

FINLAND'S REVISED WINTER MAINTENANCE STRATEGIES AND QUALITY STANDARDS 2001

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1. Abstract

The winter maintenance policy of public roads in Finland was previously revised at the end of 1995. The policy was revised at that time to bring it in line with the extensive Road Traffic in Finland Project. The results of research conducted in the project are for the most part still usable and also form a basis for new policies. Several studies were also made on the general development of road safety, pedestrian and bicyclist safety, and the environmental and economic effects of maintenance.

In 2001 the Finnish National Road Administration was divided into the Finnish Road Administration, which orders services from producers, and the Finnish Road Enterprise, which takes care of construction and maintenance and also provides consultation services. As the functions were separated it became necessary to reconsider the manner in which the level of service is specified in contract documents, especially regarding quality standards, so that all involved parties would understand the issues in the same way. Correct procedures and correct timing have a major impact on road safety and smooth traffic flow. Especially on main roads, they also affect optimal salt use and thereby in the long term they affect the environment.

The winter maintenance policy is a document that describes the principles and policies according to which the orderer wishes winter maintenance to be implemented. It specifies the desired level of service and includes the main quality standards used to describe that level of service. The policy also presents current views that act as guidelines for winter maintenance. Although the main idea of the guidelines in the policy is still the same, they have been partly revised and supplemented. The revised policy and quality standards are being taken into use in Finland in public road contracts beginning October 1, 2001. This presentation brings forth the issues that have centrally affected the formation of the policy, presents the new policy and quality standards, and describes how they have changed compared to the previous ones.

2. Background

The Finnish Road Administration, which is a state agency, is responsible for the management of the country-wide public road network. In Finland, streets in cities and municipalities are the responsibility of the municipalities. The long private road network is the responsibility of the landowners living along the private roads. There are about 78,000 km of public roads, 24,000 km of streets and planning area roads and nearly 300,000 km of private roads.

The policy presented in this presentation concerns the public roads that are the responsibility of the Finnish Road Administration, which carry around 65 % of all road traffic. The policy needs to be reviewed and revised periodically, especially when the operating environment changes. The previous winter maintenance policy was taken into use in Finland in the autumn of 1995. The policy was based on the extensive Road Traffic in Finland Project. The results of research conducted in the project are for the most part still usable and also form a basis for new policies. Several studies were also made on the general development of road safety, pedestrian and bicyclist safety, and the environmental and economic effects of maintenance.

Even though the policy does not change much, the review process itself provides an opportunity for internal discussion and for hearing cooperative partners. This type of discussion was deemed very important in Finland at the end of 2000, because in the beginning of 2001 the former Finnish National Road Administration was to be divided into the Finnish Road Administration, which functions as a state agency, and the Finnish Road Enterprise, which is responsible for production activity. After the change the Finnish Road Administration would order all work from private enterprises. From the standpoint of commissioning it was important to unify practical procedures. The goal was to minimize the need to specify job-specific details in the contracts. The decisions made in the policy are carried out in practice as district-specific maintenance class decisions, new quality standards for regional contracts and contract-specific details.

Winter maintenance is implemented in Finland as regional contracts based on the principle of quality responsibility. Winter conditions may change quite quickly, so to make road users satisfied, contractors must be able to function at the right time and select the correct procedures for each situation. Therefore, the policy is an important way to inform contractors of the principles of winter maintenance.

The winter maintenance policy is a document that describes the principles and policies according to which winter maintenance is to be implemented and the trafficability of the road network is guaranteed in winter. It specifies the desired level of service and includes the main quality standards used to describe that level of service. The policy also presents current views that act as guidelines for winter maintenance. Although the main idea of the guidelines in the policy is still the same, they have been partly revised and supplemented. The following paragraphs summarize the most significant factors that have affected changes in the policy and present the main parts of the new policy and quality standards.

3. Basis of winter maintenance

Roads are important in all societies, but they are especially significant in Finland, which has a large surface area but is sparsely populated. What's more, from the viewpoint of central Europe, Finland is marginally located. Most exports to this most important market area are transported by sea. From the standpoint of the competitiveness of industry and commerce, functional logistics, and especially the functionality of the internal transportation system, are vital. Low traffic volume, a long road network and year-round trafficability naturally mean relatively low cost efficiency. For this reason the guidelines and the selection of areas of emphasis have a major impact.

