

FACTORS THAT CAUSE ENGINE FAILURES ON DIESEL LOCOMOTIVES

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1. Abstract

The aim of the research is to find the factors that cause engine failures in diesel locomotives within Transnet. The research will focus on the diesel locomotives in the region of Thabazimbi and Pretoria. Diesel locomotives need to be in good working order for them to be able to haul goods for the growth of the economy. The company must deliver everything on time according to customer demand. The failures affect the company financially: they have to repair the engine, which costs about R1.2 million to rebuild, and a new engine costs R 3.2 million. Corrective actions play an important role in coal transportation. Reliable engineering and maintenance ensures that the product is always available. Reliability is known as the probability that an item or device can perform the required functions without failures for a specific period of time. Maintenance and reliability engineers should know all the techniques to solve engineering issues.

The research shows that the company had the same problem as China and Ukraine. The failures were caused by maintenance that was not done properly on the diesel locomotive. The company has a maintenance strategy that they used on the diesel locomotive. It was found that the major cause of engine failures was using the wrong type of cylinders on the 39 200 class diesel locomotive. The 39 200 class uses millmille cylinders, not chrome cylinders. These cylinders differ from the usual material used to make cylinders. It was found that most artisans and the logistics department did not know which cylinders were supposed to be used on the 39 200 class diesel locomotive. The locomotives were newly built in South Africa, but not all the artisans, planners and trade hands were aware of the different cylinders used on the locomotive. The reliability and maintenance engineers, including the logistics department, have to work together in purchasing new material by making sure the specifications are clear to the supplier. The company had to do root cause analyses because they wanted to be competitive in the railway industry. The company should increase resources in the Thabazimbi depot to avoid locomotives having to be hauled to Koedoespoort owing to the insufficient number of artisans and trade hands they have at Thabazimbi. The workshop in Thabazimbi should do all the lifting work required on the locomotive, change radiators, change out compressors and change out cylinders.

Key words: diesel engine of locomotive, reliability, availability, maintenance

2. Introduction

The 39 200 class diesel locomotives have a computerized screen same as the new electric locomotives, compare to the old diesel locomotives. They can operate electronically and are easy to maintain. The electronic controls, auxiliary systems, and braking systems are almost the same as the new electric locomotives. The latest diesel locomotive produces about 35% of the power of an electric locomotive of similar weight (Transnet, 2014).

Most failures are due to maintenance, malfunctions in the engine and material used in the engine (Transnet, 2014). The fleet has 50 diesel locomotives in the region. However, Transnet has only two artisans and two trade hands working in that region. Normally, if there is a lot of maintenance needed on locomotives, Koedoespoort diesel depot will assist since it is a main depot. Whenever a locomotive needs to be hauled to Koedoespoort because of failures that needs serious attention it affects the train schedule. Transnet ends up reducing the number of wagons that haul coal, from Thabazimbi to Lephalale. The train spends a week standing while waiting to be moved to main depot because normally the train from Thabazimbi to Pretoria it's set to pull a certain load.

The unavailability of diesel locomotives results in trains being cancelled in the Thabazimbi region. The weather in Thabazimbi and Lephalale is very hot, but the diesel locomotives are expected to work in all seasons and haul the same loads. Exxaro mine is the main customer in Lephalale, producing coal that gets transported to the harbour in Richards Bay. The train schedule needs 12 diesel locomotives daily to run in the region, although some will be due for service. The train schedule requires four diesel locomotives to haul 100 wagons of coal per train.

Figure 1 shows the diesel locomotive, and Figure 2 illustrates the engine of the diesel locomotive on which the research will be based. The diesel engine in the locomotive drives the main alternator to generate electricity, which powers the traction motor to make the wheels turn (Park, 2012).



Figure 1: Diesel locomotive (Transnet, 2014).



Figure 2: Engine of diesel locomotive (39 200 class) (Transnet, 2014)

In China 60% of diesel engine locomotives fail because of malfunctions and poor maintenance. The condition-based maintenance is regarded as a major cause of these failures. The failures occur in the body of the engine, cylinders, pistons, and crankshaft (Zhang Z, 2012).

Diesel engines are a fault-prone part in the diesel locomotive that always breaks in different seasons (Zhang Z, 2012). The failures differ in summer and winter owing to the influence on operations of different weather conditions.

It was found that the reliability of the components within the engine of the diesel locomotive is 66% in India (Gautam, 2013 and Ranjan, 2014). Lithuanian railways experienced 58% of engine failures in the diesel locomotives during 2013, owing to structural, technological and operational defects (Lingaitis LP, 2014 and Lebedevas, 2015). In Poland it is estimated that 65% of diesel engines fail because of severe weather conditions, and in Ukraine maintenance and failed operation affect most companies because they do not follow a maintenance plan (Merkisz, 2012 and Lingaitis P, 2012).

