

HOT BOX DETECTION SYSTEMS AS A PART OF AUTOMATED TRAIN OBSERVATION IN AUSTRIA

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Due to the ongoing remote control in signalling technology train observation by employees is reduced at traditional locations e.g. place of a station manager. The Austrian Federal Railways (ÖBB) Infrastructure Operation Company has recognised this trend very early. Several years ago, they started the construction of a wayside detection system to control the temperature of passing trains because of the increasing discontinuation of station managers doing the observation of boxes and brakes. Outcome of this research and development activities is the hot box detection system TK 99 of the HOA-group at Infrastructure Service in the Infrastructure Operation Company of ÖBB which is used in the railway network of Austria over one hundred times at the moment. If an ineligible heating of a box or a brake is not discovered early enough, lubricating grease in the box will lose its function and a break-down of the box would follow. Thereby, inhomogeneous loads per axle are possible which can lead to a derailment of the boogie. Economic efficiency of a wayside hot box detection system can be demonstrated in comparison with the costs of prevented derailments.

1. Introduction

The ongoing withdrawal of station inspectors from the field means a drawback on the organizational and technical level for the system of railway operation. The original function of a station inspector was being the safety part of the operation, i.e. setting routes. For this task, there were aids since the very beginning of the railway: as the first design of a signal box the dependencies between signals and points were shown by means of mechanical obligations. The development led via push-button signal boxes to the electronic signal boxes which are common practice nowadays in most European countries.

Over the years more tasks for the station inspector were added, that led even up to ticket sales. A significant function has always been the monitoring of the passing trains. This important task was also fulfilled by other personnel working along the track, e.g. block posts and so on. These functions became replaced over the years by the evolving signal box technology. With the passage of a train primarily the presence of the train-conclusion-board is examined, as well as apparently recognizable irregularities, as for instance overheated axles.

Particularly experienced station inspectors can recognize by the sound of the rolling wheels out-of-roundnesses or flat spots. Moreover, loose tarpaulins, exceeding the vehicle circumscription profile, can be seen by a station inspector. But there are also train-characteristics, which are impossible to be examined on an optical and/or acoustic basis. Similar problems arise when wheel loads and/or wheel pressures have to be evaluated. Only substantial overload conditions can lead to visible deformations of the car construction. Unfortunately, loading conditions can already lead to derailing and/or tearing up the lead to derailing and/or tearing up the train before they become visible. Due to the restructuring of operating structure also checking of the passing trains at the commercial stations is decreased,

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and a call for action exists, since these functions must be taken over now by technical systems to guarantee at least same safety as usual before.

