WINTER SERVICE MANAGEMENT AND SERVICE VEHICLE ACTIVITY REPORTS

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ABSTRACT

Iceland's location is in the pathway of low pressure weather systems crossing the Atlantic with frequent weather changes, temperature fluctuations and adverse conditions. Condition monitoring is paramount in order to be able to respond to adverse conditions for mitigation. Adverse conditions can relate to weather, road conditions as well as aspects of road user safety. Winter maintenance management based on “real time” information systems is a powerful tool for assistance. Icelandic Road Administration (ICERA) has numerous monitoring equipment and stations. It is a challenge to run such a system in imperfect environmenst where communication and electricity services are sparse. This is an important factor to address - because far too often the environment is the troubling factor. ICERA has financed and participated in research projects aimed at weather and road condition monitoring. It has also been involved in projects aiming to develop methods for high-resolution forecasts, about expected weather changes for established road sections and effect of these on road conditions and state. How these are used in winter maintenance management will be among the subjects addressed in my talk. For six years ICERA has tried out and experimented with vehicle tracking in association with winter road maintenance with the aim to quantify and qualify the service carried out on the road. Early on it was decided to try out solutions from winter service equipment providers, with mixed results so far. These mixed results relate to imperfect communication services and each solution’s ability to deal with imperfect environments. ICERA’s involvement in a trial project for a road user charging scheme (based on GNSS – technology), addresses these network imperfections. An on-board unit intended for that scheme has been modified so as to include winter service locationing and activity. Its purpose is to be able to provide live tracking information and a summary activity report at the end of the day, thus minimizing central back-office calculation.

KEY WORDS

WINTER SERVICE MANAGEMENT / ACTIVITY RECORDING / TRACKING / REPORTING

1. INTRODUCTION

Iceland is situated just south of the Arctic Circle. The mean temperature is considerably higher than might be expected at this latitude. Relatively mild winters and cool summers characterize Iceland’s oceanic climate. Iceland’s topography is mostly mountainous with deep fjords and glaciers. The main roads are along the coast, traversing mountain passes between fjords and valleys. Iceland is the most sparsely populated country in Europe. The population density (just over 300 thousands) is less than three inhabitants per square kilometer.
Winter service is a challenge to run in such environments where communication and electricity services are sparse. ICERA has financed and participated in research projects aimed at weather and road condition monitoring. It has also been involved in projects

aiming at developing methods for high-resolution forecasts for expected weather changes for established road sections and their effect on road condition and state.
For six years ICERA has tried out and experimented with activity recording in association with winter road maintenance with the aim to quantify and qualify the service carried out on the road. For management continuous and reliable data is needed from activity recording. Otherwise it is of little use. ICERA's experience in activity recording and how ICERA uses gathered data in management will be discussed.

2. DATA AND MANAGEMENT

ICERA decided early on to try out activity recording solutions from winter service equipment providers. The reason was simple. Service equipment providers know best their equipment and this solution was available. The Danish Road Administration had experience working with equipment providers which ICERA benefitted from.

2.1. Activity recording data

Trials in the capital area gave promising results. Figure 1 shows fleet activity recording on a typical winter day.

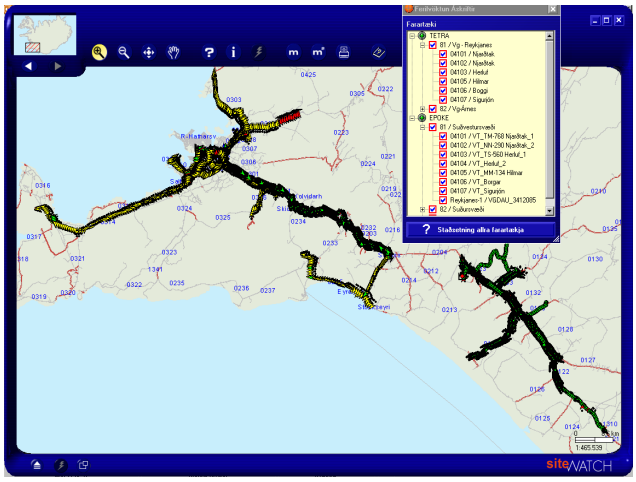


Figure 1 – Fleet Maintenance Management. Activity Recording - Green: Non Activity Driving; Yellow: De-icing; Red: Plough deployment.

