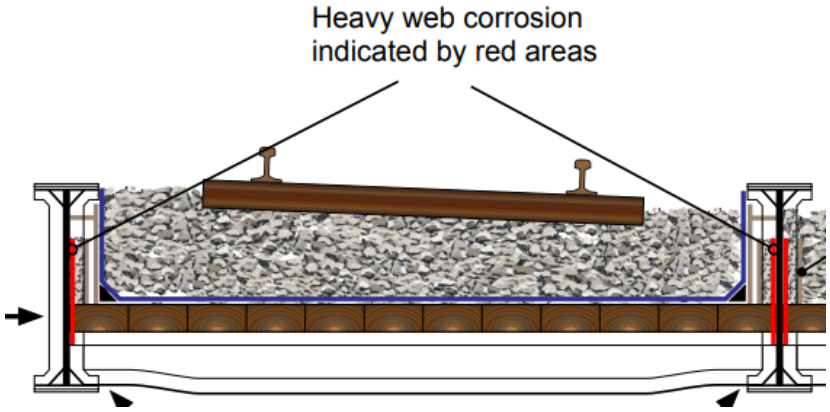
High Impact Infrastructure incidents

Wessex Route Asset Management

11 September 2018

RAM Structures
High Impact incidents

Stewarton



Stewarton, Scotland, 2011

Failure was caused by severe corrosion to hidden elements highlighted red above.

Since the failure, examination of these ‘hidden elements’ has been mandated at defined intervals. These examinations continue to highlight significant defects to our assets.

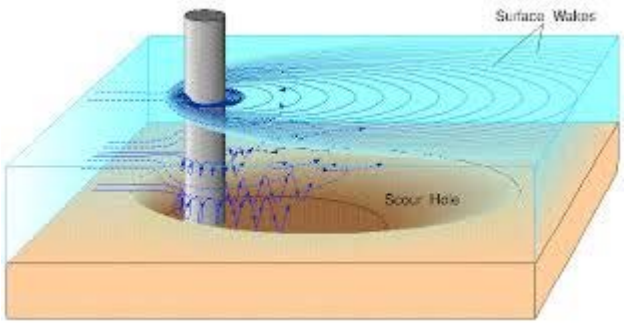
Contributing factors:

- Examination.

River Crane / Lamington

River Crane, Wessex, 2011

Lamington, Scotland, 2017



Both failures caused by the effect of scour action on the bridge foundations.

Contributing factors:

- Examination.
- Procedures for extreme weather.

Balcombe Tunnel

Balcombe, South-East, 2013

A partial collapse of the water-catchment system occurred due to failure of the anchors fixing into the tunnel lining.

Contributing factors:

- Examination
- Design

Road vehicle incursion

Great Heck, LNE, 2001

Oxshott, Wessex, 2010

Ten people were killed at Great Heck when a vehicle came off a bridge onto the railway.
At Oxshott, a cement lorry landed on the roof of a train.

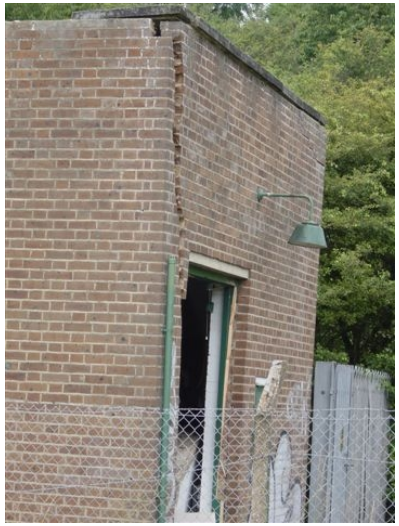
RAM Electrification & Plants
High Impact incidents

