

WINTER RESILIENCE IN AN UNPREDICTABLE CLIMATE

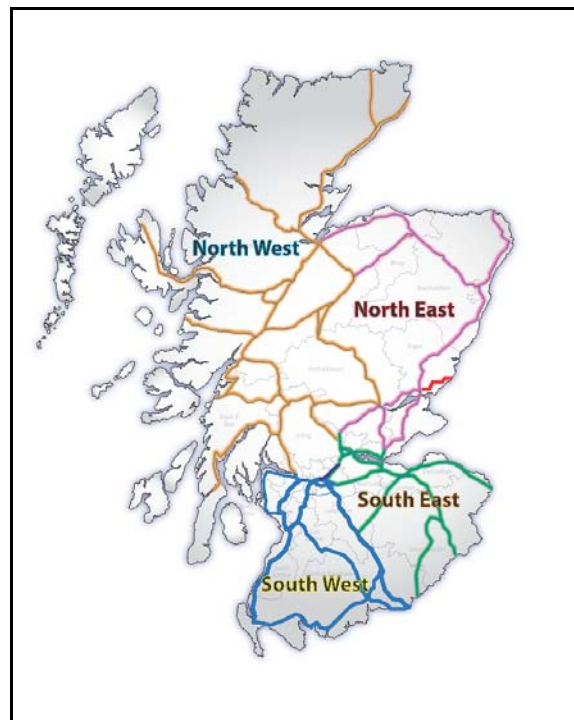
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1. INTRODUCTION

The winter maintenance of roads is challenging in all but the mildest of countries. In locations where it is normal to deal with extended periods of sub-zero temperatures, and large volumes of snow, the roads authority has little choice but to be fully equipped to deal with these conditions. Scotland, although not unique, has a rather unpredictable climate which in recent years particularly has demonstrated that dealing with such conditions offers a particular challenge to winter service professionals.

The paper explores the challenges faced by the Scottish Government agency Transport Scotland and its Operating Companies in dealing with the winter service on the trunk road network in Scotland. It highlights the lessons learnt in response to unpredictable winter weather. The paper will show how this was achieved through increased investment and innovation with regard to winter treatments; improved flow of information to decision makers; improved communications between stakeholders and with customers; and enhanced capability to deal with extreme weather events.

The paper is prepared from the perspective of a Trunk Road Operating Company responsible for the North East, North West and South East Trunk Road Networks. They operate 53 precautionary treatment routes out of 23 depots with a fleet of 130 spreaders and up to 340 winter drivers.

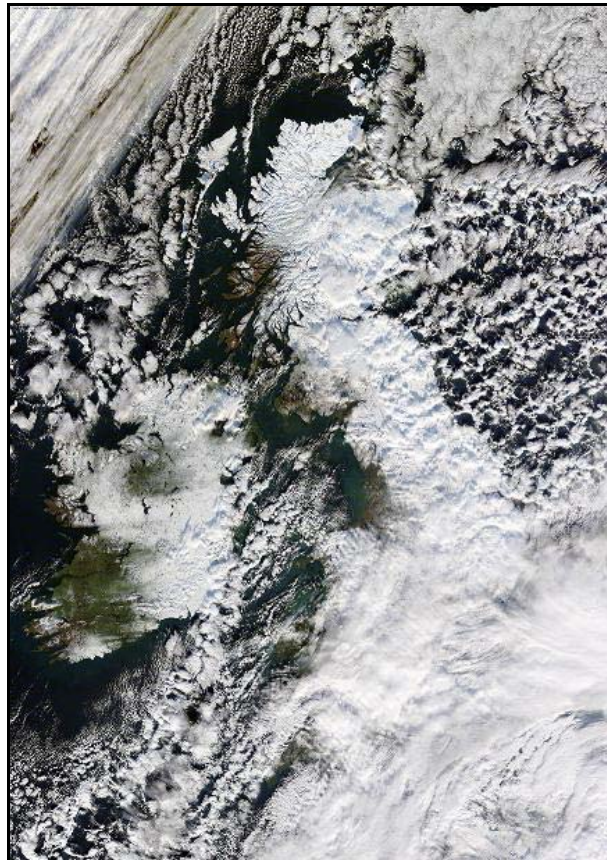


[Figure 1 – Scottish Trunk Roads]

The Scottish trunk road network covers some 3,218km of motorways, dual carriageways and single carriageway roads with traffic flows that range from 1,000 to 90,000 vehicles per day. At present the network is divided into four Units that have the same specification for winter service, which runs from 1 October through to 15 May. Generally winter service operations will allow the safe movement of users of the trunk road network and will minimise delays and disruption to users caused by ice and snow conditions.

