HIGHWAYS AGENCY

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Managed Motorways – Dynamic Hard Shoulder (MM-DHS) Concept of Operations

(to accompany IAN 111/09)

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Version Control

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Approvals

Version	Approved by	Date
3.0	Andrew Page-Dove 	4 May 2012

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Summary of Amendments from Previous Version

The table below summarises the main differences between this and the previously released version of the Concept of Operations[1]. Where the differences are due to changes in policy, the body granting approval for the change in policy is indicated in the table.

Section	Change	Change Approval
General	General updates to ensure consistency with MM-ALR Concept of Operations and currently used terminology.	N/A
2.5	Addition of section which describes the secondary legislation required to operate a managed motorway and the legal status of LBS1 according to the signals displayed to traffic.	DfT
3.1	Removed references to the requirement for any 'pre-opening' drive through check of the hard shoulder by on-road TOS patrols, to reflect change in operational procedures.	NSCRG Dec 2010
3.1	Rationalisation of existing sub-sections and extension of the 'normal state (i.e. hard shoulder closed) to consider MIDAS-generated speed restrictions and controlled motorways.	N/A
3.1.1	Addition of guidance on the exemptions applied to Traffic Officer vehicles associated with observing the solid Red X aspect.	DfT
5.1	Revision to general guidance on the key differences in managing an incident on a MM-DHS scheme including the re-classification according to incident phases: Incident Detection; Responder Access; Incident Management; and Network Restoration.	N/A
5.4	Revision and expansion of operational guidance associated with broken down and abandoned vehicles to reflect recent stakeholder engagement and clarification.	N/A
5.5	Addition of operational guidance associated with dealing with debris on MM-DHS schemes	N/A
6	Addition of guidance associated with AMOR requirements and risk-based approach to maintenance.	N/A
6.6	Revision and expansion of guidance on access for maintenance to reflect recent developments and clarification of the expectations on maintenance service providers to manage network occupancy.	N/A
7.2	Addition to incorporate the findings of the RCC Capacity Report of July 2010.	N/A

[1] The previously released version of this Concept of Operations was titled 'Managed Motorways Operational Guidance' v2.0, June 2010.

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1. Introduction

1.1 Purpose of Document

This Concept of Operations document sets out, at a high level, guidance around the operational elements of managed motorways designed to Interim Advice Note (IAN) 111/09 (known as MM-DHS (Managed Motorways – Dynamic Hard Shoulder)[2] throughout the rest of this document). The intended audience for this Concept of Operations is all those who will be responsible for either the design or operation of managed motorways schemes, including those involved in incident management or maintenance activities.

The material contained within this Concept of Operations is largely based on the experience of the Highways Agency (HA) and its stakeholders in operating and maintaining those MM-DHS schemes that are already operational, and consultation with the industry and subject matter experts. It has been deliberately written at a high level to introduce the concepts behind the physical design. It is not intended to set out detailed operational procedures or processes within this document – these exist within the relevant "business as usual" documentation.

The generic requirements contained within this Concept of Operations document are intended to demonstrate that a generic managed motorways scheme designed to IAN 111/09 can be safely operated and maintained. These generic requirements are given in black boxes[3] Reasons why the operation of a particular scheme might vary from this guidance must therefore be discussed with, and approved by, the scheme's Senior User (normally the Network Delivery and Development Directorate Regional Divisional Director) and recorded in the appropriate PCF products.

The specific Project Control Framework (PCF) products that will be informed by this Operational Guidance are:

PCF Product	Relevant Chapters from this Document
Operating Regime	Chapter 3
Compliance Strategy	Chapter 4
Implications on Core Responders	Chapter 5
Maintenance and Repair Strategy Statement	Chapter 6

[2] This MM-DHS Concept of Operations (and IAN 111/09) also covers Controlled All Lane Running (CALR) links within an MM-DHS scheme. Although these links do not themselves have a dynamic hard shoulder, in all other respects they can be considered as MM-DHS where the hard shoulder is always open. These links are distinct from MM All Lane Running (MM-ALR), which are schemes designed and implemented according to guidance given in IAN 161/12.

[3] There are also Frequently Asked Questions given in boxes, but marked as FAQs; these are not Generic Requirements.

PCF Product	Relevant Chapters from this Document
Civils Maintenance (MAC) Handover Documentation & Certificate	Chapter 6
Technology Maintenance (TechMAC) Handover Documentation & Certificate	Chapter 6
RCC Technology and Capacity Implications Report	Chapter 7
TOS Training Requirements	Chapter 7

1.2 Relationship to MM-DHS Implementation Guidance and other Documents

This MM-DHS Concept of Operations complements IAN 111/09, which provides guidance on the design, construction, and implementation of MM-DHS; and IAN 112/08, which provides guidance specific to the implementation of full time Through Junction Running (TJR) (and refers designers to NetServ for advice on any part time scenario).

The material contained within this document must be considered alongside existing standards, guidance and procedures governing how the HA network is operated and maintained, the vast majority of which will continue to apply to a managed motorway.

HA documents of particular importance in this regard are:

- the *"Traffic Officer Manual"*;
- the HA/ACPO *"Network Operations National Guidance Framework"*;
- the *"Network Management Manual" (NMM)*;
- the *"Routine and Winter Service Code" (RWSC)*;
- the *"Asset Maintenance and Operational Requirements" (AMOR)*[4];
- the HA/ACPO *"Traffic Incident Management Guidance Framework (TIM GF)"*;
- the *"VMSL and HADECS Implementation Guidance";*
- the *"Highways Agency policy for the use of Variable Signs and Signals" (IAN 162/12).*

Schemes that are due to start construction from 2013 onwards will be built to the design set out in IAN 161/12. A separate Concept of Operations document for 'Managed Motorways – All Lanes Running' (MM-ALR) - is available for schemes designed to IAN 161/12.

A bibliography giving details of the latest version of all of the documents referenced within this Concept of Operations is available from the email address overleaf.

[4] AMOR is the replacement for the Highways Agency's Routine and Winter Service Code and Network Management Manual (RWSC & NMM), in use by incumbent Providers. The AMOR represents a shift to a more outcome-based approach, to encourage efficiency savings for the Highways Agency and innovation by the Provider, with no compromise to safety.

1.3 Further Information or Clarifications

Any requests for further information, comments or suggestions for changes to this guidance should be sent to the following address:

MMOperations@highways.gsi.gov.uk

2. Managed Motorways Operating Principles

2.1 Realising the Benefits of Hard Shoulder Running

Managed motorways are being deployed as a mechanism to increase the capacity of the strategic road network, without requiring additional land take or compromising safety. Methods used include allowing traffic to use the hard shoulder as an additional running lane during periods of peak demand, implementing control mechanisms such as moderating speed limits to smooth flow, or controlling access to the main carriageway (ramp metering).

On a conventional motorway, the hard shoulder must not be driven on except in an emergency or breakdown. In areas where an MM-DHS scheme is in force, motorists may use the hard shoulder as a running lane when indicated by a speed limit sign above all open lanes, including the hard shoulder. A Red X (lane control aspect) or blank sign above the hard shoulder means that motorists must not drive on the hard shoulder except in an emergency or breakdown. Emergency Refuge Areas (ERAs) have the same status as a conventional hard shoulder – they are only to be used in cases of emergency or breakdown.

Once a managed motorway scheme featuring dynamic hard shoulder running is built, the ability to use the hard shoulder as a running lane becomes an integral part of the network. From a network capacity perspective, the ability to open the hard shoulder is equivalent to keeping a regular running lane open during periods of heavy demand. Any situation where the hard shoulder cannot be opened when needed is conceptually equivalent to closing a regular running lane.

The hard shoulder cannot be opened to traffic until the Regional Control Centre (RCC) operator has confirmed that it is safe to do so. This will depend on: the quality of, and adherence to operational procedures; the technical tools provided to assist in checking the hard shoulder prior to opening; the extent to which the equipment critical to hard shoulder use is working; and staffing arrangements that are in place to ensure that sufficient operational resource is available.

2.2 Overriding Operational Principles

The following overriding operational principles govern the operation of MM-DHS schemes, and have been reflected in this guidance document:

- On links where the hard shoulder is dynamic, the hard shoulder should only be opened when justified by either actual or forecast traffic demand. Opening the hard shoulder unnecessarily imposes a reduced speed limit on drivers and may compromise the credibility of the associated speed limit;
- No new carriageway lighting will be installed specifically for MM-DHS. Further, the implementation of MM-DHS is not a reason to retain lighting that cannot be justified on other grounds;

- Advanced motorway indicators (AMIs) on a given gantry must either be “all on” or “all off” so that the motorway can operate normally if no signals are set[5];
- The ultimate decision about whether it is safe to open the hard shoulder rests with the operator;
- Maintenance of equipment cannot be carried out over live traffic and hence certain maintenance activities will require lane closures (the gantries installed on managed motorways schemes will not usually have walkways);
- The dynamic hard shoulder is considered part of normal network capacity and should therefore be maintained and treated for snow and ice to the same standard as a normal running lane. Any debris must be removed in the same way as for any running lane;
- The ERA is an extension of the hard shoulder; it must be maintained in the same manner as the hard shoulder and motorists should only use it in case of emergency or breakdown. HA service providers may use it for maintenance stops but access is tightly controlled (see section **Error! Reference source not found.**);
- Electronic roadside equipment is an integral part of a managed motorway and managed motorways cannot be safely operated where the number and location of equipment failures (by type) exceeds predefined thresholds;
- Managed motorways are being deployed on some of the busiest parts of the network. To minimise disruption to traffic, maintenance will generally need to be carried out at night or in other periods of low demand – such as weekends.

2.3 Lane Referencing Terminology

2.3.1 Lane Referencing for MM-DHS

Generic Requirements

The lane naming convention implemented for the M42 MM pilot must be adopted for all managed motorways projects that incorporate a dynamic hard shoulder; referring to “lane below signal” to unambiguously number the lanes. This results in LBS 1 (lane below signal 1) for the hard shoulder, LBS 2 for lane 1, LBS 3 for lane 2, etc.

This terminology must be used within the HA and the Traffic Officer Service (TOS) in particular. Third parties should be encouraged to adopt this terminology, although the TOS (RCC operators in particular) will be responsible for confirming the lanes that are affected, by either asking on-scene personnel for supplementary information (such as number of lanes from the inside or outside of the carriageway) or by remote observation through Closed Circuit Television (CCTV).

[5] The only exception to this policy may be in road works where lanes are closed using temporary traffic management.

FAQ

Why is the LBS1, LBS2, etc terminology used by the HA on managed motorways with a dynamic hard shoulder?

Background

On conventional motorways, the HA, emergency services and public alike use the following convention to refer to different motorway lanes:

- Hard shoulder, lane 1, lane 2, lane 3, etc

This lane naming convention is generally considered inappropriate for MM-DHS as the use of the term “hard shoulder” currently refers to a place of refuge and does not reflect the fact that the dynamic hard shoulder on a managed motorway may in fact be open to traffic.