E&P High Profile incidents

Incident	What happened	Underlying Cause	What happened…
Kenton - 2009	Member of staff manually applying short circuit device to live 11kV	Test before earth not carried out, no safe system of work plan, confusion on site and no warning notices applied to adjacent live switchgear	Person manually applying short circuit device to live switchgear was very significantly burnt by resultant arcing
Worting Jn - 2009	Member of staff applied a short circuit strap to a live conductor rail	The member of staff had not received permission to test and apply the S/c strap, did not test the conductor rail, and did not apply the short circuit bar	Person suffered from severe burns to face, arms and body from resultant arcing
Esher - 2006	The slipper on a class 444 unit was running low due to a loose adjustment mechanism. The slipper hit a ramp end face on and due to the impact the shoegear disintegrated and the downstop bracket became detached from the train at 90mph	The conductor ramp end was high and out of gauge, as following a con rail renewal the length of renewed conductor rail had not been anchored as required and had moved with the ramp end riding up on an insulator.	The shoe-gear bracket, having become detached from the train, struck a passenger who was sitting on a bench of the Down Main Slow line platform The passenger suffered cuts and bruising to the right leg and was conveyed by ambulance to Kingston Hospital.
Dunton - 2004	Catastrophic failure of minimum oil 25kV circuit breaker	The maintenance team was not undertaking correctly maintenance tasks on the circuit breaker leading to malfunction	The circuit breaker failed explosively which ked to structural failure of the building. No one was in the building at the time

Esher and Dunton photos…

Ramp end with impact damage and bracket that hit passenger on the platform



Dunton 25kV feeder station building

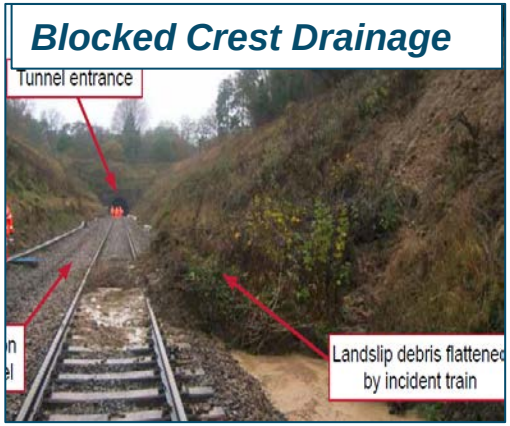
RAM Earthworks
High Impact incidents

When earthworks fall down…

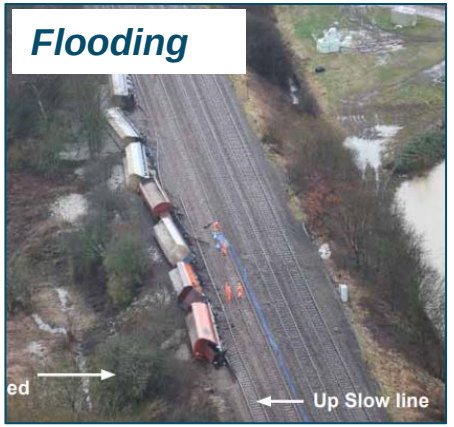
Prolonged Rainfall

Root Ball Failure

Blocked Crest Drainage



Flooding



Blocked Culvert

Blocked drain

Rapid Snowmelt

Outside party developments

High Profile Derailments

Incident	Immediate Cause	Underlying Cause	What happened…
Ais Gill Fatality – 1993	Prolonged Rainfall	No specialist knowledge on earthworks Inadequate management of emergency call by Route Control	Recruitment of first territory Geotech Engineers. Earthwork failure reporting commenced. Computerised Earthworks inspections began in 1997.
Hooley Cutting - 2007	Root Ball Failure	Lack of guidance in NR standards regarding root balls	Change in examination standard to recognise mixed geologies and update of vegetation standards re. root balls
Gillingham - 2009	Blocked Crest Ditch	Inadequate off track drainage management process	Strengthened off track drainage inspection and maintenance. Drainage inventory commenced
Barrow Upon Soar - 2012	Flooding resulting in loss of track support	Flooding and impact on track geometry was not reported to Geotechnical Team	Earthwork Evaluations to consider track quality Embankments included in Adverse Weather Plans
St Bees/ Loch Treig - 2014	Blocked drainage/ Intense rainfall	Poor operational risk management in response to adverse and extreme weather	Improvement Notice for adverse weather management and mitigations. Introduction of technology to detect asset failure
Watford Tunnel - 2016	Outside Party Development	Water concentration feature not recognised as a significant risk	Review of drainage assets at high consequence locations
Loch Eilt - 2018	Outside party slope failure	Rapid snowmelt led to landslide	Review of weather service provided to NR and enhanced scope for new weather service from 2020

