RAIU

Railway Accident Investigation Unit

Report into the derailment of a Tara Mines freight train at Skerries on the 10th of January 2008

Report Number 08011001

Function of the Railway Accident Investigation Unit

The Railway Accident Investigation Unit (RAIU) is a functionally independent investigation unit within the Railway Safety Commission (RSC). The purpose of an investigation by the RAIU is to improve railway safety by establishing, in so far as possible, the cause or causes of an accident or incident with a view to making recommendations for the avoidance of accidents in the future, or otherwise for the improvement of railway safety. It is not the purpose of an investigation to attribute blame or liability.

The RAIU's investigations are carried out in accordance with the Railway Safety Act 2005 and European railway safety directive 2004/49/EC.

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Executive Summary

At 22.53 hours on the 10th of January, 2008, a Tara Mines freight train operated by Iarnród Éireann consisting of a locomotive and eleven wagons derailed south of Skerries station on the Dublin to Belfast line. The first wagon of the train suffered a burnt off axle journal due to a catastrophic bearing failure, it derailed at the 17 ½ milepost and continued to travel a further 230 yards, damaged crossover SK 244 resulting in the derailment of five further wagons before the train came to a stop. Moderate damage was sustained by the leading wagon, the remaining derailed wagons suffered wheel impact damage, there was damage to sleepers over a distance of 230 yards and components of crossover SK 244 were broken as well as rail in its vicinity. There were no injuries and there was no release of the zinc concentrate that the wagons were transporting at the time. A Hot Axle Box Detector reading of 56 degrees Celcius was recorded eleven miles before the point of derailment, however, no alarm was triggered due to the detector's alarm temperature settings and the train continued its journey. In addition, the bearing appears to have been in operation since its manufacture in 1981 without undergoing overhaul.

The immediate cause of the derailment:

- The catastrophic failure of bearing 633A leading to a BOJ.

Probable contributory factors were:

- The HABD settings not triggering an alarm;
- The lack of a robust bearing maintenance regime.

Underlying cause:

- Failure to detection bearing deterioration.

Recommendations:

- Iarnród Éireann should put in place a risk based process to ensure ongoing review of the suitability of the temperature settings of the HABDs;
- Iarnród Éireann are to identify the necessary maintenance requirements for all Class D bearings, including producing detailed maintenance procedures taking into account their operational conditions and allowing for traceability of safety critical components, with assistance being sought from the Original Equipment Manufacturer where appropriate.

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1 Factual information

1.1 The incident

On the 10h of January 2008, an Iarnród Éireann (IÉ) Tara Mines freight service (train identification number M107) departed Tara Mines outside of Navan in County Meath after 22.00 hours (hrs) having been loaded with zinc concentrate and destined for Alexandra Road Depot in North Wall, Dublin 3. The train was crewed by a driver and a guard. The train travelled approximately 18 ½ miles on the Drogheda to Kingscourt branch line to Drogheda station located at 31 miles 1012 yards from Connolly Station[1] where it joined the Dublin to Belfast line. The guard departed the train and there was a change of driver. The train then travelled south on the Up Road towards Dublin passing the Drogheda Up Hot Axle Box Detector (HABD) at 28 miles 1509 yards at 22.36 hrs, no alarms were activated. At 18 miles 631 yards the train was routed from the Up Road to the loop at Skerries station and was routed back onto the Up Road at crossover SK242 (18 miles 176 yards). After passing signal ND 359 the train driver felt a slight tugging movement and looked back at the train. The driver could see sparks coming from the train and applied the brakes stopping the train 50 m north of a road bridge over the railway, overbridge OB 49, see figure 1. The driver made an emergency call to Central Traffic Control (CTC) advising of a possible derailment and seeking Signal Protection to stop train movements on the Down Road. The driver then left the cab to verify that the train had derailed and carry out Emergency Protection on the adjacent line. There were no injuries and none of the transported zinc concentrate was discharged.

