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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: Derailment of an empty passenger train at Paddington station, 25 May 2014

I write to provide an update¹ on the action taken in respect of recommendations 1, 2, 3, 4 and 5 addressed to ORR in the above report, published on 30 April 2015.

The annex to this letter provides details of the action taken regarding these recommendations, the status of which is now **'Implemented'**. We do not propose to take any further action in respect of the recommendations, unless we become aware that any of the information provided becomes inaccurate, in which case I will write to you again.

We will publish this response on the ORR website on 6 October 2017.

Yours sincerely,

Oliver Stewart

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

Recommendation 1

The intent of this recommendation is for the load distribution to remain evenly spread across all wheels on Siemens Desiro vehicles following tyre turning or bogie replacement.

Siemens' procedure for setting the vehicle ride heights after tyre turning or bogie replacement should be revised to reflect the original design intent, including the function of the anti-roll bars and the risks associated with incorrectly setting the anti-roll bar links. The revised procedure should also include checks of the bogie setup post-intervention to ensure that the wheel load distribution is maintained within Siemens' acceptable limit. These checks could be direct wheel load measurements, measurements of other indicators such as the Z1 dimensions or any other checks which positively confirm that the wheel load distribution has been maintained within Siemens' acceptable limit.

ORR decision

1. Siemens' procedure for setting the vehicle ride heights after tyre turning or bogie replacement have been revised and republished as Maintenance Procedures UOP001, UO01 and UOP801. The revised maintenance procedures include a systematic method of adjusting the carbody height when required (including the role of the anti-roll bar), which should ensure load is distributed evenly across all wheels.
2. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Siemens PLC has:
 - taken the recommendation into consideration; and
 - has taken action to implement it.

Status: Implemented

Previously reported to RAIB

3. On 21 April 2016 ORR reported that the regular updates provided by Siemens PLC had given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated.

Update

4. Siemens PLC provided a letter dated 7 September 2016 to confirm completion of previously agreed actions:

The RAIB's investigation identified that a causal factor in the derailment of the TOS2 vehicle of unit 360205 was the asymmetric wheel loads brought about by the bogies being "...incorrectly set up during the PTT ["post tyre turning"] interventions..."

For the Desiro UK family fleets, this activity was covered by a Maintenance Procedure in each of the respective maintenance manuals for the three product groups as follows:

- *Desiro UK Classic EMU: UOP001 (Classes 350/x, 360/x, 444 & 450)*
- *Desiro UK Classic DMU: UO01 (Class 185)*
- *Desiro UK Express EMU: UOP801 (Class 380)*

Despite the adoption of the same design of bogie and suspension system for each of these groups (although it is noted that some detail differences exist on the DMU), each of the procedures had evolved slightly differently during their life, but all lacked a systematic description of the process and precautions required to avoid introducing a static twist in the vehicle suspension and the associated redistribution of wheel loads.

As a result, Recommendation 1 of Rail Accident Report 03/2015 required three activities:

- *Determination of “Siemens acceptable limit” for safe wheel load distribution;*
- *Revision of “the procedure for setting the vehicle ride heights”*
- *Inclusion of “checks of the bogie set-up post intervention” to confirm that a successful outcome has been reached.*

In regard to the acceptable wheel load distribution, the vehicle assembly process included a requirement to achieve a “factory setting” with a maximum cross axle loading of 4%. This requirement remains and although obsolete for the purposes of new vehicle construction, Siemens has chosen to apply this principle in the programmed overhaul of Desiro UK bogies, where the objective is to return the performance of the asset to as-built standard and restore this “factory setting”.

In order to validate this approach, four vehicle sets of freshly overhauled bogies (a total of 8 bogies) were installed on a four-car Class 450 unit whereupon the wheel load distribution was confirmed by use of portable train weigh equipment. Cross-axle loadings inside the required 4% were achieved in all cases without adjustment.

Whilst the proposed procedure is able to achieve the as-built cross-axle load tolerance of 4%, this is by simultaneous installation and adjustment of pairs of bogies in a controlled condition fresh from overhaul. Clearly, other maintenance scenarios exist where such conditions are not present – for example the exchange of single bogies or maintenance of suspension systems where the factory setting is lost. In this case, it is necessary to adopt a “default setting” of the suspension in order to create a new, albeit compromised, pairing of bogies on the same vehicle.

Investigations on Class 350/1 and 360/1 units, including the use of portable train weigh equipment, demonstrated that in application of the default setting (where the secondary suspension shimming was first equalised on each side of both bogies and the anti-roll bar neutralised) it was not possible to achieve the factory setting standard of 4% cross-axle loading.

Our investigations of the origin of the 4% cross-axle loading requirement confirmed that this value is not a specific requirement of the design, but rather a nominal value derived from standards and experience which was demonstrated to be valid at the design acceptance stage. In order to establish the specific requirements of the vehicle design, the design authority for this area, our bogie dynamics department in Graz, Austria, undertook calculations and modelling to determine the actual permissible cross-axle loading.

Unsurprisingly, this varied between vehicle types on account of tare weights and suspension characteristics, but the recommended maximum value, which Siemens has adopted as the service limit for cross-axle loading, was a modest relaxation to 7%. This revised service limit value is in excess of the actual values achieved during weighing of Class 350/1 and 360/1 units following application of the default setting.

In regard to the systematic adjustment procedure which was adopted for trials of both restoration of the “factory setting” and establishing a “default setting”, this was constructed in consultation with our bogie, carbody and mechanical integration departments to replicate the factory process and begins with either freshly overhauled bogies or bogies with equalised secondary shimming respectively followed by three main steps:

- 1. setting of the deflated carbody heights by insertion of symmetric secondary suspension shimming where required, whilst maintaining a neutralised anti-roll bar;*
- 2. setting of the inflated heights at the vehicle centreline by adjustment of the levelling valves*
- 3. roll correction where necessary by simultaneous adjustment of the anti-roll bars.*

Our trials have demonstrated that the procedure to restore the “factory setting” consistently achieves a crossaxle loading within the as-built standard of 4% and that application of the “default setting” consistently achieves a cross-axle loading within the new service limit of 7%.

