

Rail Safety and Standards Board

Certificate of Temporary Non-compliance from a Railway Group Standard

(in accordance with the Railway Group Standards Code)

1. Type of deviation:

Temporary Non-Compliance

Deviation Number: 08/076/TNC

2. Applicant details:

Quality Manager, West Coast Railways, Jesson Way, Crag Bank, Carnforth, Lancashire LA5 9UR

3. Status of applicant:

Railway Undertaking, RSSB Member

4. Title of certificate:

90mph testing of new build A1 Steam Locomotive 60163 'Tornado'

5a. Details of Railway Group Standard (RGS):

RGS Number:	Issue No:	Issue Date:	Title:
GO/RT3440	One	June 2007	Steam Locomotive Operation

5b. RGS clause(s):

2.2.1.1

5c. RGS clause requirements:

2.2.1.1 The infrastructure manager shall time steam locomotive movements to take account of restrictions on maximum permissible speed according to driving wheel diameters, as shown in Table A:

Driving wheel diameter		Maximum speed
	Less than 1524 mm (5 feet)	35 mph
1524 mm (5 feet) or greater	Less than 1727 mm (5 feet 8 inches)	50 mph
1724 mm (5 feet 8 inches) or greater	Less than 1880 mm (6 feet 2 inches)	60 mph
1880 mm (6 feet 2 inches) or greater		75 mph

Table A

6. Scope of deviation:

The steam locomotive 60163 'Tornado', for which this application is submitted, has a driving wheel diameter of 2032mm (6feet-8ins) and is therefore limited by the RGS criteria to 75mph.

This application is for a temporary non-compliance to allow the speed limit of 75 mph to be exceeded for testing to be undertaken up to a maximum speed of 90 mph, on specified stretches of the ECML between York and Newcastle only. Two return runs are planned (subject to satisfactory prior testing of the locomotive up to 75mph), with speed to be increased in 5mph stages on a leg-by-leg basis. Each further speed increase will be subject to satisfactory conclusion of the previous leg.

Full details of the proposed test running is appended to this application.

7. Reason for deviation:

Clause 2.2.1.1 limits the speeds of locomotives according to wheel diameter and places an overall speed limit of 75mph on steam locomotives with Driving wheel diameters of 1880mm (6feet-2ins) or greater. (Clause 1.2.1.2 explains that the limits for maximum speeds for the operation of steam locomotives working over Network Rail infrastructure are set in order to control track forces).

In contrast to all other Steam Locomotives registered for operation on UK mainlines (and hence covered by the scope of GO/RT3440), 60163 'Tornado' is a replica locomotive, of all new construction. Hence, it is free from typical age-related considerations. The original A1 locomotives were designed as express passenger locomotives to operate at the prevailing operating speeds of the time. In common with other 4-6-2 'pacific' locomotives on the East Coast Mainline, service speeds of up to 90mph were common, with occasional 100mph maxima being recorded.

This application is for a temporary non-compliance to allow testing of the new locomotive to proceed at speeds of up to 90mph. Dependent on the outcome of this testing and subject to an initial successful period of operation to the current 75mph limit, the A1 Trust intends to submit a further application for derogation for the maximum authorised operational speed of the locomotive to be increased up to 90mph in accordance with an agreed, structured acceptance program.

Alternatively, the A1 Trust would be willing to share the results of its testing programme to assist in the anticipated re-writing of GO/RT3440; a more representative set of criteria for speed limits may permit future potential operation up to 90mph for a new build locomotive of this kind.

8. Proposed alternative measures to manage the risk:

A submission to the Standards Committee, for derogation against the relevant range of Railway Group Standards was made on behalf of the A1 Trust in March 2006, for line speed operation up to 75 mph. That submission was accepted and a certificate (05/150/DGN) was issued. It is not intended that this application for a temporary non-compliance should nullify, or in any way affect this previously issued certificate of derogation.

The risk mitigations quoted within the previous application for derogation remain the same for the majority of the RGS referenced in the original submission. That is to say the increase in the maximum speed from 75mph to 90 mph for testing purposes is not seen to increase risk so far as these Railway Group Standards are concerned, or does not compromise the existing derogation mitigations. These Railway Group Standards are listed at the end of this section.

