WINTER MAINTENANCE

18 September 2007 (am)

TECHNICAL COMMITTEE 3.4

INTRODUCTORY REPORT

Contents

SUMMARY

Ice and snow on streets, roads, pavements, sidewalks and cycle paths cause problems for users and require maintenance actions. Such actions influence safety, accessibility, mobility and vehicle cost. Winter maintenance operations also impact our environment. Consequently, it is essential to develop effective strategies and methods for maintenance actions and to document different winter standards. It is also important to develop methods for efficient measurement of the standards achieved. A strategic objective is to make the contractors understand the area contracts as a maintenance service contract and the road users as customers.

Support systems and information

In reality, today's challenge is no longer to put together road weather information networks, but rather to optimize the use of the large mass of data for tracking operations in real time and developing decision and management support tools.

Moreover, the need for standardization, data sharing, and the development of operations and management support systems depend on initiatives that spotlight international harmonization. The points that countries share in terms of the issues involved in developing road weather information systems are the main justification for the desired sharing of data on best practices, over and above simple data exchange, so as to meet the needs of roadway users.

Contract

The organizational mode of the activities of winter maintenance (private public, articulation planner, main contractor, operator) differs notably between the countries.

It is necessary to know the climate and the road consequences of weather, in order to know the amplitude of the phenomena and to determine what must be inserted in a contract. The levels of service must be very clearly defined and well understood by all partners. The check procedures in particular for the road condition are to be developed by establishing indicators and methods of measurement. Which indicators are best adapted? It is difficult to know which is the best approach to define the levels of service, prescribing the specific methods or specifying objectives.

It is almost impossible to compare costs and to determine which is the optimal mode of remuneration for these types of services.

Snow and Ice Control Data book – Edition 2006

Available and safe roads during the winter – demographic and climatic constraints – costs and benefits regarding safety, mobility, environment – human, material, equipment means – private partnership – decision support systems: these are the main parameters of today's "winter road maintenance equation". All included in the data book but each country uses its own set of methods to reach the goal.

Environment

A life cycle assessment of the environmental impacts of spreading materials showed that less than half of the environmental impact was generated by the products when spreading salt and abrasives. Other impacts are energy and vehicle emissions, production and transport of materials.

Important activities start at the design of the road and further comprise drainage and rainwater management, depots, equipment, salt management, training and communication. So winter road needs to begin at the road planning stage: think winter maintenance at every stage of planning a road!

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1 Outcome of the work of the Committee

The challenges of the today's winter road maintenance are the focus of TC 3.4's work resulting in the following reports on the State-of-the-Art.

1.1 Winter maintenance support systems and information exchange

In most countries where winter affects road traffic conditions, information systems have been installed to improve winter road maintenance operations. Primarily made up of atmospheric and road sensors, the data gathered is used to provide support for decision making and management.

The report, written in the context of PIARC's 2004–2007 strategic plan, was intended to provide a scan of various practices worldwide for the use of road weather condition information systems. To do so, a survey of nineteen organizations made it possible to get an overview of the many facets of data acquisition and data processing. The evolution of standardization and development of decision-making support and management optimization systems were among the areas that were spotlighted. Then, the latest literature was selected, referenced and grouped in themes in order to give readers the opportunity to document their interests more easily.

The work done shows that there are, nonetheless, many common points among the countries, even though their circumstances may differ in terms of climate, geography, economy and, in particular, in terms of infrastructure (characteristics of the road network). Among the similarities is the issue of obtaining standardized data. In fact, for many road weather systems, the difficulty lies in getting reliable information. Selecting measuring instruments, especially road sensors, is not a straightforward task given that standards still need to be developed to define their characteristics and performance (several initiatives are now underway regarding road sensors). What's more, once installed, the sensors are not always subject to regular maintenance and calibration, which can affect the accuracy of the measurements. Existing standardization in this regard is more or less precise, depending on the country, and occurs at various levels: within a road authority for a region of a country, at the national level, and sometimes at the international level. The standardization component is primordial, as the reliability of the data provided by road weather information systems predetermines the quality of decision support or management support systems. Standardization is also what makes it possible to share data among separate networks.

