Winter and Railways
Study
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1. Background / Introduction

Train operations in winter conditions has always been a challenging task. From steam engines, with water freezing on its way to the boiler, to modern electrical locomotives with frozen pantographs and catenary, different winterly conditions has cost the railway undertakings and infrastructure managers much money and many man hours.

It is an almost impossible task to define “winter conditions”. Just within the field of “snow” there are many variations depending on the temperature, wind conditions and amount of snow. The different types of snow may require different measures, and a measure taken to counter one type of snow may have a negative effect when a different type of snow manifests itself.

As for the track, snow mostly constitutes a problem in switches. Once the snow has been cleared of the track itself, the problem is solved. However, cold conditions may cause rail breakage, due to weak welding. In addition, cold temperatures may cause the catenary to freeze up, inflicting damage to the pantograph coal, and causing improper power supply to the trains.

In this report, we will try to look at all the aspects of rail operations, and look at possible solutions. In the coming years, climate changes may cause the weather to become more instable, and winter conditions may vary even more than what has been experienced in earlier years.

1.1. What are “winter problems”?

The field of “winter problems” is as diverse and complicated as the variations in the weather. We have, however, chosen to view the problems broadly, defined as “operational problems typically experienced in the period between November and April.

Fig.1.
Our group is diverse, with participants from different parts of Europe. In this respect, it is important to underline that the problems experienced in the different countries may vary, and what is considered unproblematic in Norway and Sweden may constitute a majestic challenge in Spain or Italy.

2. Infrastructure

The infrastructure has many different areas to control and prepare when the winter comes. There are completely different tasks, for examples from make switches and crossings in cold climate work, removing snow from the track, problems to placing the snow from the track or shunting yard, white frost on the contact wire, etc..

2.1. Reports

These phenomenons with winters that have a long period of low temperature and more snow than average years, and appear randomly. Several reports have been done in Sweden and some of them are presented in this chapter.


The rapport from the winter 1965 -1966 says that there come to much snow on a little period and the ordinary operation and maintenance personnel was not prepared to remove this quantity of snow. There have been rationalizing in the personnel during a period before this winter, and therefore that are not enough personnel to send out and maintain the track from snow. This, less personnel, makes the emergency plan inadequate and do not manages to make a functional track work when the quantity of snow and a long period of cold climate. The reducing of the personnel during the years before makes this problem more widespread than it had to be. This show’s also that when the connection in traffic has a problem in one part of Sweden, considerable interference occurs in other parts of Sweden.

During this winter period, 1965-1966, when it was problem in the traffic, the personnel get much appreciation from the public when they tried to do there best to get the traffic go again. The management has been criticised after this period. The management was hoping to evaluate the experience from this winter for the future.

The fist challenge when it is a difficult winter like this is to get an overview of the situation. Next step is to find out the best countermeasure to the situation. It takes to judge the coming consequences and how to take actions against that, e. g. look how the weather reports are for the coming days.

There was over represented damage in material like, switches & crossings, trains, locomotives and rails this period. So in the beginning of February in 1966 there was a lack of locomotive in the fleet so that old steam engine locomotive was taken out to help to set free electrical locomotives were there could be an steam locomotive instead, and the electrical locomotive was used where they was needed most. To make the cargo functioning better, cargo wagons was borrowed from DB, Germany.
In the future it has to be more tracks to manage the increased of capacity and better locomotives that manage the winter conditions. Update the infrastructure to get new and better solutions for the coming winters ahead. But in the same time it is hard to predict that everything is going to control in a coming winter period, when it is a period like this winter 1965 – 1966, in the future, that nothing will be out of function or will create problems. To solve all these winter problems in the future the investment cost going to be high for a problem that appears as seldom as this problem compare to the cost.

The information to the travellers has not been working on a sufficient way. When everything in traffic is function and it should do, there is not much information to send out, but when many trains are delayed and even trains that not arrive at all, the need of information grow very quickly.

This year 1965-1966 it was SJ, (Statens järnvägar, The Swedish State Railways) that have the overall responsibility for the infrastructure, the operation and the rolling stock.

2.1.2. Investigating Winter Railway [2]

The average of snow was between December and Mars 20 cm of snow every week, and the top of snowfall was 15 cm snow per day. During the second half of February it fall on several occasions nearly 30 cm of snow in central of southern part of Sweden, Götaland, with gave the consequences that the shunting yard in Hallsberg, that is 300 000 square meters big have to shout down for 12 days. Hallsberg is a big hob for the cargo in Sweden.

The train delays this winter was twice as big from a normal winter. The direct cost for the public society for the total delays it amount to 3 billion Swedish crowns. The lack that contributed to the situation was in four areas, infrastructure, interface to and capacity within the contractors, internal management and processes, and also the information to the passengers, operators, and the public. To take care of this lacks a great part of the delays could be avoid and the negative effects have been less. With contributes investments of initial equivalent to 410 to 450 millions Swedish crowns approximate half of the delays, which are related to the winter problems, could have been avoided.