The risk is seen to increase so far as the following Railway Group Standards are concerned and additional mitigation(s) to control this increase is outlined against each accordingly:

A) GM/RT2042, Issue 2, April 2000 - Braking System Requirements and Performance for Traction Units

The replica locomotive is to be fitted with air operated brakes. The braking system has been designed to achieve the requirements of the standard (based on a successful steam locomotive air brake design as applied to, for example, locomotive No. 6233 'Duchess of Sutherland') and will be subject to a series of tests to demonstrate achievement of the requirements for stopping distances mandated in clause 5.1.2a for lines signalled in accordance with GK/RT0034 Appendix B.

It is proposed that the maximum speeds of the acceptance tests will be incrementally increased from 75mph to 90 mph in steps of 5mph. During and after each of these increments, the stopping distance will be monitored and extrapolations made to ensure continued compliance with this RGS.

All tests will be conducted on infrastructure agreed for the tests with Network Rail (planned to be ECML between York and Newcastle).

So far as the requirements for the Parking Brake are concerned, as these regulations apply only to a stationary locomotive, no changes are seen as necessary from the previously agreed derogation.

B) GM/RT2120, Issue 2, April 2004 - Requirements for the Control of Risks arising from Fires on Railway Vehicles

Nature of Non-compliance (as submitted for the Derogation dated March 2006):

- As with other steam locomotives, the source of power is a coal fire. Emissions could lead to line-side fires.
- The Class A1 Steam Locomotive is to use coal as its fuel, which will be stored in an open tender.
- The cab floor is to be constructed of wood, a flammable material.
- No fire detection system is to be fitted.

Current Mitigations:

- [Coal fire] The A1 class locomotive will be fitted with spark arrestor screens to control cinder and ash emissions from both the chimney and the ash-pan. These will be subject to specific acceptance through the Engineering Acceptance procedures.
- [Coal Fire] Discharge and disposal of ashes from the ashpan is only permitted at designated points at maintenance depots.
- [Coal tender] The ignition of tender coal has not proved to be a significant hazard on any steam locomotive operating in this country. The A1 will not be different in this respect to any other heritage locomotive. One of the duties of the fireman is to slake the coal with water to reduce dust to a minimum and improve its burning efficiency. This additionally reduces such fire risk.
- [Cab floor] It is of great importance that the cab floor should be non-slip, to enable the fireman to work safely. Wood has been traditionally used on steam locomotives and has not proved to be a significant fire hazard, but has given the stability required for non-slip operation. The A1 will be no different in this respect to any other heritage locomotive.
- [Fire Detection] An automatic or semi-automatic fire detection system would be impractical in the open environment of the cab, subject to the smoke and heat emissions from the fire-hole door. There is invariably at least one person in attendance in the cab.
- [General] The maintenance of the cab environment with particular attention to the cleaning of oil spills and general cleanliness is regarded as being of specific importance.
- [General] Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigations for 90 mph Testing:

- The effectiveness of the spark arresting equipment will be closely monitored during the early tests up to 60 mph and if deficiencies are found these will be corrected before undertaking further tests.
- There will be a continuous monitoring of the spark arresting equipment during the tests up to 90 mph. The testing will be undertaken late evening/night time which will accentuate the visibility of any excessive spark emissions.
- Each of the successive runs of the tests will be conducted over the same stretch of railway, which will enable continuous monitoring for any line-side fires that may arise.
- The increase of risk between 75 and 90 mph is seen to be minimal (the locomotive will work for longer at the same power setting, rather than any harder, in order to achieve the increase in speed).
- The locomotive is fitted with an ashpan sprinkler, which is available for use to reduce the risk of emission of hot cinders from this source.

Conclusion: With these additions, the risk is maintained as ALARP.

C) GM/RT2149, Issue 3, Feb. 2003 - Requirements for Defining and Maintaining the Size of Railway Vehicles

Nature of Non-compliance (as submitted for the Derogation dated March 2006):

Because of the semi-rigid driving wheelbase, assessment of swept envelopes using modern analytical techniques is considered inappropriate.

