

## METHODS AND OPTIONS FOR PRESERVING RAILWAY SAFETY KNOWLEDGE IN A CHANGING ENVIRONMENT. – THE IMPORTANCE OF HUMAN FACTORS MANAGEMENT IN TRAIN OPERATIONS.

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### SUMMARY

The South African Cape gauge commuter train services operator provides a service in four major metropolitan areas, namely Western Cape, Eastern Cape, KwaZulu-Natal, and Gauteng.

Gauteng has the oldest infrastructure, in particular the signalling system.

In less than ten years, more than ten rear end collisions occurred on the South African commuter rail network in Gauteng. The root causes of these rear end collisions can largely be attributed to poor management of human factor elements in safety critical grades. Train operating personnel contravened the train operating rules and regulations, when “abnormal trains working” procedures were introduced due to failure or vandalism of signalling infrastructure.

The Railway Safety Regulator, in conjunction with the South African Bureau of Standards and the South African rail industry, developed the South African National Standard, SANS 3000 – 4, Human Factors Management in 2011 to introduce a method to enhance human factors management in train operations. This standard is unique in that it is applicable to both management and employees.

Full implementation of this standard will only be achieved five years after publication. However after three years in the implementation process it appears that there is now a downward trend in human factor related incidents as indicated in the following graph.

The Railway Safety Regulator will conduct a full audit on the implementation of the Human Factors Standard in the first half of 2017 to determine its effectiveness.

