Application of Technical FMECA (Failure Mode and Effect Analysis) in Roller Bearings for Freight Car

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Summary: The railway is one of the sectors of greatest growth in Brazil. Today the market demands precision for the arrival time of their products, besides increasing the reliability with which the load is carried. There are the environmental concerns, where the impacts of the operation of transport should be minimized managed by minimum standards focused on governmental guidelines. This requires the railway companies a pro-active in trying to improve the planning through techniques and technologies more current. One of the key to improving the planning rail, as it pertains to the operation of its assets, is the use of tools for managing and disposing of failures. The bearing is one of the items at significant cost and difficult to identify failures. Therefore, this study proposes the use of the tool FMECA (Failure Mode and Effect Analysis) for analysis of bearings in rail wagons, one of the critical components of active rail freight. With the results we can conclude that the FMECA can be used for a study of data for the study of failure of this component, and can be applied to other equipment, trying to improve the process of maintenance, to ensure that will meet the expectations of the customer.

Index Terms: FMECA, rolling tapered bearings

1 ABOUT THE BRAZILIAN RAILROAD

The Brazilian railroad presents an increasing demand in its production in the load transport with growth of 76% in the same period.

The MRS Logistic a company of the railroad branch in the private sector since 1996 located in the Southeastern sector of Brazil presents a significant growth. We can verify a growth of 37.5% in the production, leaving of 51 million tons carried in 1997 the 135 million in 2008.

Had to this promising prognostic, the railroad system must be prepared to keep the level of in agreement service the planned one, becoming this way of transport to be one of most competitive of the world-wide scene. The increase of the trustworthiness of its assets, the fulfillment of the transport stated period is common requirements nowadays of the customers who use this service. Knowing that the railroad system is composed of some different components, must be had in the guideline of the management quarrels the possibility of centralization of efforts in most critical, has seen that the market determines high cost of the capital for investments and defrays.

2 USE OF THE FMECA IN TAPERED ROLLING BEARINGS

2.1 Introduction

Certainly that the asset plays its function is important, to determine clearly what it will have that to carry through and also to assure that it is capable to play this task. An imperfection is an occurrence where the component is hindered to play the function the one that it projected or was waited. With this it is clearly that the goal of the maintenance is the treatment and the management of the imperfections, and for this management the identification is necessary of that type of imperfection can occur, its effect and which its gravity. The FMECA-Failure Mode, Effects and Criticality Analysis analyzes in a systemic way which the possible ways of imperfections that can occur, identifies which is the causes and effect that these imperfections can generate; it prioritizes, that is, it shows which are the imperfections most critical inside of a process and serves of a reference’s technician, a filed time can be generated for consultations.

The reasoning of the FMECA is of low for top, that is, is looked to determine the different failure modes of simpler components, verifying as the effect of these imperfections
affect the superior levels they. The main applications of the FMECA are:

- Decrease the probability of occurrence of imperfections in products, that still are in the phase of projects;
- Reduction the imperfections in products and processes that already are in functioning;
- Increase the trustworthiness, that is, to also reduce the imperfections of the products or processes that already had occurred, through the description of the imperfections;
- Reduction of the risks of imperfections and errors in administrative services. This work considers the use of tool FMECA (Failure Mode and Effect Analysis) for analysis of tapered rolling bearings of railroad freight wagons, considered as one of the components most critical of the components of rolling material. This tool of analyzes of can generate decisions of management and monitoring of these causes in order to reduce rework, to increase the trustworthiness of the components consequently and its security.

2.2 Concept

Like Sucena [1] the FMECA is a method that analyzes systematical and qualitatively all the possible potential ways of imperfection of a system, as well as identifies the resultant effect of such imperfections on the system.

In this section the necessary steps for elaboration of a FMECA will be presented. Figure 01 shows a flowchart with sequence of the necessary steps for elaboration of a FMECA.

![Figure 1 Steps for elaboration of FMECA-Sucena 2008](image)

**To define the system and its requirements**

This step is important to define the level of analysis of the imperfections, that is, which system that will be being considered. It is important to define which or which components will be analyzed, to characterize the macro-functions of the system and its interfaces, through plants or diagrams, projects etc. It is important also to define the standards of performance and efficiency.

**To analyze the system functionally**

In this stage the detailing of the function of the system is important, as well as decomposing the functional block-type systems and defining the functions of same and the existing resources. Through the detailing of function it is that it can be understood as they are the entrances and exits of the analyzed system, which controls that limit the form of execution of a function, what it is necessary for the desired execution of this function and results.

**To define failure modes, to determine the causes of failure, to determine the failure effect**

The failure mode is an event where the components or equipment leave to carry through the function in which they had been established inside of operational standards or project. The potential way of an imperfection, inside of a system can be cause in one another failure mode in a superior level or effect of an inferior level. This step is important to not only identify the potential failure modes in the component, as in inferior or superior levels and also in the operation of the system.

This phase establishes the process analysis or product of form to identify which is the causes in the failure modes cited in the previous step. A good tip and that it can be used is the diagram of cause and effect (Ishikawa), listing a cause/mechanism that can cause the failure mode.

In this stage it is important to define which are the failure effects. To determine the effect, it is important to answer the questions as what it occurs if to happen the failure mode, which consequences the user/customer will be able to suffer.

