

IMechE FS-AI ADS-DV Vehicle Loan Requirements and Info

Event Year 2023

This document outlines the responsibilities of a Team or Organisation borrowing on loan an IMechE FS-AI ADS-DV for development and testing associated with the Formula Student AI competition.

Version	Date	Changes
0.0	2022-11-22	Information copied into new document for Event Year 2023.
1.0	2022-12-04	First release.

Organisational Requirements

A response to these Organisational Requirements must be communicated in writing to the IMechE Formula Student Office before an ADS-DV loan can be approved. There is no specific format for this document, but the document must be signed by a representative of the Team / Organisation and witnessed & countersigned by the team's Faculty Adviser. A new response document will be required for each competition year.

Requirements List:

1. Team / Organisation to declare what 'entity' they are (e.g. University Faculty, independent student organisation, etc.) and provide full contact details for liaison purposes.
2. Organising Entity to declare that they have 3rd party liability insurance (people and property) that would cover any injury or property damage caused during storage, transport or operation of the ADS-DV and any Inventory items (e.g. handling equipment or the charger).
 - Ideally a copy of the Insurance Certificate should be provided.

3. Organising Entity to confirm / clarify that personnel involved with the development and testing of the ADS-DV are considered 3rd parties and are covered by the above.
4. Organising Entity to assume all liability for loss of the vehicle and provided inventory (see below) while in their care, to Fire, Flood or Theft at full replacement value. The replacement value of the ADS-DV and inventory is considered to be £99,000.

Whether this is insurance based or independently under-written is at the discretion of the Organising Entity. Please inform the IMechE Formula Student Office accordingly.

5. Organising Entity to assume all liability for repair / replacement of any parts of the vehicle or inventory damaged during static or dynamic operation of the vehicle while in their care.

Whether this is insurance based or independently under-written is at the discretion of the Organising Entity. Please inform the IMechE Formula Student Office accordingly.

6. Organising Entity to provide a copy for approval of any Risk Assessments or other documentation required by the Organising Entity's internal Health & Safety policies.

If none required internally, the IMechE will still require a document outlining the proposed ADS-DV operation plan for review & approval.

7. Autonomous System Responsible personnel (ASR) must be designated and approved (according to the rules on the IMechE Formula Student website) before an ADS-DV can be loaned to an Organising Entity. Note that new ASR applications **MUST** be made for every competition year. ASRs should be identified in the signed response document.
8. Organising Entity to confirm that all personnel will be provided with a copy of the ADS-DV Operating Manual (available on the IMechE Formula Student website) and be familiar with its content and requirements.

This document does not duplicate the content of the ADS-DV Operating Manual.

Inventory

The following is an Inventory of the ADS-DV and equipment & accessories provided when an ADS-DV is loaned to an Organising Entity:

1. ADS-DV vehicle fitted with:
 - InCarPC.
 - USB hub.
 - ZED Stereo Camera.
 - GEMS DA3 Datalogger and memory card.
 - Wiring harnesses & cables for the above.

The above listed items must not be removed from the ADS-DV without prior approval from IMechE Formula Student AI Technical Support.

2. Plastic crate including:
 - Main battery charger & leads.
 - Grossfunk RES with 2x batteries.
 - Grossfunk battery charger & wall plug.
 - Joystick & joystick cable.
 - MPP dongle.
 - GEMS memory card reader.
3. Quick-Lift jack.
4. Pair of 'skateboard' trolleys.
5. Set of 4x black plastic ramps.
6. Documentation wallet containing operating procedures and check-sheets.

In the event of loss or damage to any of the Inventory the Organising Entity must inform the IMechE Formula Student Office and IMechE Formula Student AI Technical Support.

Booking Loan of an ADS-DV

Please contact the IMechE Formula Student Office to request loan of an ADS-DV and for further information on the precise details of the loan offer.