The diesel engines' reliability and durability can only be increased if their technical condition is constantly monitored as failures require time and material (Lingaitis LP, 2012). In winter starting up diesel locomotives at low temperatures increases the wear around the crankshaft (Lingaitis LP, 2012). Reliability engineering can help by applying good techniques and knowledge to avoid frequent failures (O'Connor, 2012). It helps with the identification and correction of those failures, and determines the ways of managing them (O'Connor, 2012). Reliability engineering is responsible for identifying the methods that can be used to analyse reliability data on locomotives (O'Connor, 2012 and Valis, 2014), and can help with the maintenance and operations optimization decisions on the locomotives (Valis, 2014).

The industry is critical because of the operation process, which involves certain individuals with special skills. Everyone who works in this industry needs to be trained and tested to work in it. The locomotive business requires good maintenance plans to ensure proper operation of the business. Transportation is seen as the most important business when it comes to the economic development of each country (Yaghini, 2012). Diesel locomotives have been produced in many countries for the same economic reasons. They operate better in hard weather conditions compared to electric locomotives, and have more power, which is needed for the difficult gradient from Lephalale to Thabazimbi. However, we must consider the question of how to improve the reliability of the engines on the diesel locomotives. The failures might be caused by the weather or other hard conditions the locomotives are working in.

3. Results on the analysis

The results were based on the 39 200 class diesel locomotives that operate between Thabazimbi and Lephalale only. Availability target is 90% per day that is set by the company, taking in consideration the planned maintenance. Transnet had poor availability from 2013 to 2014 according to Figure 3. They introduced Pareto analysis by looking at the highest failures that cost train delays. The availability started to pick up early 2015 and the data was collected until September 2015. The maintenance and reliability engineers found that the depot was using wrong material on the 39 200 class locomotive because they artisans were not aware of the difference between chrome and millmille cylinders. Figure 4 shows the highest failures on the diesel locomotive.

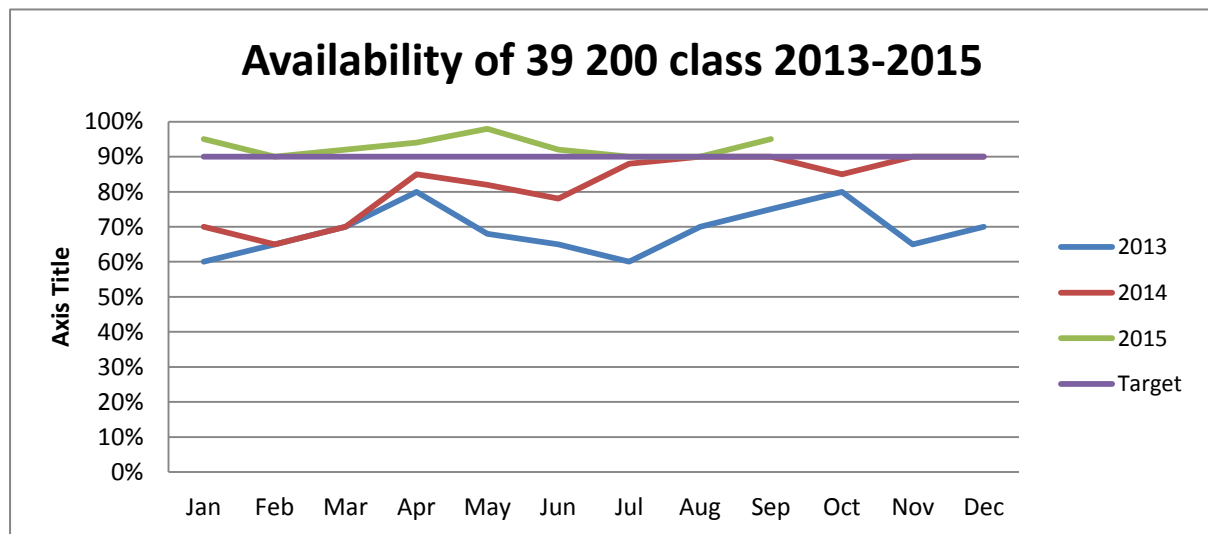


Figure 3: The availability graph of 39 200 (2013-2015) (Transnet, 2014)

