MANAGING WINTER SERVICEABILITY DURING AN ADVERSE WEATHER CONDITION (AWC) WITH THE AID OF ADVANCED TECHNOLOGICAL SYSTEMS. SPANISH EXPERIENCE IN SPORADICALLY EXPOSED GEOGRAPHICAL AREAS.

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ABSTRACT

During winter storms road authorities should not only keep the pavement clear of snow, but should also provide information to road users and other authorities responsible for regulating road traffic and should facilitate the coordination efforts with the other authorities involved in these episodes. This paper presents the procedure used by the Spanish Road Authority to manage winter serviceability operations in areas where winter storms occasionally occur. The organization and the modern technologies used to manage these operations are described.

The road network is divided into sectors and within each sector an operational plan is prepared that details the procedures to be used. Modern tools and technologies such as fixed and portable weather stations, fixed and portable video cameras, GPS devices providing information on the position and the operations being carried out by snow clearing equipment, dynamic information systems, mobile communications and others provide good assessment of the snowfall and its evolution thus permitting road managers to take the correct actions and provide motorists with up to date information concerning road conditions. These technologies also allow the road manager to take decisions without having to be at control centres, which is of primary importance because many of these storms do not occur during normal working hours.

The paper ends by explaining the relations among the different authorities involved in writing up and signing Winter Serviceability Protocols for Roads. The highest government authority in the area participates in these protocols that permit the mobilization of extraordinary resources, where necessary, in extreme conditions.

KEYWORDS

WINTER SERVICEABILITY / GPS / CURATIVE MAINTENANCE / PREVENTIVE MAINT-ENANCE / WEATHER STATION

1. INTRODUCTION

Winter serviceability is the branch of road operation concerned with keeping roads open in a safe and functioning state during the onset of adverse weather conditions (AWC) such as ice or snow episodes.

On the Spanish plateaux at altitudes ranging from 650 to 1,000 MASL ice frequently forms but snowstorms only occur sporadically. Historic records show a very high number (60-80) of days with ice formation yet a small number (8-9) of days affected by snowstorms. Such snowstorms however may or may not affect the entire road network simultaneously.

In the areas affected, the fact that both maintenance staff and drivers are not overly accustomed to this routine adds to the AWC situation.

Furthermore, the sporadic nature of the AWC demands the existence of a flexible short-term weather prediction and communication system and the need to keep personnel and machinery in a state of standby, as a function of short- and medium-term predictions, over the winter serviceability period.

2. NETWORK ORGANIZATION

For the purposes of winter serviceability and maintenance, the network of State-run Spanish Roads is organized into sectors. Each sector forms the subject of an integral maintenance contract outsourced to a service company. Winter serviceability constitutes a section of this contract.

Winter serviceability management is covered in a specific document, the Service Note on Action by the Maintenance Services for Winter Serviceability Campaigns, originally from November, 2000 and updated in October 2006, which includes the ”Winter Serviceability Operation Plans” providing the resources and actions to be implemented in every case of an AWC.

The Service Note sets up three possible Levels of Service, SL-1 to SL-3. Service conditions are set up depending on the number of traffic cuts on carriageways or blocked roads permitted over a one-year period and their duration, accordingly no total traffic cut or carriageway block is permitted for SL-1 whereas any frequency and duration is permissible for SL-3 roads.

3. OPERATION PLANS

The operation plans contain all the data pertaining to the particular road section involved and to the resources available and the organization of the work. In addition, they include all necessary information for the appropriate traffic management, as also for the back-up facilities and service for drivers. Typical contents of an Operation Plan could be Introduction, Climatology, Section description, Resources available, Work organization, Communication systems and Conclusions.

It also incorporates a set of annexes providing the following information: elevation profile of the road, table of stored and stockpiled equipment, location of snowplough machinery and

runs; median crossover points and intersections; points for traffic cuts; areas for vehicle retention and parking; areas for stopping vehicles to fit chains; gas station; telephone numbers and people to contact.

4. EQUIPMENT, MATERIALS AND FACILITIES

4.1. Snowploughs

All the contracts include the number and type of snowploughs to be available from the maintenance firm along with their technical specifications and maximum age at the start of the contract.

In these areas where roads have wide layouts two- and three-axle large-scale machinery is generally used, fitted with salt spreader and brine tank so that they can perform both preventive and curative maintenance tasks.

