Welding Process and Technology Development

What is the situation?

We are reliant on conventional welding processes for joining and repairing rail (Aluminothermic circa 1900, Arc welding circa 1950s, Flash butt welding 1980/90s). These processes have evolved and are limited in their application. The quality of these welds are operator dependent requiring a high level of individual skill to deliver consistent weld quality.

There have been some developments in the processes and automation of flash butt and arc welding. Induction welding is also currently being developed for Switches and Crossings. The implementation of these processes is inconsistent and the potential benefits of automation are not being fully realised.

R&D to develop increased automation and reliability of rail joining and the introduction of plant and equipment specifically designed for welding and repairing rail offers improved quality, reliability, consistency, safety (asset and individual) and sustainability.

Numbers to support

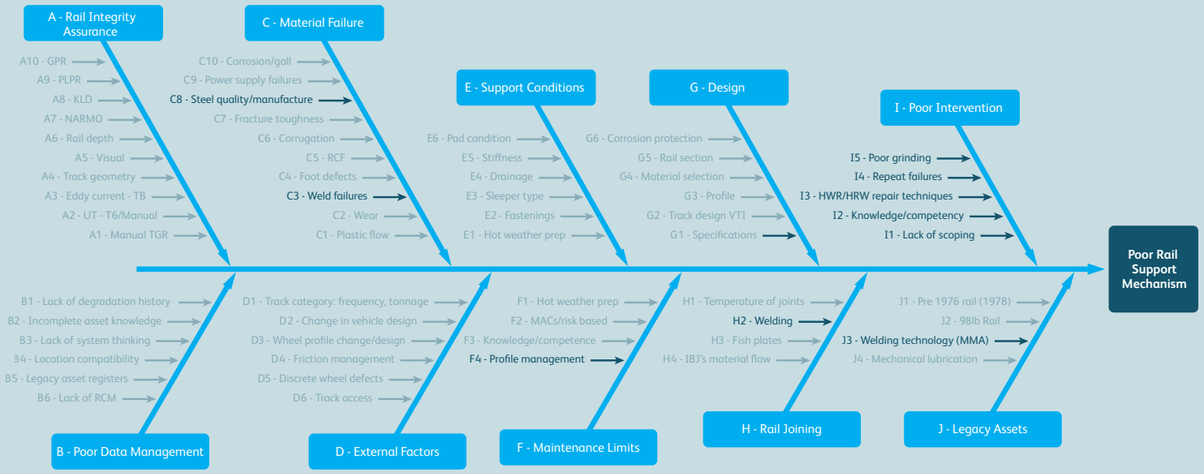
RDMS defect data on welds and rail defects – Rail welding and defect repair/removal generates a large workbank. Aluminothermic welds accounted for 30,000 maintenance welds and approximately 10-15,000 renewal welds in 16/17 with a national rejection rate of ~2.29 % .

Rail head repairs (Manual Metal Arc, Flux Cored Arc Welding and Automatic welding) accounted for 3,400 Plain Line Track defect repairs and 8591 Crossing defect repairs and 1636 switch defect repairs (of which 1530 are MMA).

Traceability of repairs that fail is not available from Network Rail databases. Based on Wales Route analysis a failure rate of ~15 % has been reported.

-700 NR welding staff, 38 competences, 3 NR welder training centres at York, Walsall and Bristol, 2 external training centres at InLine (Kent) and Babcock's (Scotland).

Analysis of causes



Priority problems

Specific priority problems

- Rail degrades in traffic necessitating replacement and repair of track.
- Replacement and repair of rails introduces defects requiring remediation.
- Automated welding technologies are limited.

Related goal

- To join and repair rails consistently so as to minimise the introduction of defects.
- To deliver consistent rail performance in traffic.
- Increased welding automation technologies.

Benefit

- Technology innovations facilitate improved rail management, safety, performance and reliability.
- Reducing reactive defect removal, risk and cost.
- Increased safety, quality, reliability and performance.