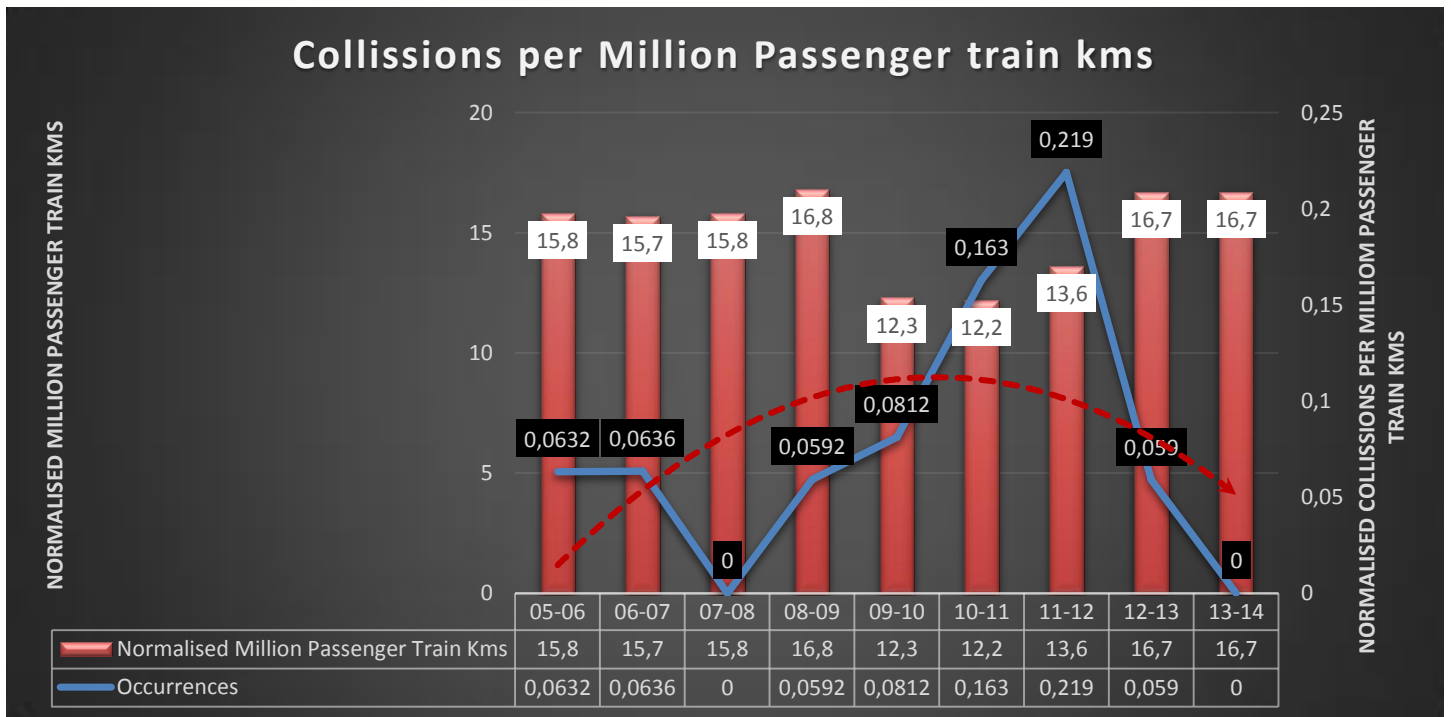


Figure 1: Normalised collision trends

## 1. INTRODUCTION

Traditionally the commuter train drivers were sourced from highly experienced freight and passenger train drivers.

In less than ten years after this practice came to an end in the late 1990's, due to some restructuring of the South Africa rail industry, more than ten rear end collisions occurred on the Gauteng commuter rail network.

In the same timeframe as the accidents, an accelerated training program for commuter train operating staff, including train drivers, was implemented. This drastically reduced the duration of their training period and also removed the practice of train drivers progressing from junior driver grades to the grade of commuter train driver.

Concurrently with this practice, qualified train operating personnel were rapidly promoted to supervisory grades, without receiving sufficient training to fulfil their new role as supervisors to the junior train operating personnel. This had the effect that the operator rapidly lost skills.

Following this spate of rear end collisions, by commuter trains, the South African commuter rail operator requested the South African Railway Safety Regulator in 2009 to facilitate the development of the South African National Standard, SANS 3000– 4 Human Factors Management. This was done in conjunction with the South African Bureau

of Standards, and the South African rail industry. The standard was developed and published in February 2011.

It is a requirement by the Regulator that operators declare in their annual application for a safety permit, the progress made with the implementation of the Human Factors Standard. This process will require five years for full implementation and will be complete by the end of 2016. The Railway Safety Regulator will conduct a full audit on the implementation of the Human Factors Standard in the first half of 2017 to determine its effectiveness.

## 2. DESCRIPTION OF INCIDENTS AND FINDINGS

This paper will provide ten examples of incidents that occurred largely due to poor human factors management. However, the presentation will only concentrate on the three incidents discussed in 2.2, 2.8 and 2.10.

The following rear end collisions can largely be attributed to human factor elements.

### 2.1 Merafe halt

The train accident occurred on 13 July 2005 at 19:16, on a downgrade towards the Merafe halt, where train B collided with the rear of stationary train A during an overhead traction power supply failure.

The train operating rules states that, in the event of a traction power supply failure, all trains affected must come to an immediate halt.

This accident can be attributed to the fact that

- the driver of train B failed to adhere to the standard operating practice of stopping until the traction power was restored, and
- he passed a series of signals at danger, due to a chronic medical condition which he did not declare to the operator. The train driver concealed the facts that he was diabetic; was receiving insulin treatment, and was partially night blind.

A series of internal deviations from the agreed norms and standards with respect to medical surveillance of safety critical grade employees, as well as management's tolerance of sub-standard acts and practices in train operations, were conducive to the occurrence of the accident.

It is unlikely that such an incident would re-occur because the Human Factors Standard mandates the disclosure of reportable medical conditions to management. The standard also requires appropriate action by management.

### 2.2 Pinedene station

Kaalfontein is a mini centralised train control office in Gauteng South, controlling a few stations along the line between Germiston and Pretoria. Its area of authority terminates at Pinedene station. Pretoria North centralised train control office controls the rest of the line. At the time of the incident, Gauteng North and South were functioning as two autonomous regions, their border being at Pinedene station.