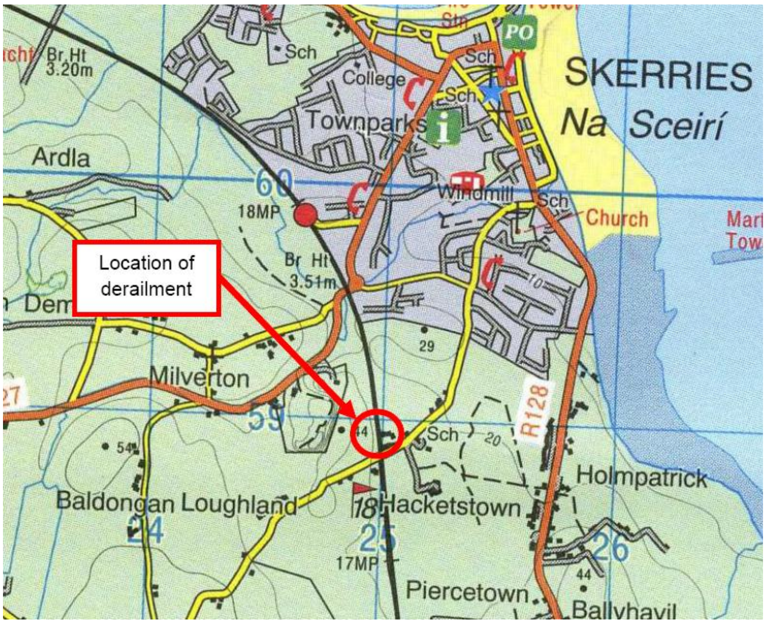

Figure 1 – Location Map

Ordinance Survey Ireland Licence No. EN 0058208.

[1] All locations referenced are measurements north of the 0 milepost at Connolly Station, Dublin 1.

The train consisted of locomotive 084 hauling eleven wagons in the following order 31005, 31023, 31020, 31002, 31017, 31027, 31019, 31003, 31012, 31014 and 31007. The train was approximately 139 metres long and had a mass of approximately 953,000 kilos (kg).

The incident occurred after nightfall and the weather was dry with a temperature of approximately 4 degrees Celcius (°C).

1.2 Site examination

Train M107 suffered a catastrophic bearing failure leading to failure of the axle, this is commonly referred to as a Burnt Off Journal (BOJ). The train derailed and came to a halt at 17 miles 585 yards, north of overbridge OB 49, at 22.53 hrs, see figure 2. The derailment occurred on a section of double track on the Dublin Connolly to Belfast line. The train was travelling south on the Up road when the first six wagons in the train derailed, all wagons remained upright. The first wagon behind the locomotive, 31005, suffered a BOJ on the leading axle of its trailing bogie and the bogie was derailed. Wagons 31023, 31020, 31002 and 31017 had both bogies derailed and wagon 31027 had the leading bogie derailed with the trailing bogie still on the tracks just short of points for crossover SK 244. The wagons 31019, 31003, 31012, 31014 and 31007 did not derail.