During the term of this policy no changes are expected in the road network or in road management responsibility that would have a significant impact on winter maintenance. Traffic is

expected to grow at an annual rate of about 1.5 %. Traffic will increase the most around growth centers and on the main roads in the south. This increase will cause a rise in the proportion of the road network placed in the highest maintenance class. As the road network improves, road length and the managed surface area will grow somewhat.

Winter maintenance has a significant effect on the functionality of the entire transportation system. Traffic volume during the six winter months is around 44 % of the year-round volume. In many fields of industry and commerce, the share of transports taking place in the winter months is greater than that in summer. Communities, industry and commerce that depend on transports and road traffic expect transportation to function reliably all year round. Regardless of our northern location, Finland’s winter is not especially difficult from the standpoint of road management. The long-term average snowfall converted to millimeters of water varies from 120 to 220 mm in different parts of Finland. This amount of snow accumulates throughout the winter season, mainly as snowfalls under 10 mm. Conditions in different parts of the country are different. In the coastal areas, where the climate is closer to a marine climate, weather and driving conditions vary greatly and slippery conditions develop easily. In the country’s eastern and northern parts the weather resembles a continental climate and is clearly colder.

The winter maintenance policy is based on current traffic laws concerning winter tires and especially studded tires. Studded tires are allowed in Finland from November 1 to March 31, and about 90 % of cars are equipped with studded tires, although studless winter tires have become more popular in recent years. The policy is also based on the possibility to use salt to combat slipperiness. Figure 1 shows the trend in salt use in 1959-2000. The exceptionally little use of salt in 2000 was due to a mild autumn and early winter, resulting in practically no salting in southern Finland.

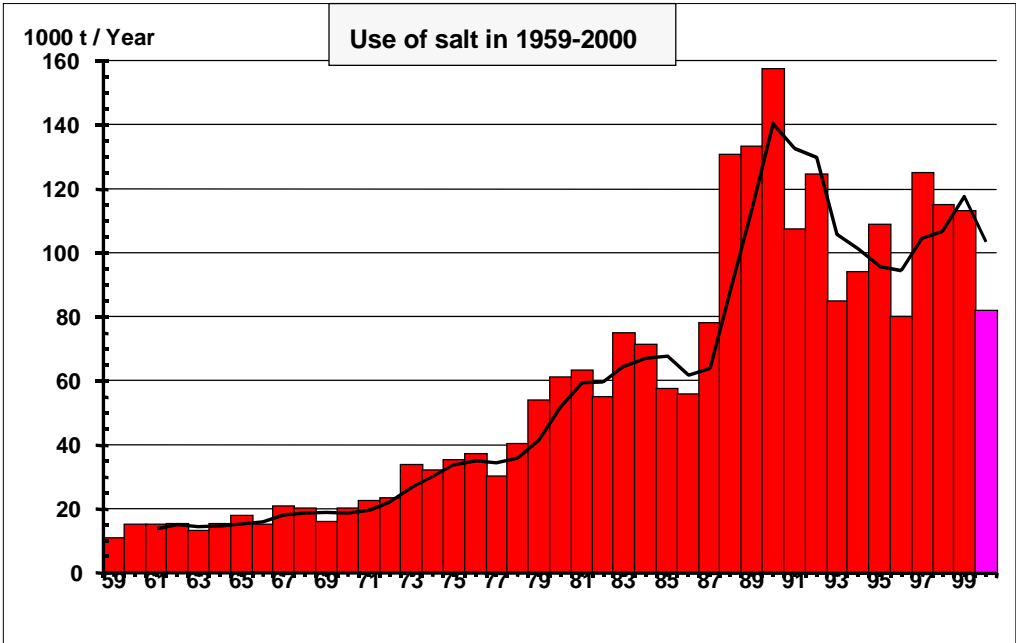


Figure 1. Use of salt in Finland in 1959-2000.