During this period the Operating Companies, who manage and maintain the Units on behalf of Transport Scotland, are responsible for deciding daily the need for treatments, when these treatments will be carried out and the spread rate necessary to keep the roads free of ice and snow. Thereafter they are responsible for monitoring conditions to ensure that changes in the weather do not render the treatments ineffective and to provide additional reactive treatment as necessary.

Following a number of years of relatively mild winter weather, the winter seasons of 2009/10 and 2010/11 were the most severe in recent times across the UK.



[Figure 2 - December 2010]

In particular, during December 2010 the country experienced an unprecedented and extended period of extremely low temperatures and persistent heavy snowfall. This led to significant problems for all modes of transport.



[Figure 3 – Central Scotland – Transport Problems]

The busy trunk road network in the central area of Scotland suffered particularly badly. Ice and hard-packed snow led to sections of motorway closing, which brought the resilience of the transport network into question at Ministerial level.

The heavy and continuous use of salt during these winters meant that salt stocks across the UK became uncomfortably low and for a period the road authorities and Operating Companies were reliant on shipments of imported salt delivered at significant cost. In some instances deliveries were received only just in time.

These conditions, with their economic and social impact, highlighted the fragility of our transport systems and encouraged all involved to review their severe weather arrangements to improve resilience to such events in the future. It was however recognised that these conditions might not be regularly repeated and therefore a degree of caution was required to avoid a potentially wasteful use of resources.



[Figure 4 – 2010/11 Conditions (Forth Road Bridge)]

2. WEATHER PATTERNS

Between 2001 and 2008 the winters in Scotland were generally mild. However, the winter season of 2008/9 saw a 20% increase in precautionary treatments. The winter season of 2009/10 saw a further 10% increase in precautionary treatments along with an increase in prolonged snow events.

Precautionary treatments increased by a further 10% in winter season 2010/11 with extreme temperatures of -15°C experienced for extended periods in the central belt of Scotland as well as a number of prolonged snow events. These were the worst winter conditions since 1960 resulting in significant traffic disruption on major routes for a number of days.

The winter of 2011/12 proved to be milder but high winds, hail and flooding presented considerable challenges.

During the 2012/13 winter season unusually the cold temperatures were experienced through until the end of March. Although there were no major snow events in the central belt and North of the country the Dumfries & Galloway area of South West Scotland was hit by heavy snow and drifting in March 2013 resulting in a requirement for mutual aid. This extended period of lower temperatures resulted in a 16% increase in precautionary treatments and an increase in salt usage of 10% when compared with the difficult winter of 2010/11.

3. IMMEDIATE RESPONSE

In immediate response to the problems experienced during the winter of 2010/11, Transport Scotland, working in conjunction with their Operating Companies, set up a multi-agency response team (MART) and launched the 'Six-Point Plan' to keep the Scottish trunk roads moving.

3.1 MART

The lack of information regarding the condition of the roads and the delays caused by the snow was a major criticism from the general public. Transport Scotland set up the MART, which included Traffic Scotland, the Police, the Operating Companies and Network Rail to improve the flow of real time information to the media and the travelling public.

3.2 Tier 1 Winter Service Patrols

Additional winter patrol spreaders were introduced on the motorway network to provide a 30 minute response time to incidents. Three were introduced on the South West Unit and five were introduced on the South East Unit.

3.3 Six-Point Plan

- Storing additional salt and grit at key locations on the national trunk road network for quicker access.
- Using traffic management resources to enable diversions where necessary.
- Further improving the Operating Companies' resources by adapting vehicles, such as landscaping vehicles, for clearing snow.
- Using the option of removing trunk road and motorway central barriers to allow easy access to blocked or broken down vehicles.
- Working with the Police to consider how to "stack" HGVs if conditions deteriorate in order to keep roads clear and the remaining traffic moving.
- Providing central Scotland's Trunk Road Incident Support Service (TRISS) crews with welfare kits of blankets and supplies to distribute to road users in need.