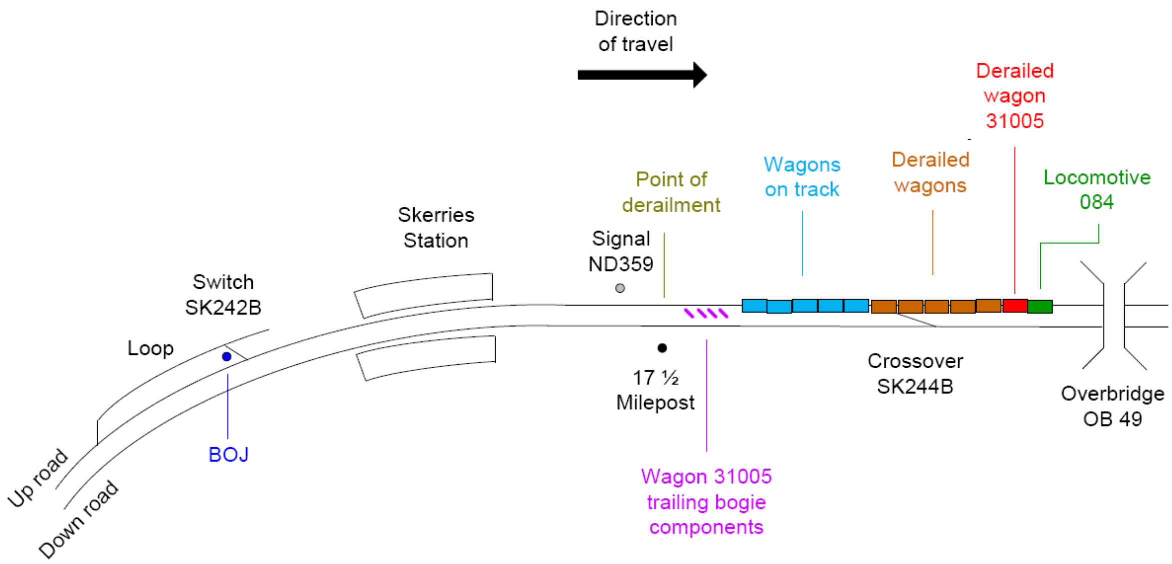

Figure 2 – Site Map

The BOJ was found with the end cap and end cap screws, locking plate and ½ inch pipe plug in place in between the Up road and the loop at the nose of switch SK242B at 18 miles 607 yards, see photo 1. The train travelled approximately ½ a mile with the axlebox of the leading wheelset on the trailing bogie on wagon 31005 leaning on the axle journal. The wheelset with the failed axle then derailed and damage could be seen on the sleepers starting at the 17 ½ milepost. Components from the trailing bogie of wagon 31005 were found in the six foot after the 17 ½ milepost. The failed bearing had fused to the axlebox, see photo 2. The remaining wheelsets derailed at crossover SK244B facing points, located at 17 miles 707 yards.

Photo 1 – Burnt Off Journal

Photo 2 – Failed Bearing & Axlebox

The diameter of the axle narrowed to 90 mm before it failed.

The derailed bogie from wagon 31005, including the failed wheel set, was transferred to IÉ Inchicore Works for examination.

1.3 Track

The Dublin to Belfast Line is a double track line throughout. The track at the derailment site was continuous welded rail installed in 1994. The line is surveyed twice a year with the Track Recording Vehicle. The most recent survey was carried out on the 2nd of October 2007. The report for the Up Road between the 17 and 18 mileposts showed there were no defects requiring action. In the vicinity of the derailment site, the track is patrolled three times a week with the most recent patrol occurring the day before the derailment on the 9th of January 2008. Post derailment inspection of the site showed no out-of-tolerance defects that could be considered causal.

1.4 Signalling and communications

The line between Dublin and Belfast is equipped with two, three, and four aspect colour light signals with the area of the derailment controlled by three aspect signalling. Trains are signalled under IÉ Track Circuit Block regulations. There is radio communication between drivers and the controlling signalman.

1.5 Operations

The freight service is operated under Driver Only Operation with assistance provided for shunting at both Tara Mines in Navan and Alexandra Road Depot in North Wall, Dublin. The maximum line speed on this section is 90 miles per hour (mph), with a restricted maximum speed for freight trains of 50 mph. The Hasler disc on locomotive 084 records the speed of the train, it indicated that the train had been travelling at 25 mph at the time of the incident, the train slowed to 20 mph and then to a stop. The driver was familiar with the route, qualified for the position and met established fitness and rest standards.

1.6 Wagons

The wagon with the BOJ, 31005, was manufactured by IÉ in 1977 and is equipped with vacuum brakes, one load weigh valve and brake blocks that act on the wheel treads. The wagons are fitted with Y23 bogies which permit operation on 1600 mm gauge track. The Y23 bogies are similar to Y25 bogies commonly used throughout Europe on 1435 mm gauge track. The bogies are fitted with concentric helical spring suspension and are friction damped with Lenoir links controlling plungers that rub against a manganese plate. They have outboard bearings housed in an axlebox, meaning the bearings located at the end of the axles and are pressed on after the wheels. The trailing bogie of wagon 31005 and its wheel sets inspected and pertinent data was recorded in relation to all relevant components, no out-of-tolerance issues of concern were identified.

1.7 Hot axle box detectors

1.7.1 General

The Drogheda Up and Down Hot Axle Box Detectors (HABDs) are manufactured by Signal & System Technik, these are known as Phoenix MB HABDs. They use infrared sensors reflected by a mirror scanning eight points over a width of 0.12 m. The alarms were set to 112 °C for a hot alarm, 112 °C for a warm alarm and 67 °C for a difference alarm. HABD alarms trigger an alarm in CTC and drivers are contacted by radio in case of an alarm. At the time of the incident the Phoenix MB HABDs were in the process of being installed throughout the IÉ network.

Temperature settings for HABDs are normally set to take into account the operating temperature range of the bearings on all of the rolling stock operated over the infrastructure. In the case of IÉ rolling stock, the temperature settings are required to take into account enclosed bearings, as in the case of the Tara Mines Wagons, and bearings with an exposed underside. Due to this, the HABDs are required to effectively manage abnormal temperatures readings taking into account measurements over a normal operating range of approximately 5 °C to 70 °C for differing wheelset types. The settings used for the HABDs were the historical settings used for the old equipment, for which a risk assessment was not available. In addition, the HABD readings were not actively monitored to ensure their effectiveness.