In regard to the final point concerning post intervention checks, we have monitored the variance in the “Z1” primary suspension values throughout our investigations and trials as a potential option for identifying undesirable wheel load distribution. We have found that this dimension responds clearly to changes in wheel loads and that alterations in the pattern of Z1 dimensions around a vehicle are able to provide a reliable indication of disturbance in the wheel load distribution. As such, we have chosen this to be the method by

which we will confirm that a satisfactory outcome has been reached following adjustments to the carbody height.

Additionally, the revised procedures also make full use of the available height tolerance of the vehicle in connection with the gauging requirements. For example, when adjustments are required, the procedure directs that the vehicle is set to the upper height tolerance in order to take full advantage of the available range as wheel diameter subsequently reduces. Further adjustment is only required when the vehicle height nears the lower tolerance which may be after, for example, multiple wheel reprofiling events. In this way, the number of interventions is significantly reduced.

These changes have been implemented by publication of revised Maintenance Procedures UOP001, UO01 and UOP801, which now adopt common principles and methodology and reference other new procedures where circumstances require (for example, the method of equalising the secondary shimming and neutralising the anti-roll bar in order to implement the “default setting”). Prior to release and as required by Siemens internal procedure the proposed changes passed through our Engineering & Operational Change Control process, including review and release by internal stakeholders followed by review and authorization by the respective vehicle owners and Duty Holders.

Siemens therefore proposes that the requirements of Recommendation 1 of Rail Accident Report 03/2015 have been fulfilled by publication of revised Maintenance Procedures UOP001, UO01 and UOP801 incorporating a systematic method of adjusting the carbody height when required, including the role of the anti-roll bar, which demonstrably maintains the wheel load distribution within defined limits and introduces a process of identifying disturbance to this wheel load distribution by monitoring the Z1 dimensions.

Recommendation 2

The intent of this recommendation is for Siemens’ maintenance staff to fully understand the role and importance of anti-roll bars.

Siemens’ training materials and competence assessments for technicians and supervisors should be revised to capture the function of anti-roll bars, their method of adjustment and the risks associated with incorrectly setting the anti-roll bar links. Siemens should also make this information available to maintenance and overhaul contractors working on its behalf.

ORR decision

5. Siemens have updated the training material and competence assessment procedures for staff and third party contractors that carry out maintenance work on the Desiro fleets. Changes have been made to assessment documents to test

understanding of the function of the anti-roll bar and the potential consequences of it being incorrectly adjusted.

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

- taken the recommendation into consideration; and
- has taken action to implement it.

Status: Implemented

Previously reported to RAIB

7. On 21 April 2016 ORR reported that Siemens' training materials and competence assessments for technicians and supervisors should be revised to capture the function of anti-roll bars, their method of adjustment and the risks associated with incorrectly setting the anti-roll bar links. Siemens should also make this information available to maintenance and overhaul contractors working on its behalf.

Update

8. Siemens PLC wrote to ORR on 31 January 2017 to confirm completion of actions in connection with recommendations 2:

The RAIB's investigation identified the need for "...Siemens maintenance staff to fully understand the role and importance of anti-roll bars." and stated the requirement for relevant revisions to "Siemens' training materials and competency assessments for technicians and supervisors."

Immediately following the RAIB's investigation, the circumstances of the incident and its causal factors were communicated to Siemens' technician and trainer communities by face to face briefings. Since that time, the specific issues of suspension adjustment and load imbalance have been taught and assessed by our trainers during our "SCA01" Safety Critical assessment process, which includes all technicians and supervisors. However, this was conducted by the trainers outside of its formal inclusion in the associated documentation.

I can now confirm that questions specifically testing candidates' understanding of the anti-roll bar and the potential side effects of adjustment have been formally included in revised assessment documents to ensure this area is systematically and consistently assessed.

Although we had previously discounted the Vehicle Basic Training (VBT) as a suitable opportunity to cover the topic thoroughly, our trainers have been briefed on the principles of the suspension design, vehicle assembly process

and maintenance philosophy and are delivering a degree of knowledge suitable for the audience capability.

In order to fully capture the key points of the subject, more thorough instruction will now take place as planned in the stage of training known as “Running Maintenance”. This occurs later in the training cycle when candidates have a stronger working knowledge of the product after a period of ‘on the job’ training, and includes information specific to Safety Critical maintenance tasks, of which the “Vehicle Height Check and Adjust” (formerly the “Post Tyre Turning Exam”) is one. The material pertaining to this is complete and its roll out on a stand-alone basis to technicians and supervisors involved in suspension adjustment activities has commenced. This also relates to Recommendation 3 where there is a requirement for Siemens to “rebrief its maintenance staff.”

Siemens therefore proposes that Recommendation 2 is closed on the basis that introductory level training is provided during the Vehicle Basic Training, followed up systematically during the Running Maintenance phase and understanding formally examined during the Safety Critical Assessment.

I note that the Recommendation also specifically mentions the arrangements for “maintenance and overhaul contractors”. Vehicle suspension adjustments, including when first installing overhauled bogies, are carried out in Siemens’ maintenance locations. Where contractors are employed in this environment, they are subject to the same competence requirements as Siemens technicians and, as such, are covered by the arrangements described above. In respect of the bogie overhaul process itself, this is undertaken by an external contractor approved by Siemens to our technical requirements described in the relevant Component Overhaul Instructions. These instructions specifically state the final construction sequence of the bogie so as to ensure the correct initial assembly of the secondary suspension and anti-roll bar. Vehicle adjustments of the type which may subsequently affect the vehicle wheel load distribution, including the anti-roll bar, are outside the scope of the bogie overhaul activity.

Recommendation 3

The intent of this recommendation is to ensure that other safety critical procedures used by Siemens to maintain its vehicles operating in the UK embrace the original design intent.

Siemens should complete its review of the safety critical procedures used to maintain its vehicles operating in the UK to confirm that they meet the original design intent and are capable of being implemented by competent staff. Based on the findings of this review, Siemens should make any necessary changes to the procedures and re-brief its maintenance staff.