Data sharing is another important component, one which is also closely tied to standardization, if only with respect to the definition of data exchange protocols. Currently, a wide variety of file formats is used for transferring data from entity to entity, with some formats offering more benefits in terms of universality, or ease of reading and processing. From a broader perspective, the key requirement of information sharing involves the delivery of the measurements taken to meteorological services with the goal of obtaining a forecast of road weather parameters. However, it is also essential to share data among organizations in the framework of road users' mobility needs, in order to give them continuous news throughout their journey. This approach, which is desirable at both the national and international levels given how open borders are, probably requires the interchanges to be formalized, perhaps even an agreement among road organizations. To contemplate information being pooled among different entities, some non-technical roadblocks could be identified, such as the differences between the types of roadway organization and between their objectives.

Finally, another point that the various countries have in common has to do with the need to optimize use of the data provided by road weather stations. In fact, the study, which examined all initiatives worldwide via a survey and literature review, shows that there are varying degrees of data exploitation. Depending on the organization, the measurements taken by the sensors are sometimes simply posted, with interpretation left up to the user; in other cases, the data flow into a process for forecasting road weather parameters, or are used by decision or management support systems. However, the issue of these systems' cost-effectiveness remains to be precisely quantified: improving the operational process and variation in costs often have to do with a set of changes, not to mention the fact that it is hard to compare one winter with another. Some management tools, such as winter severity indexes, are especially difficult to develop due to the number of parameters that have to be considered and the variation in road weather conditions over a territory.

In reality, today's challenge is no longer to put together road weather information networks, but rather to optimize the use of the large mass of data for tracking operations in real time and developing decision and management support tools. What is crucial is, based on the specific features of the organizations, to establish the investment threshold at which relevant data will begin to improve winter road maintenance operations.

Moreover, the need for standardization, data sharing, and the development of operations and management support systems depend on initiatives that spotlight international harmonization. The points that countries share in terms of the issues involved in developing road weather information systems are the main justification for the desired sharing of data on best practices, over and above simple data exchange, so as to meet the needs of roadway users.

Contents of the communication:

Results of the survey
- System components and data capture
- Data processing and usage

Supplementary analysis
- Installation and development of RWIS
- Different uses for RWIS
- The RWIS of tomorrow

1.2 Report of a survey on winter maintenance contracts

The manufacturing sector today, largely manages its' production operations with greatly reduced inventories. The requirement for 'just-in-time' delivery to support such an approach has placed greater demands on the transportation sector. Meeting the greater needs of road users within the constraints of public finances remains a difficult challenge but is one which must be met by the responsible organizations.

The characteristics of the winter season and the specific winter weather phenomena, even within the same country, can vary considerably from region to region and from winter to winter. This makes winter road maintenance programmes rather difficult to administer.

A public winter road maintenance service can be assured in various ways, however, the mission remains comparable whatever the nature of the responsible organization. Whether the services are provide in whole or in large part by the public sector or private companies, it is essential that the roles reserved for each partner be very clearly defined.

This is why the establishment of pseudo-contractual links within an administration or legal contracts between a road administration and private companies is necessary to the ensure winter road maintenance services.

The work completed within the framework of the PIARC 2004-2007 Strategic Plan is not exhaustive. It provides a preliminary review of existing practices, considers their merits, and lays the ground work for a more complete understanding later on. A survey was carried out within Technical Committee 3.4 using a questionnaire covering some 50 topics. 23 completed questionnaires were received from 11 countries. However a number of committee members cautioned that with winter road maintenance being done entirely outside of their organization, it was difficult to provide complete and satisfactory answers to some of the questions posed.

Concerning the organization of winter road maintenance services, it was noted that the distribution of responsibilities between mandated entity, management, and operators could differ significantly from one country to another. In the majority of cases, the mission entrusted by the responsible organization (mandate holder) on a single entity included management and operations (this remains true whether a government entity or the private sector). (Readers are cautioned however that some countries did not answer because they did not feel that certain responsibilities could be appropriated delivered by contracting out.)

