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For those who dare to disturb the universe.

CHALLENGE DELIVERABLES

DRIVERLESS CAR CHALLENGE

OCTOBER 2014

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Rise Prize – Driverless Car Challenge

Technical Evaluation Criteria

1. SCOPE

This document provides information on the capabilities of the Driverless car to be demonstrated in Stages 1 and 2 of the Rise Prize - Driverless Car Challenge ("Challenge" hereafter), namely the Working Prototype and Full Solution Visibility stages. The information in this document is to be read with the evaluation criteria listed in the Challenge document.

2. TEST LEVELS

The capabilities to be demonstrated are organised into four Levels, with each Level progressively requiring more complex vehicle behaviour. Level 0 is applicable to Stage 1 (Prototype Phase) of the Challenge and the other three levels are applicable to Stage 2 (Full Solution Visibility Phase).

Within each Level, each "**test**" is classified as either "**Mandatory**" or "**Optional**". The vehicle under test (VUT) has to perform successfully in all the Mandatory Tests in that Level to qualify for the next Level/Stage. In addition, the vehicle has to clear 60% of the Optional Tests to qualify for the next Level. In Level 0, teams are given **a maximum of two chances** to clear the level. Each such chance will constitute the full range of tests.

The tests describe acceptable behaviour required for qualification. However, in case they are not mentioned, Rules of the Road Regulation 1989 will apply for the respective tests. Unless otherwise mentioned, all measurements will have a tolerance band of ±10%. In case of any dispute arising out of measurements, subjectivity or any other matter of judgement, the verdict of the jury will be considered final and binding.

3. TEST & CONTROL PROVISIONS TO THE VEHICLES

A. Real Time Data Logger

All participating teams ("Teams" hereafter) will have to make provisions for transmitting real time data of the VUT computer to an on-board data logger with a provision for downloading stored data offline as well as 3G or faster mobile communication so that the VUT's responses to various stimuli such as obstacles, traffic signals etc. can be assessed by the jury at the end of the tests. The data logger should be able to record and transmit the VUT's time, location, speed, brake position, gear position, steering angle and motor RPM (of e2o), at all points in addition to object/ signal recognition time, systems actuation time on a second by second basis. A 3G capable telematics unit in the car is highly recommended for this which should connect to a remote server and transmit monitored parameters at a predefined periodicity and format. It should also be capable of receiving control signals from the server and forward the same to the VUT's main on-board computer. The minimum data sampling rate shall be communicated separately.

The Data Logger must have sufficient built-in flash memory to record the following:

a) Vehicle data for the last 6 hours of driving. It must be possible to download this data from an SD card or USB port on the Data Logger post a test.
b.) Front and rear camera video, LIDAR and other sensor streams for at least 3 hours.

It is highly recommended that in addition to the above, the Data Logger is also able to record into the built-in flash memory (or in a SD card in the Data Logger), image streams from any other video cameras in the car and other sensor and actuator inputs and outputs in the vehicle. This will help the teams and the jury assess vehicle behaviour even better.

B. Emergency Stop

Teams will have to make provisions for an "Emergency Stop" that can be activated from outside the vehicle at a safe distance. The purpose of this feature is to stop the VUT and/or completely shut down the VUT if it goes out of control or behaves dangerously during the tests. The same Emergency Stop can be used to start the engine from a distance whenever required. The range for the Emergency Stop has to be a minimum of 500 metres. Additionally, it must be possible to activate the Emergency Stop through the server and telematics unit in the vehicle.

C. Trip Plan File

Teams will have to make provisions for uploading a Trip Plan File (TPF) to the vehicle computer on a USB 2.0 flash drive. The vehicle and software system must be configured to enable automatic pre-processing of data without the need for human inspection of the data. The flash drive will be removed from the vehicle after the upload. The format of the TPF will be communicated at a later date.

4. LEVEL 0: STAGE 1 PROTOTYPE TEST REQUIREMENTS

Working prototype tests will be carried out in the Mahindra nominated sites. Teams will be communicated about the date and location of the test, one month in advance, within the time frame outlined in the Challenge document. The speed limit for the VUT for the tests in Level 0 is 20 kmph.

A. Loading the TPF

The TPF will be uploaded to the vehicle computer on a USB 2.0 flash drive and then removed. The TPF provides a series of path points defined by their latitude and longitude. The specific path between path points will not be provided. The performance will be considered successful if the VUT starts moving towards the first path point, no later than 5 minutes from the time of TPF upload **(Mandatory)**

B. Range and Time to Emergency Stop

The VUT will be given a command to "Stop" and "Start" from a distance of 500 m, anytime during the course of run. The performance will be considered successful if the VUT responds to the Start and Stop signals within 1 second of the command. **(Mandatory)**

C. Moving through the Path Points to the End Location

The VUT has to move to the last path point through all the path points indicated in the TPF. Covering all path points along the way will qualify as success. **(Mandatory)**