These proved to be vital tools in maintaining the resilience of the road network during challenging weather conditions throughout the remainder of the winter season.



[Figure 5 – 2010/11]

4. ADDITIONAL RESILIENCE

It was clear that to deliver real improvements to the winter service, both Transport Scotland as Client, and their Operating Companies, had important roles to play in what was to become an extremely successful partnership approach. This went beyond the normal Client / Operating Company relationship, with Transport Scotland leading on some aspects and the Operating Companies taking the initiative on others. Throughout the short non-winter period, from May to September 2011, workshops were held to explore a wide range of possible resilience measures. Most were delivered during the season 2011/12 with others being introduced in the winter seasons since and through the new 4th Generation contracts.

The additional resilience measures agreed with Transport Scotland were:-

- INFORMATION - Improved real time information for decision makers.
- COMMUNICATIONS - Improved real time communications between stakeholders and with road users.
- CAPABILITY - Enhanced capability to deal with extreme events.

5. IMPROVED INFORMATION FOR DECISION MAKERS

Reliable, site-specific information is the cornerstone of an excellent winter service. The variability of the Scottish trunk road network and the weather conditions experienced across the area on any particular day, or more generally from week to week and year to year, make it essential that reliable site specific information is gathered and used.

Whilst steady improvements had been made over many years there were still some areas of the network that would benefit from additional weather stations and CCTV cameras. The

Operating Companies worked with Transport Scotland to determine the gaps in the network and arrange for new installations of weather stations and cameras.

For winter season 2011/12 more winter service patrol spreaders were deployed to the strategic motorway and dual carriageway network. There were a total of 21 additional patrols introduced to operate in conjunction with the 13 existing patrols that were mainly deployed on the single carriageway roads.

These patrols operated from 0200 hours through until after the morning traffic peak at 1000 hours. All were fitted with mobile sensors providing real time air and road surface temperature readings to both the driver and winter controller in the Operating Company Control Rooms.

Transport Scotland funded the provision of mobile sensors and the Operating Companies fitted them to their patrol vehicles and then tracked them using a stand alone web-based system. The mobile sensors provide extra decision-making information especially when forecast temperatures were such that pre-treatment wasn't required, it also allowed the driver and the winter controller to track and compare the road surface temperatures against those predicted and provide comprehensive road surface temperature records for evidential purposes in the event of an incident.



[Figure 6 - Vaisala DSP310 Condition Patrol Installed on Winter Patrol Spreader]

The use of mobile sensors on winter patrol spreaders has been further developed and trialled in the winter season 2012/13 by Vaisala and BEAR Scotland to provide details of the actual surface condition as the patrol vehicle travels along its route.

The 'Vaisala Condition Patrol DSP310' is a vehicle mounted weather station capable of measuring:

- Road Condition (Dry, Moist, Wet, Snow, Ice)
- Surface Temperature
- Grip (Slipperiness)
- Dew Point Temperature
- Air Temperature
- Humidity
- Layer Thicknesses



[Figure 7 – Mobile Sensor Output as seen by the Winter Service Patrol Driver]

It uses existing technology that has been combined to collect the data that can then be displayed on a smart phone within the winter patrol spreader. The winter patrol driver can now actually “see” the condition of the carriageway as he drives over it. Spot treatments on the routes are no longer a matter of experience or judgement. Furthermore, by using the phone’s mobile network the real time information showing the vehicle position, road surface temperature and surface condition, such as dry, moist, wet or ice, can be viewed on road weather management software at our control room.



[Figure 8 – Vaisala DSP310 Graphic Output]

These sensors provide additional information that can be used to complement existing fixed weather stations allowing winter duty personnel to make better informed decisions on the need to carry out ad hoc treatments on the network. The winter patrol driver can also immediately treat an area where ice is present thereby reducing the risk to motorists.

To further improve the provision of real time information BEAR Scotland also carried out a trial fitting CCTV cameras to spreaders covering the strategic motorway network. This allowed the spreaders to be deployed to specific problem areas and feed back live images to our Control Room of actual conditions allowing better informed decisions to be made about where to position additional resources and the level of additional resources required.