A majority of contracts (70 %) refer to a level of service with, in half of the cases, these service levels being made generally available to the public and road users. However these levels of service are, in many cases, only vaguely quantifiable. Many contracts take the approach of specifying required numbers of operators, competencies and qualitative and quantitative levels of equipment and materials.

Where operations are specified, few contracts (24 %) refer to particular methods.

The terms of payment can vary considerably as well with the two more common being payment for work at a fixed price or by hourly rates.

Some mechanisms have been developed to take the variability in winter severity and the difficulties in programming winter maintenance activities into account.

One such approach is to use a winter severity index designed to correlate well with winter road maintenance operations. Another is the use of no-claims bonuses or penalties based on the quality of the services provided.

Control methods differ depending on the objectives and the meteorological phenomena. Control can be simply an a priori audit of the organization, its installations and procedures to assess its ability, based on ratios, to meet the objectives.

Controls can also be applied after the fact and based on the resultant level of service achieved as for example through the use of friction measurements. Independent organizations can be called upon to conduct the quality control checks.

In the majority of the cases several control methods are used.

The principal conclusion which can be drawn from this analysis is that contracting for winter road maintenance services is very challenging!

The specific approach to winter road maintenance (private public split, management approaches, main contractor, operators) differs significantly between countries rendering any analysis a complex exercise. But a number of interesting opportunities to improve things does nevertheless emerge.

First of all it is necessary to have an excellent grasp of the climatology and the winter weather phenomena of the region in order to correctly assess their impacts on the road and to establish appropriate contract criteria. It is especially important to define those extreme weather limits beyond which the level of service simply cannot be reached.

The levels of service must be very clearly defined and well understood by all of the partners and stakeholders.

The quality control procedures in particular must be carefully developed with clear indicators and precise methods of measurement.

Another basic requirement is to precisely quantify and document as many of the standards and other information as possible.

This preliminary survey could not truly compare the relative effectiveness of the various contracting approaches it documented and so many questions remain.

For example, no recommendation can be made regarding the optimal approach for the definition of levels of service; prescribing the maintenance techniques s to be used or defining road state objectives.

It is not possible to compare the relative costs of various approaches or even to determine which method of payment is most effective for these services.

Finally questions remain regarding the quality control methods; should these emphasize service organizational structure and approaches or post-treatment monitoring of resultant road conditions?

Winter road maintenance is a field which is ripe for further study in a large number of areas not the least of which is contracting approaches. The entire community of practice faces many of the same types of problems making it possible, based on the collective actual operational experience, to establish some theoretical recommendations.

1.3 Snow and Ice Control Data book – Edition 2006

Origins, Objectives and Methodology

A Snow and Ice Data Book was first published as an interim report in conjunction with the XIth International Winter Road Congress, 2002, Sapporo, Japan. Considering the usefulness of this first issue to support the exchanges of experiences between international experts the PIARC Executive and TC3.4 decided to pursue this initiative and stated that future efforts should be directed at documenting practices in additional countries as well as adding topics on economic and environmental issues, public-private partnerships, training, road user needs and finally emerging technologies.

The update was prepared for the XIIth International Winter Road Congress, 2006 in Torino-Sestrière, Italy with 22 technical contributions.

Assessment of the Snow and Ice Control Measures

The cost and benefit of winter road maintenance activities is given prominence in the databook with summaries provided of measures introduced in recent years to minimise the use of de-icing materials. These include the measurement of efficiency both on an internal and external basis, and the use of performance indicators.

Winter indices correlate winter activities and costs to winter severity or winter events. Where winter road maintenance is contracted out such indices are also useful for setting up tenders and monitoring performance. However no international classification system (with a few maintenance-specific indices applied to some representative climate stations in each country) is yet available to report objectively and coherently on the climatological characteristics that are important in terms of winter maintenance.

Cost effectiveness is also discussed in the document – for instance the challenge of providing an efficient winter maintenance service on a long and lightly trafficked network which unavoidably leads to a relatively low level of cost effectiveness.

Environmental issues are widely covered including how to achieve the joint goals of reducing costs and environmental impact whilst maintaining service levels. The challenge is to implement measures to decrease the use of de-icing products, leading to cost reductions, whilst maintaining service levels and saving the environment.

