

# ASSESSMENT OF EXPERTISE AND SKILLS OF WINTER MAINTENANCE OPERATORS

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## ABSTRACT

A research program, initiated by the Swedish Transport Administration and the Norwegian Public Roads Administration in 2012, will develop qualifications standards for winter maintenance crew. The objective of the program is to ensure competent winter maintenance operators to get safe and effective flow of traffic with low cost. The program constitutes a part of the project “Scandinavian Infrastructure Competence”, a Scandinavian cooperation project within the European Regional Fund.

A system for examination of winter maintenance personnel is developed. The main focus of the first stages has been on the expertise and skills requirements for winter operation managers and winter operation crew. The competence requirements are described according to a competence model based on National Qualifications Framework (NQF) for Sweden which in turn is developed from The European Qualifications Framework (EQF). Later a management system for secure handling of personnel certificates will be developed.

The examination of the candidates is performed by a set of questions with multiple choice answers. To pass the examination the candidate must give the right answer to 70 – 80 % of the total amount of questions.

The implementation of the competence requirements in the winter maintenance contracts will start in 2014.

## 1. INTRODUCTION

Winter maintenance of roads constitutes a major factor to road safety and traffic flow quality in Sweden and Norway. At the same time, winter maintenance represents a considerable cost for the road administrations.

Competence in performing winter maintenance is of vital importance in order to provide the road users with safe and available roads at lowest costs and with minimum environmental damage.

Figure 1 – Winter maintenance is of vital importance to traffic flow and safety.  
(Photo: Knut Opeide, Norwegian Public Roads Administration)



In this perspective, it is important to identify the competence needs for winter maintenance and secure that all persons involved in winter maintenance possess the necessary competence. This paper describes work performed to identify the competence requirements in winter maintenance, how the requirements could be expressed in a practical and contractual way and how the competence could be verified on a personal level.

## **2. MAINTENANCE CONTRACTS IN SWEDEN AND NORWAY**

### **2.1 Winter maintenance contracts**

Winter maintenance in Sweden and Norway is carried out through maintenance contracts procured by competitive tendering in an open market. The maintenance contracts also include other maintenance activities in addition to winter maintenance, as drainage, road equipment, vegetation care, etc. The contracts normally cover a road network of 300 – 600 km in Norway and 700 – 1 200 km in Sweden, within a defined geographical area. Winter maintenance often constitutes 40 – 70 % of the costs in the contracts.

The procurement strategy differs somewhat between Sweden and Norway. The Swedish Transport Administration base their procurement strategy on a business model where the contractor has the main responsibility for designing and performing the maintenance activities while the Transportation Administration acts as a pure procurer or client.

The Norwegian Public Roads Administration is governed by instructions from the Department of Transportation stating wide responsibilities for the Administration with regard to important national issues regarding transportation and transportation infrastructure, including the maintenance and developing of knowledge and competence. This is publicly known as the Administration's "sector responsibility".

These two different strategies result in different manners of operation within the two agencies although the aims most often are the same in both countries. With regard to securing competence within the winter maintenance area the Public Roads Administration in Norway, according to their instructions, has developed and offer courses in winter maintenance to the contractors, while The Swedish Transport Administration seeks to

describe competence requirements and leave contractors or the market to develop the necessary educational systems.

## 2.2 Contract specifications and regulations

The winter maintenance specifications are designed in the same way both in Sweden and in Norway. The road network is divided into 5 road classes according to importance and traffic volume, including separate classes for roads for pedestrians and cyclists. Different specifications are assigned to each class, based on socioeconomic and political considerations. The main specification consists of requirements regarding road condition (friction, thickness and evenness of snow/ice-surface) during stable periods with no snowfall and requirements concerning start-up time and continuation of winter activities as plowing, salting and gritting during periods with snowfall.

The payment for winter maintenance in both countries consists of a combination of a fixed sum per year and variable part related to the work carried out. The variable part can be related to the number of occurrences of specific weather conditions, length of treated road, number of km plowed, tons of salt spread, etc.