**Figure 2: Pinedene rear end collision**

On the 25<sup>th</sup> of June 2006, the negative traction return cables were stolen. These cables are required to route both normal traction return currents, and currents initiating from short circuits, back to the electrical substation. On the 26<sup>th</sup> of June 2006 the 3000V dc feeder cable broke on a splice joint, and fell on the exposed signalling cables next to the railway line. The resulting current was fed back to the Kaalfontein relay room. This caused considerable damage, and knocked out the whole signalling system between Kaalfontein and Irene stations.

This loss of signalling resulted in the institution of “abnormal trains working” where one train control officer issued multiple authorisations, from Kaalfontein station to the first signal, controlled by the Pretoria North centralised train control office, at Pinedene station. This signal was displaying a danger aspect.

Train A was authorised to proceed to this signal. On arriving at this signal, the driver of train A did not succeed in contacting the train control officer at the Pretoria North centralised train control office, to obtain permission to pass the signal that was at danger. This authorisation process increased the workload of the train control officer to unacceptable levels.

By this time the train control officer at Kaalfontein authorised train B to proceed to the same signal, without ascertaining from the train control officer in Pretoria North centralised train control office, that train A had cleared the section. The driver of train B did not “drive on sight” (to drive at such a speed, with your train under control, to enable the driver to stop within sighting distance) as required by the train operating rules. He could not stop in time, and collided with the rear of train A.

The driver of train B contravened the train operating rules by

- not “driving on sight” when authorised to pass the faulty signals, and
- the driver was speeding by exceeding the maximum speed limit of 90km/h on the line by driving at 104km/h.

The wrong method of train control in an abnormal situation was used. This had the effect that the train control officer in the Pretoria North centralised train control office could not cope with his workload. The introduction of speed monitoring and adherence to the correct train operating rules were ignored by management. There was no formal intraface agreement between the two regions, regulating train operations. Six commuters did not survive this incident.

The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices.

### 2.3 Schapensrust station

The Schapensrust to Springs section of line east of Johannesburg is controlled with intermediate block signals, and a signal cabin at Springs station, controlling the station. On 2 Feb 2009 at 16:51, a track circuit failure occurred on the section of railway line between Schapensrust and Springs station. This caused an intermediate block signal, just outside Schapensrust station, to display a 'red' (danger) aspect.

Train A stopped at this signal, as dictated by the train operating rules. The driver of train B stopped at the Schapensrust halt platform. After departing from the platform he passed the intermediate block signal, situated just beyond the platform end, at danger. At the same time, he was being distracted by updating his train journal, and packing his kitbag, as his shift was ending at the next station. He admitted to not wearing his spectacles as is required, when he passed the said signal, and collided with the rear of train A.

In this incident, as in the previously mentioned ones, the train operating rules were contravened by:

- the train driver by passing a signal at danger,
- not wearing his spectacles at all times, and
- being distracted by updating his train journal and packing his kitbag, whilst driving the train.

The Human Factors Standard should prevent this type of incident re-occurring as the person that is easily distracted will not be employed in a safety critical grade.

### 2.4 Wonderboom station

Wonderboom station situated in the greater Pretoria area, is controlled by the Pretoria North centralised train control office. On 8 May 2009 at 17:07, train B collided with the rear of train A at the platform of Wonderboom station.

Train B travelled at a speed of 90 km/h. in a 60 km/h. area and passed the 1<sup>st</sup> signal that was faulty, showing no aspect, without stopping as required by the train operating rules. Furthermore, these rules require the driver to drive his train as if "the next signal could be at danger" when proceeding from a dark signal. Train B also passed the 2<sup>nd</sup> signal at danger, because the driver did not have her train sufficiently under control to stop at the signal that displayed a danger aspect, before colliding with train A.

Again the train operating rules were contravened in that

- the train driver exceeded the maximum allowable section speed and
- not stopping at a faulty dead (dark) signal as required by the train operating rules.

Management also failed to staff the signals department sufficiently. The signals technical maintenance department, at that time, was operating with a 50% staff complement. The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices.

## 2.5 New Era station

The Brakpan to Springs section of railway line east of Johannesburg, has a signal cabin at either end of the line, controlling the stations respectively, with intermediate block signals between the said stations. On 2 January 2011 a rear end collision of commuter train B into goods train A occurred near New Era, on the Brakpan to Springs section.