In general, the following protocol will be applied:

1. ADS-DV loans will be offered equally to all UK mainland Teams registered for the FS-AI DDT class for Formula Student 2022. It is not feasible to transport the ADS-DVs out of the UK.
2. Organising Entities will be responsible for all costs and administration associated with ADS-DV transportation.
3. ADS-DV loans will for a minimum of 2 weeks. Should there be no Team requesting an ADS-DV at the end of an agreed 2-week period, extra time will be offered to the Team that has the vehicle.
4. The initial period of ADS-DV loans will run from January 2023 to end May 2023. During June and July 2023 the ADS-DVs will be required for IMechE organised group tests and the Silverstone event.
5. Priority access during July will be given to international Teams travelling to the UK for the Silverstone event.
6. Where possible, ADS-DV transportation will be co-ordinated between Teams such that each Team either collects or delivers a vehicle from / to another Team. However, it may prove necessary for a Team to arrange both collection and delivery of a vehicle from / to a storage facility at either MIRA (Nuneaton), Silverstone, Oxford or Banbury.

Transportation and Handling

Handling & Lifting

Note that the ground clearance of the ADS-DV is low and plastic ramps have been provided to allow smooth transitions over steps, lips, kerbs etc.

The ADS-DV must only be lifted using the Quick Lift jack on the underside of the chassis, or the wheels. The bodywork, including the nosecone, or the suspension, must not be used for lifting. If lifted using the wheels, safe handling & lifting practices must be employed under the supervision of competent and trained personnel.

The ADS-DV weighs 300kg which means each wheel carries 75kg. Thus, a single person at each wheel is considered insufficient to lift the ADS-DV safely.

Transportation (General)

The ADS-DV and Inventory must be transported inside a locked van, covered & locked car carrier or by covered & locked trailer.

At all times during transport the ADS-DV must be securely tied down using at least 4 straps preventing longitudinal, lateral and twisting motion of the vehicle. The straps must attach to the ADS-DV wheels and not the suspension or bodywork.

At all times during transport the Inventory must be secured such that it cannot slide around and sustain damage, or impact the ADS-DV in any way.

Transport by Covered and Locked Car Carrier or Trailer:

This transport method is preferred as the lowest risk and most convenient. No special procedures apply unless the carrier / trailer requires ramps to load the ADS-DV, in which case please refer to the section below 'Transport in a van without a tail-lift'.

Transport in a 'Luton' van with a tail-lift:

The ADS-DV loading procedure using a tail-lift must be approved by IMechE Formula Student AI Technical Support. In particular the handling of the vehicle on and off the tail-lift to avoid any risk of the ADS-DV falling. Dollies may be required to rotate the ADS-DV 90 degrees when loading.

One advantage of 'Luton' style vans with tail-lifts is that the width of the van is generally sufficient for the ADS-DV without issue. The minimum width to accept an ADS-DV is 1500mm. However, the size and load capacity of tail-lifts varies from van to van and must be confirmed to be adequate.

Transport in a van without a tail-lift:

The van interior dimensions and loading procedure using separate ramps must be approved by IMechE Formula Student AI Technical Support. In particular, the handling of the vehicle on and off the ramps to avoid any risk of the ADS-DV falling.

Note that most easily available vans are NOT wide enough to accept the ADS-DV between the wheel arches. The minimum width between wheel arches to accept an ADS-DV is 1500mm.

Unattended Storage and Access

Access to the ADS-DV must be controlled by the Organising Entity to minimise any risks to uninvolved personnel.

1. The ADS-DV may only be accessed by authorised personnel who have been briefed on the ADS-DV and read the Operation Manual.
2. The ADS-DV must be stored in a secure and locked area when unattended. CCTV is recommended, please advise the IMechE Formula Student Office whether or not CCTV is in place.

Preparation for Storage

The ADS-DV should be prepared for storage as follows:

1. Confirm that the minimum cell voltage of the 48V battery is at least 3.2V, if required re-charge the 48V battery before storing the vehicle.
2. Lift the ADS-DV with the Quick-Lift jack and place onto the 'skateboard' trolleys, so all 4 wheels are in the air.
3. Discharge the hydraulic brakes according to the Operation Manual section 10 until the wheels are free to turn. This minimises the retained pressure in the brake lines and calipers to avoid any leakage.
4. Confirm that all Red keys are removed and safely stored along with the MPP dongle in the plastic Inventory crate.