When Wessex earthworks aren't happy

Geotech & Drainage Risk Management

TOP GEOTECHNICAL CHALLENGE – Detection of asset failure by means other than train drivers

- **INPUTS**
- Earthworks examination
- Track geometry trace
- Photo of fenceline

- **TRENDS**
- Trends in movement indicator
- Track geometry "signature"
- Fenceline seems to move over time

- **CAUSE** (why is this happening?)
- **TRIGGERS** (what could make it fail suddenly?)
- **CONSEQUENCE** (what happens if it fails?)

- **PRIORITISE/RISK RANKING**
- "No significant risk at Site 1. Maintain only."
- "Site 2 is likely to fail if the crest drain blocks. Therefore it will be inspected every 6 months and monitored for blockages"

Continuous Improvement has reduced the number of potentially high consequence earthwork failures

Table showing key performance and safety metrics by regulatory control periods. Safety ***KPI's*** are improving but all failures and ***TSR*** numbers are relatively stable (varying with weather trends). First time Earthwork specific asset policy was issued in 2012 during the planning process for CP5.

Control Period	Date Range	Earthwork TSR's (% of all TSRs)	All Earthwork Failures	Potentially high consequence earthwork failures	Earthwork attributable derailments
CP1	1994/95 – 98/99	No data	No data	No data	7
CP2	1999/00 – 03/04	273 (7.3%)	No data	No data	8
CP3	2004/05 – 08/09	135 (3.8%)	477	41	8
CP4	2009/10 – 13/14	441 (4.8%)	528	32	8
CP5*	2014/15 – 18/19	290 (3.4%)	381	18	2
CP6	2019/20 – 23/24				
Trend		relatively stable	relatively stable	reducing	reducing

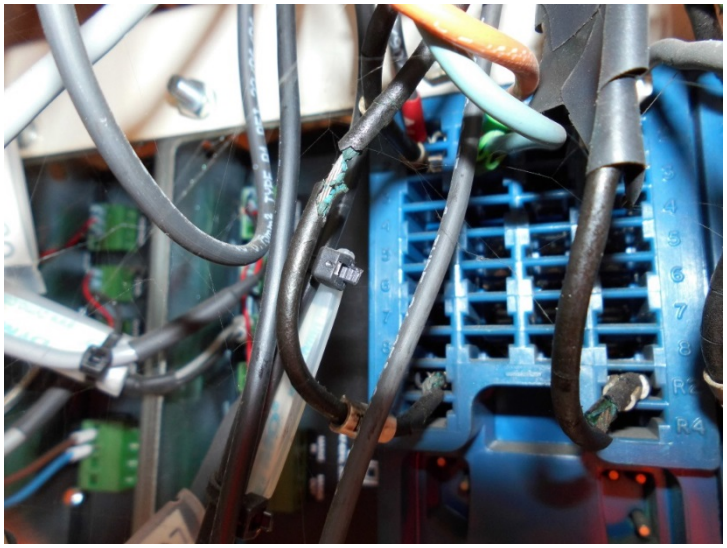
*Data for 4yr period 14/15 to 17/18 ***TSR*** = Temporary Speed Restriction ***KPI*** = Key Performance Indicator

RAM Signalling
High Impact Incidents

When signalling goes wrong…

When signalling isn't happy…

Feltham
Location Case
2013



2 x Feltham
Relay Rooms
2018

Overton 2017

Root cause

Derailment	Cause	What happened…
Clapham Junction - 1988	The collision was the result of a signal failure caused by a wiring fault. New wiring had been installed, but the old wiring had been left in place and not adequately secured. The signalling technician responsible had not been told his working practices were wrong and his work had not been inspected by an independent person. He had also performed the work during his 13th consecutive week of seven-day work weeks.	93 recommendations in total but here are a few: - • Creation of a Design; Installation and Testing Handbook. • Creation of the Independent Test & Commissioning Engineers post. • Standards briefings face to face • Improved training and re-certs • O/T to be monitored • All grades to have a JD and know what is expected of them • Introduction of a system to classify and review all WSF's (SINCS) • All unprotected WSF's to be investigated. • All future reorganisations to be properly planned • BR to implement BS5750 Quality Management System • Installation of Cab Secure Radios • Installation of voice recorders • Rolling Stock integrity to be improved • Ensure all signal boxes have direct lines to ECRO & adjacent signal boxes. • Finally, BR gave a commitment to install ATP (Automatic Train Protection) within 5 years!