In the case of the Y23 bogies because of the presence of the axlebox traverser only the three points at the outboard edge of the bearing measure effectively and the temperature readings at the remaining five points, including those towards the centre of the bearing cup that give a more accurate bearing temperature, are affected by the underside of the axlebox, see figure 3. Therefore, the true temperature reading of a bearing enclosed in a Y23 axlebox would be greater than the measured temperature.

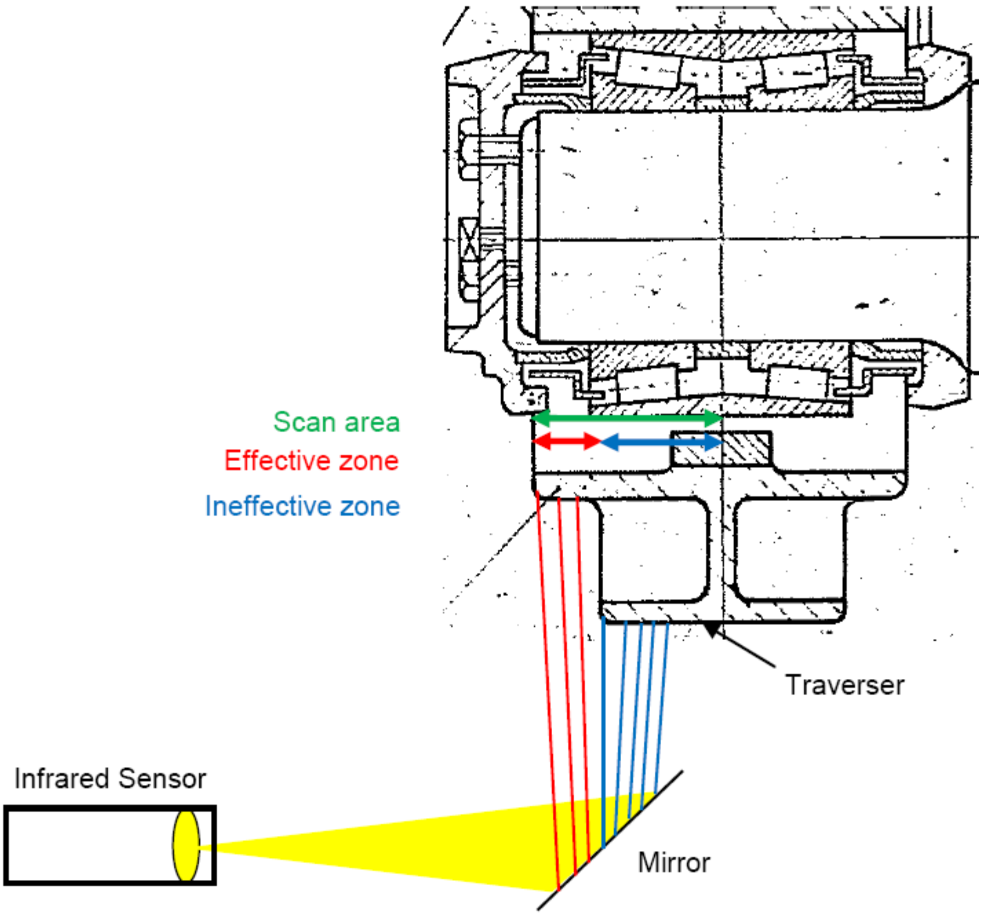

Figure 3 – HABD Scanning

1.7.2 Drogheda HABDs

HABDs are located at 28 miles 1509 yards on both the Up and Down roads south of Drogheda Station, these are referred to as the Drogheda Up HABD and Drogheda Down HABD. HABD temperature readings for the wagons were recorded for the derailed train following departure from Tara Mines at 22.36 hrs, for its unladen journey prior to arrival at Tara Mines at 17.27 hrs and for the previous laden train departure from Tara Mines at 13.43 hrs. These were reviewed and showed no anomalies for the train other than the failed bearing temperature reading, see table 1. In addition, there were no errors recorded on the HABDs.

Train service	Ambient temperature (°C)	Temperature range (°C)	Average temperature (°C)	Failed bearing temperature (°C)
Up laden wagons	7	10 – 21	13.5	15
Down unladen wagons	5	6 – 16	10.32	14
Up derailed train wagons	4	7 – 17*	11.25*	56

*Excluding failed bearing

Table 1 – HABD Temperature Readings

1.8 Bearings

1.8.1 General

The bearings fitted to the Y23 bogies are standard AP class D (5 ½ x 10) tapered roller bearings used throughout the world and in this case manufactured by British Timken[2], see figure 4. The bearing assembly consists of an outer cup, two tapered roller bearing cone assemblies separated by a spacer, and two (inner and outer) grease seals with wear rings. The bearing assembly is pressed on to an axle journal and then retained by the end cap, which attaches to the end of the axle via three cap screws and a locking plate. Bearings are normally stamped around the cup with a component type number, serial number and the date of manufacture.