The problems can be divided in to direct problems with to much snow and ice in the track and on the trains, the cold temperature that makes material get more fragile and it shows in more damages in switches and crossings, wheels, rails damages and so on, but also indirect problems for example missing drivers for the trains and locomotives.

The lack of management is how to control the prioritising and the redistribution of the traffic when there is a reducing capacity of the tracks.
Technical solutions are expanding route clearance, ice scraper for the contact wire, glycol based de-icing constructions and also upgraded switches and crossings. Furthermore it is important to have feedback how the capacity and maintenance work on a good manner to the contractors. Have training and education of the personnel together with contractors. Finely have possibilities to purchase capacity for extraordinary snow clearance resources to use in extraordinary situations.

Consultant agency has done this report as a commission from Trafikverket (Swedish Transport Administration).

2.1.3. Operational problems due to ice on contact wires [3]

The hard weather problem during the December 2009 and January 2010 have caused large problems for that train traffic in Sweden, mostly in the middle and the northern part of Sweden. It have been icing on the contact wire that have caused many problems. This problems comes out when it is freezing rain and it freeze on the contact wire or fog drops that freeze on the contact wire. The consequence from this is bad contact between the carbon on the pantograph and the contact wire. This makes that is appear a light between the carbon and the copper wire. The temperature can be as high as 3000°C Celsius. When it is frequent enough it makes the glue let go and the carbon on the pantograph cracks.

Some of the discussions of solutions are to make the carbon deeper, switch from carbon to aluminium, a 20 mm deep brass strip in front of the carbon strip. SL (Stockholms Lokaltrafik, Stockholm public traffic) uses a roller that covers the wire with glycerol to prevent icing on the contact wire. The speed of the train is 20 – 50 km/h.

Some preventive action could be as example to force the introduction of ADD (Auto Drop Device), which is a construction that automatically drops the pantograph when it is a damage carbon strip on it. An other action are more detectors along the track that takes photos and control the carbon strip and sends alarm if there is something wrong with it.

More feedback from the operators what are there experience and looking over what other counties doing to solve there problems during the winter period.

2.1.4. Analysis Winter problems Switches and crossing [4]

Here is presented some technical solutions for switches and crossings.

This model is a snow shield where the switches are encapsulated with a board or a tarpaulin. This snow shield is for to protect the outside of the support rail along the switch.
Another snow shield is with brushes. The brushes are mounted 10 cm from the outside of the rail. It manages train speed up to 160 km/h but have a worse behaviour when the temperature drops below – 20° Celsius.

The there is the switch heaters, to melt the snow and ice away. This is an effective solution but a costly solution. The heaters are from 5 kW up to 30 kW and are on all the winter period. But there is a project that shall look over the heaters to have a alarm on the heaters, to monitor them better, control system to manages the heaters in a better manner than today.

Further on in chapters 2.2, 2.3 are mentioned main winter problems for track and signalling devices, and also given an approximate plan which is used on Russian railways to be well prepared for winter conditions. Of course both Months and specifics of organisation and preparation may vary due to different climatical conditions in different structures of involved railways, but this gives just a general idea of what kind of works may reduce a number of problems occurring during winter periods.

### 2.2. Protection of tracks from snow

Main assurance that railway will be working safely and on schedule fulfilling cargo transportation plan, is reliable fencing of railway lines, stations and intermediate points from snow drifts by protective afforestation, as well as timely cleaning of railway tracks by snow plowing machines, snow cleaning trains, cleaning of points from snow by stationary pneumatic blowing devices and point heating devices. Timely utilization of technical measures are much dependent on weather forecasting.

To eliminate breaks in railway traffic due to snowdrifts, the most advanced and reliable snow cleaning machinery and stationary devices for cleaning points from snow, must be firstly placed on major marshalling yards, major passenger stations and junctions, as well as on stations which are located on the lines with high capacity train traffic.

Track protection at open lines and stations should be mainly done by protective afforestation. In case when due to climatic or soil conditions it is impossible to grow such afforestation, track protection must be done by making permanent snow-retaining barriers.

Usage of mobile snow-retaining screens must be done only as a temporary measure until permanent protection measures are put into operation, or as an additional measure helping permanent snow-retaining to increase its snow capacity. At the stations for in-station protection in wide intertrack spaces can be used smaller size mobile snow-retaining screens.

As an additional track protection measure from snow drifts may be used mechanized snow-retaining by means of creating snow barrages and ditches on the territories adjacent to the open line.

Track protection from snow drifts must be foreseen along all snow prone sections of the line, separately for each side of the track, as well as around the stations and, in some cases inside station territories.

The following types of snow-retaining barriers may be used:
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a) with evenly distributed openings along all height;
b) lightweight type (wooden);
c) combined lightweight type (reinforced concrete base with wooden inside part);
d) wooden with openings 75% along all height;
e) reinforced concrete.