ORR decision

9. Siemens' have reviewed the safety critical procedures used to maintain its vehicles operating in the UK and one urgent matter for immediate action was identified, in relation to Desiro gearboxes. No other urgent issues have been identified and we are satisfied Siemens' are meeting the original design intent.

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

- taken the recommendation into consideration; and
- has taken action to implement it.

Status: Implemented

Previously reported to RAIB

11. On 21 April 2016 ORR reported that the regular updates provided by Siemens PLC had given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated

Update

12. Siemens PLC wrote to ORR on 31 January 2017 to confirm completion of actions in connection with recommendations 3:

Further to my previous update where I reported the publication of the risk assessment Desiro UK EMU maintenance tasks, the equivalent for the Desiro UK DMU has now also been released under document reference FM/Rail Systems/3019, allowing it too to be used as a reference for evaluating engineering changes as described under Recommendation 4.

Our "design intent" review of the Safety Critical tasks arising from these assessments is also complete and we recently concluded our examination of the extensive feedback which we received from our specialist colleagues. The feedback was categorised into three levels, where Category 1 was deemed to be an urgent matter requiring action in the context of this Recommendation. I am pleased to report that following the earlier withdrawal of one Desiro EMU gearbox procedure, no further cases of Category 1 feedback have been identified amongst our Desiro UK platform fleets, and whilst we will continue to evaluate the need to include other points of best practice which have come to our attention, we are satisfied that no other risks concerning the effective transfer of design intent are present and that our procedures satisfactorily "embrace the design intent" of the product. On this basis, we propose that Recommendation 3 is now closed.

As I mentioned under Recommendation 2, we are carrying out the rebriefing process in respect of changes to the “Vehicle Height Check and Adjust” procedure which was the subject of Recommendation 1 and have ensured that this is incorporated into the initial training and ongoing Safety Critical Assessment process.

Having concluded this process on our Desiro UK fleets and found it to be successful, we shall continue to apply the same process to other fleets which we maintain including, for example, the Class 319 units operated by London Midland.

Recommendation 4

The intent of this recommendation is for Siemens to ensure that safety critical maintenance and overhaul procedures do not undermine the design intent and import a risk.

Siemens should review the effectiveness of its recently developed processes for ensuring that all necessary information from the design process is correctly incorporated in maintenance procedures and training materials. If found necessary, Siemens should update its processes and continue to monitor their effectiveness.

Note: this recommendation may also apply to other suppliers and manufacturers of rolling stock.

ORR decision

13. Siemens' have introduced a new internal standard for vehicle maintenance documentation, covering risk assessment, requirement to review design intent of maintenance tasks following creation or material change and how safety critical changes to procedures are communicated to maintenance staff.

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

- taken the recommendation into consideration; and
- has taken action to implement it.

Status: Implemented

Previously reported to RAIB

15. On 21 April 2016 ORR reported that the regular updates provided by Siemens PLC had given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated. ORR did not refer this recommendation to other suppliers and manufacturers but expected that they would consider the findings of the report and its recommendations and take appropriate steps that they consider relevant to their duties under health and safety law.

Update

16. Siemens wrote to ORR on 19 December 2016 with the following information:

The RAIB's investigation identified that the 'design intent' of the train could potentially be undermined by safety critical maintenance and overhaul procedures. In my letter of 29 June 2015, following clarification of the intent of Recommendations 3 & 4 with the RAIB, it was concluded that Recommendation 4 concerned processes to ensure that the design intent was retained into the future through new or updated maintenance documentation.

Since that time, I have reported our internal review of the "recently developed processes" referred to in the Recommendation and described our intention to publish an internal standard for maintenance documentation. This has now been completed with the submission of document PRO/Rail Systems/284, "Vehicle Maintenance Documentation" into our Business Management System.

This document contains:

- *The risk assessment process for the purposes of assessing the 'Safety Critical' categorisation in connection with Recommendation 3;*
- *The requirement for undertaking a review of the 'design intent' of designated safety critical maintenance tasks following creation or material change;*
- *The manner in which to place warnings in maintenance tasks, where required, to draw attention to specific product related risks, especially where identified during the risk assessment process.*

Additionally, we have included an additional step in our engineering change process through modification of our form FM/Rail Systems/188, "Engineering Change Checklist" which now requires, in the event of changes to maintenance either following a modification or in their own right, a review of the risk assessment and, where necessary, a revalidation of the design intent. The checklist has also been amended to include an assessment of potential changes which may be required to training and competence assessment material.

Recommendation 5

The intent of this recommendation is for Network Rail to establish the reasons why the West Ealing depot failed to comply with Network Rail's own processes.

Network Rail should review the supervision and self-assurance arrangements in place at West Ealing depot to identify any shortcomings which led to the non-compliances with mandated standards going unnoticed. Network Rail should then include any lessons learnt into its revised assurance framework.

ORR decision

17. We are satisfied that Network Rail has enhanced the self-assurance arrangements and provided briefed the changes to relevant staff at the West Ealing Depot. In addition, Network Rail has revised standard along with the new question sets were issued by Network Rail nationally in the June 2016 Group Standards update.

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

- taken the recommendation into consideration; and
- has taken action to implement it.

Status: Implemented

Previously reported to RAIB

19. On 21 April 2016 ORR reported that Network Rail's formal response and the outcome of ORR's subsequent meeting with Network Rail had provided ORR with confirmation that it had identified shortcomings in how the supervision and self-assurance arrangements were being implemented, addressed them locally, and that it is reviewing whether the lessons learnt should be mandated nationally through its self-assurance framework. ORR was awaiting the outcome of this review.

Update

20. On 1 February 2017 Network Rail provided a closure statement containing the following information:

Part a)

TME West Ealing along with the RAM (T) Support Engineer have reviewed the supervision and self assurance arrangements at West Ealing depot in order to identify the shortcomings that led to the non-compliances with mandated standards going unnoticed.

At the time of the derailment the supervision levels within the West Ealing TME area were double the required 2B/C organisational complement. Therefore, with the correct self-assurance arrangements in place, it is acknowledged that there are adequate managerial and supervisory resources to manage this section.

The self-assurance arrangements as West Ealing Depot have been enhanced.