The long-term road management policy (Road management policy 2015) proposes that, in general, the level of maintenance of the road network should continue to be kept at the current level.

This level of maintenance should be maintained even though overall funding of road management decreases or the cost level rises. The main goal is to increase the productivity of winter maintenance so that a growing need for maintenance can be satisfied with less resources.

Other bases for the winter maintenance policy include the long-term objectives of various ministries, especially with respect to road safety and sustainable development.

4. Expectations of winter maintenance

In addition to the above-mentioned objectives set by higher authorities, the winter maintenance policy is based on the expectations of different road user groups and interest groups. These groups emphasize the significance of good traffic conditions from the national perspective and from the standpoint of regional development. The smoothness and safety of traffic, especially on the main road network, is seen as an important matter. Because long-distance transports mainly take place at night and they are increasingly tied to schedules, sufficiently good conditions are necessary 24 hours a day.

Ensuring the trafficability of the lower-class road network is necessary from the standpoint of the functionality of transportation. Many industrial raw material shipments, especially in agriculture and forestry, begin on the lower-class road network. Road users want the level of service on quiet roads to be better than it currently has been (during the past few years). They want to see improvement in anti-slipping procedures, in particular.

The Ministry of Transport and Communications has emphasized the importance of pedestrian and bicycle traffic for a long time, already. The intent is to raise the status of light traffic to the level of motor vehicle traffic and to make it an alternative form of travel. Pedestrian and bicycle routes are of major importance in people's day-to-day travels, especially on short trips. The number of pedestrian and bicycle routes in Finland is high in proportion to the size of the population.

Responsibility for road safety is one of the main factors in winter maintenance. Nevertheless, the risk of being in a serious accident in Finland is at the same level in winter as it is during the rest of the year. Only the number of minor accidents (fender-benders) is higher in winter than in summer. Head-on collisions are the only type of accident that occurs more often in winter than in summer. Snowfalls and driving conditions together with other factors increase the risk of drifting into the lane of oncoming traffic. According to the latest study, 47 % of fatal winter accidents occurred when it was snowing, even though snowfalls occur only 10 % of the time. Table 1 shows the relative risk of being in an accident in winter and in summer. If the risk ratio is higher than 1, the wintertime risk is greater than the summertime risk.

The main environmental problem of winter maintenance is still the effect of salt on groundwater. Although this issue has been studied much in Finland and it is still being developed, no simple solution exists. The objective is to decrease the total amount of salt used, and especially to decrease the amount of salt ending up in groundwater. Groundwater shielding is built along approximately 15 km of road per year in Finland. The new policy states that roads in groundwater areas will be maintained using no salt or less salt than is currently used. This means, however, that a lower speed limit must be set for these roads. The behavior of biologically decomposable salts (acetates and formiates) in the ground is being studied, and whether they would provide even a partial solution to the rising chloride contents.

Table 1. Ratio of wintertime (6 mo.) and summertime (6 mo.) accident risk in Finland.

	Coast	Inland
All accidents		
ADT < 1500	1.33	1.31
ADT 1500 - 6000	1.45	1.43
ADT > 6000	1.36	1.41
total	1.39	1.38
Personal injury accidents		
ADT < 1500	0.83	0.88
ADT 1500 - 6000	1.00	0.98
ADT > 6000	1.23	1.12
total	1.02	0.97
Deaths		
ADT < 1500	0.78	0.89
ADT 1500 - 6000	1.21	0.93
ADT > 6000	1.02	0.90
total	1.03	0.91

5. Policy

The main principles of the new winter maintenance policy are presented as theses:

Uniform, regionally equal prerequisites for travel throughout the country.

Uniform principles of categorizing road maintenance and uniform quality standards are observed throughout the country. Nevertheless, common principles are adapted according to regional and local needs and conditions. Especially differences in climate are taken into consideration.

A uniform level of service on connecting traffic routes.

Regardless of administrative borders, contract areas or different traffic volumes, the level of service of the road network should be kept sufficiently uniform along connecting traffic routes from the standpoint of the road user. Maintenance area borders should be located logically from the viewpoint of traffic.