2.3. **Signalling and telecommunication**

Signalling structures and devices, wired and wireless communications, mechanized and automated marshalling yards, instruments for detection of overheated axles must be constantly operating and must guarantee the safety of train movement strictly on schedule.

Special attention must be paid to timely and quality finishing of works for preparation of signalling, wired and wireless communications devices for winter operation according to the rules.

Measures of preparation of devices for operation in winter period include also reconstruction, major and current repairs of above mentioned equipment, also training of personnel and organizationally-technical measures aimed at safety and trouble-free movement of trains in a winter period.

2.3.1. **Planning of preparation of signalling devices for operation in winter conditions**

Based on the experience of former USSR railway network are developed the following procedures which have to be followed in order to achieve stable operation of signalling and telecommunication devices on railway.

In September-October managers of signalling and telecommunications according to the established order are making autumn inspection of structures and devices of signalling and telecommunications, hot box detectors, marshalling yards and technical structures.

During inspections special attention is paid to maintenance of outdoor signalling equipment, cabling and availability of spare parts, spare cables and materials according to the established rules. Special attention is also paid to training of personnel who is going to work in winter conditions for the first time.

Defects and disrepairs of devices and structures which are discovered during the inspection must be immediately repaired. Inspection results must be considered by the railway administration together with managers of structural units.

During August-September in signalling and telecommunication departments which are connected with providing traffic safety seminars, must be performed instructing training with signalling technicians teaching them specifics of winter operation, while to workers who will be first time working in winter conditions are attached tutors from experienced staff.

During March-May managers of departments perform detailed check of condition of all signalling and telecom devices and prepare detailed list of discovered defects and works which are necessary for fixing and raising reliability of operation during winter period.
Based on analysis of last year operation failures of equipment are prepared measures aimed at elimination of repeating of these failures. Approved plans are then used by maintenance staff and are controlled by dispatcher staff of signalling and telecommunications units.

Until September must be finished refurbishment and preparation of all technical rooms. According to existing rules these rooms must be provided with necessary fuel stock and domestic inventory.

Until September in signalling and telecommunication units must also be finished following works:

- Preparation of electric point machines (cleaning, washing, replacement of worn out parts, greasing, painting);
- Preparation of point control locks and casing, electric locks (cleaning, washing, replacement of worn out parts and greasing);
- Warming battery manholes and protection of relay and battery cabinets from snow entering into them;
- Sealing of outdoor equipment lids (transformer boxes, electric point machines, signal heads, splitting and universal sleeves, cable frames, etc) from snow entering them;
- Performing measures for prevention of frosting of electric point machine contacts, freezing of relay anchors, photo detectors glass getting misty, etc.);
- Check and adjustment of automatic devices at the level crossings;
- Installation of landmarks on signalling devices to prevent damage during snow plowing equipment;
- Check of clearance of signalling equipment installation and fixing discovered defects;
- Preparation of technical buildings;
- Check and in case it necessary, replacement of cables in signalling devices, which have insulation resistance below set norms;
- Visual check of cable routes, fixing of discovered defects. Special attention must be paid to cable lines which are laid in cable ducts crossing the bridges.

During August-October unit managers are checking readiness of electric point machines and fittings for operation in winter period, and also working order of electric heating of point machines (which must be connected at the start of winter).

Until October unit managers together with track foremen must perform a thorough check of track circuits condition, condition of joints, insulating joints, point suspension arms and connection bars, existence of water drainages from signaling devices and their condition, checking of automatic blowing of centralized point turnouts. All defects must be fixed.

Until October on marshalling yards besides items mentioned above must also be performed following works:

- Planned repairs of magnetic sensors (disassembly, replacement of worn out parts, filling with cable mass);
- Checking and preparation for winter operation of photoelectrical devices;
• Complete disassembling, washing and greasing of brake cylinders and retarders lifting device cylinders with replacement of collars if necessary;
• Check and if necessary repair of outdoor equipment of automatic sorting;
• Planned repair of wagon retarders control equipment, installation of heating elements for winter period and testing of their operation;
• Planned repair of compressors with dismantling and disassembling of valve boxes, conrod-piston group;
• Planned repair of pumps and electric motors of compressor room (disassembling, cleaning, check of bearings, replacing of worn out parts);
• Checking of condition, cleaning and painting of air collectors, faucets, valves and shutters of air duct network;
• Planned repair devices of pneumatic conveying system.

Until October heads of signalling and telecommunication maintenance and track maintenance units must perform commission survey of condition of track equipment and water drainages in the area braking positions. Any defects must be eliminated in due time.