- *The mandated Management Self Assurance (MSA) question sets have been amended so that both the Section Manager (SM) and Engineer check that the TG codes have been inputted into Ellipse as per L3/TRK/3202. (This check previously only formed part of the Infrastructure Maintenance Engineer (IME)*

MSA question set.) - The Management Self Assurance Question sets were updated and re-published in September 2016 to reflect the gauging element

- *Across Reading DU there is greater support and mentoring from the RAM T Support Engineer at periodic IME Track Quality meetings and at mandated Section Trace Review meetings - The SAE is usually an attendee at the IME period TQ meeting giving support and highlighting issues. The SAE also regularly attends both sections Trace reviews and arranges visits with the TME/SM's to discuss issues or help in coaching and mentoring when required.*
- *The periodic IME Track Quality meeting agenda now includes a review of MNT, MPV, TRV and Amber Trolley inspections to ensure a compliant foot print. The sections are tasked to bring TEF forms to the meeting so they can be reviewed and any lessons learnt are shared. Dependant on what TQ meeting (A is Track Quality or B which is Track Geometry) different paperwork will be supplied by the sections for review. Any requirement to consider mitigation or dispensation is agreed immediately and not limited to the periodic meeting. The change to the MSA questions is another check within the process to check compliance. Additionally the following procedural changes have been implemented to reduce the risk of human error leading to a similar situation:*
- *Amber Trolley patrols are now entered into Ellipse as MSTs and the West Ealing Technical Team have been briefed not to close Work Orders until the IA (Immediate Action) report is sent to the SM - The process is now fully embedded and being actioned within the required timescales by the sections. All amber trolley runs (MSTs) are in ellipse and depending on the output of the run the WO's with RFD and TG codes are entered in ellipse for the sections to complete. With TG codes assigned this highlights non-compliances should a fault go over its RFD.*
- *Track is now measured with the MPV (not just manual track recording) which allows a greater level of assurance and highlights to all whether the work has been entered into Ellipse - All MPV work is entered in ellipse with TG fault codes. Following the runs discussions with the RAM(T) takes place (dependant on volume of faults) and where required a TV applied for with glide path and risk ranked due to the volume of faults not being able to be completed within their timescales.*

Part b)

A review will be undertaken of the changes made to the Western route MSA question sets to determine whether it is appropriate to mandate these nationally. This work will happen alongside the review of the MSA question sets for track being undertaken as part of the Business Critical Rules implementation. – The MSA question sets have all been revised and the specific question set added to the Section Manager Track tab. The revised standard along with the new question sets were issued nationally in the June Group Standards update.

Previously reported to RAIB

Recommendation 1

The intent of this recommendation is for the load distribution to remain evenly spread across all wheels on Siemens Desiro vehicles following tyre turning or bogie replacement.

Siemens' procedure for setting the vehicle ride heights after tyre turning or bogie replacement should be revised to reflect the original design intent, including the function of the anti-roll bars and the risks associated with incorrectly setting the anti-roll bar links. The revised procedure should also include checks of the bogie setup post-intervention to ensure that the wheel load distribution is maintained within Siemens' acceptable limit. These checks could be direct wheel load measurements, measurements of other indicators such as the Z1 dimensions or any other checks which positively confirm that the wheel load distribution has been maintained within Siemens' acceptable limit.

ORR decision

1. The regular updates provided by the end implementer have given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated.
2. After reviewing information received ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Siemens has:
 - taken the recommendation into consideration and
 - is taking action to implement it by 29 April 2016.

Status: Implementation ongoing. ORR will advise RAIB when actions to address this recommendation have been completed.

Information in support of ORR decision

3. On 29 June 2015 Siemens provided the following initial response:

This Recommendation concerns the maintenance procedures in use on Desiro UK family vehicles which describe the method of adjusting the secondary suspension to achieve the correct carbody height and, additionally, a means of verifying the outcome in respect of wheel load distribution.

Siemens' overall objective surrounds establishing a robust 'factory setting' of the suspension system during significant maintenance events such as bogie overhaul, following which the level of intrusive adjustment during subsequent ongoing maintenance will be minimised (for example, in response to straightforward activities such as wheel re-profiling).

Siemens has established three maintenance scenarios in which it intends to apply differing approaches. These are:

- a) *Bogie overhaul, where a pair of as-new bogies are received in a known condition and installed beneath the carbody in accordance with new-build procedure in order to establish a new 'factory setting'.*
- b) *Wheel re-profiling or wheelset exchange/renewal, where only the size of the wheel and, therefore, the ride height of the bogie has altered which must be compensated for by raising or lowering of the carbody height, without the need to make any adjustment to the anti-roll bar.*
- c) *Bogie exchange on an ad-hoc basis, where it may be necessary to re-establish the 'factory setting' which creates a new pairing between the two bogies.*

Due to the number of current and imminent bogie overhaul programmes among the Desiro UK family fleets, Siemens' current emphasis is on scenario a) above. In respect of this, it has already implemented some process improvements to the overhaul of SF5000 series bogies to give added assurance that they are returned to a more consistent standard in preparation for their installation.

In relation to all scenarios, it is considering other peripheral factors such as depot track geometry and the methods employed in the measurement of the carbody height.

The first milestone in this activity is to undertake trials of the proposed procedure to establish a new 'factory setting' on a number of vehicles and verify the outcome by weighing the wheel loads for each. Subject to establishing the necessary track geometry for a suitable fleet, Siemens expects to be in a position to commence these trials no later than the end of August 2015.

In respect of verification of the post-adjustment wheel load distribution, it is Siemens' intention to provide the necessary assurance through application of a systematic procedure accompanied by evidence that a predictable outcome will be secured without the need for weighing to be undertaken on each occasion. Nevertheless, it is engaged with suppliers of weighing equipment in order to explore its options should this prove unavoidable.

4. On 27 August 2015 Siemens provided the following update:

Siemens had proposed that it would undertake trials of the procedure to establish a new 'factory setting' on a number of vehicles and verify the outcome by weighing the wheel loads no later than the end of August 2015.

This did indeed take place in August 2015 on all four vehicles of a Class 450 Desiro UK EMU (ie, the installation of a total of eight freshly overhauled bogies), and that the trial was successful in achieving cross-axle loading to its new build standard, which is well within the permissible service limits emerging as "Siemens' acceptable limit" as referred to in the Recommendation.