D. Stopping on reaching the End Location

Upon reaching the end location, the car should come to a standstill within 1 metre of a spot marked "Stop". Stopping at the end location within 1 metre will be deemed a success. Post stopping, the VUT must securely park itself including application of parking brakes, ensure the e2o is 'off', and the VUT in 'P' position in e2o. **(Mandatory)**

E. Lane Driving

Teams will be provided with a stretch of 500 m with proper lane markings. The VUT will have to remain within the lane at all times in that stretch. The stretch may have light bends which the VUT will have to negotiate. Wheels over the lane markings or straddling lanes will be declared unsuccessful. **(Mandatory)**

F. Reading Basic Traffic Signals

This test is designed to evaluate the VUT's ability to read basic traffic signals. The signals will be placed on the top of the road near an intersection.

i. Stopping Time and Distance at a Red light

The VUT should be able to stop at a Red signal. The signal will turn red at approximately 20 metres or more from the VUT. The VUT is expected to stop within 7 metres of the signal, at/before the 'Stop Line' drawn across the road. The front edge of the VUT must NOT cross the 'Stop Line' at the Red light nor must it be more than 2 metres behind the 'Stop Line'. The data logger should record the time lag and distance travelled between the turning on of the Red light signal and the activation of brakes. **(Mandatory)**

ii. Starting Time at a Green light

The VUT should start moving forward when the signal turns green within a time lag of 2 sec. **(Mandatory)**

iii. Turning at Left and Right Signals

The VUT should take a left or a right turn, along with blinking indicator lights, according to the signal given at a cross-road. This will be achieved by either switching the indicator on at least 10 seconds prior to reaching the turn when the VUT is in motion or switching the indicator on when the VUT is at rest. In the latter case, the VUT is expected to start moving within 2 seconds of turning the indicator signal on. **(Mandatory)**

G. Speed Tests

i. Straight stretches without obstacles

The VUT is expected to drive at a speed not greater than 20 kmph in the straight stretches where there are no obstacles. Any object on the clear pathway of the VUT measuring more than 15 cms in height (from the road surface) and 30 cms (perpendicular to the road length, in the same plane) in length will be qualify as an obstacle for the purpose of this document. **(Mandatory)**

ii. Around corners

The VUT is expected to slow down while turning a corner. During any such turn, turning on the appropriate indicator signal is mandatory. **(Mandatory)**

iii. Negotiating speed bumps

The vehicle is expected to slow down significantly at a speed bump painted with white stripes. **(Mandatory)**

H. Identification of Static Obstacle

i. Distance

The VUT should be able to identify a static obstacle on the road at least 10 seconds or at a minimum distance of 30 metres ahead (whichever is earlier) and start taking appropriate steps to negotiate it. The data logger should identify the distance at which the VUT has taken cognisance of the obstacle and started taking appropriate steps. **(Mandatory)**

ii. Behaviour

The VUT should be able to take appropriate steps upon identifying an obstacle. If the obstacle is small (leaving more than one vehicle width of pathway unhindered), the VUT should get around it; if a bigger obstacle, covering most of legal pathways leaving less than a vehicle width open is present, the VUT should stop. **(Mandatory)**

I. Simple Collision Avoidance

The VUT should avoid any collision whatsoever at all times, whether with a stationary or a moving obstacle. At this level, oncoming traffic will not be present. **(Mandatory)**

5. LEVEL 1: STAGE 2 TEST REQUIREMENTS - BASIC LEVEL

Full Solution tests will be carried out in a **Mahindra nominated site**. The intimation of a time slot for this will be communicated to the teams two months in advance, along with the complete details of test track. The VUTs will have to check into the track a few days in advance. The test specifications given below subsume the ones specified in Level 0. Therefore, vehicle behaviour in Level 1 will have to adhere to all the specifications in Level 0 if not otherwise specified. All tests here are mandatory, as defined in paragraph 2. However, the minimum qualification criteria will be communicated at a later update, closer to the day of the tests. Like in Level 0, a TPF file will be uploaded to each VUT and it is expected to start within 5 minutes of the upload. Additionally a Route Network File (RNF) will be provided to the teams whereby all legal routes (paved or otherwise) will be given. Multiple VUTs will be tested simultaneously in this Level.

A. Adhering to the Maximum and Minimum Speed Limit

Maximum speed limit will be 30 kmph. A tolerance of ± 10% will be provided for errors for the said limits. Minimum speed limits will not apply for parking areas. A list of legal road signs are given in Annexure-I for reference. **(Mandatory)**

B. Excess delay on route

VUTs should not exhibit excessive "stop and stare" delays beyond 30 seconds. Adhering to this will allow other vehicles to move around without disrupting the smooth flow of traffic. **(Mandatory)**

C. Stopping at intersection

VUTs should look for traffic signals at an intersection. If the traffic sign is not visible, the VUT must stop and monitor the traffic at the intersection having turned on its hazard lights at least 5 seconds prior to reaching the intersection. Only when the VUT perceives clear road ahead, should it then move forward. The hazard lights must be turned off within 2 seconds of moving forward. **(Mandatory)**

D. Vehicle distance

At all times, VUTs are required to maintain a minimum forward vehicle distance of 1 vehicle length for every 15 kmph of speed. For intersection areas, from 30

metres to the intersection and the parking areas, the minimum forward vehicle distance is 2 metres