6. COMMUNICATION BETWEEN STAKEHOLDERS AND WITH CUSTOMERS

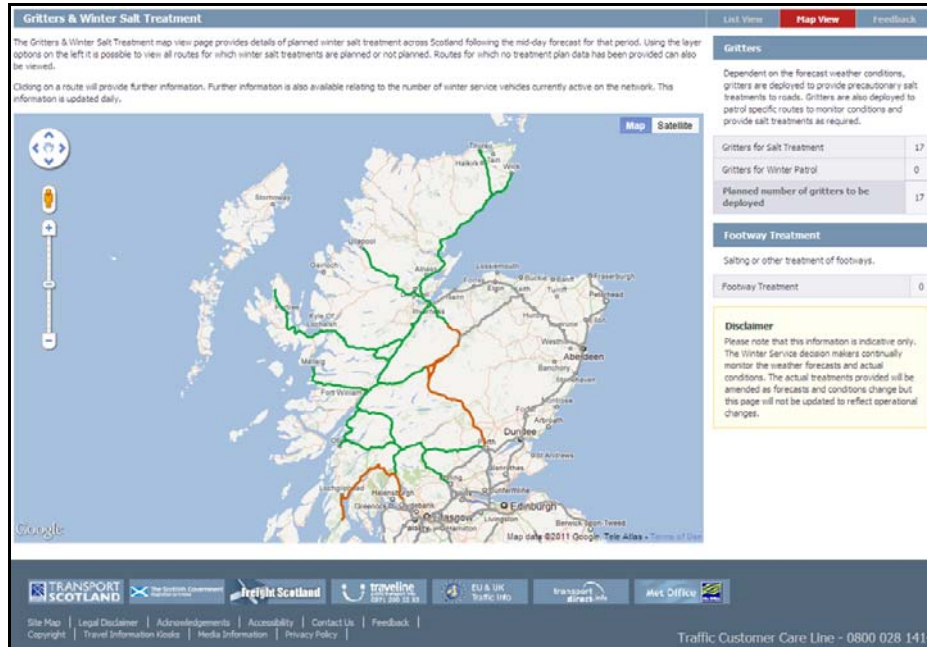
The use of the Multi-Agency Response Team (MART), trialled in the second half of the 2010/11 winter, was considered to be a successful additional resilience measure for not only winter weather conditions but also other incidents affecting the trunk road network.

MART was a forum for representatives from Transport Scotland (Road and Rail), Traffic Scotland Operators, Police Scotland, the MET Office and the Operating Companies to coordinate information flow. Based in the Traffic Scotland Operator's Control Room it facilitated cross-party and cross-boundary communications and support. At times of extreme weather TV cameras regularly attended the MART and broadcast news updates and interviews directly from the MART offices.

For winter 2011/12 BEAR Scotland set up a staff rota such that MART could be resourced at short notice in the event of a significant incident or forecast of severe weather. Over and

above the normal MART, senior representatives from each organisation were required to attend virtual MART sessions convened via conference calls on a weekly basis and more often as the weather forecasts dictated.

The Transport Scotland website was improved to provide the public with unprecedented information about winter service resources and daily action plans.



[Figure 9 – Extract from TS Web Page Showing Maps Coloured]

Traffic Scotland Radio is an internet radio service which has been launched and provides frequent national traffic and travel information bulletins focussed on the strategic motorway and trunk road networks that are streamed over the internet. The service is available through the Traffic Scotland desktop and mobile websites as well as the joint Traveline Scotland/Traffic Scotland smartphone apps on iPhone, Android, Windows Phone and the latest BlackBerry platforms.



[Figure 10 - Traffic Scotland Web Based Radio Interface]

Traffic Scotland Radio provides:

- Regular pre-recorded national and regional audio bulletins providing timely traffic updates and forewarning of incidents 24/7.
- Daily national broadcasts updated with information up to three times each hour.
- Regional broadcasts updated twice an hour during peak times and once an hour at all other times (Sunday to Friday).
- Information on the latest network conditions direct from the Traffic Scotland National Control Centre (TSNCC) in South Queensferry including incidents, congestion, roadworks, events, severe weather warnings and public transport information.
- Information broadcast in different formats to ensure it is compatible both for the desktop website users as well as those accessing this service on the move on internet enabled mobile devices.
- Broadcasts delivered as an automated message service on the Traffic Customer Care Line providing national traffic and travel information together with regional bulletins.
- A higher frequency of broadcasts during events such as extreme winter weather ensuring people get the latest information in a timely fashion.
- Information for strategic routes that, while not the responsibility of Transport Scotland, have a key impact on the trunk road network.
- Other relevant driving messages such as advice for driving in poor weather conditions, events related information, safety campaigns etc.
- A free tool that users can embed within their own website as a link to the Traffic Scotland Radio service.