Siemens is in the process of documenting the results obtained during the trial in support of publishing the revised procedure for adoption into its maintenance manuals.

In parallel, it is now preparing to carry out similar trials in relation to scenario c) in an attempt to restore a 'factory setting' involving bogies which have been previously installed (ie, not fresh from overhaul). It aims to commence these trials no later than the end of September 2015.

Once these two procedures are implemented, this will allow the execution of scenario b) – the ongoing maintenance of carbody heights without adjustments to the anti-roll bar – to take place through a simplified procedure.

5. On 30 October 2015 Siemens provided the following further update:

Siemens' engineering colleagues in Siemens Graz, Austria, have completed their assessment of a suitable separate value for "Siemens acceptable limits" as referred to in the Recommendation and, as planned, Siemens has conducted further trials of a procedure in relation to scenario c) in an attempt to restore a 'factory setting' involving bogies which have been previously installed (ie, not fresh from overhaul) on a Class 350/1 Desiro UK EMU. These trials were also successful in that they achieved the "Siemens acceptable limit" specified and a further attempt is planned within the next week on a Class 360/1 Desiro UK EMU to further demonstrate the repeatability of this procedure. Should this also prove to be successful, it is anticipated that Siemens will be in a position to declare the procedure to be valid and commence an implementation plan.

However, during the course of its investigations and in conducting its trials, it has examined the track geometry at its maintenance sites and identified that some improvements are required in order to support the intended methods of measurement and adjustment on designated "level roads". Siemens is in the process of establishing the options available to it and the timescales involved.

6. On 11 December 2015 Siemens provided the following further update, which included a response to ORR's request that it also provide indicative timescales for the completion of each recommendation and an explanation of how the delivery of actions to implement the recommendations is being monitored and managed at a senior level within Siemens:

Siemens Rail Systems in the UK has three levels of safety management process. On a day-to-day level, it operates a "Management of Safety Related Defects and Information" procedure which deals with individual events within Siemens or elsewhere in the industry (including, for example, responses to National Incident Reports). The Paddington derailment event entered this procedure once it became evident that the train was likely to have been a contributory factor.

At management level, an “Operational Safety Panel” takes place at four-weekly intervals chaired by the Service Director and comprising representatives from Engineering, Fleet Management, Projects & HSQE teams. The intended actions in response to each of the RAIB’s Recommendations were endorsed by this forum.

At top level in Rail Systems, a “Safety Executive Management Meeting” also takes place at four-weekly intervals chaired by the Managing Director and comprising selected members of the Executive Management Team plus a representative of Siemens plc and an independent advisor. A status report concerning each of the RAIB’s Recommendations is discussed at this forum and further directives made where necessary.

In respect of recommendation 1, following an internal review of the evidence obtained from trials undertaken to prove that Siemens’ intended procedural revisions perform as their theory suggests and are able to deliver a consistent and predictable outcome, Siemens has concluded that this is, indeed, the case and has begun finalising the documentation and supporting evidence for submission through its Engineering Change process. This is the means by which Siemens will secure formal review and acceptance of revisions to its Maintenance Plans by interested parties, including the relevant Duty Holders.

There are currently three variants of the procedures relating to carbody height setting within the Desiro family:

- Desiro UK Classic EMU product group comprising Classes 350/x, 360/x, 444 & 450, all of which share a combined maintenance manual;*
- Desiro UK Classic DMU, which is exclusively Class 185;*
- Desiro UK Express EMU, which is exclusively Class 380.*

The procedures as they apply to the Desiro UK Classic EMU and Desiro UK Express EMU (which is a separate document, but with similar content) will be released into the Engineering Change process by 31 January 2016. There then ensues a period of formal internal review which, given their extensive consultation throughout their development, Siemens expects will result in the documents being released for external review and acceptance by 21 February 2016.

Concerning the Desiro UK Classic DMU, the same procedural content applies, but an open technical query remains in respect of variations in the permissible heights with changes in fuel load. Siemens is awaiting a response from its colleagues in Siemens AG, but as this will not fundamentally change the adjustment process itself, it is currently anticipating that the same timescales will apply.

Due to the number of stakeholders involved in the external review, Siemens anticipates the Engineering Change process to last a number of weeks, but

are currently planning for the revised procedures to finally be made operational by 31st March 2016, subject to resolution of a compliance related matter in respect of the permissible cross-axle loading calculations on which it is currently seeking advice.

7. On 5 February 2016 Siemens provided a further update:

Siemens has prepared all the change documentation associated with implementing the revised procedures which has now entered its Engineering Change process and a period of formal review by internal stakeholders as planned. The query concerning the Desiro UK DMU in respect of the effects of variable fuel load has been resolved and some adjustments made to the associated requirements.

In respect of the post-intervention checks specifically mentioned in the Recommendation, Siemens has selected a method involving monitoring of the Z1 dimensions in order to confirm the absence of asymmetric wheel loads arising from such adjustments.

The changes include the revised tasks, plus accompanying Siemens Technical Bulletins for each of the three product groups involved. This process allows the subsequent implementation to take place independently from formal releases of the Maintenance Manuals, although the changes will be included at the next available opportunities, following which the Technical Bulletins shall be withdrawn.

Siemens still expects the changes to be released for external review and acceptance by 22nd February 2016 and anticipate the revised procedures to finally be made operational by 31st March 2016 as previously advised.

8. On 1 April 2016 Siemens confirmed that the Engineering Change Packs for each of the three product groups had been circulated for internal review as planned, but that further clarification was required prior to the documents being released externally. Publication of the Siemens Technical Bulletins is now expected by 29 April 2016.

Recommendation 2

The intent of this recommendation is for Siemens' maintenance staff to fully understand the role and importance of anti-roll bars.

Siemens' training materials and competence assessments for technicians and supervisors should be revised to capture the function of anti-roll bars, their method of adjustment and the risks associated with incorrectly setting the anti-roll bar links. Siemens should also make this information available to maintenance and overhaul contractors working on its behalf.