## 2.3 Competence requirements

Both Sweden and Norway have implemented competence requirements in the maintenance contracts. In Sweden, the requirements are stated in contract documents SBD, Level of service for maintenance, and appendix 5 to AF, Administrative regulations [1]. The regulations describe competence requirements for the contract manager, manager for winter maintenance and personnel engaged in winter maintenance operations. The managers should have documented knowledge of winter maintenance and they must pass a standardized examination in the field of road weather and road weather information systems. All personnel engaged in winter operations should have at least 1 year practice within winter maintenance.

In Norway, the competence requirements regarding winter maintenance are regulated in contract document no. C3 Special Contract Regulations [2]. These requirements include the following regulations:

The contractor is obliged to provide for the competence necessary for carrying out the work according to the contract.

All personnel engaged in winter maintenance activities should attend course (3-4 days) given by the Public Roads Administration and pass an exam in connection to the course.

The contractor is obliged to develop procedures to ensure that all use of vehicles, machines and equipment is performed by persons with adequate training.

## 2.4 Education in winter maintenance

In Sweden there have been two available winter maintenance education and training courses, both given by the Swedish Transportation Administration's Education Center:

One course is given in Winter Maintenance with duration of two days and covering the following subjects: standards and policies, information systems, road weather services, planning, de-icing and gritting, snow removal and other winter activities. The other course covers the Swedish Road Weather Information System (VVIS) and includes theory and

practical training for two days. In the future, the Swedish Transportation Administration will not deliver courses in winter maintenance, but depend on the market to develop adequate courses and training according to the competence requirements set forward by the Administration.

The Public Roads Administration in Norway has, based on their national sector responsibility and the fact that there exists no suitable education and training for winter maintenance operators available, developed a winter maintenance course. The Administration takes responsibility to carry out this course every year, making them available to all contractors that are engaging in a new winter maintenance contract. This course includes the following subjects: Decision support systems, snow removal, de-icing and gritting, other winter activities and traffic safety. The course cover 4 days, including 1 day practical training related winter maintenance equipment.

In addition, the Norwegian Public Roads Administration also gives courses for managers for maintenance contracts, including subjects related to winter maintenance. The Norwegian University of Science and Technology gives a two week post-qualifying education in winter maintenance and several university colleges give courses in road maintenance including winter maintenance.

### **3. RESEARCH PROGRAM: SCANDINAVIAN INFRASTRUCTURE COMPETENCE**

#### **3.1 About “Scandinavian Infrastructure Competence”**

The work reported in this paper is a part of a larger research project called “Scandinavian Infrastructure Competence” (SIK) [3]. The project is financed partly by the Swedish Transport Administration, Norwegian Public Roads Administration and the Norwegian Rail Administration, and partly by the EU via Interreg IV A Öresund-Kattegat-Skagerrak (Interreg ÖKS). Interreg ÖKS is a Scandinavian cooperation project within the European Regional Fund, which sponsors cross-border cooperation within the EU. SIK has a budget of EUR 2 million.

“Scandinavian Infrastructure Competence” is a large competence project managed by the Swedish Transport Administration, the Norwegian Public Roads Administration and the Norwegian Rail Administration. During the period 2012–2014, the competence requirements set by procurers in the construction industry are to be reviewed. The objective is to take a step towards a joint Scandinavian set of requirements, which will also form the basis for a model for certification and management of the requirements.

In the longer term, the project shall contribute to cross-border cooperation between suppliers, consultants and contractors, create greater attraction for the industry and provide greater utility from the money invested.

The project objectives are:

- Get more for the money invested
- Create safer working environments
- Increased cross-border mobility
- Increased diversity in the industry

The project shall map and safeguard the procurers’ requirements for supplier competence for critical work during execution. This means requirements for competences set by the

procurer over and above professional competence on the part of the executor. This relates, for example, to safety work and competence within environmental issues as well as attitude and behavior.