Sideways and rear distance from all obstacles and vehicles are to be minimum 1.5 metres unless otherwise specified. **(Mandatory)**

E. Overtaking manoeuvre

A VUT can overtake another vehicle by first, validating it is safe to make such a manoeuvre (no oncoming vehicles, no vehicles overtaking or about to overtake the VUT at the same time, proper road on the right of the vehicle, clear visibility ahead (no blind turns coming up), and the road signages do not bar overtaking – either a signpost or a double line on the centre of the road could bar overtaking), turning on the appropriate indicator signal and only then shifting to the next lane by keeping 1 vehicle length distance at minimum. After complete shift, the VUT can accelerate and overtake the said vehicle. Only after maintaining a minimum rear distance of 3 vehicle lengths with the other vehicles can it return to its original lane. **(Mandatory)**

F. U turn manoeuvre

A VUT may take a U turn on a 9 metre wide road within a 30 metre road length from the start of the U turn manoeuvre. While taking the U turn the VUT must stop to complete rest on the divider line to allow oncoming traffic pass. Vehicle distance rules and collision avoidance will apply all times while doing so. If there is an explicit 'No U Turn' sign posted on the road, even if the Route Network File indicates making a U-Turn, the VUT must heed the signage and not make the U-Turn. **(Mandatory)**

G. Precedence at Roundabouts

While negotiating a roundabout the VUT must give precedence to the vehicles that are already in the roundabout (i.e. on its right hand side). Vehicle distance rules and collision avoidance will apply all times while doing so. **(Mandatory)**

H. Driving on an inclined plane

i. Stop and go behaviour on the upward slope

On an upward slope, vehicle behaviour of stopping at a red signal will be monitored. The time to stop and the distance accuracy from the red signal will be monitored in the same way as paragraph 4.F.1 of this document.

Upon the signal turning green, the vehicle behaviour will be measured as in paragraph 4.F.2. Additionally, there should not be any backward movement of the VUT more than 45 cms during start of motion. **(Mandatory)**

ii. Stop, go and Speed control on the downward slope

On a downward slope, vehicle behaviour of stopping at a red signal will be monitored. The time to stop and the distance accuracy from the red signal will be monitored in the same way as paragraph 4.F.1 of this document. Additionally, the VUT should not move forward after it stops upon the signal turning red. Upon the signal turning green, the vehicle behaviour will be measured as in paragraph 4.F.2. Additionally, the speed of the vehicle in a downward slope should not exceed 20 kmph at any instant. **(Mandatory)**

I. Identification of Moving Obstacle

i. Distance

The VUT should be able to identify a moving obstacle at a minimum distance of 30 metres ahead and start taking appropriate steps to negotiate it. The data logger should identify the distance at which the VUT has taken cognisance of the obstacle and started taking appropriate steps. **(Mandatory)**

ii. Behaviour

The VUT should be able to take appropriate steps upon identifying a moving obstacle. If it is a smaller obstacle, the VUT should get around it. If it is a bigger obstacle covering most of legal pathways leaving less than a vehicle width open, the VUT should stop. **(Mandatory)**

J. Creep and Crawl

Test the ability of the car to move forward in a stop-and-go traffic environment at not more than 10 kmph. There will be other vehicles (2 and 4 wheelers) in the front, rear, sides of the vehicle-under-test (VUT). The vehicle in front will move forward in a stop-and-go fashion. The VUT must follow the vehicle in front, which may be a 2 or a 4 wheeler, maintain safe distance from the vehicle in front, detect vehicles (2-wheelers) passing it on either side and less than 30 cms from the VUT and ensure no contact with any vehicle at all times. This test will be carried out over a 50 m straight road. **(Mandatory)**

6. LEVEL 2: STAGE 2 TEST REQUIREMENTS - INTERMEDIATE LEVEL

Upon successful completion of Level 1, teams move to Level 2, which will commence after a day from Level 1. This Level has a mix of Optional and Mandatory Tests. Clearing all Mandatory Tests are essential to qualify for the next round; clearing the Optional Tests will fetch the teams' bonus points. Additionally, certain behaviours in the Mandatory Tests will attract bonus or negative points, as discussed separately for each test. Like in Level 1, a TPF file will be uploaded to each VUT and the VUT is expected to start within 5 minutes of the upload. A Route Network File (RNF) will be provided to the teams whereby all legal routes (paved or otherwise) will be provided. All the VUTs will be tested simultaneously.