ORR decision

9. The regular updates provided by the end implementer have given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated.
10. After reviewing information received ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Siemens has:
- taken the recommendation into consideration and
 - is taking action to implement it by 6 May 2016.

Status: Implementation ongoing. ORR will advise RAIB when actions to address this recommendation have been completed.

Information in support of ORR decision

11. On 29 June 2015 Siemens provided the following initial response:
- This Recommendation concerns improvements to Siemens training and competence assessment materials in order to ensure that information pertaining to the function and adjustment of the anti-roll bars on SF5000 series bogies is systematically communicated to staff undertaking maintenance of that system.*
- Siemens has undertaken a review of its training material and identified a number of documents which require revision.*
- Its priority is to revise the training notes and presentation material which accompany its "Vehicle Basic Technical" (VBT) courses to include the function of the suspension as a complete system and identify the role of the critical components therein, including the anti-roll bar. Siemens estimates that this will be completed during August 2015.*
- Concurrently, as the revised content of the training material emerges, related assessment questions will be devised for implementation from September 2015.*
- The means by which the need to communicate this information to non-Siemens personnel is systematically identified and executed is currently under review in association with its existing procedures to manage contractors and its supply chain.*
12. On 27 August 2015 Siemens provided the following update:
- Working with its Training Team, Siemens has identified the technical requirements which require insertion in the training material for its VBT courses, including not just the anti-roll bar, but all the major suspension components, their role in the complete system and key points to observe regarding their maintenance and inspection.*
- The necessary revisions, as a result, are more in depth than had originally been planned for and Siemens has yet to complete this task. It is Siemens*

intention to now complete this during September 2015 concurrent with the related assessment questions to which it previously committed.

In respect of communicating this information to non-Siemens personnel, it has completed the review of the current competence management arrangements for contract labour and identified some potential improvements. Siemens aims to draft these changes during September which will then require consultation with internal stakeholders.

13. On 30 October 2015 Siemens provided the following further update:

The necessary revisions, as a result, were more in depth than had originally planned for and were taking longer to implement than first envisaged. Work on this aspect of the Recommendation continues, involving a complete restructuring of the training and assessment material for the Desiro bogie and inclusion of new information and guidance.

Siemens recognises the delay to its original timescales regarding delivery of this particular recommendation and is taking steps to ensure that the necessary priority is maintained regarding completion of this activity.

14. On 11 December 2015 Siemens provided the following further update:

Siemens has now made significant progress on substantial revision of the training material for the complete Desiro bogie.

Working in conjunction with its in-house training team, Siemens will be piloting the revised material on the next scheduled 'Vehicle Basic Training' course commencing on 22 February 2016 [subsequently notified by Siemens as being revised to 9 February 2016]. Following any final amendments which may arise, Siemens plans to complete the final implementation of both this and the associated competence assessment questions by 31 March 2016.

15. On 1 April 2016 Siemens reported that the revised bogie training material had been piloted on 9 February 2016 as intended. Further consideration has concluded that the intended material must be presented later in the training process and as a separate supplement to the Vehicle Basic Training once candidate have secured a further level of practical experience on the product. Siemens expects that this will now be concluded by 6 May 2016.

Recommendation 3

The intent of this recommendation is to ensure that other safety critical procedures used by Siemens to maintain its vehicles operating in the UK embrace the original design intent.

Siemens should complete its review of the safety critical procedures used to maintain its vehicles operating in the UK to confirm that they meet the original design intent and are capable of being implemented by competent staff. Based on the findings of this review, Siemens should make any necessary changes to the procedures and re-brief its maintenance staff.

ORR decision

16. The regular updates provided by the end implementer have given ORR confidence that the work being carried out will meet the intent of the recommendation.
17. After reviewing information received ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Siemens has:
- taken the recommendation into consideration and
 - is taking action to implement it but has yet to provide a firm timebound plan for doing so.

Status: Progressing. ORR will advise RAIB when actions to address this recommendation have been completed.

Information in support of ORR decision

18. On 29 June 2015 Siemens provided the following initial response:
- The investigation reported that information concerning the design of the suspension system and, in particular, the anti-roll bar, had not been adequately captured in the associated maintenance procedures. This Recommendation seeks to confirm that similar omissions of ‘design intent’ do not exist elsewhere in other existing “safety critical” maintenance documentation.*
- It is Siemens’ intention to first confirm that “safety critical” tasks among the 3322 documents contained within Siemens maintenance manuals have been correctly identified. This will be by means of a risk-based desktop review to categorise each procedure based on ROGS Regulation 23 and associated guidance.*
- This process will begin with its “Desiro EMU Maintenance Manual”, which is shared between its Desiro UK Classic EMU fleets. Whilst this comprises around just 35% of the total content of all its maintenance manuals, it covers eight of the twelve Siemens fleets currently in service. Siemens’ aims to have completed this review by the end of September 2015, whereupon it will continue with each of the remaining four maintenance manuals in turn.*
- In parallel, as it completes its assessment of each of the train systems, suitably competent engineering personnel will be identified in order to conduct a review of those tasks which are categorised “safety critical”.*
19. On 27 August 2015 Siemens provided the following update:
- Siemens has now adapted its existing risk assessment processes in order to provide a framework for carrying out this review which will be undertaken by a combination of experienced engineering and production staff,*

beginning shortly with its “Desiro EMU Maintenance Manual”, as expected, during September.

In parallel, as it completes its assessment of each of the train systems, suitably competent engineering personnel will be identified to conduct a more detailed review of those tasks which are categorised “safety critical” in an attempt to ensure that the design intent has been captured. Where required, the necessary amendments will subsequently be made and submitted through Siemens’ usual change management processes.

20. On 30 October 2015 Siemens provided the following further update:

Having previously adapted its existing risk assessment processes in order to provide a framework for carrying out the afore mention desktop review, Siemens has commenced as planned with the “Desiro EMU Maintenance Manual” and also the separate manual for its Class 333 fleet. Having held four workshops involving a combination of experienced engineering and production staff (including, where possible, its Representatives of Employee Safety), it has further developed the approach to consider the likelihood of an error or omission based on five criteria involving the complexity of the task, the requirement for special tools or equipment, the accessibility and environment in the which the task is undertaken, the criticality of the materials required and whether the presence of an error would be immediately obvious to the Technician.

