

Maintenance Assistance Vehicle (MAV) Functional Design Specification

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1 PREFACE

This document provides requirements and guidance for the design of a Maintenance Assistance Vehicle (MAV) for the installation and/or replacement of Advanced Motorway Indicators (AMIs), to meet the requirements for Highways England operation. The requirements stated herein shall be applied by Highways England and the contractor as agreed and defined in the Contract.

This document has been produced on behalf of the Information and Technology Directorate (I&TD), Highways England, Bristol.

The appropriate parts of this document are to be used, when called by the Contract, for all future design, and whenever practicable for amendments to existing designs. If any difficulty arises which prevents application of this document, I&TD shall be informed so that a remedy may be sought.

Any enquiries regarding this document, in relation to an invitation to tender or a contract in which it is incorporated, are to be addressed to the relevant Highways England Procurement Officer named in the invitation to tender or contract.

This document has been devised solely for the use of Highways England and its contractors in the execution of contracts for Highways England. To the extent permitted by law, Highways England hereby excludes all liability whatsoever and howsoever arising (including, but without limitation, liability resulting from negligence) for any loss or damage howsoever caused where the Document is used for any other purpose.

1.1 MUTUAL RECOGNITION

Where there is a requirement in this specification for compliance with any part of a “British Standard” or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in TR1000.

2 INTRODUCTION

2.1 PURPOSE OF DOCUMENT

This specification describes the required functionality of the MAV vehicle for the installation or maintenance of gantry mounted AMLs.

2.2 CONTENTS OF DOCUMENT

Section 3: Functional Requirements, describes the primary functional requirements expected from the Maintenance Assistance Vehicle.

2.3 REQUIREMENTS

To clarify the requirements expressed in this document, statements are expressed as either:

- Mandatory requirements, denoted by M:xxxx
- Desirable requirements, denoted by D:xxxx
- Information statements, denoted by I:xxxx

where xxxx is the unique statement identifier.

Mandatory requirements are those requirements which must be met in full. They represent the minimum necessary subset of the requirement which, if not fulfilled, would make it impossible to meet the system's objectives. Desirable requirements are those which are less crucial and need not be met on a specific procurement. Information statements provide additional information for clarification purposes or to support the requirements, they do not constitute a requirement. These will generally appear at the start of the requirement statements. Text which introduces a section has not explicitly been identified as an Information statement.

A requirement will sometimes comprise several closely related detailed requirements such that it is sensible to express them as part of the same requirement statement. In these cases, the detailed requirement statements are given sub-references of the form a:xxxx.y, where:

- a is M or D
- xxxx is the specific requirement number
- y is the sub-reference number.

These will appear within brackets appended to the sub-requirement statements.

2.4 SCOPE OF DOCUMENT

Gantry mounted signals have become commonplace on the Highways England's network with the continued rollout of Smart Motorways. The signals are an integral part of the success of these traffic management solutions; they display mandatory speed limits and facilitate enforcement of speeds. The ongoing maintenance of these signs can be better facilitated using the MAV. This functional specification details the core facilities that are essential in producing a vehicle capable of undertaking the maintenance of the AMLs on the majority of gantries. It is accepted that this solution will not be a "one size fits all" solution and existing methods of maintenance will be required from time to time.

2.5 RELATED DOCUMENTS

If the prototype MAV forms the basis of the production vehicle the following documents may be pertinent.

- DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC.
- BS EN 1915-1:2013 – Aircraft Ground Support Equipment. General requirements. Basic safety requirements.

- BS EN 1915-2:2001 +A1:2009 – Aircraft Ground Support Equipment. General requirements. Stability and strength requirements, calculations and test methods.
- BS EN 12312-2:2014 – Aircraft Ground Support Equipment. Specific requirements. Catering vehicles.
- The lifting mechanism will be constructed to comply with British standard BS EN 1570-1:2011+A1:2014 Safety requirements for lifting tables. Lifting tables serving up to two fixed landings.
- BS EN 60309-1:1999+A2:2012, IEC 60309-1:1999 - Plugs, socket-outlets and couplers for industrial purposes. General requirements.
- HD 60364-7-717 : 2010 COR 2014 - Requirements for special installations or locations - Mobile or transportable units.
- BS EN 280:2013+A1:2015 - Mobile elevating work platforms. Design calculations. Stability criteria. Construction. Safety. Examinations and tests.
- BS EN 62305-1:2011 – Protection against lightning. General principles
- BS EN 62305-3:2011 Protection against lightning. Physical damage to structures and life hazard
- BS EN 131- British and European Ladder Certification Standards.
- Traffic Signs Manual ('Chapter 8')
- TR2607 and associated MCX drawings
- <https://www.gov.uk/browse/driving>
- <https://www.gov.uk/government/organisations/driver-and-vehicle-standards-agency>
- <http://www.hse.gov.uk/work-at-height/index.htm>

3 FUNCTIONAL REQUIREMENTS

This functional specification does not define the mechanical or electrical design of the proposed MAV. It does not include the details as to how the vehicle functions will be implemented. Instead, it focuses on what operators might "observe" when interacting with the vehicle and its systems. For example, the functional specification might state as follows:

- Operatives or personnel must be able to stop the engine in the event of an emergency. This must be possible from the nearside and offside (front & rear) of the vehicle and within the cab and rear box section (front and rear).
- The ability to stop the engine must be quick and activated without the need for a key or any form of additional equipment i.e. screwdriver or spanner.
- The emergency stops must not have any cover which might impede their actuation.