In addition, the systems that are/will be used by RCC control rooms to set signals on a managed motorway use the designations 1, 2, 3 etc to refer to lanes, where 1 is the left most running lane. On an MM-DHS scheme, 1 is the hard shoulder. This means that the RCC operators would need to “convert” any other terminology to this 1, 2, 3 etc terminology.

Solution

In order to address this issue and remove any possible confusion with the “conventional” terminology, the term “lane below signal” is used to unambiguously number the lanes for MM-DHS schemes. This results in LBS 1 (lane below signal 1), LBS 2, LBS 3, etc.

The Central Motorway Police Group have also adopted this terminology for MM-DHS schemes, however the responsibility still lies with the RCC control room operators to confirm the lanes affected. Where terminology may be different between the RCC operator and the Core Responder confirming the lanes that are affected by the incident, the RCC operator is required to confirm lanes in terms of number of lanes to close and whether they are from the inside or outside of the carriageway, or by using CCTV.

Concerns have been expressed regarding the potential for confusion between adjacent links that have and do not have a dynamic hard shoulder, and inconsistency relative to conventional and controlled motorways. This inconsistency also applies relative to MM-ALR schemes, for which the hard shoulder is a permanent running lane and “conventional” lane referencing terminology is used.

However, lane numbering is not wholly consistent on the current motorway network. For example in areas where there is lane drop/lane gain at junctions the outside lane may be lane 3 or lane 4 depending on the road markings. In those areas, as on MM-DHS schemes, operators are advised to ask for any closures in terms of the number of lanes to close and whether they are from the inside or outside of the carriageway.

2.4 Monitoring LBS1 (the Hard Shoulder)

2.4.1 Equipment to Monitor LBS1 Prior to Opening

Control room operators must be able to monitor the entire length of LBS1 to confirm that it is clear of stopped vehicles prior to it being opened to traffic.

A fixed camera CCTV system is used on MM-DHS schemes to provide operators with a comprehensive view of LBS1, plus coverage of the ERAs. This system works well, but requires regular checks to ensure that the cameras remain properly aligned and that no gaps appear between successive images. Each RCC with managed motorway schemes designed to IAN 111/09 standards will have a single control system to allow them to monitor LBS1.

Network Delivery & Development (NDD) Directorate's Traffic Technology Division have trialled a range of fixed 'low light' CCTV cameras to determine the extent to which they are able to provide visibility of LBS1 to RCC operators in unlit conditions (i.e. at night, where there is no street lighting), and defined minimum acceptable performance criteria.

Only cameras which meet these minimum acceptable performance criteria will be made available to scheme designers. This will ensure that MM-DHS schemes can continue to be safely operated during the hours of darkness.

It is important that cameras are located and aligned in a such a way that ensures there is sufficient overlap between successive images to provide comprehensive coverage of LBS1 (as in particular, vehicles can be parked partly on and off LBS1).

Each scheme's maintenance strategy must incorporate appropriate arrangements for cleaning the cameras, and must also ensure that after any site visit cameras are correctly re-aligned to provide the required coverage.

2.4.2 RCC Control Systems

The technology infrastructure and equipment necessary for the safe operation of managed motorways is controlled from the Highways Agency's Traffic Operations and Management Systems (HATOMS). The HATOMS central system provides an interface for use by operators; contains the business rules that govern operations; and controls all input / output to field equipment and external systems.

For managed motorways, the following HATOMS subsystems are of particular significance:

- HSM - The Hard Shoulder Monitoring subsystem provides operators with the functionality to check, open and close the hard shoulder as described in section 3.1, and sets the Red X on the AMI over LBS1 during the conditioning phase (see section 0);

- MIDAS - The Motorway Incident Detection and Automatic Signalling subsystem controls the communications between the vehicle detectors (loops) and the corresponding signalling infrastructure. The queue protection element contains the business logic used to first detect and subsequently protect queues, through the setting of appropriate warning messages and signals; while the controlled motorway algorithm calculates and displays appropriate dynamic speed limits to prevent or delay the onset of flow breakdown;

- SIG and MSS - The Signalling subsystem and Message Sign subsystem control all AMI and VMS settings respectively, (apart from the Red X over LBS1 during conditioning, which is set by the HSM subsystem).

2.5 Status of LBS1

MM-DHS schemes require secondary legislation to be made, in the form of a statutory instrument (SI), which introduces the concept of the dynamic hard shoulder, ERAs and Variable Mandatory Speed Limits (VMSL) and legally permits their operation in defined sections of motorway (the 'relevant roads').

Specifically in respect of LBS1, these regulations modify the Motorways Traffic (England and Wales) Regulations 1982 so as to allow controlled use of the hard shoulder as an additional running lane in certain circumstances.

The statutory instrument for each scheme details that the time for which LBS1 can be considered part of the normal carriageway:

- Begins when any mandatory speed limit sign (other than the national speed limit sign) is displayed on a gantry above LBS1. In this period traffic is able to use LBS1 as an additional running lane; and
- Ends when either a Red X aspect, or a 'blank' aspect (i.e. nothing) is displayed on a gantry above LBS1. At this time LBS1 reverts to a hard shoulder as defined by the Motorways Traffic (England and Wales) Regulations 1982, meaning vehicles are only permitted to use it in the event of an emergency.

LBS1 is a 'live lane' when it is open to traffic, which has certain operational implications for the TOS. These are discussed specifically in respect of managing incidents and other heightened situations in section 5.

3. Operating Regimes

3.1 Dynamic Hard Shoulder

3.1.1 Normal State (Hard Shoulder Closed)

The photograph below shows an MM-DHS scheme operating in a normal state, with the hard shoulder closed and no mandatory speed limits displayed.

In normal state, MIDAS will operate at all times. MIDAS, if required, will set dynamic speed limits above all open traffic lanes (and a Red X if the hard shoulder is not open) as shown in the photograph below.

This will also be the mode of operation for any sections of controlled motorway. In controlled motorway schemes, there is a hard shoulder that is never used as a running lane, but gantries are installed according to advice given in IAN 111/09 so that VMSL can be used to control traffic on the main carriageway. In this case there will not be an AMI over the hard shoulder.

A further variation of this mode of operation exists where the hard shoulder is permanently converted to a running lane - known as controlled all lanes running (CALR)[6]. In this case, the solid white line between LBS1 and LBS2 will be removed and replaced with a dashed line, and the left hand lane will usually be available to traffic at all times (the exceptions being when it is closed for maintenance, an incident or similar).

Both sections of controlled motorway and sections of CALR, with infrastructure designed according to IAN 111/09, fall within the scope of a MM-DHS scheme and therefore this MM-DHS Concept of Operations applies.

Whichever specific MM-DHS design has been implemented, the key differences between a conventional motorway and MM-DHS in respect of MIDAS generated speed limits are:

- the speed limits on MM-DHS (including controlled motorway links) will be mandatory, whereas on a conventional motorway they are advisory. It is critical that any speed limit displayed is appropriate to traffic conditions in order to protect the credibility of the system and enforcement regime; and
- gantries displaying MIDAS generated speed limits will be located at regular intervals on MM-DHS (and controlled motorway links), unlike a conventional motorway where the distance between successive MIDAS displays can be much greater (if they are present at all).

Generic Requirements

In normal state (with the hard shoulder closed) and no MIDAS speed restriction generated:

1. Operation is as per any conventional motorway.
2. The AMIs above normal running lanes and the AMI over the hard shoulder (where present on schemes with a dynamic hard shoulder) will be set to blank.
3. The VMS will not display any message specific to hard shoulder use.

[6] Note that controlled all lane running (CALR) links designed to IAN 111/09 are within the scope of this MM-DHS Concept of Operations. Although these links do not themselves have a dynamic hard shoulder, in all other respects they can be considered as MM-DHS where the hard shoulder is always open. These links are distinct from MM all lane running (MM-ALR), which are schemes designed and implemented according to guidance given in IAN 161/12. Operational guidance for these schemes is contained within a separate document titled 'MM-ALR Concept of Operations'.

In normal state (with the hard shoulder closed), where a MIDAS speed restriction is generated:

4. AMIs over the normal running lanes will display MIDAS generated mandatory speed limits;
5. the AMI over the hard shoulder will display the broken Red X aspect (see diagram below) to indicate that the hard shoulder is closed (in accordance with the all on / all off signalling policy);
6. VMS will display a queue warning message, if warranted.
7. The same speed limit must be shown over all open main carriageway lanes on a single gantry[7].
8. Although DMRB permits a maximum drop in the speed limit displayed on consecutive signals of 30 mph, for safety reasons, operational policy is that the speed limit shown on adjacent gantries should not drop by more than 20 mph. There may be instances on managed motorways where the distance between gantries makes even a 20 mph drop in speed limit undesirable. The scheme's operating regime needs to consider this issue.
9. Signal sequencing rules will result in signs and signals being set on up to five gantries upstream of an incident, where available. There may be instances at the start of a managed motorway scheme where the distance between the Gateway Gantries and first gantry within the scheme is too long to make this desirable. The scheme's operating regime needs to consider this issue.
10. Where the national speed limit is in operation, the AMIs will either be blank, or will display the standard national speed limit symbol (as defined by the signalling rules).

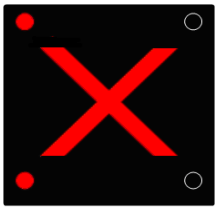
In all instances:

11. In an emergency, drivers can stop on either the hard shoulder or in the ERA, but drivers should be encouraged to use the ERA as it is a safer place to stop and has an Emergency Roadside Telephone (ERT) for communication between the driver and the RCC.
12. At all times, the system will alert operators whenever a vehicle enters or leaves the ERA bay. Operators should monitor the vehicle on CCTV and, if required, attempt to contact the driver or dispatch a TOS patrol as deemed necessary.

[7] With the exception of lane specific signal gantries which span multiple carriageways, for example those at complex junctions which extend across both the mainline carriageway and a parallel exit slip road or diverge

FAQ

1. What is the difference between broken Red X and solid red X signal aspects and when are they used?

"Lane Control" Indicator	**"Stop" Indicator**
	
The "Lane Control" Indicator (broken Red X with no flashing lanterns) informs drivers that the hard shoulder is reserved for emergency use only. This signal can only ever be displayed over the hard shoulder	The "Stop" Indicator (solid Red X with flashing red lanterns) instructs drivers that a lane is closed. This signal may be set over any lane, including the hard shoulder. It is an offence for any unauthorised vehicle to continue in the same lane beyond a Stop Indicator signal. The Traffic Signs (Amendment) (No. 2) Regulations 2011, which came into force on 30 January 2012, introduce an exemption for Traffic Officer vehicles where "observance of the prohibition would likely hinder the use of that vehicle for the purpose for which it is being used".

2. Given that no Red X is displayed over the hard shoulder (in normal state – with no MIDAS-generated speed restrictions in place), isn't there a risk that drivers will not realise that the hard shoulder is closed?

This is a risk that needs to be tracked during operations. However, this risk is outweighed by the benefits of drivers perceiving a managed motorway in the same way as a "conventional" motorway when none of the managed motorways management tools are in use (this is a specific benefit in that the road will operate normally in the event that the hard shoulder AMI cannot be set for any reason).