Root cause

Derailment	Cause	What happened…
Purley - 1989	Signal Passed at Danger (SPAD).	The report recommended that an automatic train protection system should be introduced without delay
Cowden - 1994	Signal Passed at Danger (SPAD)	Blame for this accident lay with the driver as he had allowed a friend to join him in the cab and it was unclear who was actually driving the train. This happened on a very foggy day and signal lamps were notoriously hard to read in those weather conditions. Whilst ATP introduction was not mentioned, it was unclear at the time as to why the Cab Secure Radio installation had been stopped.

Root cause

Derailment	Cause	What happened…
Watford – 1996	Signal Passed at Danger (SPAD) as the driver did not react correctly to two signals set at caution - he should have slowed down and prepared to stop. ATP would have prevented this accident.	21 Recommendations. • Consider adding to the sectional appendix, reasons for PSR's • All Multi signal SPAD incidents to be investigated by a special signal sighting committee. • Risk assessment of all signal reduced overlaps • Creation of layout risk assessments • Full audit of speed restrictions in sectional appendix v's what is on site.
Southall - 1997	Signal Passed at Danger (SPAD) as the driver did not react correctly to two signals set at caution - he should have slowed down and prepared to stop. One of the trains AWS was also faulty, which contributed to the accident. This accident occurred on one of the two ATP trial sites – which was not switched on due to neither driver being qualified in its operation.	93 Recommendations. • Better driver training. Monitoring of behaviours and encouragement to report faults. • Controllers' posts within NR / TOC should be designated "Safety Critical". • Better Fleet maintenance. • Better post commissioning sighting checks / records & Annual checks. • All trains to be fitted with data recorders which are quick and easy to download. • More risk assessments.

Root cause

Derailment	Cause	What happened…
Ladbroke Grove - 1999	Signal Passed at Danger (SPAD) by an inexperienced driver, compounded by poor visibility of a gantry signal following the installation of OHLE. This accident would not have happened if the Chiltern turbo train was fitted with ATP – the GW HST was.	74 Recommendations • Establishment of System Authorities – NoBo / CiP's / Safety Cases etc. • More controls over contractors, their training and quality of work. • Sentinel Card "tied" to an individual and records their hours. • Creation of Safety Management Systems + processes of Senior Managers engaging with front line staff. • System of licensing of Drivers and Signallers. • Full review of signal sighting standards including the classification of complex or non-complex signals and increased sighting times. • The ATP delays and cost benefit analysis debate was reopened following this accident and concluded ATP was not cost effective. So a cheaper Train Protection & Warning System was developed and deployed and is still in operation today.

Post Clapham Accident and IRSE Licensing

In order to help rebuild BR staff morale post Clapham, a new look S&T department was launched under the brand ‘Safety, Quality & Teamwork’ (SQT). A high level of staff engagement was sought in order to provide a successful launch of the new standard handbooks. Allied to this was the enhancement of training provision. The Railway Engineering School at Derby became the academy for testing training and a range of design and maintain courses covering complex equipment.

The regional schools had no less an onerous role in providing training on the important basic elements of S&T – installation, points, track circuits, interlocking principles, wiring techniques, cable jointing, local telephone exchanges etc.

Sadly these excellent initiatives had a short life span with the break-up of the industry just a few years away. BR’s S&T training units were sold off and have subsequently either been closed or had a chequered career. To some extent, training has turned full circle with Network Rail building its own brand-new signal engineering training centres.

