Attachments

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Attachment 2 – E-ZPass Group Members Historical Transponder Order Quantities
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Attachment 1 – E-ZPass Group Members

A point of contact will be provided for each E-ZPass Group Member for Vendors at the Notice of Award.

E-ZPass Group Members (as of May 2021)
Buffalo and Fort Erie Public Bridge Authority
Burlington County Bridge Commission
Cape May County Bridge Commission
Central Florida Expressway
Cline Avenue Bridge
Delaware Department of Transportation
Delaware River and Bay Authority
Delaware River Joint Toll Bridge Commission
Delaware River Port Authority
Florida Department of Transportation
Illinois State Toll Highway Authority
Indiana Toll Road and Concession Company LLC
Kane County Department of Transportation
Kentucky Public Transportation Infrastructure Authority
Maine Turnpike Authority
Maryland Transportation Authority
Massachusetts Department of Transportation
Metropolitan Transportation Authority Bridges and Tunnels
New Hampshire Department of Transportation
New Jersey Turnpike Authority
New York State Bridge Authority
New York State Thruway Authority
Niagara Falls Bridge Commission
North Carolina Turnpike Authority
Ohio Turnpike and Infrastructure Commission
Port Authority of New York & New Jersey

E-ZPass Group Members (as of May 2021)
Rhode Island Turnpike and Bridge Authority
Skyway Concession Company
South Jersey Transportation Authority
State Road and Tollway Authority
The Pennsylvania Turnpike Commission
Thousand Islands Bridge Authority
Virginia Department of Transportation (Serves as the primary Member for the 9 independent toll agencies within the State of Virginia)
West Virginia Parkway Authority

Attachment 2 – E-ZPass Group Members Historical Transponder Order Quantities

The tables in this Appendix present historical annual Transponder order quantities for the E-ZPass Group Members. Historical annual quantities are not a guarantee of actual order quantity.

TDM Transponders

Model	Historical Order Quantity (Annual)
Interior, windshield-mounted, hard-case	2,860,000
Interior, windshield-mounted, hard-case, feedback	100,000
Interior, windshield-mounted, hard-case, switchable	140,000
Exterior, license plate-mounted, hard-case	130,000
Exterior, roof-mounted, hard-case	50,000

SeGo Transponders

Model	Historical Order Quantity (Annual)
Interior, windshield-mounted, sticker	120,000
Interior, windshield-mounted, hard-case, switchable	50,000
Exterior motorcycle headlamp sticker	14,000
External truck headlamp sticker	5,000

6C Transponders

Model	Historical Order Quantity (Annual)
Interior, windshield-mounted, sticker	120,000
Interior, windshield-mounted, hard-case, switchable	50,000
Exterior motorcycle headlamp sticker	14,000
External truck headlamp sticker	5,000

Multi-Protocol Transponders

Model	Historical Order Quantity (Annual)
Interior, windshield-mounted, hard-case	50,000

Attachment 3 – E-ZPass Logo Requirements

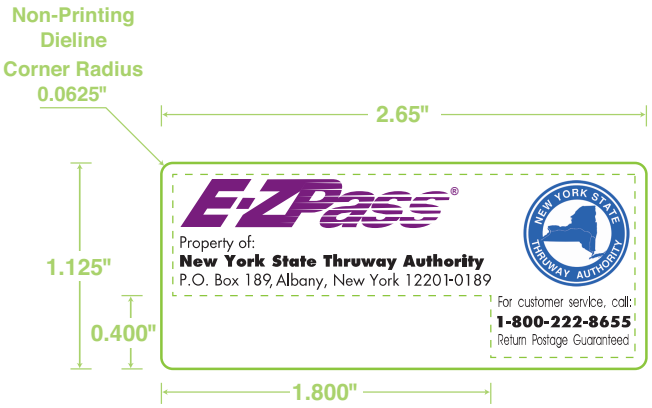
Enclosed is E-ZPass logo requirements and branding guidelines.

ASL Proof Date: Jan-27-2012
ASL# MAR-120-5073A

Proof Prep: NP
Customer Name: Kapsch TrafficCom IVHS Corp.
Product: 801610-040

SIZE: 2.65" x 1.125" DIE#TF00004 COPY POSITION:1
2ac x 8ar @ 80T 0.125"sp ac x 0.125"sp ar Corner Radius 0.0625"

Black Dieline 259 C Reflex Blue C



enlarged for proof reading

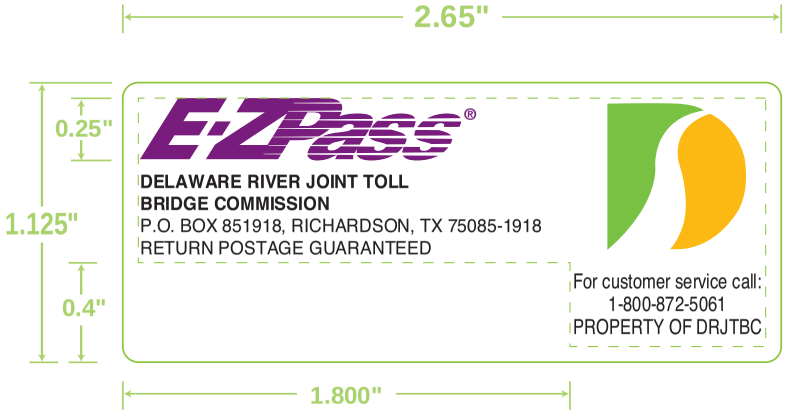
ASL PRINT FX

ASL Proof Date: Jan-23-2012
ASL# MAR-120-5095A

Proof Prep: CR
Customer Name: MARK IV INDUSTRIES LTD
Product: P/N 801610-300

SIZE: 2.65" x 1.125" DIE#TF00004 COPY POSITION:1
2ac x 8ar @ 80T 0.125"sp ac x 0.125"sp ar Corner Radius 0.125"

Black Dieline 130 C 259 C 368 C

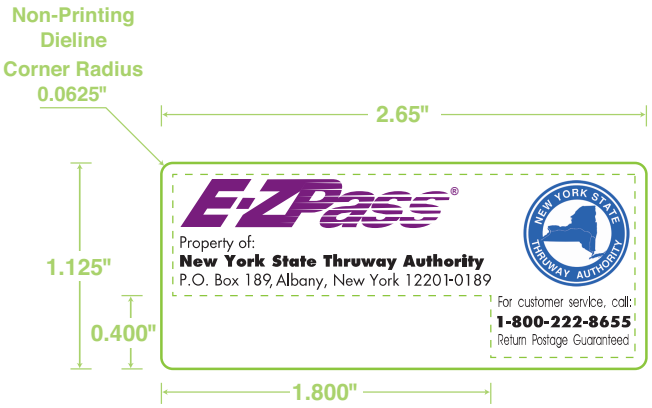


ASL Proof Date: Jan-27-2012
ASL# MAR-120-5073A

Proof Prep: NP
Customer Name: Kapsch TrafficCom IVHS Corp.
Product: 801610-040

SIZE: 2.65" x 1.125" DIE#TF00004 COPY POSITION:1
2ac x 8ar @ 80T 0.125"sp ac x 0.125"sp ar Corner Radius 0.0625"

Black Dieline 259 C Reflex Blue C



enlarged for proof reading

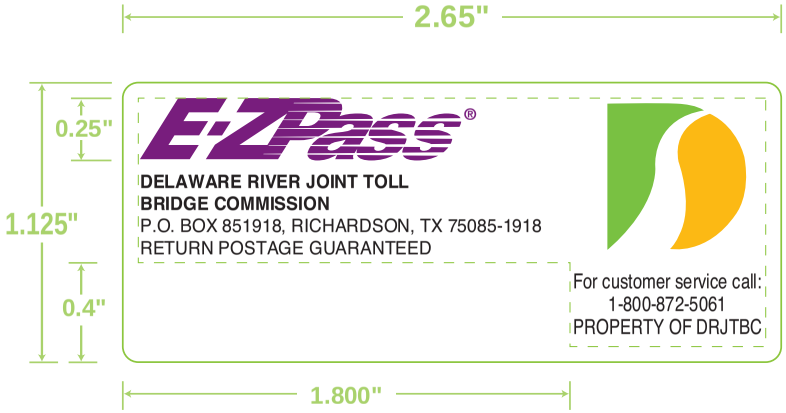
ASL PRINT FX

ASL Proof Date: Jan-23-2012
ASL# MAR-120-5095A

Proof Prep: CR
Customer Name: MARK IV INDUSTRIES LTD
Product: P/N 801610-300

SIZE: 2.65" x 1.125" DIE#TF00004 COPY POSITION:1
2ac x 8ar @ 80T 0.125"sp ac x 0.125"sp ar Corner Radius 0.125"

Black Dieline 130 C 259 C 368 C



E-ZPass®

Property of:

West Virginia Parkways Authority
3310 Piedmont Road
Charleston, WV 25306-1469

WEST VIRGINIA PARKWAYS AUTHORITY

For customer service, call

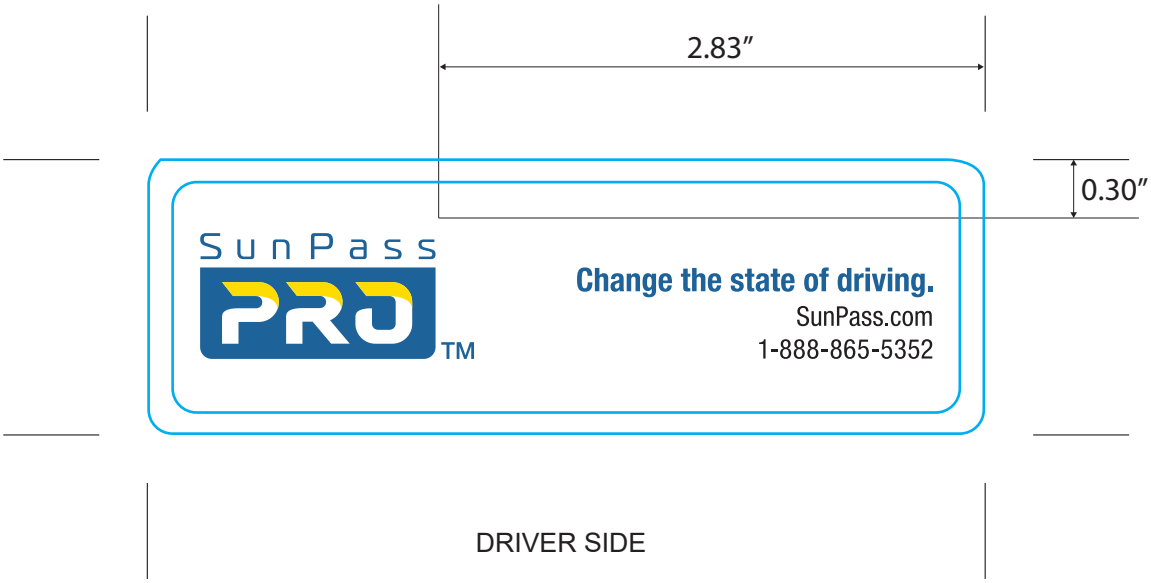
1-800-206-6222

Return Postage Guaranteed

(Visual reference only)

Registration marks indicate edge of tag

Blue lines are for reference only and should not be printed



Print Requirements:

1. Fonts to Paths
2. Colors to match:
   - Blue = equivalent of Pantone 7698 CP (C:65, M:9, Y:0, K:53)
   - Yellow = equivalent of Pantone 109CP (C:0, M:9, Y:100, K:0
   - Black = equivalent of Pantone Process Black (C:0, Y:0, M:0, K:0

CUSTOMER APPROVAL	
☐ ACCEPT	
INITIAL	DATE

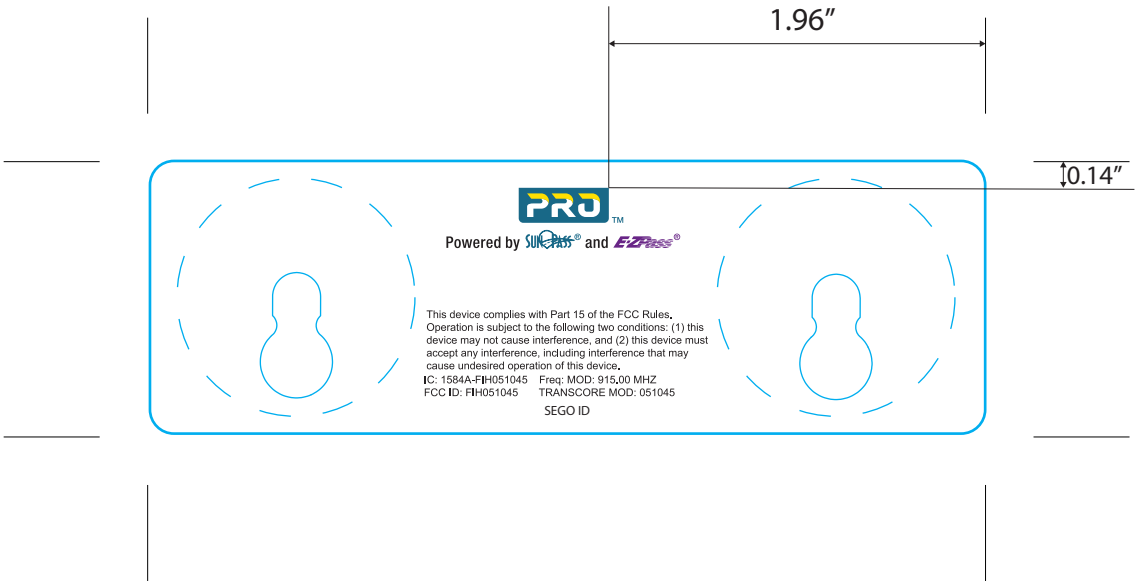
AW, BASE, NP2 FDOT SP PRO

04388-XX

(Visual reference only)

Registration marks indicate edge of tag

Blue lines are for reference only and should not be printed



WINDSHIELD SIDE

Print Requirements:

1. Fonts to Paths
2. Colors to match:
   - Yellow = equivalent of Pantone 109CP (C:0, M:9, Y:100, K:0)
   - Blue = equivalent of Pantone 7698CP (C:65, M:9, Y:0, K:53)
   - Purple = equivalent of Pantone 7663CP (C:69, M:100, Y:0, K:8)
   - Black = equivalent of Pantone Process Black (C:0, Y:0, M:0, K:0)

CUSTOMER APPROVAL ☐ ACCEPT	
INITIAL	DATE

AW, RADOME, NP2, FDOT SP PRO

04389-XX

Attachment 4 – E-ZPass Group Test Plan

Enclosed is the E-ZPass Group Test Plan that includes E-ZPass Test Cases to be used to meet Vendor Certification for Tags and Readers.

The E-ZPass Test Plan consists of two parts:

1. Part 1 is the Test Plan entitled "VALIDATION TEST PLAN VOLUME 2 - VOLUME TEST SCRIPTS - VERSION 1.1"
2. Part 2 is the Test Cases for Reader and Transponder Testing.
3. Part 3 is the E-ZPass Approved Readers.

E-ZPass Interagency Group

VALIDATION TEST PLAN VOLUME 2 - VOLUME TEST SCRIPTS - VERSION 1.1

TEST PLAN

July 8, 2020

Table of Contents

1. INTRODUCTION

1.1 General

This test plan volume provides the test scripts to be used for volume testing of a single protocol transponder. It can be adapted for testing multi-protocol transponders by requiring that the multi-protocol transponder have all of its protocols enabled with the all NIOP protocols captured on each pass in the lane the vehicle with the multi-protocol transponder is assigned to travel in subject to the test standards.

The scripts are grouped by site type: Plaza or Open Road Tolling (ORT). For each site, a table in their respective sections lists the test cases that will be used in each scenario. There are two types of vehicles mixes that are used in carry out Plaza test cases. The test cases in PV1 are carried out using standard vehicle mixes. The test cases in PV2 are carried out using special vehicle mixes. There are two types of vehicle mixes used to carry out ORT test cases. The test cases in OV1 are carried out using standard vehicle mixes. The test cases in OV2 are carried out using special vehicle mixes. Different numbers of samples will be gathered in each scenario, leading to different sets of cases tested in each.

The scenarios to be tested for each Proposer are:

Table 1 – Volume Scenario List

Site	Scenario Code	RSE	Existing OBU %	Proposed OBU %	Planned Transactions
Plaza Standard Vehicles	PV1	Kapsch MPR 2.3	0	100	**2,514**
Plaza Special Vehicles	PV2	Kapsch MPR 2.3	0	100	**504**
ORT Standard Vehicles	OV1	Kapsch MPR 2.3	0	100	**6,626**
ORT Special Vehicles	OV2	Kapsch MPR 2.3	0	100	**608**

1.2 References

N/A

1.3 Vehicle Notation

Each test script describes the order, lane assignment and type of vehicles for the test case. Vehicle types are abbreviated using the following codes:

- CC – Compact car
- MC – Midsize car
- FC – Full-size car
- SS – Small SUV
- LS – Large SUV
- MV – Minivan
- BX – Box Truck
- PU – Pickup
- DU – Dump Truck
- TR – Tractor
- BS – Bus
- MT - Motorcycle

1.4 Grid Notation

Each test case will display the vehicles to be used in the test in a grid format to indicate position relative to other vehicles.

The grid will show the vehicle type, vehicle lane, order within the lane and approximate lateral position with other cars ('row').

For each row, the relationship between the vehicles in the row will depend on if the test case is a 'Simultaneous' case or not. If it is, all drivers for the vehicles in the row will attempt to travel through the capture zone at the same time. If the test case is not simultaneous, drivers do not have to focus on traveling through the capture zone at the same time.

Specific vehicles are selected just prior to the test case execution based on usage and availability and are not defined as part of the test case.

1.4.1 PLAZA

A plaza configuration will be comprised of three lanes. Lane three is the leftmost lane and lane one is the rightmost lane when viewed by an approaching vehicle.

Table 2 - Plaza Vehicle Grid Example

	Lane 3	Lane 2	Lane 1
Row 1			SS
Row 2	CC	MV	
Row 3	BX		LS

	Lane 3	Lane 2	Lane 1
Row 4		FC	
Row 5		MC	CC

In this example, a small SUV will go through first in lane 1. Shortly afterwards, a compact car and a minivan will drive through in lanes 3 and 2, respectively. Next, a box truck in lane 3 and a large SUV in lane 1 will drive through the plaza followed by a full-size car in lane 2. The final row will be a midsize car in lane 2 and compact car in lane 1.

1.4.2 OPEN ROAD TOLLING (ORT)

An ORT test track shall have four striped lanes. Lanes are designated from the left to the right. As an ORT site, vehicles may appear in straddle lanes. This will be part of the testing and is part of the vehicle grid shown in Table 3.

Table 3 - ORT Vehicle Grid Example

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	MV		CC	
Row 2		SS		LS
Row 3		BX	FC	
Row 4	CC			
Row 5				MC

The first row has a minivan in lane 1 and compact car in lane 3.

In row 2, a vehicle is using a straddle lane. A small SUV is straddling between lanes 2 and 3. A large SUV is using the striped lane 4.