Until October must be performed following works: inspections of antenna-mast constructions, radio relay towers, reserve and emergency power supplies and all defects must be eliminated;
Control-repair points must be checked and supplied with necessary control-measurement equipment, spare parts and materials;
Feeding lines (networks) of yard communications must be checked, outdoor intercoms, loudspeakers antennas, train, shunting and technological radio communications, must be checked sealing of sleeves, operation of radio communications of snow plowing machines. Necessary repairs or replacement of failed devices must be done.

Until October it is necessary to check and repair if necessary movable diesel generators, supply fuel stock and greasing materials.
Until August in signalling and telecommunication maintenance units where exist overhead communication lines, must be corrected operational plans for cases of rime, frost, frost strengthening, snowstorm and floods, taking into account experience from the last winter.

To organize works for knocking down rime and ice from signal wires and communication lines, and their repair, until November is developed a plan of allocation people and transport from other units and providing food for people out on the line. Allocated people, before start of work must be instructed about the rules of knocking down rime and ice from signal and communication wires.
For works management must be allocated experienced people, who are well knowing working rules, safety procedures and specifics of work in real situations.

Until October must be checked internal communications between various types of units, stations, etc., and discovered problems must be fixed.
For increased performance of main line and other high frequency communication lines during frost, and for creating bypass channel in case necessary, must be checked and prepared additional amplification points.
Transport and machinery must be repaired and prepared for operation in winter conditions until November. For devices controlling rolling stock during travel, until October must be finished following works:

- Checking, repair and adjustment of equipment together communication line cables;
- Warming outdoor cameras; checking of heaters condition.

Until September heads of signalling and telecommunications maintenance units must perform a survey with commission of track condition in the area of outdoor equipment of hot box detectors, paying special attention to ballast condition and condition of water drainages. Discovered problems must be fixed immediately.

### 2.3.2. Cleaning and greasing of outdoor equipment, checking of electric point machines

In maintenance of electric point machines, automatic barriers, transmitters main concern is prevention of failures and prolongation of operation of parts which are subject to friction and mechanical wear. Mechanical changes of friction surfaces of bearings, axles and parts of reduction gear, motor armatures, switching devices and other joint places are much dependent on cleaness, observance of sizes and tolerances between friction parts and selection of suitable greasing and its cleaness. Main purpose of greasing is reduction of friction forces between parts. This greasing must strictly correspond to friction type (rolling, sliding), geometry of friction parts, their materials and operation conditions (load, speed, temperature). There are specific greasing recommended for different types of application.

### 2.3.3. Sealing of devices and other works

Quality of sealing of protective gear in signaling devices has a major importance. However often provided by manufacturer rubber sealing gaskets in low temperatures lose their qualities. Rubber becomes hard, breaks, and then gradually deteriorates. Experience shows that the best sealing material is oakum.

Cable entries into relay and battery cabinets, track boxes, signal sleeves, automatic barriers must be securely fixed and sealed with rubber isolation.

### 2.3.4. Preparation of track circuits for operation in winter conditions

Preparation of track circuits for operation in winter conditions must be started in the summer period with a thorough check of condition of all elements. Special attention has to paid to: condition of joints of point, intertrack and electric traction connectors; condition of insulating joints, elements of tips of the point, point fittings, heating fittings and fastening of bolt connectors; existence of gaps between sole of the rail and ballast; condition of water drainages and groundings of signaling equipment.

After establishing of stable minus temperature it is necessary to perform additional adjustment of voltage in track circuits.
2.3.5. Electric heating

As experience shows the most effective measure for removal of moisture which forms in electric point machines, relay cabinets, and other equipment during fogs, thaws, frosts is electric heating. It prevents icing of contacts, freezing of relay armature, etc.

2.3.6. Checking of cable networks and grounding

Cable network measurements are the basis for planning of repair works. During summer period, all cable which has low insulation must be repaired; reserve wires must be checked and marked with special markers.

Special attention must be paid to condition of cable lines which are laid in ducts along bridge crossings. Movement of bridge girders during temperature changes and vibrations due to train movement often leads to damaging of cable armor and sheath. Therefore cable ducts are hard fixed to banks and laid on brackets welded to bridge girders. Between brackets and duct are put metallic plates which are working as sleds. On electrified line to prevent burn-through cases cable sheaths must be insulated from metallic constructions of the bridge.

Quality of groundings is determined by results of measurements of ground resistance. In regions with continental climate it is reasonable to make these measurements during maximum ground freezing, i.e. march-april. In this case it is possible to get the results in worst conditions, by which can be made objective findings on quality of grounding and plan necessary works for improvement of these groundings.

2.3.7. Preparation of devices for operation of snow ploughing machinery

Observance of clearance for installation of outdoor equipment according to norms is highly important for saving devices from damage during operation of snow plowing machinery. Before start of the snowfalls clearance must be thoroughly checked, which on devices already in operation may change due to reconstruction, track major repair, etc.

To prevent damage of outdoor sleeves and boxes which are located in the intertrack space or on the embankment, they have to be marked with landmarks.