The importance of keeping comprehensive historic records is highlighted.
It is also essential that technical equipment is accurately calibrated prior to the start of the winter maintenance period to ensure correct application rates of de-icing materials and that the fleet is kept in good working order.

Many entries cover the necessity, where the service is contracted out, of monitoring the performance of private contractors, to ensure the quality of the services provided. Road user feedback has proved to be valuable in service assessment. Findings from user surveys are taken into account when the winter maintenance strategy is reviewed and updated.

Traffic Safety and Road Users Information

A majority of countries highlighted the importance of sharing of information about road conditions with drivers, traffic information centres and various media organizations. Traffic (information) centres which operate 24 hours a day have been set up in a number of countries. They disseminate real time information to road users by various means including radio, websites and Variable Message Signs (VMS). VMS are used to give a range of information including in many cases road and air temperatures, road closures and recommended diversion routes, wind speed, weather forecasts and general road conditions. Reduced speed limits come into operation in some countries if the road is slippery or snow I present.

The dissemination of information is not restricted to national boundaries. Five countries in the Baltic Sea Region have set up a cross border road information project.

Educating road users is also most important and there is a growing use of media campaigns to encourage road users to be careful by increasing their awareness of the inherent risks of winter driving and how their driving habits need to change.

On-going Researches and Studies

The reports illustrate that the latest technologies to continuously optimize winter maintenance operations are being tested by many countries by either improving the performance of the machinery or by developing the on-board equipment for vehicles involved in snow and ice control (integration of new technologies) but also through research into new spreading methods. Other major research involves the modernization and the improvement of the Road Weather Information Systems and pilot projects related to skid resistance measurement, road surface assessment, residual salt modelling and winter traffic problems.

Some administrations are engaged in a process of reflection with the aim of refocusing their role in the winter road maintenance process; (extended) public-private partnerships is in this case being considered as an alternative. Other countries which already contract with private companies to manage their road maintenance are developing their supervision and assessment methods.

1.4 Winter road maintenance practises – strategies to reduce their impact on the environment.

Recently, the European Union directed that any significant and sustained upward trend in the concentration of any pollutant in groundwater should be identified and reversed by 2015. Finland reacted with a research program on "Migration of alternative de-icing Chemicals in Aquifers". Aim: to identify de-icers which have the least harmful impact on vegetation, soil and groundwater. Potassium formate was found to be the most promising alternative.

To define requirements for a new German eco-label, an ecological analysis was undertaken for different products: sodium, calcium and magnesium chloride, sodium and potassium formates, urea, gritting material. Results: undifferentiated use of formiate can not be recommended, despite its very low aquatic toxicity and the fact that it's easily bio-degradable, because of its very energy-intensive production.

A life cycle assessment of the environmental impacts of spreading materials showed that in Munich half of the environmental impact was generated by the actual spreading operations themselves for salt and abrasives, including energy and vehicle emissions. One third of the impacts were made up by production and transport of gritting materials. In Nuremberg, where an energy intensive gritting agent was used, two thirds of all impacts originated from the production process. Conclusion: final judgements can only be made after careful assessment of the entire process.

Thawing agents and the trucks used to spread are both sources of pollution. International regulations and manufacturer policies require efforts in developing environmentally friendly engines and vehicles. The manufacturers focus lies on fuel consumption, exhaust emissions, noise, durability, recycling and savings in material and energy resources.

Administrations are striving to improve winter maintenance to minimize the salt consumption. Yet the efficiency of such changes in strategy is not known unless the impact on groundwater is investigated.

Sweden is now developing an appropriate tool: an automated system for monitoring groundwater salinity or "Electronic Tongue", based on a system for monitoring frost depth by wireless communication.

In a Finnish groundwater supply region salting was reduced by half and the quality requirements for friction were simultaneously reduced from 0.30 to 0.25. No changes in the number of road accident were registered and the majority of the wells showed a stabilization or a decrease in chloride concentration.

Novelties: trials were made with an agricultural by-product as an additive to rock salt in the UK. It showed a significantly lower level of apparent corrosion by the end of the season. Sweden added a sugar product to a salt solution in order to find out whether a certain amount of the salt could be replaced by this additive. The trials will be continued to get all the answers and the environmental impacts will be studied.

