GB NDT AXLE TESTING
& DEFECT TYPES FOUND

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GB NDT Axle Testing & Defect Types Found.

- Manual ultrasonic testing used for 50 years primarily from the axle ends.
- Initially introduced for passenger coaches using a 0 deg twin probe.
- The 5 deg twin probe scan replaced the 0 deg scan to improve detection capability.
- MPI introduced in 1985 on coaches & now mandatory at overhaul for all axles.
- Eddy Current Inspection introduced in 1999 for some freight axles & since has further expanded to include some passenger classes.
GB NDT Axle Testing & Defect Types Found.

- Currently corrosion fatigue mid-span axle body and wheel seat transition radius defects only found occasionally. The NDT techniques employed are MPI / Eddy Current inspection. UAT does not find these defects unless they are gross.

- Note:- Regarding transition radii corrosion fatigue is where corrosion pitting has occurred where the two radii meet (not at radius bottom where stress concentration is deemed to be higher).

- Historically cracks found by UAT at the inner end of the wheelseat originating from poor design.

- Improved axle design and assembly methods (shrink fitting wheels) have significantly reduced the amount of cracks found in the seat areas.

- Some freight organisations now only apply MPI or similar inspection i.e. Eddy Current to wagon axles at overhaul and cease UAT at overhaul and in-service.
GB NDT Axle Testing & Defect Types Found.

• In the past axles have suffered corrosion fatigue defects, although the issue found now is mainly corrosion. The corrosion pitting to start a crack can be quite small (See example photographs below and the actual samples here to examine or hand around).

• Examples –mid span crack – (MK 2 coach axle found in 1985). Another small crack is located next to the broken open main crack from a corrosion pitted area.

• Mk 3 coach axle (transition radii cracks)

• Potash axle severe corrosion (mid-span cracks)

• Note:- Toilet chutes adjacent to axles in the past have allowed axles to be contaminated and serious cracks have been quickly induced. This also applies to wagon axles carrying corrosive substances.
GB NDT Axle Testing & Defect Types Found.

- The corrosion levels on GB wagon axles are generally light unless they are working in a contaminated environment.

- However corrosion in the transition radii is an issue regarding wagon axles, as according to the standard it is not allowed and attempting to polish out is common, but does not always succeed.

- Sometimes skimming out of corrosion is allowed providing there is enough tolerance in the axle drawing to do so and it is accepted as OK by a Technical Competent Authority.

- In-service Eddy Current using certain equipment can identify corrosion areas under paint as well as finding fatigue defects (see photograph below).

- If the corrosion depth is above 0.5 mm then the Eddy Current technique is very noisy and cannot be applied.
GB NDT Axle Testing & Defect Types Found

- Large fracture face (mid-span crack)
- Small crack from corrosion pore
GB NDT Axle Testing & Defect Types Found.

MK 3 AXLE TRANSITION RADIUS CRACKS

SAMPLE 3 COACH AXLE
SECTION RADI CRACKS
(MAX 12 X 1.6mm DEEP)
GB NDT Axle Testing & Defect Types Found.
Cracks / Corrosion in potash axle sample
GB NDT Axle Testing & Defect Types Found.

- Eddy current response from potash axle cracks & severe surface corrosion noise and crack non/ lightly corroded surface.
GB NDT Axle Testing & Defect Types Found.

Passenger Vehicle Axle Testing

- Some train operators allow non-intrusive in-service testing techniques.
- This is a combination of eddy current for the axle body / transition radii and shear wave into seats.
- This avoids the costly removal of the axle end fitments and risk involved.
- This is mainly for solid axles, but one type of hollow axle fleet has also been included where the body access is favourable.
GB NDT Axle Testing & Defect Types Found.

Passenger Vehicle Axle Testing

• Sometimes on long trains where a lot of train wheelsets are involved the body and seated area techniques are tested at split times and different test frequencies.

• The defect detection capability for the axle body is validated at 0.5mm deep natural defect as per MPI using Eddy Current and this has also allowed a relaxation of the test interval in some cases.

• An NDT operative, or a number of operatives if it is a long train, can therefore test the train overnight on maintenance, allowing no loss of train revenue regarding NDT and little involvement from the depot, therefore saving up to 4 fitters time for end fitment removal and replacement.
GB NDT Axle Testing & Defect Types Found.