3.1.2 Deciding When to Open the Hard Shoulder

Generic Requirements

1. The operator will be alerted when traffic flows reach a pre-determined threshold. In the absence of an incident this would normally take place at about the same time each weekday in the build up to periods of routine congestion.
2. The decision to open the hard shoulder is made for a complete Link (i.e. the entire stretch between two junctions) and not for parts of a Link.
3. Links can be opened independently of one another, except where there is dynamic TJR in which case the requirements in the next table apply.
4. Where there is no TJR there will always be lane drop / lane gain at junctions and hence there is no additional benefit from having adjacent links open.
5. In the lead up to the anticipated opening time, RCC operators should prepare the hard shoulder for opening by:
   a. Requesting that any vehicle whose stop is not an emergency leaves the hard shoulder (with assistance from the on-road TOS if necessary);
   b. Where possible, moving any vehicles whose stop is an emergency from the hard shoulder to an ERA bay (this normally requires manual intervention from an on-road TOS patrol);
   c. Attempting to contact vehicles in ERA bays.

   These actions will enable the hard shoulder to be opened as soon as the final checks have been made, saving valuable time.
6. The Operating Regime will need to specify the trigger points at which each Link should be opened. These trigger points will be based primarily on a flow threshold but may make reference to MIDAS alerts, vehicle speeds, the level of bunching of traffic (as observed on CCTV) and environmental conditions (e.g. rain) that affect link capacity.
7. The Operating Regime should take account of: (i) the time required to complete the hard shoulder opening process; (ii) the rate of increase of flows in the lead up to the peak period when determining the trigger points; and (iii) the extent to which these will vary at different days of the week, different times of the year and under different environmental conditions.
8. The RCC may decide to open the hard shoulder when one or more of the normal running lanes are closed due to an incident or road works. The hard shoulder can provide additional capacity which helps to avoid flow breakdown.
9. The RCC may also wish to open the hard shoulder to manage a temporary increase in

flow, such as that caused by an incident elsewhere on the network leading to vehicles being diverted through a MM-DHS scheme.

Through Junction Running (TJR) may be appropriate at junctions where a high percentage of the traffic continues along the main carriageway, rather than exiting at the junction. This design avoids a lane drop at the diverge, and provides additional capacity for the traffic that is continuing along the route. TJR should not be provided as a matter of course, but only when the traffic flow patterns dictate.

The current guidance on TJR can be found in IAN 112/08. The preference is that it should be permanent, i.e. the hard shoulder through the junction is permanently converted to a running lane. However, dynamic use of the hard shoulder through a junction was first introduced in December 2009 on the M42 southbound at junction 5, and can be designed as a departure from standard.

Generic Requirements Specific to Through Junction Running

1. TJR permits continuous hard shoulder use through a junction and avoids lane drop / lane gain at this point. Where TJR is implemented, there is significant benefit in keeping the dynamic hard shoulder on adjacent links open as this will maintain a continuous route of hard shoulder use, leading to a corresponding reduction in lane-changes.
2. For any junction, TJR may be designed to operate either permanently (i.e. the hard shoulder is replaced by a running lane) or dynamically (i.e. the hard shoulder is only opened when required).
3. Where TJR is dynamic, the junction link must only be opened when the dynamic hard shoulders on both the downstream and upstream links are open to traffic.

FAQ

1. Given that the volatile nature of traffic flow means that it can be difficult to predict exactly when the additional capacity is required, is it better to open the hard shoulder earlier or later than is theoretically optimal?

If the hard shoulder is opened too late, there is a risk of flow breakdown from which the link may take a long time to recover. This in turn creates a higher risk of rear end shunts in the resulting congestion. From a safety perspective, this problem is worse than the situation where the hard shoulder is opened too early, resulting in minor delays to motorists from the reduced speed limit that applies when the hard shoulder is open (typically 60 mph). Therefore the preferred time to open the hard shoulder is immediately before the peak flow threshold is reached.

3.1.3 Process of Opening the Hard Shoulder

The hard shoulder is opened on a Link-specific basis, one Section at a time (where a Section is defined as the length of motorway between successive signal gantries). Sections are opened in turn from downstream to upstream (i.e., in the opposite direction to the flow of traffic), as shown in the figure below. The key stages are:

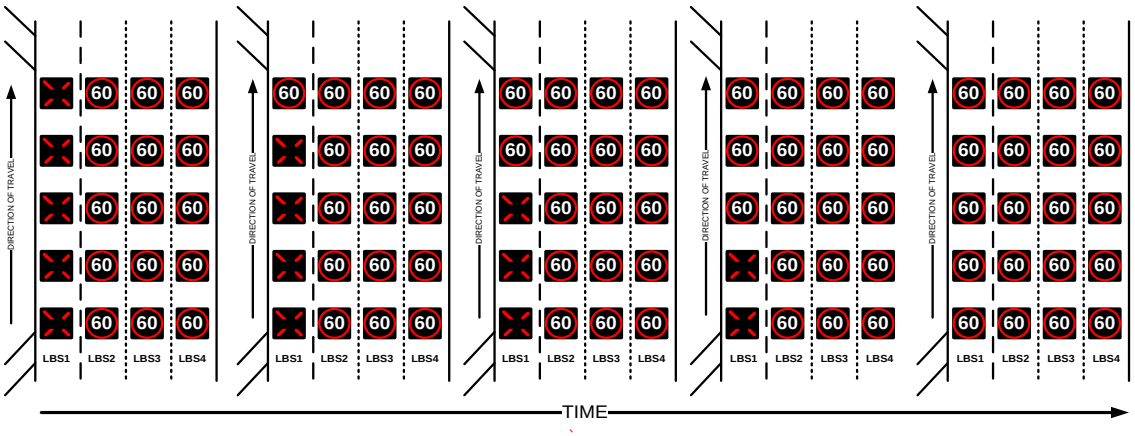
Stage 1: For a given link, conducting a preliminary check to ensure that there are no vehicles on the hard shoulder or in the ERAs that will prevent the hard shoulder from being opened;

Stage 2: Organising the removal of any vehicles that would prevent the hard shoulder from being opened and verifying that there is no risk of a vehicle leaving the ERA at the point where the hard shoulder is opened (this will typically require contact with the driver);

Stage 3: “Conditioning” the link for hard shoulder running by reducing the speed limit in the normal running lanes to the agreed limit so that traffic is flowing smoothly (as shown in the photograph);

Stage 4: In reverse section order, completing final confirmation that it is safe to open the hard shoulder and open the section.

As the hard shoulder is being opened, the Red X aspect displayed on the AMI above the hard shoulder (during the conditioning phase) will be replaced by a mandatory speed limit aspect. These signals will migrate upstream as the hard shoulder CCTV check is completed for each section of a link. The process is illustrated in the diagram below.



Generic Requirements

1. The RCC operator is responsible for carrying out the procedure to determine whether the hard shoulder may be opened. The time required to complete the necessary checks will vary depending on visibility and other environmental conditions.

2. A hard shoulder link **may only be opened** when the operator is satisfied that:
   - **a.** the traffic speed has been reduced to the speed defined in the operating regime for the scheme by conditioning the link;
   - **b.** there are no obstacles on the Link that pose a danger to traffic;
   - **c.** the hard shoulder is clear, (confirmed through observation of the images from the dedicated CCTV cameras);
   - **d.** any vehicles in the ERA bays will not attempt to rejoin the mainline as the hard shoulder is being opened (this will typically require contact with the driver);
   - **e.** for junction links with dynamic TJR, the hard shoulders on the links upstream and downstream of the junction are both open.

3. A hard shoulder within a Link **must always be opened in reverse section order** (downstream to upstream) to avoid the risks of drivers from the slow moving "normal" lanes merging in front of faster moving drivers in the open hard shoulder. The current system software ensures that the operator can only open in reverse section order.

4. The relevant section of the hard shoulder must be opened **as soon as the check that the hard shoulder is clear is complete**. This will avoid the risk of a vehicle stopping in the hard shoulder in the time between the hard shoulder check being completed and the link being opened. The current system software ensures the hard shoulder AMI is set to display the appropriate speed limit as soon as the operator has confirmed the relevant section is clear.

5. If a vehicle or other obstruction is detected on the hard shoulder during the hard shoulder opening process, the opening process for that link must stop. The remainder of the link cannot be opened until the obstruction is cleared.

FAQ

1. Will an RCC operator/supervisor, a Regional Operations Manager (ROM), etc be held personally liable for any incident resulting from the opening of the hard shoulder?

Full training on the process of opening the hard shoulder will be given, and as long as the correct procedures are followed, no individual will be held personally liable.

2. Checking that the hard shoulder is clear is much easier when the road is lit. Is there a reason why the HA does not light all MM-DHS schemes?

The hard shoulder will only ever be opened after the operator is satisfied that the necessary safety and operational checks have been carried out. Following trials, the HA has identified suitable low light CCTV cameras that will enable the operator to monitor the hard shoulder, even in areas without street lighting.

3.1.4 Operating with the Hard Shoulder Open

The photograph below shows a MM-DHS scheme operating with the hard shoulder open to traffic.

Generic Requirements

1. For each link, the operating regime needs to define the maximum speed limit that will be in force when the hard shoulder is open (typically, this will be 60 mph although lower speeds may be required for some motorway links). This same speed limit will apply to conditioning the link as part of the hard shoulder opening process.

2. The MIDAS high-occupancy (HIOCC) algorithm will determine the speed limit necessary to keep traffic flowing smoothly, up to the above limit.

3. By default, the Motorway Signal Mark 4 (MS4) located on each gantry will display a message to reinforce the open status of the dynamic hard shoulder. These would be overridden by higher priority messages if needed.

4. Where TJR is not enabled, the MS4(s) on the approach to the diverge slip road will indicate that the hard shoulder is for exiting traffic only.

5. Where dynamic TJR is enabled, the MS4 on the approach to the exit will contain the same advice as those on the rest of the link (i.e. it will indicate that the hard shoulder is open).

6. Where a driver doesn't initiate contact with the RCC after entering an ERA, operators should attempt to contact the driver to see if they require assistance. TOS patrols may need to assist slow moving vehicles or drivers with particular concerns to leave the ERA. Operators are also able to set a 'lane divert right' (LDR) aspect on the hard shoulder AMIs adjacent to and upstream of the ERA to assist vehicles wishing to rejoin the main carriageway.

FAQ

1. What determines the speed limit to be used during the conditioning phase and can it be changed?

By default, MM-DHS schemes are designed to be operated at up to 60 mph during the conditioning phase. However, there may be instances when the scheme's Safety Report requires a lower limit. Any change to the agreed limit requires a formal amendment to the Safety Report.

3.1.5 Triggers to Instigate Hard Shoulder Closing Process

Generic Requirements

1. Operators will decide when to close the hard shoulder on a Link specific basis.

2. The operating regime for each scheme will establish appropriate flow thresholds at which the hard shoulder should be closed. These thresholds should be Link specific. The thresholds should be set so that operators are confident that traffic levels have dropped sufficiently such that the hard shoulder will not typically need to be reopened until the next normal opening time.

