

CHAPTER 17

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CHAPTER 17

SERVICES FOR LAND TRANSPORT

17.1 Introduction

17.1.1 This market sector is concerned with all activities primarily directed at the conveyance of people and freight over land, i.e. by road or rail. Services which cover leisure activities of land transport customers such as car rally or canal boat drivers are included in the market sector for leisure and tourism (chapter 13).

17.1.2 The primary requirement for repayment services comes from those responsible for the provision of the transport system, i.e. the highways maintenance authorities (section 17.2) and rail authorities (section 17.10). Numerous commercial road user groups may be considered as potential customers, e.g. road haulage companies, bus and coach operators, taxi firms, vehicle hirers, etc., but are not considered separately here. Consultancy, forecast and warnings services may be appropriate and should be negotiated locally. The needs of the travelling public are largely met by information available via the media, including telephone services. Warnings services for the Police and BBC Travel Centre are discussed further in section 17.8. Breakdown and recovery organizations, e.g. the Automobile Association (AA) or the Royal Automobile Club (RAC) form an important area for services discussed in section 17.9.

17.1.3 A feature of many of the segments of this market is the need for highly site-specific information about actual or expected weather affecting individual stretches of road. Often, even with a suitably placed conventional observation, it may not be a simple matter to infer whether, for example, snow is accumulating or ice is forming because of unknown variables such as traffic or gritting activity. Suitable observations are needed from the network of roads themselves, involving cooperation from customers or potential customers. This is discussed further in section 17.3.

17.2 Services for highways maintenance authorities

17.2.1 The DTp, the Welsh Office (WO) and Scottish Development Department (SDD) are responsible for trunk roads and motorways in England, Wales and Scotland respectively. The DOE is the responsible authority in Northern Ireland. When major roads are being planned or improved, these Government Departments or their agents, such as consulting engineers sometimes require climatological studies to be carried out particularly with regard to the likely incidence of fog, but wind, heavy rainfall and the incidence of snow and ice are also important. Such studies are carried out by the Commercial Services CP Climate Consultancy Group on repayment, and any enquiries received at WCs in relation to such studies should be referred to them. The booklet *Climatological services for highway planning and design* describes these CP services. WCs may receive requests for forecast or warning services in connection with the construction of new roads. These are properly part of the construction sector considered in chapter 7.

17.2.2 Responsibility for the maintenance of trunk roads and motorways is usually delegated by DTp, WO and SDD to county or regional councils who for this purpose are known as agent authorities. In former metropolitan county areas (e.g. Greater Manchester, West Midlands) responsibility for motorways rests with consulting engineers appointed for this purpose. County and regional authorities are also directly responsible as highway authorities for all other roads in their areas, but in some cases this is delegated to city, borough and district councils.

17.2.3 Maintenance activities may be divided into two areas. In winter there is a responsibility to keep roads, as far as possible, clear of ice and snow. In summer the authorities are responsible for resurfacing activity etc. Both activities are sensitive to weather variations and can benefit significantly from the provision of forecast or warning services, though the winter requirement is the greater. The cost of a single night's salting of one authority's roads will reach several thousand pounds and the national bill for an average winter can amount to £100million or more. The requirements for summer maintenance are discussed in section 17.6. The following sections describe the organization of services to meet the winter requirement.

17.2.4 As can be seen the benefits of avoiding salting operations (when these are not necessary) can be very large. The consequences of not salting when severe weather is predicted, in terms of road safety, public confidence and political popularity have to be weighed by the highway authorities against these purely monetary considerations. Some authorities err on the side of caution when organizing their maintenance operations. In addition the effect of excessive quantities of salt, not only on vehicles, is becoming more important, and authorities are having to recognize this. It is clear that either way accurate and timely weather information can greatly assist in the decision-making process by the highway authorities.

17.2.5 The present Office services for winter road maintenance are provided under the generic title 'OpenRoad'. These services have developed in response to opportunities presented by the availability of new technology in four areas of relevance:

- a. The development of road surface sensors which measure such parameters as temperature, wetness, salinity and telemetry by a central computer terminal which uses ordinary telephone Public Service Telephone Network (PSTN) lines (see section 17.3).
- b. The development for use on microcomputers of numerical models of the heat exchange at the road surface in response to atmospheric forcing; these are the so-called ice prediction models (see section 17.4).
- c. The introduction of improved methods of forecast dissemination in particular fast document facsimile and computer to computer links.
- d. The development of methods for surveying relative road surface temperatures over local authority major road networks known as thermal mapping (see section 17.4).

Under the guidance of the DTp these elements have been brought together into a 'National Ice Prediction System'. This allows an authority, having installed a relatively small network of sensors, to monitor the road surface conditions, to receive on a central computer terminal graphical forecasts of the expected variation in road surface temperature and wetness for up to 24 hours ahead for selected sensor sites and to extrapolate the expected minimum road surface temperature by means of the thermal map to any point on the road network. The OpenRoad service also includes text forecasts and precipitation radar imagery if required. The service is described in detail in section 17.5.

17.3 Ice detection sensors and thermal mapping

17.3.1 An increasing number of highway authorities have installed or are installing ice detection systems. These complete systems consist of a network of 'ice detection' sensor installations placed strategically around the authority's major road network and connected to a control computer facility which automatically polls the sensors on a regular basis. The data from these sensors are displayed on request on a number of Visual Display Unit (VDU) workstations, which may be located anywhere in the authority's premises or at a Weather Centre.

17.3.2 Typical installations provide measurement of road surface temperature, wetness and salinity, and temperature at a depth within the road construction, typically at a 'sub-base' level of approximately 30 cm. Many have associated atmospheric sensors measuring air temperature, humidity, wind speed and direction. Polling rates vary according to manufacturer. DTp requirements stipulate the provision of data at least hourly. Some systems sample at 2 to 3 minute intervals.

17.3.3 The DTp have established, in association with the Office and the manufacturers, a communications protocol (MCE 2020G) which allows the transmission over the PSTN of data from sensor networks to PS offices as input to ice prediction models (section 17.4), and to allow forecasters to monitor temperatures etc. on customer authorities' road networks. The DTp has now issued a new protocol, TR2020B, which will gradually be introduced during the next year or so with the cooperation of sensor manufacturers.

17.3.4 The siting of road sensors by the installing authority is usually determined according to two important considerations. The first concerns the location of known cold spots where experience indicates that ice is liable to form most frequently. The second is the need for representativity, so that when considered jointly the minimum number of locations may be used to give an adequate indication of the conditions over the whole network. Use of thermal mapping is of considerable assistance, though it needs to be carried out in a variety of synoptic situations to be representative. The usual technique involves an infrared detector mounted in a van which is driven along the required roads at around the time of minimum temperature under a number of different radiation situations ranging from calm weather and clear skies to heavy cloud, rain and strong winds. In the former case spatial variations in road surface temperature are at their greatest; in the latter they are small and in some circumstances may change sign. In addition to the weather type a variety of factors influence the pattern, and include altitude, slope, shelter, buildings, road surface composition, proximity to water, etc. The DTp has produced a publication entitled *Thermal Mapping Specification*, to which all surveys should conform. Copies of this are available from CS Headquarters. It includes a useful account of the meteorological factors involved.

