SUSTAINABLE WINTER MAINTENANCE ON THE SWISS NATIONAL ROADS

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SUMMARY

In 1960, the national road network became the shared task of the federal government and the cantons, which were responsible for operational and structural maintenance. Since 2008, the federal government has borne sole responsibility for national roads open to traffic. This shift in responsibility provides an opportunity to modernize winter service on motorways. The development potential for sustainable winter service is to be explored in areas of optimization. Components of the future winter service concept that are already known are presented with comments on the requisite data and projections, the new management system, vital training for those in charge and quality-assurance. The key criterion for evaluating the winter service is grip, the traction coefficient between tire and winter road surface. The grip criterion will be used not only for planning and decision-making purposes, but also to monitor the quality of road conditions in the light of established standards. The full concept will be ready in early 2011. It will be followed by nationwide implementation. The aim is a better quality, more uniform and safer motorway network in winter.

KEY WORDS

WINTER SERVICE / SUSTAINABILITY / NEW TECHNOLOGIES / GRIP / MANAGEMENT / CONCEPT

1. INTRODUCTION

The motorways are the arteries of every modern country. Today, they carry very high traffic densities. Disruptions to normal operation caused by congestion and accidents result in unwelcome tailbacks and delays. Traffic movements can also be disrupted due to operational maintenance on pipes, shafts, landscaping and the like, when lanes have to be closed temporarily to permit site access and work safety. Unfortunately, however, though these operational maintenance activities are essential to ensure that the network is always in good condition and ready for use, the connection is not always immediately obvious to the road user.

Expectations with regard to operational maintenance are particularly high in winter. People nowadays tend to perceive seasonal snow and ice simply as a nuisance, especially when they are prevented from travelling as fast as they would like. With the hectic pace of modern life, they tend to forget that nature can have the last word and that, particularly in winter, it imposes its own limits. Accordingly, the task of operational maintenance is all the more demanding in winter.

In Switzerland, winters vary considerably from one year to the next and from one region to another. Despite constant progress in technical methods and the accuracy of weather forecasting, winter maintenance still depends heavily on human assessment and there is still room for various measures to improve the effectiveness of operational motorway maintenance, especially in winter.

This paper will describe how the Swiss motorways came into being, how operational maintenance was carried out in the past and what possibilities have been opened up, particularly for winter maintenance, by the recent redistribution of financial responsibilities. An overview is provided of the future requirements for winter maintenance and, above all, the potential for technical and organisational optimisation. On this basis, important conceptual aspects are presented for a sustainable winter maintenance programme for the Swiss national roads.

2. ESTABLISHMENT AND OPERATION OF THE SWISS NATIONAL ROAD NETWORK

In 1960, parliament decided in the name of the people that a national road network should be established in Switzerland. This decision was implemented jointly with the cantons as a community or federal task. While the cantons were the clients, the Confederation approved the projects, acted as the principal source of finance and supervised project implementation. At the present time, 1 763 km of national roads are in operation out of a scheduled total of 1 893 km. The system, which includes 220 tunnels and over 1 500 bridges, provides more than 400 interchanges to transfer traffic to the secondary road network. The national roads are largely financed out of earmarked revenue deriving mainly from fuel taxes.

Though the operational maintenance of the national roads was at first carried out entirely by the cantons, the Confederation started making substantial contributions with effect from 1983.

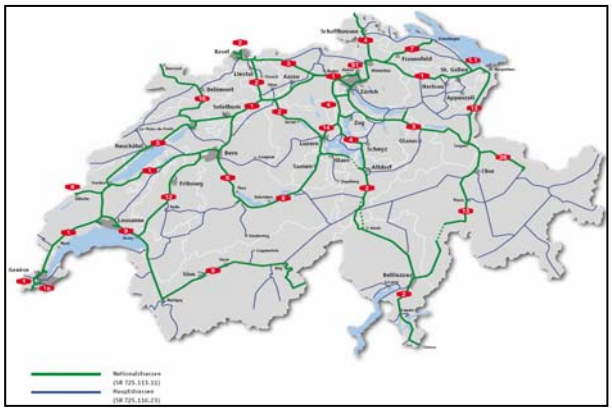

Figure 1: With effect from 1960, the Swiss national road network was constructed by the 24 cantons acting as clients.

