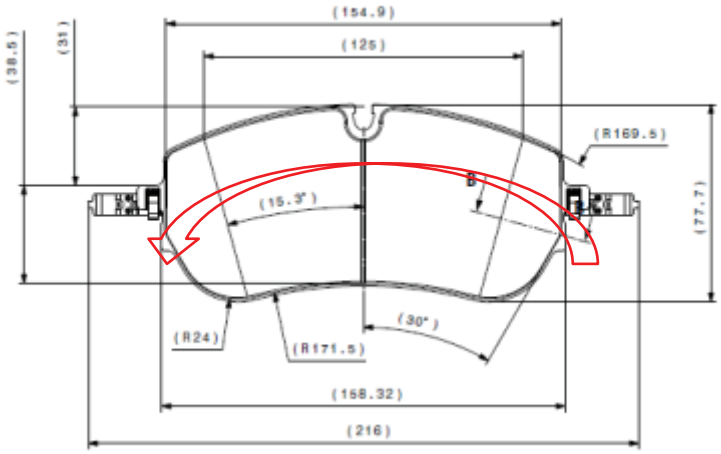
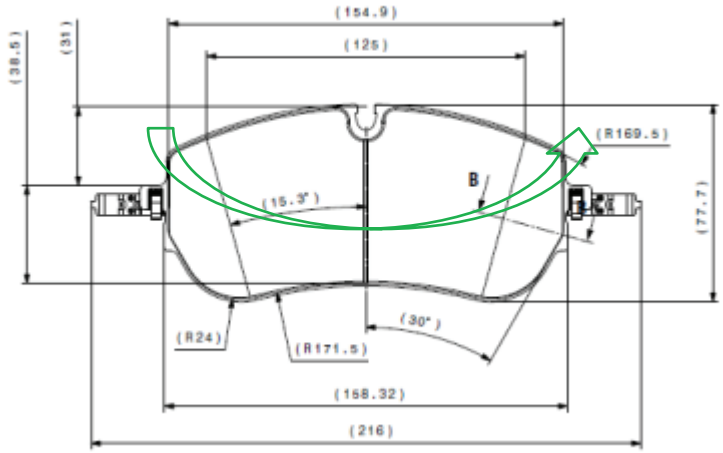
PTA 21MY 18” FRONT PAD FINISH GRINDING



Current pad is finish-machined with tool path that is concentric to the machined finish on the brake disc



Proposal from pad supplier to invert the machining path, to accelerate friction material bedding – successfully trialled, release in progress, introduction Feb-2022.