One aim of the activity recording is to settle contractor payoffs. Upon receipt of data from a device, the grid position is slotted into the road system, i.e., information about activities is collected for certain roads and stretches of road for each vehicle. As winter service contracts for the capital area are distance-based, totaling working hours for this area was not an issue.
Figure 2 shows typical example for such contractor payoff.

VEGAGERÐIN

Snow removal and de-icing

Date from 01.03.2006 to 15.03.2006

Vehicle / Date	Chore no.	Chore element	Treatment route	Salt/sand (tons)	Treatment length (km)	Treatment Cost (kr)
04101 VT_TM-768 Njarðtak_1						
07.03.2006						
341-4060	0041.20	Krýsuvíkurv-flugstöð		0,9	26,2	11.806 kr.
341-4060	0043	Grindavíkurvegur		1,0	28,9	13.011 kr.
341-4060	0044	Hafnavegur		0,9	17,4	7.812 kr.
341-4060	0045	Garðskagavegur		0,8	16,0	7.202 kr.
341-4060	0425.10	Hafnir-Reykjanesvita		2,2	25,2	11.358 kr.
341-4060	0425.20	Reykjanesvv.-Grindav		0,0	0,4	160 kr.
341-4060	0429	Sandgerðisvegur		0,4	6,9	3.086 kr.
Date total:				**6,3**	**121,0**	**48.386 kr.**
08.03.2006						
341-4060	0041.10	Nesbraut-Krýsuvíkurv		0,5	11,5	5.179 kr.
341-4060	0041.20	Krýsuvíkurv-flugstöð		3,5	83,9	37.770 kr.
Date total:				**4,0**	**95,4**	**38.177 kr.**
Vehicle total: 04101				**10,4**	**216,4**	**86.564 kr.**
04102 VT_NN-290 Njarðtak_2						
06.03.2006						
341-4060	0041.10	Nesbraut-Krýsuvíkurv		0,6	9,5	4.273 kr.
341-4060	0041.20	Krýsuvíkurv-flugstöð		10,2	121,6	54.726 kr.
341-4060	0043	Grindavíkurvegur		2,3	29,9	13.452 kr.
341-4060	0421	Vogavegur		0,2	2,7	1.236 kr.
341-4060	0427	Ísólfsskálavegur		0,0	0,5	242 kr.
Date total:				**13,3**	**164,3**	**65.715 kr.**
07.03.2006						
341-4060	0041.20	Krýsuvíkurv-flugstöð		2,0	81,6	36.699 kr.
Date total:				**2,0**	**81,6**	**32.621 kr.**
Vehicle total: 04102				**15,3**	**245,8**	**98.336 kr.**
04103 VT_TS-560 Herluf_1						
06.03.2006						
341-4060	0001.10	Bláfjallav.-Nesbr		0,1	2,7	1.199 kr.
341-4060	0001.20	Nesbraut-Þingvallav.		0,0	0,1	61 kr.
341-4060	0040	Hafnarfjarðarvegur		0,6	8,8	3.978 kr.
341-4060	0041.10	Nesbraut-Krýsuvíkurv		0,1	1,7	771 kr.
341-4060	0049	Nesbraut		0,4	5,7	2.547 kr.
341-4060	0413	Breiðholtsbraut		0,0	0,9	389 kr.
Date total:				**1,3**	**19,9**	**7.951 kr.**
07.03.2006						
341-063	001	Álftanes		1,0	17,6	7.899 kr.
341-4060	0001.10	Bláfjallav.-Nesbr		1,1	13,2	5.927 kr.
341-4060	0040	Hafnarfjarðarvegur		4,3	98,9	44.507 kr.
341-4060	0041.10	Nesbraut-Krýsuvíkurv		1,9	16,7	7.530 kr.