The day of the accident, a fault affected the intermediate block signals. Train A, which was a light locomotive, followed the operating instructions to the letter. The driver tried to contact the relevant train control officer, when he encountered the dead signals. When he was unsuccessful in contacting the train control officer, the train driver waited the required time period before departing, whilst “driving on sight” to the next block signal, where he repeated the process, as required by the operating rules.

The driver of train B frequently exceeded the maximum speed allowed on the section during this trip. He also passed two faulty intermediate block signals that were dark (at danger). The train driver then passed another intermediate block signal, which displayed a danger aspect. The brakes of train B were finally applied at a speed of 93 km/h when the driver of train B saw train A standing in the section in front of him. Train A was struck at a speed of 61km/h.

The driver of train B contravened the train operating rules by:

- not responding correctly on the dead (dark) signals and the displayed signal at danger aspect, as required by the train operating rules,
- the driver of train B did not “drive on sight”, as required when encountering dead (dark) signals,
- nor did he attempt to contact the relevant train control officer, as required, and
- the train driver did not follow the instruction of waiting for a pre-determined period of time before departing to the next signal.

The staffing levels of the signalling department and supervisory staff in train operations were inadequate.

The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices. It will also ensure adequate levels of supervisory staff.

## 2.6 Alliance station

The Daveyton - Dunswart section of line also east of Johannesburg is controlled by a signal cabin at Dunswart station. On 14 January 2011 a rear end collision occurred near Alliance on the Daveyton to Dunswart section.

Train A departed from Alliance station, situated on this section, and broke down in the section en route to Dunswart station. The driver did not report the broken down train to the Dunswart train control officer, which is the norm. The driver chose instead to report the broken down train directly to the standby rolling stock technician.

Train B departed from Alliance station platform, being authorised to pass a faulty dead (dark) signal. The driver of train B however did not “drive on sight” after passing this signal, as required by the train operating rules. By the time the driver of train B saw train A standing in the section, there was not enough time to stop. Train B collided with the

rear of train A, again because the train operating rules were contravened in that:

- the driver of train B did not “drive on sight” and did not keep his train under control, as stipulated by the train operating rules,
- the driver of train A did not instruct the train guard to protect the rear of his train as required by the train operating rules,
- the driver of train A also did not report the failure of the train to the train control officer but instead reported the failed train to the rolling stock technician.

The staffing levels of the signalling department and supervisory staff in train operations were inadequate.

The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices. It will also ensure adequate levels of supervisory staff.

## 2.7 Akasiaboom station

The whole of the greater Pretoria railway system falls in the area that is controlled by the Pretoria North centralised train control office. On 08 April 2011, a rear end collision occurred when train B collided with the rear of train A, near Akasiaboom station. The driver of train B in this incident passed signal X at caution, and did not bring his train under control to “drive on sight”, before passing signal Y that was at danger, and collided with the rear of train A, which had stopped at signal Z which was at danger.

In this incident the train operating rules were again contravened in that

- the driver of train B did not “drive on sight” with his train under control as required by the train operating rules, after passing signal X at caution, and
- the driver of Train B also passed signal Y that was at danger without stopping.

In 2010, the year preceding this incident, the driver of train B committed several substandard acts as substantiated by the person’s disciplinary record. The driver was appointed in 2001 and drove without incident. Until 2010 when, in a period of 12 months, there were three incidents where the driver passed signals at danger effectively 4 months apart. The frequency of the incidents should have indicated to management that the driver had developed into a high risk driver. Management should have seriously considered removing the driver from the footplate until the issues involved were resolved. The train driver did not survive this incident.

The Human Factors Standard requires management to monitor the employee’s fitness for duty, the employee’s wellness, as well as stress management. It is also required by the standard that the employee discloses any of the above conditions to management. The standard also requires management to constantly monitor the risk profile of employees in safety critical grades.

## 2.8 Mzimhlope station

The section of rail between Mzimhlope and Phomolong stations south of Johannesburg falls in the area that is controlled by the New Canada centralised train control office, controlling some of the stations, with intermediate block signals not controlled by New Canada in the section.