This method has now become established and further workshops are planned.

In readiness for the next stage of the process involving the detailed review of those tasks which are categorised “safety critical”, Siemens has opened discussions with its engineering colleagues in Germany and Austria in order to identify suitably competent engineering personnel to ensure that the design intent has been captured. Where required, the necessary amendments will subsequently be made and submitted through its usual change management processes.

21. On 11 December 2015 Siemens provided the following further update:

The activity to conduct a more systematic assessment of the 3322 documents contained within Siemens maintenance manuals to determine those which are “safety critical” based on the likelihood of error and the potential consequences is now 40% complete for Siemens’ Desiro EMU maintenance manual (covering 8 of the 12 current fleets) and 50% complete for the Class 333 maintenance manual, both of which will be concluded by 29th January 2016. It is anticipated that much of this work can then be transferred onto the remaining maintenance manuals which it aims to have completed during February 2016.

In the meantime, for those tasks which have already been identified as “safety critical” in accordance with Siemens’ new criteria, since the last update it has secured the support of colleagues in Germany and Austria and the reviews for “design intent” will begin in earnest from the beginning of January 2016.

Until the full extent of this large project materialises, it is extremely difficult to confidently declare a completion timescale, but since the initial aspiration was to have all Recommendations concluded within 12 months of publication of the RAIB's report, Siemens does not wish this process to extend beyond April 2016.

22. On 5 February 2016 Siemens provided a further update:
The systematic document re-assessment is now complete for Siemens' Desiro UK Classic EMU maintenance manual (covering 8 of the 12 current fleets) as planned and following this review a total of 294 (26%) tasks have been categorised as Safety Critical either by virtue of the score they have attracted from the assessment or by falling within the scope of guidance published in Railway Safety Publication 4.

The process of transferring the relevant information to the Desiro UK Classic DMU and assessing the remaining product-specific tasks has already begun with the aim of completion by the end of February 2016. Additionally, Siemens is examining the similarities with the Desiro UK Express Class 380, however, it also awaits confirmation concerning its responsibilities here with regard to categorization of Safety Critical tasks, as it is not the maintainer of this product.

Siemens has also concluded, as planned, the assessment of its Class 333 maintenance manual. It is anticipated that much of this work can be transferred onto the Class 332 maintenance manual which it aims to have completed during February 2016.

Regarding review of the procedures themselves to confirm adequate capture of the design intent, Siemens has agreed a structure with its German colleagues and tentative arrangements are in place in anticipation of the imminent allocation of the relevant experts.

Whilst it remains difficult to declare the timescales until the full extent of this large project materialises, it is anticipated that amendments may only be required to a modest quantity of documents and since Siemens' initial aspiration was to have all Recommendations concluded within 12 months of publication of the RAIB's report, Siemens still does not wish this process to extend beyond April 2016.

23. On 1 April 2016 Siemens provided the following update:
Siemens had previously completed the systematic re-assessment of its Desiro UK Classic EMU maintenance manual (covering 8 of the 12 current fleets) and following this review based on the requirements of its risk assessment process and Railway Safety Publication No.4, 26% of the tasks had been categorised as Safety Critical.
Since then, it has also completed this evaluation for the Desiro UK Classic DMU (Class 185) fleet where a similar figure of 25% has been categorized as Safety Critical.

The process of reviewing the procedures themselves to confirm adequate capture of the design intent has commenced. By way of example, the review for the Desiro UK Classic EMU Transmission System was conducted by a drivetrain specialist from Siemens Mechanical Integration department of Krefeld, Germany. Based on experience of manufacturer's manuals and other Siemens projects, 28 observations or queries were fed back to Siemens which it is considering for potential inclusion. However, none of these would be considered fundamental errors or omissions in design intent which must be addressed in the context of the Recommendation.

The expectation of a modest quantity of amendments has been supported, and Siemens' aspiration to conclude this process by the end of April 2016 remains.

Recommendation 4

The intent of this recommendation is for Siemens to ensure that safety critical maintenance and overhaul procedures do not undermine the design intent and import a risk.

Siemens should review the effectiveness of its recently developed processes for ensuring that all necessary information from the design process is correctly incorporated in maintenance procedures and training materials. If found necessary, Siemens should update its processes and continue to monitor their effectiveness.

Note: this recommendation may also apply to other suppliers and manufacturers of rolling stock.

ORR decision

24. The regular updates provided by the end implementer have given ORR confidence that the work being carried out will meet the intent of the recommendation by the timescales anticipated. ORR did not refer this recommendation to other suppliers and manufacturers but would expect that they consider the findings of the report and its recommendations and take appropriate steps that they consider relevant to their duties under health and safety law.

25. After reviewing information received ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, Siemens has:

- taken the recommendation into consideration and
- is taking action to implement it but has yet to provide a firm timebound plan for doing so.

Status: Progressing. ORR will advise RAIB when actions to address this recommendation have been completed.

Information in support of ORR decision

26. On 29 June 2015 Siemens provided the following initial response:

This Recommendation is related to Recommendation 3, but concerns measures to ensure that relevant design information continues to be incorporated into maintenance documentation (thus it is its interpretation that Recommendation 3 relates to ensuring that the design intent is, where necessary, reflected in existing documentation, whereas Recommendation 4 concerns future documentation).

The “recently developed processes” referred to in the Recommendation concern the maintenance review procedures adopted for the new Desiro City product in the Thameslink project. Based on this, it is Siemens’ intention to develop a generic standard for Siemens maintenance documentation in the UK which will apply to both creation of material associated with new projects, as well as amendment of existing documentation. This standard will incorporate the requirements for categorising and validating “safety critical” procedures as defined in relation to Recommendation 3.

In the meantime, it is finalising its proposed arrangements for checking the effectiveness of these procedures which it intends to have completed by the end of August 2015.

27. On 27 August 2015 Siemens provided the following update:

Siemens previously reported that it was making arrangements for checking the effectiveness of the “recently developed processes” referred to in the Recommendation. Since that time, its internal audit team has completed an evaluation of its implementation on the Thameslink project as proposed.