A web-based Service Information Centre is also being developed by BEAR Scotland that will allow customers improved access to a wide range of information including real-time winter data.

Communication with the media has also been improved. Operating Companies have dedicated professional Media and Communications Officers who maintain close links with media outlets in local and national radio and press. They also utilise social networking to deliver up-to-the-minute messaging.

TWITTER was used to inform motorists and stakeholders of the daily winter action plan and also of extreme events such as hailstorms which caused short term problems across the network towards the end of the 2011/12 winter.

A further area of difficulty, highlighted by the events of winter season 2010/11, was the system of warning the public particularly in advance of forecast poor weather and driving conditions. The use of 'Don't travel unless it is essential' type warnings are ambiguous and leaves the motorists unsure as everyone may have a different interpretation of 'essential'. To counter this, a four stage warning system has been agreed with the Police.

The four stages are:

- Normal operations – no severe weather.
- Travel with caution – driving conditions are potentially hazardous and drivers should drive with caution.
- High risk of disruption for road journeys – extremely poor driving conditions, travellers are likely to experience considerable delay and disruption.
- Avoid travelling on the roads – advice to drivers not to travel as delays of several hours will be experienced.

This has been well received by the public and has improved communications and the public's understanding of the conditions on the network

7. CAPABILITY

Transport Scotland wished to improve our capability to deal with unexpected conditions as well as provide further resources for snow clearance when required. This was facilitated through the provision of 21 additional winter patrol spreaders as highlighted above.



[Figure 11 - BEAR Scotland Additional Winter Patrol Spreaders]

Whilst patrols had previously been provided in locations where winter conditions have been traditionally most difficult, the emphasis now moved to include the busiest routes, where even a small amount of snow might have the potential to cause significant traffic disruption.

The issue of hard-packed ice on the M8 motorway in 2010 highlighted the difficulty of dealing with this situation in extreme circumstances. To provide improved resilience two Raiko Icebreaker attachments were procured on behalf of Transport Scotland. One was retained by BEAR Scotland for use on our networks whilst the other was passed to another Operating Company. Conditions have not been such on the trunk road network to utilise the icebreaker yet.



[Figure 12 - Raiko Icebreaker]

In 2012, however, mutual aid was offered to Stirling Council. This local road authority was experiencing difficulty with a local hill road that was covered with thick ice. This proved to be a very useful trial of the equipment and showed that it was capable of dealing with thick hard-packed snow and ice conditions albeit the process proved to be relatively slow and required several passes. It was concluded from the trial that the combined use of the icebreaker and the direct application of alternative de-icer (see below) offered the best method for the removal of hard-packed thick ice.

To give additional resilience in extreme temperatures when salt no longer performs adequately, stocks of alternative de-icers, such as agricultural by-products and magnesium chloride, are now kept by the Operating Companies. These stocks are distributed across the country at various depots to ensure good response times can be achieved fairly consistently on a national basis.

BEAR Scotland has adapted two vehicles, one a landscaping Fastrac tractor fitted with a 1,500 litre tank and spray bar, the other a gully emptier fitted with a spray bar, for the application of these alternative de-icer liquids. These simple adaptations improved our ability to deal with hard packed snow and ice in extreme conditions, at minimal cost.

During the 2010/11 winter season BEAR Scotland assisted the Scottish Government by purchasing 120,000 tonnes of salt for the national strategic salt stock. This centrally located stock was made available to the Operating Companies and Local Authorities at cost.

For the 2011/12 season, we increased our own salt stocks at the beginning of winter to 32,000 tonnes, 50% more than the previous year and approximately 70% of the maximum anticipated annual usage. For winter season 2012/13 this was increased to 48,000 tonnes of salt, or 100% of maximum annual usage, available at the beginning of the winter season. This gave Transport Scotland a higher degree of comfort that salt stocks would be sufficient throughout the season and we would not have concerns over salt supplies should such extreme winter conditions occur again. To achieve this, additional bulk salt stores were secured and filled.