Current Mitigations:

- There would be practical difficulties and very high costs involved with the verification process(es) outlined in the RGS.
- It is intended that the replica locomotive will be subject to the Gauging Acceptance process by the Infrastructure Manager for all routes on which it will be operated. For the purpose of build conformance, the dimensions shown on the vehicle diagram will be subject to verification by the CCB. The principal dimensions and weights of the replica A1 steam locomotives are shown in Appendix 4 of this document. These will be declared to NRAB for consideration for Route Acceptance.
- The original class A1 locomotive was built to the L2 gauge, and was 13'-1" (3988 mm) in height, but following early representation from [the then] RSAB, the overall height of the replica locomotive has been reduced to 13'-0" (3962 mm). This has resulted in a reduction of height to the chimney, cab, boiler steam dome and safety valves; the latter two items being referred to the boiler manufacturer, to be taken into account in the boiler design.
- Gauging issues similar to other steam locomotives in regular heritage operation having similar suspensions.
- All operational movements are subject to clearance by the Infrastructure Manager.
- Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigations for 90mph test running:

- Throughout the test programme, regular maintenance checks of the locomotive will be undertaken in between each run; this includes inspection of suspension components to check for any unusual wear patterns.
- All 90mph running will be done on lines where linespeed is higher, so loco will not be seeing high cant deficiencies at speed.
- Reduced overall height (see above) means that 'bounce' should not be a critical mode of movement.
- The locomotive is fitted with roller bearings throughout, hence more robust bearing arrangement for speed and less lateral 'slop' to affect dynamic performance.

Conclusion: With these additions the risk is maintained as ALARP.

D) GM/RT2160, Issue 2, Oct. 2000 - Ride Vibration and Noise Environment Inside Railway Vehicles

GM/RT2161, Issue 1, Aug. 1995 - Requirements of Driving Cabs

(these 2 Railway Group Standards considered together)

Nature of Non-compliances relevant to speed increase (as submitted for the Derogation dated March 2006):

- Little cognisance was taken of the vibration and noise environment in the locomotive cab when this class of locomotive was designed in the 1940's. No measurements, calculations or data exist to verify compliance.
- As for other steam locomotives, forward sighting of signals below buffer level is restricted because of the bulk and location of the boiler. Similarly, the tender restricts reverse sighting.
- As for other steam locomotives, windscreen wipers, washers, heaters, & de-icers will not be fitted.

Current Mitigations:

- To check compliance with the RGS type tests would have to be undertaken on the locomotive at considerable cost.
- Footplate crew are subject to specific training in the handling of a steam locomotive.
- There are always at least 2 persons on the footplate whilst the locomotive is in motion.
- Infrequency of any individual driver being rostered to work the locomotive.
- At difficult locations, drivers stand and lean out of the side windows to enhance their view, or may be assisted by the fireman.

- The open cab environment does not generally give rise to the misting of windscreens. In the event of poor visibility, a driver is able to stand and lean out of the side window to enhance his view, or may be assisted by the fireman.
- Footplate crew are subject to specific training in the cab environment and the handling of a steam locomotive.
- Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigations:

- For the duration of these proposed 90 mph tests, there will be a minimum of 3 persons on the footplate, at least 2 of whom are competent both in handling the locomotive and in operating regulations, with particular reference to signal sighting.
- A signal sighting survey has been undertaken to ensure the required minimum viewing time* for each signal on the proposed test route (*8 seconds unless where authorised).
- A cab video (of a mainline steam locomotive run) has been made and independent assessment (ISA) of cab environment is being undertaken in support of the proposed 90mph running. The aim of this is to demonstrate that the cab environment, whilst markedly different from a modern diesel/electric locomotive, is not demonstrably worse at the higher speed.
- It is proposed to measure the cab vibration dose levels (ref GM/RT2160) during the testing, as part of the instrumented testing of the locomotive (see GM/TT0088 below for further details).

Conclusion: With these additions, the risk is maintained as ALARP.

E) GM/RT2483, Issue 1, June 2004 - Visibility Requirements for Trains

Nature of Non-compliance (as submitted for the Derogation dated March 2006):

- Heritage steam locomotives are not fitted with headlights and the front of the locomotive does not display a painted yellow panel.