3. Where the hard shoulder would normally be opened twice a day, the operating regime should consider the likely level of traffic between the normal opening and closing times and the length of time that the hard shoulder would be closed for.

   This is because there may be situations where the level of inter-peak traffic is close to, but not above, the level that would justify hard shoulder running. In these cases, it may be desirable to leave the hard shoulder open throughout the day. The act of closing and opening the hard shoulder implies an increased amount of traffic changing lanes and hence safety risk. As such, the hard shoulder should not be closed if it is anticipated that it will need to be re-opened within a short period of time.

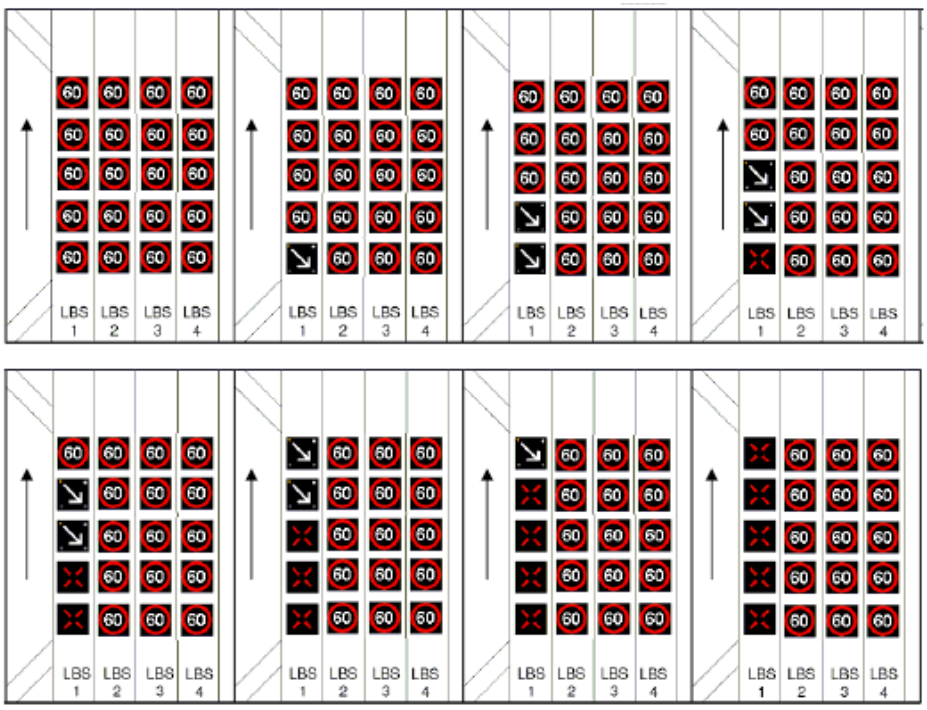
4. Where the hard shoulder was opened because one of the normal running lanes was blocked, operators should close the hard shoulder when the effects of the blockage are cleared (unless there is another reason to keep it open).

5. It may also be necessary to close LBS1 due to an incident, such as a broken down vehicle in either the hard shoulder (LBS1) or the ERA, but this is no different to closing any normal running lane.

3.1.6 Closing the Hard Shoulder

Generic Requirements

1. Once the RCC has initiated closure of the hard shoulder, first a lane divert right signal, then a broken red X will be displayed on the AMI above LBS1 in sequence progressing down the link, as shown below.



2. Depending upon prevailing traffic conditions, variable speed limits over the open three lanes may be displayed for some time. As traffic levels reduce still further, the algorithms clear the speed limits to ‘Delimited’ for a defined period of time.

4. Compliance and Enforcement

A compliant environment is one in which drivers understand what is expected of them and behave accordingly. This is particularly important with MM-DHS, where speed limits and lane configurations change dynamically.

In undertaking the design, Designers must have due regard for the operation of the scheme and must ensure that the creation of a compliant environment is undertaken in a holistic way for the entirety of the scheme, the lead-in from the section immediately upstream and the lead-out into the next adjacent section downstream.

In designing for and evidencing that compliance can be achieved, Designers should consider the application of the 4 E's (Engineering, Education, Encouragement and Enforcement) and how, when considered together, these will achieve a compliant and operable environment that meets the scheme objectives.

4.1 Compliance Issues Specific to Managed Motorways

Managed motorways raise a number of specific issues in terms of compliance:

Area of Non Compliance	Comment
Exceeding variable mandatory speed limit restrictions	Does not arise on a conventional motorway where VMSL are not used
Driving under stop indicator (solid Red X) signals displayed over running lanes	Potential for more abuse on a managed motorway due to the greater volume of signals and higher propensity for their use
Driving in the hard shoulder when it is not in use as a running lane	Potential for more abuse on an MM-DHS scheme due to potential driver confusion with the dynamic hard shoulder concept and unfamiliarity with the meaning of signs/signals used
Non emergency stops in the hard shoulder	Impact of non emergency stops is higher on MM-DHS schemes as the safety risk is coupled with the inability to open the hard shoulder when a vehicle is stopped on it
Non emergency stops in ERAs	Does not arise on a conventional motorway. Impact is significant as slows down or prevents hard shoulder opening.

4.2 Achieving Compliance on Individual Schemes

Each MM-DHS scheme is required to produce a Compliance Strategy, which must highlight exceptions to the "VMSL and HADECS Implementation Guidance". This PCF product will define the actions being taken by the scheme to ensure that an appropriate level of compliance is achieved.

The advice in the compliance and enforcement guidance document regarding the deployment of enforcement cameras and the generic compliance strategy form part of the work of NetServ and the Emergency Services Liaison Team and must be complied with unless exceptional circumstances warrant a departure that is: agreed by the scheme Senior User; does not conflict with the documented enforcement agreements; and is accepted by the prosecuting authorities.

Generic Requirements

1. The Compliance Strategy product must start with an assessment of the potential for non compliance with specific rules, together with the safety risks that non compliance would cause.
2. The above assessment should take account of aspects such as: the physical characteristics of the road; the proportion of different vehicle types expected to use the scheme; and the levels of motorist familiarity with managed motorways, recognising that the latter two will vary by time and day.
3. The assessment must consider the impact not just on the scheme itself, but also on adjoining stretches of road.
4. The Compliance Strategy must consider engineering, education, encouragement and enforcement measures that could be deployed to improve compliance.
5. Compliance with signs and signals improves when drivers understand why they have been set. Wherever possible, VMS should be used to display supporting messages to explain why signals have been set.

4.3 Agreements with Enforcing Bodies

The HA's Emergency Services Liaison Team has agreed a National Enforcement Strategic Agreement between: the Highways Agency; the Association of Chief Police Officers (ACPO); the Crown Prosecution Service (CPS); and Her Majesty's Courts Service (HMCS) on the enforcement regime for contravention of VMSL. The intention is that processing of offences is carried out by one or two centralised Police Fixed Penalty Offices within a given region. Likewise, the payment of fixed penalties will be centralised into one or two Court Offices and the prosecution of offenders in one or two Magistrates' Courts per region. Processing will be

done regionally to encourage consistent standards. Regional Enforcement Coordinators within NDD Directorate will be responsible for managing the evidential trail to ensure that variable mandatory speed limits can be enforced, and for maintaining any local Memoranda of Understanding (MoU) with the police. A jointly agreed MM Enforcement National Guidance Framework (ENGF) document sets out the national principles, processes and procedures for enforcement. This forms the baseline for local agreements.

4.4 Achieving Compliance with Specific Managed Motorways Features

4.4.1 Variable Mandatory Speed Limits

Generic Requirements

1. VMSL will be enforced through the HA Digital Enforcement Compliance System (HADECS).

2. The HA will reimburse the local police forces, courts, and CPS (as appropriate) for the resource to process and prosecute VMSL offences when the managed motorways are in operation using HADECS. The enforcement of speed limits when the managed motorway is not in operation will be at the discretion of the local police force as appropriate.

3. Each scheme will need to consider how many HADECS cameras it requires and where they should be deployed. This must be in accordance with the “VMSL and HADECS Implementation Guidance”.

4. Rates of compliance with VMSL should be monitored on a regular basis by the HA working in conjunction with the police. Where compliance rates are deemed to be low, consideration should be given to introducing additional measures such as, for example, installing additional HADECS units.

5. If the RCC identify or are made aware of instances where automatically set speed limits are not credible or appropriate to traffic conditions, they should take immediate action to remove or amend those speed restriction settings. Where displayed limits are not reasonable, compliance will be affected on both the link on which they are signed, as well as potentially on nearby links.

6. Once an incorrect or inappropriate sign has been removed, the RCC should notify both the police (so that compliance with speed limits is not enforced during this period) and TTD (so that the cause can be investigated). The police may refuse to enforce limits that are clearly not reasonable, or which regularly lack credibility in their setting.

4.4.2 Red X (Stop) Signals

Generic Requirements

1. As with the rest of the network, any enforcement of Red X (stop) signals will need to be carried out by the police at the scene as there are currently no type-approved automated enforcement devices available.

4.4.3 Hard Shoulder Violations

Generic Requirements

1. There is currently no automated method of enforcing hard shoulder violations and hence any enforcement would initially need to be carried out by police at the scene.

2. The extent to which the police would be willing to dedicate resources to enforcing this type of violation will depend on the extent and impact of the problem and the regional agreements that are in place.

3. Where the RCC becomes aware of vehicles driving in the (closed) hard shoulder they should consider putting up a VMS message to reinforce the fact that the hard shoulder is for emergency use only. Experience has shown this to be an effective form of "encouragement". A similar approach may be adopted to discourage non-emergency use of the ERA.

4. The RCC may also wish to deploy Traffic Officer patrols, particularly on sections with high levels of non-compliance, to encourage the correct behaviour.

5. Schemes that feature permanent TJR may experience higher levels of hard shoulder violations than other managed motorway schemes. This is because through a permanent TJR section, LBS1 will be a full running lane and not a dynamic hard shoulder. This unfamiliarity may initially increase driver confusion and lead to a corresponding increase in hard shoulder violations on adjacent links with dynamic hard shoulder running. The extent of this risk should be informed by scheme-specific observations over a period of time.

6. In schemes where consecutive links operate as CALR and dynamic hard shoulder running, there is the potential for an increased risk of drivers using the hard shoulder when it has not been opened to traffic. This is because of the possibility for driver confusion over whether the hard shoulder is available for use or not.

4.4.4 Non Emergency Stops on the Hard Shoulder

The impact of non emergency stops on the hard shoulder of a MM-DHS scheme is greater than on a conventional motorway, due to the effect that such stops have on the hard shoulder opening process.

In general, it will be difficult for the police to enforce non emergency use of the hard shoulder, due to the transient nature of the violation and level of resource required to enforce it.

Generic Requirements

1. Where such violations occur frequently, it will generally be necessary to apply both engineering solutions and an increase in education and encouragement activities (such as the use of VMS messages to remind drivers of the correct use of the hard shoulder as described in section 4.4.3) to reduce the extent of the problem.