[2] British Timken a division of the Timken Company which was closed in 2002. Timken Rail Services originated as a unit of British Timken and then became a unit of Timken UK after the closure.

The four bearings from the trailing bogie of wagon 31005 as well as the axleboxes for the failed bearing and its partner bearing were transferred to Timken Rail Services (TRS) in Northampton and subsequently to Health & Safety Laboratory (H&SL) in Buxton for further evaluation and inspection. The failed bearing and its partner were identified by serial numbers 633A and 751 respectively, both were manufactured in July 1981. The bearings from the trailing axle of the bogie were identified by serial numbers 2569 and 2408 respectively, both were manufactured in November 1981. The bearing information on the outside of the cup of the failed bearing was hand etched rather than stamped.

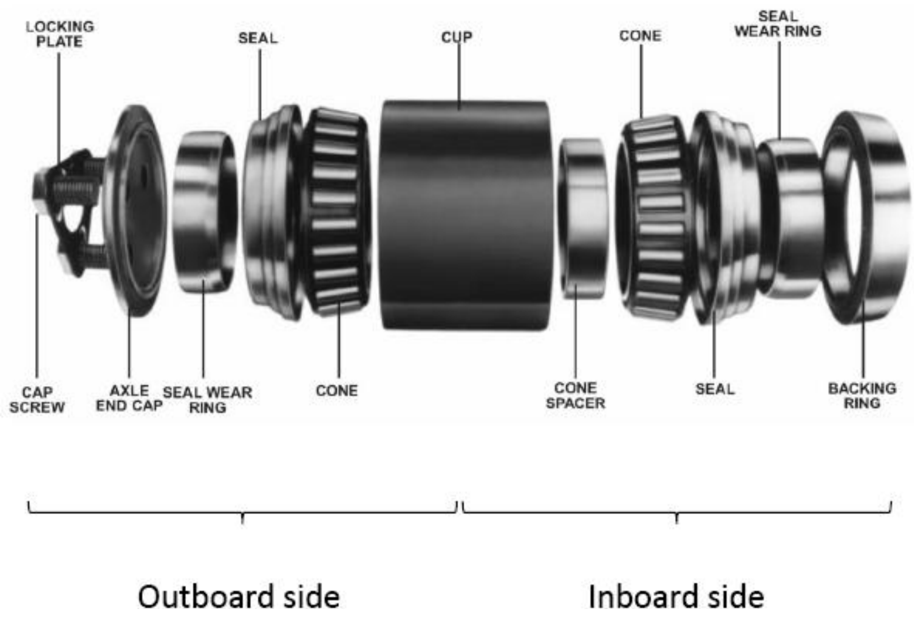

Figure 4 – Class D bearing components

1.8.2 Maintenance

IÉ carried out the bearing overhaul up until the mid to late 1990s, after this bearing overhaul was outsourced to the Original Equipment Manufacturer (OEM). There were no markings on the failed bearing or bearings 751, 2569 and 2408 indicating that they had been overhauled at any stage. In addition, the age of the seals (dated August 1979) on the bearings would indicate that they had not been overhauled. Neither IÉ nor TRS had any records of overhaul for these bearings. TRS mark the overhaul date on bearings, IÉ advised that they did not. TRS advised that Association of American Railroads (AAR) practice was followed in relation to bearing manufacture and overhaul. IÉ advised that they implemented parts of AAR and United Kingdom practice.

Maintenance work on wagon components was recorded by wagon number. Detailed maintenance documentation was not available and traceability of safety critical components such as bearings was not possible. Wheelsets were exchanged between wagons in an uncontrolled manner, which may have led to wheelsets missing maintenance inspections and overhaul. IÉ had no maintenance requirement for bearings other than cursory inspections at wheel turning and axle ultrasonic testing, in addition to overhaul following life expiry of a wheel on the wheelset it was fitted to. IÉ retained axle serial numbers for axles which receive an ultrasonic test, there was no company requirement to record and retain assembly and maintenance information on turned wheelsets. Paper records recovered from maintenance personnel indicated that the wheel set containing the failed bearing was turned on the wheel lathe at the Inchicore Wheel Shop in March 2007.