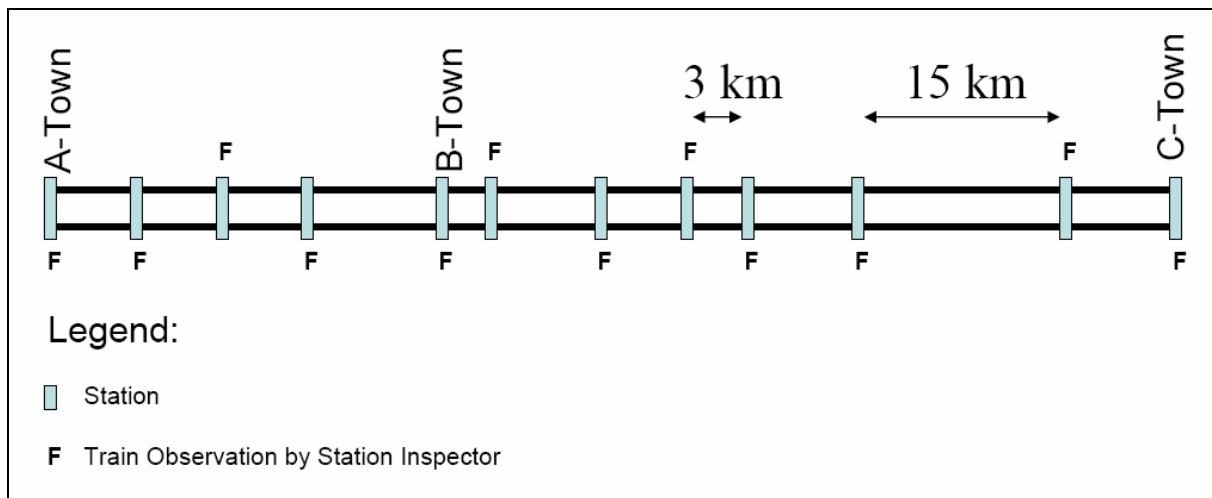


Figure 1. Train observation on an existing line with sedentary staff at stations

On an existing line the locations of station inspectors are as a traditional rule distributed on both sides of a track (Figure 1). Due to the restructuring process in signaling technology the even distribution is sometimes disturbed. Also the distance between two observation points can vary from 3 to almost 15 or more kilometres. One of the first irregularity if train observation is reduced, is an increase of derailments caused by hot boxes. So, therefore, it is necessary to develop a technical solution to control temperature of boxes of passing trains.

2. Technical Solution for Hot Box Detection

The Hot Box Detection System used in Austria by ÖBB Infrastruktur Betrieb AG consists of the following elements:

- Track-side equipment (scanners)
- Evaluation and control unit
- Data transmission equipment
- Visual display unit

The track-side equipment includes (Figure 2):

- The control and evaluation electronics accommodated within a cabinet
- The rail fastened measurement equipment with infrared sensors to record axle box and wheel temperatures and axle counters.

Two hot box detection sensors, one provided at each side of the track, measure the axle boxes, thus, meeting the requirements of UIC 501 and the new version of the TSI Infrastructure. Simultaneously with the scanning of the axle box, a hot disk detection sensor scans the temperature of the disk brakes. A hot wheel detection sensor measures the temperature of the wheel flange to detect critical temperatures of blocked brakes. Visualization of the results from measurements is possible on a customary PC with WINDOWS as operating system. Moreover, all data transmitted from track-side equipment, can be stored and if necessary exchanged to other systems.