Cont……

In-house measures by BR were however not seen as sufficient to restore the credibility of the S&T profession. “A form of independent assessment of competence was needed and the chosen solution was the IRSE Licensing Scheme.

Since the IRSE is both the body representing the interests of the profession and independent of any railway organisation or equipment supplier, it was a logical decision. It took a while for the scheme to be designed and developed, and it was not until 1994 that the scheme was formally launched.

There are currently 62 categories of licence for S&T covering specific roles within the broad categories of installation, maintenance, testing, design, project engineering and engineering management. Licences are issued on a personal basis.

It is fair to say that the role out of Licensing over the 24 years has largely been within the Design; Installation and Testing disciplines and Maintenance has always been playing catch-up.

But, then this happened!

Derailment	Cause	What happened…
Waterloo - 2017	The collision was the result of an un-controlled modification to points control circuits during the testing of the Waterloo Capacity Blockade.	Investigation is still continuing!

RAM Track
High Impact incidents

When track goes wrong…

High Profile derailments

Derailment	Immediate Cause	Underlying Cause	What happened…
Hatfield – 2000	Broken rail due to RCF	RCF – and mismanagement, poor understanding of RCF, inspections from CESS	Improved inspection regime (4-foot), RCF management and UTU testing
Potters Bar - 2002	Detached Stretcher Bar	Stretcher bar failures and repeat component failures	Clarifying responsibilities between Track and Signalling
Waterloo - 2006	Facing switch defect	Inadequate inspection regime and track opened to traffic following poor quality repairs	Improved 053 inspections and focus on competence of Handback
Grayrigg - 2007	Detached Stretcher Bar	Track inspections incomplete with stretcher bar failures	Tubular stretcher bars, checks for FBC and FWC and Patrolling diagrams
Gloucester - 2013	Cyclic Top	Failure to impose risk controls with inadequate manual repairs	Cyclic Top Red clauses
Liverpool St - 2013	Wide Gauge	No dynamic geometry measurement of S&C	MPV dynamic S&C recording of London Terminals
Canute Road - 2016	Wide Gauge	No SM(T) inspection and failure to apply risk controls to reprioritised work	Validating coverage of inspection regime for SM(T)
East Somerset Jn - 2017	Wide Gauge	Track not subject to track recording and non-designed plain lining of S&C	SIN167 – confirming Rail Testing and Track Geometry recording coverage
Wimbledon - 2018	Wide Gauge	Gap in inspection regime, uncontrolled gauge spread on Pan8 track	Review of boundaries to confirm overlap

When track isn't happy…


Byfleet 2018


Berrylands 2007


Durnsford Rd 2018


Fords Crossing 2018


SE – Victoria 2012/13


Byfleet 2018

Wimbledon 2016


Surbiton 2017

Core Principles of Track

1. Plan to inspect all the Track
2. Confirm that all of the track is being inspected as planned
3. Train and instruct **all** staff how and when to apply risk controls
4. Confirm that risk controls are being applied when required
5. Train and instruct staff how repairs are to be planned and delivered correctly
6. Confirm that repairs are being done correctly

The majority of track incidents can be traced back to at least one of these principles not being followed

Core Principles of Track - when not followed:

Incident: Derailment	1. Plan to Inspect the Track	2. Confirm that the track has been inspected	3. Know how and when to apply risk controls	4. Confirm that risk controls are applied	5. Plan repairs with capable and briefed staff	6. Confirms that repairs have been delivered correctly
Hatfield		■	■	■		
Potters Bar				■		■
Waterloo				■	■	■
Grayrigg	■	■				
Gloucester			■	■	■	■
Liverpool Street		■	■			
Canute Road	■	■	■			
East Somerset Jn	■	■				
Wimbledon	■	■				
Byfleet Buckle - 2018						■
Fords Crossing COT TSR - 2018					■	
Victoria S&C - 2012			■	■	■	■
Byfleet Cracked Crossing - 2018			■	■		
Wimbledon Broken Rail – 2016			■	■		
Berrylands Rail Break – 2007			■	■	■	■
Durnsford Road - 2018			■	■	■	■
Surbiton Non-compliant joint - 2017			■	■	■	■

Thank you