The maintenance records for bearings sent to TRS for overhaul between October 1997 and July 2008 were reviewed. The main causes for bearing components to fail the inspection were found to be heat discolouration, roller water etching and bore size. Heat discolouration is the discolouration of a bearing due to overheating, which can be caused by lack of lubrication or overloading. Roller water etching is distress due to water ingress which is related to lubricant degradation. Oversized cone bores can be caused by retained austenite or overloading. Inspection failure due to cone bore size may also have been due to the tightening of AAR requirements for cone bore diameter in 1988.

1.8.3 Wheelset inspection

The failed axle was manufactured in November 1981. There were no markings on the wheel fitted at the failed end to indicate its date of manufacture or the manufacturer, only the press on force was marked and based on this it is believed that the wheel was pressed on by IÉ. No wheel flats were observed on the wheel.

Photo 3 – Failed Bearing

The failed components along with the four bearings from the trailing bogie of wagon 31005 and the axlebox the partner bearing was supporting were examined by the Health & Safety Laboratory in Derbyshire, United Kingdom[3]. The BOJ stub fracture appearance was consistent with the axle failing at a high temperature, under torsion loading. This indicates that the axle journal failure was probably a consequence of the heat generated and increased torque resulting from the bearing failure. The axle failed in line with the inboard cone of the bearing. The failed bearing had plastically deformed into a pear shape at the inboard side (see photo 3). The high temperatures caused by the bearing failure resulted in significant plastic deformation of the cup, cones and rollers. The principal cause of the high temperatures appears to have been frictional heating resulting from the rotation of the inner cone around the axle surface. There was no evidence of rolling contact fatigue, spalling, corrosion or wear on the internal surfaces of the failed bearing. The cone assemblies were seized with the rollers skewed in a herringbone pattern. A roller in the outboard cone had suffered a brittle fracture primarily in the longitudinal direction (see photo 4). There was no evidence that the fractured roller had indented the adjacent rollers suggesting that it may have been a consequence of the bearing failure rather than the cause. The inboard cage had failed in the area of the peak of the pear shape and two adjacent rollers had moved out of their relative position in the cage (see photo 5).

Photo 4 – Fractured Roller

Photo 5 – Failed Cage

[3] Health and Safety Laboratory (May 2008), Metallurgical Examination of Components from the Tara Mines Derailment, reference MM/08/07.

1.8.4 Cone Bore Growth

Dimensional checks performed by TRS showed increased bore diameters of both cone bores of the partner bearing. One possible explanation for the increased diameters is the transformation of retained austenite while in service which is a known phenomenon with bearings manufactured in the early 1980s. If this had caused the increase in cone bore diameters, it is reasonable to expect that the microstructure of the material close to the track, where transformation of retained austenite is most likely to occur, would have contained less retained austenite and had a higher hardness than material close to the axle surface. To check for this phenomenon, sections of the partner bearing cones were examined metallographically and subjected to microhardness testing. Neither revealed any significant differences that could be attributed to the transformation of retained austenite in the partner bearing. In addition, there was no evidence of spun cones in the partner bearing to indicate cone bore growth.

1.8.5 Bearing grease

There was no grease present in the failed bearing. This would be expected with a BOJ due to the temperature the bearing would have reached. To check if the condition of the grease may have contributed to the failure, grease samples were taken for analysis from all of the older bearings on wagons that derailed and the amount of grease in each bearing was measured.

TRS advised that the lubricant would have been either an AAR approved lubricant to standard M-942 or a British Rail approved lubricant to standard BR673. The only AAR approved greases for use in these bearings prior to the bearing manufacture were Arapen RB 320 and Shell Alvania D. IÉ believe that the type of grease they used during IÉ overhauls was Shell Alvania RA. British Timken approval was not sought for the use of Shell Alvania RA.

The grease samples underwent the following tests (see table 2):

- Fourier Transform Infrared Spectroscopy (FTIR) – to determine type and establish if there was any oxidation/contamination;
- Spectrographic Analysis – to confirm soap type, oil based additive levels and check for evidence of wear;
- Worked Penetration – to verify consistency;
- Water Content – to check for evidence of water contamination.

Bearing Number	Manufacture Date	Mass of Grease* (grams)	Water Content (%)	Work Penetration
7920	June 1972	390	1.4	315
11832	February 1973	382	<0.1	382
004158	November 1973	634	0.4	298
000182	January 1974	626	0.6	282
9326	June 1979	412	1.2	291
9810	June 1979	262	<0.1	383
751	July 1981	501	<0.1	414
2338	November 1981	638	<0.1	377
2408	November 1981	424	<0.1	431
2569	November 1981	534	0.1	423
2783	November 1981	658	0.6	373

*The mass may be affected by debris.