Maintenance of main roads according to climate areas.

Winter climate differs in coastal areas and further inland, for which reason operating procedures are different. Salt is used to keep the main roads mainly bare in the coastal area. Less salt is used inland and more wintry driving conditions more often prevail on the road network.

The level of service is focused according to location and time. The demands of traffic and the condition of the road network are taken into consideration.

Even on similar roads, the demands of traffic vary with time and location. The amount and role of heavy traffic and public transport routes should be taken into consideration when deciding the maintenance class and specifying possible road-specific quality standards.

Winter maintenance guarantees the best possible wintertime road safety and expected driving conditions.

The basic principle is that the wintertime road safety risk is no higher than during the rest of the year. It is important from the standpoint of road safety that the level of maintenance is as uniform and predictable as possible. Unexpected borders and other variations that lower the quality level should be avoided. Wintertime road safety requires matching the level of maintenance with speed limits.

The level of service is specified cost-effectively. Roads with little traffic have a basic level of service.

From the viewpoint of efficiency and good effectiveness, the quality level and amount of maintenance are graded according to road use. A basic level of service that allows 24-hour travel is guaranteed on quiet roads. However, travel may become significantly more difficult during exceptional weather conditions, which may occur a few times per winter.

Maintenance of the road network and its parts adheres to the principle of social fairness.

Road user categories and the routes and parts of routes that serve them are given equal status when defining the level of quality. Sufficiently good maintenance of pedestrian and bicycle paths and bus stops promotes the role of pedestrian and bicycle traffic. The special demands of pedestrian and bicycle traffic are taken into consideration in maintaining the shoulders of roads where there are no separate routes for such traffic.

Environmental hazards are reduced. The use of salt is limited in groundwater areas.

The total amount of salt used is reduced by revising the maintenance classes of the road network and groundwater risk is reduced by locally reducing the use of salt. Contractors are required to have knowledge and be precise in the use of salt, so that as little salt as possible is used, but keeping road safety in mind.

The Finnish Road Administration as the orderer specifies the level of service and ensures that contractors keep the roads at the agreed quality level.

It is important to ensure that the intent and content of the winter maintenance policy and the quality standards based on the policy are known and taken into consideration throughout the entire chain of operation from the orderer to the employees of the contractor. From the standpoint of guaranteeing the level of service it is important that contractors are continuously aware of developments in the weather and driving conditions and the condition of the road network.

Providing road users with information improves their chance of affecting their own safe, smooth wintertime traveling.

Traveling in winter conditions requires adaptation of driving and travel habits in all situations and preparation according to the weather and driving conditions. Providing information related to winter traffic boosts road users' own chances of acting safely and responsibly.

6. Level of service in different maintenance classes

A uniform level of service and a classification describing that level are used throughout the country. The level of service is mainly defined according to traffic volume, the road's functional class and the regional climate. The road network is divided into five main maintenance classes (Is, I, Ib, II, III). In addition, class Ib has a corresponding maintenance class T-Ib for built-up areas. Each class has a different level of service and quality standards. Road classes are defined by connecting route in such a way that they function logically from the road user's point of view, and differences in quality do not cause unexpected situations. In deciding the maintenance class of a road not only are the classification criteria taken into consideration, but also local conditions, the nature and composition of traffic, the speed limit and qualitative integration with the level of service of the municipality's road network.

If special traffic needs so require, maintenance methods, timing or quality on specific sections of road may be modified locally without changing the maintenance class. The spirit of serving and customer orientation of winter maintenance calls for ensuring a good level of maintenance at times when the road network has an abnormally large amount of traffic or the nature of the traffic differs from normal. Such cases are the traffic peaks at Christmas and on other holidays.

The division of the road network into maintenance classes according to traffic volume is illustrated in figure 2.