On 19 May 2011, between Mzimhlope and Phomolong, train A failed in front of an intermediate block signal situated

around the bend from the end of the platform of Mzimhlope station, displaying a proceed aspect.

En route to Mzimhlope station, the driver of train B passed the 1st intermediate block signal displaying a caution aspect without slowing down, as required by the train operating rules. The driver of Train B then passed a second intermediate block signal displaying a danger aspect, before coming to a halt at the Mzimhlope station platform. After the driver of train B departed from the platform, he kept on accelerating and passed another intermediate block signal at danger. Shortly after this he noticed train A standing in the section in front of him. He applied the emergency brake and collided with the rear of train A.



**Figure 3: Mzimhlope rear end collision**

Contravention of various train operating rules took place in this incident.

- The driver of train A did not instruct the train guard to protect the rear of his train.
- The driver of train B did not bring his train under control, to stop at the next signal which was displaying a danger aspect when encountering the intermediate block signal displaying an aspect at caution.
- The driver of train B did not stop when he encountered the intermediate block signal displaying a danger aspect.
- The driver of train B should not have departed from the station platform whilst facing a signal at danger.

The driver of train B committed seven disciplinary offences during the previous eighteen months. Several of these offences were for speeding. If management had followed the disciplinary process correctly, the driver of train B would have been removed from driving duties before this incident occurred.

Management also failed to heed his medical surveillance report. Allegedly he was a hyper active, jovial person. These factors placed him in a high risk category that is not suitable for a train driver.

A series of internal deviations by management from the agreed norms and standards, with respect to their tolerance to sub-standard acts and practices in train operations, were conducive to the occurrence of the accident.

It is unlikely that such an incident would re-occur because the Human Factors Standard mandates that management only appoints personnel in safety critical grades with the correct risk profile for the particular occupation. The



standard also requires appropriate action by management, if there is a sudden deviation of the said profile.

## 2.9 Soshanguve station

The whole of the greater Pretoria railway system falls in the area that is controlled by the Pretoria North centralised train control office. On 04 February 2012, at approximately 04:47 between Lebaleng and Soshanguve, train B, en route from Wolmerton yard to Mabopane, collided with the rear of train A.

Train A was stationary in the section after an electrical traction power failure. The train driver of train B passed signal 1 at danger. The driver of train B could not see train A in time to stop the train in the braking distance that was available.

In this incident the following train operating rules were contravened:

- the driver of train B exceeded the section speed limit,
- the driver of train B did not adhere to the train operating rules and point 7.4.1 of the motor coach manual which requires that the driver must stop the train immediately when electrical traction power to the train is lost, and
- the train driver of train B passed signal 1 at danger.

The staffing levels of the signalling department and supervisory staff in train operations were inadequate.

The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices. It will also ensure adequate levels of supervisory staff.

## 2.10 Cor Delfos station

Cor Delfos falls in the area that is controlled by the Pretoria North centralised train control office. On 31 January 2013, train B collided with the rear of train A between Cor Delfos and Kalafong stations.

Due to cable theft, several signals were not working between Cor Delfos and Saulsville, affecting signals 1, 2, 3, 4 and 5.

The day shift train control officer was late for duty and reported for duty around 06h20 instead of the usual 06h00.

The standby train control officer took over the panel as train control officer at 06h14 from the night shift train control officer, when the latter went off duty.

The handover of the panel was not done properly between the night shift train control officer and the standby train control officer - it was not in writing. The standby train control officer then handed the panel to the day shift train control officer, who was late reporting for duty. The night shift train control officer had not yet authorised train A past signal 1. The fact that train A was standing in front of signal 1 was lost in the verbal hand over of the panel.

The driver of train A was not authorised to pass signal 1. The driver of train B was driving at a speed exceeding 20km/h before the accident occurred and was therefore not driving on sight, as required by the train operating rules.

