The purpose of this article is to present the tool of analysis of failures in locomotives of the Estrada de Ferro Vitória a Minas (EFVM). The focus of the work is the locomotive reliability improvement reached through the reduction of the failures number. This reduction is reached through the application of a methodology of evaluation, systematization and prioritization of functions of the several systems of the locomotive. The result of work is the delineation of the main operational systems locomotive. In this case, the presented system will be of air admission system.

Keywords: Productivity, Reliability, Failure Analysis, Locomotives.

INTRODUCTION

The EFVM is a rail road with 905 km length, metric gauge, has a 276 locomotive fleet (152 GE), approximate 16,000 wagons. The iron ore is the most representative product transported representing 75% of the railroad production estimated in 140,000,000 tons per year.

OBJECTIVE

Increase EFVM locomotive reliability through the reduction failure number presented in the Air Admission System.

PROBLEM DESCRIPTION

Currently, the demand for high performance of the companies in general, also of the railroads, demands to carry through each time more, with each time little resources. This means to say that the necessary equipment for the consolidation of a process must have a raised availability, being the direct consequence and the high reliability.

To reach these objectives, the maintenance must change from being reactive and begin to establish a more pro-active position. Focusing on the continuous improvement of its processes and, mainly, the deep analysis of the equipment, the indicated tool in this scenario is the failure analysis, that has for primordial objective to quickly identify the root cause of a failure, supplying given quality tools and objectifying the blockade of the root cause.

BOUNDARY CONDITIONS

The following definitions are necessary to support the paper structure:

This paper has focus on the Air Admission System;

The system studied is the conventional turbo charging system, used in the GE locomotives;
The used data is collected in the maintenance system on a 7 month period.

MOTIVATION

A single part can fail for dozens of reasons. A group of parts or a system, such as air admission system, can fail of hundreds of reasons. For locomotives, the number can rise into the thousands.

Most managers shudder at the thought of the time and effort likely to be involved in identifying all these failure modes. Many of them decide that this type of analysis is just too much work, and abandon the whole idea entirely. In doing so, these managers overlook the fact that on a day-to-day basis, maintenance is really managed at the failure mode level. Proactive management on the other hand, means dealing with events before they occur. In order to do this, we need to know beforehand what events are likely to occur. The "events" in this context are failure modes. So if we wish to apply truly proactive maintenance to any physical asset, we must try to identify all the failure modes which are reasonably likely to affect that asset. Ideally, they should be identified before they occur at all, or if this is not possible, before they occur again.

PROPOSAL SOLUTION

The first step in the analysis of the Air Admission System is the determination of inputs and outputs. So that you understand its exactly function in the locomotive.

![Air Admission System Boundary Definition](image1)

In the studied system the turbo charger is the main component and the most complex. Therefore its inputs and outputs had been also analyzed.

![Turbo Charger Boundary Definition](image2)

To have the complete notion of how the Air Admission System works the elaboration of the System Diagram is necessary. This diagram allows the visualization of the function of each part in the system.

![System Diagram](image3)

After the elaboration of the System Diagram it is necessary the Function Diagram developing, that has for purpose to demonstrate the main functions of the chosen system. A basic division is made between primary functions, which are indispensable for reach the function of the system, and secondary, that by itself, they don't hinder the functioning, but affects the income and reduces the useful life. The FMEA (Failure Modes and Effects Analysis) identifies the main failures modes and its effects what letting us to take preventive actions.

![Air Admission System FTA](image4)

Figure 4 – System Diagram

1 - surrounding air
2 - filtered clean air
3 - clean/filtered/compressed/warm air
4 - clean/filtered/compressed/cooled air
5 - clean/filtered/compressed/cooled lead air
6 - dispersed gas of exhaustion with high energy
7 - gas of exhaustion lead with high energy
8 - gas of exhaustion with low energy

![Air Admission System FTA](image5)

Figure 5 – Air Admission System FTA

THIS FIGURE MISSING IN PUBLISHED PROCEEDINGS
Figure 5.a,b,c – Axial Deformation
FTA Part
The figure 6, shows the most significant failure causes already identified in the tree. This data has been collected in the maintenance system, and confirm that with 4 root cause we can eliminate 87% of the air admission system.

To increase the performance, the FMEA may be used to help finding the root cause of a determinate fail or system. The air admission system FMEA is not presented in this paper but was used in other systems during the initial studies.
FINAL CONSIDERATIONS

The methodology used in this paper is widely accepted and recognized as the best way to improve reliability of complex machines such as airplanes, special equipments and locomotives. The Air Admission System is not the most complex system of the locomotive but the methodology can be easily extended to others systems.

After the studies, where other systems were studied with the same intensity, we achieved a better comprehension, with the technicians, about the importance of the correct system data input and the relation between all the locomotive systems. By now, it’s impossible isolate the results only from the air admission system, but the increase in the MKBF fleet is about 52% after the analysis beginning.

REFERENCES