17. mars 2006 Bls. 1 af 5

Figure 2 – Activity Recording. Contractor Payoff Example

2.2. Management, Weather Station Data and Activity Recording

For management purposes it is informative to have data from weather stations which can be compared with winter maintenance activies. Figure 3 shows how often air temperature goes below zero per week for the last three winter seasons.

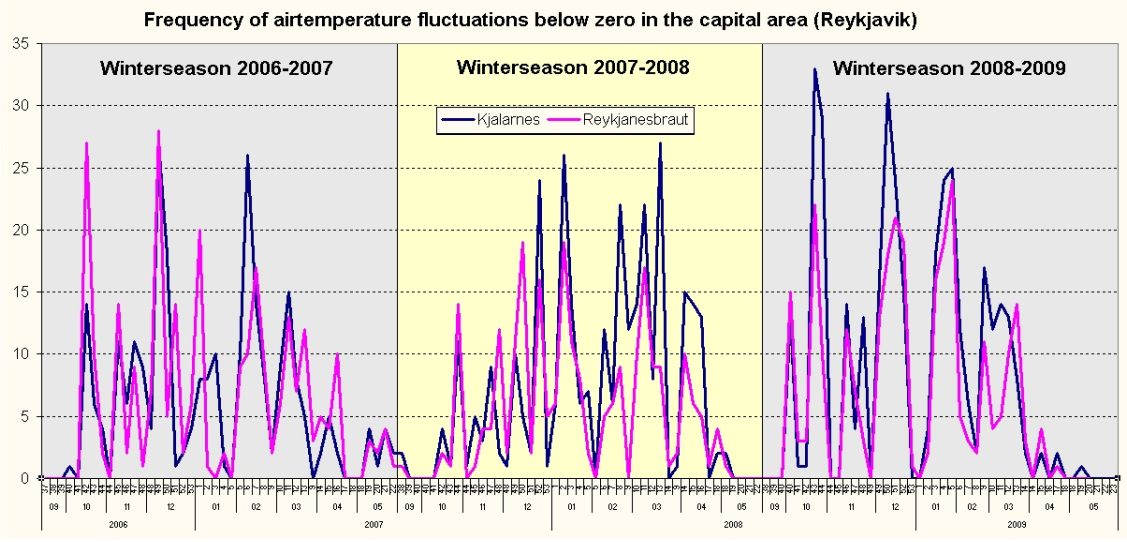


Figure 3 – Weekly Frequency of Air Temperature Fluctuations below Zero in the Capital Area. Data from two Weather Stations.

Having this weather station data and data about de-icing activity (amount of deicing agent dispersed) it is interesting to plot the both in the same timescale. As could be expected, air temperature fluctuation below zero and de-icing activity coincide. Figure 4 shows the results.