17.3.5 Highway authorities have been informed by DTp circular that advice on siting of sensors may be obtained from PS offices. Outstations should be aware that OP(1b) have expertise in this area particularly with regard to

exposure of the atmospheric sensors and should be consulted when enquiries are received. Nevertheless the local WC has an important role to play and may well be invited by the authority to put forward their own requirements for forecasting purposes. Charges in connection with this work should be discussed with the Market Sector Manager Land Transport (R)).

17.3.6 Sensor calibration is the responsibility of the manufacturers. However the current DTp specification requires sites to be inspected and readings checked for accuracy at least once per year. Such services may be provided by S&B offices or referred to Met O(OPR). Charges may be raised locally but advice should be sought from MSM(R).

17.4 Ice prediction

17.4.1 The development of numerical models of the heat and moisture balances at the road/air interface was pioneered by the University of Birmingham under contract to DTp. Their model was tested in the winter of 1985/86 using data from sensors on motorways in the West Midlands and input forecast atmospheric variables from forecasters at Birmingham WC. Subsequently a separate version of the model was developed in Met O 9 (see *The Meteorological Office forecast road surface temperature model*, by P.J.Rayer, *Meteorol Mag*, Vol. 116, pp. 180-191, June 1987). A brief account of this model, which is used operationally for OpenRoad services, is given in Annex A. Both models produce forecasts of the variation with time of road surface temperature and wetness at a specific site, usually a road sensor location for 24 hours from 1200 UTC. Output in graphical form is available for transmission using the DTp protocol via the PSTN to the highway authority workstation, where engineers may superimpose sensor readings to monitor the accuracy of the forecast.

17.4.2 In addition to indicating the likely minimum temperature at the site concerned, the use of the temperature profile provides the highway engineer with an indication of the period over which temperatures are below 0 °C. In marginal situations where the forecast temperature may be close to 0 °C but not below it for long periods, the profile provides an indication of risk, which cannot be adequately represented by a single minimum value.

17.4.3 Input to the model is derived from two sources: road surface temperature and depth temperature at the start of the forecast from the appropriate sensor (if available, otherwise estimated) and 3-hourly values throughout the forecast period of air temperature, dew-point, wind speed, cloud amount and type and precipitation (index). Site characteristics including location and composition of the road bed are contained in a database. Full instructions, both technical and meteorological, are contained in the *OPENROAD Manual*, available at all Weather Centres. As well as technical information (mainly for the use of the OpenRoad local expert), all forecasters should be aware of the contents of the section 'Forecasting for OpenRoad'.

17.4.4 A new ice prediction model is currently being developed by PR Division within The Met. Office. Field studies are being carried out at Cardington.

17.5 The OpenRoad service

17.5.1 Office services to highway authorities for winter maintenance operations have been developed and are supplied jointly with VAISALA TMI. VAISALA TMI is responsible for thermal mapping techniques and ongoing software support. In addition, they provide statistical analyses on our behalf and provide a hot-line consultancy to authorities using VAISALA TMI equipment. Much of the original model and software development work was carried out by an organization known as Thermal Mapping International Ltd (TMI) which was a commercial offshoot of the University of Birmingham. TMI was taken over by VAISALA in 1989. The overall services are promoted under the name OpenRoad. The major elements of these services are:

- a. Ice Prediction
- b. Forecast thermal maps
- c. 24-hour text forecasts of road weather
- d. 2-5 day planning forecasts
- e. Routine morning summaries
- f. Annotated radar imagery

- g. 24-hour weather consultancy
- h. 24-hour system consultancy
- i. 24-hour sensor monitoring
- j. Statistical analysis of the sensor database.

Full definitions are given in Annex B.

Various levels of service are offered, by elements a. to j. being taken in various combinations. These services cater for different levels of development of sensor systems in a given authority's area of responsibility. Basic services not part of OpenRoad are also available including the Road Danger Warning Service (RDWS), which previously was the standard form of service to highway authorities. The RDWS is described in Annex C.

17.5.2 Provision of all OpenRoad services is co-ordinated by MSM(R) in collaboration with VAISALA TMI, but all technical aspects are the responsibility of S&B(CP). Services for individual authorities are negotiated by the commercial representative at the responsible WC (see Annex B to chapter 1) with assistance from MSM(R) as necessary. Invoices will be locally raised by the office providing the service, based on a price matrix issued by MSM(R). Promotion of services is coordinated by S&B(Marketing), in association with MSM(R).

17.5.3 A feature of the OpenRoad service is the use of regional weather centres to provide monitoring of sensor data and forecasts, using additional hardware and software for this task.

17.5.4 Some of the responsibilities for software maintenance rest with VAISALA TMI. All queries on software should be raised with CP who will make appropriate arrangements. In an emergency, back-up may be provided from VAISALA TMI. All proposals for improvements within the software are to be directed to CP but Office software expertise in this area is limited.

17.5.5 The provision of sensor data to the Office by the highway authorities leads to significant improvement in the quality of forecasts provided. The DTp has indicated that such data should therefore be available at no charge to the Office as long as they are used only in the provision of services to the supplying authority. In these circumstances all requests for discounts in the charges for OpenRoad services must be refused, authorities being referred to DTp Highways Maintenance (HM) if necessary. Any requests of this nature should be notified to MSM(R).

17.6 Summer services

17.6.1 Highways authorities are responsible also for the maintenance of road surfaces, e.g. resurfacing. These operations are usually carried out in the summer months and services may be required from authorities in connection with these operations. The work is usually carried out under contract, for which purposes the authority will invite tenders. These may be from the authority's direct labour organization or from outside contractors. In the latter case the authority will have no interest in the provision of weather information which becomes the responsibility of the contractor.

17.6.2 The primary variables of interest are temperature and rain. Resurfacing work involves either the application of a layer of chippings on to an adhesive tar base or replacement of a layer of hot-rolled asphalt. In very hot weather the loss of chippings because tar has not set can require reapplication. Conversely, with asphalt premature setting can be a problem if temperatures are too low or there is a strong cooling wind. Heavy rain can cause serious problems, but the often localized nature of summer precipitation makes reliable warning difficult. Radar can be of considerable assistance but access to forecasters from road sites is limited and many authorities prefer to work until actual weather intervenes. Consultancy services at this point may be useful in discussing the likely resumption.

17.6.3 Most road sensor systems are calibrated only for winter use. Their availability cannot be guaranteed for summer operations. A summer version of the road surface temperature model is available for use as guidance.

17.6.4 All summer services should be arranged and invoiced locally.

17.7 PLAINOBs

17.7.1 Plain-language observations (PLAINOBs) from motorway depots (MOWOBs) and at AA or RAC centres (AUTOBs) covering England and Wales are a useful extra source of information particularly with regard to parameters

which cannot be measured effectively using sensor systems. Since their inception in 1965 a network of several dozen MOWOBs has been developed. The network is administered by (OPR) who issue a booklet *Guidelines for reporting weather in Plain Language (PLAINOBs)* to co-operating centres. The information is reported to the appropriate Office collecting centre using Metform 5967 illustrated at Annex D.