Other tests added tenside to the salt brine with the following results: surface dries faster, fluid creeps easier down into the pores of the asphalt, and no effect on friction.

Norway compared brine of sodium chloride and of magnesium chloride and found a tendency towards less salt consumption with the magnesium brine without reducing friction. A tendency towards increased friction values was found at temperatures below -6˚C.

Japan showed that only 5 % of the salt spread reached the cultivated areas. Result: the tolerance threshold for one of the most salinity intolerant plants (the cucumber) was only exceeded at one point.

Also in Japan, in a laboratory test, the impact of chlorides on the growth of fruit trees was established confirming that there was little impact variation between the constituents of anti-icing chemicals but a great difference in their concentrations and that plants are more susceptible to anti-icing chemicals when the plants enter their active phase, end of winter.

Lithuanian traffic is increasing and also the use of salt. An investigation showed that with the use of salt the traffic safety was improved and on the salt itself (content of moisture, chlorides and sulphates) that the quality requirements were met by all samples taken.

Every year, large quantities of polluted snow are dumped into Norwegian rivers. To estimate the impact on pollution distribution in the water and in the river sediment, simulations with mathematical models were undertaken: it was determined that there was only a low probability that snow dumping will significantly pollute rivers or fjords.

Another Norwegian study concerned a tiny lake and the effects of sodium chloride on the circulation properties of the lake water. Although the populations of zooplankton and fish seemed to be little affected by the pollution, biologists feared that if more salt comes into the lake, the water stability will increase.

For storm water discharge on a French motorway, settling tanks have been installed. Purpose: reduction of peak flow, decantation of solid materials, containment of floating waste and hydrocarbons, settling of accidental pollution and supervision of discharge qualities.

Belgium compared two storm-water basin sites in three aspects: interaction of collected water with the concrete structure, water-mineral reactions in the basin and seepages of water from the basin into aquifer.

Recommendations were made on the choice of concrete and management of the basin.

For new Swedish roads, the strategy is to leave in situ the cultural layers not directly affected rather than to excavate the entire layer. It is assumed that the soil protects the archaeological artefacts far better than the museum. Yet, excavated metal artefacts show greater deterioration than those excavated before, implying that recent pollution is responsible for accelerating the corrosion, probably by chloride-based de-icing chemicals.

Sweden used a road simulator to investigate the production of inhalable wear particles from pavement which can cause serious respiratory problems.

Important activities start at the design stage of the road and further comprise drainage and rainwater management, depots, equipment, salt management, training and communication. So winter road maintenance begins at a road's planning stage:

- Think winter maintenance at every stage of planning a road.
- A project has to take into account the exposure of the road. Plentiful sunshine on its surface allows a marked reduction of salt use.

1.5 Sharing Knowledge

1.5.1 Report from the Riga Seminar

The international seminar on Safe and Efficient Winter Maintenance Practices was held in Riga, Latvia on September 22 and 23, 2005. The seminar was planned as a regional event in cooperation with PIARC TC 3.4 – Winter Maintenance, the Baltic Road Association and the Latvian State Roads and it focusing on the Baltic states, the neighbouring Scandinavian countries, Russia, Belarus and the Ukraine.

The seminar's aims were to:

- present an overview of the current state of winter maintenance,
- understand needs and difficulties of Latvia and neighbouring countries,
- confirm the objectives and work program set for TC 3.4.

The main focus of the seminar was the management of winter maintenance operations, contracting, safety and environmental aspects.

Interest from experts and managing engineers was high as evidenced by the fact that the seminar brought together some 150 participants from 21 countries.

Mrs. Gudrun Öberg – the Chair of the TC 3.4 Winter Maintenance Committee, presented the PIARC Strategic Plan and the work programme for TC 3.4.
The session "Management and Standards" introduced that the Baltic region with a total population of 7.1 million people and 58 thousand kilometres of state roads. Winter weather conditions are very changing, influenced by Atlantic cyclones and Artic anticyclones, and are comparable with conditions in southern Finland.