A. Unstructured Obstacle Avoidance

A maze of unstructured obstacles will be provided in a section of the track, while keeping a gap of little more than a vehicle width to go forward. The VUT will have to avoid the obstacles and go forward within the gap without hitting any obstacle **(Mandatory)**

B. Parking Behaviour

VUT is to be parked at the End location (last Path point) of the TPF. Parking on an incline is the optional mode in this test and all other modes are mandatory.

i. Parallel parking

The VUT should be able to park itself upon reaching the end location on the TPF. The VUT has to locate the parking spot and do a parallel parking along the kerb side. Parking without collision will be marked a success. Keeping at –most 40 cm distance to the kerb and at least 75 cm distance to the next vehicle both to the front and rear will fetch bonus points. Completing the parking in a single manoeuvre (stop-reverse-stop-forward-stop) will fetch bonus points. A tolerance of ± 10% will apply to all dimensions. **(Mandatory)**

ii. Angle parking

The VUT should be able to park itself upon reaching the end location on the TPF. The VUT has to locate the parking spot and park at an angle of 45° to the kerb side. Parking without collision will be marked a success. Keeping at most 40 cm distance to the kerb from the front and at least 50 cm

distance to the next vehicle on both sides will fetch bonus points. A tolerance of ± 10% will apply to all dimensions. **(Mandatory)**

iii. Perpendicular parking

The VUT should be able to park itself on reaching the end location on the TPF. The VUT has to locate the parking spot and do an angle parking at an angle of 90° to the kerb side with the VUT boot facing the kerb. Parking without collision with the kerb and vehicles on either side while being within the parking lot boundary drawn will be marked a success. Keeping at most 40 cm distance to the kerb from the front and at least 50 cm distance to the next vehicle on both sides will fetch bonus points. Tolerance of ± 10% will apply to all dimensions. **(Mandatory)**

iv. Parking on an incline

The VUT should be able to park itself upon reaching the end location on the TPF. The VUT has to locate the parking spot on the inclined plane provided and do an angle parking at an angle of 45° to the kerb side. Parking without collision will be marked a success. Keeping at most 40 cm distance to the kerb from the front and at least 50 cm distance to the next vehicle on both sides will fetch bonus points. A tolerance of ± 10% will apply to all dimensions. **(Optional)**

C. Route Re-planning

In case a specific route is blocked, it will not be shown on the RNF. The VUTs are expected to take a legal U turn and then explore alternate options of reaching the next path point. An alternate route will always be provided in such circumstances. The VUTs should not attempt to leave the road to bypass the roadblock, but instead plan an alternate route based on RNF given. **(Optional)**

D. Merging into traffic

i. Parallel to the Flow

The VUT should merge with the alongside traffic at an angle when either:

a. The distance between the rear end of the VUT and the oncoming vehicle is at least 100 m
(OR)

b. The time for the oncoming vehicle to reach the point of entry is 8 seconds.

After merging, the VUT should be able to maintain a vehicle distance mentioned earlier in the document. Excessive delay in affecting the merge will attract negative points. **(Mandatory)**

ii. U turn

The VUT must take a U turn if the oncoming vehicle is at least 10 seconds from the point of the said turn. VUTs should then able to accelerate and come up to speed rapidly with the rest of the traffic flow. Excessive delay in affecting the turn will attract negative points. **(Mandatory)**

iii. Taking a Right Turn at Intersection

The VUT must take a right turn at intersection, in the absence of a signal and if the oncoming vehicle is 10 seconds from the point of the said turn. This is to ensure safe traffic conditions and to avoid excessive delay. Excessive delay in taking the turn will attract negative points. **(Mandatory)**

E. Collision avoidance

i. Stationary

The VUT must avoid a stationary obstacle on the road by either moving to the parallel legal lane if there is space to do so (Merging rules will apply). Or else, the VUT should slow down (even to stop) until space is available in the parallel lanes. If the VUT has a lane available to move around the obstacle, the turn signal indication must be 'on'. If no clear path is available, the VUT must stop with hazard lights on. The obstacle recognition distance will be monitored from the data logger and early detection and action will fetch bonus points. However, should the VUT stop, it should be done in a smooth manner, without skidding, to avoid any collision with the traffic behind it. A safe behaviour in this respect will fetch bonus points. **(Mandatory)**

ii. Crossing

The VUT must stop completely to a crossing object on the road by slowing steadily. Once the object has passed, the VUT must start within 5 seconds. The obstacle recognition distance will be monitored from the data logger and early detection and action will fetch bonus points. The vehicle halt should

be smooth, without skidding, to avoid any collision with the traffic behind. A safe behaviour in this respect will fetch bonus points. **(Mandatory)**

iii. Items falling off a vehicle

The VUT must stop completely, in response to obstacles falling on the road from a vehicle ahead of it, by slowing steadily. After this, the VUT can start by avoiding the obstacles by shifting into a parallel legal lane or in the in between spaces. At all times the VUT has to minimise inconvenience/avoid traffic from behind, as mentioned in earlier tests. The obstacle recognition distance will be monitored from the data logger and early detection and action will fetch bonus points. The vehicle halt should be done in a smooth manner, without skidding, to avoid any collision with the traffic behind it. A safe behaviour in this respect will fetch bonus points. **(Mandatory)**

7. LEVEL 3: STAGE 2 TEST REQUIREMENTS - INDIAN CONDITIONS

Upon successful completion of Level 2, teams move to Level 3. The Level 3 tests will commence a day after Level 2 tests are completed. All tests in this level are optional. Certain behaviours, as described in the tests below, will attract bonus or negative points. Like in all previous levels, a TPF will be loaded on to the VUT computer corresponding to the team's choice of tests. These tests will be done one VUT at a time unlike Level 1 & 2.