17.7.2 In addition to providing MOWOBs, motorway authorities are required to make supplementary observations whenever any of the following criteria are met:

- a. Rain is turning to snow
- b. Snow is turning to rain
- c. Freezing fog is observed
- d. Ice or frost is forming on roads
- e. Snow is accumulating

It is recognized that at times of severe weather, when MOWOBs can be most useful, pressure on observers for other activities is at its greatest. The reduction of staff levels and gradual move to automated sensor systems by highway authorities is depleting the MOWOB network.

17.7.3 The DTp position on payment by the Office for such observations is that they should be seen, like the sensor observations, as a useful aid to the provision of forecasts and warnings, and as such should be made available freely. Cases of difficulty should be reported to MSM(R).

17.8 Motoring weather warnings to the BBC Travel Centre and Emergency Services

17.8.1 Motoring weather warnings constitute part of the National Severe Weather Warning Service. They are issued for all roads in an affected area to the BBC Travel Centre (formerly Motoring Unit) and the appropriate emergency services (normally Police and Fire services).

17.8.2 Details of criteria and procedures for the issue of warnings are described in Annexes A and B to chapter 24.

17.9 Services for motoring, breakdown and recovery organizations

17.9.1 There are a number of nationally organized breakdown and recovery organizations for motorists, the foremost of which are the AA and RAC. These organizations maintain large fleets of patrol vehicles ready to respond to members' requests for assistance. A large range of other services is also offered to their members some of which may have a requirement for weather information. The AA operate a 'Roadwatch' service based on an operations centre at Stanmore which provides reports of traffic congestion, road works, etc. The primary requirement for weather information is for planning purposes, to anticipate the level of demand for breakdown services, which can be greatly enhanced by cold or wet weather. Both organizations, and the AA in particular, act as distributors of weather information affecting roads. Here the need is primarily for actual road weather information (for which the AA with its patrols is perhaps better placed to monitor than the Office), supplemented by forecasts. They operate a premium-rate telephone weather information service currently not using forecasts from the Office.

17.9.2 Both the AA and RAC provide a small amount of PLAINOB reports (see section 17.7) from their centres at Brighton (AA) and Nottingham (AA), Birmingham (RAC) and Exeter (RAC). Other centres are infrequently manned. There is no quid pro quo for these AUTOBs.

17.9.3 WCs may receive requests for forecasts or other weather information from regional offices of motoring organizations. These requests should be notified to Headquarters to check whether similar services are being provided elsewhere, to examine the possibility of wider services and to co-ordinate charging.

17.9.4 A number of organizations provide recovery services outside the United Kingdom, e.g. Europ Assistance. All contacts with these organizations will be arranged by MSM(R). Requirements can include warnings of adverse weather across Europe, which is the responsibility of LWC, sea crossings information and weather in relation to the operation of air taxis.

17.10 Services for railways

17.10.1 The privatization of British Rail (BR) is continuing to cause changes to Met. Office services to railways. As a result, all dealings with the railway companies should be co-ordinated through the Rail Account Manager. The main service to the railways is OpenRail (described in section 17.11).

17.10.2 The main customer for Met. Office services is Railtrack plc. This newly formed company is responsible for signalling and track and has contracted the Met. Office Land Transport to provide daily national weather forecasts under the OpenRail scheme.

17.10.3 Responsibilities of WCs for the provision of services to BR regions are set out in Annex B to chapter 1. Certain areas may continue to opt for individually tailored services in place of or in addition to those mentioned above and such services may be negotiated locally. Every effort should be made to ensure that they are provided at a similar multiplier on marginal cost to that of OpenRail. Guidelines on charging are promulgated annually by Meteorological Office Order Series B. All such services should be reported to MSM(R).

17.10.4 Services to LUL and those for light railways operated by other local authorities should be negotiated and billed locally at PS offices.

17.10.5 Special non-routine services are from time to time requested by such bodies as the BR Research Laboratories at Derby. WCs should be careful when responding to such approaches. If the service requested applies to a location within the normal area of responsibility of the office concerned, appropriate arrangements may be agreed locally in the normal way, but when the service concerns weather in some other area of the country the request should be referred to MSM(R).

17.11 OpenRail — weather forecasts for railways

17.11.1 OpenRail is a Met. Office Land Transport product name which covers seven services provided to the railway industry. The service is organized by the Rail Account Manager who is also responsible for raising the invoices. Only six of the OpenRail services are widely advertised. They are Strong Wind Warning Service, Winter Service, Sea Conditions Forecast, Conductor Rail Icing Forecast, Summer Service and Heavy Rainfall Warnings. The seventh service is an Extended Leaf Problem Forecast which operates to a limited number of Railtrack addresses in the autumn.

17.11.2 Forecasts are provided on an area basis. The areas are a compromise between Railtrack Zones and identifiable climatic regions and were defined by The Met. Office after consultation with Railtrack. OpenRail applies in all areas — a full schedule is given in Annex F.

17.11.3 All OpenRail forecasts and warnings are sent by telex to British Rail Telecommunications in London. Distribution around the count is by their NTN and TOPS systems and is not the responsibility of The Met. Office. OpenRail includes a direct access consultancy service for the use of nominated control room staff.

17.11.4 Full details of the OpenRail service are given in Annex 17F.

THE MET. OFFICE ROAD SURFACE TEMPERATURE MODEL

17A.1. The model assumes horizontal homogeneity and considers a one-dimensional profile through the road bed and underlying "soil" down to a depth where diurnal variations in temperature are unimportant (1.15 m). The flux of energy through the surface is derived by a set of physical schemes, in which energy transfers from radiative and turbulent processes above the surface are calculated from input values of air temperature, dew-point, wind speed, cloud and precipitation. This energy flux is balanced by the "ground flux" or heat flow into the road bed.

17A.2. The radiation scheme considers direct solar (short wave) radiation and long-wave radiation from the road surface, atmosphere and clouds, taking into account attenuation by water vapour and aerosol.

17A.3. Turbulent transfers of sensible and latent heat are included in relation to wind and temperature at 10 m and screen level (1.22 m) respectively. The model also considers the deposition of moisture on, and evaporation from, the road surface, assuming that the road is covered by a film of moisture 0.05 mm deep for the whole of any 3-hour period for which precipitation is forecast. It does not model the ice phase.

17A.4. The heat flow within the road-bed/soil is modelled by an explicit finite difference integration of the conduction equation, applied to each of the 20 layers of the core varying in thickness from 1 cm at the top by 0.5 cm to 10.5 cm at the base. The temperature at the base is held constant while the upper boundary condition is the balance of energy flux at the road surface.

17A.5. The model requires the albedo, thermal conductivity and heat capacities of the road bed and soil at the site in question. Some measured values have been obtained from authorities but most are standard values for the different materials stated for each site. Latitude is also necessary. Climatological values of deep base temperature are used.