Row 3 has a box truck and full-size car in striped lanes 2 and 3, respectively.

A compact car is straddling between lanes 1 and 2 in row 4 while the final row is only a midsize car in striped lane 4.

2. PLAZA TESTING

2.1 Test Case Summary

The goal of the plaza testing will be to test a variety of situations involving low to high vehicle volumes in a plaza environment.

Test case variables include: vehicle types, vehicle platoon size, vehicle order, lane assignment, simultaneous arrival, speed and vehicle maneuvers.

2.2 General Test Standards

Each OBU transaction is expected to meet the following standards. If these standards appear not to be met, an investigation will be conducted. The standards include but are not limited to:

- OBU must be reported only once and only to a single lane. This lane may not be a straddle lane.
- OBU must be reported in the lane in which the vehicle traveled.
- All read-only fields must be read and reported with their programmed values.
- All variable fields must be read and the reported values must match the previous data written to those fields, if known.
- All OBUs traveling in a particular lane must be reported in the same order that they went through the lane.
- No OBUs are reported that have not traveled through a lane.

2.3 Test Conditions

2.3.1 EQUIPMENT

The equipment will meet the following conditions in order to run the test.

Item	Condition
RSE	Sending data to data recording system. No failed modules or other reported anomalies.
OBUs	OBU Tester indicates that OBU is working properly.
Vehicles	Operable in a safe manner – Lights functional, no flat tires, and no significant body damage.

2.3.2 TRACK

The track will be kept clear of obstructions except for traffic cones, signage or other devices needed to direct traffic or maintain safe operating conditions.

The Site Director will direct the monitoring of the track for the level of mud, snow, ice or other slickness that may affect vehicle safety and select test cases or adjust operations to maintain an acceptable safety level.

2.3.3 WEATHER CONDITIONS

The weather must meet the following conditions in order to run test cases.

Temperature Range: -20°F to +120°F as reported from a weather station installed at the site.

Visibility: Sufficient to operate safely for the test cases in the judgment of the Site Director. If visibility is reduced, test cases that use lower speeds will be performed.

Precipitation: Low enough to operate safely for the test cases in the judgment of the Site Director. If precipitation affects visibility or track quality, test cases that use lower speeds will be performed.

The Site Director will also monitor for weather alerts in accordance with the Site Management Plan.

2.3.4 RF EMISSIONS

RF emissions will be monitored using a spectrum analyzer connected to a PC that will sound an alarm when emissions exceed the thresholds in the monitored frequency bands.

Testing will be halted until emissions remain under the threshold for at least five minutes.

2.4 Special Vehicles Cases

Special vehicles testing at the plaza are expected to include a bus and motorcycle. It is assumed that the bus has the same safety limitations as the box truck – it cannot go above 20 MPH.

The test cases listed below will include vehicle patterns with the special vehicles included as well without special vehicles. Since the special vehicle drivers may be unfamiliar with site procedures, it is recommended to start with the basic tests and move to more difficult ones.

1. 1001 - Gated Three Vehicle
2. 1003 - 30 MPH Three Vehicle
3. 1005 - Gated Three Vehicle Simultaneous – Order B
4. 1007- 30 MPH Three Vehicle Simultaneous

2.5 Test Cases

2.5.1 TEST CASE 1001 – GATED THREE VEHICLE

2.5.1.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes.

2.5.1.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

2.5.1.3 Special Conditions

None.

2.5.1.4 Special Standards

None.

2.5.1.5 Iterations

Fourteen (14).

2.5.1.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	1
Full-size Car	1	1
Small SUV	1	2
Large SUV	1	1
Minivan	1	2
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Interior OBU	9	9
Exterior OBU	-	-

2.5.1.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in if performing special vehicles testing Table 4 or Table 5 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle in the test log.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 4 or Table 5 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 4 - Test Case 1001 Vehicle Grid (Special Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	BS	CC
Row 3	MT	MC	SS

Table 5 – Test Case 1001 Vehicle Grid (Regular Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	MV	CC
Row 3	SS	MC	SS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that the vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH and come to a complete stop at the traffic cones that simulate a gate for at least one second before proceeding through the rest of the plaza. Vehicles do not have to be synchronized with other vehicles in their row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH. The drivers will pull up to the gate if no one is in front of the vehicle or hold a few feet behind any preceding vehicles. Vehicles do not have to be synchronized with other vehicles in their row.

10. When each vehicle reaches the gate, it will come to a complete stop for at least one second before proceeding through the rest of the plaza.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 4 or Table 5 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until fourteen (14) iterations are complete.

2.5.1.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at less than 15 MPH.

5. Stay at least 5 feet behind any vehicle in front of you. If no one is in front of you, pull up to the gate.

6. Stop before the traffic cones for at least one second as if it were a toll gate.

7. Once you get past the plaza, return to the assembly area. You can speed up but don’t exceed 30 MPH.

8. You will drive 14 laps.

2.5.2 TEST CASE 1002 – 5 MPH THREE VEHICLE

2.5.2.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and low speeds.

2.5.2.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 5 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.2.3 Special Conditions

None

2.5.2.4 Special Standards

None

2.5.2.5 Iterations

Twenty-eight (28)

2.5.2.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	1
Minivan	1
Box Truck	1
Interior OBU	9
Exterior OBU	-

2.5.2.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 6.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle in the test log.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 6 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 6 – Test Case 1002 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MC	SS	CC
Row 2	MV	CC	LS
Row 3	MC	BX	FC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 5 MPH. Vehicles do not have to be synchronized with other vehicles in their row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 5 MPH as they reach the plaza islands. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.

10. All vehicles will proceed through the plaza at 5 MPH.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 6 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-eight (28) iterations are complete.

2.5.2.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at less than 15 MPH and then reduce speed to 5 MPH as you reach the front edge of the plaza islands.

5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.

6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.

7. You will drive 28 laps.

2.5.3 TEST CASE 1003 – 30 MPH THREE VEHICLE

2.5.3.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and high speeds.

2.5.3.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 30 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.3.3 Special Conditions

None

2.5.3.4 Special Standards

None

2.5.3.5 Iterations

Fourteen (14)

2.5.3.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	1
Full-size Car	1	1
Small SUV	1	2
Large SUV	1	1
Minivan	1	2
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Interior OBU	9	9
Exterior OBU	-	-

2.5.3.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 7 if performing special vehicles testing or Table 8 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle in the test log.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 7 or Table 8 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 7 – Test Case 1003 Vehicle Grid (Special Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	BS	CC
Row 3	MT	MC	SS

Table 8 – Test Case 1003 Vehicle Grid (Regular Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	MV	CC
Row 3	SS	MC	SS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will approach and proceed through the plaza at 30 MPH. Vehicles do not have to be synchronized with other vehicles in their row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the plaza at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.

10. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 7 or Table 8 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until fourteen (14) iterations are complete.

2.5.3.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at 30 MPH and stay at that speed through the plaza.

5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.

6. Once you get past the plaza islands, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 14 laps.

2.5.4 TEST CASE 1004 – GATED THREE VEHICLE SIMULTANEOUS – ORDER A

2.5.4.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes when vehicles are arriving at about the same time.

2.5.4.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop at approximately the same time prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

2.5.4.3 Special Conditions

Traffic cones will be placed in a line to indicate the position of where a gate would be.

2.5.4.4 Special Standards

None

2.5.4.5 Iterations

Twenty-eight (28)

2.5.4.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	-

2.5.4.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 9.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle in the test log.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 9 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 9 – Test Case 1004 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MV	MC	FC
Row 2	CC	CC	MC
Row 3	SS	MV	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH, synchronizing their movements so they come to a complete stop at the traffic cones that simulate a gate at the same time. They will hold for at least one second before proceeding through the rest of the plaza.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements.

10. When the vehicles reach their gates, they will come to a complete stop for at least one second before proceeding through the rest of the plaza. They should leave the plaza at the same time.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 9 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-eight (28) iterations are complete.

2.5.4.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at less than 15 MPH.

5. Stay aligned with the other vehicles in your row.

    a. If the leftmost vehicle, set the pace.

    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.

    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.

    b. All other vehicles, be aware that you may have to slow down or stop prior to the gate as the leftmost vehicle maintains this distance.

7. Stop before the traffic cones for at least one second as if it were a toll gate and leave when the leftmost vehicle leaves.

8. You will drive 28 laps.

2.5.5 TEST CASE 1005 – GATED THREE VEHICLE SIMULTANEOUS – ORDER B

2.5.5.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes when vehicles are arriving at about the same time.

2.5.5.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop at approximately the same time prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

2.5.5.3 Special Conditions

Traffic cones will be placed in a line to indicate the position where a gate would be.

2.5.5.4 Special Standards

None

2.5.5.5 Iterations

Fourteen (14)

2.5.5.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	1
Full-size Car	1	1
Small SUV	1	2
Large SUV	1	2
Minivan	1	1
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Interior OBU	9	9
Exterior OBU	-	-

2.5.5.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 10 if performing special vehicles testing or Table 11 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 10 or Table 11 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 11 - Test Case 1005 Vehicle Grid (Special Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	BS
Row 2	MT	SS	FC
Row 3	CC	LS	BX

Table 12 – Test Case 1005 Vehicle Grid (Regular Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	LS
Row 2	SS	SS	FC
Row 3	CC	LS	BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH, synchronizing their movements so they come to a complete stop at the traffic cones that simulate a gate at the same time. They will hold for at least one second before proceeding through the rest of the plaza.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements.

10. When the vehicles reach their gates, they will come to a complete stop for at least one second before proceeding through the rest of the plaza. They should leave the plaza at the same time.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 10 or Table 11 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until fourteen (14) iterations are complete.

