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Mr Andrew Hall
Deputy Chief Inspector of Rail Accidents
Cullen House
Berkshire Copse Rd
Aldershot
Hampshire
GU11 2HP

Dear Andrew,

**RAIB Report: Electrical arcing and fire under a train near Windsor & Eton Riverside,
30 January 2015**

I write to report¹ on the consideration given and action taken in respect of recommendations 1- 4 addressed to ORR in the above report, published on 21 October 2015.

The annex to this letter provides details in respect of each recommendation. The status of recommendation 1 is '**implemented**'; the status of recommendation 3 is '**Implementation on-going**'; and the status of recommendations 2 and 4 is '**progressing**'. ORR will advise RAIB when further information is available regarding actions being taken to address these recommendations.

We will publish this response on the ORR website by 21 October 2016.

Yours sincerely,

Oliver Stewart

¹ In accordance with Regulation 12(2)(b) of the Railways (Accident Investigation and Reporting) Regulations 2005

Initial consideration by ORR

1. All 4 recommendations were addressed to ORR when the report was published on 21 October 2015.
2. After considering the recommendations ORR passed recommendation 1 to Wabtec, 2 and 3 to South West Trains (2 also copied to Alstom and Porterbrook) and 4 to Network Rail, asking them to consider and where appropriate act upon them and advising ORR of their conclusions. The consideration given to each recommendation is included below.
3. ORR also brought recommendation 2 to the attention of other owners, operators and manufacturers of electric trains as it was agreed that that there are equally important lessons for them. ORR did not ask these organisations to provide a reply. This was done by asking the Rolling Stock Standards Committee to bring the report to the attention of their members.

Recommendation 1

The intent of this recommendation is to improve the quality, and thus the safety, of rail vehicle and component conversion and overhaul work carried out at Wabtec, Doncaster.

Wabtec Rail Ltd should review and improve its production quality assurance arrangements to include, but not necessarily be limited to, the development of statistical confidence levels for verification of work carried out, and the provision of work instructions issued to the shop floor that are complete and suitable for the task.

ORR decision

4. Wabtec's response outlined the new quality assurance methodology they were introducing and how it was expected to prevent a recurrence of the maintenance shortcomings that RAIB identified as a causal factor in the cable junction coming apart, causing the electrical arcing that started the train fire.
5. By reviewing and improving their quality assurance procedures Wabtec have addressed the recommendation. ORR will carry out assurance work, including a site visit to their overhaul facility, to ensure Wabtec continue to address the risk of rail vehicles going back into service with unsafe components.
6. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Wabtec has:
 - Taken the recommendation into consideration; and
 - Has taken action to implement it.

Status: Implemented

Information in support of ORR decision

7. On 11 January 2016, Wabtec provided the following initial response:

1. *Production Quality Assurance*

Wabtec Rail Ltd building upon existing controls are introducing elements of Advance Product Quality Planning (APQP), a methodology used within automotive and aerospace industry, as a means of providing a framework for improving Product Assurance.

- a) *Process Failure Mode Effect Analysis (PFMEA)*
- b) *Statistical Approach- Torque Verification Sheet- Sampling plan*

2. *Process Failure Mode Effect Analysis*

PFMEA provides a framework from which to quantify (RPN) the risk associated with the production steps required to produce a finished product. Each of the three elements Severity, likelihood and Detection are independently scored on a scale of 1to 10 against an in house criteria and then multiplied together, this calculation generates the Risk Priority Number (RPN). The in house criteria document (number F-1-9-2 Issue2) is available for review by the ORR.

The initial focus for the roll out of PFMEA has been within two business units which provide the highest risk to Safety of The Railway, Bogies and Wheels overhaul.

3. *Bogies PFMEA*

A bogie type was selected and a cross functional team formed to carry out a PFME, document available for review by the ORR, the RPN's generated greater than 250 were reviewed to identify actions to either reduce the likelihood of occurrence and or increase detection level. The stepped improvement in both likelihood and detection is the implementation of an intelligent torque system. This system is designed to

- a) *Reduce the likelihood of operator using an incorrect torque due to*
 - a.1. *Information for fastener joints per discreet operation being captured on a validated bar code on the shop floor control document.*
- b) *Reduce the likelihood of operator not completing task completely*
 - b.1. *Information for each individual fastener joint is validated against pre-set criteria and the torque wrench will not progress unless all joints completed*
- c) *Increase the detection level of an incorrect fastener joint*

c.1. Information for a bogie is downloaded via the torque wrench on to a PC and actual torque values per joint are reviewed against pre validated criteria to provide a go/no go.