When rotary snow ploughing machines are working, relay cabinets are often covered by snow and even damaged. In heavily snowing up places to prevent such cases it is recommended to install relay cabinets 3-4m away from the track axis and place them on raised base with cable protection by asbestos cement pipes.

3. Rolling Stock

Beside of infrastructure and signalling the rolling stock is the third technical area where extreme winter conditions may have or have an impact of the performance of the complete railway system.
Two main scenarios of weather conditions described in the literature are causing problems for Rolling Stock:

- Temperature changes crossing the point of zero degrees Celsius.
- Extreme snow conditions due to the occurrence “dry snow”.

The first scenario occurs when the train is coming from the cold outside area and entering then a warmer area. This effect can be observed for instance in long distance tunnels in the Alps region when the train enters the higher temperature area of the tunnel or in Norway when the train is coming from the cold mountain area and finalizes its journey on sea level in a warmer region. But beside these examples of local conditions a similar situation of the temperature changes occurs in regular operation at a service or stopping brake generated by the hot brake disc or a hot brake resistor. The effect is the same that the trainborn snow melts and then freezes on the rolling stock.

The above described second scenario of bad weather conditions is the problem of “dry snow” at cold temperatures. “Dry snow” consists of fine particles that whirls around the running train and cling to the trains especially in the bogies and underframes. This effect and its consequences for High-speed operation are detailed described in [5].

The sensitive areas of extreme winter conditions for the problems are “well known components” as it is shown in the results of the recent performed UIC Questionnaire [12]. There are on the top of the most frequently listed issues couplers, electrical connectors, Sliding doors, air loss of the braking system and breaking windows. These components are directly affected, but there are other components like the Pantograph, whose are affected indirectly, because the frozen infrastructure of the catenary is the reason for the problems.

In the following chapter there are some of the Rolling stock problems described and the ideas to solve those, but due to the difference of environmental conditions of weather (winter problems in Northern Europe are not identical to Spain), of infrastructure and at end the different types of rolling stock, an universal manual valid for the avoidance of all kind of winter problems cannot be defined. It is like a brief collection or catalogue of winter problems, which might be it is helpful for the stakeholders (operators, infrastructure, rolling stock) to identify their specific solution. But finally the performance of an assessment together with all stakeholders is recommended for an operator with winter problems. In such a round of experts the critical areas and then the most efficient and cost effective solution for solving the problem could be identified. The best solution for rolling stock in Scandinavia containing a complex design solution is not in any case the best solution for rolling stock operating in Central Europe. Furthermore the assessment of the best solution should not consider only the technical point of view, because in many cases an organisational approach is more economical and successful and faster to implement.

3.1. Bogies

Bogies and in the bogie assembled electrical, electronically or pneumatically equipment are subject to extreme conditions during winter time due to low temperatures, snow or ice packing and effects of ballast pick-up.
Snow and ice packing increase the mechanical loads on the bogie and carbody due to the additional weight and it can damage components, cable or pipes. In extreme cases it can even block movements of bogie as shown in Fig. 2.

Fig.2. Snow and ice gatherings in a bogie [5]

Snow and ice packing have to be reduced as far as possible in bogies and underframes. In [5] were technical aspects of the rolling stock design (shape of surfaces, spoilers, paint, heated areas, etc.) and maintenance to avoid that problem were collected, but in the collection the most practical approach seems to be the use of anti-icing methods by covering surfaces with a layer of propylene glycol similar to the aviation sector.

3.2. Couplers

Problems with automatic couplers were the most frequent listed issue in the UIC questionnaire [12]. The automatic coupling consists in mechanical components to transfer the longitudinal forces between the train sets, a integrated low voltage and air coupling.

Most important for the functionality of couplers seems to be an intensified maintenance of the mechanical parts (lubrication) and to cover the automatic coupling when it is not in use. Attention should be turned to the type of lubrication, because experiences have been made in the previous winter in Norway [12] where the greased hardened due to low temperature. For the electrical parts of the couplers the functionality of the heating system of the coupler head is of most importance.
3.3. **Pantograph**

Pantograph problems are in many cases on top of lists of winter problems. Due to the fact that most of problems are caused by the frozen catenary a reasonable approach would be to avoid or even to reduce as much as possible the icing on the catenary. There are several areas of the pantograph system, which might be affected by the frozen catenary or extreme winter conditions directly.

One effect is the increased wear on carbon pantograph strips caused by dramatically increased arcing. In extreme cases this can be resulting in cracking of the complete carbon strip. Therefore it is absolute necessary that the pantograph is equipped with a fast lowering device to protect in such an event further damages of the catenary.

Following items should be considered:

- Increased maintenance of the pantographs and especially of the carbon strips. (This includes the inspection of the strips as well as the inspection of the fastening between the strip and the fastening.)
- The definition of higher wear limits for the copper strips should be analysed.
- Inspection of all components responsible for the optimal dynamic behaviour of the pantograph and the preventive use of de-icing.