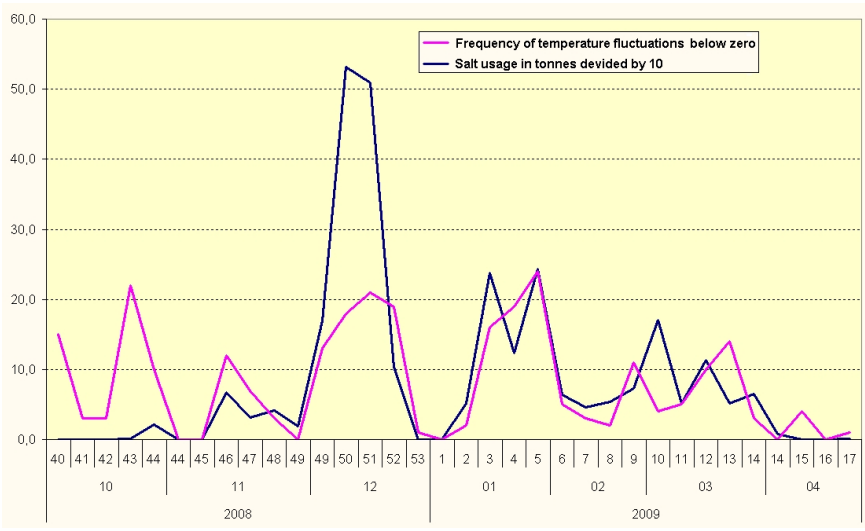
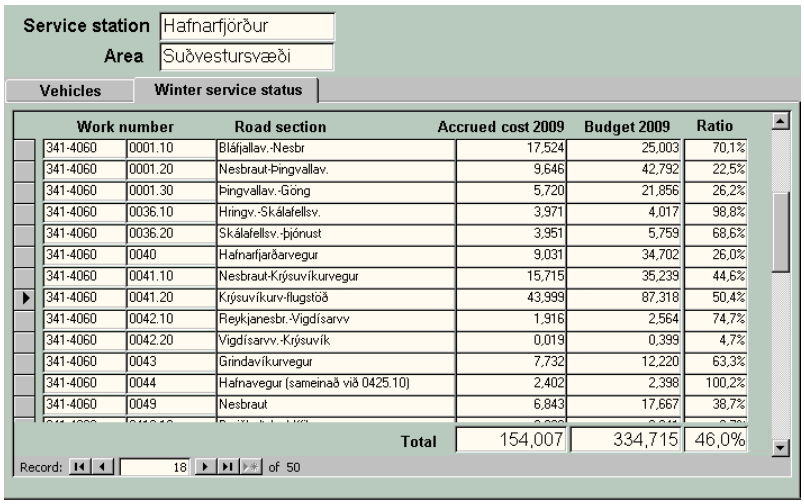


Figure 4 – Frequency of Temperature Fluctuations below Zero and Amount of De-icing Agent Used on Road adjacent to the Weather Station. Figure Shows Data from two Weather Stations.

In winter service management, - costs are an important control parameter. In general we are obliged to maintain certain winter service standards, not entailing excessive costs.
To take costs into account, ICERA attempts to allocate a winter service budget to each winter service route.
Through activity recording accrued costs can be accumulated upon generation, allowing control personnel to take mitigative action early on. Figure 5 shows how activity recording data is summarised and compared to the budget sum.



Work number		Road section	Accrued cost 2009	Budget 2009	Ratio
341-4060	0001.10	Bláfjallav.-Nesbr	17,524	25,003	70,1%
341-4060	0001.20	Nesbraut-Þingvallav.	9,646	42,792	22,5%
341-4060	0001.30	Þingvallav.-Göng	5,720	21,856	26,2%
341-4060	0036.10	Hringv.-Skálafellsv.	3,971	4,017	98,8%
341-4060	0036.20	Skálafellsv.-þjónust	3,951	5,759	68,6%
341-4060	0040	Hafnarfjarðarvegur	9,031	34,702	26,0%
341-4060	0041.10	Nesbraut-Krýsuvíkurvegur	15,715	35,239	44,6%
341-4060	0041.20	Krýsuvíkurv-flugstöð	43,999	87,318	50,4%
341-4060	0042.10	Reykjanesbr.-Vigdísarvv	1,916	2,564	74,7%
341-4060	0042.20	Vigdísarvv.-Krýsuvík	0,019	0,399	4,7%
341-4060	0043	Grindavíkurvegur	7,732	12,220	63,3%
341-4060	0044	Hafnavegur (sameinað við 0425.10)	2,402	2,398	100,2%
341-4060	0049	Nesbraut	6,843	17,667	38,7%
		Total	154,007	334,715	46,0%

Figure 5 – Winter Maintenance Management. Daily Winter Maintenance Costs Summations and Budget Sum Comparison.

The data examples above show what can de done with high-quality data. However, quality activity recording is not always easily attainable, at least not for a modest budget.