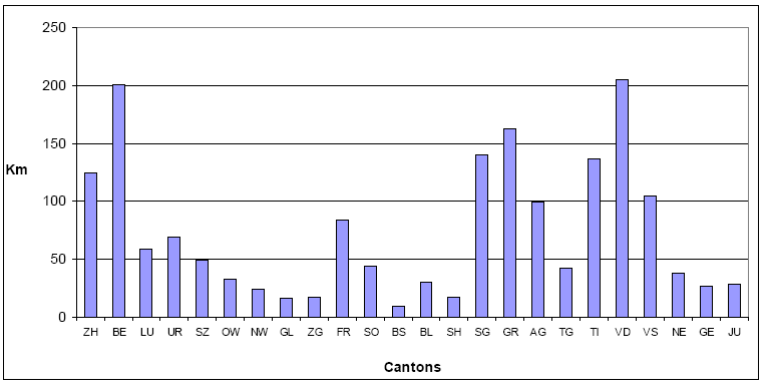

Figure 2: The lengths of national road within the 24 cantons varied greatly.

As the cantons had sovereign power over the national roads, they conducted winter maintenance under their own responsibility. On average, 67% of the cost of operational maintenance was paid to the cantons by the Confederation on the basis of a standardised cost accounting system. The cantons implemented the general standards laid down by the Confederation but were allowed considerable latitude. The weather forecasting systems differed from one canton to another. Thermal cartography and weather zones existed in only a few cantons. Some cantons had video camera with free access from the Internet and variable message signs were to be found here and there along the national roads. Accordingly, winter maintenance on the national roads also differed and there was little the Confederation could do about it. Coordination covering the whole country was a very difficult matter.

3. REDISTRIBUTION OF FINANCIAL RESPONSIBILITY IN 2008

With the coming into force of the new "Redistribution of Financial Responsibility" on 1 January 2008 and the accompanying division of duties, the Confederation assumed complete responsibility for the development of the existing national road network, the extension of the network and the maintenance and operation of the national roads. With the exception of operation, these tasks were taken over by the Confederation itself, with operational maintenance entrusted to third parties. The national road network was divided into eleven cross-cantonal groupings – so-called territorial units – with which service agreements were concluded. As previously, it was the cantons which stood behind the territorial units. In order to deal with the territorial units, it was necessary for them to merge to a certain extent. To this end, a company – cantons under the leadership of a lead canton – was subsequently formed. Certain territorial units correspond more or less to the territory of a single canton.

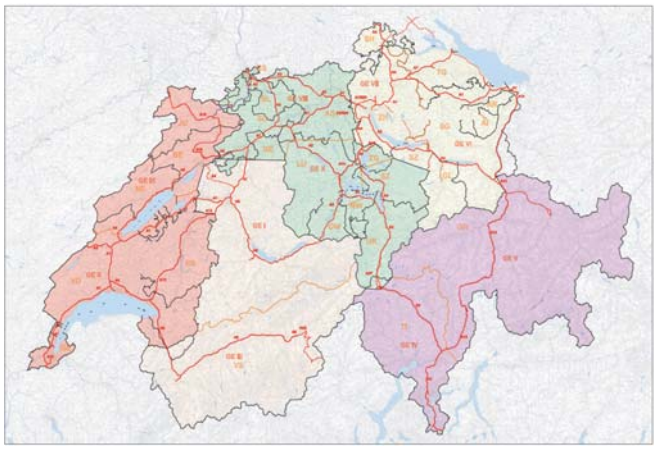

Figure 3: With effect from 2008, 11 territorial units were responsible for carrying out operational maintenance on the national roads.