Teams are required to demonstrate performance in at least 4 out of the 8 tests below to get into contention for the Prize.

A. Trailing or avoiding a truck with protruding rods

The VUT must detect and avoid a truck ahead of it carrying protruding rods in an unsafe way. The VUT must detect the nearest point of the protruding rods and take appropriate steps to avoid it in the way described earlier in section 6.E **(Optional)**

B. Identifying and slowing down to a shallow ditch or unmarked bumps

The VUT is expected to slow down to a speed between 5-15 kmph at a shallow ditch up to 15 cm. Any ditch more than 15 cm should be treated as an obstacle. An early detection (30 metres or more from the ditch) of the ditch will fetch bonus points.

The VUT is expected to slow down to a speed between 5-15 kmph at a speed bump with a height of 30 cm or more. An early detection (30 metres or more from the bump) of the bump will fetch bonus points. **(Optional)**

C. Navigating through a Multi-modal situation

The VUT should detect all the multiple modes of transport on the road as moving objects and should negotiate the situation as outlined in section 6.E. **(Optional)**

D. Behaviour upon blowing horns from behind

The VUT should respond to horns from a vehicle immediately behind itself by either allowing the vehicle to pass, by moving into a parallel legal lane if there is safe

space, or by moving forward and then giving space at an appropriate time in the same way. **(Optional)**

E. Wading through water logged streets

The VUT should be able to judge the depth of water in an alley and decide whether to wade in or not. If the water depth is more than 15 cms, it should not wade in. A tolerance of ±10% will be allowed for errors. **(Optional)**

F. Night driving capabilities:

The VUT must detect low light conditions (will be defined) and automatically turn on the headlight in LOW BEAM. In rain and fog, it must also turn on the headlight and also use hazard lights if required in foggy/poor visibility conditions. **(Optional)**

i. Parking

Basic angle parking ability will be checked at nights under sodium vapour lamps 10 metres apart. The evaluation criteria will follow conditions mentioned in 6.B.ii. **(Optional)**

ii. Obstacle avoidance

Static and crossing obstacle avoidance ability will be checked for night driving at under sodium vapour lamps 10 metres apart. The evaluation criteria will follow the conditions mentioned in 6.E.i and 6.E.ii. **(Optional)**

iii. Reading road signs

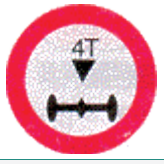
The VUT should have the ability to read the road signs (mentioned in Annexure-I). A total of three road signs will be kept in a stretch and the VUT has to read them accurately and behave accordingly. Reading at least two signs correctly will qualify as a success. All the road signs will be under sufficient illumination. **(Optional)**

SUMMARY OF TESTS

Level	Stage	Test	Test Type
Level 0	Stage 1	Loading the TPF	Mandatory
Level 0	Stage 1	Range and Time to Emergency Stop	Mandatory
Level 0	Stage 1	Moving through the Path Points to the End Location	Mandatory
Level 0	Stage 1	Stopping on reaching the End Location	Mandatory
Level 0	Stage 1	Lane Driving	Mandatory
Level 0	Stage 1	Reading Basic Traffic Signals – Stopping Time and Distance at a Red light	Mandatory
Level 0	Stage 1	Reading Basic Traffic Signals – Starting Time at a Green Light	Mandatory
Level 0	Stage 1	Reading Basic Traffic Signals – Turning at Left and Right Signals	Mandatory
Level 0	Stage 1	Speed Tests – Straight stretches without obstacles	Mandatory
Level 0	Stage 1	Speed Tests – Around corners	Mandatory
Level 0	Stage 1	Speed Tests – Negotiating Speed bumps	Mandatory
Level 0	Stage 1	Identification of Static Obstacle – Distance	Mandatory
Level 0	Stage 1	Identification of Static Obstacle – Behaviour	Mandatory
Level 0	Stage 1	Simple Collision Avoidance	Mandatory
Level 1	Stage 2	Adhering to the Maximum and Minimum Speed Limit	Mandatory
Level 1	Stage 2	Excess delay on route	Mandatory
Level 1	Stage 2	Stopping at intersection	Mandatory
Level 1	Stage 2	Vehicle Distance	Mandatory
Level 1	Stage 2	Overtaking Manoeuvre	Mandatory
Level 1	Stage 2	U Turn Manoeuvre	Mandatory
Level 1	Stage 2	Precedence at Roundabouts	Mandatory
Level 1	Stage 2	Driving on an inclined plane – Stop and Go behaviour on the upward slope	Mandatory
Level 1	Stage 2	Driving on an inclined plane – Stop, go and speed control on the downward slope	Mandatory
Level 1	Stage 2	Identification of Moving Obstacle – Distance	Mandatory
Level 1	Stage 2	Identification of Moving Obstacle – Behaviour	Mandatory
Level 1	Stage 2	Creep and Crawl	Mandatory
Level 2	Stage 2	Unstructured Obstacle Avoidance	Mandatory
Level 2	Stage 2	Parking Behaviour – Parallel Parking	Optional
Level 2	Stage 2	Parking Behaviour – Angle Parking	Mandatory
Level 2	Stage 2	Parking Behaviour – Perpendicular Parking	Mandatory
Level 2	Stage 2	Parking Behaviour – Parking on an incline	Optional
Level 2	Stage 2	Route Re-planning	Mandatory
Level 2	Stage 2	Merging into traffic – Parallel to the flow	Mandatory
Level 2	Stage 2	Merging into traffic – U turn	Mandatory
Level 2	Stage 2	Merging into traffic – Taking a right at Intersection	Mandatory
Level 2	Stage 2	Collision avoidance – Stationary	Mandatory
Level 2	Stage 2	Collision avoidance – Crossing	Mandatory
Level 2	Stage 2	Collision avoidance – Items falling off a vehicle	Mandatory
Level 3	Stage 2	Indian Conditions	Optional (Any 4 out of 8)