17A.6. The input atmospheric variables are screen temperature and dew-point at 3-hourly intervals through the forecast period plus average values over 3 hours of wind speed, cloud amount (total and low) and type (predominantly low or predominantly medium). High cloud is ignored. Precipitation for the 3-hour periods is a simple yes or no, but note the wetness assumption in 17A.3. The model also requires initial values of road surface temperature and "depth" temperature (a value of the depth, typically 30 cm, is also needed). Sensor values are used where available. The initial profile of temperature through the core is a linear interpolation between surface, depth and deep soil temperatures unless a profile is available for the appropriate time from a previous forecast when this profile, corrected observed temperature values, is used.

17A.7. Program details are given in the User Manual. For more information see "The Meteorological Office Road Surface Temperature Model" by P.J. Rayer, Meteorol Mag, Vol. 116, June 1987), but several improvements to the scheme have been introduced since publication of that article.

OPEN ROAD SERVICE ELEMENTS

- 17B.1 Ice prediction graphs These are prepared for specific locations within the authorities' road network, usually ice detection sensor locations. Each graph indicates expected variation of road surface temperature and wetness at the specified location for a period of 24 hours from noon daily (and is computed using a heat and moisture balance model), together with a qualifying text statement briefly discussing the nature of particular hazards and indicating confidence levels.
- 17B.2 Forecast thermal maps Colour-coded maps of the expected overnight minimum temperature at each point on an authority's road network are prepared by combining the results of thermal mapping surveys carried out in the appropriate weather conditions with the minimum road temperature values computed for several ice prediction locations. These maps are displayed on the local authority work stations.
- 17B.3 24-hour forecast texts These forecasts of road weather describe the evolution of the weather over the whole of the authority area with particular reference to hazards, e.g. snow, ice, wind, fog, and relate expected precipitation to the salting operation where necessary.
- 17B.4 2- to 5-day forecasts Text forecasts of general weather and temperature for a further 4 days ahead are given for planning purposes, with special emphasis on likely hazards.
- 17B.5 Routine morning summary This consists of the overnight weather (just part) together with a brief forecast for the coming day.
- 17B.6 Annotated radar imagery Maps of observed precipitation patterns are issued as appropriate. Annotation will be made to indicate whether the precipitation is rain or snow.
- 17B.7 24-hour weather consultancy Access to a forecaster is made available by means of an ex-directory telephone line to discuss any aspects of the expected weather.
- 17B.8 24-hour system consultancy Access is available to TMI personnel to discuss sensor behaviour, hardware and software behaviour or difficulties.
- 17B.9 24-hour monitoring A monitor of sensor data and forecasts is maintained in the local ice prediction centre.
- 17B.10 Statistical analyses Compilation of a database of sensor and forecast information is carried out and a subsequent end-of-season data analysis made.
- Note that items 17B.1, 17B.2 and 17B.3 are updatable according to criteria agreed with the authority.

ROAD DANGER WARNING SERVICE**17C.1 General**

17C.1.1 The standard road danger warning service is discussed below. It is included as an alternative to Open Road forecast services for smaller authorities, e.g. district councils, metropolitan boroughs and private transport undertakings, factories, etc. It will not normally be offered to county or regional authorities, except as part of a package with Open Road elements.

17C.1.2 Warnings of snow or icy roads are issued (road temperatures below freezing) at any time day or night but, whenever possible, warnings for the evening, night and early morning periods should be issued at about 1500 LCT each day. Amendments or cancellation messages will also be issued as necessary though subscribers may elect not to receive these during night hours, at least not those indicating improvement.

17C.2 Snow Warnings using the indicator SNOW will be issued for even slight falls unless it is confidently expected that road temperatures will remain above 0 °C. Snow warning messages should refer to the expected accumulation using the terms slight (less than 1 inch or 2.5 cm), moderate (1 to 4 inches or 2.5 to 10 cm) or heavy (more than 4 inches or 10 cm). A note should be included to indicate regional variations and timing as appropriate. If drifting is expected this should be stated and the wind direction given.

17C.3 Icy roads Warnings of road surface temperature below freezing will indicate timing where possible. Warnings should be amplified by the following indicators:

- a. ALPHA: Road surface temperatures are expected to fall below 0 °C but roads are expected to remain dry.
- b. BRAVO: Road surface temperatures are expected to fall below 0 °C and hoar frost is expected to form.
- c. CHARLIE: Road surface temperatures are expected to fall below 0 °C and icy patches are expected to form.
- d. DELTA: Road surface temperatures are expected to fall below 0 °C and widespread ice is expected.

If temperatures are expected to remain above 0 °C the indicator NIL will be used.

17C.3.1 The prediction of the circumstances leading to icy roads may be classified into the following broad categories, in order of occurrence:

- a. Freezing of wet road surfaces Often the road will be wet because of rain which was above the freezing point, or because there was a dew or fog deposit, or earlier snow melted or hoar-frost melted. A subsequent spell of radiative cooling of the road surface to or below 0 °C will cause the water film to commence to freeze.

- b. Deposit of hoar-frost Sometimes this is preceded by a dew deposit. With little traffic the surface is not slippery but heavy traffic will cause partial melting and packing of the ice crystals and eventually may lead to a treacherous surface if the road surface temperature is near to the freezing point.
- c. Freezing of deposited moisture on a cold, dry surface When there is a sudden change in the weather, from a relatively long period with temperatures below the freezing point, to one where temperature is at or a little above the freezing point and the humidity is high, then water which condenses on the cold road surface may freeze. This condition is most severe if the onset of the warmer conditions is accompanied by drizzle. This form of icing situation is not a frequent occurrence but invariably leads to treacherous road conditions because freezing takes place from below and the ice layer has a lubricating (between the road wheel and the surface) film on its surface.
- d. Freezing rain or drizzle This phenomenon is well known to forecasters, who should remain alert to the meteorological situations causing it.

PROFORMA METFORM 5967 USED IN PLAIN LANGUAGE OBSERVATIONS

Metform 5967

METEOROLOGICAL OFFICE
PLAIN LANGUAGE WEATHER OBSERVATIONS

AUTOB	PLACE			
	DATE	MONTH	YEAR	CLOCK TIME 24-HOUR CLOCK
MOWOB			19	

(1) SKY

CLEAR	FAIR	CLOUDY	OBSCURED	NOT OBSERVED
Less than ¼ cloud	¼ to ¾ cloud	Over ¾ cloud	No cloud or blue sky visible	Due to light glare

(2) WEATHER

NIL	SLIGHT	MODERATE	HEAVY	
	RAIN	SLEET	SNOW	HAIL THUNDER- STORM

(3) VISIBILITY

FOG METRES 200 metres or less	POOR 200 to 800 metres	MODERATE 800 metres to 3 kilometres	GOOD Over 3 kilometres
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(4) ROADS

DRY	WET	ICY	SNOW LYING CM
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(5) TEMPERATURE