The most frequently available types of snowclearing apparatus are 4WD snowplough trucks fitted with salt spreader and angle- or V-blade ploughs, useful for curative maintenance; 6WD, three-axle trucks with 7,500-litre brine tank, 7.2-ton salt spreader and angle- or V-blade, useful for curative and preventive maintenance tasks and 9000-litre brine tank wagons fitted with angle- or V-blade, useful for preventive maintenance and occasionally for curative tasks. In some cases, snowploughs are fitted with a side plough allowing them to clear virtually the entire carriageway in one go, this type of ancillary equipment is however not yet available on a regular basis.

4.2. Salt barns

Solid-form salt is stored at Maintenance Depots and distributed at strategic points throughout the sector in order to supply the snowplough brine tanks.

The salt stored can either be from salt mines (rock salt) or sea salt depending on what it is to be used for. Sea salt, which is purer, is required for the production of brine, consequently its barns are associated with the existence of brine production plant. Rock salt is apt for curative and preventive maintenance in wet road conditions and is distributed from separate deposits located strategically throughout the sector so that the salt spreaders can be refilled without the need to return to base depot.

Salt is stored in two ways, either in weather-proof bays known as barns or in silos. The normal procedure is to use barn storage in the base depots, fitted with truck loading equipment, whereas closed silos are used in the deposits distributed throughout the sector, allowing trucks to be filled without any mechanical means.

4.3. Brine production plant and storage depots

Preventive maintenance tasks regularly use brine, which calls for brine production plant and storage depots. Brine plant can produce between 2,500 and 6,000 l/h of brine through a saturation process in concentrations of around 23-26 %.

The brine plant and deposits necessary to cater for a full preventive treatment are sized as a function of the salt content of the brine, the objective amount of salt to be left on the pavement and the spreading method used. The dose of salt to be left on road pavements varies between 5-10 g/m^2 in preventive treatments and 20-40 g/m^2 in curative applications.

A 23% concentration of brine contains a 260-kg/m^3 solution. In preventive treatments a 9,000-l tank, spreading a 10-m wide carriageway and leaving a 5-g/m^2 dose of brine, has a large enough range to treat 46.8 km of carriageway including hard shoulders. Given that this range is clearly small, the tendency has been to spread solid-form salt moistened with brine, in the proportion of 2.65 g in brine form and 4 g in solid salt form. This way, using a combi truck with a 7,500-l brine and a 7-t solid salt capacity, 75 km can be spread with a 2.65-g/m^2 brine solution and up to 175 km with a 4-g/m^2 solid salt proportion, the capacity of the brine tank consequently being the limiting factor.

4.4. Automatic brine sprinkling facilities

Automatic brine sprinkling facilities are being installed in critical areas such as bridge decks or prolonged ramps. These systems can be supervised from control centres or left working in automatic mode so that the weather station sets them going in cases where adverse climatology requires this. The customary parameters for the start up of sprinkling operations are ambient temperature or the carriageway temperatures obtained from the weather station linked to the facility.

These pumping and sprinkler stations allow a single basic system to control areas of up to 1 km by placing sprinklers that each individually cover a minimum 80-m^2 surface area. The 2,000-l brine tanks and 500-l Diesel oil capacity for the pump provide the system with a large enough range for a crisis lasting several days, without the need for back up. Even so, they are fitted with alarm systems to indicate when they are getting down to the reserve tank.

The fact that the electricity supply is from solar panels, that they carry fuel and brine tanks and that mobile communications are used makes the system totally independent of supply networks so that they can easily be installed anywhere.

5. TECHNOLOGICAL INFORMATION SYSTEMS

5.1. Weather stations

The Spanish expressway and motorway network has a weather or meteorological station system installed by the Directorate General for Traffic (DGT). These stations supply meteorological data to both the DGT's Data Management Centre and the Maintenance Depots. In addition, fixed weather stations managed directly by the Maintenance Depots have been installed in perimeter locations and places where the mountainous terrain creates problems of ice sheets or snow and they are not covered by the DGT network.

Portable weather stations are also installed in the different winter service vehicles in order to collect data on the state of the highway.