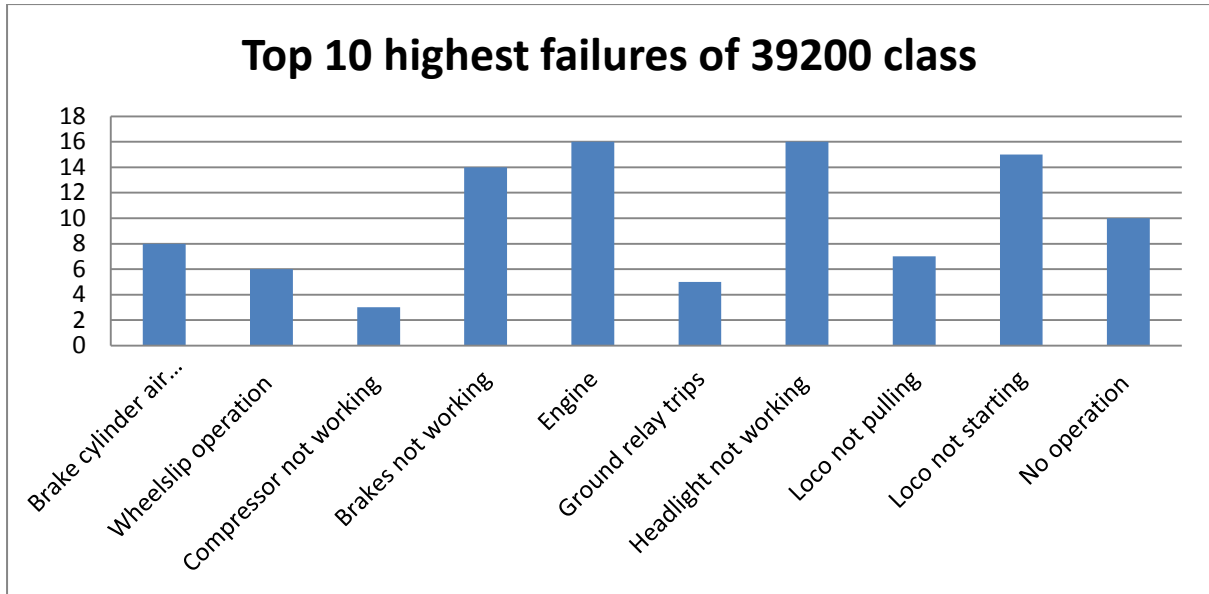


Figure 4: Top 10 highest failures of 39 200 class (Transnet, 2014)



Figure 5: Diesel engine cylinder

Figure 5, illustrate the wrong type cylinder that was used on the 39 200 diesel locomotive. The millmille and chrome look similar but two cylinders are engineered with different material. It was found that it caused a lot of engine failures on the diesel engine locomotives. Some locomotives failed after scheduled maintenance that affected locomotive availability.

Early returns are locomotives that came back within a week after the scheduled maintenance. Normally it is due to maintenance done by the workers, or things that were impossible to notice during the planned maintenance. Figure 6, shows how many locomotives failed from 2013-2015 each month. It shows high failing rate during a year of 2014.

Shortage of resources and material at Thabazimbi was one of the contributing factors for early returns. The personnel were not able to do all the works due to the time constrain.