3.1 PROTOTYPE VEHICLE

I:10 The current prototype MAV is based upon an aircraft catering vehicle; as such references have been made to the specifications and regulations governing its manufacture.

If the MAV prototype forms the basis of the production vehicle then related documentation should be followed, the primary (non-exhaustive) list of documents are contained in Section 2.5. (I:10.1)

3.2 GENERAL REQUIREMENTS

I:20 This functional specification assumes that the production vehicle is of a newer design to the current prototype MAV which consisted of a steel front and rear frame body, fixed to a steel sub-frame and bearers with a full width hydraulically extending platform. This body is mounted to an 'L Series' scissor lift powered by two electro-hydraulically controlled hydraulic rams which gives a direct vertical and parallel lifting and lowering motion. This scissor lift is mounted to a 2005 Iveco 180e24s Euro 3 chassis cab with right hand drive and manual transmission. There is a close-coupled hydraulic pump driven by the Power Take Off (PTO) which is mounted directly to the vehicle gearbox; a warning light in the driver's cab indicates when PTO is in mesh. Several hydraulic systems located throughout the vehicle serve the main scissor lift, self-levelling system, forward platform, jib and tail lift.

M:500 Any deviation from the mandatory clauses shall be discussed and agreed with the Procurement Team prior to implementation.

M:600 The supplied vehicle, along with the modifications contained within this specification, must be suitable to carry out the intended function of AMI swap outs and installations.

I:30 The fundamental concept of the MAV is to provide operators with a safe and secure vehicle and platform that can be elevated to a minimum of 7.4 Meters (either in one lift or by means of a double lift, where just the front bridge is elevated above the height of the main body. elevating just the front bridge section), above the carriageway, enabling operators to undertake the primary functions of the maintenance, swap out or the new installation of AMIs.

- M:610 The vehicle must be fully compliant with all relevant certifications and approvals for use on the UK road and motorway network including any requirements for tachograph use.
- The vehicle shall be compliant with the Traffic Signs Manual ('Chapter 8'), to permit it to be used as a motorway maintenance vehicle; (M:610.1)
- Control of the Chapter 8 compliant beacons must be possible within the cab section; (M:610.2)
- In addition to the beacons on top of the vehicle (Chapter 8), 2 sets of repeater beacons are to be installed on the front cab section and the rear chassis to ensure visibility whilst the rear box section is elevated. (M:610.3)
- M:620 In addition to the requirements detailed within the mutual recognition clause (Section 1.1), any vehicle used must comply with the legal requirements applicable to its use on UK roads and will include (but not limited to) the relevant requirements contained within www.gov.uk/government/organisations/driver-and-vehicle-standards-agency that are specific to the type of vehicle used.
- M:630 The vehicle must incorporate a method of alignment relative to the position of the AMI and Bracket mounted on the gantry.
- D:310 All CCTV cameras mounted externally are to be coated with a water repellent to aid water run-off. Any coating must not affect the optical performance of the camera.
- M:640 All external equipment must be rated a minimum of Ingress Protection 66 (IP66 – IEC60529 Degrees of Protection Provided by Enclosures). Any deviation from this must be agreed and approved by the Procurement Team.
- M:650 The vehicle's footprint must remain within a standard carriageway width (3.65 meters), when the vehicle is correctly aligned within the carriageway and when the hydraulic jacks are in the lowered position and with the working platform fully widened.
- M:660 The vehicle, once modified and loaded, must not exceed any measurement (size, weight & height) restrictions as defined in Section 2.5.
- Vehicle measurement restrictions refers to the vehicle whilst travelling on the Strategic Road Network (SRN) and not whilst undertaking maintenance operations. (M:660.1)
- I:40 The current prototype vehicle is capable of undertaking AMI swap outs in wind speeds up to 26mph.
- M:670 The vehicle must be able to operate at wind speeds up to 47mph.
- An anemometer must be installed on the roof of the vehicle in such a location so that it is not obstructed in any way. (M:670.1)
- 2 digital displays indicating wind speeds must be provided with displays available in the drivers cab and body. (M:670.2)
- The displays must indicate current wind speed and maximum wind gusts in mph. (M:670.3)
- An audible warning must alert operators if the wind speeds are consistently exceeded (configurable for local policy). (M:670.4)
- The anemometer and displays must be powered via the vehicle's electrics. (M:670.5)

A UKAS accredited certificate of calibration for the anemometer must be supplied. (M:670.6)

M:680 The vehicle must incorporate effective lightning protection measures to protect against direct and indirect lightning strikes (complying with Section 2.5).