Fixed weather stations, generally powered by solar panels giving them enough range to function for two days in total darkness, are fitted with the following sensors: wind speed, wind direction, temperature and humidity, rain gauge, barometer, carriageway temperature and freezing point, carriageway salinity gauge and turbidity sensor.

Changes recorded in the parameters of ambient and carriageway temperature, humidity, wind direction and speed, and volume and type of rainfall are vitally important if winter serviceability is to be managed well. Other parameters, such as carriageway salinity, are orientative and depend on multiple factors to be taken into account prior to making decisions based on their values.

The portable weather stations provide data on the meteorological condition at the vehicle location point, supplying valuable information on humidity and ambient and carriageway temperature. Knowledge of the ambient temperature is especially useful for deciding on the type of de-icing chemical to be spread. Information is transmitted via the GPRS or UMTS networks depending on the coverage available at each point.

5.2. Television cameras

The expressway and motorway network has a surveillance system based on cameras installed by the Directorate General for Traffic. The images supplied by these cameras are also accessible from the Maintenance Depots, permitting remote, real-time knowledge of the state of the highway and the weather conditions prevailing.

In addition, other complementary fixed and portable cameras have been installed that depend directly on the Maintenance Depots. The fixed cameras tend to be installed at points with weather stations whereas the portable cameras are installed on board snowploughs and maintenance vehicles. The fixed cameras can be connected by fibre optics or via Internet while the portable cameras always use Internet connection.

The basic equipment of the cameras connected via Internet consists of a server and a CCTV camera. The server has an internal computer with a 4-channel video card, a GPRS/UMTS (3G)/WIFI router and a 12-V power source. The 4-channel video card allows simultaneous connection of as many other cameras to the equipment. The computer processes the images, stores them digitally on its internal hard disk and posts the images via the integrated web server connected to Internet via the router. The server records the images captured by the cameras and stores them on its internal hard disk, which means that images can be viewed in both real time and consulted later.

These actions are carried out automatically without the need for an operator. This means that once the driver turns on the system when starting up the vehicle that he can then cease to worry about it, a vitally important factor while he remains at the driving wheel. From the moment it starts up, the equipment is recording the images being captured by the cameras and posting them on Internet.

The router has SIM cards with a fixed IP address thus avoiding the customary connection failures through dynamic IP servers. In the event of loss of connection, the latest images are automatically recovered when this is restored.

Connected to the web server, the user can select from amongst the four possible cameras and amongst the different image resolutions available - 176*144(QCIF), 352*288(CIF) and 528*384(DCIF) as the quality and the particular requirements of the time need to be offset since the broad band is limited, depending on the coverage available. In optimum UMTS network conditions, one CIF-quality image is received every second. For fixed cameras, where only checks on climate variations are sought, DCIF quality can be used although it takes longer to refresh the image.

The cameras used are CCTV as the quality of the optics is superior to that of a similarly priced WebCam, apart from providing better quality images in poor light. They are fitted with auto focus, auto iris and optical and digital zoom devices and, in the event of being housed in posts adjacent to weather stations, domotized cameras are used meaning their angle and rotation can be controlled.

5.3. Variable message panels

The Directorate General for Traffic has installed a motorist information system using variable message panels on high capacity roads. These panels are controlled from the corresponding Regional Traffic Management Centre and allow motorists to be kept informed about the state of the highways sufficiently in advance of the particular section affected by an incident so that they are able to make informed decisions. The same standardized messages are used throughout the network.

5.4. Automatic fleet tracking system (GPS)

Every single road maintenance vehicle carries GPS equipment on board, consisting of a GPS receiver, analogical data collection card, condition sensors, controller, GPRS modem and user screen. The GPS receiver antenna captures the signals sent from satellites in geostationary orbit and calculates the position of the vehicle at each moment in time.

The data collection card monitorizes the different sensors, consisting of a vehicle contact sensor giving us the vehicle's mechanical condition, whether with the ignition off, running but stopped or moving; a mercury plough sensor providing information on the state of the plough – high or ploughing snow; salt tank sensor, using a pressostat in the salt tank hydraulic circuit that activates the 'spreading salt' condition once the right pressure threshold is reached for the spreader to start working. This sensor has proved to be more reliable than others such as end-of-run, magnetic or optic types, etc., where reliability was compromised by the corrosive nature of the salt.