Current Mitigations:

- The essence of running special trains with the replica steam locomotive is an attempt to recapture the nostalgia of the previous era, for the benefit of the paying enthusiast, and original authenticity of the design is therefore of considerable importance. Modifications to make the replica steam locomotive compliant with this RGS would mar its overall appearance, thereby destroying this criterion.
- The locomotive will be fitted with marker lights.
- A portable high-intensity headlight is mounted on the front of the locomotive when in operation.
- Of specific note, is the generally lower operating speed, and the presence of the smoke and steam emissions from the locomotive chimney, which are an aid to visibility.
- Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigations for 90 mph Testing:

- The 90 mph tests will be conducted at late evening/night time.
- The electric lighting system being fitted to the locomotive has now been developed to achieve the intent of the Railway Group Standard and the locomotive will display the correct light 'triangle' of marker lights/headlight configuration on its front end during the test runs.

NOTE: The existing derogation for the yellow panel is unchanged.

Conclusion: With these additions, the risk is maintained as ALARP.

F) GM/RT2484, Issue 2, April 2007 - Audibility Requirements for Trains

NOTE: The Certificate of Derogation issued in March 2006 (originally submitted April 2005) applied to Issue 1 of this RGS.

Nature of non-compliance (as submitted for the Derogation dated March 2006):

- No measurements, calculations or data are available to verify compliance.

Current Mitigations:

- As for other heritage steam locomotives, the Class A1 Steam locomotive whistle is distinctive, but not two-tone. The whistle can be manipulated to give Loud and Soft tones, but this is in the skill of the driver.
- Of specific note, is the generally lower operating speed, and the noise of operation of the locomotive, with its loud exhaust beats, giving a clear indication of approach, which are an aid to audibility.
- Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigation for 90 mph Testing:

- Tests on the locomotive whistle will be undertaken to ensure compliance with the sound pressure minimum criteria paragraph 2.1.4.1.
- The locomotive will be fitted with a 'chime' whistle as further aid to audibility in addition to the existing single pitch, high tone type referred to above. The 'chime' whistle is considered suitably 'distinctive'* so as not to be confused with 'road transport, factory or other common warning devices', which is the intent of the Railway Group Standard (clause 2.1.3.1). *A 'chime' type whistle was fitted to the high-speed streamlined A4 locomotives in the 1930's to address audibility concerns.

Conclusion: With these additions, equivalent compliance with the Railway Group Standard is considered to have been demonstrated.

G) GM/TT0088, Issue 1, Oct. 1993 - Permissible Track Forces for Railway Vehicles

Nature of Non-compliance (as submitted for the Derogation dated March 2006):

- No measurements, calculations or data are available to verify compliance.

Current Mitigations:

- Because of the high cost, it is not intended to undertake specific tests to establish vertical dynamic forces or to establish longitudinal and lateral forces.
- Steam locomotives have relatively low un-sprung mass & Q/D ratio, when compared with diesel locomotives fitted with axle hung traction motors, but give rise to "hammer-blow" effects from the out of balance proportion of the rotating mass of side rods and reciprocating motion. Hammer blow is reduced to a minimum by balancing weights fitted to the wheels, but cannot be eliminated.
- On the A1 locomotive, hammer blow is significantly reduced on account of it being a three cylinder locomotive*, with its three crankpins set at 120 degrees to each other, similar to the other LNER 4-6-2 locomotives (*the 1928 Bridge Stress Committee Report measured hammer blow with 3-cylinder engines as being typically 25% of that shown by 2-cylinder locomotives).
- Hammer blow has been raised as an issue by NRAB, and its value will be established and optimised by wheel balancing.
- Problems with variable ride quality at initial service introduction in 1949 (as described in Appendix 5) are known about and the replica A1 locomotive will be fitted with the modified level of bogie side control springing to ensure that it does not suffer the same problem. Particular check is to be made of the bogie side control spring force prior to fitting to ensure that this is within tolerance and will be subject to audit by the CCB.
- The quality of ride will be monitored subjectively during running trials to ensure that this is similar to, or better than, other steam locomotives.
- Use of locomotive restricted as a 'heritage' vehicle.

Additional Mitigations for 90 mph Testing:

- The locomotive has already been subject to a programme of wheel balancing (supported by theoretical calculations) in order to minimise hammer-blow forces caused by the reciprocating motion.
- Some basic instrumented testing will be carried out whilst at the Great Central Railway at speeds of up to 60 mph to measure lateral track forces and vehicle ride characteristics, in comparison with another mainline registered steam locomotive. The testing proposal testing document is appended to this application (courtesy of Delta Rail).