The driver of train B was standing in front of the signal preceding signal 1. This signal operated normally. Due to the

wrong handover procedure, the day shift train control officer was not aware that authorisations only start at signal 1. He authorised train B to pass the signal preceding signal 1 at danger, not realising that the signal was detecting train A, occupying the track circuit in front of signal 1

Except for train B, all authorisations of trains, that morning on the section, affected by cable theft, were done starting from signal 1.



**Figure 4: Cor Delfos collision**

In this incident the following train operating rules were contravened:

- the driver of train B not driving on sight, as required by the train operating rules when passing a signal with an authority obtained from the train control officer,
- the dayshift train control officer did not report for duty at the correct time for a formal documented hand-over of the train control panel, and
- there was no formal handover of the panel between the night shift train control officer and the standby train control officer.

The staffing levels of the supervisory staff in train operations were inadequate. There was a lack of discipline by employees not reporting on time for duty. They were not disciplined for it. There were no supervision of the handover procedures between employees signing on and off duty. This is a critical element of safety in any train control office. The Human Factors Standard prevents management from over burdening an employee and provides an avenue for the employee to object to such practices. It will also ensure adequate levels of supervisory staff.

## 3. CONCLUSION

All of these collisions can be attributed to human factors. Under normal and abnormal working conditions, some drivers don't adhere to, or comply, with the requirements of the train operating rules governing operational speed restrictions or "drive-on-sight" prescriptions. Instances also occurred where compliance to the train operating rules and safe operating procedures in the train control offices were not adhered to, or were not enforced.

In many of the above incidents, the train drivers were found to be young and inexperienced, with very little or poor and insufficient supervision from their supervisors and line managers.

Reportable medical conditions, which have an effect on the ability and proficiency of safety critical staff to perform their duties, are not always reported or disclosed to management by affected staff members. Supervisors and management didn't pick up on these conditions because the necessary controls were not in place. Examples of these reportable medical conditions are diabetes, hypertension and night blindness.

In some instances supervisory- and managerial staff also didn't adhere to sound safety management and disciplinary principles. Staff members, who should have been removed from normal duties, due to health or other high risk factors, were allowed to continue with their normal duties. Train operating personnel, with high risk profiles, were not sent for refresher training or wellness counselling. No investigation or study was done to ascertain why staff, who initially had low risk profiles, suddenly evolved into personnel with high risk profiles.

There is some evidence to suggest that some of the incidents were aggravated by 'driver habituation'. With the earlier generation of colour light signalling currently still in use (also an upgrade program is underway), most of the intermediate block signals automatically display a proceed aspect if the track conditions are clear. Drivers therefore become used to the signals 'always 'being green, and their current level of training and experience does not include measures to ensure that 'abnormal 'circumstances are observed and reacted to. The Human Factors Standard mandates reoccurring training and supervision for safety critical grades.

## 4. CORRECTIVE ACTIONS AND CLOSURE

The South African Railway Safety Regulator has been instrumental in creating a Human Factors Standard. This standard addresses most of the circumstances and conditions, which could adversely affect the capability and proficiency of safety critical grades in performing their duties.

The Human Factors Standard, as introduced to the South African rail industry, focusses on:

- the recruitment process for safety critical- and other grades,
- their initial training and subsequent refresher training,
- their supervision,
- their medical surveillance,
- fatigue management, and
- other human factors elements that should be managed.

It is a requirement of the South African Railway Safety Regulator that all railway operators declare, in their annual application for a safety permit, the progress made with the implementation of the Human Factors Standard. Full implementation will only be achieved after 5 years, at the end of 2016.

Implementation and enforcement of the Human Factors Standard are monitored by the South African Railway Safety Regulator when doing special- and/or routine safety audits and/or inspections of railway operators.

The South African commuter train services operator has installed and commissioned several train simulators in South Africa. They will be used for the initial training of trainee drivers, and for refresher training for existing drivers for both normal and 'abnormal' circumstances. The Human Factors Standard mandates refresher training after every twenty four months, or after six months of not driving a train. The standard also accepts a Continuous Program for Learning as implemented by the South African Freight rail operator, after consultation with the German operator. The South African Railway Safety Regulator is in the process of developing a licencing system for all railway safety critical grades, based on the Office of the Rail Regulator, European and local industry standards.