Gap Analysis			Measure					
Cause	Countermeasure Name & description	Impact	0	20	40	60	80	100
H2, C3	**Aluminothermic process improvements**	• Developing single use crucibles for all NR approved rail steels and profiles to deliver increased weld consistency and reliability. • Development of the full suite of welding procedures for existing and new premium grade rail to facilitate use of premium rail steels. • Approvals of new manufacturing facilities to ensure continued supply of consumables (supplier relocating facilities). • Innovative Welding Processes for New Rail Infrastructures (WRIST) project outcomes have potential to automate some parts of the ATW process.						
J3, C3	**Introduction of arc welding within Mobile Maintenance Train**	MMT – delivering the capability to weld in a factory type environment delivering consistent and reliable welds on the asset: • Three phase generator, inverter and wire feed unit provision. • Compatibility of new equipment with existing approved equipment.						
J3, C3	**Arc welding three phase generation**	Three phase generation provides necessary power output in a single unit that can be coupled with inverters and wire fed units. Options include a tracked vehicle (transports generator and tools required in the four foot = 415kg total) carrying a single three phase generator or a modular generator capability (50kg/module machine) or a battery powered generator (under development). A Tracked option is used extensively in France and Italy where 5000+ cast crossings are welded per annum compared with 178 (15/16) & 141 (16/17) in UK using Network Rails automatic welding system (single phase power generation). Arc welding is currently dependent on single phase power generation, which necessitates sending two generators (115kgx2) to site to provide sufficient power OR over sized generators that introduce significant manual handling risks.						
J3	**Track circuit deposit work by fully automated system** *Zig zag welding that enables track circuits to work on little used PLT rail.*	This is labour intensive and an under utilised skill inconsistently applied. Two options to replace this are: 1. Current automatic technology available with wider application. Access and transportation issues are minimised as in PLT only. 2. Automatic system (used in Europe) using a tracked three phase power system (approval dependent) offers the potential to deliver reliable outputs and increased productivity **Note:** Continuous strip welding requires Signal and Telegragh approval.						
H2	**Induction welding modular S&C**	Existing welding techniques for modular S&C are limited to aluminothermic only due to space constraints between the S&C components. Aluminothermic welds take a minimum of 90 minutes to complete, whereas an induction weld takes a maximum of 45 minutes. This time saving facilitates welding operations during the core possession removing the need to clamp, impose a TSR and weld the following weekend. Cost and risk are significantly reduced by up to £750k @125MPH cross over. In 17/18 Infrastructure Projects (IP)renewals are replacing circa 200 sets of S&C. Induction welding process is potentially 100 % reliable. Safety considerations include reduced equipment weight (manual handling) and no high temperature and minimal gas emissions.						
C8	**Material development rail steels**	Continuous review and development of rail steels. Other European railways have ongoing work streams. Requires effective welding techniques to support installation, maintenance and repair (weld-ability).						
I5, F4, 14	**Automated portable datum grinder**	Semi automated grinding machine deliver consistent grinding outputs. Developments to move to a fully automated grinder capable of grinding a full profile using a laser measurement system offer continuous ergonomic improvement opportunities.						
F4, H2, I4, I5	**Modular switch grinder development**	A variation to the modular plain line grinder . This is currently in the design phase and requires a detailed specification. This would replace the existing Switch grinding units with a single type modular switch grinder improving ergonomic performance.						
C3, C8 H2	**Induction welding plain line**	Existing welding techniques for PLT are aluminothermic and flash butt welding. Aluminothermic welds take a minimum of 90 minutes to complete, whereas an induction/ Flash Butt weld takes a maximum of 30-45 minutes. Times include grinding. The cost of induction welding is potentially less than Mobile Flash Butt Welding and is potentially 100 % reliable. Safety considerations include reduced equipment weight and less risk in transportation/delivery of the working system. Environmental outputs are also reduced with no high temperature and minimal gas emissions.						
	Introduction of autonomous welding vehicles	Long term view to produce a fully automated vehicle that can operate on track, access to site, identify the defect, test, grind, weld, post grind, retest and move onto the next defect without human intervention.						
J3	**Induction rail pre heating system**	To replace the use of propane and propane rail heaters with an induction preheating system using 3 phase generators (with additional transformers).						
H2, I1, I2, I3, I4, I5	**National Welding Database**	There is a need to introduce a new National Welding Database that can allow all internal and external welding staff and welding companies/suppliers, management and engineers to input welds and weld inspections, create reports and conduct trend analysis etc. This needs to be accessed in real time and via site as well as desktops.						