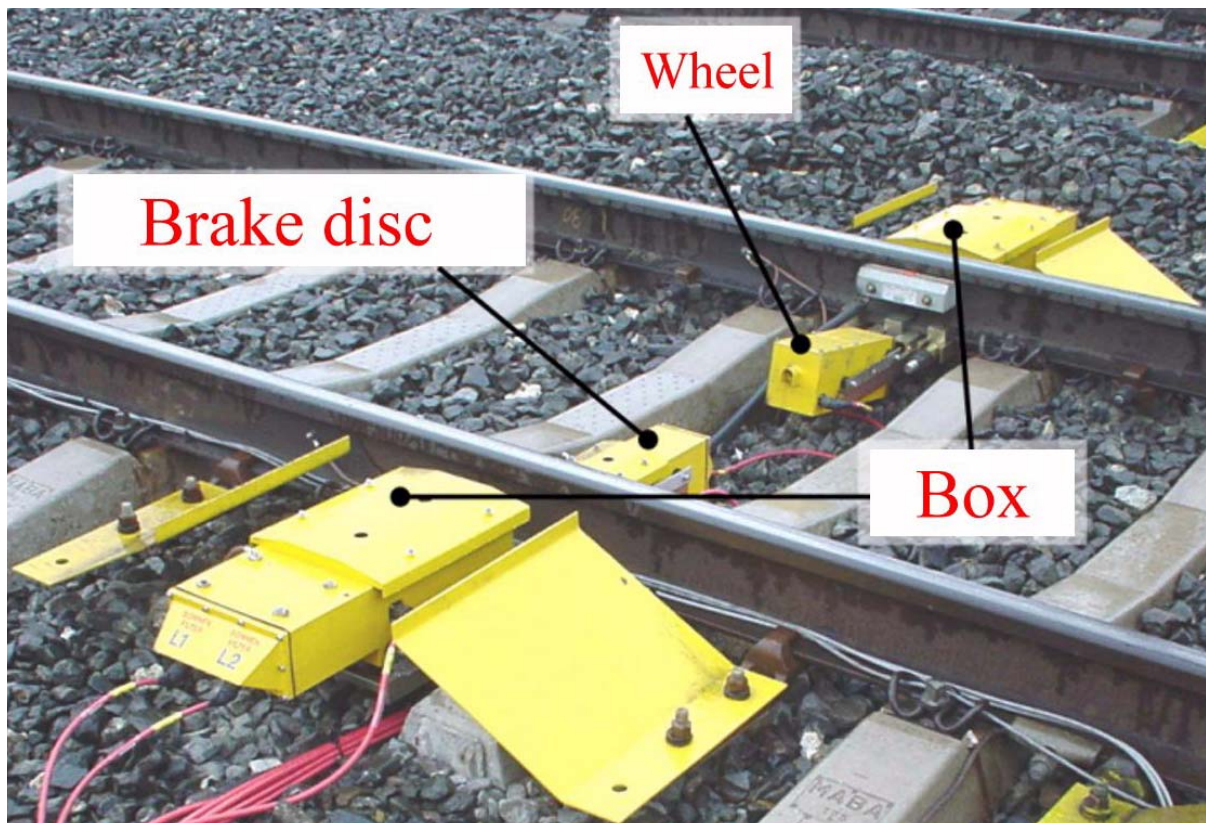


Figure 2. Combination of a wayside box, wheel and brake disc wayside detection plant

In most locations, where a hot box detection system is positioned, there is also a hot wheel detection system and a hot disk detection system. The main reason for this accumulation of sensors are the installation costs for a single system. The shared use of power supply and a connection to the railway data network results in synergies.

The technical solution is able to check the temperature even in a temperature array which cannot be seen by a station inspector. The visual check of boxes leads only to an alarm if the box is already glowing but in the beginning phase a box doesn't glow. So, a technical solution will recognise an initial hot box earlier than one station inspector ever can. Moreover, the technical plant controls both sides of a train even if most glowing boxes can be seen from both sides of a train. This also leads back to the basic argument in Chapter 1 why station inspectors were positioned on alternate sides on an existing line.

After the general decision to use a technical support for checking temperature of boxes, wheels and brakes, the question of locations for these systems and the maximum distance between two plants appear. For the choice of location the operational handling has to be taken into account because the alarm message has to be verified and afterwards the wagon has to be isolated from the train. The maximum distance can be calculated by a risk-analysis where the increase of the temperature has to be specified. In case of having no data from realtime operation it is possible to ask experts for their judgment how fast the temperature can increase.

Observations of occurred hot box alarms have shown that there are two differential cases of temperature increase: linear and exponential. So, an additional advantage of a continuous wayside train observation is the early recognition of linear temperature increases, which allow to plan the operation handling in a more efficient way [1].