8. Annexure – I: Standard Road Signs

Mandatory Signs or Regulatory Signs

			
Straight Prohibited or No Entry	**One Way Sign**	**One Way Sign**	**Vehicle Prohibited in Both Directions**
			
All Motor Vehicles Prohibited	**Truck Prohibited**	**Bullock Cart Prohibited**	**Tonga Prohibited**
			
Hand Cart Prohibited	**Cycle Prohibited**	**Pedestrians Prohibited**	**Right turn Prohibited**
			
Left Tturn Prohibited	**U-Turn Prohibited**	**Overtaking Prohibited**	**Horn Prohibited**
			
Bullock Cart & Cart Prohibited	**Length Limit**	**Speed Limit**	**Load Limit**
			
Height Limit	**Width Limit**	**Axle Load Limit**	**Restriction Ends Sign**
			
No Parking	**No Stopping or Standing**	**Compulsory Ahead Only**	**Compulsory Keep Left**

			
Compulsory Turn Left	**Compulsory Turn Right**	**Compulsory Turn Right Ahead**	**Compulsory Turn Left Ahead**
			
Compulsory Ahead or Turn Left	**Compulsory Ahead or Turn Right**	**Compulsory Cycle Track**	**Compulsory Sound Horn**
			
Stop		**Give Way**	

Cautionary or Warning or Precautionary Signs

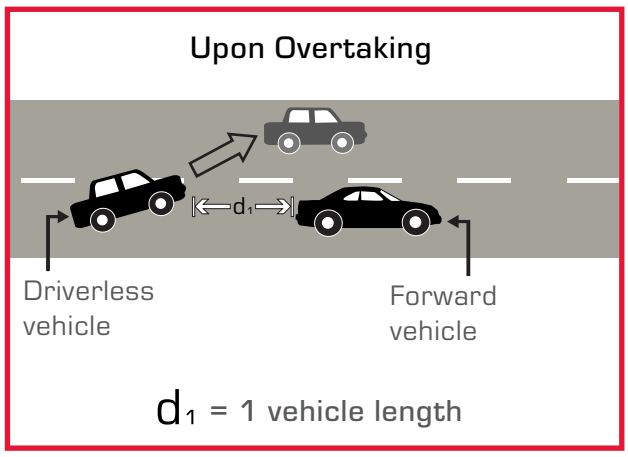
				
Right Hand Curve	**Left Hand Curve**	**Right Hair Pin Bend**	**Left Hair Pin Bend**	**Right Reverse Bend**
				
Left Reverse Bend	**Steep Ascent**	**Steep Descent**	**Narrow Road Ahead**	**Road Wideness Ahead**
				
Narrow Bridge	**Slippery Road**	**Loose Gravel**	**Cycle Crossing**	**Pedestrian Crossing**
				
School Ahead	**Men at Work**	**Cattle**	**Falling Rocks**	**Ferry**

				
Cross Road	Gap in Median	Side Road Right	Side Road Left	Y-Intersection
				
Y-Intersection	Y-Intersection	T-Intersection	Staggered Intersection	Staggered Intersection
				
Major Road Ahead	Major Road Ahead	Roundabout	Dangerous Dip	Hump or Rough Road
				
Barrier Ahead	200 Meters	50-100 Meters	200 Meters	50-100 Meters

9. Annexure – II: Explanatory Sketches

Sample figures demonstrating possible test conditions for the driverless car prototype.