Within the framework of SIK, and in cooperation with industry actors, a number of full-scale tests of the requirement models shall be carried out during operations in progress. Priority areas for testing of the requirement models are winter maintenance and safety work.

### 3.2 Winter maintenance: Competence requirements

“Competence requirements in winter maintenance” constitutes one focus area within the SIK research project. The work in this area is managed by the Swedish Transport Administration and the Norwegian Public Roads Administration and carried out in close cooperation with the contractor industry.

The objective for this program is to establish common competence requirements for those who carry out winter maintenance in Sweden and Norway and to develop adequate methods for verifying that individual persons possess the required competence. This will make it simpler for contractors to work across the borders between Sweden and Norway and ensure competitive prices and the right quality. Good competence will also ensure better working environment and a higher status for the industry and the winter maintenance area. This could contribute to increase in recruiting to both the contractor industry and the public agencies.

In addition to the Swedish Transport Administration and the Norwegian Public Roads Administration, several contractors from the Öresund-Kattegat-Skagerrak region in Sweden and Norway participate in the project: Mesta, PEAB, NCC, Skanska and Svevia, many of them include their sub-contractors in the project work. The work is also performed in close connection with industry organizations as Byggindustrin (BI, Building Industry Sweden), Entreprenørforeningen – Bygg og Anlegg (EBA, Norwegian Association of Contractors), Maskinentreprenørenes Forbud (MEF, Norwegian Association of Heavy Equipment Contractors) og Norges Lastebileier-Forbund (NLF, The Norwegian Haulier’s Association) and with trade unions within this industry.

## 4. RESEARCH PROCESS

The competence requirements and the method for verifying personal competence are developed through a staged approach as follows:

1. Describe and compare winter maintenance in Sweden and Norway with regard to procurement strategy, specifications, contract regulations, competence requirements and education systems.
2. Identify critical task within winter maintenance
3. Develop and describe competence requirements
4. Develop a system for verification of individual competence of operators and carry out practical tests of the verification system
5. Evaluate the tests and develop complete competence requirements and verification system

Task 1 – 4 are to be completed during 2013, task 5 will be dealt with in 2014.

## 5. CRITICAL WORK TASKS IN WINTER MAINTENANCE

In order to define and describe the competence requirements for winter maintenance, it is necessary to identify the critical tasks in winter maintenance. The work in this phase of the project is restricted to deal with the two executing activities of winter maintenance; operational management and maintenance operations. The planning of winter maintenance, complete activities and special task related to avalanches, drifting snow and mountain road sections are to be dealt with later.

In close cooperation with the Swedish and Norwegian client agencies and winter maintenance contractors in both countries, the following tasks were identified as critical in winter maintenance:

### Operational management

- Planning of winter maintenance routes, re-allocating of resources due to traffic congestion or equipment breakdown
- Monitoring and interpretation of road weather information
- Monitoring and interpretation of road condition information
- Decision of snow and ice control actions and time for action
- Actions during extraordinary weather conditions (heavy prolonged snowstorms)
- Best practices during difficult weather conditions (super cooled rain, extremely cold periods, etc)
- Other complete winter activities (clearing of snow for sight, cleaning of signs, removing icicles, thawing for water drainage, etc)
- Traffic information
- Inspection and documentation

### Maintenance operations

- Snow removal – snow plowing, snow and ice grading
- Friction improvement - use of salt (de-icing, anti-icing, anti-compacting) and sand (gritting)
- Winter maintenance equipment (connect, adjust, calibrate, daily maintenance)

These critical tasks form the basis of developing requirements for competence related to winter maintenance.

In some places, the maintenance crew is not directed by winter operational managers, but makes their own decisions whether to start maintenance operations or not. In these cases, the maintenance crew must possess some of the competence required for operational managers, especially regarding monitoring and interpretation of road weather information and decision making for snow and ice control actions.