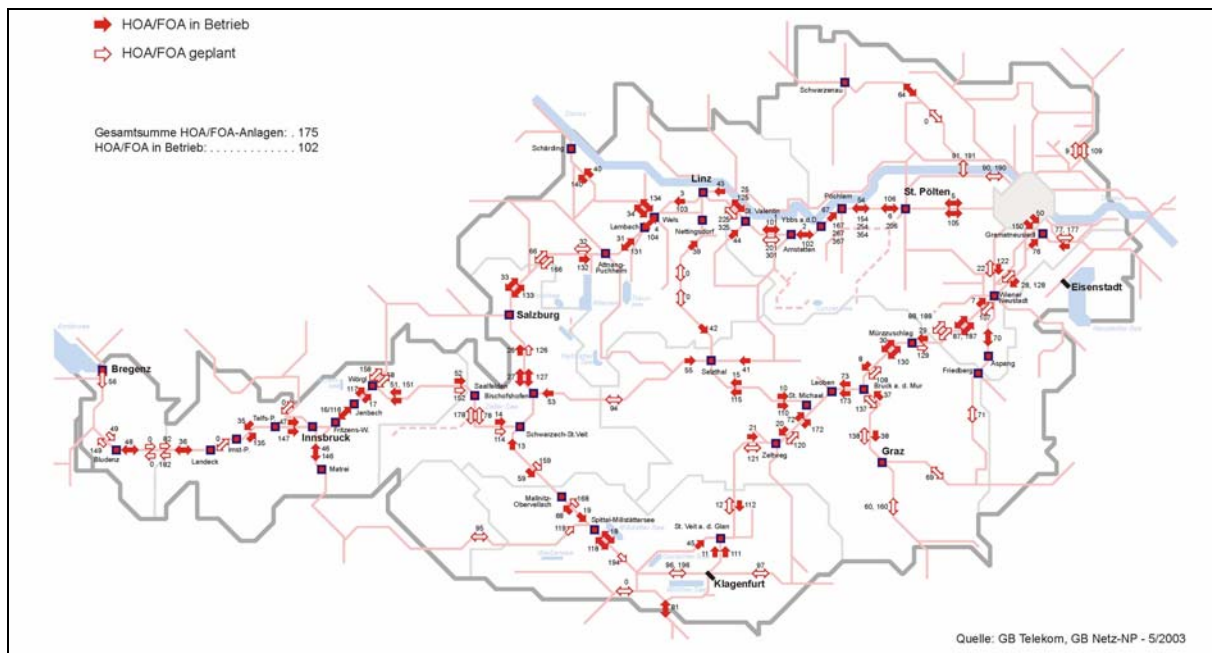


Figure 3. Development condition of the hot box detection system in Austria

3. Operational Handling

For realtime operation it is very important to develop the process in case of an alarm to assure immediate reaction. Only if a technical solution has a high reliability it will be acceptable to stop a train because of new European legislation. Wayside train observation plants are used by Infrastructure Manager to protect the infrastructure for production. Trains are owned by Railway Undertakings which pay a user fee for a time slot. So, if one train of one railway undertaking has a hot box, other railway undertakings may be influenced. Therefore, a balanced proceeding is a basic requirement for a discrimination-free handling.

So, in case of an alarm the Infrastructure Manager has to inform the driver of a train that a wayside hot box detection system has recognised a temperature exceeding a warning limit. It is also possible to declare two limits of temperature for warning and for alarming. In both cases an inspection of the axle has to be done. This will be done by technical inspectors in big stations or by the driver of the train. Important for the breaking process is the normal use of the braking power and to prevent an emergency brake because this could cause a derailment through forces by heavy braking.

A driver can only prove visual if an axle journal is broken or a axle-bearing is glowing or a axle-box case is deformed. Even if none of these indicators can be found, the train will continue its journey with reduced maximum speed to the next place where a technical inspector is available.. Otherwise- if the driver verifies the defect - the wagon has to be sorted out yet the locomotive has generated the alarm.

New development in signaling box technology would also allow to define a signal or stopping point where a train has to be stopped automatically in case of an alarm [2]. An automation of the process is one aim of the project “Checkpoint systems and their integration into solid state interlockings for automatic train supervision” which is lead by Alcatel Austria AG in cooperation with Vienna University of Technology, Institute for Electrical Measurements and Circuit Design and Institute for Railways, Traffic Economics and Ropeways and Austrian Federal Railways (ÖBB), Infrastruktur Betrieb AG. This project is also funded by the