On infrastructure side it should be ensured that the track profile is free of foreign obstacles (ice formations at tunnel entrances, tree or bushes hanging down due to heavy snow loads).

3.4. **Iced sliding Doors**

In the previous winter problems occurred in UK with iced sliding doors. This is a good example showing the human behaviour to forget a problem and its solution, if it not occurs regularly. In [11] the author reminded that iced sliding doors were successfully handled in 1987. The doors were de-iced by fluid aerosols and additional staff was located in stations to clean and to pick out ice of the door tracks. This “best practise” was forgotten in 2009/2010 when the Railway in UK faced similar strong weather conditions and had again problems with the doors.

It is further a good example that the solution has not to be in any case a technical solution, especially in cases where the problems occurs not frequently.

3.5. **Electrical and electronic Equipment**

In many cases the failures are causes in the electric or electronic by moisture in the system and failed isolation. Condense water will be generated when taking a train in or out of the warm depot as explained in chapter 4. The areas of weakness in the system have to be identified and the isolation needs to be improved.

In another case Traction motors failed due to frozen motor isolation [12]. During the daily operation moisture and snow went through the traction motor without resulting in a problem. The problem occurred when the trains were parked outside over night and the freezing water in the traction motor expanded and damaged the traction motor isolation. In that case the solution was to park the trains inside in the depot over night.
4. Organisation

4.1. Introduction

The following plan defines the organizational framework of actions recommended for a weather-type incident. This plan will seek minimize the problems affecting the different areas of activity of the company before harshness of this type. In addition to measures to be taken before a situation of imminent danger, advisable to adopt preventive measures, in anticipation of a period bad weather, and throughout the duration of this Plan is delimited from November to February.

Treatment ordered an incident includes the following phases:

1. Identify the type of incident (snow, wind, rain, storm, hail, etc.).
2. Notice to emergency services: internal and external.
4. Information to passengers suffering immediate or near future.
5. Immediate measures to control the trains in transit to the affected area.
6. Coordination among the staff that is on the scene and 24 h. Control Centers
7. Design of an Alternative Transportation Plan in accordance with the indications and Infrastructure Managers recommendations, based on projections and assessment standards policy proposals

The areas affected by the incident should designate a single contact with Infrastructure managers, to represent them at the central level. These partners will be in the first instance related agents on the list of guards, although it later, and according to characteristics and evolution of the incident may be removed. Depending on the severity of the incident and the danger for people affected shall request the assistance of emergency services trained to meet the required performance.

Below are a series of recommendations to follow when compliance current transportation plan is not guaranteed:

- In accordance with instructions received from Infrastructure managers, first, it will be to ensure continuity of passenger trains and dangerous goods. As these problems are solved, it will be continued with other trains.
- If there are alternative routings in accordance with infrastructure managers, assess whether be the diversion of trains.
- Examine the suppression of certain services frequently.
- The passenger trains on that route is expected to be arrested, made a idle, in preference to prolonged detention.
- In accordance with Infrastructure managers be sought whenever possible, make the arrests those stations with better benefits for the attention of travellers.
- The trains involved in origin, will delay his departure long enough to avoid stop en route.
The resources are arranged taking into account the experience of last time, the effects and more frequent breakdowns and the availability of technical and human resources.

4.2. Actions Against Temporary Rain and Snow

The appearance of these can cause the following temporary risk situations for Railway:
- Intermittences in the movement to overcome the water level the height of the rail.
- Ripping this track being washed away by water.
- Landslides on the track or near intercepting the gauge.
- Interruptions in electrical power by a short and referrals.
- Flooding of underpasses at stations.

In the days after the period of rain is possible that some of these recurrence risks.

For the implementation of the measures taken will distinguish four phases namely:
- Warning Phase: Start with the ad through rainfall character AEMET strong downpour.
- Pre-emergence Stage: From the moment in which rainfall is heavy or very strong.
- Emergency Phase: We materialize some of the risks identified above.
- Standardization Phase: Since the end of the rainfall to total standardization of railway traffic.

The Network Management Centre Infrastructure managers H24 emits from the reported information AEMET receiving report in which weather forecasting and unleash phases warning, pre-emergency and emergency.

For the pre-emergency phase is recommended to take the following measures:
- Have compositions for ballast and cargo of diesel locomotives points strategic.
- Identify high risk areas.
- Limit or even eliminate trafficking of dangerous goods and exceptional transports.
- Always know the number of passengers from those trains that will travel the risk zone.

4.3. Alternative Transportation Plan (ATP)

Whenever possible, before an emergency situation, be activated by the Area Activity related an Alternative Transportation Plan in anticipation of indications Infrastructure managers received. This plan assumes the continuation and complement to immediate and adopted.

This Plan provides maximum performance the state of infrastructure advice. In terms of content not only address aspects of movement but actions include logistics and traveller care.