## 6. COMPETENCE REQUIREMENTS

The competence requirements are described according to a competence model based on National Qualifications Framework (NQF) for Sweden which in turn is developed from The European Qualifications Framework (EQF) [4].

The core of the adjusted model for winter maintenance competence concerns 4 reference levels describing what a learner knows, understands and is able to do, Table 1.

Table 1 – Model for describing competence requirements

Level	Name	Description	NQF-level
4	Practiced	Possesses general perspective, able to identify, formulate, analyze, plan, evaluate and solve problems, able to execute complex tasks	6
3	Experienced	Able to make plans for his own field, execute and identify resources for specialized tasks. Able to solve complex problems within his field.	5
2	Confident	Able to identify and use relevant concepts, theories, models, materials, equipment and methods within the field. Able to work according to instructions and perform practical and theoretical task within given time limits.	4
1	Basic	Able to choose and make use of information with assistance of advised methods, equipment and materials.	3

Level 1 will only be used to a small extent, mainly for apprentices. Most activities within winter maintenance are supposed to belong to level 2 or 3. Level 4 represents experts in the field, with special responsibilities within support, education and problem solving.

For each critical task there are developed competence requirements, or learning goals. These competence requirements are quoted in Appendix 1.

## 7. VERIFICATION PROCEDURE

The verification of individual competence will be performed through a written examination of the candidate. The examination will consist of a number of questions, normally based on multiple choices, this means choosing between a number of alternative answers. The basic principle for developing the examination questions are the following:

- Level 1 Questions that requires the candidate to quote, describe and demonstrate what he/she has learned.
- Level 2 Questions that requires the candidate to make his/hers own decisions to reach a solution to the problem.
- Level 3 Questions are asked concerning a situation, illustrated with figures, diagram and pictures, that requires the candidate to suggest solutions.
- Level 4 Questions asking for evaluation and decision based on certain assumptions and conditions.

Appendix 2 gives some examples illustrating typical questions and multiple choice answers for level 2 and 3.

The number of questions necessary for verification of individual competence on level 2 or 3 is assumed to be in the order of 25 – 35, based on statistical considerations. The validity of the test will not increase substantially if the number of questions is increased beyond this. On the other hand winter maintenance consists of several disciplines, as decision making, meteorology, snow removal, salting and gritting, and therefore there is a need for a certain number of questions within each field. This could be reason for increasing the number beyond 25 – 35 and up to 50. The personnel undergoing this examination are not

accustomed to office work and could be tired and lose focus if the test is too prolonged; this speaks for a rather short examination.

The examination may be differentiated to accommodate different groups of winter maintenance personnel. Typical groups with different competence requirements are personnel working on roads with high or low traffic volumes, personnel engaged in de-icing or just snow removal/gritting and personnel working only on roads for pedestrians and cyclists. For the time being, Sweden tends to differentiate the competence requirements between different personnel groups, while Norway aims for basic competence requirements that apply to all personnel engaged in winter maintenance.

To pass the examination the number of right answers should be 70 – 80 %. This level is assumed to show that the candidate has sufficiently understanding of the essential concepts of winter maintenance. In addition the criteria for passing the examination should allow for some misunderstanding and for the possibility that more than one of the multiple choice answers could be right. The level of right answers should be in the higher region if the examination is in direct connection to attending a course and in the lower region if the examination is performed without going through a specific course.

Many individuals working with winter maintenance are not accustomed to address problems described in writing. In addition quite a few of them suffer from dyslexia. Therefore there should be offered an opportunity to perform the examination by word of mouth.

This kind of examination will only relate to the candidate's theoretical knowledge. In order to become a good snow fighter, there is also necessary to possess knowledge of the equipment used in winter maintenance and to demonstrate the ability to handle the equipment in a safe way with regards to the driver and the road users and at the same time obtain an adequate result on the road. Verification of the practical skills for winter maintenance personnel is not a part of this research project. However, it is assumed that one way to document this type of skills is to require that the personnel participate in a practical demonstration and test of the equipment used in the contract. This participation should be documented by an attestation signed by the driver stating types of equipment and operational practices performed.