3. MANAGEMENT AND ACTIVITY RECORDING CHALLENGES

ICERA's fleet includes heterogeneous vehicles and equipment, each with their own solutions and technical characteristics. It is seldom possible to rely on one vendor's activity recording solution. The fleet consists of new and old equipment as well as control vehicles, each with individual data pecularities. Recent standards like EN 15430-1:2007 are changing this – but it takes time to come into general application.
The standards will always be a little behind. Today on some occasions there is need for two-way communication – sending commands to and receiving data from service equipment of various types.
Activity recording has its price and can be quite expensive to run, in particular if you have operational problems. It is ICERA's experience that good running in one area is no assurance of smooth running in another area. An investment made is there for several years to come and at times problems that arise take time to solve.
When activity recording was expanded to include rural areas the results were mixed, sometimes good but more often bad. Slowly it became apparent that these mixed results partly originated in an imperfect communications network and each solution's ability to deal with such imperfect environments. ICERA experienced data losses that undermined data integrity.
To generalise, there seemed to be design flaws in some activity-recording solutions, flaws which originate in a design for city environments with good communications reception. Applying these solutions for activity recording in rural areas with bad communications reception lead to data losses. These losses were due to:

- Communication problems
- Cpu-overflow due to unsatisfactory prioritisation between datalogging and communication.
- Insufficient memory capacity, (circle-buffer) where "Oldest" data was overwritten. (One solution only had a one-hour memory capacity).

If the device solution available does not include an internal clock and pulse counter (ODO-meter), distance and time are based on the GNSS. With this design data losses will occur when there are:

- Explained or unexplained antenna problems (loss of GNSS(GPS)-signal).

Figure 6 shows typical data losses in rural area with bad communications reception.

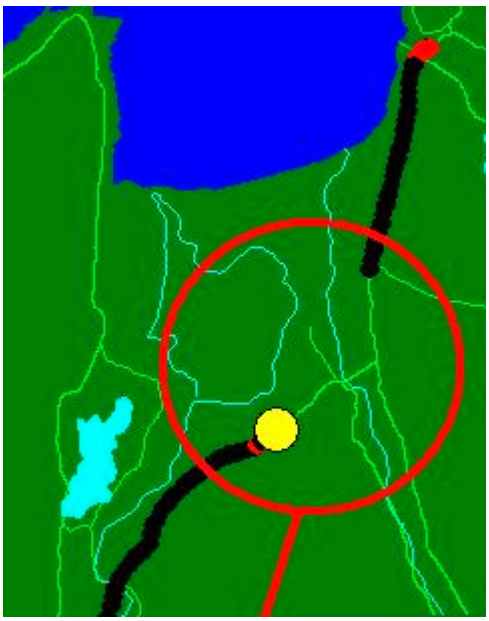


Figure 6 – Activity Recording. Typical Data Losses in a Rural Area with Bad Communications Reception.

This being said, ICERA has had good experience running activity recording in areas with good communications coverage. Equipment providers have also made amendmends – even come up with special solutions to overcome some of these flaws mentioned. So, slowly there is progress.

4. MULTI-FUNCTIONAL ON-BOARD UNIT

ICERA is involved in a trial project to make a device for a heavy-vehicle road-user charging scheme (based on GNSS – technology). This project addresses above mentioned network imperfections. An on-board unit intended for that scheme has been modified so as to include winter service locationing and activity. The basic design is built on several years experience working with data logging, activity recording and data transmission in city areas as well as rural areas.
For activity recording it is meant to be a low-cost device intended for various equipment and control vehicles. Its purpose is also to close the gap in those areas where off-the-shelf equipment solutions aren't adequate. One design prerequisite is a complete separation of data acquisition and data transmission. No matter what – data should always be collected and stored. Another prerequisite is detailed time-and-distance sensing of activities in kilometers and minutes. For example, packed ice removal where an underplough is deployed with force on the road surface to scrape ice away, is heavy work. This activity is to be recorded for special payoff.

The on-board unit for winter service vehicles includes the following elements:

- CPU
- Memory
- Internal clock
- GNSS-high sensitivity receiver
- Pulse counter
- Serial interface
- CAN-bus

- Sensors
  - Front plough
  - Under-plough
  - De-icing
  - Temperature
  - ...
- Communications
  - GSM, GPRS, Edge, G3
  - TETRA

For use in road inspection vehicles it is planned to include camera and serial connection to friction measurement device.

The first on-board units are undergoing extensive tests before application in winter 2009-2010.

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