5. Confirm the black AI Master Switch is rotated anti-clockwise to isolate any drain on the 12V battery.

Note that during storage the brake lines remain locked-off by a normally closed valve. Thus, a variation in temperature or ambient pressure may result in the wheels re-locking. If this occurs the residual brake line pressure is still very low compared to the deployed EBS pressure.

Should the ADS-DV need to be stored for a period longer than 14 days, please contact IMechE Formula Student AI Technical Support for information on an inspection / service schedule.

Management of the 12V Battery

The 12V battery fitted to the ADS-DV is of a very low capacity and is not intended to supply current except to allow the vehicle to start up and energise the internal DC / DC converter.

However, to ensure the AI system remains powered during power-cycles & resets of the ADS-DV, loads supplied via the black AI Master Switch (AIMS) are connected direct to the 12V battery.

This means that if the AIMS is switch 'On' (clockwise), with the ADS-DV Low Voltage Master Switch (LVMS) switched 'Off', there is a significant risk the 12V battery will be fully discharged. If this happens the ADS-DV will no longer start up.

It is important that the ASR responsible for the vehicle is aware of this issue and takes steps to ensure it does not occur.

Do not leave the ADS-DV powered down (Low Voltage Master Switch 'Off') with the AI Master Switch 'On' (clockwise) for more than 30s.

Should the 12V battery become so discharged the vehicle will not start up, a recovery procedure may be required, this is documented separately and will be provided if required.

Note that if the 12V battery is repeatedly run flat and recovered, it will sustain damage and loss of capacity, and may need replacement. This cost will need to be met by the Organising Entity.

Mechanical Checks & Faults

The Organising Entity must conduct basic maintenance checks on the ADS-DV on the following schedule:

1. After transportation, before Dynamic Operation.
2. After the ADS-DV has been left unattended, before Static Operation.
3. Weekly (if neither of the above precede it).

These basic checks must be performed (or supervised) by competent, trained or experienced personnel such as mechanical workshop technicians, automotive technicians or other engineering trained personnel:

1. Visual check of brake lines and wheel speed wiring for damage.
2. Visual check for brake fluid leakage.
3. Check of all visible chassis, suspension, steering and brake fasteners for tightness.
4. Tightness check of all Wheel Nuts.

5. Move steering from lock to lock and check driveshafts and steering are free from binding and all components are free from play and secure.
6. Rotate wheels on stands and listen for any indication of motor, bearing or belt drive issues.
7. Inspection of 'skateboard' trolleys for loose nuts & bolts or damage.
8. Inspection of Quick-Lift jack for loose nuts & bolts or damage.

Any issues encountered must be communicated to IMechE Formula Student AI Technical Support for advice before the ADS-DV may be operated.

A Mechanical Checks log sheet will be provided which must be kept with the ADS-DV and filled in by the checking personnel.

The following components should not be removed and / or refitted without consultation with IMechE Formula Student AI Technical Support:

1. Wheels & Wheel Nuts.
2. Middle bodywork section ('Sharks Fin').
3. Nosecone.

It is especially important that the wheels are refitted according to the correct procedure if removed. Improper fitment has caused damage in the past to Wheel Nuts and Wheels.

ADS-DV Operations

To ensure safety during ADS-DV operations the following rules must be followed:

Static Operation

When in a workshop, other enclosed space or anywhere not specifically designated a dynamic area, the ADS-DV may only be used in the Static Operation mode.

Static Operations must be conducted as follows:

1. There must be a Safe Area for general personnel (at least 5m away from the ADS-DV).
2. There must always be an ASR present to operate the vehicle with the RES.
3. The ADS-DV must be lifted onto stands (wheels in the air) at all times.
4. The stands used must conform to the following requirements:
 - At least 90mm clearance below the wheels.
 - At least 100mm clearance to the front wheels when on full steering lock.
 - At least 800mm x 400mm spread of support under the chassis to avoid rocking / tipping.
 - The 'skateboard' trolleys provided in the Inventory are considered suitable for Static Operation if used on a firm and level surface.
 - **The Quick-Lift jack provided in the Inventory is NOT suitable for Static Operation and must only be used to lift the ADS-DV on and off the 'skateboard' trolleys.**
5. The ASR must only be responsible for the mission selection and the RES – they must not perform any other duties when the ADS-DV is active.