2.5.5.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at less than 15 MPH.

5. Stay aligned with the other vehicles in your row.

    a. If the leftmost vehicle, set the pace.

    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.

    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.

    b. All other vehicles, be aware that you may have to slow down or stop prior to the gate as the leftmost vehicle maintains this distance.

7. Stop before the traffic cones for at least one second as if it were a toll gate and leave when the leftmost vehicle leaves.

8. You will drive 14 laps.

2.5.6 TEST CASE 1006 – 5 MPH THREE VEHICLE SIMULTANEOUS

2.5.6.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and low speeds when vehicles are arriving at about the same time.

2.5.6.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 5 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.6.3 Special Conditions

None

2.5.6.4 Special Standards

None

2.5.6.5 Iterations

Twenty-eight (28)

2.5.6.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	0
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1
Interior OBU	9
Exterior OBU	-

2.5.6.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 12.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 12 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 13 – Test Case 1006 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	BX
Row 2	SS	MC	MV
Row 3	LS	CC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 5 MPH and synchronize their movements so they pass through the capture zone at the same time.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 5 MPH as they reach the plaza islands. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.

10. All vehicles will proceed through the plaza at 5 MPH.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 12 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-eight (28) iterations are complete.

2.5.6.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at less than 15 MPH and then reduce speed to 5 MPH as you reach the front edge of the plaza islands.

5. Stay aligned with the other vehicles in your row through the plaza.

    a. If the leftmost vehicle, set the pace.

    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.

    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.

    b. All other vehicles, be aware that you may have to slow down as the leftmost vehicle maintains this distance.

7. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.

8. You will drive 28 laps.

2.5.7 TEST CASE 1007 – 30 MPH THREE VEHICLE SIMULTANEOUS

2.5.7.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and high speeds when vehicles are arriving at about the same time.

2.5.7.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 30 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.7.3 Special Conditions

None

2.5.7.4 Special Standards

None

2.5.7.5 Iterations

Fourteen (14)

2.5.7.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	1
Full-size Car	1	1
Small SUV	1	2
Large SUV	1	2
Minivan	1	1
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Interior OBU	9	9
Exterior OBU	-	-

2.5.7.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 13 if performing special vehicles testing or Table 14 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 13 if performing special vehicles testing or Table 14 if using regular vehicles in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 14 – Test Case 1007 Vehicle Grid (Special Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	BS
Row 2	MT	SS	FC
Row 3	CC	LS	BX

Table 15 - Test Case 1007 Vehicle Grid (Regular Vehicles)

	Lane 3	Lane 2	Lane 1
Row 1	SS	CC	MV
Row 2	MC	CC	FC
Row 3	MV	SS	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will approach and pass through the plaza at 30 MPH, synchronizing their movements so they pass through the capture zone at the same time.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and pass through the plaza at 30 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.

10. All vehicles will proceed through the plaza at 30 MPH.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 13 or Table 14 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until fourteen (14) iterations are complete.

2.5.7.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza and drive through the plaza at 30 MPH.

5. Stay aligned with the other vehicles in your row through the plaza.

    a. If the leftmost vehicle, set the pace.

    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.

    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.

    b. All other vehicles, be aware that you may have to slow down as the leftmost vehicle maintains this distance.

7. Once you get past the plaza islands, return to the assembly area. Don’t exceed 30 MPH.

8. You will drive 14 laps.

2.5.8 TEST CASE 1008 – THREE VEHICLE LOW SPEED ACCELERATION

2.5.8.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment when three vehicles at a time accelerate through the capture zone.

2.5.8.2 Description

Vehicles will approach the toll plaza three at a time at about 10 MPH and then accelerate to no more than 30 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.8.3 Special Conditions

None

2.5.8.4 Special Standards

None

2.5.8.5 Iterations

Twenty-eight (28)

2.5.8.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	1
Box Truck	0
Pickup Truck	1
Interior OBU	9
Exterior OBU	-

2.5.8.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 15.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 15 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 16 – Test Case 1008 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	LS	MC	FC
Row 2	SS	LS	PU
Row 3	MV	CC	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row of vehicles will approach the toll plaza at 10 MPH and as they near the capture zone markers, begin accelerating up to 30 MPH.

8. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the toll plaza at 10 MPH and as they near the capture zone markers, begin accelerating up to 30 MPH. Vehicles shall not pass any vehicles in any other lanes and shall maintain a few feet of spacing with any vehicle directly in front of them. Vehicles do not have to be synchronized with other vehicles in their row.

10. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 15 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

2.5.8.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 10 MPH and then begin speeding up as you reach the point indicated by the OBU/Vehicle Organizer.
5. Do not go faster than 30 MPH.
6. Stay behind the vehicles before you by at least 5 feet no matter what lane they are in.
7. Once you get past the plaza islands, return to the assembly area. Do not exceed 30 MPH.
8. You will drive 28 laps.

2.5.9 TEST CASE 1009 – THREE VEHICLE DECELERATION

2.5.9.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment when three vehicles at a time decelerate through the capture zone.

2.5.9.2 Description

Vehicles will approach the toll plaza three at a time at about 30 MPH and then decelerate to about 10 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.9.3 Special Conditions

None.

2.5.9.4 Special Standards

None.

2.5.9.5 Iterations

Twenty-eight (28)

2.5.9.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	-

2.5.9.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 16.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 16 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 17 – Test Case 1009 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MV	MC	MC
Row 2	CC	LS	LS
Row 3	FC	MV	SS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row of vehicles will approach the toll plaza at 30 MPH and as they near the capture zone markers, begin decelerating down to 10 MPH.

8. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the toll plaza at 30 MPH and as they near the capture zone markers, begin decelerating down to 10 MPH. Vehicles shall not pass any vehicles in any other lanes and shall maintain a few feet of spacing with any vehicle directly in front of them. Vehicles do not have to be synchronized with other vehicles in their row.

10. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 16 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

2.5.9.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.

3. Go when directed to.

4. Approach the plaza at about 30 MPH and then begin braking up as you reach the point indicated by the OBU/Vehicle Organizer.

5. Slow down to about 10 MPH. Do not stop as you pass through the plaza.

6. Stay behind the vehicle before you by at least 5 feet no matter what lane that vehicle is in.

7. Once you get past the plaza islands, return to the assembly area. You should speed up but do not exceed 30 MPH.

8. You will drive 28 laps.

2.5.10 TEST CASE 1010 – PASSING

2.5.10.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment when two vehicles are passing through the capture zone at different speeds.

2.5.10.2 Description

Vehicles will approach the toll plaza in pairs. One vehicle will go first and drive around 10 MPH through the capture zone. A second vehicle will follow in a different lane at around 25 MPH and should pass through the capture zone at about the same time as the other vehicle.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.10.3 Special Conditions

None.

2.5.10.4 Special Standards

None.

2.5.10.5 Iterations

Twenty-five (25).

2.5.10.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

2.5.10.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 17.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 17 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 18 – Test Case 1010 Vehicle Grid and Speed

	Lane 3	Lane 2	Lane 1
Row 1		CC 10 MPH	SS 25 MPH
Row 2	MC 25 MPH		MV 10 MPH
Row 3	LS 10 MPH	LS 25 MPH	
Row 4		FC 25 MPH	CC 10 MPH
Row 5	MV 25 MPH		SS 10 MPH

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the slow vehicle in the first row will approach and proceed through the capture zone at 10 MPH.

8. The OBU/Vehicle Organizer will wave a flag to indicate that the fast vehicle should proceed approximately 3 seconds or at an interval deemed appropriate by the Test Coordinator for

safety and to meet the purpose of the test after the first vehicle. This vehicle will approach and proceed through the capture zone at 25 MPH.

9. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. They will follow the same process as Steps 9 and 10 with the slow vehicle in the row being sent and then the fast vehicle so that they should arrive in the capture zone at about the same time. There will be a three second gap between vehicles in the row and three second gaps between the last vehicle in one row and the first vehicle in the next. The gaps may be modified by the Test Coordinator to ensure that they are appropriate for safety and to meet the purpose of the test.

10. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 17 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

2.5.10.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach Instructions:

    a. Slow Driver – Approach and go through the plaza at about 10 MPH. The other vehicle should catch up to you about the time you are passing by the toll booth.

    b. Fast Driver – Approach and go through the plaza at about 25 MPH. You should catch up to the other vehicle about the time you are passing by the toll booth.

5. Stay behind the vehicles in the rows in front of you by at least 5 feet no matter what lane that vehicle is in.

6. Once you get past the plaza islands, return to the assembly area. You should speed up but do not exceed 30 MPH.

7. You will drive 25 laps.

2.5.11 TEST CASE 1011 – BRAKING/ACCELERATION

2.5.11.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment when two vehicles are going through the capture zone and one vehicle is braking while the other is accelerating.

2.5.11.2 Description

Vehicles will approach the toll plaza two at a time at about 15 MPH. As they reach the capture zone, one vehicle will accelerate to 25 MPH and the other vehicle will decelerate to 5 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.5.11.3 Special Conditions

None

2.5.11.4 Special Standards

None

2.5.11.5Iterations

Twenty-five (25)

2.5.11.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

2.5.11.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 18.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 18 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 19 – Test Case 1011 Vehicle Grid and Action

	Lane 3	Lane 2	Lane 1
Row 1	LS Accelerate	CC Brake	
Row 2		MV Brake	FC Accelerate
Row 3	CC Accelerate	MV Brake	
Row 4		SS Brake	MC Accelerate
Row 5	MC Accelerate		LS Brake

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row of vehicles will approach the toll plaza at 15 MPH and as they near the capture zone markers, one vehicle will accelerate to 25 MPH and the other vehicle will begin decelerating down to 5 MPH.

8. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about five seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the toll plaza at 15 MPH and as they near the capture zone markers, one vehicle will begin accelerating to 25 MPH and the other vehicle will begin decelerating down to 5 MPH. Vehicles shall not pass any vehicles in any other lanes and shall maintain a few feet of spacing with any vehicle directly in front of them.

10. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 18 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

2.5.11.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach the plaza at about 15 MPH.

5. Capture Zone Instructions –

    a. Accelerating Vehicle – When you reach the capture zone markers, speed up to 25 MPH. The other vehicle in your row will be slowing down.

    b. Decelerating Vehicle – When you reach the capture zone markers, slow down to 5 MPH. The other vehicle in your row will be speeding up.

6. Stay behind the vehicle before you by at least 5 feet no matter what lane that vehicle is in.

7. Once you get past the plaza islands, return to the assembly area. You should speed up but do not exceed 30 MPH.

8. You will drive 25 laps.

2.5.12 TEST CASE 1012 – SIMULATED MANUAL INTERACTION

2.5.12.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment where one vehicle may be stopped for a period to interact with a simulated toll collector while other vehicles continue normally through a simulated gated environment.

2.5.12.2 Description

Vehicles will approach the toll plaza one at a time at a slow speed of less than 15 MPH. They will stop prior to passing a simulated gate to be marked by traffic cones. Most vehicles will come to a complete stop for about 1 second before proceeding through the plaza. A couple vehicles will be designated to sit at the toll booth for a longer period of time to simulate manual interaction.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

2.5.12.3 Special Conditions

Traffic cones will be placed in a line with the gate installed in Lane 3 to indicate the position where a gate would be.

2.5.12.4 Special Standards

If a vehicle is stopped in the capture zone for a period longer than the timeout, multiple reads from that vehicle from that lane are acceptable.

2.5.12.5 Iterations

Twenty-five (25)

2.5.12.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	1
Box Truck	1
Interior OBU	9
Exterior OBU	1

2.5.12.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 19.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 19 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 20 – Test Case 1012 Vehicle Grid and Actions

	Lane 3	Lane 2	Lane 1
Row 1		LS Hold	
Row 2			BX
Row 3	CC		
Row 4	SS Hold		
Row 5			MC
Row 6			CC Hold
Row 7		MC Hold	
Row 8	MV		
Row 9		SS	
Row 10	FC		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first vehicle will proceed through the approach area and capture zone at no more than 15 MPH and come to a complete stop at the traffic cones that simulate a gate for 10 seconds or as appropriate for the RSE configuration before

proceeding through the rest of the plaza where appropriate is at least a few seconds less than the configured timeout parameter.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the plaza at no more than 15 MPH. The driver will pull up to the gate if no one is in front of the vehicle or hold a few feet behind any preceding vehicles with the exception of the Hold vehicles.

10. When the vehicle reaches the gate, it will come to a complete stop for a period depending on its status before proceeding through the rest of the plaza.

    a. Vehicles with 'Hold' in Table 19 will stay stopped at the toll booth for 10 seconds or as appropriate for the RSE configuration before proceeding.

    b. All other vehicles will stop at the toll booth for about a second before proceeding.

11. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 19 following the instructions of the OBU/Vehicle Organizer.

    a. Vehicles should stay on the right in order to provide enough room for Hold vehicles to pass on the left and get into the correct position.

    b. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-five(25) iterations are complete.

2.5.12.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in the preceding row is <Vehicle Number> who will be in Lane <Assignment>.

3. Go when directed to.

4. Approach the toll plaza at less than 15 MPH.

5. Stay at least 5 feet behind any vehicle in front of you. If no one is in front of you, pull up to the gate.

6. Stop before the traffic cones for at least:

    a. If a Hold vehicle – 10 seconds (or as appropriate for RSE configuration). Vehicles will pass you while you are sitting here.

    b. All other vehicles – 1 second. You may pass a vehicle stopped at the toll booth.

7. Once you get past the plaza, return to the assembly area. You can speed up but don't exceed 30 MPH.

    a. If a Hold vehicle, pass on the left to get back to your correct spot.

   b. All other vehicles, stay to the right.

   c. If the vehicle before you is a Hold vehicle, make sure there is enough room when you come back around for that vehicle to get back in front of you.

8. You will drive 25 laps.

3. OPEN ROAD TOLLING TESTING

3.1 Test Case Summary

The goal of the ORT testing will be to test a variety of situations involving low to high vehicle volumes in an ORT environment.

Test case variables include: vehicle types, vehicle platoon size, vehicle order, lane assignment, simultaneous arrival, speed and vehicle maneuvers. Both striped and straddle lanes will be used and vehicles may change lanes in some of the test cases.

3.2 General Test Standards

Each OBU transaction is expected to meet the following standards. If any of these standards are not met, the sample will be declared an anomaly and an investigation will commence in order to determine the cause. The standards are:

- OBU must be reported only once and only to a single lane. Straddle lane assignment is allowed.
- OBU must be reported in the correct travel lane which may be a straddle lane.
- All read-only fields must be read and reported with their programmed values.
- All variable fields must be read and the reported values must match what the RSE last wrote.
- All OBUs traveling in a particular lane must be reported in the same order that they went through the lane.
- No OBUs are reported that have not traveled through a lane.

3.3 Test Conditions

3.3.1 EQUIPMENT

The equipment will meet the following conditions in order to run the test.

Item	Condition
RSE	Sending data to data recording system. No failed modules or other reported anomalies.
OBUs	OBU Tester indicates that OBU is working properly.
Vehicles	Operable in a safe manner – Lights functional, no flat tires, and no significant body damage.

3.3.2 TRACK

The track will be kept clear of obstructions except for traffic cones, signage or other devices needed to direct traffic or maintain safe operating conditions.

The Site Director will direct the monitoring of the track for the level of mud, snow, ice or other slickness that may affect vehicle safety and select test cases or adjust operations to maintain an acceptable safety level.

3.3.3 LANE AND ENTRANCE/EXIT USAGE

The Site Director or Test Coordinator may adjust the usage of the entrances or exits during the course of testing if deemed necessary for safely accelerating, decelerating, accessing the return road or accessing the track.

3.3.4 WEATHER CONDITIONS

The weather must meet the following conditions in order to run test cases.

Temperature Range: -20°F to +120°F as reported from a home weather station installed at the site.

Visibility: Sufficient to operate safely for the test cases in the judgment of the Site Director. If visibility is reduced, test cases that use lower speeds will be performed.

Precipitation: Low enough to operate safely for the test cases in the judgment of the Site Director. If precipitation affects visibility or track quality, test cases that use lower speeds will be performed.

3.3.5 RF EMISSIONS

RF emissions will be monitored using a spectrum analyzer connected to a PC that will sound an alarm when emissions exceed the thresholds in the monitored frequency bands:

Testing will be halted until emissions remain under the threshold for at least five minutes.

3.4 Special Vehicles Cases

Special vehicles testing at the ORT site are expected to include a bus, motorcycle, dump truck and tractor (no trailer). For case selection, it is assumed that the special vehicles, except the motorcycle, have the same safety limitations as the box truck. Use of these vehicles in Lanes 1 and 5 should be limited to lower speeds than for regular vehicles.

The test cases listed below will include vehicle patterns with the special vehicles included as well without special vehicles. The test cases are also listed in the recommended order for executing the test cases. Since the special vehicle drivers may be unfamiliar with site procedures, it is recommended to start with the basic tests and move to more difficult ones.

1. 2001 – Stop and Go Four Vehicle
2. 2021 – 85 MPH Two Vehicle Order A
3. 2048 – Mixed Lane Stop and Go
4. 2051 – Mixed Lane 30 MPH
5. 2053 – Mixed Lane 60 MPH

3.5 Test Cases

3.5.1 TEST CASE 2001 – STOP AND GO FOUR VEHICLE

3.5.1.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles stop in the capture zones for four striped lanes, simulating stop and go traffic on a road.

3.5.1.2 Description

Vehicles will approach the toll zone in two rows of four at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.1.3 Special Conditions

None

3.5.1.4 Special Standards

None

3.5.1.5 Iterations

Sixteen (16)

3.5.1.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	2
Midsize Car	1	1
Full-size Car	0	1
Small SUV	1	1
Large SUV	1	2
Minivan	0	1
Box Truck	0	0
Bus	1	0
Motorcycle	1	0
Tractor	1	0
Dump Truck	1	0
Interior OBU	8	8
Exterior OBU	-	-

3.5.1.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in if performing special vehicles testing Table 20 or Table 21 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will assemble their vehicles in the order shown in Table 20 or Table 21 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 20 - Test Case 2001 Vehicle Grid (Special Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	BS	TR	SS	CC
Row 2	MT	DU	LS	MC

Table 21 – Test Case 2001 Vehicle Grid (Regular Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	LS	FC	SS	CC
Row 2	CC	MV	LS	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop within the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

8. The second row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The second row will approach the gantry at no more than 15 MPH and will stop as necessary based on previous row stopping in the capture zone.

10. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

11. After clearing the gantry and unless it is the last iteration, the vehicles will return to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 20 or Table 21 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until sixteen (16) iterations are complete.

3.5.1.1 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. Vehicles <Vehicle Number> will be on your left and right.

    a. SECOND ROW ONLY - The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. SECOND ROW ONLY - Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don’t exceed 30 MPH.

9. You will drive 16 laps.

3.5.2 TEST CASE 2002 – 10 MPH FOUR VEHICLE

3.5.2.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and low speeds in the striped lanes.