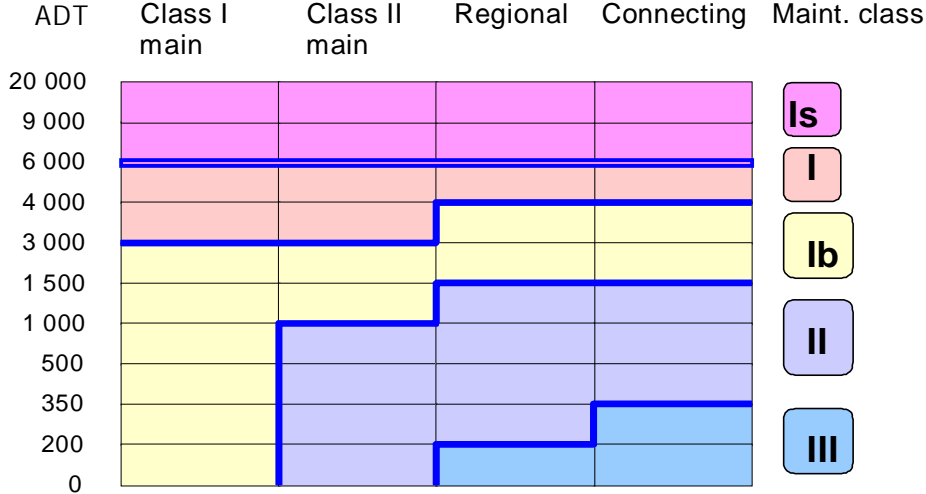


Figure 2. Division of the road network into maintenance classes according to traffic volume.

Pedestrian and bicycle paths are divided into two maintenance classes (K1, K2). This way the procedures of different routes can be timed to serve traffic on the route as well as possible at the correct time, especially in the case of commuter traffic, routes to public transport, schools, day care centers and services.

Most of the main road network belongs to categories Is, I and Ib. Categories Is and I are completely free of ice and snow most of the winter. Salting is the main anti-slipping procedure. Class Ib is maintained using less salt and the conditions are clearly more wintry than in categories Is and I, but otherwise the level of maintenance is high. Roads have been intentionally moved into this class with the purpose of using less salt. The reasons have been environmental impact (salt penetrating groundwater) and drivers’ negative attitude toward the use of salt.

Classes II and III are used on quiet roads. Very little salt is used. Instead, sand is used to combat slipperiness. The friction requirements of these roads are also lower, so the characteristics of car tires are very significant. Figure 3 shows road length, traffic volume and rough estimates of unit costs, and figure 4 shows the typical conditions of the different maintenance classes.

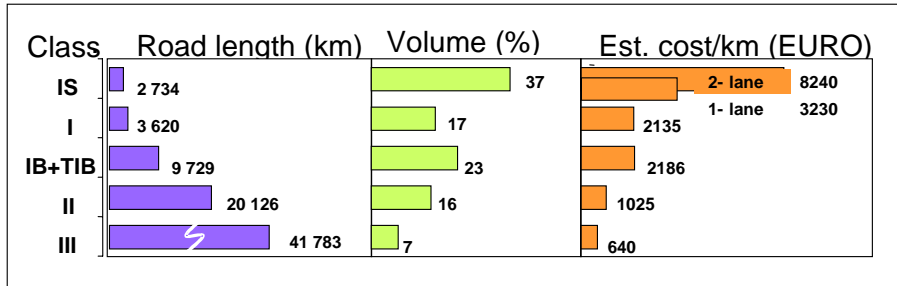


Figure 3. Distribution of the road network and traffic volume among maintenance classes in Finland and the approximate costs of different maintenance classes (EUR/km). 1 EUR = \$ 0.9.