DRY BULB	MINIMUM	ROAD SURFACE

(6) SPECIAL REMARKS AMPLIFYING WEATHER

RAIN TURNING TO SNOW	SNOW TURNING TO RAIN	FREEZING FOG depositing Rime on Surfaces	ICE/FROST forming on Road Surfaces
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(7) REMARKS _____

(SEE INSTRUCTIONS ON FRONT OF PAD)

INITIALS _____

DETAILS OF OPEN RAIL SERVICE

17F.1 Strong Wind Warnings

The warning service for strong winds is designed to warn of conditions which may cause damage to overhead electrification. Forecasts are provided for eleven Strong Wind Warning Service areas which have been designed to fit within Railtrack Zone boundaries. For map of areas see Appendix A. The areas are:

• EA	East Anglia	Norwich, Kings Lynn, Royston, Stansted, Southend
• EC(M)	East Coast (Midlands)	Peterborough, Grantham
• EC(NE)	East Coast (North East)	Newark, Doncaster, Leeds, York, Skipton
• EC(N)	East Coast (North)	Darlington, Newcastle, Berwick
• M(S)	Midlands (South)	Northampton, Bedford, Huntingdon, Watford, Stevenage
• S	South	Dollands Moor and Channel Tunnel area
• SC	Scotland	Edinburgh, Glasgow, Ayr, Helensburgh, Dumbarton
• SW	South West	Bournemouth
• WC(M)	West Coast (Midlands)	Rugby, Birmingham, Lichfield, Redditch, Stafford, Stoke
• WC(NW)	West Coast (North West)	Crewe, Liverpool, Manchester, Preston, Glossop
• WC(N)	West Coast (North)	Lancaster, Oxenholme, Penrith, Carlisle

- *Forecast Period:* The service will run all year.
- *Advance Warning:* Warnings are for a 36-hour period and give the approximate starting time and duration. A duration time will be given even if the strong wind is expected to last beyond the 36-hour period.
- *Updates:* Once in operation the warning will be updated every 3 hours.
- *Termination:* Written termination of the warning will be provided (even when it has run its time).
- *Threshold Values:* Mean wind speed of 39 m.p.h. (34 knots) or gusts of 69 m.p.h. (60 knots). Quoted wind speeds will be in m.p.h.
- *Production Centre:* All warnings will be issued by London Weather Centre.
- *Transmission Method:* Forecasts are sent by telex from London Weather Centre to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met. Office.

The forecast will contain the following sections:

Status: First Issue, Update or Cancel.

Area: Forecast area or areas affected.

Duration: Expected duration of the strong winds.

Mean Wind Speed: Mean Wind Speed expected during the period of the warning

Maximum Gust: Maximum gust expected during the period of the warning.

Example of a Strong Wind Warning

OPENRAIL — MET.OFFICE WEATHER FORECAST
STRONG WIND AND GALE WARNING
ISSUED BY LONDON WEATHER CENTRE
AT 1300 ON 13/01/99

STATUS: UPDATE

AREA: WC(M) — WEST COAST (MIDLANDS)

DURATION: FROM 1500 ON 20/01/99
TO 1800 ON 20/01/99

MEAN WIND SPEED EXPECTED: 50 MPH
MAXIMUM GUST EXPECTED: 62 MPH

STRONG WIND WARNINGS WILL BE UPDATED EVERY 3 HOURS UNTIL WRITTEN CANCELLATION IS GIVEN

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17F.2 OpenRail Winter Service

The warning service for winter weather is designed to highlight hazards which might affect railway operations. Forecasts are produced for the 42 forecast areas (see Appendix B) which incorporate the Railtrack Zones.

- *Forecast Period:* 1 October to 31 March excluding Christmas Day (25 December). Can be extended if wintry conditions are likely in April.
 - *Validity:* The forecast will be issued at 0600 and will apply until 0800 on the next day.
 - *Updates:* May be sent at any time for the occurrence/non-occurrence of adverse weather. A weekend update will be issued at 12 noon on Friday if there are any changes to the weekend outlook. A "no change" message will be sent if necessary.
 - *Direct Access to Forecaster:* Weather Centre ex-directory numbers will be provided for use by the "Duty Manager" in each area to amplify any aspect of the forecast.
- Production Centres:* Production will be shared between the regional Weather Centres so that each office produces forecasts for its local area.
- *Transmission Method:* Forecasts are sent by telex from the 13 regional weather centres to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met.Office.

The forecast will contain the following sections:

Hazards: Frost, snow, drifting snow, gales, thunder, freezing fog, heavy rain, freezing rain, severe spray. All those that apply will be listed.

Temperatures & Wind Chill: Minimum Air Temperature (next 3 hours), wind chill (next 3 hours), minimum ground temperature (next 3 hours), maximum air temperature, wind chill (at maximum temperature), minimum air temperature (overnight), wind chill (at minimum temperature), minimum ground temperature (overnight). All temperatures will be given in degrees Celsius.

General Weather: A brief description will be given.

Wind: Direction using 8 point compass (N, NE, E, etc.), mean wind speed in m.p.h. Gusts (maximum instantaneous wind) will be given when they are expected to exceed 30 m.p.h. and are 10 m.p.h. or more above the mean wind speed.

Snow: Type of snow (wet or powder), adhesion code (showing the ability of snow to stick and build up on overhead equipment), drifting snow (nil, light or severe), expected snow depth (in cm).

Outlook: A brief description of the weather for the next four days, highlighting any hazards

Example of a Winter Service forecast

OPENRAIL — MET.OFFICE WEATHER FORECAST

WINTER SERVICE FOR AREA NW2(MERSEY)
ISSUED BY MANCHESTER WEATHER CENTRE
AT 0545 ON 15/02/99 VALID UNTIL 0800 TOMORROW

HAZARDS: FROST, SNOW, DRIFTING SNOW, FREEZING FOG

MINIMUM AIR TEMP IN NEXT 3 HOURS : MINUS 02 C
WIND CHILL IN NEXT 3 HOURS: MINUS 12 C
MIN GROUND TEMP IN NEXT 3 HOURS : MINUS 02 C

MAXIMUM AIR TEMPERATURE TODAY : 01 C
WIND CHILL AT MAXIMUM TEMPERATURE : MINUS 07 C

MINIMUM AIR TEMPERATURE TONIGHT : MINUS 02 C
WIND CHILL AT MINIMUM TEMPERATURE : MINUS 05 C
MINIMUM GROUND TEMP TONIGHT : MINUS 04 C

GENERAL WEATHER: SNOW TO ALL PARTS BY 0800. MOST OF THE SNOW LIGHT, BUT MODERATE FALLS POSSIBLE ESPECIALLY ON HIGHER GROUND WHERE THERE WILL BE DRIFTING. THE SNOW WILL SLOWLY DIE OUT THIS AFTERNOON. MAINLY DRY AND MISTY TONIGHT WITH A WIDESPREAD FROST. ONE OR TWO PATCHES OF FREEZING FOG ARE POSSIBLE LATER.