- The results of these tests will be extrapolated to establish compliance with the Railway Group Standard GM/TT0088 requirements at 90 mph. In addition, vehicle ride measurements will be taken during the 90mph testing (using on-board accelerometers), which will provide a degree of correlation.
- Wheelchex measurements will be taken from the Sessay (Northallerton) site and compared with readings from other mainline registered steam locomotives to provide data for vertical track forces.

Conclusion: With the completion of these measurements taken during the testing, it is anticipated that the locomotive will demonstrate equivalent compliance* with the Railway Group Standard. At the very least, they will show that, by comparison, the track forces exerted by the locomotive at 90mph are no worse than other existing steam locomotives at 75 mph.

*Full compliance with the Railway Group Standard would not be possible as the P2 force calculations would not give a meaningful result (not appropriate for large diameter wheel). Instead, the physical testing of dynamic loads from loco provides equivalent demonstration.

H) The following RGS are listed as unaffected by the speed increase, with a rationale given for each:

GM/RT2045, Issue 2, April 2000 - Braking Principles for Rail Vehicles

Rationale: Mitigations covering non-compliance with the specific requirements of clause 7.2.5 (Brake applications to interrupt traction power) considered equally as valid. The derogation already highlights that the proportion of brake force to tractive effort on the locomotive is notably greater than with diesel or electric traction units, hence the effect of traction power remaining (briefly) applied when a sudden brake demand is activated is considered negligible in terms of overall stopping distance and can be validated on test in any case.

GM/RT2100, Issue 3, Oct. 2000 - Structural Requirements for Railway Vehicles

Rationale: Inability to comply with this standard (lack of data to support crash-worthiness) is the same irrespective of speed. Obviously, energy to be dissipated at 90mph is greater than 75mph but the existing mitigations are adjudged to be equally valid.

GM/RT2141, Issue 2, Oct. 2000 - Resistance of Railway Vehicles to Derailment and Rollover

Rationale: Inability to comply with this standard (lack of data to support derailment/rollover calculations) is the same, irrespective of speed. Acknowledged that lateral force increases round a curve with speed but mitigations as stated remain the same and at 90mph, the locomotive will still be considerably below the linespeed of the planned test route (see comments in GM/RT2149). Additionally, with the incremental nature of each run, the opportunity exists to examine the track force data (see GM/TT0088) to confirm satisfactory ride prior to a subsequent run.

GM/RT2142, Issue 2 Oct. 2000 - Resistance of Railway Vehicles to Rollover in Gales

Rationale: Overall non-compliance with this standard unaffected by speed change (side forces imparted on loco unaffected by longitudinal speed).

GM/RT2162, Issue 1, Nov. 1995 - Traincrew Access to and Egress from Railway Vehicles

Rationale: Inability to comply with this standard (use of simple hinged plates as a 'door') is the same irrespective of speed.

GM/RT2176, Issue 1, Dec. 1995 - Air Quality and Lighting Environment for Traincrew Inside Railway Vehicles

Rationale: Inability to comply with this standard (open cab draughty, and its air unfiltered) is the same irrespective of speed. This issue is partly addressed in any case in the comments against GM/RT2160/2161 above.

GM/RT2185, Issue 2, Dec. 2001 - Train Safety Systems

Rationale: Inability to comply with this standard (non-fitment of Tripcocks, DSD, Driver-Guard communication) is the same irrespective of speed.

GM/RT2190, Issue 2, Feb. 2004 - Requirements for Rail Vehicle Mechanical and Electrical Coupling Systems

Rationale: Inability to comply with this standard (unknown proof loadings of the locomotive dragboxes) is the same irrespective of speed.

GM/RT2260, Issue 3, Aug. 2004 - Design for Recovery of Rail Vehicles after Accidents

Rationale: Inability to comply with this standard (Large diameter wheels of steam locomotives are not compatible with wheel skates) is not an issue relating to speed of operation.

GM/RT2456, Issue 2, April 2002 - Structural Requirements for Windows and Windscreens on Railway Vehicles

Rationale: Limited relevance of this standard (Locomotive not fitted with full, forward-facing windscreen) is the same irrespective of speed.