Activities that will integrate this alternative:
- Trafficking activities:
  - Removal of all or part of services.
  - Itineraries rail alternative.
  - Merge train.


1. Change station.

2. Logistics activities
   - Movements of compositions without service
   - Improving compositions.
   - Re-use compositions.
   - Use alternative diesel traction.

Customer’s Assistance

- Attention travellers:
  - Restoration: On board, at stations, in subsidized centers (Customer Services)
  - Alternative Modes Transport: buses, taxi, …
  - Parking preferential railway terminals affected resources. It is important to pay attention that nearby the railway stations there is a place to park the buses.
  - Phone and internet assistance (on line information)
  - Stock blankets, …

Passenger Stations

- Stations: improving services and customer information, as well as Information Service and Booking Office, end dates and stages pre-emergence and emergencies.
- Tracking timely to ensure the proper functioning of all systems information, the status of access and media facilities and stations.
- Establishment of a Responsible Management in each the head in each territorial.
- Meetings joint coordination to provide services in terminals and main stations
- Meetings coordinating joint programming and planning facilities alternative transportation as well as for programming operations.
- Compliance with general standards in the part that affects them

High Speed / Long Distance

- Regulation of pantographs of engines of your fleet vehicles.
- Daily: Tracking the evolution of fault-related material climatology and removing the least reliable vehicles for review.
- Improving customer information.
- Review prior to the locomotives of greater commitments.

Programming of empty shipping materials (trains).

- Programming ensuring timely reinforcements the state of the material to incorporate both self-propelled and conventional.
- Re-ensure with staff trains that can be subject to conflict due to snow or heavy rains.

4.4. Operations Coordination meetings:

- Plans alternative transport training in anticipation of delays.
- Increased Communications Operations Coordination Centre in Network Management Center H24.
- Determination of reserves in material and train staff.
- Respect for service loads Schedule Book.
• Ensure trains with diesel locomotives when conditions are foreseen heavy snow, identifying its location, informing the H24 and Delegation of Movement concerned.
• Compliance with general standards in the part that affects them

4.4.1. Commuter / Media Distance

• Regulation of pantographs of engines of your fleet vehicles.
• Improving customer information on trains.
• Programs consulting local delegations of Movement / Management of AV.
• Daily Tracking the evolution of fault-related material climate and resource control of traction.
• In mountain lines and terminal stations with low temperatures during winter, the material should be purged of staying for the duration winter and early warning in cases of low temperatures in these same areas, have personal drive to have the material in place in order to avoid freezing pipes in these materials to boot.
• Surveillance for the electric vehicles to avoid disconnections unnecessary overloads.

4.4.2. Freight and Logistics

• Proper stowage of cargo, especially the railway traffic corridors high risk.
• Punctuality on departure.
• Compliance Comprehensive Transportation Plan with regard to positions, manoeuvres and lots specifically provided for in stages of alert. Avoids unscheduled breaks traction.
• The trains carrying hazardous materials have secured their resources throughout the route during the stages of alert and end dates.
• Availability and operational staff and locomotives.
• Cessation Exceptional Transport (except automobiles and containers) end dates, with the authorization of the Network Management Center H24. Detour routes "Lower risk".

4.5. Measures to prevent damage:

• Monitoring of incidents occurring to trains by weather effects.
• Contacts with activity areas to collect contributions and to accomplish any improve the "preventive measures to inclement winter."
• Contacts with Infrastructure managers during the winter period to monitor developments current or evolving developments.
• Relations with the Autonomous Communities and the General Directorate of Civil Protection and Emergencies
  Special measures for peak periods Active Surveillance · compositions of passenger trains from one hour before leaving home in the Christmas period.
• Establishment of alternative arrangements in the formation and movement of trains to based on prevention of delays on arrival.
• Arrangement of strategic resources during peak dates, to address impacts on increased risk corridors.
• Allocation of destination drive up freight trains dangerous.
• Bans traffic of dangerous goods that lack of comprehensive program transport.
• Cessation exceptional transport, except those which move with authorizations for containers and cars.

Advance in the detection of faults in the material before the end of turn to ensure the following for communication with the Centres Managing the activities of transport services and manufacturing and Maintenance

5. Envisaged solution

As this report has shown, winter problems cannot be solved with one universal solution. To cope with winter a number of different remedies may be used; they all have in common that they demand a lot of man power and manual labour.

5.1. Personnel

One of the most frequent infrastructure failures during winter are switches that freeze up, or are packed with snow, preventing them from working properly. A switch that is packed with snow, and that has insufficient electrical heating, has to be cleaned by hand. In extreme winter conditions even good electrical heating is insufficient, due to the problems with ice blocks falling from passing trains. In such extreme situation, the infrastructure manager has to have mobile teams available, that can deploy at short notice to deal with problematic switches. The main problem with this, and many other jobs that has to be done in winter, is the fact that the IMs don’t have the recourses to hire battalions of workers to deal with this.