4.4.5 Non Emergency Stops in ERAs

Data collected from MM-DHS schemes indicates that refuge areas are sometimes used for non-emergency / unlawful stops, particularly when LBS1 is closed. Observed examples of non emergency (and therefore illegal) use include drivers stopping for phone calls, comfort breaks, map reading, tachometer breaks, etc.

Engineering design will have a particular impact on the appropriate use of ERAs, given their potential attractiveness to drivers as a place to make short duration stops.

Generic Requirements

1. Education of road users is an important tool to remind them of the lawful purposes of ERAs, and of the dangers inherent in making stops in ERAs for non-emergency use. Consideration should be given to the make-up of road users on any MM-DHS scheme to understand what type of non-emergency stops might be expected, for example more tachograph breaks where there is a high proportion of freight users, and to develop education products to target relevant audiences. These issues should typically be included in a scheme's Communications Plans.

2. Particular attention should be paid to ERAs that are in areas with nearby A roads with lay-bys, due to the potential for drivers to confuse an ERA with a lay-by.

5. Management of Incidents and other Heightened Situations

5.1 Dealing with Incidents - Key Differences on a MM-DHS scheme

On a MM-DHS scheme, as compared to a conventional motorway, there is a greater need for agreements (see section 5.2) and communications between the HA and the other "Core Responders". In this context, the HA includes the RCC and on-road TOS, service providers and their traffic incident management vehicles, the National Vehicle Recovery Manager and any other parties contracted by the HA. The other Core Responders include the Emergency Services, Vehicle Recovery Services and Motorist Assistance Organisations involved in responding to or otherwise managing an incident.

This greater need for commonly agreed processes and procedures arises due to the different operating environment encountered on MM-DHS schemes. The increased deployment of technology on the network provides staff in the relevant control rooms with greater knowledge of what is happening during incidents on the strategic network, as well as the opportunity to assist the on-road response by setting supporting signs and signals and providing information to core responders, even while they are still en-route to the scene.

As with incidents on any road, the management process can be considered in four distinct phases, namely: Incident detection; responder access; incident management; and network restoration.

From the perspective of responding to and managing incidents and other "unusual" situations, the main differences between a MM-DHS scheme and conventional motorways are:

- *Incident Detection:* A change in incident profile – the controlled environment and additional capacity mean there is likely to be a reduction in the severity of incidents on MM-DHS when compared to Dual 3-lane Motorway (D3M). However, during busy periods the dynamic hard shoulder will be open and a greater proportion of incidents will now affect a live lane. Any live lane obstruction will quickly cause traffic to slow down, with the resultant queues detected by the queue protection system. This will set message signs designed to help prevent secondary incidents and may serve to alert the control room. Comprehensive CCTV camera coverage will allow the details of an incident to be determined quickly from the control room and additional signs and signals can be set to further protect the scene. As for any live lane incident, details should be passed to National Traffic Operations Centre (NTOC) for onward dissemination;

- *Responder Access:* Due to the opening of the dynamic hard shoulder when traffic conditions dictate, responders may need to attend incidents without making use of a dedicated hard shoulder. Signs and signals can be set to facilitate incident access by whichever lane is most appropriate;

- *Incident Management:*
  - Mandatory speed limits, whether automatically generated by a queue protection system, or manually set by the operator, help to create and maintain a controlled environment;
  - Lane control signals can be displayed at regular intervals of approximately 800m[8]. They can be used to indicate lane availability for traffic passing the incident scene, or alternatively to close off a lane to enable responders to quickly access the incident location;
  - In the instance where the dynamic hard shoulder is open, the RCC may be requested to set signs and signals, for example to protect a lane for police/TOS to stop or escort vehicles, or to assist with the recovery of a live lane obstruction;

- *Network Restoration:*
  - With the dynamic hard shoulder being opened when traffic conditions dictate, a greater proportion of incidents will now be expected to impact live lanes;
  - Vehicles and debris therefore may need to be recovered to an off–carriageway location to protect the operation of the dynamic hard shoulder;
  - ERAs may be utilised as temporary off-network storage locations, and will typically be provided every 800m.

Generic Requirements

1. Variable signs and signals are the primary mechanism through which the RCC can manage traffic on an MM-DHS scheme.

2. Before the lanes that are affected by an incident are confirmed, all VMS messages and signals must be non lane specific (i.e. the same advice must apply to all lanes). Current policy dictates that until a report is confirmed, a 50mph restriction is put in place, supported by message signs bearing a legend such as “Incident”.

3. Once the lanes that are affected by an incident have been confirmed, VMS messages and signals setting should be lane specific where appropriate.

4. Once a lane closure has been confirmed, the signalling sequencing rules will typically set upstream lane divert signals and 40 mph speed restrictions across all lanes.

5. At any time, RCC operators may override the automated speed restriction with a lower speed limit, providing that the override complies with signal sequencing rules.

[8] Desired spacing is 800m, with a min of 600m and a max of 1000m.

6. Unlike a conventional motorway, the MIDAS generated speeds on managed motorways are mandatory and hence it is critical that operators ensure that the limits are appropriate to traffic conditions so as to protect the credibility of the system and associated enforcement regime.
7. RCC Operators should ensure that all appropriate signs and signals are set (or cleared) according to the requirements of the lead responder on scene.
8. Signal sequencing rules will usually result in signs and signals being set on at least the two gantries upstream of an incident. There may be instances at the start of a MM-DHS scheme where the distance between the Gateway Gantry and first gantry within the scheme is too long to make this desirable. This needs to be considered within the scheme's operational regime.

Inter-visibility of gantries on MM-DHS schemes means that many drivers will be able to see messages even when they are stationary. This increases the potential benefit from signing as compared to a conventional motorway, for example for trapped traffic.

5.2 MM Emergency Services National Strategic Agreement and National Guidance Framework

5.2.1 National Agreements

The HA's Emergency Services Liaison Team has agreed a National Enforcement Strategic Agreement between the Highway Agency, the Association of Chief Police Officers (ACPO), the Crown Prosecution Service (CPS) and Her Majesty's Courts Service (HMCS) on the enforcement regime for contravention of Variable Mandatory Speed Limits.

The intention is that the processing of offenders is conducted by one or two centralised Police Fixed Penalty Offices within a given region. Likewise, the payment of fixed penalties will be centralised into one or two Court Offices and the prosecution of offenders in one or two Magistrates' Courts per region. Processing will be done regionally to encourage consistent standards. Regional Enforcement Coordinators within NDD Directorate will be responsible for managing the evidential trail to ensure that variable mandatory speed limits can be enforced; and for maintaining local Memoranda of Understanding (MoU) with the Police, which will be set up during scheme handover.

A jointly agreed MM Enforcement National Guidance Framework (ENGF) document sets out the national principles, processes and procedures for enforcement. This framework forms the baseline for local agreements.

Guidance is given in the ENGF on:

- Roles and responsibilities of the HA and the Emergency Responders on managed motorways;
- Dealing with incidents on managed motorways, from the point of view of the core responders;
- Escorting convoys on managed motorways;
- Stopping vehicles on managed motorways.

5.2.2 Regional and Scheme Level Agreements

Each scheme will need to establish regional agreements with the Emergency Services. These agreements should replicate the principles of the NGF, unless a strong justification can be provided to deviate from them. Any variance must first be approved by the Scheme's Senior User.

The preference would be for each region to have a single agreement, signed by all three of the Emergency Services and for this agreement to be an addendum to the existing "Detailed Regional Operational Agreements" that were set up when the TOS was created. However, it is recognised that this may not be possible or desirable in all cases and that individual agreements with the police, fire and ambulance services or separate agreements from the existing Detailed Regional (or Local) Operational Agreements may be necessary in some exceptional cases.

Regardless of the precise form, these agreements will need to apply the principles of the NGF to the characteristics of the individual scheme and record the agreed operating practices based on scheme-specific requirements. It is anticipated that these agreements would record acceptance of the NGF principles apart from where specific exceptions are deemed necessary, and these should be included in the "Implications on Core Responders" PCF product.

5.3 Ability to Confirm Incidents

The HA policy for the use of Variable Signs and Signals states that lane specific signals and VMS messages related to an incident can only be set once the location and the lanes that are affected by the incident have been confirmed by an approved source agreed by the TOS (these include a Police Officer, Traffic Officer, traffic incident management vehicle at the scene, MAC/ASC or TechMAC/Regional Technology Maintenance Contractor (RTMC), NTOC or identified via CCTV).

This policy is designed to ensure the lane specific messages that are set represent the correct lane blockage pattern.

5.4 Broken Down and Abandoned Vehicles

Traffic Officers have powers under the Removal and Disposal of Vehicles (Traffic Officers) (England) Regulations 2008 enabling them to deal with broken down vehicles that are either causing an obstruction or danger to others, or are in contravention of a restriction or prohibition; and vehicles that appear to have been abandoned without lawful authority. Drivers are given a "reasonable" time to organise their own recovery and if arrangements are not made or are unsuitable, a statutory removal may be invoked by Traffic Officers, where there is no police interest in the vehicle.

As highlighted in section 2.5, where the dynamic hard shoulder is in operation on a MM-DHS scheme, all lanes are live lanes. Any vehicle that is unable to leave the main carriageway (by stopping in a refuge area or continuing to the next exit slip road), will by definition become a live lane breakdown. Since this will inevitably cause an obstruction, the vehicle will therefore be a candidate for an immediate statutory removal.

Generic Requirements

1. In the event that a breakdown occurs on LBS1 when the dynamic hard shoulder is not in operation, then the incident will typically be treated in the same way as for a conventional motorway incident on the hard shoulder, albeit that the RCC has the ability to protect the incident using signs and signals where necessary.
2. Where a breakdown occurs on LBS1 in the period immediately before the dynamic hard shoulder would usually be opened to accommodate routine congestion (for example in the morning and evening peaks), consideration should be given to expediting the removal of the vehicle to a refuge area or other place of safety.
3. If a breakdown occurs on LBS1 during the period when the dynamic hard shoulder is in use as a live lane, it should be treated as any live lane incident. The RCC must set signals to protect the scene of the incident, but should also begin closing the dynamic hard shoulder upstream of the affected link as soon as possible. LBS1 must not be reopened to traffic until the breakdown has been cleared.
4. For any live lane breakdown (including those on the hard shoulder when the dynamic hard shoulder is open), if Traffic Officers are suitably trained and equipped (e.g. with an appropriate vehicle type), they should, if possible, clear the broken down vehicle to the nearest place of safety, for example: a refuge area; a nearby motorway service area; or a downstream junction or exit slip road.
5. Any vehicle broken down in a live lane meets the definition of causing an obstruction or danger to others, and therefore statutory powers of removal should immediately be invoked if it cannot be cleared. If the Traffic Officer is unable to remove the vehicle, specialist support will be required from, in the first instance, the National Vehicle Recovery Manager (or any subsequent replacement contract).
6. If a vehicle is broken down in (or cleared to) a refuge area, the on road TOS patrol, as for any other road, should make an assessment of the obstruction or danger posed by that

vehicle to determine whether a statutory removal is justified, or whether “owners choice” of vehicle recovery can be used.