3.5.2.2 Description

Vehicles will approach and proceed through the toll zone four at a time at a constant speed of 10 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.2.3 Special Conditions

None

3.5.2.4 Special Standards

None

3.5.2.5 Iterations

Thirty-one (31)

3.5.2.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	1
Full-size Car	2
Small SUV	1
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	7
Exterior OBU	1

3.5.2.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in .

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer

Table 21 – Test Case 2002 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	CC	FC	MV	MC
Row 2	MV	SS	FC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. The second row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The second row will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will follow return to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until thirty-one (31) iterations are complete.

3.5.2.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.
2. Vehicles <Vehicle Numbers> are to your left and right.
    a. SECOND ROW ONLY - The vehicle in front of you is <Vehicle Number>.
3. Go when directed to.
4. Approach and proceed through the gantry at 10 MPH.
5. SECOND ROW ONLY - Do not pass the vehicles in front of you, no matter which lane they are in.
6. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive 31 laps.

3.5.3 TEST CASE 2003 – 30 MPH THREE VEHICLE

3.5.3.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and moderate speeds in the striped lanes.

3.5.3.2 Description

Vehicles will approach and proceed through the toll zone three at a time at a constant speed of 30 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.3.3 Special Conditions

None

3.5.3.4 Special Standards

None

3.5.3.5 Iterations

Twenty-eight (28)

3.5.3.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	8
Exterior OBU	1

3.5.3.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 22.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 23 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 23 – Test Case 2003 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	MC	LS	MV	
Row 2	SS	MV		FC
Row 3		SS	CC	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the time that check of the vehicles is completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 24 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

3.5.3.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 30 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 28 laps.

3.5.4 TEST CASE 2004 – 85 MPH TWO VEHICLE – ORDER A

3.5.4.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the striped lanes.

3.5.4.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 85 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.4.3 Special Conditions

None

3.5.4.4 Special Standards

None

3.5.4.5 Iterations

Twelve (12)

3.5.4.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	2
Midsize Car	0	2
Full-size Car	1	1
Small SUV	1	2
Large SUV	1	1
Minivan	1	1
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Tractor	1	0
Dump Truck	1	0
Interior OBU	9	9
Exterior OBU	1	1

3.5.4.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 24 if performing special vehicles testing or Table 25 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 24 or Table 25 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 25 - Test Case 2004 Vehicle Grid (Special Vehicles)

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1	DU				SS		
Row 2			TR		BX		
Row 3	CC		BS				
Row 4			LS		FC		
Row 5	MT				MV		

Table 26 – Test Case 2004 Vehicle Grid (Regular Vehicles)

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1	MC				SS		
Row 2			CC		BX		
Row 3	CC		MC				
Row 4			LS		FC		
Row 5	SS				MV		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 85 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 85 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 24 or Table 25 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twelve (12) iterations are complete.

3.5.4.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 85 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 12 laps.

3.5.5 TEST CASE 2005 – 85 MPH TWO VEHICLE – ORDER B

3.5.5.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the striped lanes.

3.5.5.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 85 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.5.3 Special Conditions

None

3.5.5.4 Special Standards

None

3.5.5.5 Iterations

Thirty-One (31)

3.5.5.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	1
Box Truck	0
Interior OBU	7
Exterior OBU	1

3.5.5.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 27.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 29 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 28 – Test Case 2005 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1	CC				CC		
Row 2			SS		MV		
Row 3	LS		MC				
Row 4	FC		SS				

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 85 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 85 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 30 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until thirty-one (31) iterations are complete.

3.5.5.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.
2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.
3. Go when directed to.
4. Approach and proceed through the gantry at 85 MPH.
5. Do not pass the vehicles in front of you.
6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.
7. You will drive 31 laps.

3.5.6 TEST CASE 2006 – STRADDLE LANE THREE VEHICLE STOP AND GO

3.5.6.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles stop in the capture zones for three straddle lanes, simulating stop and go traffic on a road.

3.5.6.2 Description

Vehicles will approach the toll zone in three rows of three at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which will be a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.6.3 Special Conditions

None

3.5.6.4 Special Standards

None

3.5.6.5 Iterations

Twenty-eight (28)

3.5.6.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	1
Full-size Car	0
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1
Interior OBU	8
Exterior OBU	1

3.5.6.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 27.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 27 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 31 – Test Case 2006 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
		Lane 12	Lane 23	Lane 34	
Row 1		SS	MV	MC	
Row 2		SS	CC	LS	
Row 3		LS	BX	MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop between the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at no more than 15 MPH and will stop as necessary based on previous vehicles stopping in the capture zone.

10. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

11. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 27 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-eight (28) iterations are complete.

3.5.6.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Try to center yourself on the lane stripe.

2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your rows in Lane <Assignment>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

9. You will drive 28 laps.

3.5.7 TEST CASE 2007 – STOP AND GO FOUR VEHICLE

3.5.7.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles stop in the capture zones for four straddle lanes, simulating stop and go traffic on a road.

3.5.7.2 Description

Vehicles will approach the toll zone in two rows of four at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which will be a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.7.3 Special Conditions

None

3.5.7.4 Special Standards

None

3.5.7.5 Iterations

Thirty-one (31)

3.5.7.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	1
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	7
Exterior OBU	1

3.5.7.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 28.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 28 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 32 – Test Case 2007 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	LS	FC	CC	LS
Row 2	MC	SS	MV	MV

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop between the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

8. The second row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The second row will approach the gantry at no more than 15 MPH and will stop as necessary based on previous row stopping in the capture zone.

10. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

11. After clearing the gantry and unless it is the last iteration, the vehicles will return to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 28 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until thirty-one (31) iterations are complete.

3.5.7.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Try to center yourself on the lane stripe.

2. Vehicles <Vehicle Number> will be on your left and right.

    a. SECOND ROW ONLY - The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. SECOND ROW ONLY - Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

9. You will drive 31 laps.

3.5.8 TEST CASE 2008 – STRADDLE LANE FOUR VEHICLE 10 MPH

3.5.8.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and low speeds in the straddle lanes.

3.5.8.2 Description

Vehicles will approach and proceed through the toll zone four at a time at a constant speed of 10 MPH.

Each vehicle will have a designated travel lane which will be a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.8.3 Special Conditions

None

3.5.8.4 Special Standards

None

3.5.8.5 Iterations

Thirty-one (31)

3.5.8.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	1
Full-size Car	2
Small SUV	1
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	7
Exterior OBU	1

3.5.8.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 33.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 35 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 34 – Test Case 2008 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	CC	SS	FC	MV
Row 2	FC	MV	LS	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. The second row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The second row will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 36 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until thirty-one (31) iterations are complete.

3.5.8.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Try to center yourself on the lane stripe.

2. Vehicles <Vehicle Numbers> are to your left and right.

    a. SECOND ROW ONLY - The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach and proceed through the gantry at 10 MPH.

5. SECOND ROW ONLY - Do not pass the vehicles in front of you, no matter which lane they are in.

6. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

7. You will drive 31 laps.

3.5.9 TEST CASE 2009 – STRADDLE LANE TWO VEHICLE 85 MPH

3.5.9.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the straddle lanes.

3.5.9.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 85 MPH in the straddle lanes.

Each vehicle will have a designated travel lane which will be a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.9.3 Special Conditions

None

3.5.9.4 Special Standards

None

3.5.9.5 Iterations

Twenty-five (25)

3.5.9.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.9.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 37.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 39 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 38 – Test Case 2009 Vehicle Grid

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1	MC				SS		
Row 2			MC				FC
Row 3					MV		MV
Row 4	LS						CC
Row 5			SS		LS		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 85 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 40 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

3.5.9.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Try to center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 85 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 25 laps.

3.5.10 TEST CASE 2010 – STOP AND GO LANE 3 ONLY

3.5.10.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles stop in the capture zones in only one lane, simulating stop and go traffic on a road.

3.5.10.2 Description

Vehicles will approach the toll zone in a single column in Lane 3 at a slow speed of less than 15 MPH. Each vehicle will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, each vehicle will proceed through the rest of the toll zone.

Each vehicle will be in Lane 3 for each iteration of the test case.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.10.3 Special Conditions

None

3.5.10.4 Special Standards

None

3.5.10.5 Iterations

Twenty-five (25)

3.5.10.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	0
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	1
Interior OBU	9
Exterior OBU	1

3.5.10.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 31.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 31 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 41 – Test Case 2010 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1			SS	
Row 2			MV	
Row 3			MC	
Row 4			SS	
Row 5			BX	
Row 6			LS	
Row 7			CC	
Row 8			MC	
Row 9			MV	
Row 10			CC	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the vehicles will all begin at once and proceed towards the capture zone at no more than 15 MPH.

8. Vehicles will approach the gantry at no more than 15 MPH and will stop as necessary based on previous vehicles stopping in the capture zone.

9. When a vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of in Table 31 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

3.5.10.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane 3. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

9. You will drive 25 laps.

3.5.11 TEST CASE 2011 – MIXED LANE STOP AND GO

3.5.11.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles are using both striped and straddle lanes while stopping in the capture zones, simulating stop and go traffic on a road.

3.5.11.2 Description

Vehicles will approach the toll zone in four rows of two to three vehicles at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.11.3 Special Conditions

None

3.5.11.4 Special Standards

None

3.5.11.5 Iterations

Twelve (12)

3.5.11.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	2
Full-size Car	1	2
Small SUV	0	2
Large SUV	1	1
Minivan	1	2
Box Truck	1	0
Bus	1	0
Motorcycle	1	0
Tractor	1	0
Dump Truck	1	0
Interior OBU	9	9
Exterior OBU	1	1

3.5.11.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 32 if performing special vehicles testing or Table 33 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 32 or Table 33 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 42 - Test Case 2011 Vehicle Grid (Special Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	DU	LS		
Row 2	CC	MV	BS	
Row 3	MT		FC	
Row 4	MC	BX	TR	

Table 43 – Test Case 2011 Vehicle Grid (Regular Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	FC	LS		
Row 2	CC	MV	SS	
Row 3	MC		FC	
Row 4	MC	SS	MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the time that check of the vehicles is completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop between the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach the gantry at no more than 15 MPH and will stop as necessary based on previous row stopping in the capture zone.

10. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

11. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 32 or Table 33 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twelve (12) iterations are complete.

3.5.11.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don’t exceed 30 MPH.

9. You will drive 12 laps.

3.5.12 TEST CASE 2012 – MIXED LANE 10 MPH

3.5.12.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and low speeds when vehicles are using both striped and straddle lanes.

3.5.12.2 Description

Vehicles will approach and proceed through the toll zone two or three at a time at a constant speed of 10 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.12.3 Special Conditions

None

3.5.12.4 Special Standards

None

3.5.12.5 Iterations

Twenty-five (25)

3.5.12.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	1
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1
Interior OBU	9
Exterior OBU	1

3.5.12.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in **Table 34**.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in **Table 34** in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 44 – Test Case 2012 Vehicle Grid

	Lane 1		Lane 2	Lane 3	Lane 4
		Lane 12	Lane 23	Lane 34	
Row 1	SS		CC	MV	
Row 2			LS		MC
Row 3			LS		FC
Row 4		CC		BX	SS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of **Table 34** following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 11 until twenty-five (25) iterations are complete.

3.5.12.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 10 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

7. You will drive 25 laps.

3.5.13 TEST CASE 2013 – MIXED LANE 30 MPH

3.5.13.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and moderate speeds when vehicles are using both striped and straddle lanes.

3.5.13.2 Description

Vehicles will approach and proceed through the toll zone two or three at a time at a constant speed of 30 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.13.3 Special Conditions

None

3.5.13.4 Special Standards

None

3.5.13.5 Iterations

Twelve (12)

3.5.13.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	2
Midsize Car	1	1
Full-size Car	1	2
Small SUV	1	1
Large SUV	1	2
Minivan	1	2
Box Truck	0	0
Bus	1	0
Motorcycle	1	0
Tractor	1	0
Dump Truck	1	0
Interior OBU	9	9
Exterior OBU	1	1

3.5.13.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 45 if performing special vehicles testing or Table 46 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 45 or Table 46 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 45 - Test Case 2013 Vehicle Grid (Special Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5
	Lane 12	Lane 23	Lane 34	Lane 45	
Row 1		MC			FC
Row 2		SS	TR	LS	
Row 3			BS		MV
Row 4		DU		CC	MT

Table 46 – Test Case 2013 Vehicle Grid (Regular Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5
	Lane 12	Lane 23	Lane 34	Lane 45	
Row 1		MC			FC
Row 2		SS	MV	LS	
Row 3			CC		MV
Row 4		FC		CC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 45 or Table 46 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twelve (12) iterations are complete.

3.5.13.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 30 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 12 laps.

3.5.14 TEST CASE 2014 – MIXED LANE 60 MPH

3.5.14.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and high speeds when vehicles are using both striped and straddle lanes.

3.5.14.2 Description

Vehicles will approach and proceed through the toll zone at a time at a constant speed of 60 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.14.3 Special Conditions

None

3.5.14.4 Special Standards

None

3.5.14.5 Iterations

Twelve (12)

3.5.14.6 Equipment

Item	Special Vehicles Testing Quantity	Regular Vehicles Testing Quantity
Compact Car	1	1
Midsize Car	1	2
Full-size Car	0	1
Small SUV	1	2
Large SUV	1	2
Minivan	1	1
Box Truck	1	1
Bus	1	0
Motorcycle	1	0
Tractor	1	0
Dump Truck	1	0
Interior OBU	9	9
Exterior OBU	1	1

3.5.14.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 37 if performing special vehicles testing or Table 38 if only regular vehicles are to be used.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 37 or Table 38 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 47 - Test Case 2014 Vehicle Grid (Special Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	MT		MV	
Row 2	BX	SS		
Row 3	BS	CC		
Row 4		LS	DU	
Row 5	TR		MC	

Table 48 – Test Case 2014 Vehicle Grid (Regular Vehicles)

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	FC		MV	
Row 2	BX	SS		
Row 3	LS	CC		
Row 4		LS	SS	
Row 5	MC		MC	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach and proceed through the gantry at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 37 or Table 38 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twelve (12) iterations are complete.

3.5.14.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 12 laps.

3.5.15 TEST CASE 2015 – STOP AND GO SIDE-BY-SIDE

3.5.15.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving in a stop and go manner.

3.5.15.2 Description

Vehicles will approach the toll zone in five rows of two vehicles at a slow speed of less than 15 MPH with reduced lateral separation. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

3.5.15.3 Special Conditions

None

3.5.15.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left, e.g. If a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the IAG.

3.5.15.5 Iterations

Twenty-five (25)

3.5.15.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.15.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 39.

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 39 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 49 – Test Case 2015 Vehicle Grid

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1	LS		CC				
Row 2			FC		SS		
Row 3		LS		FC			
Row 4	CC		SS				
Row 5		MC		MV			

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop between the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach the gantry at no more than 15 MPH and will stop as necessary based on previous row stopping in the capture zone.

10. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not aligned with the vehicle on the left.

11. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 39 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

12. The vehicles will repeat Steps 7 to 11 until twenty-five (25) iterations are complete.

    a. If an incorrect lane is reported, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will mark the iteration for later review and immediately proceed to the next iteration without further data review.

3.5.15.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don’t adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

    a. Right vehicle – The left vehicle may get a little ahead or behind your vehicle. Do not worry much about this but try and keep the side-to-side spacing low.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area. You can speed up but don’t exceed 30 MPH.

9. You will drive 25 laps.

3.5.16 TEST CASE 2016 – 10 MPH SIDE-BY-SIDE

3.5.16.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving at low speeds.

3.5.16.2 Description

Vehicles will approach and proceed through the toll zone in five rows of two vehicles at a constant speed of 10 MPH with reduced lateral separation.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

3.5.16.3 Special Conditions

None

3.5.16.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left, e.g. if a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the IAG.

3.5.16.5 Iterations

Twenty-five (25)

3.5.16.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.16.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 40.

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 40 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 50 – Test Case 2016 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1					MV		FC
Row 2		CC		LS			
Row 3			MC		LS		
Row 4					MV		SS
Row 5	MC		CC				

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH. Vehicles in a row may proceed through the gantry without being synchronized with other vehicles in the row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other

vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not synchronized with the vehicle on the left.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 40 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

    a. If an incorrect lane is reported, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will mark the iteration for later review and immediately proceed to the next iteration without further data review.

3.5.16.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don’t adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach and proceed through the gantry at 10 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area using. You can speed up but don’t exceed 30 MPH.

7. You will drive 25 laps.

3.5.17 TEST CASE 2017 – 30 MPH SIDE-BY-SIDE

3.5.17.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving at moderate speeds.

3.5.17.2 Description

Vehicles will approach and proceed through the toll zone in five rows of two vehicles at a constant speed of 30 MPH with reduced lateral separation.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

3.5.17.3 Special Conditions

None

3.5.17.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left, e.g. if a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the IAG.

3.5.17.5 Iterations

Twenty-five (25)

3.5.17.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.17.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in .

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 51 – Test Case 2017 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1			MC		FC		
Row 2			MV		CC		
Row 3			CC		LS		
Row 4		SS		MV			
Row 5	MC		SS				

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH. Vehicles in a row may proceed through the gantry without being synchronized with other vehicles in the row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other

vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not synchronized with the vehicle on the left.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 8 to 13 until twenty-five (25) iterations are complete.

    a. If an incorrect lane is reported, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will mark the iteration for later review and immediately proceed to the next iteration without further data review.

3.5.17.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don’t adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach and proceed through the gantry at 30 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 25 laps.

3.5.18 TEST CASE 2018 – 60 MPH SIDE-BY-SIDE

3.5.18.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving at high speeds.

3.5.18.2 Description

Vehicles will approach and proceed through the toll zone in five rows of two vehicles at a constant speed of 60 MPH with reduced lateral separation.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

3.5.18.3 Special Conditions

None

3.5.18.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left, e.g. If a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the IAG.

3.5.18.5 Iterations

Twenty-five (25)

3.5.18.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.18.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in .

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 52 – Test Case 2018 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1				SS		MC	
Row 2		MV		SS			
Row 3					FC		LS
Row 4			MC		MV		
Row 5					CC		LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH. Vehicles in a row may proceed through the gantry without being synchronized with other vehicles in the row.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach and proceed through the gantry at 60 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other

vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not synchronized with the vehicle on the left.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

    a. If an incorrect lane is reported, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will mark the iteration for later review and immediately proceed to the next iteration without further data review.

3.5.18.8Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don’t adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 25 laps.

3.5.19 TEST CASE 2019 – 10 MPH THREE VEHICLE SIMULTANEOUS

3.5.19.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles are arriving simultaneously in the capture zones at low speeds.

3.5.19.2 Description

Vehicles will approach and proceed through the toll zone in two rows of three vehicles at a constant speed of 10 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.19.3 Special Conditions

None

3.5.19.4 Special Standards

'Simultaneous' is a qualitative standard and an iteration shall not be rerun if there is a lag between the two vehicles in a row going through the capture zone.

3.5.19.5 Iterations

Twenty-eight (28)

3.5.19.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	2
Small SUV	1
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	8
Exterior OBU	1

3.5.19.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in **Table 43**.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in **Table 43** in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 53 – Test Case 2019 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1	FC		SS		CC		
Row 2	LS				CC		MV
Row 3	MV		MC		FC		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH and synchronize their movements, so they pass through the capture zone at the same time.

