COST-BENEFIT-ANALYSIS FOR WAYSIDE TRAIN OBSERVATION PLANTS

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Summary: Wayside train observation is a very important aspect in modern railway operation. Austrian Federal Railways recognised this very early and therefore installed a large net of hot box detection systems on Austrias railway network. This article deals with the economic aspects of wayside train observation plants by the example of hot box detection systems.

Key words: wayside hot box detection, train observation.

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.

Due to the restructuring of operating structure also checking of the passing trains at the commercial stations is decreased, 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.

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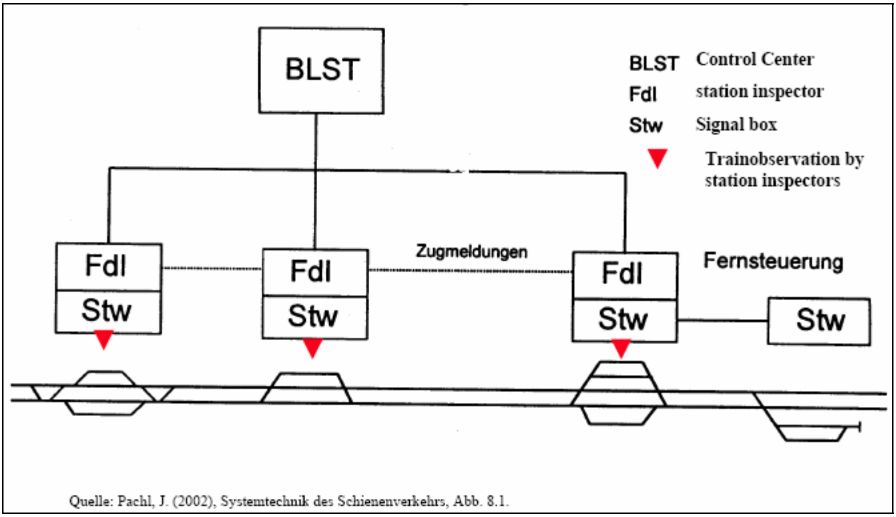


- Fig.1: Train observation on an existing line with sedentary staff at stations

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

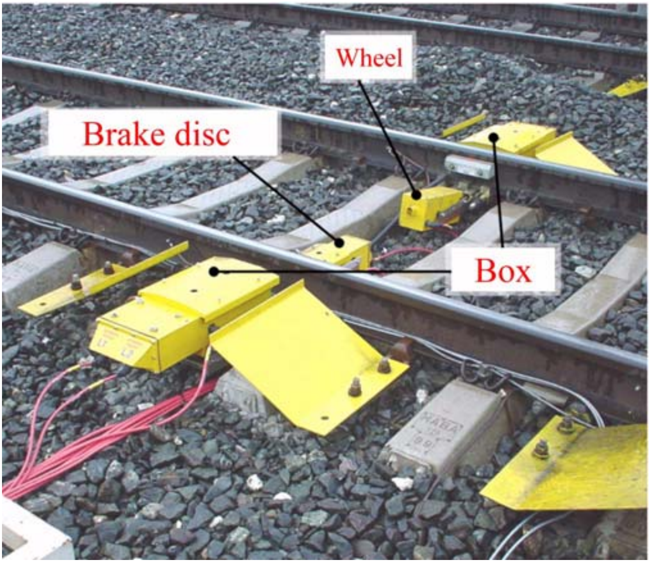
The Hot Box Detection System used in Austria by ÖBB Infrastruktur Betrieb AG consists of the following elements:

- 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.



- Fig.2: Example for a wayside train observation plant

Two hot box detection sensors, one provided at each side of the track, measure the axle boxes, thus, meeting the requirments 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 or used for a trend analysis [1].

3 Usage of Risk-matrix from EN 50126

The usage of a risk-matrix – callibrated on values for this special issue – allows to declare arrays of technical solutions for wayside train observation. The classification of the influencing factors is done with a risk matrix according to their probability and the degree of the damage. A reasonable value for the number of categories can be determined by the qualitative terms behind the descriptions of EN 50126.

Riskmatrix: Protection goals 0,1 Mill€/a / 1,0 Mill€/a / 10 Mill€/a

A daily	3,65	36,5	365,0	3650,0
B monthly	0,12	1,2	12,0	120,0
C once in a quarter	0,04	0,4	4,0	40,0
D annually	0,01	0,1	1,0	10,0
E every 10 years	0,001	0,01	0,1	1,0
F every 100 years	0,0001	0,001	0,01	0,1
	IV 10.000 €	III 100.000 €	II 1.000.000 €	I 10.000.000 €

- Fig.3: Risk-matrix for definition of harms for Infrastructure

The temporal estimation of the probability of occurrence for railways has to be take from a range of terms between "daily" and "once in one hundred years". The horizon "once in one hundred years" is only conceivable with difficulty for the human specialist, but due to the longevity of the infrastructure quite justified. The increment between the individual fields can be selected to be linear or logarithmically. Useful as temporal categories seem the following distinctions: "daily", "monthly", "once in the quarter", "annually", "every 10 years" and "every 100 years - up to now never". Besides also the consequence of the effects, meaning the extent of the damage, must be evaluated. Different factors can be consulted for the evaluation, depending upon national acceptance.

One way to specify the protection goal is to analyse the accident data base of an infrastructure manager. If accidents caused by the same mistakes are too often during a special periode, one infrastructure manager will invest money to prevent these cases. The product of the occurence for such events and the harm of these events is related to the risk potential of the harm. It is not necessary to define an exact value for this protection goal but dimension should be known.

4 Cost-benefit-analysis for wayside train observation

In cooperation with the Technical University of Vienna the Austrian Federal Railways are working on a cost-benefit-analysis for wayside train obersavtion plants to be sure that restricted expenses are used in an effective manner. So an Infrastructure Operatur has to design its extension strategy for wayside train obersavtion plants in an economic way. By the example of hot box detectors it is possible to show an economic extension strategy for Austrians infrastructure manager.

	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Damage For Infrastucture	Mio. €/a	1	2	1	1
Factor Damage - Risk	-	10	10	10	10
Risk	Mio. €/a	10	20	10	10
Protection Goal	Mio. €/a	1	1	1	0,1
Wayside Invest Volume	€/a	9	19	9	9,9
Costs for wayside plant	€	100.000	100.000	200.000	100.000
Anually Costs for a plant	€/a	10.000	20.000	40.000	20.000
Number of wayside plants	-	900	450	225	495

- Tab.1: Scenarios for economic number of wayside train observation plants

In table 1 there are different scenarios for the calculation of an economic application of wayside train observation plants. Based on the anually costs for an infrastructure manager for one harm the risk can be estimated by assuming a factor ten between the damage and the risk. In consideration of the protection goal it is possible to quote a price for the wayside investment volume for a year. Now one infrastructure manager is able to invite companies to present their products and ask them for the price of one plant. The amortisation period is another influencing parameter on closer examination. At least it is possible to ascertain a economic number of wayside plants in a railway network. Because of the interdependency of the price for a single plant and the number of ordered plants for a railway network the economic view is not so easy in reality as described in table 1 but for a first calculation it is good enough.

5 Conclusion

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. 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. In 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 other wayside train observation plants are running in a field-test to get values for the availability and reliability of these aspects [2]. Before Austrian Railways will order one product an econmic calculation as shown in this article will be done.

Reference literature

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