WIND: EASTERLY 20-25MPH WITH GUSTS TO 35MPH THIS MORNING. BECOMING SOUTHEASTERLY 10 MPH THIS AFTERNOON AND 5MPH OR LESS TONIGHT.

SNOW TYPE: POWDER AT FIRST BUT BECOMING WET AS IT BEGINS TO CLEAR
ADHESION CODE: 1
DRIFTING SNOW: MODERATE
SNOW DEPTH: 8CM

OUTLOOK FOR THE NEXT FOUR DAYS

WEDNESDAY: RATHER CLOUDY AND MISTY. ONE OR TWO WINTRY SHOWERS. MODERATE RISK OF FROST OVERNIGHT. THURSDAY: CLOUDY. MAINLY DRY. EARLY FOG AND FROST FRIDAY: CLOUDY. A LITTLE RAIN OR SLEET AT TIMES. RISK OF FROST OVERNIGHT. SATURDAY MAINLY DRY. TEMPERATURES NEAR NORMAL.

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17F.3 OpenRail Sea Conditions Forecast

Some lines in coastal areas are affected by sea spray. Forecasts are produced for twelve designated sections of line and are added to the end of the standard Winter service text. Sea conditions forecasts are produced for the following areas:

- GW5 (Pembrey & Burry Port to Llanelli)
 - GW7 (Teignmouth to Starcross)
 - M 1 (Aberystwyth to Pwllheli)
 - NW1 (Heysham to Arnside)
 - NW2 (Bootle to Maryport)
 - NW4 (Bangor to Conwy)
 - NW4 (Holyhead to Rhosneigr)
 - S3 (Dover to Folkestone)
 - S4 (Seaford to Newhaven)
 - SC5 (Saltcoats to Ardrossan)
 - SC5 (Dumbarton to Garelochhead)
 - SW3 (Portsmouth to Southampton).
- *Forecast Period:* 1 October to 31 March excluding Christmas Day (25 December). Can be extended if likely wintry conditions in April lead to the extension of the Winter Service.
 - *Validity:* The forecast will be issued at 0600 and will apply until 0800 on the next day.
 - *Production Centres:* Production will be shared between the regional Weather Centres so that each office produces forecasts for its local area.
 - *Transmission Method:* Forecasts are sent by telex from the regional weather centres to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met.Office. Sea Conditions forecasts will be added to the end of the standard Winter Service forecast.

The forecast will contain the following sections:

Sea State: Calm, slight, moderate, rough, very rough, high or phenomenal.

Spray: Nil, light, heavy or severe.

High Tide: Time of the high tide at a location appropriate to the route.

Example of a Sea Conditions Forecast (at the bottom of a Winter Service forecast)

SEA CONDITIONS (HEYSHAM TO ARNSIDE)

SEA STATE : MODERATE

SPRAY : LIGHT

HIGH TIDE AT FORMBY : 1343 AND 0158

17F.4 Railice Forecast

The Railice warning service is designed to warn of conditions which may cause ice to form on the conductor rail. The service is only used in areas of England where third rail electrification is used.

Forecasts will be produced for the following areas on the Railtrack 42-area map (see Appendix B):

- GL Greater London
- NW2 Mersey
- S1 Surrey
- S2 Mid Kent
- S3 NE Kent
- S4 Sussex Coast
- SW2 Guildford
- SW3 Solent
- *Forecast Period:* Mid November to 31 March. Can be extended if wintry conditions are likely in April
- *Validity:* The forecast will be issued at 1400 and will apply from 1800 until 1400 on the next day.
- *Production Centres:* Production will be shared between the London, Manchester and Southampton Weather Centres so that each office produces forecasts for its local area.
- *Transmission Method:* Forecasts are sent by telex from the Weather Centres to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met.Office.

The forecast will contain the following sections:

Risk of Icing.

Weather factor causing the risk.

Rail Temperature: Either above or below freezing (actual rail temperatures are not forecast)

Remarks: Details of the distribution of the risk and timing.

Example of a Railice Warning

OPENRAIL — MET. OFFICE WEATHER FORECAST

CONDUCTOR RAIL ICING FORECAST

AREA SW3 (GUILDFORD)

ISSUED BY SOUTHAMPTON WEATHER CENTRE AT 1330 VALID FOR 24 HOURS FROM 1800 TODAY,
10/12/99

ICING RISK: SLIGHT RISK IN NORTH HAMPSHIRE

WEATHER CAUSING RISK: CHANCE OF RAIN/SLEET SHOWER

RAIL TEMPERATURE: NEAR FREEZING

REMARKS: NIL

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17F.5 Summer Service

The warning service for summer weather is designed to highlight hazards which might affect railway operations. It warns of high temperatures which may cause damage to the rails and thunderstorms which may affect signalling equipment. Forecasts are produced for the 42 forecast areas which incorporate the Railtrack Zones (see Appendix B).

- *Forecast Period:* 1 April to 30 September.
- *Validity:* The forecast will be issued at 0600 and will apply until 0800 on the next day.
- *Direct Access to Forecaster:* Weather Centre ex-directory numbers will be provided for use by the "Duty Manager" in each area to amplify any aspect of the forecast.
- *Transmission Method:* Forecasts are sent by telex from the 13 regional weather centres to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met.Office.

The forecast will contain the following sections:

Hazards: Heavy rain, thunder, gales, high temperatures. All those that apply will be listed.

Maximum Temperature: The maximum air temperature in degrees Celsius.

Cloud Cover: Clear, scattered (1/8 to 3/8 cover), broken (4/8 to 7/8 cover) or overcast.

General Weather: A brief description will be given.

Rain: Intensity (light, moderate or heavy) and duration (intermittent or constant).

Risk of Thunder: No risk, low risk or high risk.

Wind: Direction using 8-point compass (N, NE, E, etc.), mean wind speed in m.p.h.. Gusts (maximum instantaneous wind) will be given when they are expected to exceed 30 m.p.h. and are 10 m.p.h. or more above the mean wind speed.

Outlook: A brief description of the weather for the next two days, highlighting any hazards.

Example of a Summer Service forecast

OPENRAIL — MET.OFFICE WEATHER FORECAST

SUMMER SERVICE FOR AREA M4 (EAST MIDLANDS)

ISSUED BY BIRMINGHAM WEATHER CENTRE AT 0530 ON 19/04/99. VALID UNTIL 0800 TOMORROW
HAZARDS: HEAVY RAIN

GENERAL WEATHER: A DRY AND SUNNY START TO THE DAY BUT BECOMING CLOUDY BY MID MORNING. OUTBREAKS OF HEAVY RAIN LIKELY MID AFTERNOON.

MAXIMUM TEMPERATURE TODAY: 13 DEG C
CLOUD COVER: OVERCAST

RAIN: HEAVY SHOWERS LIKELY PM
THUNDER: LOW RISK

WIND: SOUTHEASTERLY 20 MPH

OUTLOOK FOR NEXT TWO DAYS:

TUESDAY:

HAZARDS: NIL

MAXIMUM TEMPERATURE: 11 DEG C

WEATHER: MAINLY DRY AND SUNNY

WEDNESDAY:
HAZARDS: NIL
MAXIMUM TEMPERATURE: 15 DEG C
WEATHER: WARM AND SUNNY

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17F.6 Heavy rain warnings

The warning service for heavy rain is designed to highlight rainfall in areas which are prone to landslip or flash floods. Forecasts are produced within the Railtrack Scotland Zone only.