[Figure 13 - All Main Salt Stocks for use on the Trunk Road are covered]

A further measure that was introduced was to stockpile salt at locations near problem/key locations on the network. For instance, mid-way between Edinburgh and Glasgow a 500 tonne stockpile was established with a loading vehicle so that during snow events spreaders can reload at this resilience salt stock rather than return to their depot. Similar proposals have been recommended for a number of other roads.

BEAR Scotland has also adapted six Fastrac tractors to carry ploughs and their drivers trained in winter service. A number of new heavy duty snow ploughs have been purchased including variable V-ploughs with moveable blades for use where manoeuvrability is required. These have been used at central reserve crossover points, junctions and lay-bys where their flexibility allows a more effective and safer performance.

These Fastracs have proved to be an invaluable resource. As they are generally used for grass cutting in the summer months they would otherwise be idle through the winter season. They are highly manoeuvrable and can be deployed quickly to areas where heavy snow is forecast.

One of the main causes of disruption and road closures were large goods vehicles losing traction on inclines. We have provided all our Fastrac drivers with sector scheme approved vehicle recovery training so that they can assist the Police to get these vehicles moving again.

Safety barrier teams now remain on standby during the winter season. They are kept in a state of readiness to open crossover points on dual carriageways in extreme circumstances to free stranded motorists. Under Police control, vehicles can be turned around onto the opposing carriageway on a motorway or dual carriageway to return to the previous junction.

Operating Companies now have formalised relationships with farmers and agricultural contractors to provide assistance during snow events. They are keen to assist their local communities using their plant resources, such as fast tractors and excavators, that would otherwise be idle during snow events. Haulage contractors using small excavators can also be of use if large deposits of snow have to be removed from built-up areas, as was the case in the 2010/11 winter season.

Additional labour resources are now provided by shareholder companies and sub-contractors for footway clearance. During snow events these resources are normally unable to work at their normal duties and are therefore available to assist as required.

Transport Scotland have facilitated a self-help scheme that encourages small communities adjacent to the trunk road to undertake footway salting and snow clearance themselves, over and above the service provided by Operating Companies. This has been embraced by several local communities who are keen to help. Snow clearing equipment and salt is provided for the local communities that allow them to deal with the clearance of snow on footways as it falls when the Operating Company resources are concentrating on clearing carriageways.

The new 4G Contracts will further improve resilience during winter. The main additions to the previous contracts are the continuation of the winter service patrols on the main motorway and dual carriageway roads, the provision of strategic salt stock stores and an enhanced specification for precautionary treatments and snow clearance. As a result of these changes there will be additional spreaders with more salt carrying capacity on the trunk road network.

8. CONCLUSIONS

The partnership approach to the provision of an enhanced winter service and a more resilient network was very successful. A wide variety of additional measures were put in place, which were identified following a thorough joint review of all aspects of performance in previous years.

The untypically mild winter of 2011/12 has not put all aspects of the additional resilience to full test, however, the additional patrols, the MART, the V-ploughs and Fastracs all proved to be excellent additions to the winter service.

Although milder, the 2011/12 winter was not without challenges, particularly with high winds. Dealing with three major wind events was made easier by the implementation of the MART and making use of the improved winter lines of communication.

The last three years have been a particular challenge and have highlighted the variations in winter weather that we need to be prepared for, from deep snow in November to severe

hail in May, from minus 15 degrees in December 2010 to plus 15 in December 2011, as well as record high winds, heavy rain and flooding. We need to expect the unexpected, It's no longer politically acceptable to blame unusual weather for a failure in the transport network. We need to learn from the past to reach a level of preparedness meets the expectation of the road user.

Our customers, the travelling public, are the nation's eyes and ears. Within seconds of something happening on the network, whether it be weather related or otherwise, they use social media to tell the world. This level of network surveillance and communications is very difficult to compete with. We also have to engage with our customers through these social media channels. Whilst we currently utilise these I don't think we are quite there yet in devising manageable ways of obtaining useful intelligence. It is certainly an area that we will have to improve upon. We need to continue to look at innovation - whether that's different methods of treatment, rates of spread or different materials. As if the challenge of unpredictable weather wasn't enough!

REFERENCES

No references have been made in this paper.