The handling of the equipment on the road in a safe manner and with adequate results with regard to road condition can only be verified through a driving test or through follow-up of the driver under normal working conditions. Methods for formal approval of such skills are not explored further in this work, but could be included in a complete competence requirement for winter maintenance operations.

## **8. IMPLEMENTATION IN WINTER MAINTENANCE CONTRACTS**

The implementation of the competence requirements in the winter maintenance contracts will start in 2014. In Sweden there will most probably be a staged implementation, starting with the implementation of competence requirements for operational winter management and personnel working on roads with high traffic volumes. Competence requirements related to road weather information systems may be included or be handled as a formal requirement of attending a specific course. The next stage will comprise personnel working on roads with lower traffic volume and on roads for cyclists and pedestrians.



In Norway the competence requirements most probably will be implemented for all personnel engaged in winter maintenance. The winter maintenance course delivered by the Norwegian Public Roads Administration will still be offered as an opportunity to the contractors, at least until an equivalent education is available from another organization.

For both countries the implementation will be discussed with the contractor industry to assess different ways for implementation and the responsibility securing the necessary competence in winter maintenance.

The decision process for the implementation will proceed through 2013 and at the time of the International Winter Road Congress in February, 2014, more information will be available.

## **9. FUTURE MANAGEMENT SYSTEM**

When the competence requirements are in operation, there will be a need for a management system to keep track of individual certificates and the corresponding period of validity. This system is not decided, but it will most probably be of the same kind used for identity information in the construction industry in both Sweden and Norway.

Figure 2 – Future management system – by smart phones  
(Photo: Svante Harström)



## **10. FURTHER RESEARCH WORK**

The research project concerning competence requirements in winter maintenance will continue through 2014. The competence requirements will be refined and a complete set of examination questions will be developed. The staged implementation in winter maintenance contracts will be pursued and the specification for a management system will be developed.

## REFERENCES

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(The Swedish Transportation Administration: Level of service for maintenance)  
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(The Swedish Transportation Administration: Appendix 5 to Administrative regulations, Staff requirements)
2. Statens vegvesen Driftskontrakt, kap. C3 Spesielle kontraktsbestemmelser  
(The Norwegian Public Roads Administration, Maintenance contracts, chap. C3 Special Contract Regulations)  
<http://www.vegvesen.no/s/anbud/dkmal2013/>
3. <http://infrastrukturkompetens.eu/>
4. [http://ec.europa.eu/education/lifelong-learning-policy/eqf\\_en.htm](http://ec.europa.eu/education/lifelong-learning-policy/eqf_en.htm)

## APPENDIX 1 COMPETENCE REQUIREMENTS

### Operational management

Planning of winter maintenance routes, re-allocating of resources due to traffic congestion or equipment breakdown

- The basis of route planning (road network, resources, climate/weather conditions, winter maintenance level of service)
- Route plans and connected resources

Monitoring and interpretation of road weather information

- Basic meteorology
- Road weather information systems including local weather observation stations
- Weather information and forecasts (content and inaccuracy)
- Typical weather situations connected with adverse driving conditions as basis for making snow and ice control decisions
- Local circumstances (road, traffic, weather)

Monitoring and interpretation of road condition information

- Relevant sources for road condition information
- Road condition information as basis for making snow and ice control decisions
- Critical road sections (where, challenges, special monitoring)
- Critical traffic situations (road closure, accidents, holidays, etc)

Decision of snow and ice control actions and time for action

- Relevant snow and ice control measures (snow removal, salting, gritting)
- Basis for snow and ice control decisions
- Effect of snow and ice control measures on traffic flow, safety and environment

Actions during extraordinary weather conditions (heavy prolonged snowstorms)