- *Forecast Period:* The service will run all year.
- *Threshold Values:* Expected rainfall of at least 25 mm in a 24-hour period. The threshold in Scottish highland areas will be 40 mm in a 24-hour period. Advance Warning: There are three levels of warning. An "Early Warning" will be issued where at least 24 hours notice is given. An "Update Warning" will then be issued when more information on rainfall amounts and areas affected are known. More than one "Update Warning" may be issued. Finally an "Urgent Warning" will give 6 hours notice and will refine the information in the "Update Warning".
- *Production Centres:* Production will be shared between Aberdeen and Glasgow Weather Centres.
- *Transmission Method:* Forecasts are sent by telex from the two Scottish Weather Centres to BRT in London. Distribution within the railway companies is by their TOPS/NTN system and is not controlled by the Met. Office.
- *Direct Access to Forecaster:* Weather Centre ex-directory numbers will be provided for use by the "Duty Manager" in each area to amplify any aspect of the forecast.

The forecast will contain the following sections:

Status: Early, Update, Urgent or Cancel.

Area: Forecast area or areas affected.

Duration: Expected duration of heavy rain.

Total Rainfall: Total rainfall expected during the warning period.

Distribution: Widespread or Local. To distinguish between local showers or thunderstorms and more widespread rain covering the whole area.

Rate: Maximum rainfall rate in mm per hour.

Melting Snow: Whether the situation will be made worse by melting snow in the area.

Example of a Heavy Rain Warning:

OPENRAIL — MET.OFFICE WEATHER FORECAST

HEAVY RAINFALL WARNING
ISSUED BY ABERDEEN WEATHER CENTRE
AT 1300 ON MONDAY 19 JANUARY 1999

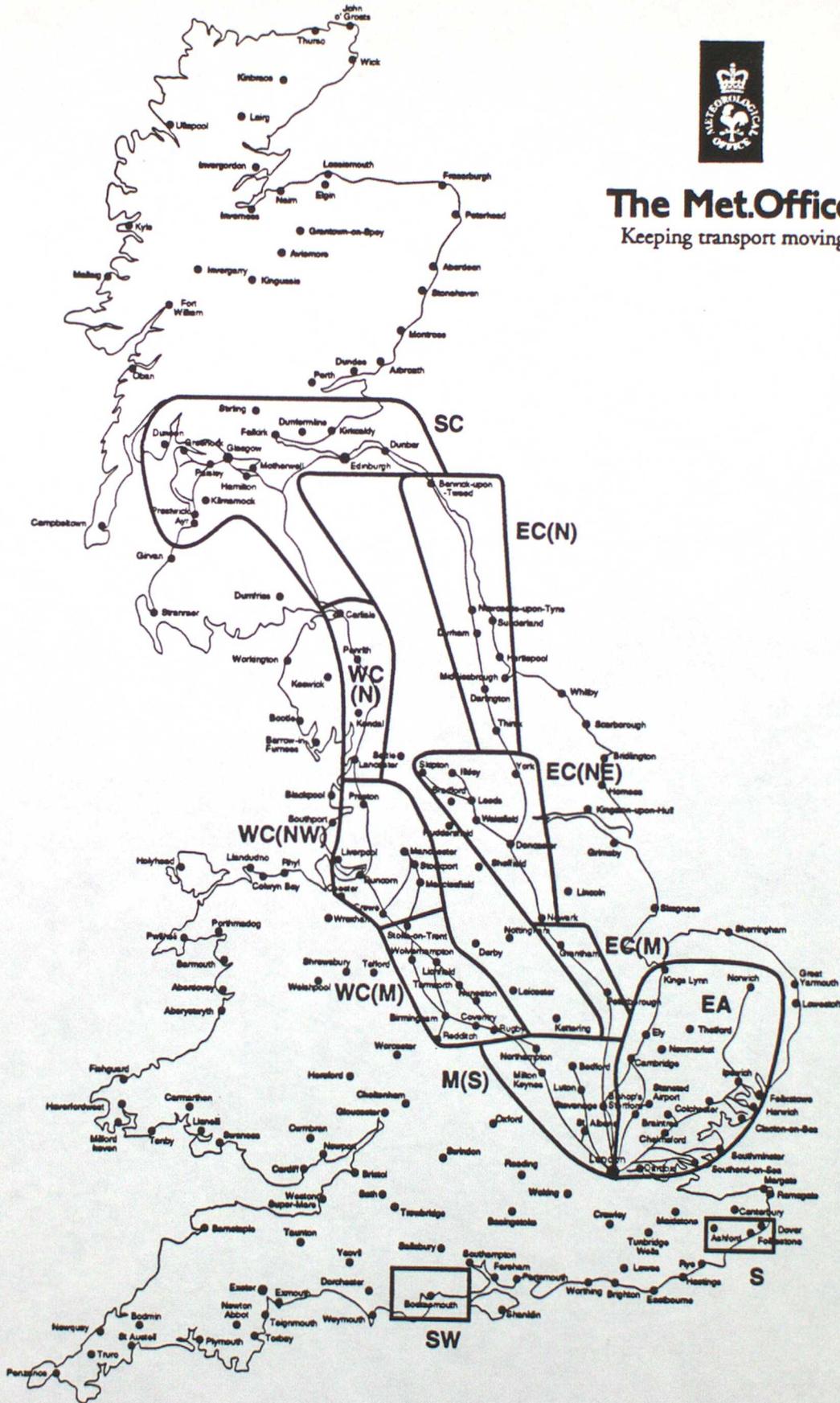
STATUS: EARLY WARNING
AREA: GRAMPIAN REGION