M:690 It must be possible to lower the vehicle at ground level in the event of hydraulic/power failure using provided emergency controls.

I:50 The swap out of a faulty AMI is currently possible in under 18 minutes (including deployment and recovery of vehicle).

In order to evaluate the performance of the MAV the following activation times were recorded:

The main vehicle body could be raised to its full height in 45 seconds; (I:50.1)

The main vehicle body could be lowered to its home position in 30 seconds; (I:50.2)

The vehicle jib could be raised to its maximum height in 12 seconds; (I:50.3)

The vehicle jib could be lowered to its home position in 12 seconds; (I:50.4)

The platform must be able to fully extend and contract in 8 seconds; (I:50.5)

The platform must be able to fully widen and contract in 11 seconds. (I:50.6)

M:700 The ascent and descent speeds of the main scissor lift hydraulics must be configurable to comply with operators' requirements.

M:710 When the hydraulic system is in operation, safety interlocks must prevent the vehicle from being moved or driven until all systems are returned to their home position.

M:720 The vehicle must be able to elevate a payload, evenly spaced throughout the body, of at least 4000kg to full height (complying with Section 2.5).

M:730 All design weight loadings must be displayed next to or close to the controls for all relevant pieces of equipment and working areas (platform, tail lift etc).

M:740 All hydraulically and or electrically operated equipment must have safety interlocks to prevent damage to themselves, the vehicle or the operatives.

Safety devices are to be used to prevent damage to the vehicle and or structure (gantry) where there is a risk of collision when elevating/extending (forward) any working platform (excluding handrails/guarding). (M:740.1)

M:750 The vehicle must transport a minimum of 4 AMIs each secured on a dedicated trolley frame. These frames must be capable of securely storing AMIs from all manufacturers (as detailed under Section 3.6).

1 additional trolley frame must be provided for marshalling purposes during maintenance, refits etc; (M:750.1)

The vehicle must allow for the marshalling of the trolley frames within its body without the need to move other secured trolley frames. (M:750.2)

M:760 The vehicle must be able to operate in temperatures between -20....+40°C.

M:770 The supplier must provide a means of self-levelling the vehicle and its associated parts i.e. the elevated platform to ensure a safe level working surface for the operatives.

The self-levelling hydraulic system must be capable of operating across Highways England Road network, the system must be able to level the vehicle

against all gradients and cambers that might be expected on this Network;
(M:770.1)

M:780 All Anchor/tether points must be clearly marked.

I:60 The current installation process incorporates the use of a step ladder. If one is also incorporated into the formal process a Class 1 Platform Step or better should be used.

The use of the step ladder should adhere to the correct safety standards as listed in Section 2.5. (I:60.1)

M:790 The modified vehicle and equipment must have a Mean Time Before Failure (MTBF) of 131,000 hours when fully maintained in accordance with the manufacturer's recommendations.

3.3 VEHICLE CAB SECTION

I:70 The vehicle cab section and chassis for the prototype MAV was based on a Commercial Off The Shelf (COTS) 18/19T vehicle. The exact specification of the new vehicle will be dependent on the manufacturer selected.

M:800 There must be provision for the operatives in the cab section to view (as a minimum) 2 real-time images simultaneously from CCTV:

- Rear of vehicle (reversing).
- Inside rear box section of vehicle.
- The AMI swap out process area, and
- Approach camera (Top rear of box section)
- Alignment camera(s) (if used).

M:810 All CCTV cameras must be suitable for the environment in which they are to be used i.e. temperature, vibration, power, ingress protection, lighting etc.

M:820 All CCTV images must be recorded in real time when the vehicle is in operation.

The playback and viewing of recordings must be possible either remotely or locally; (M:820.1)

All recording must be stored and retrievable for a rolling period of 15 days; (M:820.2)

Provision must be made to download recorded images for backup, archive, or training purposes. (M:820.3)

M:830 The vehicle shall accommodate at least 3 operatives in the vehicle cab and comply with the requirements of Section 2.5.

M:840 A PTO-compatible fully automatic transmission is to be used to reduce or remove hesitations or jerks during gearshifts typical with manual transmission and provide greater control, manoeuvrability and reduce rollback.

D:320 The cab section shall provide the means to store additional items of PPE.

M:850 It must be possible to cut power to the hydraulics from the cab in the event of an emergency.

M:860 It must be possible to control the self-levelling system from within the cab.

Interlocks must prevent the raising of the self-levelling system whilst the vehicle box section is elevated. (M:860.1)

The hydraulics for the self-levelling system must incorporate sensors with appropriate warning lights to indicate if the system is compromised i.e. losing pressure. (M:860.2)

M:870 It must NOT be possible to raise or lower the box section from within the Cab.

3.4 VEHICLE REAR BOX SECTION

M:880 The vehicle must provide a means of facilitating the loading and unloading of AMIs into the rear box section for transportation and storage purposes.