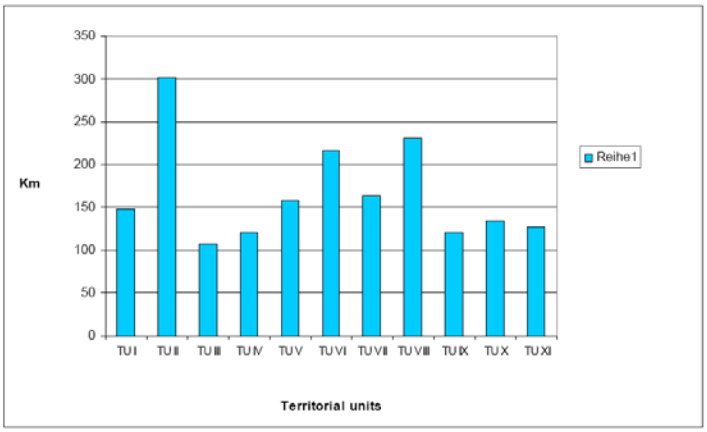

Figure 4: Lengths of the road network contained in the 11 territorial units

The lengths of the road networks of the territorial units vary considerably. When the units were formed, consideration had to be given to the operating processes, language constraints and opinions of the cantons. It remains to be seen whether the number of territorial units will need to change in the light of future developments and requirements.

4. THE TERRITORIAL UNITS AND WINTER MAINTENANCE

The territorial units have to comply with two standards in respect of winter maintenance. The first serves to ensure that sufficient maintenance vehicles are on hand to cover the whole of the relevant road network within two hours and that, with few exceptions, the national roads are completely cleared of snow and ice. The second serves to ensure that the winter maintenance organisation of a territorial unit can be deployed for action on the national road within a short time of being alerted. However, no standard exists to measure the quality of the work of the territorial unit on the road itself. Differences in the quality of performance are to be noted between regions and the system boundaries still tend to correspond to those of the cantons. The first situation report of the "Optimisation and Control of Operational Maintenance" (OPOM) project initiated by FEDRO in 2008 found that there is room for organisational and technical improvement in terms of winter maintenance. The results of this project for winter maintenance will become available at the end of 2009

5. MODERN WINTER MAINTENANCE AND THE TECHNICAL POSSIBILITIES

Before we can determine the potential for optimisation of the territorial units in terms of winter maintenance, we need to see first where scope for improvement exists. It is also necessary to bear in mind that, in these fast-moving times, not every development is equally significant and viable and, not least for economic reasons, the basic investments of a territorial unit (e.g. in vehicles and equipment) cannot be changed all the time. In this section, various fields for optimisation will be considered and assessed with regard to innovative developments and their sustainable impact on winter maintenance in the medium to long term. These considerations do not in any way claim to be comprehensive.

5.1 Standards

The consistent application of unified standards leads to simplifications and to more reliable application in the fields concerned.

5.1.1 Organisational and practical aspects

On the human resources side, the emphasis is on simplification in terms of organisation and communication. Increasing use must be made of road weather scenarios in practical application. The coordination needed for the simplifications must be underpinned by automatic work processes (workflow management). eLearning software must be deployed for training and continuous development. Maintenance vehicle drivers must be able to practise their skills on simulators. Winter maintenance today relies on a reactive approach. Thus, an important area for optimisation is the advance treatment of the stretch of road and timely gritting. The objective for winter maintenance is complete clearance of snow and ice in order to ensure maximum grip and a clear view of the road. It is necessary to bear in mind that there are different reaction times apply in practice for deployment to deal with packed snow and black ice.

5.1.2 Material aspects

Nowadays, it must be possible to apply road salt products in a range of forms from hard grit to brine and with appropriate additives. Greater attention must be paid to local conditions in the assessment of all renewal and development projects. For example, roadside sound-proofing installations sharply reduce the amount of space available for snow to be deposited when the road is cleared.

5.1.3 Technical aspects

Here, we are particularly concerned with the promotion of best practice in the field of technology. We must seek to improve compatibility between the various existing IT systems and to reduce the differences between them. Thermal cartography must be used to optimise the siting and numbers of ice warning devices. To increase the reliability of the data, ice warning devices must come with integrated quality controls. Winter maintenance interventions can be improved by data being recorded automatically in the vehicles and used to optimise coordination in the course of interventions. The gritting vehicles must be equipped to permit the application of road salt in forms ranging from solid grit to brine. Snow plough drivers need visual support to identify lanes. When snow and ice is being cleared with a blower, the visual aid must identify the edges of the lane and display them for the driver. Additional decentralised salt silos (e.g. at the ends of the gritter route) permit a rapid mobile response at short notice to any deterioration in the initial situation. Improved assessments of the model-based weather radar permit refinements as to the type and nature of the precipitation and air temperature in short-term weather forecasts (zero to four hours). Winter maintenance interventions can be optimised by the application of *grip* as

the criterion for the assessment of the condition of the road. Grip – defined as the static friction between vehicle tyre and winter road surface – is the key factor in the winter maintenance approach. At the same time, a reliable check is needed of the winter maintenance carried out by the territorial units. An ideal solution – though one that has yet to be achieved – would be automated weather forecasting, as every forecast corresponds simultaneously to a decision.