DURATION: FROM 1500 ON 20/01/99 TO 1800 ON 20/01/99

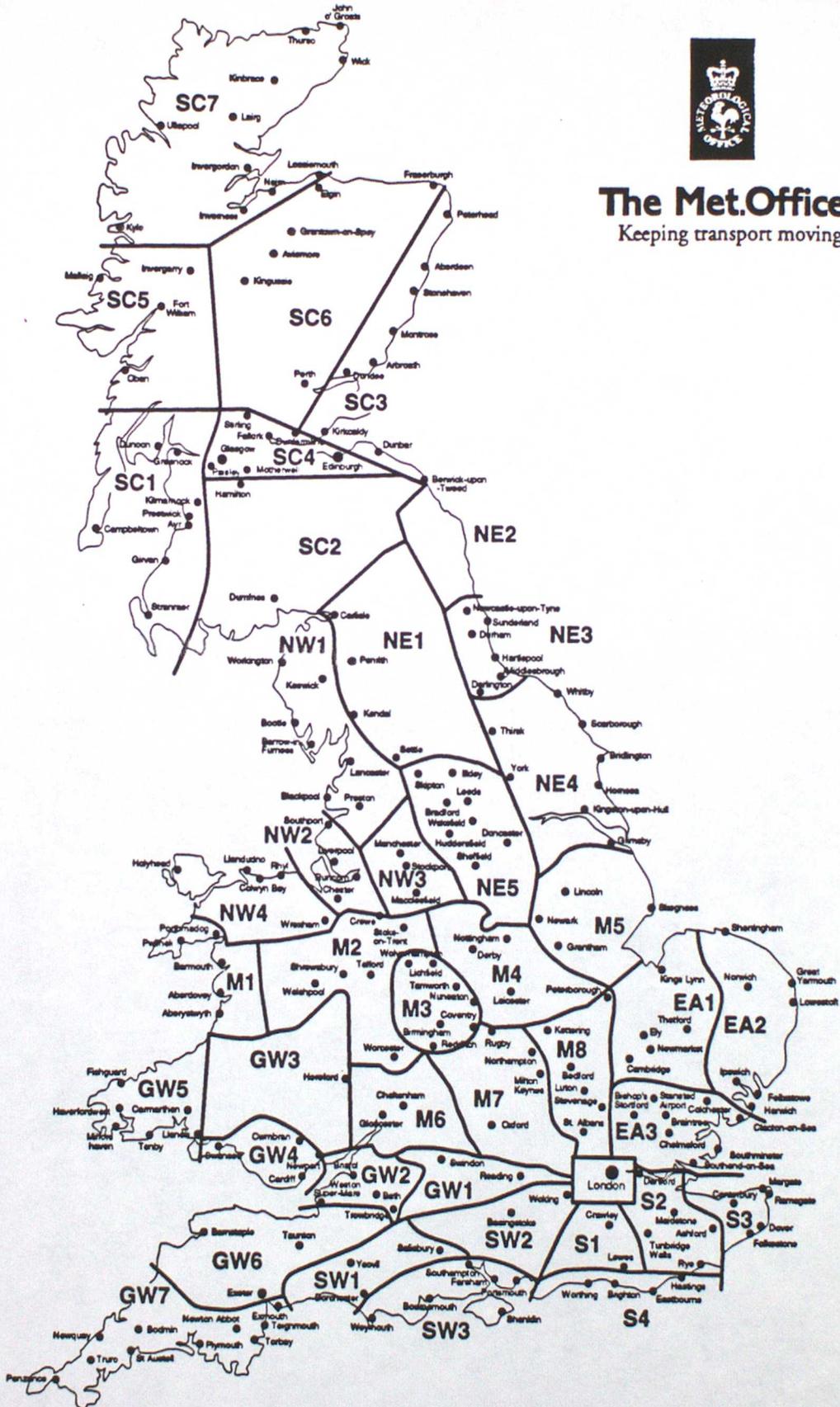
TOTAL RAINFALL EXPECTED: 30MM
DISTRIBUTION: WIDESPREAD
MAXIMUM RAINFALL RATE: 8 MM PER HOUR
MELTING SNOW: NO

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Forecast areas for Met. Office Strong Wind Warning Service



OpenRail — weather forecasts for railways. Met. Office weather forecast areas



The Met. Office
Keeping transport moving

17F.7 Forecast areas

Where reference is made to the Railtrack 42 area map (see Appendix B), forecasts will be produced for the following areas:

Code	Area Name	Coverage
GL	Gtr London	London (within M25)
EA1	Anglia West	Cambridge, Ely, Kings Lynn. Baldock to Cambridge
EA2	Anglia Coast	Norwich, Ipswich, Sheringham, Felixstowe, Lowestoft
EA3	Anglia South	Stansted, Colchester, Southend, Clacton
S1	Surrey	Gatwick Airport, East Grinstead, Uckfield, Horsham
S2	Mid Kent	Ashford, Maidstone and Tonbridge
S3	NE Kent	Ramsgate, Margate, Canterbury, Folkestone, Sheerness
S4	Sussex Coast	Brighton, Eastbourne and Hastings
SW1	Yeovil	Salisbury and Yeovil
SW2	Guildford	Guildford, Basingstoke, Winchester, Windsor, Andover, Petersfield
SW3	Solent	Portsmouth, Southampton, Bournemouth and Weymouth
GW1	Kennet/Thames	Slough, Reading, Didcot, Swindon, Stroud, Newbury, Pewsey
GW2	Bristol	Bath, Bristol, Weston-super-Mare. Bristol Parkway to Newport
GW3	Mid Wales	Newport, Hereford, Llanelli to Craven Arms
GW4	Valleys	Newport, Cardiff and Swansea. Valley Lines
GW5	West Wales	Llanelli to Fishguard, West Wales
GW6	Somerset	Taunton, Exeter and Barnstaple. Frome, Newton Abbot
GW7	Cornwall	Plymouth, Truro and Penzance. Exmouth, Torbay
M1	Aberystwyth	Pwllheli and Aberystwyth to Talerddig
M2	Severn Valley	Shrewsbury, Newtown, Worcester, Stafford, Stoke-on-Trent.
M3	Birmingham	Coventry, Birmingham, Wolverhampton, Lichfield, Redditch
M4	East Midlands	Derby, Nottingham, Leicester
M5	Lincoln	Lincoln, Sleaford and Skegness. ECML from Newark to Peterborough
M6	Cotswolds	Gloucester, Cheltenham, Evesham, Shipton
M7	South Midlands	Oxford, Leamington, Bletchley, High Wycombe, WCML Rugby to Watford
M8	Bedford	St Albans, Luton, Bedford, Kettering, ECML Potters Bar to Peterborough
NE1	North Pennine	Hexham, Haltwhistle, WCML Shap to Carlisle, Settle, Hellifield
NE2	Northumbria	Morpeth to Berwick
NE3	Tyne Tees	Newcastle, Sunderland, Durham, Darlington, Middlesbrough
NE4	Humber	ECML Darlington to York, Scarborough, Hull, Grimsby
NE5	Yorkshire	Leeds, Wakefield, Doncaster, Sheffield, ECML Newark to York
NW1	Blackpool	WCML Oxenholme to Wigan, Preston, Lancaster, Whitehaven
NW2	Mersey	WCML Wigan to Crewe, Liverpool, Southport, Birkenhead, Chester
NW3	Manchester	Greater Manchester area
NW4	North Wales	Chester, Shotton, Wrexham, Llandudno, Holyhead, Blaenau Ffestiniog
SC1	SW Scotland	Stranraer to Ayr, Greenock, Garelochhead, Ardrrossan
SC2	Dumfries	Gretna, Dumfries, Carstairs and Ayr line
SC3	E Scotland	Aberdeen, Dundee, Dunbar, Berwick-upon-Tweed
SC4	Forth Clyde	Edinburgh, Glasgow, Stirling
SC5	West Highland	Mallaig, Oban, Fort William
SC6	Grampian	Perth, Elgin, Gleneagles, Aviemore
SC7	North Highland	Wick, Thurso, Inverness, Kyle of Lochalsh