If a tail lift is utilised, a key operated switch must be installed to provide an interlock to prevent the tail lift platform from being operated if the scissor mechanism is raised. (M:880.1)

I:80 If a tail lift is utilised for the loading and unloading of AMIs into the box section then guard rails may be mandated under local policy. (Appendix A.1.4)

M:890 The proposed vehicle's rear box section must have an enclosed body with shutters or doors to permit loading, unloading, access, egress and AMI maintenance. This shall facilitate a safe working environment for the operatives.

M:900 When undertaking work on the elevated platform and with the exception of removing or installing the AMI onto the bracket, guard rails must enclose the platform to a minimum height of 1300mm.

The guard rails must move with the extending and widening of the platform. (M:900.1)

The sides of the guard rails must be meshed to prevent items from falling to the carriageway. (M:900.2)

A toe board must be incorporated around the edge of the platform to prevent small objects from falling to the carriageway. (M:900.3)

Multiple fall arrest anchor points must be provided. These should be located throughout the vehicle to facilitate the work to be undertaken and in accordance with local policy. (M:900.4)

M:910 Provision must be made for access and egress into the main vehicle body in addition to the method used for the loading of AMIs.

The aperture must be secured and interlocked to prevent its opening when the body is elevated. (M:910.1)

The opening and closing of access doors must not pose additional risks to the operators when entering or leaving the vehicle. (M:910.2)

M:920 Suitable illumination to both the inside of the vehicle and working platform must be provided to support the work being undertaken in both day and night conditions.

Any lighting provided to assist the operatives must minimise any distraction to other road users. (M:920.1)

The internal lights must be controllable from suitable positions within the vehicle body. (M:920.2)

The working platform lighting must be controlled from within the vehicle rear box section (near to the front aperture). (M:920.3)

- M:930 A suitable (wired) method of communication between the driver and the elevated section must be provided (intercom). The intercom must function when the body is raised.
- M:940 It shall be possible to secure trolleys in such a way that they are prevented from moving in any way when the vehicle is being driven or in the event of an accident. (additional information is in Section 3.6).
- M:950 The height of the box section shall must be sufficient to permit the stowage of AMIs and its trolley frame leaving sufficient space above for the storage of parts and other equipment i.e. not less than 2.44 meters in height.
- The side walls of the vehicle must be constructed so as to permit the installation of additional loadlok(s) should they be required for additional parts and equipment; (M:950.1)
- M:960 The elevating & lowering of the vehicle must incorporate dual controls both of which need to be operated simultaneously to elevate and lower the vehicle.
- The controls must be placed to allow the operatives an unimpeded view of the front platform. (M:960.1)
- The elevation and lowering of the vehicle must only be possible when operatives have full visibility of the front bridge section. (M:960.2)
- M:970 All controls associated with the operational use of the vehicle must be subjected to a Human Factors assessment and sign off.
- M:980 Steps and handrails at access and egress points must have anti-slip coatings.
- M:990 The floor surface must be hardwearing (i.e. withstand the manoeuvring of AMIs and their trolley frames) and be anti-slip.
- The floor surface must be capable of withstanding the environment for which it is to be used. (M:990.1)
- There must be suitable drainage holes to allow excess water to drain within the rear box section during adverse weather conditions. (M:990.2)
- M:1000 The rear box section must incorporate a means of powering an AMI for testing purposes (inverter).