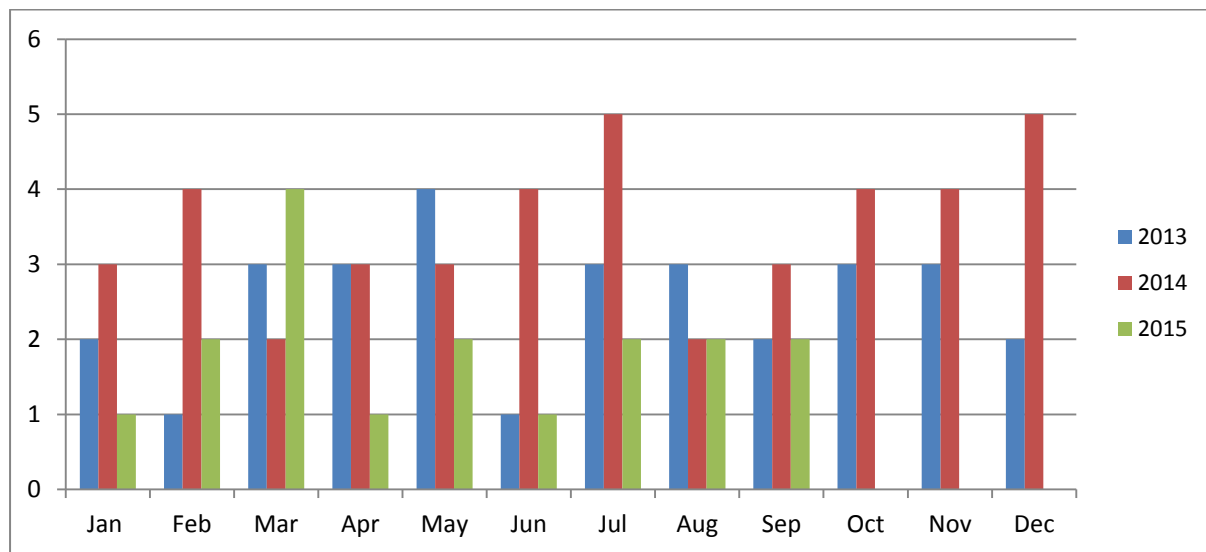


Figure 6: Early Returns 2013-2015 (Transnet, 2014)

4. Discussion

The unavailability of diesel locomotives results in trains being cancelled in the Thabazimbi region. This kind of service creates a bad image for Transnet with their customers. The weather in Thabazimbi and Lephalale is very hot, and the diesel locomotives are expected to work in all seasons and haul the same loads. The Exxaro mine is the main customer in Lephalale, producing coal that gets transported to the harbour in Richards Bay. The train schedule needs 12 diesel locomotives daily to run in the region, and other locomotives are due for service. The train schedule requires four diesels to haul 100 wagons of coal per train.

The research objective is to find out the factors leading to failures within the diesel locomotives, specifically the engine. The research is based on the 39 200 class diesel locomotive diesel locomotives that operate between Lephalale and Thabazimbi is situated in South Africa. The study will provide the company with information that can be used on reliability and maintenance management to solve problems within the company. The research question was applied in China, India, Ukraine, Poland, and Lithuanian diesel locomotive. In China 60% of Diesel engine locomotive fail due to malfunctions and maintenance. The malfunctions of Diesel locomotive Diesel locomotives can occur in different seasons. Major causes of the malfunctions include the inexperience handling, excessive loading, environmental and careless operation (Bose, 2013). In Lithuania railway most Diesel engines locomotives failed due to tons they pull and the distance they travel (Gelumbickas, 2014). The percentage of engine failures increase normally when 2000 tons of consumed fuel is reached and it increase from 30% to 100% (Gelumbickas, 2014). The Diesel engines fail due to severe weather conditions in Poland, with the estimation of 65% and in Ukraine maintenance and operation affect most companies because they don't follow maintenance plan (Merkisz, and Lingaitis P, 2012). Diesel locomotives experience high failures on engines due to mileage they travel in Lithuania.

The 39 200 class diesel failed due to wrong type of cylinders that were used on the engine. It was something related to maintenance, maybe the specification was not clear to the logistic department. China and Ukraine had the same problem, whereby the failures were caused by maintenance. The maintenance department did not follow the maintenance plan accordingly and some locomotives in Ukraine were too old, they were changing components due to the condition. It is very important to specify which components and brand should be used especially on engines to make sure they are reliable. These failures could have been avoided if it was clear, to all the users, logistic department and maintenance department.

5. Conclusion

Transnet had the same problem as China and Ukraine the failures were caused by maintenance that was carried on the locomotive. The condition based maintenance is regarded as one other major causes these failures in China (Zhang Z, 2012). The engineers had to improve the maintenance strategy to make the diesel engines more reliable. Ukraine trains were too old, out dated and they were repairing most locomotive under preventative maintenance (Gorsky, A, 2012). According to the data collected the maintenance strategy used within Transnet diesel locomotive is very good and it's working for the company. The maintenance engineers needs to review, improve the strategy whenever they had a new locomotive. The 39 200 locomotive it was a first locomotive that was built by Transnet after 3 decades, the company was supposed to review the strategy. The logistic department plays an important role in the planned maintenance of the locomotive, they should always make sure all the required components they are available to release locomotives in time.

These are major factors that caused failures on the 39 200 diesel locomotive engine:

- It was found that the major cause of engine failures it was due to wrong type of cylinders used on the 39 200 class diesel locomotive. The 39 200 class uses millmille cylinders not chrome cylinders. They cylinders differ from the material that is been used to make the cylinder.
- According to the questionnaires it was found that most artisans, logistics department were not aware of which cylinders supposed to be used on the 39 200 class diesel locomotive. The locomotives were newly built in South Africa not all the artisans, planners and trade hands were aware of the different cylinders used on the 39 200 diesel locomotive.
- Thabazimbi depot not having enough resources to perform maintenance on the locomotives to avoid locomotives to be hauled to Koedoespoort (Pretoria) depot.

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