6. No other person than the ASR is allowed closer than 5m (outside the Safe Area) to the ADS-DV while it is active. Test operations should be conducted remotely using a wired or wireless communications link to the ADS-DV.
7. Any cables and wires must be kept clear of the rotating and / or steering wheels of the ADS-DV.

Dynamic Operation

Dynamic Operations of the ADS-DV are only permitted within a designated dynamic area.

Dynamic Operations must be conducted according to the same safety principles as the Formula Student Dynamic Events:

1. There must be a Safe Area for general personnel (e.g. behind a wall).
2. There must always be an ASR present to operate the vehicle with the RES.
3. Any work on the ADS-DV in the Safe Area must take place according to the same rules as the Static Operations listed above (wheels in the air).
4. The ADS-DV must enter and exit the designated dynamic area on the supplied 'skateboard' trolleys.
5. The ASR must only be responsible for the mission selection and the RES – they must not perform any other duties when the ADS-DV is active.
6. Only one other person in addition to the ASR is allowed 'over the wall' (outside the Safe Area) to perform any other duties relating to the ADS-DV.
7. No tethered systems to the vehicle are allowed – wireless connections only (excepting the push-bar joystick).
8. Prior to selecting a Mission and Activating the RES 'Go' signal the GEMS DA3 datalogger card must be inserted and confirmed to be logging (two Green lights) – this will require downloading the data to a PC between runs to ensure free storage space is always available.

To approve a designated dynamic area(s), please indicate the size, shape and location (a marked up Google map image is good) and submit to the IMechE Formula Student Office AND the IMechE Formula Student AI Technical Support.

Designated dynamic areas will require the marking out of a 'safe run off' area which if the vehicle enters the ASR MUST activate the RES immediately.

Designated dynamic areas may be approved for 'damp track operation' if requested, which may be subject to different 'safe run off' areas than dry track operation.

A Dynamic Operations log sheet will be provided which must be kept with the ADS-DV and filled in by the ASR.

Operational Limits

If the designated dynamic area requires it, the IMechE will specify hard-coded Operational Limits to be placed on the vehicle performance. For example, maximum speed, maximum torque (acceleration) or maximum steering angle (for narrow areas).

If Operational Limits are required, the ASR will be responsible for loading and confirming these hard-coded limits.

Some designated dynamic areas will require operational limits for 'damp track operation' only.

Wet Weather Operation

The ADS-DV is not 100% waterproof especially the InCarPC. Also, slick tyres are fitted. Therefore, operation in wet weather is only permissible according to the following conditions:

1. Dynamic area must be approved for 'damp track operation' and if necessary, the appropriate Operational Limits must be applied (the ASR is responsible for this).
2. No active rain must be falling.
3. No standing water or puddles must be present.
4. The ADS-DV must be dried down if it gets significantly wet and WD40 applied by cloth to exposed metallic areas to prevent corrosion. EXCEPT the brake discs and pads.
5. The InCarPC must be regularly inspected for water. If any water is present on or around the InCarPC the operation must be stopped until conditions dry out.

Plastic sheeting may be applied to keep the InCarPC dry. This must be transparent so that any water that does reach the InCarPC can be observed, and corrective action taken.

It is not permitted to operate the ADS-DV in ice or snow conditions.

Airports & RF Interference

The ADS-DV Remote Emergency Stop (RES) operates on a frequency range of 430 to 440MHz. It has been observed previously that operation of the RES may be affected by RF systems present at airports.

If an airport is to be designated as a dynamic area, the airport should be informed that the RES radiates in this frequency band and must indicate approval.

If the ADS-DV fails to operate correctly, or spurious RES activation is observed, when in the presence of RF systems, please inform IMechE Formula Student AI Technical Support.

Support Contacts

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