**To identify the half ones to detect the failure**

In the FMECA of project, these half ones are controls that exist, to prevent or to reduce and until controlling the failure modes. When it speaks in FMECA of project, these ways of controls are ampler as indicating, equipment of measurement or procedures of verification that will go to result in the detention in the failure modes.

**To define Severity, occurrence and gravity in the failure modes**

Severity or gravity is a parameter that determines which the level of the effect or impact in the failure mode. It is also the consequence of the gravity of the failure effect af-
fects the customer. To define the frequency the probability is necessary to analyze which with that the failure mode will be able to occur. It is a estimate in which the cause of the imperfection will be able to result the type of imperfection and are attributed numerical values for analysis. Then which must be defined the probability in a failure mode to be detected before it occurs in the system level, that is, before it arrives at the customer.

To analyze the criticized in the failure mode

The criticality of a component that composes a system is a measure of. Also called risk index this criticality it is calculated by the product of the detention and severity, occurrence rate and is called RPN (Risk Priority Number), then, RPN = Index of SEVERITY X INDEX of FREQUENCY X detention INDEX. How much bigger this index of risk, more must have priority the treatment of the imperfections having a priority on the same one.

A definitive time all the steps, these information are placed in a table, where they are stored the data.

These actions must be registered of clear and objective form. An action plan can be elaborated so that the actions are lead.

The table below shows the FMECA already filled after all the steps to have been followed, Figure 2.

![Figure 2 Picture form of the FMECA](image)

<table>
<thead>
<tr>
<th>Component</th>
<th>Severity</th>
<th>Frequency</th>
<th>Detention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tapered Rolling Bearings</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

2.3 Use of The FMECA in Tapered Rolling Bearings of Freight Wagons

The acquisition, the assembly and the maintenance of railroad bearings require relative annual costs for a load railroad. Beyond possessing high initial costs, the bearings are critical in relation the operational security. Good thus practical of maintenance and study of tools for reduction of imperfections in this component they are essential. According to management of maintenance of wagons of the MRS Logistics, even so the cost of maintenance of a rolling to be approximately 5% in relation the recovery of a wagon, accidents that involve derailment, whose cause is the imperfection of the rolling, bring as main consequence material damages for the railroad transport, reliable of the security operational, interruption of the traffic and raised cost for the company for not producing. Moreover, the ambient impacts are aggravations, therefore they bring high risks and threat the collective life, promoting still of infraction to the laws and ambient resolutions high. Graph 1 shows the quantitative one of accidents.

![Graph 1 Accidents cause fail roller bearings](image)

In this function, the MRS Logistics S / A components installed at strategic points in your mesh in order to prevent failures before they occur, using detectors temperature kind of hot-Box, and an equipment for monitoring of trends of faults, developing a predictive maintenance of bearings, called Rail BAM. The hot-box measurement system temperature of the bearings of wheel-set of wagons and locomotives, by detecting infrared radiation emitted during the passage of the train. The sensors are mounted at strategic points along the track and event is detected above the heating pattern is generated a warning voice, transmitted via radio to the driver. At the same time it is sent to a central computer located in the OCC (Operational Control Center), a file with all measurements made in the composition, indicating the direction of travel, the position of the wagon, the temperature of the bearing axis. This information is stored in databases for further consultations.

The unit for receiving data is installed on OCC, and has the function to the processing of measurements made in the field. If you have any temperature outside of the parameters, it generated an audible and visual alarm to the operator to identify which is the severity of the disorder by contacting the driver. Rail BAM The system consists of acoustic sensors that monitor the failure of bearings through a pattern already established (microphones) that are within a cabinet, which has an automatic opening, are activated immediately after the passage of the composition by sensors that identify the approximation of the train. Within this cabinet (cabinet), is also located a hard disk so that all data are stored and are sent to the central unit in the CCO.
Alarms of Hot-box are important for prevention of accidents on the network, but generate non-scheduled stops in the operation, which once alarmed is required to check the train stopped. This creates loss of time to deal with loss of operational efficiency.

Therefore, the wheel-set, was removed after only sent to shops and made the repair of this component. Once the FMECA was carried out to verify the occurrence of alarm system sensors of the railroad and for analysis of accidents, spills of grease and other defects found in the inspection field. The use of FMECA for analysis of failures of bearings or other bearings alarmed that failed. The standardization of faults found, and a study of possible causes of maintenance developed by the team led the table (the table above FMECA) assisting in the taking of actions necessary to prevent or reduce the effects of heat generated by rolling, loss of grease or other defects found in the field that generate operating losses and downtime.

The team developed a report of receipt of the inspection is analyzed wheel-set where all defects and failures encountered and identifying the possible causes of wheel-set. This information feeds a database which identifies the causes and measures are taken to reduce the deficiencies found. The chart below shows the main causes of the bearings removed by heating.

3 CONCLUSION

The tool of analysis of the failures FMECA is a powerful tool in the analysis of events serving as guidelines for what actions should be taken to reduce anomalies.

The failures were analyzed and found not to support the verification of sensors on the same assertiveness.

Furthermore this information may be used in future to calculate the reliability of the bearings by means of tools can calculate the ideal time in periods of time for withdrawals from scheduled maintenance of the bearings.

REFERENCES