Table 2 – Grease analysis results[4,5,6,7]

For AAR approved grease to standard M-942 the acceptable for worked penetration is 290 to 340 and the maximum allowable water content is 0.1%. The required mass of grease for a TRS AP D class bearing is 450 g ± 15 grams (g). TRS advised that the grease masses may have been affected by debris but the expected effect would have been up to an additional 50 g. From the results, it can be seen that the mass of grease varied between 262 g and 658 g, both under lubrication or over lubrication can lead to bearing failure. The tests indicated unacceptable variability between greases, both chemically and physically. Some samples were visibly deteriorating with evidence of excessive levels of free oil. Both FTIR and spectrographic analysis indicated variability between the greases, this indicates either chemical changes within the grease, the use of several greases or a mixture of greases. There was little evidence of oxidation and wear in the samples. Water contamination of >1% is of concern and was evident for samples 7920 and 9326. All samples other than 000182 and 004158 showed evidence of thinning and grease change/breakdown, which alone could result in reduced lubrication possibly leading to bearing failure.

[4] Scientifics (April 2008), Examination of Bearing Grease from a Derailment, reference ANT/04214_V2.

[5] Scientifics (January 2009), Examination of Bearing Grease – Reissue after Additional Information, reference ANT/04774_V2.

[6] Mark Leatherland (June 2008), Bearing Inspection Report, reference 8-2008, Timken.

[7] Mark Leatherland (June 2008), Bearing Inspection Report, reference 8-2008, Timken.

An important issue with bearings that are in operation for a long period is the ability of the grease to last for the expected life of the bearing. Grease applied in 1981 would have had an operational life of in excess of 26 years, grease manufactured then would not have been expected to retain its effectiveness after this length of operation. The testing demonstrated that the condition of all of the grease samples would be considered unacceptable for their intended use in the present condition. However, since there is not a trend of related bearing failures, it is unlikely that lubrication breakdown contributed to this accident.

1.9 Fatalities, injuries and material damage

1.9.1 Injuries

There were no injuries to railway personnel or the public due to the BOJ and derailment.

1.9.2 Damage to rolling stock

Wagon 31005 suffered damage to the trailing bogie including the right trailing side bearer. The top of the frame at right trailing end was bent. The right leading brake hanger bracket was broken off. The right leading axle journal was burnt off. The right leading axlebox adapter was fused to the seized bearing. The left leading spring cap holder, four brake shoes and blocks, and the bogie centre liner were damaged. Two brake adjusting rods, two brake shafts, the truss bar and the brake linkage to the leading bogie were bent. The wheel flanges were damaged on wagons 31002, 31020 and 31023.

1.9.3 Damage to infrastructure

There were impact marks on the concrete sleepers from the 17 ½ milepost to the point of derailment. There was considerable damage to the timbers, switch rail and other metalwork of crossover SK 244. The detection bar at the switches was broken, the detection bars were bent and the stretcher bars were bent. There was damage to the timbers and some fastenings in the five foot on the Up road and the five foot at the turnout. Some timbers were dragged longitudinally to the track by the derailed wheels. The rail on the turnout at the heel of the switch was broken and the wing rails of the crossing were broken.

1.10 History of accidents/incidents

IÉ advised that there was only one prior incident relating to Class D bearings, this was the overheating of a bearing on an ammonia train on the 4th of March 1993 near Ballybrophy in County Limerick. Records of the incident were not available but it was possible to establish that following the overheating of the bearing the criteria for the application of bearings were altered. In addition, the ammonia train wagons were fitted with new D class bearings and overhaul of the D class bearings was transferred to TRS in Northampton.

2 Analysis

2.1 HABD temperature settings

The train passed the Drogheda Up HABD at 28 miles 1509 yards and the bearing in the failed position recorded a temperature of 56 °C, however, no alarms were reported as the measured temperature had not reach the established IÉ alarm thresholds of either 112 °C for a hot bearing alarm or 67 °C for an end to end differential alarm. Because there were no alarms, the train continued its journey. As the train continued, the bearing continued to heat up, ultimately resulting in loss of lubrication, bearing seizure and catastrophic failure. This in turn began to overheat the axle journal and it began to extrude, reducing its cross-sectional thickness. The BOJ occurred when the reduced cross-sectional area of the axle journal could no longer support the weight of the loaded wagon. This led to the derailment of the trailing bogie of Wagon 31005 at the 17 ½ milepost, which led to damage to crossover SK244 and resulting in the derailment of wagons 31023, 31020, 31002, 31017 and 31027.