5.5 Debris

As elsewhere on the network, there are procedures that cover the removal of debris. Traffic Officers should consider implementing a rolling road block on the approach to scene so that they can effect prompt and efficient removal of the debris at the earliest opportunity. Control Room staff will set supporting signs and signals which may include a lane closure aspect as appropriate.

5.6 Abnormal Loads

Generic Requirements

1. Managed motorways do not fundamentally affect the preferred times or routes for abnormal loads and normal guidance should be followed in scheduling such movements on a MM-DHS scheme. As for other parts of the network, no deviation from the agreed routes should be made without appropriate consultation[9].
2. Managed motorways provide significantly enhanced capabilities to monitor the movement of the abnormal load. The NTOC will have (if possible) established communication with the driver of the abnormal load, and the RCC should communicate via the NTOC to ensure that the driver is aware of downstream traffic conditions and to facilitate communication should an incident occur.

5.7 Severe Weather

This section provides general guidance regarding the desirability of opening the hard shoulder during severe weather situations. Severe weather incidents are largely situation specific, and the TOS will assess the risks in each case and make operational decisions as dictated by the prevailing conditions.

When severe weather is forecast and the HA has issued guidance not to travel unless necessary, it is less likely that the level of flow needed to justify the opening of the hard shoulder will be reached. Even if flow triggers are reached it may be appropriate to leave the hard shoulder closed so that the continuous hard shoulder is available for higher numbers of vehicles likely to encounter difficulties due to the extreme weather.

A Severe Weather Plan (SWP) must be produced by each MAC/ASC and must describe the procedures and operational arrangements necessary for the delivery of an effective winter service. Within this they are required to identify network features (such as MM-DHS sections or ERAs) or local issues (such as high altitude or steep gradients) which require special consideration.

The SWP will also define the process for snow clearance, for example by setting out the number of lanes which must be kept clear for a particular route, and the order in which lanes should be cleared if a 'phased' approach is followed. Message signs and signals can be utilised to display warning information, or inform motorists if certain lanes are not available for use.

[9] For Special Order Movements no deviation from the agreed route should be made without consultation with the HA. For all other abnormal loads, no deviation from the agreed route should be made without consultation with the Police Abnormal Loads Officer and/or Highway and Bridge authorities or RCC Team Manager outside office hours. Any deviation must be considered suitable by them before being used.

Generic Requirements

1. The density of signs and signals and the ability to implement mandatory speed limits provides the operator with useful tools to mitigate the impacts of severe weather on traffic. Implementing lower mandatory speed limits, coupled with lower flow rates, may be sufficient to condition the traffic such that the hard shoulder is not required as an additional running lane.
2. Severe weather may restrict vehicle flow to the point where flow is no longer a good indicator of congestion. In these cases, other factors and methods (vehicle speed, visual inspection via CCTV) may need to be used to determine when to open the hard shoulder.
3. Where emergency services or road workers are working on the carriageway in very severe weather conditions, it may be appropriate to set lower speed limits manually.
4. Severe weather tends to increase the risk of accidents and hence there is a benefit of retaining a hard shoulder as a location of relative safety which vehicles can recover to. Conversely, severe weather reduces effective network capacity which makes opening the hard shoulder more important to maintain congestion within acceptable levels. The judgement about opening the hard shoulder during severe weather needs to take account of these competing priorities, and any tactical decisions that have been made about reducing treatment of certain lanes to conserve salt supplies.
5. The decision to open the hard shoulder during or in anticipation of snow and/or ice requires special consideration. In particular:
    a. It will generally be best to open the hard shoulder immediately following the passage of gritting vehicles as the lack of traffic in the hard shoulder will allow snow and ice to build up, which may make opening the hard shoulder unsafe;
    b. Where snow is forecast and the RCC anticipates a need to open the hard shoulder, it may be desirable to do so prior to the snow building up as this may impede the visual safety checks that are required before the hard shoulder is opened;
    c. During heavy snow, consideration needs to be given to whether it will be possible to keep the hard shoulder clear. (This will depend on the availability of land adjacent to the hard shoulder and as such is likely to be scheme specific. It must therefore be considered in the scheme's Operating Regime PCF product and agreed with each MAC/ASC or DBFO operator).
6. The hard shoulder must not be opened where there is standing water that poses a safety risk to traffic. This is a scheme-specific issue that needs to be highlighted in the scheme's Operating Regime PCF Product.
7. Fog will reduce visibility and increase the risk of accidents. This risk is primarily related to excess speed. The controlled motorways element of MM-DHS schemes will normally

be used to reduce speeds and the associated risk of accidents. Provided that the RCC is satisfied that the dynamic speed limits are effective at reducing speeds, there will be significant benefit to opening the hard shoulder to create additional capacity to compensate for the increased headway between vehicles. Opening the hard shoulder in fog will only be possible if the operator is able to carry out the necessary safety checks.

8. The impact of high winds is scheme specific as the exposure to high winds is a function of road alignment. The scheme's Operating Regime will need to highlight areas of risk and consider the implications on the desirability of hard shoulder opening.
9. Black ice poses a particular threat of serious accidents which may require a response by emergency service and hence it is may not be desirable to open the hard shoulder when routine TOS patrols have indicated that black ice is present (so as to protect a route for emergency vehicles).

5.8 Road works Management

Generic Requirements

1. In order to minimise the impact on traffic, as on the rest of the network, road works will generally happen at night or in periods of lower flow in the middle of the day. This means that they are unlikely to take place when the hard shoulder would be open, unless the scheme uses CALR.
2. During road works, the contractor may request that the RCC set signs and signals to support setting up, modifying or removing traffic management. The policy governing requests from contractors for signal settings is set out in Annex F of the *"Highways Agency policy for the use of Variable Signs and Signals*" (IAN 162/12).
3. If an RCC Traffic Officer sets signals manually, to close a lane to offer additional protection to workers or vehicles on the hard shoulder, variable mandatory speed limits will be set automatically by the system. RCC operators must ensure that such settings are appropriate.
4. It may be desirable to open the hard shoulder to provide additional capacity if the road works require the closure of another running lane. In this case, the normal procedure for checking the hard shoulder prior to opening should be carried out.
5. It is important that maintenance contractor vehicles leave the MM-DHS section promptly when the normal hard shoulder opening time is approaching, as they may otherwise prevent the opening of the hard shoulder. The RCC should monitor repeat breaches and raise them with the relevant MAC/ASC and/or Area Team.

6. Maintenance of Highway and Technology Assets

6.1 Impact of MM-DHS on Maintenance

MM-DHS schemes are comprised of a specific mix of technology and civil infrastructure. These require regular maintenance in order to remain operational and achieve the operational and safety benefits of the scheme. However, the scheme's design itself affects the ability of maintenance service providers to carry out maintenance due to factors including:

- The regular use of the dynamic hard shoulder by HGVs and other traffic;
- The pressure of road space booking arising from the substantial increase in roadside infrastructure and field electronics, an increase in the total number of equipment failures and the reduced time window during which maintenance can be carried out;
- The reduced time window during which inspections that require the use of the dynamic hard shoulder or verge can take place;
- The potential for an increase in inappropriate use of the hard shoulder by drivers;
- The lack of a hard shoulder during certain times of the day from which to carry out maintenance or set out traffic management, and for CALR sections, the lack of a hard shoulder at all;
- The criticality of roadside equipment in respect of the ability to open the dynamic hard shoulder and safely operate the scheme; and
- The requirement for maintenance vehicles to vacate the hard shoulder and ERAs promptly, prior to when the hard shoulder will be opened.

6.2 Maintenance Requirements

The Asset Maintenance and Operational Requirements (AMOR) and the Technology Management & Maintenance Manual (TMMM) set out the HA's requirements in relation to the carrying out of maintenance and operational activities on the network (replacing the existing NMM and RWSC).

Contained within the AMOR and TMMM specifications is the requirement that the maintenance service provider must adopt a risk based approach to the execution of maintenance and operational activities, in order to deliver value for money whilst demonstrating that risks are acceptably mitigated with no detriment to the safety of either road users or road workers.

The AMOR defines the primary risks that must be mitigated by the maintenance service provider, which are to safety, and network availability:

- **Safety**: risks must be mitigated to ensure that:
  - the area network is not dangerous to traffic;
  - the area network does not present a risk to road user or road worker safety;
  - the HA is provided with a 'special defence' under Section 58 of the Highways Act 1980[10].
- **Availability**: risks must be mitigated to ensure the maintenance service provider:
  - secures the expeditious movement of traffic on the HA's area network;
  - facilitates the expeditious movement of traffic on road networks for which another authority is the traffic authority.

Maintenance service providers are required to produce a Quality Plan, which must include fully detailed processes, procedures and timescales in relation to inspection, make safe, and repair of the asset, detailing exactly what activities the provider will undertake to deliver the required outcomes whilst avoiding danger to road users.

For an MM-DHS scheme, this Quality Plan must reflect the fact that their ability to access certain assets may be compromised by the factors outlined above, including physical access (dynamic hard shoulder), or other restrictions (no routine maintenance permitted during peak periods).

The maintenance service provider is also required to produce a Maintenance Requirements Plan, which must detail:

- The planned programme of inspections;
- The response and repair timescales, covering:
  - Defect identification;
  - Verification;
  - Response;
  - Repair
- A description of how work is packaged to minimise network occupancy (including road space booking requirements, traffic management requirements, and temporary traffic regulation orders)

Designers and maintenance service providers must give careful consideration to their obligations to minimise network occupancy (see Section 6.6): both from the point of view of reducing the frequency of lane closures to minimise disruption; and by reducing the exposure of road workers to the risks of working adjacent to live traffic. The number of traffic management maintenance interventions should be minimised; this requirement becomes more pronounced on MM-DHS schemes where the dynamic hard shoulder removes a dedicated space from which to conduct maintenance at certain times of day.

[10] Section 58 provides the defence that "*the Authority had taken such care as in all the circumstances was reasonably required to secure that part of the highway to which that action related was not dangerous for traffic.*"

AMOR also requires that separate plans are produced for key operational areas, including the severe weather service and incident response. These plans must detail the activities which will be undertaken to deliver the required outcomes and avoid danger to users of the highway.

6.3 Guiding Principles for Maintenance on a MM-DHS Scheme

Designers have a statutory duty under the Construction (Design and Management) Regulations 2007 to reduce health, safety and welfare risks for, amongst other things, the maintenance of completed highway schemes.

This section gives generic guidance on issues to be considered by designers and maintenance service providers in the design and maintenance of schemes. Each scheme must undertake its own specific review of the hazards associated with maintenance, and ensure that the scheme has been designed and can be operated and maintained so that the risks are As Low As Reasonably Practicable (ALARP).