5.2 Centralisation

The efficiency of the processes involved can be increased and redundancies reduced by spatial and functional centralisation with identical or similar tasks and areas of work or responsibility being combined.

5.2.1 Logistical aspects

The optimum effect of the deployment of winter maintenance control centres on the whole road network is achieved through workflow management, i.e. the coordination of automated work processes. Workflow management supports shift scheduling and incident management. The current location of maintenance vehicles and their movements are identified by GPS through the existing navigation service. The Salt Manager platform checks the available stocks of road salt automatically and can indicate the changes to the relevant gritting service. All gritting operations carried out on the road network are subject to an automatic quality control.
On important stretches of road, heavy goods vehicles (HGVs) represent a significant proportion of the traffic carried. In winter, particularly in areas with steep gradients, HGVs can be severely affected by road conditions. Moreover, a single HGV can block a stretch of road for hours with long delays persisting before optimum traffic conditions are restored. Depending on snow conditions, it is not always possible to bring about the right conditions for HGV traffic immediately. However, traffic disruption caused by HGVs can be minimised by imposing weight limits based on the depth of the snow.
The information provided to road users before and during journeys is set to become even more important in the future. As people obtain their information in very different ways, the existing information channels must be exploited to the maximum and, to that end, further developed. The familiar radio, TV and Internet services need to be supplemented for road users by an extended information management incorporating public webcams and a nationwide system of variable message road signs. Travellers will also be able to obtain the latest information from special screens installed in motorway rest areas.

5.3 Probability of occurrence

This means the estimated probability of the future occurrence of a certain weather or winter maintenance situation within a given period of time. The capacity to assess the probability of such situations in winter must be increased quickly and, in the medium term, raised greatly by comparison with today.

5.3.1 Assessment of effectiveness

Winter maintenance situations and the probability of their occurrence must be identified by appropriate risk assessment and decision-making processes and the necessary measures must be set in place. Risk measures will be determined by correlating information of various kinds. Road weather scenarios permit coordinated forecasting and intervention on specific stretches of road. Salt consumption is greatly reduced by weather-dependent gritting. The effectiveness of the interventions can be confirmed by periodical (e.g. monthly) assessments.

6. NEW WINTER MAINTENANCE CONCEPT

6.1 Fundamentals

Certain objectives of the new winter maintenance concept have yet to be established. Accordingly, we will now consider a number of important contents and requirements that still have to be included in the new concept, which is still in the initial phase of elaboration. In particular, it is necessary to incorporate the experience of winter maintenance on the national roads since operational maintenance came under the control of FEDRO in 2008. We must not anticipate the later requirements stemming from the optimisation project referred to in section 4. These will be integrated at a later stage. In particular, the concept will include innovative contributions for a sustainable winter maintenance. The increased use of modern IT and communications technologies in a comprehensive winter maintenance management system will perceptibly improve and standardise the quality of winter maintenance on the road. An accelerated winter maintenance provides road users with a twofold benefit: on the one hand, accidents due to black ice are reduced while, on the other, time savings can be achieved through a quicker return to normal speed limits. At the same time, thanks to the winter maintenance management system, the operating units can provide this service with considerable economies in the use of resources (road salt and working hours). Hitherto, the winter maintenance has worked with one set of systems for decision-making and another set for carrying out controls. In the new system, the *grip* criterion will serve on the one hand, for scheduling and decision-making and, on the other, for checking whether the expected grip in fact obtained. Finally, it is clear that, prior to the implementation of the concept, it will still be necessary to conduct various fundamental clarifications which are not listed here (e.g. thermal cartography to determine weather zones and the locations for the necessary black ice warning installations).