This system is in place for 1 bogie type and a plan is in place to complete all bogies, output data and plan available for review by ORR.

4. Wheels PFMEA

Based upon learning from Bogies to accelerate the process a short form PFMEA approach has been taken with a team focusing on the 10 failure modes deemed to be the most severe, these in turn were reviewed and a RPN generated. This document is a viable for review by the ORR.

An intelligent torque system is being implemented for the installation of wheel mounted brake discs, current status being hardware installed, documentation pack being updated, due for trail end of January 2016. System and data generated available for review by ORR.

5. Vehicles PFMEA

Due to the nature of the vehicle build and level of variation the plan is to carry out the short form PFMEA in the first of 2016. Conscious of what would generate a high RPN, fastened joints, an approach of using inspection plans encompassing sampling plans was undertaken.

6. Statistical Approach Torque Verification Sheet (Inspection Plan)

Post the Class 458 incident an inspection plan related to fastened joints was created covering all fasteners M6 or above, if the specification was silent customer clarification is obtained either via the customer or if non available via engineering. Within this inspection plan, in line with guidance in the PFMEA detection criteria, F-1-9-2 Issue2, a change in terms of a 2"d verification for correct fastening solution has been introduced.

The quantity of joints re-verified has been defined in line with BS 6001-1:1999. BS 6001-1/150 2859-1 is the British and international acceptance sampling specification for inspection by attributes. Indexed according to the acceptance quality limit, this standard looks at the maximum defects that are allowed during an acceptance inspection. By complying with this standard, the intent is to build confidence in the quality assurance.

Through this approach Wabtec can demonstrate how it is fulfilling the RAIB recommendation of statistical confidence levels for verification of work carried out. The confidence level is increased via how many, sample size, from a 100% population are revalidated check. In the event of a failure being found the instruction is for a 100% revalidation to take place for that faster joint, the torque value used for validation is 80% of the specified level. To incorporate the inspection plan into the current work instruction documents, it was re- named torque verification sheet, these are produced at the issuing of a new work instruction document for vehicle contracts and are available for review by the ORR.

7. Provision of the Work Instructions For the shop floor

In terms of containment the work instructions for Class 458 used with the vehicle business unit was reviewed and a Golden Standard for content was issued for unit 21.

The Quality Assurance Procedure, QAP 5.2, for the creation and control of Work Instructions for the shop floor has been revised following a review by a focused cross functional working group and is in the process of being updated prior to re-issue, target date for completion end of Feb 2016, this will be available for review by the ORR.

The general principles agreed to be included into the refreshing of QAP 5.2 include, but not limited to;

- a) Signature for work not initial*
- b) Criteria for high risk process, RPN over 100 to be stricter*
- c) First version of a work instruction to be signed off by Project Manager , Production Manager, Quality and project engineer (if design included)*
- d) Every test spec clause to have as pace to sign*
- e) Never write "n/a" or cross out- add fail and add information in AAW*
- f) Planner Check sheet to be used prior to issue.*

An audit plan will be in place for verification following the up issue of QAP 5.2 , findings from this will be available for ORR review.

8. Summary

The CL458 incident helped to re-enforce the applicability of an APQP approach within WRL. The potential failure modes highlighted in the report, incorrect torque used, low level of detection of failure, availability of data to verify correct operation have been addressed and through the introduction of the RPN calculation increased awareness of the inherent risk within the various process steps to complete a build is being achieved, along with guidance to reduce the RPN.

The application of this methodology linked with a statistical approach to sampling works to demonstrate increased confidence in product assurance.

8. ORR will carry out assurance work to see that the introduction of the new quality assurance procedures have addressed the risk of overhaul work being done by the company failing to deliver appropriate levels of safety and integrity of components.

Recommendation 2

The intent of this recommendation is to confirm that the risk associated with the design of the cable junction box on the class 458 unit has been reduced to a level that is as low as reasonably practicable.

South West Trains, in conjunction with Alstom and Porterbrook, should review the electrical and mechanical protection for the shoe cables, the bus line and the joint between them on the class 458/5 units, establish whether there are any reasonably practicable changes that can be made to the design of the joint to address the risk arising from failure of any associated components or assemblies, and implement any necessary modifications.

Note: This recommendation may also apply to other operators, owners and manufacturers of electric trains.

ORR decision

9. South West Trains (SWT) engaged consultants to review the electrical and mechanical protection for the shoe cables to identify any reasonably practicable changes that could be made to reduce the risk of failure of associated components or the assembly. The report concluded that the underframe junction box should be redesigned and refitted across the fleet at the next C4 maintenance schedule. This has been approved by the SWT Executive Safety Board and communicated to Porterbrook for consideration when planning work for the next C4 maintenance schedule.

10. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, SWT has:

- taken the recommendation into consideration; and
- is taking action to implement it, but ORR has yet to be provided with a timebound plan for fitment of the redesigned underframe junction box.

Status: Progressing. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

11. On 8 January 2016, South West Trains provided the following initial response:

SWT have commissioned an external consultancy to undertake a review in order to address this recommendation. The review is being undertaken by SNC-Lavalin on the existing Class 458/5 and the review is to be completed by the end of March 2016. SNC-Lavalin as part of this review, will consider the feasibility of fitment of additional electrical protection fitted closer to the collector shoe to reduce the risks associated with component failure, the provision of an explosion vent or frangible section in the underframe junction box and improvement to the connection arrangement in the underframe junction box.

Siemens have formally confirmed to SWT that they will be undertaking a review of the Desiro class trains, of which SWT operate Class 444 and 450.

12. On 18 August 2016, South West Trains provided the following update:

SNC-Lavalin have completed their review of the electrical and mechanical protection for the shoe cables, bus line and joint between them on the Class 458/5 units. The report concluded that there is only one recommendation which will mitigate the risk, and that is a redesign and subsequent refitment of the underframe junction box. SWT need to consider whether this modification would be reasonably practicable before committing to a decision; this process we are currently undertaking.

13. On Friday 14 October 2016, South West Trains provided the following additional information:

Recommendation 2 requested that a review is undertaken of the electrical and mechanical protection for the shoe cables, bus line and joint between them on the Class 458/5 units, establish whether there are any reasonably practicable changes that can be made to the design of the joint to address the risk arising from failure of any associated components or assemblies, and implement any necessary modifications.

SNC-Lavalin was commissioned to undertake this review, and identified a number of possible modifications. Following publication of the final report, a review was undertaken of these options by South West Trains in conjunction with Porterbrook, using the RSSB 'Taking Safe Decisions' framework to assess reasonable practicability of each option. This review recommended the installation of a new junction box, which should be ideally progressed at the next C4 maintenance schedule for the fleet. This approach has been reviewed and approved by the SWT Executive Safety Board. The request has been formally communicated by SWT to Porterbrook for consideration when planning work for the next C4.

Learning Point 4 of the report identified the need to make sure that projects involving the conversion and/or refurbishment of existing trains are managed effectively, so that work to be done is properly planned, documented, checked and recorded, and that involved parties work co-operatively to identify and manage hazards and risks throughout the life of a project. South West Trains have formally written to Porterbrook with the express desire to establish a joint working group to make sure that this Learning Point is progressed and for any lessons learnt to be considered across other Porterbrook overhaul projects.

Recommendation 3

The intent of this recommendation is to minimise the risk associated with the possible loss of emergency lighting in a train with people on board.

South West Trains should review the need for the function that automatically shuts down the class 458/5 train after 15 minutes if traction supply is lost and no cab is in service, and 90 minutes after traction power is lost with a cab in service, and assess the risk represented by the operation of this function in circumstances where passengers or other people (such as the emergency services) may still be on the train. It should implement any actions identified by this review.

ORR decision

14. SWT carried out a review of the battery performance for the class 485/5s and following a successful trial of a modification to allow the emergency light to remain on for 90 minutes, is planning to carry out fleet fitment work between December 2016 and February 2017.

15. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, SWT has:

- taken the recommendation into consideration; and
- is taking action to implement it

Status: Implementation on going. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

16. On 8 January 2016, South West Trains provided the following initial response:

This recommendation relates to the emergency lighting on-board the Class 458/5 involved in the incident turning off after 15 minutes. During the incident, the coupler between the two units divided and, with no key in the driving cab, the trailing unit no longer recognised itself as being in service and initiated shutdown to preserve battery life. The immediate shutdown was as the result of a modification initiated by SWT in 2001, and only affects the class 485/5s. SWT have undertaken a review of the battery performance of the Class 485/5 in order to determine the optimum length of time the emergency lighting could be activated with consideration of the length of battery life. Once this review and the necessary tests have been completed, a modification will be made to the units to allow the emergency lights to remain on for 90 minutes; this is expected to be completed by July 2016.

17. SWT provided an update on 18 August 2016:

The three month trial of the first fit is underway. The unit will be checked during September to confirm that relay timings have not drifted. Assuming trial is successful full fleet roll out will commence in October.