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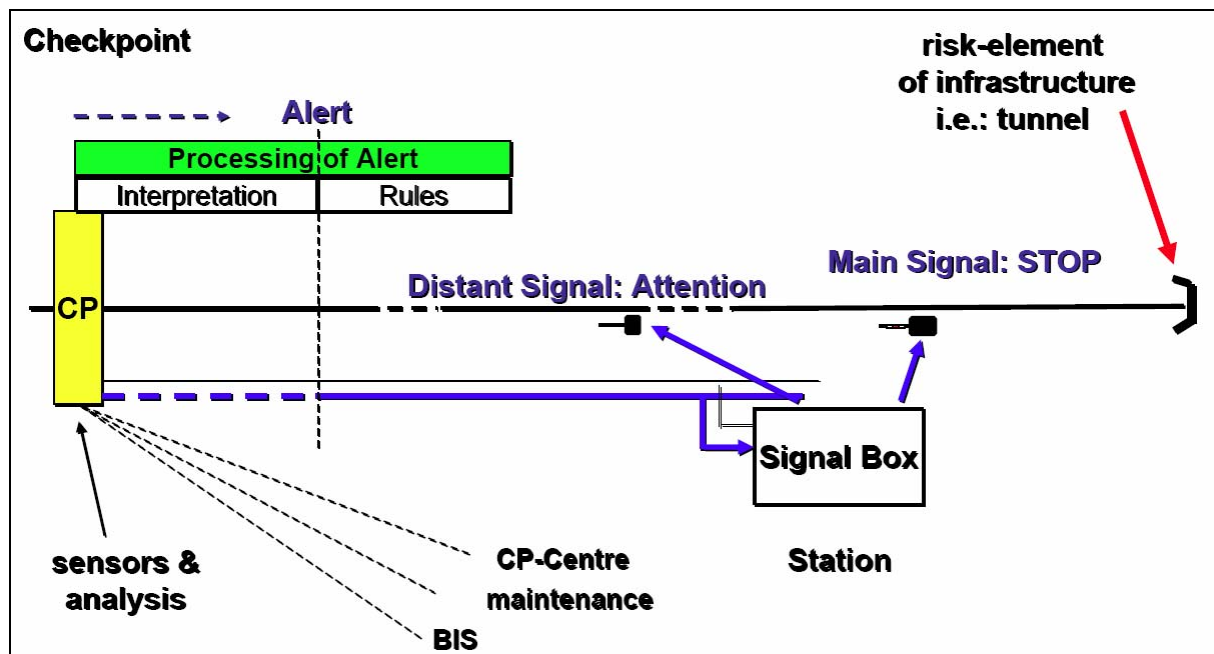


Figure 4. New Development of Operational Handling by Checkpoints

During the last years Austrian Federal Railways invested in a large number of hot box detection systems. The number of warnings and alarms has changed in this period because of many factors. One technical aspect is the density of plants because if more plants are installed the probability is rising that hot boxes are recognised earlier than in former times. As an indicator for safety in railway operation it is, therefore, not possible to consult only the number of alarms and warnings in a network.

4. Outlook

Today's hot box detection systems allow to control an important aspect of train observation but this is only one part of a general concept for automated wayside train observation. Advantages of technical plants for train observation can be seen in this example for hot box detection. Moreover, it is apparent that such a system has to be highly reliable and accurate for the usage in realtime operation. For this part of wayside train observation the cost-benefit analysis is simple due to the fact that each detected hot box could cause a derailment with high costs.

Literature:

- [1] Schöbel, A., Karner, J. *Optimierungspotentiale bei der Stationierung von Heißläuferortungsanlagen*. ETR – Eisenbahntechnische Rundschau 54 (2005), Heft 12. S. 805 – 809.
- [2] M. Sünder, A. Schöbel, M. Pisek, T. Maly: *Sicherheitssystemintegrierte Checkpoint-Anlagen für automatische Zugüberwachung*. Vortrag: 36. Tagung Moderne Schienenfahrzeuge, Graz; 18.09.2005 - 21.09.2005; in: "Sonderheft Tagungsband", Glasers Annalen / Georg Siemens Verlag, 129/11/Berlin (2005), 1618-8330; S. 130 - 135.