Generic Requirements

The design of MM-DHS must consider the downstream life cycle impacts on maintenance in terms of equipment reliability, equipment quantities and access, in accordance with IAN 69/05 “Designing for Maintenance”. These considerations should include the following items, which is not an exhaustive list:

1. Efforts must be made during design to increase equipment reliability and reduce equipment quantities, so as to reduce the significant pressures on maintenance activities that the density of equipment and number of associated equipment failures create;
2. The dynamic hard shoulder and ERAs must be maintained to the same standard as a running lane, including winter maintenance;
3. The failure of certain technology components, or combinations of technology components are termed ‘critical’ where they prevent the dynamic hard shoulder from opening. These types of failures need to be rectified quickly to protect the additional capacity that the dynamic hard shoulder provides;
4. Accordingly, maintenance should be prioritised such that there is a sufficient level of equipment working to allow the dynamic hard shoulder to be opened, operated and closed safely;
5. Where access to the highway for maintenance is particularly difficult, it may be appropriate for the MAC/ASC to review the balance between preventative and reactive maintenance;
6. Due to significant pressures on road space, faulty units should generally be replaced and repaired off site rather than repaired at the roadside (unless this repair can be implemented sufficiently quickly);

7. Many inspections and surveys are currently carried out during daylight hours from the verge or hard shoulder. On MM-DHS schemes there will be times in which these inspections and surveys can no longer take place because the hard shoulder is being used as a running lane. Maintenance service providers will need to demonstrate they have developed techniques for safely and adequately performing these tasks in the reduced time available.

6.4 Prioritisation of Maintenance Activities Specific to MM-DHS

AMOR requires the maintenance service provider to prioritise their activities in order to optimise the use of (and achieve the best value from) available resources.

Unlike conventional motorways, technology is integral to the operation of a MM-DHS scheme. The prioritisation of maintenance needs to reflect the impact of faults and defects on operations - and specifically on the ability to open the dynamic hard shoulder to traffic. (The inability of the RCC to open the hard shoulder when traffic conditions dictate it is necessary is conceptually equivalent to a peak hour lane closure on a conventional motorway section.) This requirement is complicated by the fact that a combination of several faults may be critical, even where the faults themselves, if considered in isolation, are non-critical.

The guidance is to prioritise maintenance on a managed motorway as follows:

Highest Priority to Lowest Priority	a)	Repair of Category 1 defects, as defined in the NMM.
	b)	Repair of faults that inhibit the hard shoulder from being opened or closed.
	c)	Litter blitz
	d)	Routine maintenance and Category 2 defect repairs (as currently defined), where these activities will reduce the instances where the hard shoulder cannot be opened.
	e)	Other types of routine maintenance and Category 2 defect repairs

The allocation of maintenance to priority categories should be based on the criticality of the maintenance to operations. The points below provide high level guidance and background information on which to base this prioritisation. In completing this work, due cognisance must be taken of the prioritisation of repairs that have already been agreed for those MM-DHS schemes currently in operation, and the work conducted on technology fault classification.

Loop detectors and outstations	Loop detectors support multiple system functions, namely MIDAS queue detection, variable speed limits, flow measurement (used to determine when to open the hard shoulder), ramp metering and speed measurement. The impact of any fault on the ability of these systems to operate will govern the response. MIDAS is a safety system and the RWSC defines MIDAS faults as Category 1 defects. MIDAS only requires one loop of any pair to be working in order to function correctly so there is some resilience to loop faults. However, there has to be a minimum of one working loop in every lane to ensure that queues are detected. Variable speed limits, ramp metering and flow detection for hard shoulder opening require the loops to be operational. However, as these systems use data from multiple sets of loops, they can tolerate some level of faults. At some point the number of failed loops may become “critical” as the variable speed limits may no longer operate correctly and the need for repair will elevate this to a critical fault even if the loss of MIDAS functionality has not generated a Category 1 fault.
Advanced Motorway Indicators	AMIs are mounted on gantries above each lane (and post mounted at the top of entry slips) and display speed limit and lane control instructions to motorists. AMIs require routine maintenance to clean the face and check the physical and electrical integrity of the units. Repairs may take place on site if they can be completed within the available time constraints. Otherwise, faulty AMIs must be replaced and taken off-site for repair. When AMIs are faulty, the speed restrictions that they display cannot be enforced.
Electronic Message Signs	MM-DHS uses MS4 signs to provide supplementary information to drivers to warn them of traffic conditions and to help them understand why lane control and speed limits have been set. MS4s are designed to be accessed from the rear and contain various modules that can be replaced on site. They require routine maintenance to clean the face and check the physical and electrical integrity of the units. The extent to which MS4s (particularly on the approach to an off slip) are critical to MM-DHS operation need to be established for each scheme.

CCTV for Hard Shoulder Monitoring	Most MM-DHS schemes will use dedicated fixed CCTV cameras to monitor the hard shoulder and ERAs. The cameras are mounted 6-8 metres high on specially designed poles. The cameras must deliver images of acceptable quality across the full length of the hard shoulder in order for operators to check and then open the link. The maintenance activity is focussed on fault repair, cleaning of the camera lenses[11], and re-alignment of cameras to maintain the comprehensive hard shoulder coverage and the required overlap between camera views.
HADECS	The HADECS unit comprises a dedicated speed enforcement camera and AMI combination that has passed Home Office Type Approval. A specialist contractor, usually the unit supplier/manufacturer, is required to maintain HADECS to the necessary standard in order to preserve the evidential trail. HADECS is not critical to the operation of MM-DHS and hence response times to faults can be longer than for some of the other equipment. However, in the medium term, an inability to enforce may damage credibility and lead to increased non-compliance and the associated safety risks that this entails.
Ramp Metering	Ramp Metering is designed to increase the efficiency of managed motorway operation by smoothing the flow of traffic onto the highway. The various component parts (signal, signs, and loops) require maintenance. However, as ramp metering infrastructure is located on the entry slip road, access is typically less of an issue than for equipment on the main carriageway. Ramp metering affects the efficiency but not the safety of MM-DHS operation. Specifically, it does not impact upon the ability to open the hard shoulder to traffic and hence repairs will normally be of relatively low priority.

6.5 Scheduling of Planned Maintenance Activities

The high daytime traffic volumes experienced on some MM-DHS schemes means that on weekdays, LBS1 may be open to traffic throughout the day. Closing lanes may create significant congestion and delay to travellers. Weekday inter-peak closures may therefore not be feasible except for emergency works and in this situation, the majority of activities will need to be scheduled at night with the provision of additional temporary lighting as appropriate.

[11] The preferred method for cleaning is to use a localised “wash/wipe” facility that can be operated from the base of the camera pole. In such cases, the cleaning solution will need to be replenished on a periodic basis.

According to scheme-specific assessment and historical data on operation of the dynamic hard shoulder, intelligent road space management may be employed to establish when it would be possible to implement lane closures during daylight hours. These are predominantly expected to be associated with activities that are deemed infeasible or too high risk to be carried out in the dark (e.g. litter picking, soft estate clearance),

6.6 Network Occupancy

The purpose of a dynamic hard shoulder is to provide extra capacity when traffic flow dictates that it is needed. In order to maximise the benefits from operating such a scheme, it is essential that the hard shoulder can be opened and closed to traffic when required. Due to the different environment and the fact that hard shoulder running may need to be implemented at any time of day, access to the road space will need to be strictly controlled for safety as well as operational reasons.

As defined in the NMM and the AMOR, the maintenance service provider has overall responsibility for managing all activities and occupancies on the network, including those by third parties. Section 6.1.3.2 and 6.1.3.3 of the NMM (entitled "Network Occupancy Management") states that:

> *"The primary responsibility for coordinating works activity […] is contractually delegated to the Service Providers […] any activity on the network that may contribute, either directly or indirectly, to congestion on the network is covered by this process. This includes activities on the hard shoulder, cycle tracks and footways".*

Part 2 of the AMOR sets out the operational requirements for managing network occupancy, and relates to all occupancies[12] on the area network, as well as all activities which may adversely impact road users. The maintenance service provider is required to maintain a complete knowledge of all such occupancies or activities on the network.

The maintenance service provider is also required to deliver (and comply with) a Network Occupancy Plan, which must contain occupancy booking procedures and pro-forma, and must also maintain a fully populated record of all occupancies and any activities which cause an adverse impact on road users; with a view to optimising all occupancies, and minimising the effect of activities.

There is therefore no additional operational requirement for a "Permit to Access" system specific to MM-DHS schemes. The requirements set out in AMOR for a Network Occupancy Plan which outlines the provider's processes and procedures for managing network occupancy are deemed to be sufficient. Under the ASC contract these general requirements are considered to be a lump-sum duty which will not incur additional costs to the HA.

[12] "Occupancy" is a defined term referring to all works, all Abnormal Indivisible Load Movements, all Incidents, or all Events that take place on the Area Network.

Any system employed must ensure that the maintenance service provider is able to monitor and make contact with all contractors, including third-party maintainers.

Generic Requirements

1. Effective communications systems will be needed to ensure that if the RCC needs to request that maintenance personnel leave the network, the maintainer is able to comply with that request in a quick and efficient manner.

2. Any information communication technology systems used to track road-space bookings should be operated entirely by the maintenance service provider themselves, and no expectation should be placed on the RCC to access these systems in order to obtain information.

3. Routine maintenance will typically only take place outside the agreed peak times. If it becomes necessary to carry out emergency maintenance during the defined peak times for a particular scheme (regardless of whether the hard shoulder is open), the maintenance service provider should inform the RCC and obtain permission to access the network before proceeding

4. If it becomes necessary to implement or continue hard shoulder running outside the agreed normal peak times for a particular scheme, the RCC will inform the maintenance service provider by exception, and obtain clarification that all maintenance activities have ceased before proceeding.

5. The decision to open the hard shoulder to traffic will in any case remain the responsibility of the RCC; and can only take place after the standard pre-opening hard shoulder checks have been carried out.

6. Any instances of a contractor delaying or preventing the opening of the dynamic hard shoulder should be recorded by TMD and escalated through the appropriate channels. This should be considered in the same way as a road closure for maintenance over-running and resulting in delays to road users.

7. The maintenance service provider is responsible for ensuring that any organisation being given access to work on a managed motorways section has undergone specialist training, to make them aware of the hazards associated with working on the scheme and the correct procedures to follow.

6.7 Permission to Access Equipment

Generic Requirements

1. Remote access to signs and signals is being developed and maintenance service providers must make use of this where possible to minimise visits to the roadside. The maintenance service provider will need to obtain permission from the RCC to take over the piece of equipment, as they would currently for physical repairs, to ensure that the equipment is not being used for operational purposes.

7. RCCs and the Traffic Officer Service

7.1 Staffing Levels

An exercise being carried out by the Future Operating Model (FOM) team will review the future staffing needs across TOS as a whole. Their approach will take account of the resource requirements that will be necessary to safely operate MM-DHS schemes as intended. Therefore no additional work will be needed to assess staffing levels for MM-DHS schemes in isolation. The “Operating Regime” PCF Product for each individual scheme will formally record that an assessment has been completed for their schemes and that the staffing requirements to operate the scheme have been agreed.