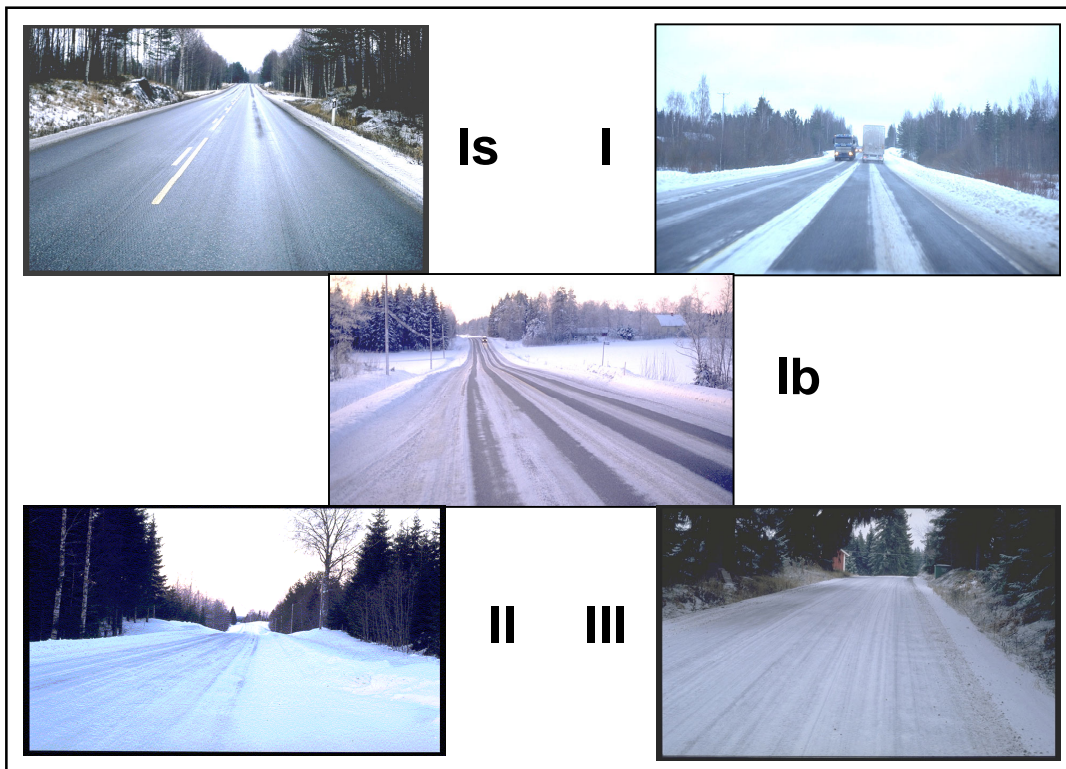


Figure 4. Typical conditions on roads in different maintenance classes.

7. Quality standards

One of the quality standards of anti-slipping procedures in Finland is a friction value, which is measured with a device that measures deceleration. Evaluation of driving conditions also includes a verbal description (table 2). The friction values are not exactly comparable with the values obtained with other devices like the BV-11 equipment commonly used at airports. The device (C-trip) that measures the friction value on the basis of deceleration is reasonably inexpensive and it can be installed on an ordinary passenger car, making its use routine for both the orderer's supervisor and the contractor. Although the measurement results are not fully reliable, the measurements make it easier for the orderer and contractor to agree on the prevailing level of quality than without any measurements.

Table 2. Correlation between friction values and driving conditions

Friction value	0.00 – 0.14	0.15 – 0.19	0.20 – 0.24	0.25 – 0.29	0.30 – 0.44	0.45 – 1.00
Description of road surface	bad driving conditions, wet ice, very slippery	icy, slippery	tightly packed snow, satisf. winter conditions	rough, packed ice and snow, good winter conditions	bare and wet, not slippery	bare and dry, not slippery

Friction measurements are held important in Finland because packed snow and ice is also allowed on the main roads. In many places the traffic volume on the main roads is so low that a reasonable amount of salt is not able to keep them bare. Today environmental reasons strongly favor less use of salt. However, from the standpoint of road safety it is important to ensure that there is enough grip on the roads to allow safe driving under the circumstances.

The following tables present the main quality standards of winter maintenance. These standards only concern the actual lane of traffic. Separate winter maintenance quality standards describe other parts of the road, like bus stops, rest areas, shoulders, ramps and road equipment.