The 56 °C temperature reading for the bearing prior to failure would not have been a true reading of the temperature of the bearing. Had the HABD alarm temperature settings been more effectively set, the differential alarm would reasonably have been expected to trigger an alarm in CTC permitting contact with the train driver to allow him stop the train prior to the catastrophic bearing failure resulting in a derailment.

2.2 Bearing maintenance

BOJ failures usually lead to the destruction of significant amounts of evidence from the failed bearing. Therefore, it is not always possible to establish the exact failure mode that led to the failure. However, information obtained from the partner and other bearings which were subjected to the same life cycle as the failed bearing may provide insight into possible failures modes. In this case, it was not possible to determine the cause of the catastrophic bearing failure. It was possible to determine that it was unlikely that either cone bore growth due to retained austenite or lubrication failure were contributory factors in this occurrence.

From the investigation it was possible to establish that the bearing had most likely been in service more than 26 years. Maintenance of safety critical components was not strictly controlled and there was no system of traceability of safety critical components in place. Had more stringent controls been in place, the bearing would most likely have undergone overhaul with the OEM. This would have permitted close examination of the condition of the bearing and permitted removal from service of bearings that fail to meet the service limit criteria, reducing the likelihood of a catastrophic bearing failure.

3 Conclusions

It was not possible to determine the exact cause of the derailment other than to identify the catastrophic bearing failure. However, based on the information provided, it was possible to determine how the incident could have been avoided. Either a more effective risk based approach to HABD alarm temperature settings or a more stringent maintenance regime preventing bearings from remaining in service indefinitely without overhaul could have prevented the catastrophic bearing failure.

The immediate cause, probable causal factors and underlying cause are identified below.

The immediate cause of the derailment:

- The catastrophic failure of bearing 633A leading to a BOJ.

Probable contributory factors were:

- The HABD settings not triggering an alarm;
- The lack of a robust bearing maintenance regime.

Underlying cause:

- Failure to detection bearing deterioration.

4 Recommendations

The following recommendations are made in relation to the incident:

- IÉ should put in place a risk based process to ensure ongoing review of the suitability of the temperature settings of the HABDs;
- IÉ are to identify the necessary maintenance requirements for all Class D bearings, including producing detailed maintenance procedures taking into account their operational conditions and allowing for traceability of safety critical components, with assistance being sought from the Original Equipment Manufacturer where appropriate.

5 Relevant actions already taken or in progress

The following actions have been reported by IE as already taken or in progress relevant to this report (March 2009):

- The HABD absolute alarm settings have been lowered to 100°C;
- The differential alarm setting has been lowered from 67°C to 50°C;
- Further evaluation and analysis of temperature levels of bearings on the same axle is currently under review with a view to lowering the differential temperature settings;
- Monitoring of HABD readings is now being carried out by CME technical support staff;
- Maintenance policy has been updated to remove class D bearing from service after a period no greater than 8 years;
- All class D bearings have been replaced on both the Tara Mines and Bogie Cement Wagon fleets;
- Wheelset records now include the bearing manufacturer’s serial number, year of manufacture, date of overhaul and axle number;
- Vehicle records will record bogie and wheelset data.

6 Additional information

6.1 Acronyms

ARR	Association of American Railroads
BOJ	Burnt Off Journal
CME	Chief Mechanical Engineer
CTC	Central Traffic Control
CWR	Continuously Welded Rail
FTIR	Fourier Transform Infrared Spectroscopy
HABD	Hot Axle Box Detector
IÉ	Iarnród Éireann
mph	Miles per hour
OEM	Original Equipment Manufacturer
TRS	Timken Rail Services

6.2 Glossary of terms

Burnt Off Journal	Axle failure by extrusion due to bearing seizure
Central Traffic Control	Main signalling centre based in Dublin
Detonator Protection	Three detonators places 20 yards apart on track to warn train drivers of danger ahead
Down Road	Track on which trains normally operate away from Dublin
Five Foot	Area between the two rails of a piece of track
Hot Axle Box Detector	Device that is used to detect overheating axleboxes and bearings
Signal Protection	All signals into a section set to the red aspect
Six Foot	Area between the rails of adjacent tracks
Track Circuit Operating Device	A device that creates a link between the rails mimicking the presence of a train and causing a red signal aspect
Up Road	Track on which trains normally operated towards Dublin
Wayside	On the ground