This reported that the process “was found to be implemented in accordance with its requirements”, but also that some practical improvements could be made in the light of experience.

These improvements will be incorporated into the development of the generic standard for Siemens maintenance documentation in the UK. This process is already underway, having previously commenced to capture some unrelated changes to other areas of the business, and a draft is expected for review during October 2015.

28. On 30 October 2015 Siemens provided the following further update:

This action to develop a generic standard for Siemens maintenance documentation in the UK remains ongoing and will now also include the more specific risk assessment process in respect of Safety Critical tasks which has emerged during Siemens work on Recommendation 3.

29. On 11 December 2015 Siemens confirmed its intention to publish this standard by 29 February 2016, incorporating lessons learned from its activities in pursuit of Recommendation 3.

30. On 1 April 2016 Siemens reported that the compilation of its proposed generic standard for maintenance documentation in the UK had progressed to describe both the risk assessment process for categorisation of Safety Critical tasks and the method of undertaking technical reviews to capture design intent in

parallel with Recommendation 3. Siemens considers that these processes have, in general, emerged in the manner anticipated although finalisation is now expected to be concluded concurrently with Recommendation 3 at the end of April 2016.

Recommendation 5

The intent of this recommendation is for Network Rail to establish the reasons why the West Ealing depot failed to comply with Network Rail's own processes.

Network Rail should review the supervision and self-assurance arrangements in place at West Ealing depot to identify any shortcomings which led to the non-compliances with mandated standards going unnoticed. Network Rail should then include any lessons learnt into its revised assurance framework.

ORR decision

31. Network Rail's formal response and the outcome of ORR's subsequent meeting with Network Rail has provided ORR with confirmation that it has identified shortcomings in how the supervision and self-assurance arrangements were being implemented, addressed them locally, and that it is reviewing whether the lessons learnt should be mandated nationally through its self-assurance framework. ORR is awaiting the outcome of this review.

32. After reviewing information received 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 by 30 June 2016.

Status: Implementation ongoing. ORR will advise RAIB when actions to address this recommendation have been completed.

Information in support of ORR decision

33. In its response of 15 October 2015 Network Rail provided the following information:

TME West Ealing along with the RAM (T) Support Engineer have reviewed the supervision and self-assurance arrangements at West Ealing depot in order to identify the shortcomings that led to the non-compliances with mandated standards going unnoticed.

At the time of the derailment the supervision levels within the West Ealing TME area were double the required 2B/C organisational complement. Therefore, with the correct self-assurance arrangements in place, it is acknowledged that there is adequate managerial and supervisory resources to manage this section.

The self-assurance arrangements at West Ealing Depot have been enhanced

- *The mandated Management Self Assurance (MSA) question sets have been amended so that both the Section Manager (SM) and Engineer check that the TG codes have been inputted into Ellipse as per L3/TRK/3202. (This check previously only formed part of the Infrastructure Maintenance Engineer (IME) MSA question set.)*
- *Across Reading DU there is greater support and mentoring from the RAM T Support Engineer at periodic IME Track Quality meetings and at mandated Section Trace Review meetings.*
- *The periodic IME Track Quality meeting agenda now includes a review of MNT, MPV, TRV and Amber Trolley inspections to ensure a compliant foot print. The requirement for mitigation or dispensation is agreed immediately.*

Additionally the following procedural changes have been implemented to reduce the risk of human error leading to a similar situation:

- *Amber Trolley patrols are now entered into Ellipse as MSTs and the West Ealing Technical Team have been briefed not to close Work Orders until the IA (Immediate Action) report is sent to the SM.*
- *Track is now measured with the MPV (not just manual track recording) which allows a greater level of assurance and highlights to all whether the work has been entered into Ellipse.*

A review will be undertaken of the changes made to the Western route MSA question sets to determine whether it is appropriate to mandate these nationally. This work will happen alongside the review of the MSA question sets for track being undertaken as part of the Business Critical Rules implementation.

34. Network Rail has indicated that this work is expected to be completed by 30 June 2016.

35. Further to this response ORR met with Network Rail to with the intention of:

- (a) exploring what the scope of its review was; the review findings, and specifically the shortcomings it identified;
- (b) obtaining a better understanding of the link between shortcomings and proposed actions so as to confirm the actions address the shortcomings;
- (c) confirming that the proposed June 2016 timescale remains valid and that the BCR enabled MSA review will be completed within that timescale and includes refreshing, enhancing and adding to the existing MSA question set as necessary; and
- (d) clarifying the process requirement around not closing an Ellipse work order until the IA fault report has been sent to the SM(T).

36. At this meeting Network Rail was unable to provide evidence that it had identified the root cause of West Ealing's failure to comply with standards and ORR

has concerns that the review referred to in the initial response had been documented. Network Rail did, however indicate that it had identified the specific failings as being due to:

- underperformance by the IME;
- a cultural issue whereby all parties failed to appreciate the significance of the data from the Amber Trolley and manual recording as they regarded it as being less important than that provided by the NMT or TRV which received priority attention; and
- the Technical team who were involved in the use of the Amber Trolley in effect worked independently from the SM who did not appreciate or undertake his role of monitoring their activities.

37. Since the derailment Network Rail has taken the following steps:
overall staff competence has been increased by the transferring in of new staff;

- a procedure has been adopted whereby the reports from the Amber Trolley (and manual recording) are not filed unless accompanied by an Ellipse printout showing that the correct TG codes have been assigned. It was agreed that this process could be incorporated in future as a means of control under BCR;
- the IME and TME have been consulted on the national review of MSA question sets and have recommended additional questions regarding the processing of non-TRV data to ensure that all TG Faults entered into Ellipse have the correct codes attached to them. This ensures that failure to close out would result in a non-compliance being flagged up. It is not known whether these recommendations have been accepted;
- monthly Track Quality Review Meetings chaired by the IME are held which encourage the technical and managerial development of attendees (inc SMs and TMEs) and promote ownership of track problems;
- visualisation, extended in Reading DU down to SM level now gives greater visibility of track performance; and
- an NCAP audit carried out by LNW and an Engineering Verification Audit of Management Inspections since the derailment apparently show the DU as performing well.