

THE AVALANCHE WARNING SERVICE OF AUSTRIAN RAILWAYS - DEVELOPMENT OF AN INNOVATIVE SAFETY CONCEPT

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ABSTRACT: Natural phenomenon like avalanches, torrents, floods or rock falls have impacts on the safety and operational abilities of railway lines. According to the railway act the Austrian Railways Infrastructure Plc. (OEBB) is the operating company of the railway lines and thus responsible for all safety aspects on the route network of 5000 km in Austria. More than 1000 avalanche zones touch the railway net. That is why avalanche safety represents a particular challenge. The Avalanche Warning Service of OEBB is responsible for assessing the avalanche risk in specified railway sections of the Austrian railway network and for recommending preventive measures. This unit is composed of 65 employees and organised in 13 avalanche committees. The avalanche experts in the committees are employed full-time and are responsible for the standardised evaluation and documentation of the avalanche situation. The experts assess the avalanche risk according to a special safety concept.

This article illustrates the innovative development of a new methodology in decision making and documenting. The knowledge of the area and the experience of the experts in the avalanche committees play a crucial role in evaluating the avalanche danger. Whereas decision making has been an analogue process so far, the base of our new development is a digital system which structures and simplifies the process of analysis, evaluation, documentation, and communication. In collaboration with selected avalanche committees the new safety concept of the Avalanche Warning Service of OEBB was tested and evaluated continually throughout last winter. The aim is to use this method for all Austrian Railways avalanche committees next winter and sustainably implement it into the company.

1. INTRODUCTION

The railway infrastructure is mainly protected from avalanches through safety constructions and protective forests.

Where it is not possible to establish technical constructions or where more protection is needed, measures of

preparedness as reducing or closing railway sections are taken. The combination of technical, forestal and organisational measures to protect railway sections against avalanches has been proved of value since establishing transalpine railway lines.

For more than 100 years the employees of Austrian Railways have carried out observation studies of weather data and the composition of the snow pack in order to safeguard railway lines against avalanches.

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In Austria the risk assessment by avalanche committees is highly effective. That is why in 2005 Austrian Railways decided to found a standardised in-house avalanche committee based on already existing structures.

An essential factor for the successful work of the avalanche committees is basic and advanced training in order to enhance and preserve expert knowledge. The avalanche experts of OEBB take part in courses run by official avalanche warning services as well as in annual courses of Austrian Railways. In addition to technical education, high emphasis lies in communication and networking. Whereas in official courses regional networking takes place with avalanche committees of communities and officials, the main focus of Austrian Railways avalanche courses lies in nationwide, intern communication.

2. THE AVALANCHE WARNING SERVICE OF AUSTRIAN RAILWAYS

The aim of the Avalanche Warning Service of Austrian Railways is to guarantee the safety of railway operation and optimise the availability of railway lines with the help of standardised processes and specific staff.

The avalanche warning service is responsible for the comprehensible, standardised evaluation of the avalanche danger in specific railway sections. 65 intern avalanche experts in 13 avalanche committees observe the avalanche situation and advice the decision makers (operations managers). After assessing the danger, measures of preparedness are being taken. The staff of the avalanche warning system has the state of specialists and is not bound by directives in their decision making

processes. The head of the avalanche warning service is responsible for the equipment and the training of the experts.

Only employees who know the area very well and provide specific experience in order to recognise, assess and protect against avalanche dangers are commissioned to the avalanche committee.

A safety concept is the comprehensive base for the work of the Avalanche Warning Service of OEBB. In general, a situation analysis which follows the development of the snow pack is carried out from the first snow fall in a winter season until the snow-melting in spring time. During non-critical situations it is enough to observe the official avalanche report and the weather development by checking weather data and weather forecasts. If visibility allows it, the avalanche experts observe the area on avalanche activity. The result of the situation analysis is the danger assessment and the decision whether to take safety measures or not.

The existing safety concept has been used successfully for 13 years. Due to new findings and especially through the extraordinarily fast technological development the time has come to assist the avalanche experts in their demanding and responsible task with new methods. In doing so, it is of high significance to process experience and know-how for future generations.

This article describes the innovative development of a new methodology in decision making and documenting data.

3. THE NEW SAFETY CONCEPT

The knowledge of the area and the experience of the experts play a crucial

role in assessing the avalanche danger. Whereas up to now decision making processes have taken place in an analogue process, the base of the new development is a digital system. This system enables better structures and simplifies the process of analysis, assessment, documentation, and communication.

3.1 Avalanche zone database

The base of the new concept is a digital database that locates all avalanche zones concerning railway lines and describes their specific characteristics. Next to the geographical reference fundamental data include the type and size of avalanches, the runout zone, the state of avalanche barriers, as well as the level of central thresholds. If those thresholds are exceeded the respective avalanche can become potentially dangerous.

The parameters for the thresholds are namely wind speed and direction, air temperature, amount and forecast of fresh snow, total amount of snow and rain, and the regional avalanche danger level. Weather and snow data are recorded from three different points at various heights per avalanche zone.