The controller is responsible for collecting all these data, displaying them on the user screen and passing them on to the GPRS modem. The user screen allows drivers to check the system condition. Once the vehicle has left the base depot, the driver is actually the only person to know the real condition of the plough and brine, can check this against the sensor readings and, in the event of failure, can notify the base depot so that the returning vehicle is met by technical personnel to solve the incident.

The GPRS modem is responsible for sending all data to the central servers. In the absence of coverage, it comes with a 64 kB memory for data storage until coverage is restored, at which time it resends the data. In our case, we opted for GPRS communications against other options because they combine the following advantages - continuous Internet connection, virtually total coverage and low cost. Continuous Internet connection in this type of application provides the important advantage of knowing the position and condition of each vehicle in real time. The disadvantage affecting use of SMS systems for instance is the possibility of suffering delays by minutes or even hours when the network is saturated. Coverage is broad because the GPRS network is combined with the GSM network allowing a 99% coverage of the territory. Any coverage problems are isolated in nature and extremely localized. In the case of Spain, the UMTS (3G) network does not obtain these levels of coverage. Cost is low because it is the same as UMTS (3G) communications and very much cheaper than communications by SMS.

Data packages are very small – position and bits related to the condition of the sensors take up less than an SMS, which has a fixed cost. The fact that these packages are so small, along with the low byte price of the data communications, allows us to configure the system to update the position of each vehicle every ten seconds (a configurable value) and twice over – in the maintenance firm's server and in the road authority server. This duplication in the transmission of data is designed to provide the system with greater security under the possible, though unlikely, threat of the server going down. Each firm

has a server where it stores the data pertaining to its vehicles whereas the road authority server stores the data pertaining to all the firms and to its own vehicles.

The control centre operators have a user application allowing them to visualize the position and state of the vehicles in real time, superimposed over the set of georeferenced maps of the State-run Road Network. This application allows vehicles to be activated on a fleet basis or a particular vehicle to be located on the map through its indicative identification. Each vehicle shows a set of descriptive data such as indication number, make, model, type of vehicle and fleet to which it belongs plus location - road, kilometre point, direction, speed and mechanical condition.

This software permits routes to be reproduced on screen based on the historical data stored, meaning that the work carried out by maintenance firms can be checked. In addition, it also enables different types of report to be generated in the form of detailed lists, showing all the data available on a particular vehicle in a time range - date, time, position, speed, distance run and duration in each mechanical condition; fleet summary, generating a list showing the totals of the previous data for each individual vehicle of a particular fleet; runs graph in the form of a space-time graph per road. Here the y-axis corresponds to the kilometre points on every road and the x-axis to the time range selected and shows the tasks carried out by the vehicles selected on a particular road using different colours for each mechanical condition – plough yes/salt no, plough yes/salt yes, plough no/salt no, plough no/salt yes. This graph means it is possible to check the work carried out on each road during a meteorological crisis.

The data servers can be accessed from Internet so that with equipment connected to this and the customer software a mobile control centre can be set up anywhere, worldwide.

5.5. Maintenance depots and the road authority centre

All the information provided by the means described is stored in a server in the Maintenance Depots and is displayed on a set of screens showing the images from the cameras, the weather data supplied by the roadside stations and the position of the vehicles belonging to the maintenance fleet. In addition, Internet also gives access to the meteorological data published by the AEMET met. office, the situation of the roads put out by the DGT and the government Tele-ruta service on their web pages and to the images supplied by other public cameras. Each Depot receives the data corresponding to its sector.

In addition, the Operation and Maintenance Service belonging to the Road Authority has access to the information pertaining to all the sectors, to the DGT and to the rest of the public data.

As the entire system is on Internet, it can be obtained on a laptop PC meaning that managers do not have to be physically present to attend to a particular incident and can follow the evolution of the storm from wherever they happen to be.

6. BACK UP FACILITIES FOR REAL TIME MANAGEMENT

By way of summary of the facilities described above, the following resources back up winter serviceability management during an adverse weather condition (AWC).

6.1. Road weather information system (RWIS)

Weather data are published by the AEMET, Spain's State Meteorological Agency. This office is responsible for putting out warnings forecasting adverse weather conditions. The data issued by the AEMET are channelled via the Civil Protection Service, which is responsible for transmitting the data via the Government Subdelegation to all interested institutions and bodies. Weather data warnings are complemented during the development of an AWC with very short-term alerts on the evolution of storms. In addition to the AEMET data, real-time detailed information is also provided by the roadside weather stations that supply the data described in Section 5.1.