GM/RT2459, Issue 1, Dec.2000 - Data to be Displayed on Rail Vehicles

Rationale: Non-fitment of Data Panels and Lifting and Jacking Points is not an issue relating to speed of operation.

GM/RT2466, Issue 1, June 2003 - Railway Wheelsets

Rationale: Compliant with geometry interface but not the design requirements of this standard (does not cover the large diameter, spoked wheelsets used on heritage steam locomotives) is the same irrespective of speed.

GM/RT2470, Issue 2, Dec. 2004 - Wheelset Supplier Qualification

Rationale: Inability to comply with this standard (No supplier of steam locomotive wheels is currently shown on the approved list) is the same irrespective of speed.

GE/RT8080, Issue 1, Dec. 2003 - Train Radio Systems for Voice Related Messaging Communications

Rationale: Use of portable radio equipment instead of a permanent radio system considered equally as valid irrespective of speed.

9. Justification for deviation:

In order to test the locomotive at 90mph, a temporary non-compliance against the current 75mph maximum stated in GO/RT3440 is required.

As stated above, this is partly to assist in providing test data in support of possible arguments for revising the RGS in the future.

In terms of the other RGS listed above, the additional mitigations listed are considered to adequately address any incremental change in risk as a result of testing in the 75-90mph speed range. It is not considered otherwise practical to comply with the requirements of the RGS listed; in many cases, due to their wide diversity of design from modern traction units and the general scarcity of technical information now available to prove their compliance or otherwise, demonstration of compliance is not possible in any case.

Steam locomotives are in a minority group, and subject to the restrictions in GM/RT2000 for "Heritage Vehicles".

10. What other options have been considered?

None - in order to test at 90mph and provide representative data over Network Rail infrastructure, a TNC is required.

11. Method of elimination:

It is the intention that satisfactory completion of tests will lead to submission of results (presented in industry-recognised report with conclusions/recommendations) which will provide an objective basis for revision of Railway Group Standard GO/RT3440 to permit higher operating speed for a new-build locomotive of this type.

12. Start and end date:

01/07/2008 to 30/06/2009

13. Alternative words for the RGS:

NA

14. Additional actions/observations:

Upon receipt, the applicant is required to identify affected, interfacing parties and copy this certificate, together with supporting information, to those parties.

90mph mainline test running is part of the full locomotive test plan drawn up by the A1 Steam Locomotive Trust (copy attached). This has been submitted as part of the Route Acceptance strategy to Network Rail Acceptance Board (VSRP) who have actioned the Trust in a number of areas, one of which being to provide a suitable response to demonstrate that the new locomotive will not impart undue track forces whilst running on the network (extract from VSRP meeting notes attached).

The Trust has consulted with Delta Rail Vehicle Dynamics specialists for assistance with this work and, consequently, has commissioned a series of track force and vehicle dynamic tests (see attached), intended to provide objective evidence (using the comparison method) that the track forces exhibited by the locomotive will be acceptable. This will initially take place at the Great Central Railway at speeds of up to 60mph and be followed up by analysis of results (from vehicle mounted equipment) during the 75-90mph test running.

Delta Rail has consulted with RSSB on behalf of the Trust in respect of this temporary non-compliance and has received an indication from RSSB that suitable objective evidence in terms of the effects of track forces and reciprocating masses on the locomotive would be welcomed in the anticipated revision of GO/RT3440. The carrying out of mainline testing of the locomotive up to 90mph will provide such evidence.

This temporary non-compliance is for testing purposes only and does not cover the operation of the locomotive running in tender-first mode.

15. Signature of applicant:

Quality Engineering Director

Date of application:

16/04/2008

16. Status in respect of Notified National Technical Rules:

GO/RT3440 is not on the list of the proposed NNTRs under the Conventional or High Speed Rail TSIs.

17. Lead Standards Committee details:**Name of Committee:**

Traffic Operation and Management

Date of meeting

22/07/2008

Minute reference:

08/TOM/07/533

Authorised by:

Signed by Richard Evans on 14/08/2008

Date of Authorisation:

14/08/2008

Richard Evans
Head of Delivery, Traffic Operation and Management