3.5 WORKING PLATFORM

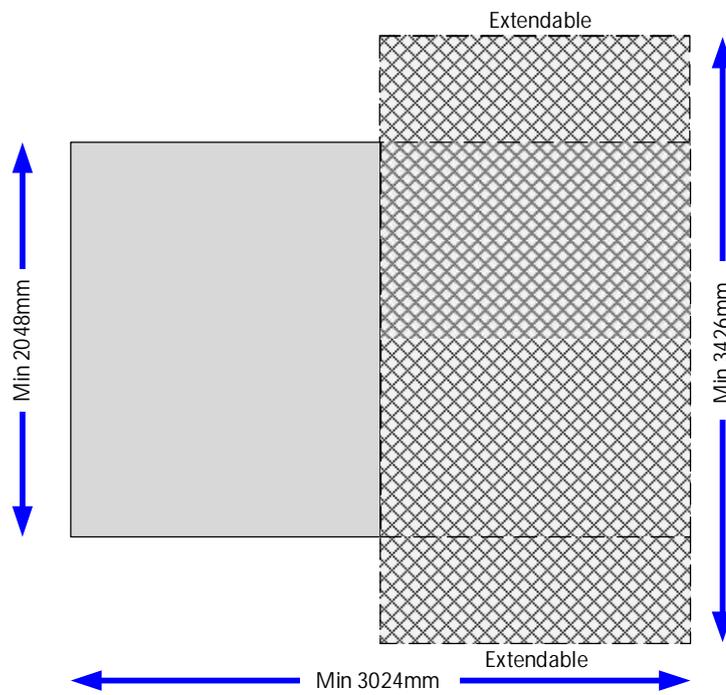
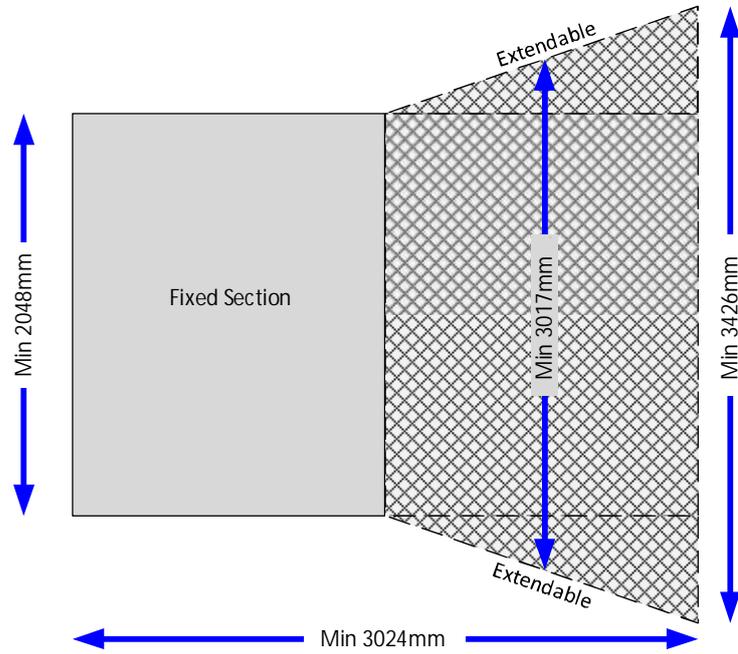
- M:1010 The minimum lifting height required for the working platform is 7.4 metres.
- D:330 The front working platform with all fitted equipment is to remain in situ during transit and AMI maintenance and therefore should be designed accordingly i.e. weather resistant.
- M:1020 The use of a remotely operated motor assisted lifting aid suitable for the lifting of the AMIs from the trolleys onto and off of the gantry bracket must be provided.
- I:90 The prototype vehicle utilised a jib to manoeuvre the AMI from the trolley frame onto the gantry mounting bracket.
- D:340 Depending on the chosen method of lifting the AMI it is recommended that it is secured to the vehicle to improve rigidity and strength.
- M:1030 In the event of an emergency, engine and hydraulic override controls must be mounted externally on the vehicle, with linked overrides located on the nearside, offside, front and rear. This will be in addition to the emergency stops within the driver cab and rear box section (front and rear).

The use of the emergency stops must be possible without the need for a key or any form of additional equipment i.e. screwdriver or spanner. (M:1030.1)

The emergency stops must not be covered in any way that might impede activation. If any emergency stop is activated it must not be possible to restart the vehicle and or systems without the device being reset. (M:1030.2)

- M:1040 The elevated platform must provide suitable delineation (clearly indicating the outer edges of the operating area) and show where AMIs are to be rotated if required.
- M:1050 The working platform for the installation of the AMIs must be capable of supporting 2 operatives, associated equipment and at least 1 AMI including trolley frame.
- M:1060 The working platform floor surface must be hardwearing (i.e. withstand the manoeuvring of AMIs and their trolley frames) and be anti-slip.
- M:1070 The front platform must be capable of supporting the combined weight of the AMIs from different manufacturers, trolleys and operatives.
- M:1080 The working platform used for the installation and commissioning of AMIs must be of sufficient size to permit the manoeuvring of the AMI by the operatives who may require access to it from all sides.
- M:1090 The front 'bridge' working platform must be at least 3246 mm wide at the leading edge and of sufficient size to permit the installation of AMIs.
- M:1100 The front platform must incorporate a hydraulically operated extending section of a minimum of 250 mm.
- M:1110 If utilised, the widening or extending of the platform must be undertaken in a safe and secure manner without presenting a danger to operatives.
- Interlocks are to be provided to ensure that the vehicle cannot be moved until all platforms, gates, jib etc are fully stowed. (M:1110.1)
- I:100 Examples of the MAV prototype and design ideas for the front platform are shown within Annex A

I:110 Examples of adjustable platforms and sizes are as follows:



3.6 TROLLEY FRAME REQUIREMENTS

- M:1120 The trolley frame must be capable of transporting all types of AMIs approved by Highways England both inside and outside of the vehicle complying with the requirements of TR2607 and associated MCX drawings.
- M:1130 The trolley frame must remain stable whilst they are manoeuvred, both when loading and unloading of the trolley frame in and out of the vehicle whilst it is carrying an AMI.
- M:1140 The trolley frame must incorporate a safe, reliable and quick method of releasing the AMI from the trolley frame.
A secondary safety mechanism must be used to prevent the accidental release of the AMI; (M:1140.1)
All handles and locking devices must be differentiated by colour from other fittings to indicate their purpose. (M:1140.2)
- M:1150 The trolley frame design must be suitable for use on the surfaces likely to encountered at depots and compounds.
- M:1160 All trolley frames must be fitted with a braking system to render the trolley and its load unmoveable. It must be possible to engage and release the braking system by a simple foot operation.
- M:1170 The trolley frame must be constructed in a manner to prevent corrosion and be weather resistant.
- M:1180 The trolley frame must be of such a size to allow for their manoeuvring within the vehicle.
- M:1190 The trolley frame must incorporate a quick release mechanism for securely stowing and releasing the frame from its home position within the vehicle.
- M:1200 The trolley frame must be safe and easy to load and not exhibit any sharp edges that may present a danger to operatives.
- D:350 Edge protection strips (silicon / rubber) may be used to protect the trolley frame and vehicle.