6.2 Prerequisites

Various kinds of meteorological data and forecasts are needed. For example, we need a forecast of the road surface temperature for the next 72 hours with an accuracy of +/- 1.5°C between the measured and the forecast figure during the following 24 hours. The data for the road weather scenarios to be expected must be adapted to the weather zones and harmonised with the territorial units for every stretch of road. The radar forecast for the next 240 minutes must be updated every 10 minutes and related to the meteorological model. During the same time interval, an updated forecast of the risk of precipitation is needed for the location of every black ice warning installation.

For every weather zone, at least one black ice warning installation is required to measure dew point, the road surface temperature, the air temperature and the ground temperature at a depth of -6 cm respectively -30 cm. In addition, it is necessary to record humidity, road condition (dry, wet, ice and slush), grip and the depth of any water, ice or snow lying on the road. From the location of the black ice warning installation, it will be necessary to transmit a picture of the stretch of road every five minutes, indicating the current visibility from 0 to 2 000 m.

The automatic acquisition of the gritting data together with the standard road weather scenarios will serve to ensure that gritting is carried out only at the right time. As a rule, this means that gritting could take place later than would be the case today. In order to permit the gritting data to be further processed, they must be time-stamped in the winter maintenance vehicle and then stored on the Internet.

6.3 Operations management

The internal web-based system for operations management prepares and displays the operating data. It reports deviations between the actual and the forecast road surface temperatures. It transmits warnings if frost builds up to a thickness of more than 0.02 mm and if ice forms on the carriageway. It also triggers alarms if data is lacking or if the computer centre is down. The operating data is entered in real time. The system further generates an activity report. It proposes action plans if the forecast and actual data fall below predetermined thresholds (e.g. grip < 0.35). The progress of every winter maintenance operation is automatically monitored in real time. In addition, there is a permanent connection for video pictures.

All data and information relevant to winter maintenance are collected in internal web-based systems and made available in a simple easy-to-read display. There are separate systems for precipitation radar and satellite data, for black ice reports, for road salt management, for operations management, for gritting data acquisition and accounting, as well as automatic monitoring of order processing.

6.4 Training of winter maintenance personnel

Reference has already been made in section 5.1.1 to the need for key winter maintenance personnel to be trained using the latest methods. The operations managers must be able to cope with a combination of standard road weather scenarios with a brightening sky and different frost conditions. For service vehicle drivers, it is necessary to ensure that they do not make any system or application errors and are able to conduct just-in-time gritting operations safely with the help of standard road weather scenarios. Finally, if training is put correctly into practice, there will be considerable scope for savings in terms of gritting materials and operating hours.

6.5 Quality assurance

A vital component of the black ice warning system is a comprehensive and intensive quality assurance conducted by the managers of the territorial unit. This serves to ensure that the winter maintenance achieves its stated quality targets. As a rule, the assessment of the stationary road weather stations takes place once a month. The quality assurance includes a comparison of the actual meteorological data with the target data of the stationary road weather stations. The control of execution covers the systems for gritting data acquisition, for operations management and for the weather forecasts. Post-gritting checks are conducted with mobile road weather stations to determine the quality of implementation and the mission (see Figure 5). The outcome of the quality assurance and the results of the road weather scenarios are made immediately available for viewing by all authorised persons. Where necessary, the checklists will be modified to incorporate the possibilities of implementing just-in-time gritting with standard road weather scenarios and to adapt the training modules.

The detailed quality assurance plan will be drawn up and agreed with the winter maintenance managers for the relevant territorial unit. This will also include the adjusted gritting data statement and the recording of minor accidents in cooperation with the police.
The analyses of ice-related accidents provide the bases for a successful implementation of our future road weather scenarios