6.2. Snowplough fleet position and action information

The GPS setup allows us to know the snowplough position and action at any one time.

6.3. Visual data from cameras

Other information available is supplied by the images conveyed by both the fixed and portable TV cameras providing direct data about the intensity of an AWC and of the condition of the highway at a particular spot.

6.4. Variable message panels

Installed along highways, these provide motorists with different types of information related to the state of the highway. These panels are operated from the DGT's Traffic Management Centre, which also holds the camera images plus weather and traffic data. This combined set of data is extremely useful for managing winter serviceability during an Adverse Weather Condition.

6.5. Other data

Direct phone connection via mobile or Internet to the DGT, Tele-ruta Service, adjacent sectors and Traffic Management Centres provides knowledge of the general situation set off by an AWC.

6.6. Post-awc action

Once the AWC is over there is still work to do to finish clearing hard shoulders and areas excluded from traffic and retreating critical points such as areas in shade or where seeping water can be conducive to ice formation, etc.

7. TARGETS AND PROCEDURES

The targets for preventing ice formation and the level of service or snow clearing desired are set out in the Service Note published by the Subdirectorate General for Operation and Maintenance and in the Operation Plan of the Roads Division, the regional government agency for management of the road network.

7.1. Preventive treatments

Preventive treatment has a clear objective of not allowing ice to form at any point on the carriageway.

Preventive treatment consists of the systematic spreading of salt/brine throughout the entire sector. Depending on the weather conditions of temperature, humidity and rainfall involved, the treatment uses brine or moistened salt if the weather is dry and temperatures

do not fall below -5º C and solid form salt if the carriageway is moist enough to fix and dissolve the salt or light rain is forecast along with suspected subsequent ice formation at temperatures above -5º C. When forecast temperatures are below the -5º C limit, the salt/brine is mixed with calcium chloride that works down to temperatures of -15º C.

The number of treatments is another variable to be considered. When scenarios of low to very low temperatures are forecast, two treatments per day throughout the sector are usually carried out. They are done in the evening, starting at 18:00, and in the morning, from 04:00 onwards. In extreme cases work can be extended to three treatments per day but this is highly exceptional.

Current doses used are 7 g/m^2 of salt when brine-moistened salt is applied (2.65 g/m^2 brine+4.35 g/m^2 solid salt). If solid-form salt is used alone, the dose increases to 10 g/m^2 owing to the greater losses occurring with this system.

A preventive treatment of a full sector should take two hours at most. Depending on the truck range reported above, the doses to be used and the average sector length involved, each treatment should have three/four combi trucks at its disposal, thus allowing a full sector to be treated with brine-moistened salt or else with solid-form salt.

Truck routes are preset in the Operation Plans so that each operator knows which itinerary to take and the doses to be applied. The time employed in each run is thus also set and complies with the stipulation of not exceeding two hours.

At some critical points, such as bridge decks and prolonged ramps, automatic brine sprinklers have been installed that automatically spread this product when temperatures drop below a certain level (2º C). This means that the truck runs do not have to be altered to attend to these areas where ice may form as a result of the low inertia of the decks at an earlier time than the rest of the stretch or have worse consequences, even knowing that they have already been treated.

In the event of the weather staying dry with low temperatures, the brine-moistened salt stays spread longer making it possible to cut down treatment on a full sector to a minimum of once a day as a function of the degree of salinity involved, complemented where necessary with a partial application at critical points.

Motorists are advised of snowplough operation on the highway through variable message panels for them to be able to take suitable precautions in the presence of heavy-duty vehicles travelling slower than the permitted pace and spreading salt.

7.2. Curative treatments

Spain's entire so-called Network of State-run Roads of General Interest in the plain areas we refer to is classed as belonging to Service Level 1 (SL-1), except for the roads and service lanes complementary to the main distributor routes or arteries.

The Roads Division's Operation Plan stipulates the routes of priority and secondary attention, based on traffic density criteria and maintaining communications by road at both inter-regional level (between Spain's autonomous regions) and intra-regional level (between provincial capitals).