3.7 ADDITIONAL EQUIPMENT

- M:1210 An active fire protection device to extinguish or control small fires in an emergency must be provided within the cab and rear box sections.
- M:1220 The use of hydraulic jack pads must be of a sufficient size and design so that when lifting the vehicle at maximum payload the road surface is not damaged.
- D:360 Integrated hydraulic jack pads are preferred as additional jack pads should be avoided as deploying such extends maintenance times.
- D:370 In addition to the (wired) method of communication the use of Personal Mobile Radio (PMR) devices are recommended for communication between the driver and operatives.

4 ABBREVIATIONS

AMI	Advanced Motorway Indicator
BS EN	British Standard European Norm
CCTV	Closed Circuit Television
COTS	Commercial Off The Shelf
KG	Kilogram
MAV	Maintenance Assistance Vehicle
MTBF	Mean Time Before Failure
PMR	Personal Mobile Radio
PPE	Personal Protective Equipment
PTO	Power Take Off

5 REFERENCES

5.1 REFERENCES USED IN THE MAIN BODY OF THE SPECIFICATION

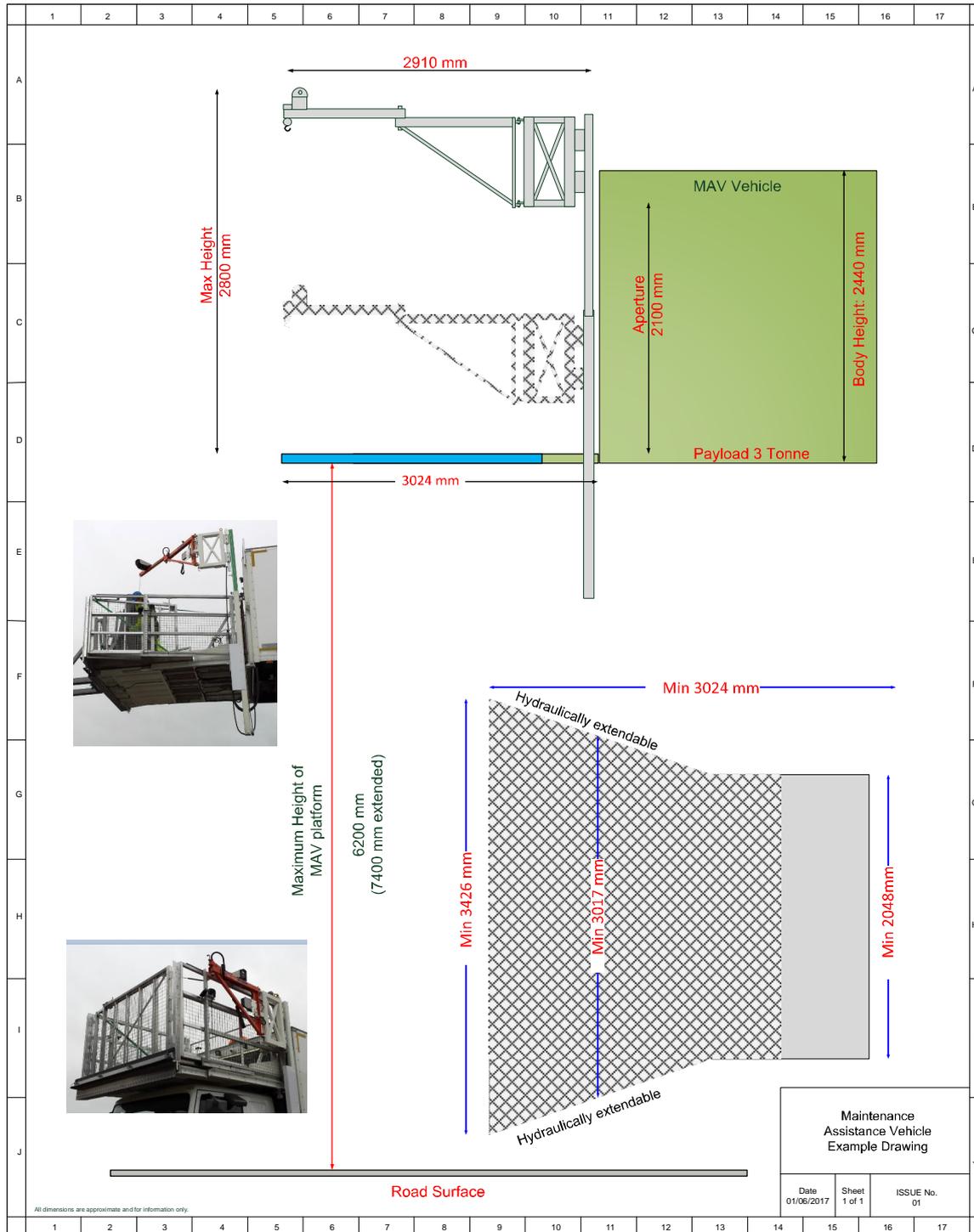
- www.gov.uk/government/organisations/driver-and-vehicle-standards-agency
- TR2607 - Performance Specification for Electronic Motorway Display Equipment
- Chapter 8 of the Traffic signs Manual (Traffic Safety Measures & Signs for Road Works & Temporary Situations)
- IEC60529 Degrees of Protection Provided by Enclosures