Figure for test 5.E :- Overtaking manoeuvre



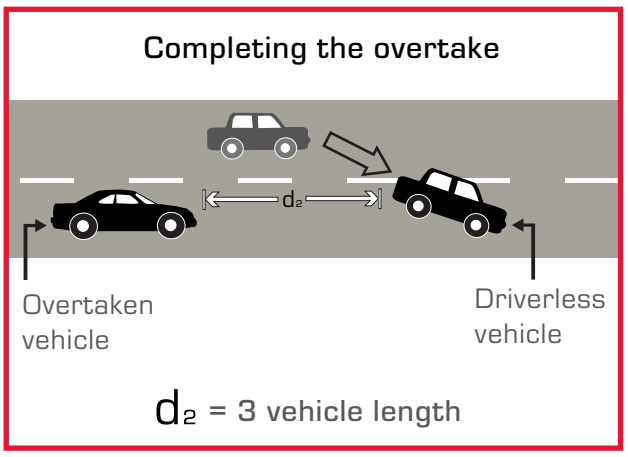


Figure for test 5.F :- U turn manoeuvre

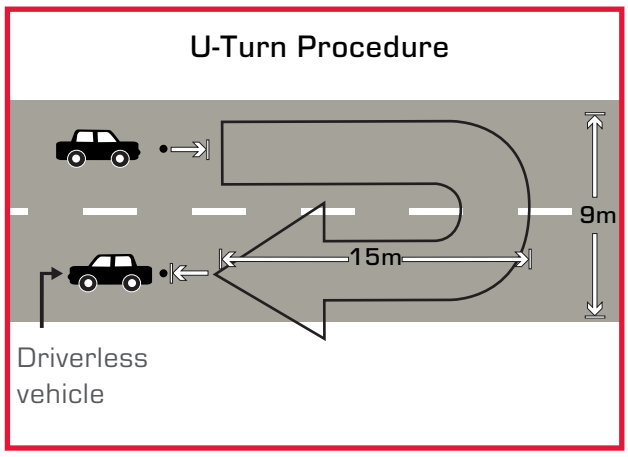
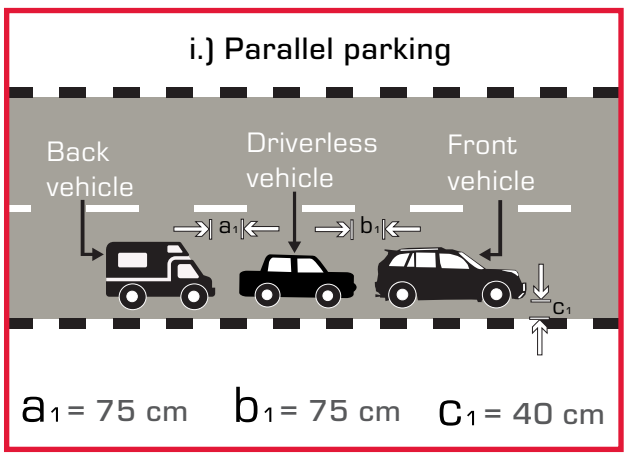
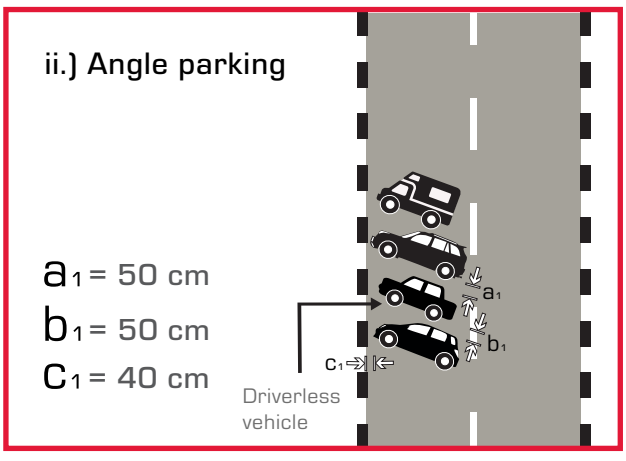