5.2. Legal framework

All workers hired to work on or near active railway infrastructure has to be given extensive training to obtain their security certificate. Such training is bound to take weeks and months, the time where you could be hired to work in the railways and go “straight out to work” have long gone. All IMs and RUs are bound by complex safety requirements, designed to secure the wellbeing of all workers. Because of this, each new hired worker is expensive. To hire workers to deal with winter problems alone is therefore not possible in many cases; they have to be full time workers, also during summer. The result of this is that most RUs have enough workers to tackle the “ordinary winter”, but fails badly when we get extreme conditions like in 2009/2010.
5.3. Personnel backup – let the administrative personnel “go to work”.

Most RUs in Europe today have large administrations of engineers, lawyers and other officials. These are typically working in an office environment, far from the daily operation of the railroad. They are, however full-time employees, and can easily be turned into a valuable personnel reserve during winter.

Being full time employees, the administrative personnel have ordinary tasks the rest of the year, and indeed in “normal” winters as well. It is only in the crisis situation that their efforts in the daily traffic may make a difference. Besides the point of having extra labour, the “administrative winter workers” may be a valuable media point as well; to underline the fact that the railways are doing everything in our power to restore traffic without delay.

5.4. Extra locomotive power

Extreme winters take their toll on the snow battling equipment, such as rotating snow ploughs, locomotives and other maintenance equipment. Such equipment is expensive, and it is unlikely that the IMs will buy large batches of equipment just to keep a reserve for crisis situations. However, most Infrastructure Managers already has such a reserve material stock; they just don’t use it.

In the crisis winter of 2009/2010, much of the network of Danish infrastructure manager Bane Danmarks was cleared of snow using the locomotive MY 1101. It is a museum locomotive, and has been so for NN years. This winter however, the locomotive was lended out by the museum, and played a key role in keeping the Danish network running. To comparison, the Norwegian railway museum has two identical locomotives to MY1101, both in running order, but these were not used to plough the network, even though there was a critical lack of snow clearing equipment.

Similarly, on the NNNN bahn I Switzerland, a steam powered rotating snow plough is still in use on especially troublesome winters. This helps the railway clear the track, and at the same time there is a chance to get positive media coverage in the same way as with the “extra personnel”. Given the fact that extreme winters only occur every 5-10 years, and the material used here in most cases will be held operational by rail enthusiasts, it is a much more cost effective way to ensure extra capacity with regards to the snow clearing equipment.

5.5. Emergency route plan

To be able to clear snow fast and effective, the infrastructure managers has to be given capacity on the track. On many lines, most of the capacity is already used to run ordinary trains, leaving the IMs few possibilities to clear snow in an effective manner. In situations with extreme amounts of snow, the IM has to clear snow several times during each day in order to ensure smooth operation of the infrastructure. This means that
some of the paths allocated to railway undertakings has to be cancelled. In order to ensure a non-discriminatory cancellation of paths, an emergency route plan should be made. In the working groups opinion, international train paths should not be cancelled, as cancellation of international paths may have major impacts on several national networks.

The emergency plan will show which trains are to be cancelled in a “winter emergency”; such an emergency should be declared by the IM when certain requirements has been met, such as a specific amount of snow over a specified time period e.g.

Emergency route plan may also be put into force by the railway undertaking, if and when they no longer have the rolling stock to uphold normal production. Last winter there were massive cancellations, but in many cases the cancellations were on a “ad-hoc”-basis rather than the result of planning.

5.6. Good planning

An emergency route plan is part of good planning, but as is showed in the signalling chapter above, good planning in the maintenance of the infrastructure is also important. In winter, many components may be more difficult and time consuming to maintain, and preventive maintenance should therefore be done during the summer and fall season. The different national rail networks should also divide their network into different “winter regions” and make a master winter plan for each region based on lessons learned in the past.

5.7. Joint operations centre

In Germany, France, Holland and a few other companies, the IM provide a “joint operations centre, where the different RUs are welcome to have representatives present. This centre make “real time” decisions regarding the traffic on the network, and the scope is to have all RUs present to take part in decisions when operations are halted. In other countries, such decisions may be taken by the IM alone, without consulting the RUs. A joint operations centre may enable the IM and RUs to take better decisions for the customers, and, to some extent, help each other in order to make the network recover more quickly from traffic interruptions.

6. References

6.1. Literature

[6] LDZ experiences (R.Ostrovskis), Signaling and Telecom in winter period
[8] RZD instruction No. ЦП-751 “ИНСТРУКЦИЯ ПО СНЕГОБОРЬБЕ НА ЖЕЛЕЗНЫХ ДОРОГАХ РОССИЙСКОЙ ФЕДЕРАЦИИ” (R.Ostrovskis)
[10] RENFE experiences (David Soto)