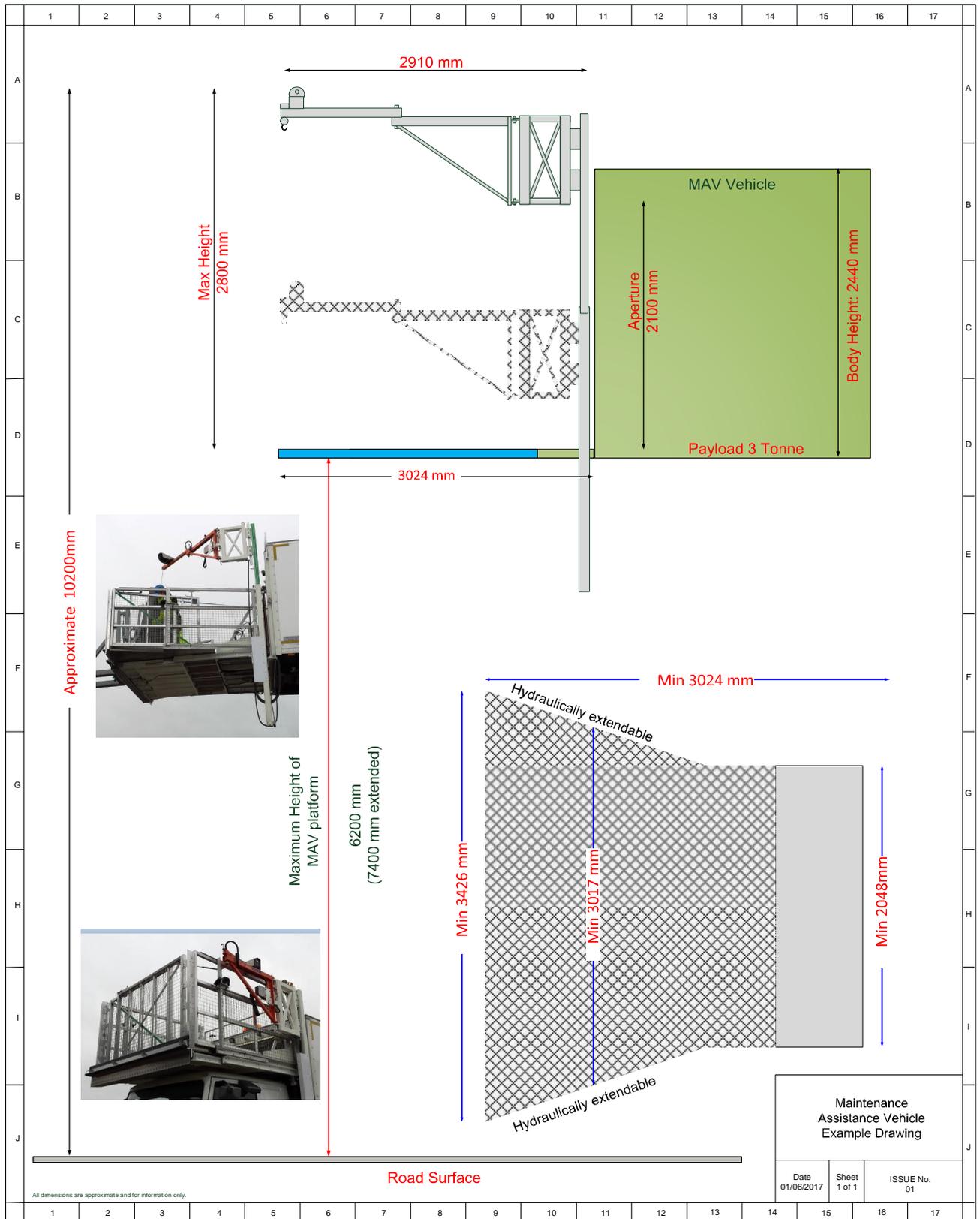
6 HISTORY
Issue A – June 2017 – first draft.