In principle, with the network being divided into sectors, the primary attention routes within each sector should be attended first, but if a sector only has secondary attention routes,

for sector maintenance purposes these become priority. Only in the event that the priority route targets of other sectors cannot be met, can the resources devoted to secondary attention routes be commandeered to treat them through back-up arrangements between sectors. The Plan lays down the relations between the different government authorities for the correct coordination of these back-up procedures.

In practice, the attention to each individual route translates into the maximum time between two snowplough runs past a point on the road and into the clearing or otherwise of all lanes on one-way carriageways.

A maximum time of 60 minutes has been set for all routes, adequate as a function of the maximum snow storms predictable in the area so as not to have to cut use of the road for light traffic and only eventually for heavy goods vehicles.

To design the number of snowploughs necessary, the factors to be taken into account are the run speed in the clearing position, time out for recharging the de-icing chemicals, fuel supply, blade replacement and personnel breaks.

These data make it possible to calculate the number of snowploughs necessary in the event of a snow storm affecting the full sector. One snowplough operating at 60 km/h in a curative treatment, considering a 70% performance rate and taking time out into account, can clear 42 km in one hour. A large 150-km expressway sector would therefore need a fleet of eight snowploughs working simultaneously. On a conventional two-lane road, with lower working speed performance rate, a 36-km stretch can be treated in one hour.

It is also necessary to site and size the salt deposits needed for curative treatment. The doses used in curative treatments are clearly much larger than for preventive treatments, in the order of 20-30 g/m^2 or 30-40 g/m^2 depending on the thickness of snow involved (under or over 2 cm) and on the temperature. As in the case of preventive treatments, for temperatures below -5º C, calcium chloride is applied, mixed with common salt in proportions of up to 30% owing to the danger of $CaCl_2$ precipitating and giving rise to slippery surfaces.

With average doses of 25 g/m^2 and salt spreading tanks with a 6-7 t capacity, a truck can provide a curative treatment for as much as 70 km of lane. This affects the location of the deposits not to be more than 70 km of run distance apart. On conventional two-lane roads, treating both lanes at the same time, this distance is cut down by half.

In addition, the volume of de-icing chemicals storage necessary depends on the duration of the snow storm. In a large expressway sector with 250-300 km of carriageway, a full run requires 30 t for one lane and without treating intersections. This type of sector has at least three deposits distributed throughout its length and each deposit usually has a minimum capacity of 200 t, whereby a snow storm would need to last for 20 consecutive hours to deplete the stores of salt, and in the regions we cater for an episode like this is highly improbable.

In principle, the Operation Plans of each sector determine the standby location of the snowploughs in each stretch of highway and the standard runs they should carry out. However, what normally happens is that a snow storm does not occur simultaneously in all the sectors of a province or a Roads Division at the same time. This allows a smaller number of resources to be managed with the same degree of clearing efficiency. To this

end, it is necessary to rely on greater coordination with knowledge of the resources available, their location, the evolution of the storm and the situation of the highway.
This coordination is amply facilitated by the GPS, the data from the weather stations and the AEMET and the road images. The GPS gives the real-time location of every snowplough and consequently, knowing the situation of each stretch through the weather data and road images, resources can be distributed more efficiently in advance of the storm episode.

In addition, the variable message panels work at highway level giving information to motorists on the state of the highway, use of chains, traffic cuts and the presence of snowploughs, etc.

8. REPORTS ON STORM EPISODE MANAGEMENT

All the information generated by the GPS equipment, cameras and weather stations is stored and therefore allows subsequent analysis of the AWC and the action taken by the winter serviceability teams with a view to providing feedback on the system and improving the procedures.

The GPS gives the snowplough runs and the times each point has been treated throughout the duration of the AWC while the cameras allow the circumstances giving rise to incidents during the development of an AWC to be looked at again.

Finally, as a result of the management by the Maintenance Depots, the de-icing chemicals consumed is a known quantity, meaning that average figures for the doses applied can be obtained.

9. COORDINATION WITH OTHER GOVERNMENT AUTHORITIES, ORGANISMS AND INSTITUTIONS

Winter serviceability is not only the concern of road and traffic managers. The ultimate goal of all road serviceability operations is to keep the roads in a sufficiently serviceable state for motorists to be able to drive along them with adequate guarantees of road safety. This is the reason why winter serviceability not only involves institutions responsible for highway and traffic control but also political institutions, meteorological agencies, civil protection systems and even the Army for mobilization in situations of serious emergency.