18. On Friday 14 October 2016, South West Trains provided the following additional information:

This recommendation relates to the emergency lighting on-board the Class 458/5 involved in the incident turning off after 15 minutes. A successful trial of a modification to the emergency lighting to enable it to stay on for 90 minutes has been undertaken, this finished in September. Materials for the modification are now on order, due for delivery at the end of November, with fleet fitment roll-out due to commence December, with completion anticipated February 2017.

Recommendation 4

The intent of this recommendation is to clarify the rules on the type of switch-off or isolation that is required for passenger evacuation from trains on third rail lines, to reduce delays and potential for uncontrolled egress by passengers.

Network Rail, in consultation with those Train Operating Companies which operate passenger trains on the DC electrified networks, should assess the adequacy of the present rules relating to the evacuation of DC electric trains, and propose to RSSB any appropriate changes to module DC of the rule book to minimise the risk of uncontrolled evacuation after an incident has caused a stoppage of trains. Consideration should be given to whether there are circumstances under which it is better to permit a controlled evacuation of passengers under the protection of an emergency switch-off, rather than a temporary isolation.

ORR decision

19. Network Rail have provided an initial response, but have not properly addressed the recommendation as it is concerned with how drivers and signallers address delayed rather than an uncontrolled evacuation. We have written to Network rail asking them to clarify the steps they will take to allow evacuations to take place more promptly, thus reducing the possibility of uncontrolled evacuation.

20. ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Network Rail has:

- taken the recommendation into consideration; and
- is taking action to implement it, but ORR has yet to fully address the recommendation and provide ORR with a timebound plan for implementation.

Status: Progressing. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

21. On 30 August 2016, Network Rail provided the following initial response:

Network Rail has through RSSB's TOM SC (standards committee) worked with those Train Operating Companies which operate passenger trains on the DC electrified networks to assess the adequacy of the present rules relating to the evacuation of DC electric trains to minimise the risk of uncontrolled evacuation after an incident has caused a stoppage of trains including whether there are circumstances under which it is better to permit a controlled evacuation of passengers under the protection of an emergency switch-off, rather than a temporary isolation.

A proposal was made and accepted at RSSB's TOM SC to amend Module M1 (see below) of the Rule Book to address the requirements of the recommendation. This will be published during December 2016.

Network Rail has as an interim measure issued a Periodical Operating Notice item to take into account the risk of uncontrolled evacuations.

6.6 Uncontrolled evacuation

You must tell the signaller that an uncontrolled evacuation is taking place and ask the signaller to provide immediate signal protection on all lines that may be affected. If necessary, you must also ask for the electric traction current to be switched off.

If you cannot contact the signaller, or the signaller cannot provide signal protection, you must carry out emergency protection.

You must try and prevent passengers making an uncontrolled evacuation and warn passengers that have evacuated, of any risks.

22. ORR wrote to Network Rail on 11 October 2016 requesting further information as we did not feel the recommendation had been properly addressed:

Rec 4 says:

Network Rail, in consultation with those Train Operating Companies which operate passenger trains on the DC electrified networks, should assess the adequacy of the present rules relating to the evacuation of DC electric trains, and propose to RSSB any appropriate changes to module DC of the rule book to minimise the risk of uncontrolled evacuation after an incident has caused a stoppage of trains. Consideration should be given to whether there are circumstances under which it is better to permit a controlled evacuation of passengers under the protection of an emergency switch-off, rather than a temporary isolation (paragraph 163c).

The intent of this recommendation is to clarify the rules on the type of switch-off or isolation that is required for passenger evacuation from trains on third rail lines, to reduce delays and potential for uncontrolled egress by passengers.

Network Rail's response is to change the rules to improve how driver's and signaller's deal with uncontrolled evacuation. In our view this response has missed one of the key point of the above recommendation this was not an uncontrolled evacuation, it was a delayed evacuation that could have led to an uncontrolled evacuation.

Paragraph 157 summarises RAIB's underlying concern:

The RAIB has concluded that, to keep control and encourage safe behaviour during an incident, prompt and decisive action is necessary. Experience (including this incident) shows that if railway staff do not take such action, passengers may try and leave the train without authority, putting themselves

at risk. The present rules provide insufficient guidance on steps to be taken in circumstances where there is no immediate danger, but early evacuation is required in order to manage the situation effectively.

Network Rail needs to work with the TOCs and RSSB to think how it can change the rules to enable it to speed up evacuation to reduce the likely hood of uncontrolled evacuation. If uncontrolled evacuation occurs then the revise rule 6.6 will come into play.