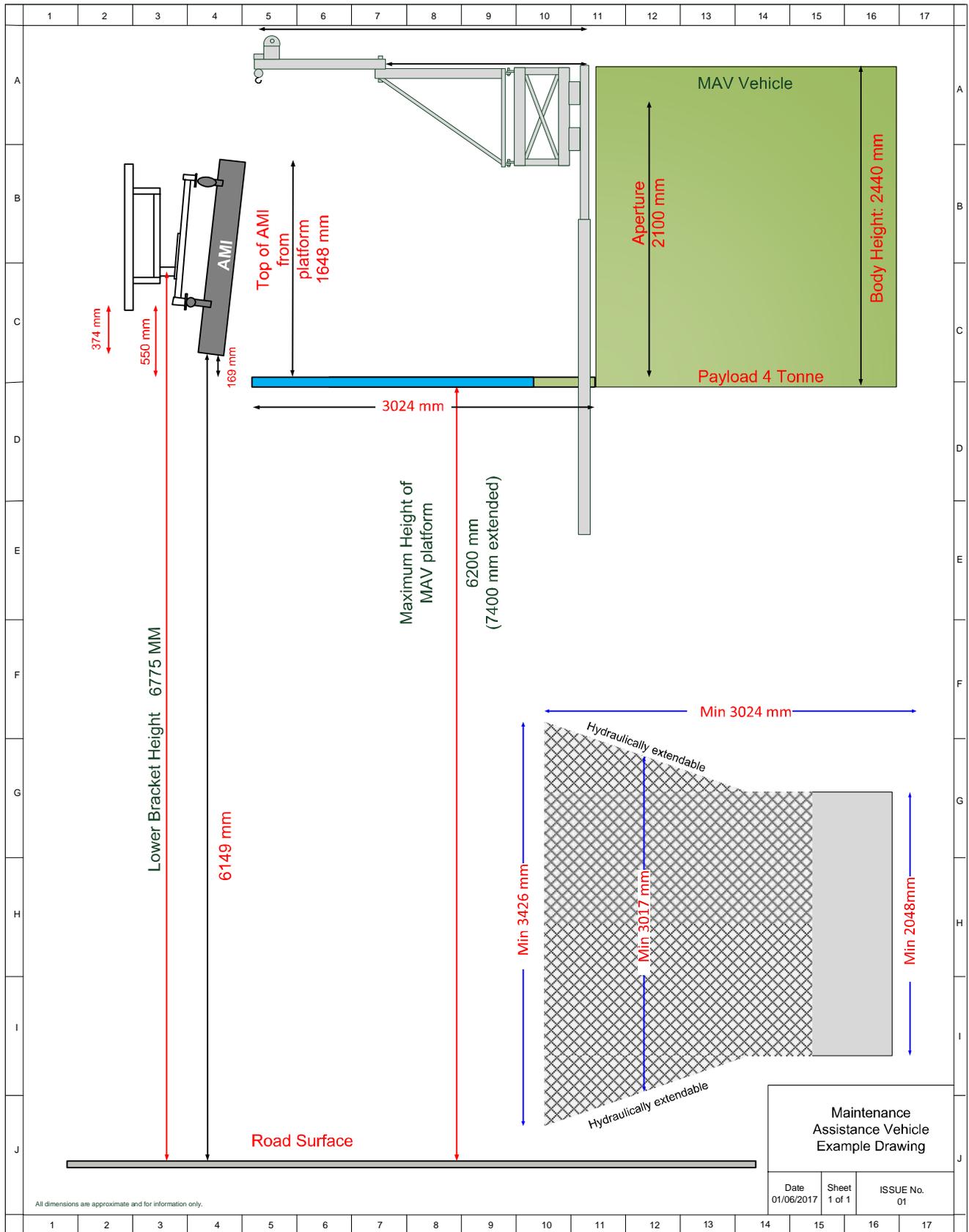
Examples Annex A

A.1 EXAMPLE DESIGN IDEAS

A.1.1 EXAMPLE (EXTERNAL) VEHICLE DESIGN:







A.1.2 EXAMPLE INTERNAL VEHICLE DESIGN:



A.1.3 EXAMPLE EXTERNAL VEHICLE DESIGN:



A.1.4 EXAMPLES OF TAIL LIFT GUARDS:



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M:740.1	8	M:920.1	10	M:1150	14
M:750	8	M:920.2	10	M:1160	14
M:750.1	8	M:920.3	10	M:1170	14
M:750.2	8	M:930	11	M:1180	14
M:760	8	M:940	11	M:1190	14
M:770	8	M:950	11	M:1200	14
M:770.1	9	M:950.1	11	M:1210	14
M:780	9	M:960	11	M:1220	14

Desirable Requirements

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D:310	7	D:340	11	D:370	14
D:320	9	D:350	14		
D:330	11	D:360	14		

Information Statements

Req No	Page No	Req No	Page No	Req No	Page No
I:10	6	I:50.2	8	I:70	9
I:10.1	6	I:50.3	8	I:80	10
I:20	6	I:50.4	8	I:90	11
I:30	6	I:50.5	8	I:100	12
I:40	7	I:50.6	8	I:110	13
I:50	8	I:60	9		
I:50.1	8	I:60.1	9		

END OF SPECIFICATION