Table 3. Quality standards of anti-slipping procedures

QUALITY STANDARDS OF ANTI-SLIPPING PROCEDURES							
Winter maintenance class	Is	I	Ib	II	III	K1	K2
Normal	0.30	0.28	0.25	According to traffic needs	According to traffic needs	According to traffic needs	
Friction requirement	road surface below -6 °C 0.25	road surface below -4 °C 0.25	spot sanding 0.25 line treatment 0.20-0.22				
At night	22 - 05 0.28	22 - 05 0.25	22 - 05 as needed	22 - 06 as needed	22 - 06 as needed	after 22 K1 by 05 K2 by 06	
Cycle time	2 h	2 h	salt 3 h sand 4 h	6 h line sanding	10 h line sanding	2 h	

The **friction requirement** requires at least half of the width of the lane normally used by traffic to meet the requirement. Driving conditions in which the middle of the road and the area between the ruts meet the requirements but the ruts do not, do not meet the quality requirements.

The **temperature limit** refers to the lowest temperature of the road surface where the friction requirement of 0.30 is effective on winter maintenance class Is roads and 0.28 on winter maintenance class I roads. If the temperature is lower, the friction requirement of class Is and I roads is 0.25.

Table 4. Quality standards for snow removal.

QUALITY STANDARDS FOR SNOW REMOVAL							
Winter maintenance class	Is	I	Ib	II	III	K1	K2
Maximum snow depth	4 cm	4 cm	4 cm (8 cm, night)	8 cm (10 cm, night)	10 cm (10 cm, night)	3 cm (8 cm, night)	
Cycle time	2.5 h (slush 2 h)	3 h (slush 2.5 h)	3 h	4 h	6 h	3 h	4 h
If snowing stops after 22 at night	Plowed clean within cycle time		05 or cycle time	06 or cycle time	06 or cycle time	05	06

The maximum snow depth must not be exceeded while it is snowing or during the cycle time thereafter. Only half as much slush is allowed as snow. Plowing must be started no later than when half the maximum amount of snow has accumulated on the lane. This starting threshold is not used at night in classes II, III and K. The starting threshold for class Ib at night is 4 cm.

Table 5. Quality standards for surface evenness.

QUALITY STANDARDS FOR SURFACE EVENNESS							
Winter maintenance class	Is	I	Ib	II	III	K1	K2
Evenness requirement	-	1 cm	1.5 cm (Tib 3 cm)	3 cm	3 cm	2 cm hindering ruts	
Cycle time	1 day	1 day	1 day	2 days	3 days	12 h	

The evenness requirement refers to the maximum allowed depth of ruts and unevenness in packed snow. During very cold periods when salting is not possible, the evenness requirement of maintenance class Is is 1 cm. The evenness requirement does not allow sharp edges on ruts (classes I and Ib). In other classes, including Tib, the maximum edge is 10 mm. Even during the cycle time, evenness must not be worse than the requirement by more than 1 cm.

8. Effects of the changes in the winter maintenance policy

One of the main starting points in renewing the winter maintenance policy was that the cost level should not rise significantly. It is not possible to improve road safety by means of the changes at the current level of funding. Studies have shown that it is difficult to improve the safety of the main road network using winter maintenance procedures alone, because the average wintertime and summertime accident risks are nearly the same in Finland.

According to the new policy, the effects of road salt on groundwater will be further reduced. Winter maintenance in risky groundwater areas will gradually change to nearly salt-free maintenance. At the same time, safety will be promoted by lowering speed limits. The traffic volume limit on the inland salted road network was raised, which means winter conditions will prevail on 1000-2000 more kilometers of road. At the same time the maintenance class of the main road network maintained with little salt was improved (class Ib). The friction requirement of maintenance class I was lowered slightly in an attempt to prevent salting just to be sure. The contractors' salting procedures will be guided and controlled more closely.

The maintenance level of the lower-class road network was raised slightly. It is hoped that changes in the borders of classes in the lower-class road network will improve the functionality of transportation. Another purpose of the change is to improve regional and social equality. Customer-orientedness was added by focusing and timing maintenance procedures. Roads in built-up areas were also taken into consideration in the maintenance classification. Maintenance of pedestrian and bicycle routes was improved so that the most important routes (approx. 10 %) will be taken care of more quickly.

Approximately 90 million euros a year are used for winter maintenance in Finland. The changes in the winter maintenance policy are expected to increase winter maintenance costs by about 2.5-3.4 million euros, or about 2.9-3.8 million USD.