7.2 RCC and Outstation Space Requirements

The RCC Capacity Report of July 2010 showed that demand for MM-DHS workstations (and desks) is primarily driven by the length of DHS in each region. The requirement for additional workstations in a Control Room to operate MM-DHS is determined by two factors: (i) the number of un-utilised workstations during peak times and (ii) how the MM-DHS operations are handled by the RCC.

The report concluded that following the deployment of MM-DHS schemes (then termed Tranche I), no *additional* workstations will be required for the operation of MM-DHS. This is due to the fact that even in the unlikely event that not all of the additional workload for operating MM-DHS can be absorbed into the existing RCC operations, there are still enough ‘free’ workstations in the RCCs that could be used to run MM-DHS functionality.

7.3 Traffic Officer Procedures for Managed Motorways

The TOS Procedures Team has produced national procedures for MM-DHS - approved by both the National Health & Safety Team (NHST) and the Resource and Capability Group (R&CG). The result is a standardised set of core procedures covering MM-DHS managed motorways operations.

It is the responsibility of each scheme to identify any specific considerations that require a “non standard” operational procedure. In particular, the scheme will need to identify any hazards that may not have been included in the MM-DHS generic hazard log, and where necessary determine appropriate mitigations.

Where necessary, the national TOS Procedures Team will work with each scheme to develop a set of procedures to cover such scheme specific conditions and to gain the necessary approvals. Where applicable these will form a set of regional procedures that will be described for each TOS region.

The core and regional (scheme specific) procedures will be held and maintained centrally on the Traffic Officer Procedures Index on the HA’s Portal by the TOS Procedures Team.

7.4 Traffic Officer Service Competence Standards, Learning Requirements and on-going Competence Assurance

TMD, through the Resource and Capability Group (R&CG), will be coordinating the national approach to all Traffic Officer learning requirements associated with MM-DHS schemes. To deliver this work, R&CG will:

- analyse the competence requirements associated with the operation of each scheme for all TOS roles (mapping legal, safety and national standards requirements);
- determine any gaps between the existing operational standards and any new standards required to operate MM-DHS schemes;
- create new and/or adjust current learning interventions and assessments required to deliver the required competence standards;
- record individual achievement against these standards; and
- maintain competence within TOS through appropriate interventions/ existing R&CG services.

Detailed training delivery plans will be agreed with the TOS regions.

7.5 Relationship with the National Traffic Operations Centre

The National Traffic Operations Centre (NTOC) provides strategic diversion advice and traffic information via VMS, internet, telephone and other information service channels. The NTOC also provides the HA's strategic partners with a single source for data and information relating to the status of the HA's network.

The NTOC service is managed by TMD. Introducing MM-DHS will impact the services delivered by the NTOC, and create additional requirements for communication between the NTOC, and those RCCs operating MM-DHS schemes.

- The Highways Agency policy for the use of Variable Signs and Signals to MM-DHS schemes will need to ensure that sufficient strategic roadside information can be communicated (the key issues are the relative priorities of tactical versus strategic messages on variable message signs, and whether dedicated VMS need to be installed and/or retained for strategic information purposes);
- The RCC need to provide timely information to the NTOC regarding the status of each MM-DHS scheme. For example, the NTOC will need to know when the dynamic hard shoulder is opened and closed and of situations where the hard shoulder will not be able to be opened in the peak period (e.g. due to an equipment failure).
- The RCC need to be aware of all situations where the NTOC plans to implement a strategic diversion which passes through a MM-DHS section, so that the DHS

could be opened in time to cope with the additional traffic that such diversions might generate.

The NTOC provides significant opportunities to inform drivers of planned disruption associated with managed motorways construction and maintenance.

8. Glossary

Term	Definition
ACPO	Association of Chief Police Officers. ACPO is an independent, professionally led strategic body responsible for the direction and development of the police service in England, Wales and Northern Ireland.
ALARP	As Low As Reasonably Practicable. ALARP describes the level to which risks can reasonably be expected to be controlled, weighing the risk against the trouble, time and money needed to control it.
AMI	Advanced Motorway Indicator. Usually installed on gantries over each lane and used for displaying speed restrictions and lane status indicators
AMOR	Asset Maintenance & Operational Requirements – the replacement for the RWSC and NMM which sets out the HA's requirements for the delivery of routine maintenance and operational service within the ASC.
ASC	Asset Support Contract – the replacement for the Managing Agent Contractor (MAC) contracts, which form the basis of maintenance agreements on most parts of the Agency's network.
CCTV	Closed Circuit Television. The system of video cameras used for the purposes of Hard Shoulder Monitoring and general surveillance.
COBS	Control Office Based System: In-station software and servers enabling RCC operators to interact with roadside infrastructure and equipment.
Conditioning	Preparing the Link for hard shoulder running by reducing the speed limit across all running lanes to ensure smooth traffic flow
Core Responders	Those organisations involved in responding to an incident on the HA network. The Traffic Incident Management Guidance Framework defines Core Responders as: the Highways Agency, (including the RCC and on-road Traffic Officer Service, Service Providers and their Incident Support Units, the National Vehicle Recovery Manager and any other party contracted by the HA) and the Emergency Services, Vehicle Recovery Services and Motorist Assistance Organisations involved in responding to an incident
CPS	Crown Prosecution Service. The body that prosecutes criminal cases investigated by the police in England and Wales, including those cases brought under road traffic law.
D3M	Dual 3-lane motorway. Also referred to within this Concept of Operations as a “conventional” motorway.
DBFO	Design, Build, Finance & Operate. DBFOs are a private finance initiative where, in the context of roads, the private sector assumes responsibility for the operation and maintenance of a length of existing road and for building specified improvement schemes to provide a service to road users (typically for a period of 30 years),
DfT	Department for Transport. The central government department responsible for determining overall transport strategy.
DLOA	Detailed Local Operating Agreements
DROA	Detailed Regional Operating Agreements

Term	Definition
EMS	Enhanced Message Signs. EMS can usually display two lines of 12 characters and are used to provide tactical information to road users to support the setting of signals.
ERA	Emergency Refuge Area. ERAs are areas located beside LBS1. These may be used, particularly during periods when the dynamic hard shoulder is open, as an area of refuge during emergencies, such as vehicle breakdown. ERAs have the same status as a conventional hard shoulder – they are only to be used in cases of emergency or breakdown.
ERT	Emergency Roadside Telephone
Gateway Gantries	Two gantries located upstream of where hard shoulder running begins for a scheme with AMIs over the normal running lanes but not over the hard shoulder.
HA	Highways Agency. An executive agency of the DfT responsible for operating, maintaining and improving the strategic road network in England on behalf of the Secretary of State for Transport.
HADECS	Highways Agency Digital Enforcement Camera System
HATOMS	Highways Agency Traffic Operations & Management System. HATOMS is system that controls the technology infrastructure and equipment necessary for the safe operation of managed motorways The HATOMS central system provides an interface for use by operators contains the business rules that govern operations and controls all input / output to field equipment and external systems
HGV	Heavy Goods Vehicle
HIOCC	High Occupancy – an algorithm that is used by the MIDAS sub-system to look for several consecutive seconds of high detector occupancy, such as would be caused by stationary or slow-moving vehicles, to detect incidents in high traffic flows.
HMCS	Her Majesty's Courts Service
HSM	Hard Shoulder Monitoring - technology deployed by an RCC operator to confirm that the hard shoulder is safe to open to traffic
IAN	Interim Advice Note
Lane Referencing	The terminology used operationally to ensure that the RCC operator understands which lane on a MM-DHS scheme is being referred to when signal settings are requested. This is Lane Below Signal (abbreviated to LBS) where the lanes are numbered starting at 1 (the left most lane) and then LBS2, LBS3, LBS4 etc. The LBS terminology is used to differentiate from the Hard Shoulder, Lane 1, Lane 2 etc terminology currently used on the rest of the network
LBS	Lane Below Signal - this is the terminology used operationally to ensure that the RCC operator understands which lane on a MM-DHS scheme is being referred to when signal settings are requested. The lanes are numbered starting at LBS1 (the left most lane) and then LBS2, LBS3, LBS4 etc. The LBS terminology is used to differentiate from the Hard Shoulder, Lane 1, Lane 2 etc terminology currently used on the rest of the network

Term	Definition
LDR	Lane Divert Right signal
Link	A length of motorway between successive junctions
MAC	Managing Agent Contractor
MIDAS	Motorway Incident Detection and Automatic Signalling
MM	Managed Motorways
MS4	Motorway Signal mark 4. These signs have pictogram capability
MSS	Message Sign Subsystem (of COBS)
NDD	Network Delivery and Development Directorate
NGF	National Guidance Framework. Refers to the 'Managed Motorways Emergency Responder National Guidance Framework', published in December 2010. This document takes the principles encapsulated in the 'Managed Motorways Emergency Responder National Strategic Agreement' and expands them into a set of operational requirements and procedures that are agreed with the Emergency Services.
NHST	National Health & Safety Team
NMM	Network Management Manual
NTOC	National Traffic Operations Centre
Operating Regime	A PCF product developed for each Scheme which sets out any divergence from this Concept of Operations document that may be necessary to deal with scheme specific issues that could affect operational practice
PCF	Project Control Framework - This is a joint DfT and HA approach to managing major projects. It comprises: • A standard project lifecycle • Standard project deliverables • Project control processes • Governance arrangements
PTZ	Pan-Tilt-Zoom
Ramp Metering	A process to regulate the number of vehicles joining a motorway at a given point by limiting the flow on the access slip using signals. Also known as Access Control.
RCC	Regional Control Centre
R&CG	Resource and Capability Group (formerly Traffic Learning Centre)
Red X	Indicator on AMIs used to indicate either that the hard shoulder is for emergency use only (lane control indicator with no flashing lanterns – a broken Red X) or that the lane is closed (stop indicator with flashing lanterns). See section 3.1.1
ROM	Regional Operations Manager
RTMC	Regional Technology Maintenance Contract. The RTMC is the HA's new contract for reactive and preventative maintenance for traffic technology and will replace the existing TechMAC arrangements. The RTMC contract operates with a parent contract, the ASC, which acts as Service Manager to the RTMC.

Term	Definition
RWSC	Routine & Winter Service Code. The RWSC describes which describes the requirements for routine and winter service activities on the trunk road network. These requirements are being phased out and replaced by AMOR
Section	A length of motorway between successive gantries
SIG	Signalling Subsystem - the subsystem of the COBS system that is used to transfer RCC operator actions into signal settings on road
TechMAC	Technology Managing Agent Contractor
TJR	Through Junction Running. Managed motorway design which allows vehicles to use the hard shoulder within a junction, avoiding lane drop/lane gain.
TMD	(HA) Traffic Management Directorate
TOS	(HA) Traffic Officer Service
TTD	(HA) NDD Traffic Technology Division
VMS	Variable Message Sign. VMS are road traffic signs with a legend that can be varied – typically light-emitting discontinuous message signs which can be used to provide information to road users.
VMSL	Variable Mandatory Speed Limit