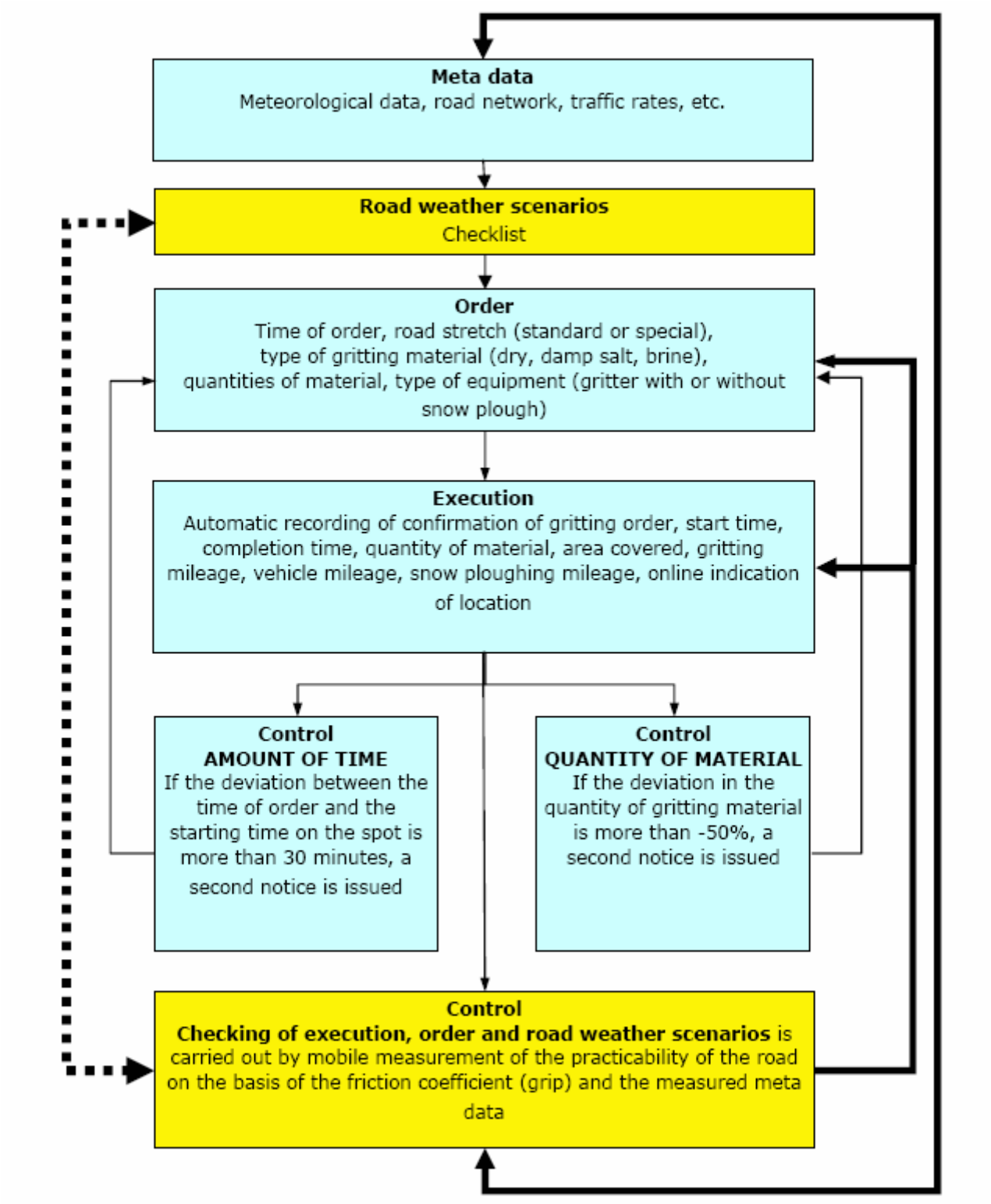

Figure 5: Control of order for gritting and snow clearance operations and implementation

7. PROSPECTS FOR THE FUTURE

We must take full advantage of the propitious circumstances resulting from the creation of the territorial units which, since 2008, have been carrying out the winter maintenance of the national roads under the direct control of FEDRO in order to pursue the development of a modern and sustainable winter maintenance service. The recommendations of the "Optimisation and Control of Operational Maintenance" project (see Section 4) must be incorporated. A certain amount of work is still needed on the concept and on checking its practical application. The concept will be finalised by no later than the beginning of 2011. An earlier start to implementation can be made with territorial units which make themselves available for pilot projects and the experience gained in this way can be continuously introduced in the fine-tuning of the concept. The particular individual concerns of the territorial units will be taken into account in the implementation. Finally, the concept will be implemented throughout the country. As a result, those who use the Swiss national roads in winter conditions will have at their disposal a network that is safer, more homogeneous and of higher quality than the one that exists today.