As a result of frequent audit and inspection findings by the Regulator, it was established that little formal training and development of supervisory staff is available for supervisors. The operator has developed and implemented a formal training and development program for section managers. This program specifically targets the first line supervisors for the train operating staff, and will go a long way in creating and preserving new and existing railway safety knowledge within the organisational structures of the operator.

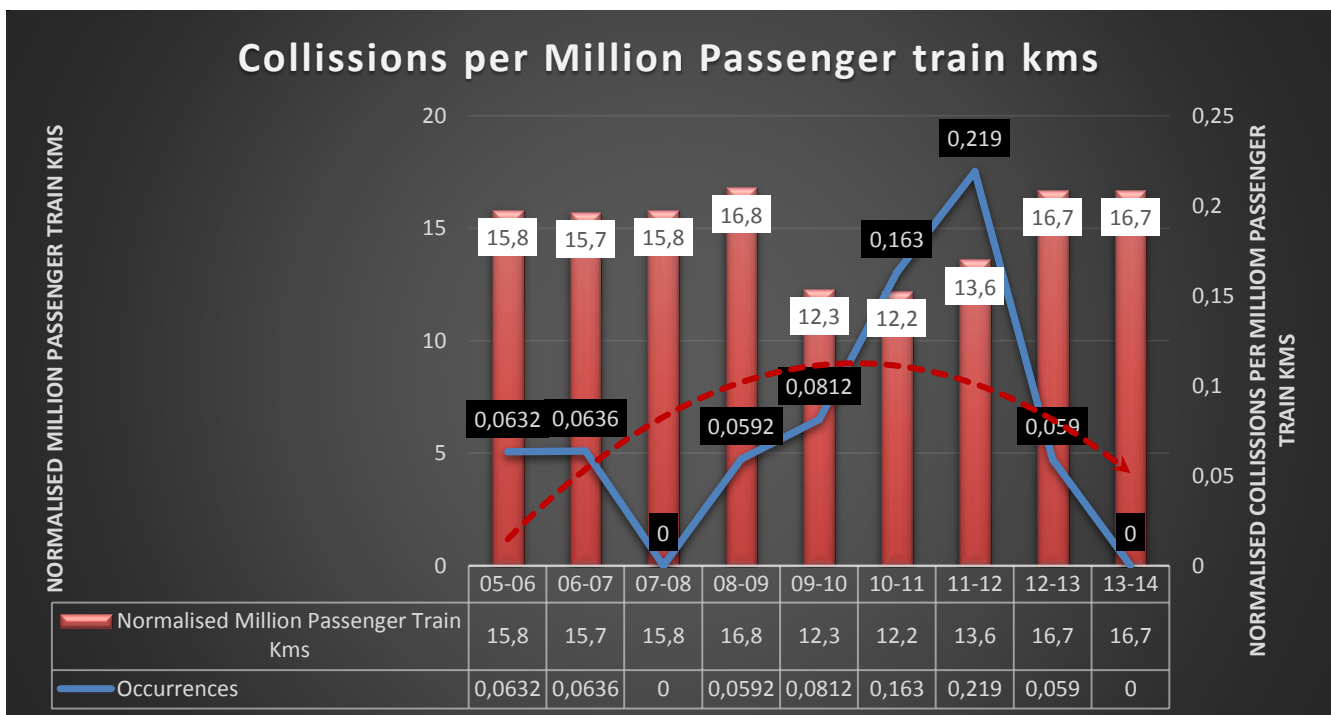


Figure 5: Normalised collision trends

The South African Railway Safety Regulator can report that, since the introduction and implementation of the Human Factors Standard, it appears that there is a positive downward trend to the occurrence of rear end collisions. It is expected that operators will develop and preserve the critical safety skills which are rapidly diminishing, by fully implementing, and adhering to the Human Factors Standard. This expectation will be verified, by conducting a full Human Factors Standard audit on the commuter train operator in Gauteng.