During the last fifteen years, road administrations of the Baltic States worked hard to transform road management from the Soviet socialist style to modern more market oriented approaches. The close cooperation between the Nordic Road Association and the Baltic Road Association, technical assistance and support from the Nordic countries as well as technology transfer from the USA all played important roles in this process.

Performance specifications for winter road maintenance in the Baltic countries are set on the same bases and principles as in Sweden and Finland. All Baltic countries are using road weather information systems, developing their own road user information centres and cooperating with Finland in a common system Baltic Roads Net system.

The session on "Contracting" introduced the situation not only in the region but also around the world with an analysis of public and private sector roles in the delivery of optimal winter road maintenance.

Three different models of winter road maintenance management in the Baltic countries were presented. Lithuania has 11 state enterprises, one year contracts, and no competition. Latvia is contracting out 100% of the maintenance work in open tenders with the result that four separate five year contracts were won by state owned joint stock companies. Four very large contract areas with approximately 5000 km each do not stimulate competition. In the new plan for a seven year contracting period from 2007 to 2014 the network is divided into 12 areas of about 15 hundred km each. Estonia has developed a system. 63% of the maintenance works is contracted out with 56% being done by private companies, but 37 % of the maintenance is assured by the state agency.

The session on “Environmental Aspects” showed that the road administrations of the Baltic countries together with their contractors were using proven and testing new methods to minimize the negative impact of de-icing chemicals. Wet salt technology is widely used for roads with high traffic volumes. Contractors’ performance monitoring, new tools for salt distribution control on roads, experiments on pre-wetting salt with hot water and sugar brine (glucose, fructose) and heated sand use on low volume roads were reported on in the presentations from the Nordic countries.

The Seminar included a technical tour conducted in the Central and North-Eastern part of Latvia. Participants had an opportunity to see the newest contractors’ winter maintenance base at Neceri near the Riga Hydro Power Station and to attend the presentation of the biggest contractor “Central Region Roads” just inside the salt storage shelter. A captivating film was presented showcasing Latvia’s machinery operators training competitions.

Conclusions:

- Chlorides (NaCl and $CaCl_2$) are and will remain the basic de- icing chemicals for roads with high traffic volume in the region.
- Existing Road Weather Information Systems in Baltic countries do not measure the precise use of chemicals for de-icing, significant improvements are needed in near future.
- Some chloride-free anti-skid treatments need to be tested on low volume roads.

For more information please visit: http://www.lvceli.lv

1.5.2 Main conclusions from the PIARC XIIth International Winter Road Congress 2006. Technical Programme Overview

The Technical Programme was divided into six Topics. A total of 130 documents from 18 countries were presented. Japan distinguished itself once again with the number of papers it presented.

Topic I – strategies, levels of service and standards
Topic II – performance and financing
Topic III – safety and mobility in winter
Topic IV – environment
Topic V – winter maintenance management systems
Topic VI – snow and ice control technologies

Some new aspects from previous years and reported in the Winter Road Congress 2006 will be highlighted. Some are quite new while others build on earlier results.

- Think winter maintenance at every stage of planning a road!
- Out-sourcing of winter road maintenance continues to expand to more countries. There is now a need to concentrate on contractor performance monitoring. Requirements must be clearly set and measurable.
- Socio-economic models are needed to assess the consequences for road users, road administration and the society at large of changes in strategies in winter road maintenance.
- Cost-Benefit-Analysis of winter maintenance in pedestrian areas shows that the accident costs are much higher than maintenance costs.
- The full life cycle assessment of the environmental impacts of spreading materials including also fuel consumption, emissions, noise, durability, recycling, energy use in manufacture etc. need to be refined. So final judgements can only be made after analysing the whole process.
- Partnerships between road administration and road user need to be nurtured.
- The addition of sugar (glucose, fructose) to salt spreading is being trialled to determine whether a certain amount of the salt could be replaced by this additive.
- The spreading of sand with hot water (95ºC) is being used to extend the staying power of sand on frozen roads
- Remote friction sensing is being pursued.
- Enormous development is taking place in the areas of Road Weather Information Systems and Winter Maintenance Management Systems that integrates many different types of information to support transportation operations, including administration, crew call-outs, operations, and documentation.
- A new Electronic Tongue is being developed to constantly monitor in-situ levels of chlorides based on a system for monitoring frost depth by wireless communication.
- Concerns about effects of salt on buried archaeological artefacts are growing in some countries.