Figure for test 6.B :- Parking Behaviour





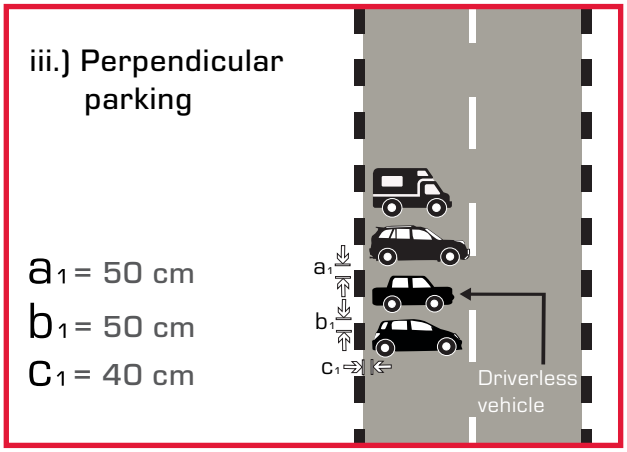


Figure for test 6.C :- Route Re-planning

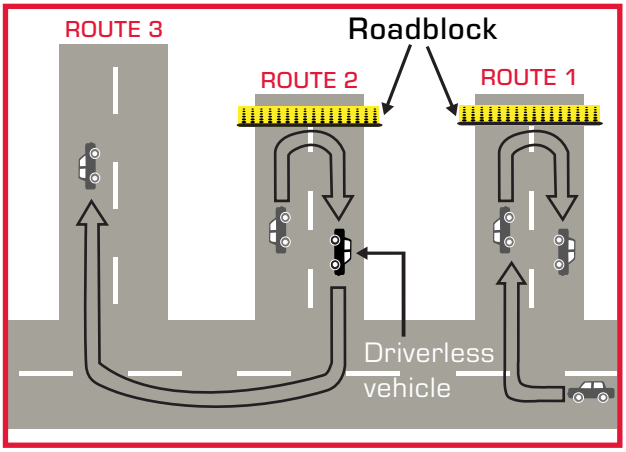
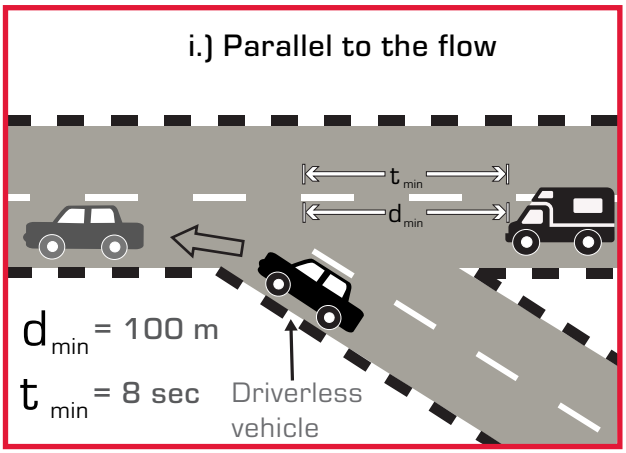


Figure for test 6.D :- Merging into traffic



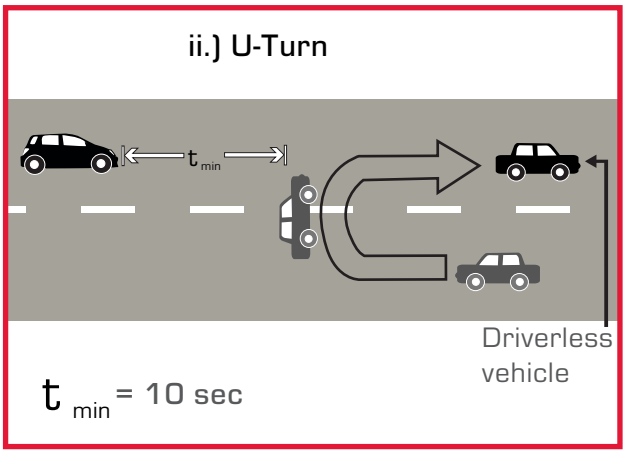
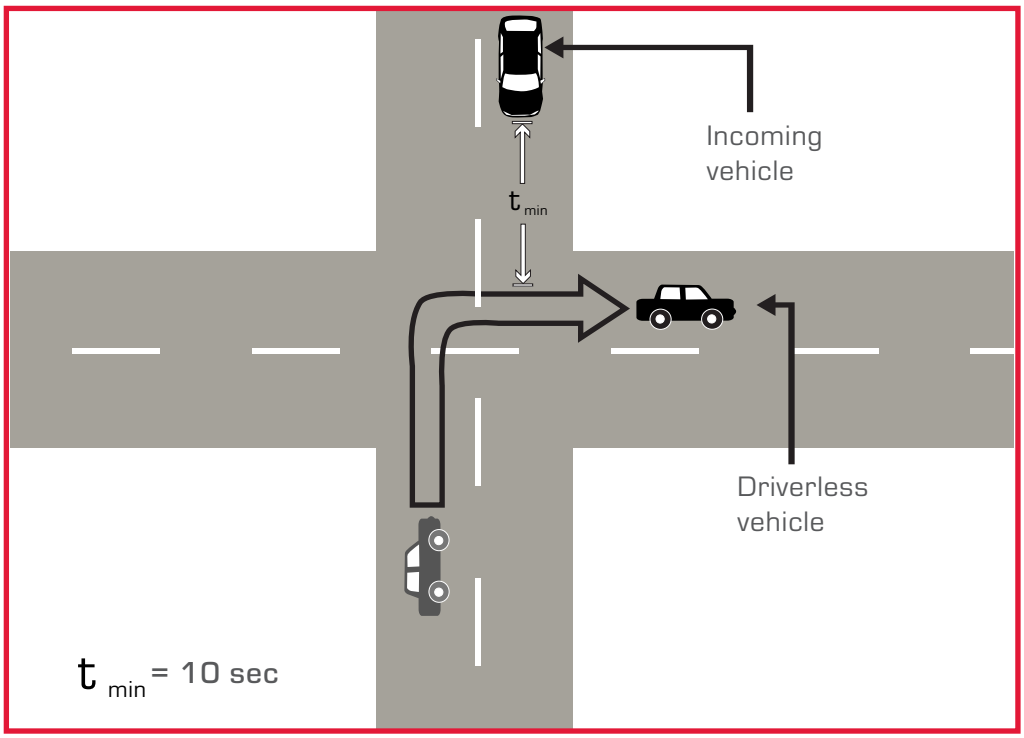


Figure for test 6.D :- Taking a Right Turn at an Intersection



THANK YOU

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