9.1. Action protocol in awc scenarios

Different levels of coordination protocols exist for winter serviceability action in AWC scenarios – a National, a Regional and a Provincial Protocol. These Protocols cover matters ranging from a most general nature to a most particular, each containing criteria and guidelines to develop matters on a lower level.

9.2. The regional government protocol

This has the following sections:

- aim and ambit;
- geographical, climatological and socioeconomic characteristics of the appropriate Autonomous Community or Region relative to the threat of snowstorms;
- characteristics of the State-run Road Network in the Castile and León Region and the stretches that predictably give more trouble in the event of snowstorms;

- meteorological data and warnings in the face of snowstorm threat;
- organization;
- operation procedures;
- catalogue of means and resources. Directories.

The Protocol is aimed at coordinating and mobilizing all the means at the disposal of the General State Administration for achieving the aims of serviceability, information and action in emergency events such as isolated towns or individuals blocked, services interrupted and evacuation of the sick, etc.

It relies on the weather data put out by the AEMET included in the so-called National Adverse Weather Prediction and Vigilance Plan. It sets out the different stages of the episode, starting with the Pre-emergency Stage (scenario 0) in which all the resources are put on standby, subsequently developed over three stages of Emergency, corresponding to onset of the snowstorm, road closure and the necessary attention to people blocked by it.

The directing and coordination is the responsibility of the Government Delegation Head assisted by an Executive Committee made up of the Heads of the Roads Division, Directorate General for Traffic, the Civil Guard, National Police, Civil Protection Service and the Army.

The Protocol lays down the specific functions of the Delegation Head and the members of the Executive Committee.

Highlighted amongst the functions of the Head of Delegation are:
- declaring stages and situations;
- ordering traffic restrictions, traffic cuts on highways and pocketing of vehicles related to the sphere of the Castile and León Region.

The functions of the Roads Divisions and Civil Guard include:
- proposing the declaration of situations, the driving conditions and the need to commission standby and extraordinary means and resources for serviceability purposes.

The functions of the Civil Protection Service include:
- guaranteeing broadcast through the provinces of the Adverse Weather Condition Warning;
- during the development of the episode, this Service is responsible for transmitting the short- and very short-term weather reports issued by the AEMET.

Responsibility for broadcasting information to the public through different means lies with the Government Delegation Press Office. In addition to the information channelled through the Press Office, both the Civil Guard and the Directorate General for Roads have services for transmitting information either by telephone or Internet. The service of the Directorate General for Roads is called Tele-ruta and informs on all the incidents affecting the Network of State-run Roads of General Interest.

Finally, matters pertaining to serviceability and traffic are coordinated by the Head of the Road Operation and Maintenance Service and by the Provincial Head of Traffic. It therefore corresponds to both to decide jointly on the compulsory use of chains on a particular stretch or on traffic restrictions, total closure or permission only for light traffic to circulate and the combined action of all the road resources of the two Directorates

General. This decision, in accordance with the provisions laid down in the Protocol, will be conveyed to the Head of the Government Delegation who will then formalize it.

Lastly, the procedures are laid down for starting up each individual stage and the coordination articulated with the institutions not belonging to the General State Administration.

The Protocol includes a set of annexes containing the catalogue of resources available, the threshold values of the situations involved in the Warning issued by the National Adverse Weather Prediction and Vigilance Plan according to region and altitude involved in the event of snowstorms, and the telephone numbers and addresses of the personnel engaged in winter serviceability work.

9.3. The provincial protocol

The Provincial Protocol has a parallel structure to that of the Regional Protocol whereby the agents intervening are the provincial representatives of each individual institution, the Government Subdelegate takes on per Delegation, in the provincial sphere, the functions attributed to the Delegate in the preceding Protocol, coordination with the local and regional institutions not belonging to the General State Administration is articulated and the specific provincial circumstances are specified.

10. CONCLUSIONS

The aim of winter serviceability is to maintain wherever and to whatever extent possible safe driving conditions and, by extension, all types of operation necessary to solve incidents affecting highways that arise as a result of this.

Depending on the type and duration of the Adverse Weather Condition, it may not prove possible to keep all or part of the traffic running without risking civic safety, consequently traffic restrictions form one more tool in winter serviceability.

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