In spite of the numerous distractions; technical tours, visits, equipment displays etc. available to Congress attendees, the technical sessions were very well attended. It can be concluded that there is no single combination of winter road maintenance approaches suitable universally for all countries. There are simply too many climatic, societal, economic, and other environmental considerations. However, sharing knowledge and learning from each other certainly can lead to significant savings in time and precious resources.

Based on the experiences, the International Winter Road Congresses continue to be premier world forums for the international exchange of information. A final sincere wish; that to facilitate technology transfer, road administrations and their service provides employ, wherever possible, open systems design principles. In closing, we hope that the Congress till bring us all a little closer to achieving the Congress' main them 'keeping road users on the move in winter'.

1.6 Recommendations for future R&D areas

Many areas deserve attention in the future. Both in the areas listed above under the title news and in areas where development has continued for many years already but also in quite new areas. Stimulating topics are listed below:

- The use of weather and road condition related traffic management and information systems including the use of the newest technologies.
- The application of Winter Maintenance Management Systems on the strategic level and the tactical (day-to-day) level.
- Climate change – its' impacts and pro-active management to mitigate the impacts.
- The on-going development of spreading methods.
- Study of traffic safety including also pedestrian safety.
- Finally, how to share knowledge in an efficient way.

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DRAFT CONCLUSIONS

Transport by road considerably increased these last decades and winter viability became a very important public utility activity for the economy, since it is a question to allow people and goods circulation when the weather conditions are degraded and is likely to make circulation difficult.

One can think that currently the majority of the countries use the services of private companies to ensure winter service, but the entrusted missions, the form of the contracts, the type of company to which one has recourse, the controls of works concerned, etc… differ notably.

These differences are related to the history, the importance and the duration of the weather perturbations, sometimes recent political upheavals (countries in transition) and more and more to the opening towards the companies of activities traditionally reserved for the administration.

Winter road maintenance activities contrary to the majority of the activities in the civil engineering field remains a random activity in many cases, indeed the meteorological phenomena is difficult to envisage precisely, can be of intensity, nature, extended and duration very variable, this is why to draw up contracts with the companies within the framework of a loyal and equitable competition, while optimizing use of the financial resources and the results obtained, remains a difficult exercise to realize.

The levels of service must be very clearly defined and well understood by all parties. The check procedures in particular for the road condition are to be developed by establishing indicators and methods of measurement. Which indicators are best adapted? Shall the definition of the levels of service be done by prescribing methods or by laying down objectives?

How to compare the costs between countries? Which is the method of payment best suited to this type of service? Payment with a fixed price for work performed or by the hour? The answers of these questions differ from country to country.

Globally, data collected worldwide by road weather information systems are currently used to support winter roadway maintenance. The potential for integrating them into decision support systems or resource management systems is pressing and important. This is why international standardization initiatives are needed to provide a shared basis for capturing and processing road weather information. This would make it easier for organizations to create links to each other that would foster data sharing and, from a broader perspective, the sharing of information on good practices while contributing to international harmonization.

In assessing the environmental impacts of winter maintenance operations, all of the factors should be considered, not just the chemicals used but also the environmental impacts of the spreading operations. Those can include fuel consumption, emissions, noise, durability, recycling, energy use in manufacture etc. So final judgements can only be made after analysing the whole process. Administrations are striving to improve the winter maintenance to minimize the salt consumption. Yet the efficiency of such changes in strategy is not known unless the impact on groundwater is investigated. But to take all effects into consideration a socio-economic model is needed to assess the consequences for road users, road administration and the society at large of changes in strategies and maintenance.

A lot has been done to support operators in winter road maintenance but there is still a need for further development and new methods in Road Weather Information Systems and Winter Maintenance Management Systems on a day-to-day level that integrates many different types of information to support transportation operations, including administration, crew call-outs, operations, and documentation.

Finally with the climate of the world changing we face new challenges to determine its' impacts and then to pro-actively manage the impacts.