Prerequisite for a working system and the meaningful input of the database is the excellent knowledge of the area concerning each avalanche zone and activity. As the well-trained and experienced members in the OEBB avalanche committees already dispose of a very high knowledge, filling in the avalanche master data is no problem. Another advantage of this methodology is that the members of the avalanche committee have been doing this job for decades and all their knowledge goes into describing the avalanche zones and determining critical thresholds. Furthermore, all information stays in

the system, even if an employee leaves the company.

3.2 Daily base check

In each avalanche zone meteorologic and nivologic parameters are being measured, calculated and tested on exceeding the thresholds daily and automatically throughout the entire winter.

If the thresholds exceed the limit, it will be shown in an app on the business phones of the members of the Austrian Railways avalanche committee. This will lead to further observation on the spot.

Preconditions for a functioning base check are correct thresholds (which can be adjusted at any time) and the allocation of reliable measurement and forecast data. Data is provided by weather forecast services or official avalanche warning services. Weather and snow data is available for every member of the avalanche committee on an app as well as on a web application. Pictograms and icons facilitate the allocation of the respective data and the communication of the values. Needless to say that all data is saved in the system and therefore, it is available at any time for documentation or evaluation.

3.3 Advanced check

Whenever the thresholds are exceeded the experts of the Austrian Railways avalanche committee are ordered to check the conditions and the local avalanche danger thoroughly. This detailed check on the spot is carried out with the help of an innovative app which enables structured work in allocating data and assessing the snow and avalanche situation.

Weather data (temperature, precipitation, wind, clouds) and snow data (total amount of snow, snow quality and composition, moisture, stability test) are collected in the avalanche zone. In addition, the starting zone, the course, protective measures and danger signs are evaluated on the spot. On 7 observation points additional Snowpack modelling analysis are used.

Data entry on the smart phone saves time, runs intuitively, and works not only as a base for decision making but also for documentation on site. All data collected is transferred into the system in real time.

The assessment of the avalanche danger – which is definitely the most demanding part of an avalanche committee – takes place in a 10 items broad heuristic system which determines the potential local avalanche danger. In addition, statements are made concerning type, size and probability of release of each avalanche, as well as concerning the local weather, snow and avalanche situation.

Prerequisite for a correct result of assessment heuristics are common knowledge and local know-how of the snow and avalanche situation. The aspect of intuition and experience is put into consideration as well.

3.4 Resolution

According to the results of the extended check and considering the standing orders of the Austrian Railways avalanche committee an avalanche alarm level (AAL) is being recommended for the relevant day, the next 24 hours as well as the next 48 hours. These avalanche alarm levels

are connected with precise measures to minimise the risk and damage:

- **AAL 1:** No restrictions of railway sections or damage are expected. Possible measures are thorough observations by the avalanche experts and a daily extended check with passing a resolution.

- **AAL 2:** Restrictions are possible. Due to preventive measures, no damages on vehicles are expected. Possible measures are speed reductions, surveillance runs and flights, temporal operational restrictions as well as artificial avalanche releases.

- **AAL 3:** Restrictions are expected. Damages due to avalanches are probable. It is forbidden to access or move on avalanche prone sections. Possible measures are the closing of sections, evacuations, surveillance flights as well as artificial avalanche releases.

In the web part of the new application each AAL resolution has to be signed by three members of the avalanche committee: This is carried out with a password protected access. The AAL resolution is transferred directly to the section operations manager who implements the recommended measures. All steps of the resolution are documented in the system and simultaneously communicated to the decision makers. The cancellation of the avalanche alarm levels is carried out through a unanimous resolution by the avalanche committee.

4. SUMMARY

In contrast to geogenic natural dangers as rock fall or landslides it is possible to estimate the time of snow avalanche releases due to forecasts and observations. This fact allows to establish preparing measures, mainly

in combination with technical constructions and a sustainable protective forest management. If the linear traffic infrastructure has to be protected, the preventive closing of transport routes guarantees a minimum presence of vehicles and therefore a very low remaining risk. Depending on their significance, it is the aim to keep traffic routes accessible to a high extent and track closures to a minimum. A team of experts, namely the avalanche committee, evaluates the avalanche danger situation and guarantees the maximum operational availability of transportation routes. It is important to know that organisational measures which protect against natural dangers protect human lives but cannot completely prevent damages on the infrastructure. In Austria the avalanche danger along the transalpine railway lines is evaluated by the experts of the Avalanche Warning Service of Austrian Railways.

Due to new findings, the Avalanche Warning Service of Austrian Railways is developing a new, innovative safety concept. The aim is to simplify and enhance the processes of analysis and

decision making and simultaneously increase intern communication. Criteria for successfully implementing this methodology are optimising the sequences in general and at the same time enhancing communication, transparency in evaluation and decision making as well as integrating current weather data and observations on the spot in real time. Structured proceedings from evaluating the situation on the spot to issuing the avalanche alarm levels including the corresponding measures and the automated documentation of all actions are extremely relevant for high legal certainty.

The elaboration of a know-how database assists in saving expert knowledge of experienced employees for the future.

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