- Relevant actions (prioritizing, use of stand by equipment, etc)
- Contractual procedures for extraordinary weather conditions

Best practices during difficult weather conditions (super cooled rain, extremely cold periods, etc)

- Different types of difficult weather conditions
- Relevant actions and best practice for different weather conditions
- Contractual procedures for difficult weather conditions

Other complete winter activities (clearing of snow for sight, cleaning of signs, removing icicles, thawing for water drainage, etc)

- The intention and the objective of these winter activities
- Relevant measures, equipment and procedures
- Contractual regulations

Traffic information

- Monitoring and reporting weather, road and traffic information to the road users

Inspection and documentation

- Type of information, format, recipient

## Maintenance operations

Snow removal – snow plowing, snow and ice grading

Equipment

- Truck, lorry, tractor, etc.
- Snow ploughs, types and area of application
- Ploughshares, types and area of application
- Equipment for snow removal on roads for cyclists and pedestrians
- Adjustment of ploughshares for safety and quality reasons

Snow removal – execution

- Equipment for different road classes and weather conditions
- Snow removal on roads for cyclists and pedestrians
- Considerations for road users, road equipment, bus stops, parked vehicles, etc.

Snow removal – working environment and traffic safety

- Safe jobs analysis
- Traffic safety – critical situations and circumstances
- Undesirable events – event analysis and report
- Regulations concerning warning lights and marking of equipment

Snow removal – effects

- Effect of snow removal on road condition and on traffic flow, traffic safety and the environment

Friction improvement - salt (de-icing/anti-icing/anti-compacting) and sand (gritting)

Equipment

- Truck, lorry, tractor, etc.
- Spreaders, types and area of application
- Equipment for friction improvement on roads for cyclists and pedestrians
- Calibration and adjustment

Friction improvement – execution

- Road salts and their effect on snow and ice
- Spreading methods and their effect on road conditions
- Spreaders and their area of application (road and weather conditions, different road classes)
- Considerations for road users, road equipment, bus stops, parked vehicles, etc.

Friction improvement – working environment and traffic safety

- Safe jobs analysis
- Traffic safety – critical situations and circumstances
- Undesirable events – event analysis and report
- Regulations concerning warning lights and marking of equipment

Friction improvement – effects

- Effect of salting and gritting on road condition and on traffic flow, traffic safety and the environment

## APPENDIX 2 EXAMINATION QUESTIONS – TYPICAL EXAMPLES

This appendix gives some examples of examinations questions together with the corresponding multiple choice answers. The right answer is marked with blue and italic font.

What is dew point temperature?

- a) A measure for the weight of an air column from ground level to top of atmosphere
- b) The temperature at which the air saturates with humidity and dew or frost is formed*
- c) Air temperature divided by road surface temperature

Why should special attention be given to road sections along water, bridges, shady areas and section with forest?

- a) The salt will disappear quickly from the road at these locations, and you must spread double amount of salt.
- b) It is very dangerous to drive off the road in these locations.
- c) These locations may freeze over very quickly and should be paid attention in order to avoid icy and slippery road surface.*

At what temperature will road salt give the best result?

- a) 0 – -10°C*
- b) -5 – -15°C
- c) 0 – -20°C
- d) -5 – -20°C

What is the duration of the friction improvement effect of gritting with sand?

- a) 50 – 100 cars drive by*
- b) 200 – 500 cars drive by
- c) 2 – 4 hours
- d) 1 – 2 days

When the road is very wet and temperature indicates that the road surface may be freezing over, what would be the best treatment?

- a) Dry road salt*
- b) Brine
- c) Vacuum salt (fine graded salt)
- d) Pre-wetted salt

What are the main criteria for determining the snow removal route length?

- a) Compliance with level of service at huge snow falls
- b) Compliance with level of service at equipment break down
- c) Compliance with level of service at extraordinary weather conditions
- d) Compliance with level of service at normal snow falls*