Passenger Vehicle Axle Testing

- Technically regarding any trailer / mid-span gearbox motor axle at least, where access is available, a surface technique rather than conventional UAT would be preferable, for the body areas. Note: The axle should be proven clear of manufacturing defect issues, prior to UAT of the axle body being dispensed with.

- To examine the axle body tells us much more about its condition, including damage, corrosion, and paint issues, that cannot be seen when testing from the axle end.
GB NDT Axle Testing & Defect Types Found.

NDT Issues Regarding Axles in Recent Years.

- It has to be said that over the recent few years there have been a number of issues we have had to deal with regarding the quality of new axle / wheelset products being imported into GB.

- Special procedures have had to be put in place to accommodate these issues and keep the trains running.

- These issues are only coming to light at the in-service inspection, highlighting the difference in the equipment used, sensitivity & rejection criteria of procedures being used at manufacture.

- The main issue with UAT outside GB is the use of a 2 MHz single crystal forging probe (class 2 axles), which is grossly down regarding defect detection sensitivity compared with what is used in GB and does not show noise.

- Where GB use a stricter defect detection threshold, to maximise the NDT test frequency as is the current theme, the transparency of the steel requires to be of a high standard.

- Therefore NDT procurement of axles / wheelsets before delivery is an issue to consider when the order is placed outside GB.

- Where in-service testing is not carried out to the same degree outside GB, then manufacturing issues may not be identified or seen to be relevant.
GB NDT Axle Testing & Defect Types Found. NDT Issues - other than Corrosion Fatigue - Regarding Axles in Recent Years.

- Welded axles
- Opaque Axles – Various reasons-including inappropriate heat treatment / manufacturing processes.
- Introduction of specialist steels (Microstructure).
- Machining Issues – rough bore wheels.
- Noise generated from interface fits.
- Centre-line defects, cold laps & other internal defects inclusions etc.
GB NDT Axle Testing & Defect Types Found. 
NDT Issues Regarding Axles in Recent Years. (Weld repaired axle)
GB NDT Axle Testing & Defect Types Found.
NDT Issues Regarding Axles in Recent Years.

➢ Cold Lap in an axle body
GB NDT Axle Testing & Defect Types Found.

NDT Issues Regarding Axles in Recent Years.

Opacity Issues

- Large pearlite grains (A1N) (Left)
- Segregation & Ferrite grains & inclusion (A4T) (Right)
GB NDT Axle Testing & Defect Types Found.

NDT Issues Regarding Axles in Recent Years.

Opacity Issues

➢ Poor Ultrasonic traces (Opacity) different types & manufacturers / axle material.
GB NDT Axle Testing & Defect Types Found.

NDT Issues Regarding Axles in Recent Years.

- Poor ultrasonic traces (centre line defects & blocking affects) regarding HA & NE scans. Also poor wheel bore finish noise NE trace.
GB NDT Axle Testing & Defect Types Found.  

Summary of Current NDT Issues Regarding Axles.

• Major corrosion fatigue cracks are now rare in GB compared with the past, as MPI at overhaul has been carried out for up to 25 years & Eddy Current 12 years.

• Light Corrosion however is available regarding freight axles and reclaiming / polishing is prevalent.

• Passenger axles are suffering with paint loss- suggested reasons (paint types used, poor preparation and bad winter weather).

• More surface techniques being applied to axle body areas in-service rather than UAT (Freight, passenger trailer & central gearbox motor axles). More types should follow on. Improved techniques and equipment should be utilised on enclosed body motor wheelsets.
GB NDT Axle Testing & Defect Types Found.

Summary of Current NDT Issues Regarding Axles.

- Less axle end fitment removal to accommodate NDT to avoid risk and save cost.

- Manufacturing defects have been on the increase over the last few years, exacerbated by the different NDT processes applied at manufacture outside GB and the in-service being here being incompatible.

- Standards including BS 5892 PT 1 and procurement regarding new axles require to be tightening up.

- The use of a 4 MHz twin probe for initial transparency checking regarding tempered axles would improve quality.

- Some UAT operators across a number of railway organisations (the majority being Level 1’s in GB) have taken upon themselves to be lenient against the procedure criteria regarding noise issues causing a lack of consistency regarding the results and this issue has been recently addressed by PCN.