8. The second row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The second row will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of **Table 43** following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

3.5.19.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach and proceed through the gantry at 10 MPH.
5. Stay aligned with the other vehicle in your row through the plaza.
    a. If the left vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.
6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Left vehicle - Remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles - Be aware that you may have to slow down as the left vehicle maintains this distance.
7. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.
8. You will drive 28 laps.

3.5.20 TEST CASE 2020 – 30 MPH THREE VEHICLE SIMULTANEOUS

3.5.20.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles are arriving simultaneously in the capture zones at moderate speeds.

3.5.20.2 Description

Vehicles will approach and proceed through the toll zone in three rows of three vehicles at a constant speed of 30 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.20.3 Special Conditions

None

3.5.20.4 Special Standards

'Simultaneous' is a qualitative standard and an iteration shall not be rerun if there is a lag between the two vehicles in a row going through the capture zone.

3.5.20.5 Iterations

Twenty-eight (28)

3.5.20.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	1
Full-size Car	2
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	8
Exterior OBU	1

3.5.20.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 54.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 54 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 54 – Test Case 2020 Vehicle Grid

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	SS		CC	LS
Row 2	SS	MV	FC	
Row 3		MC	FC	MV

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH and synchronize their movements, so they pass through the capture zone at the same time.

8. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. The following rows will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 54 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

3.5.20.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach and proceed through the gantry at 30 MPH.
5. Stay aligned with the other vehicle in your row through the plaza.
    a. If the left vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.
6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Left vehicle - Remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles - Be aware that you may have to slow down as the left vehicle maintains this distance.
7. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.
8. You will drive 28 laps.

3.5.21 TEST CASE 2021 – TWO VEHICLE LOW SPEED ACCELERATION

3.5.21.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles at a time accelerate through the capture zone from a low to a medium speed.

3.5.21.2 Description

Vehicles will approach the toll zone two at about 10 MPH and then accelerate to no more than 40 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.21.3 Special Conditions

None

3.5.21.4 Special Standards

None

3.5.21.5 Iterations

Twenty-five (25)

3.5.21.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.21.7Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in **Table 45**.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in **Table 45** in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 55 – Test Case 2021 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1			MC				LS
Row 2		LS			MC		
Row 3	FC						CC
Row 4			MV		FC		
Row 5	SS			SS			

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at 10 MPH and as they near the capture zone markers, accelerate up to 40 MPH while passing through the capture zone. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at 10 MPH and as they near the capture zone markers, accelerate up to 40 MPH while passing through the capture zone. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of **Table 45** following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until Twenty-five (25) iterations are complete.

3.5.21.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.
2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.
3. Go when directed to.
4. Approach the gantry at 10 MPH.
5. When you near the capture zone markers, speed up to 40 MPH. Don't start too early as you still want to be speeding up as you pass by both sets of markers.
6. Do not pass the vehicles in front of you.
7. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.
8. You will drive 25 laps.

3.5.22 TEST CASE 2022 – TWO VEHICLE MEDIUM SPEED ACCELERATION

3.5.22.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles at a time accelerate through the capture zone from a medium to a high speed.

3.5.22.2 Description

Vehicles will approach the toll zone two at about 30 MPH and then accelerate to no more than 60 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.22.3 Special Conditions

None

3.5.22.4 Special Standards

None

3.5.22.5 Iterations

Twenty-five (25)

3.5.22.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.22.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 46.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 46 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 56 – Test Case 2022 Vehicle Grid

	Lane 1		Lane 2		Lane 3		Lane 4
		Lane 12		Lane 23		Lane 34	
Row 1	MC				SS		
Row 2	MC		LS				
Row 3	SS		MV				
Row 4			CC		FC		
Row 5	CC				MV		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at 30 MPH and as they near the capture zone markers, accelerate up to 60 MPH while passing through the capture zone. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at 30 MPH and as they near the capture zone markers, accelerate up to 60 MPH while passing through the capture zone. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 46 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

3.5.22.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach the gantry at 30 MPH.

5. When you near the capture zone markers, speed up to 60 MPH. Don't start too early as you still want to be speeding up as you pass by both sets of markers.

6. Do not pass the vehicles in front of you.

7. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

8. You will drive 25 laps.

3.5.23 TEST CASE 2023 – TWO VEHICLE MEDIUM SPEED DECELERATION

3.5.23.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles at a time decelerate through the capture zone from a medium to a low speed.

3.5.23.2 Description

Vehicles will approach the toll zone two at about 40 MPH and then decelerate to around 10 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.23.3 Special Conditions

None

3.5.23.4 Special Standards

None

3.5.23.5 Iterations

Twenty-five (25)

3.5.23.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	1
Small SUV	2
Large SUV	1
Minivan	1
Box Truck	1
Interior OBU	9
Exterior OBU	1

3.5.23.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 47.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 47 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 57 – Test Case 2023 Vehicle Grid

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1					MC		MV
Row 2	MC				CC		
Row 3			SS				BX
Row 4	FC			SS			
Row 5	LS				CC		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at 40 MPH and as they near the capture zone markers, decelerate down to about 10 MPH while passing through the capture zone. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at 40 MPH and as they near the capture zone markers, decelerate down to about 10 MPH while passing through the capture zone. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 47 following the instructions of the OBU/Vehicle Organizer.

   a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

3.5.23.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.
2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.
3. Go when directed to.
4. Approach the gantry at 40 MPH.
5. When you near the capture zone markers, slow down to 10 MPH. Don't start too early as you don't want to slow down before reaching the first marker or coming to a complete stop.
6. Do not pass the vehicles in front of you.
7. Once you get past the gantry, return to the assembly area using. Do not exceed 30 MPH.
8. You will drive 25 laps.

3.5.24 TEST CASE 2024 – TWO VEHICLE PASSING

3.5.24.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles are passing through the capture zone at different speeds.

3.5.24.2 Description

Vehicles will approach the toll zone two at a time. One vehicle will go first and drive around 30 MPH through the capture zone. A second vehicle will follow in a different lane at around 60 MPH and should pass through the capture zone at about the same time as the other vehicle.

Each vehicle will have a designated travel lane which may be a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.24.3 Special Conditions

None

3.5.24.4 Special Standards

None

3.5.24.5 Iterations

Thirteen (13)

3.5.24.6 Equipment

Item	Quantity
Compact Car	1
Midsize Car	2
Full-size Car	0
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1
Interior OBU	9
Exterior OBU	1

3.5.24.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 48.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 48 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 58 – Test Case 2024 Vehicle Grid and Speed

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1			CC 60 MPH		SS 30 MPH		
Row 2			LS 60 MPH		BX 30 MPH		
Row 3	MV 60 MPH				MC 30 MPH		
Row 4	SS 60 MPH		LS 30 MPH				
Row 5	MV 60 MPH				MC 30 MPH		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the slow vehicle in the first row will approach and proceed through the capture zone at 30 MPH.

8. The OBU/Vehicle Organizer will wave a flag to indicate that the fast vehicle should proceed approximately 6 seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the first vehicle. This vehicle will approach and proceed through the capture zone at 60 MPH.

9. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. They will follow the same process as Steps 9 and 10 with the slow vehicle in the row being sent and then the fast vehicle so that they should arrive in the capture zone at about the same time. There will be a six second gap between vehicles in the row and four second gaps between the last vehicle in one row and the first vehicle in the next. The gaps may be adjusted as deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test case.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 48 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-five (25) iterations are complete.

3.5.24.8Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach Instructions:

    a. Slow Driver – Approach and go through the gantry at about 30 MPH. The other vehicle should catch up to you about the time you are passing under the gantry.

    b. Fast Driver – Approach and go through the gantry at about 60 MPH. You should catch up to the other vehicle about the time you are passing under the gantry.

5. Stay behind the vehicles in the rows before you by at least 5 feet no matter what lane that vehicle is in.

6. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

7. You will drive 25 laps.

3.5.25 TEST CASE 2025 – BRAKING/ACCELERATION

3.5.25.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles are going through the capture zone and one vehicle is braking while the other is accelerating.

3.5.25.2 Description

Vehicles will approach the toll plaza at about 45 MPH. As they reach the capture zone, one vehicle will accelerate to 60 MPH, one vehicle will decelerate by breaking to 25 MPH.

Each vehicle will have a designated travel lane which may be a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.25.3 Special Conditions

None

3.5.25.4 Special Standards

None

3.5.25.5 Iterations

Twenty-eight (28)

3.5.25.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	1
Full-size Car	1
Small SUV	1
Large SUV	2
Minivan	1
Box Truck	1
Interior OBU	8
Exterior OBU	1

3.5.25.7Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 49.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 49 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 59 – Test Case 2025 Vehicle Grid and Action

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1			MV Accelerate		BX Decelerate		LS Constant
Row 2		FC Accelerate		LS Decelerate		MV Constant	
Row 3	MC Accelerate		SS Decelerate		CC Constant		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row of vehicles will approach the toll plaza at 45 MPH and as they near the capture zone markers, one vehicle will accelerate to 60 MPH, one vehicle will begin decelerating down to 25 MPH and the third vehicle will remain at 45 MPH.

8. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about five seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at 45 MPH and as they near the capture zone markers, one vehicle will begin accelerating to 60 MPH, one vehicle will begin decelerating down to 25 MPH

and the third vehicle will remain at 45 MPH. Vehicles shall not pass any vehicles in any other lanes and shall maintain a few feet of spacing with any vehicle directly in front of them.

10. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 49 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

11. The vehicles will repeat Steps 7 to 10 until twenty-eight (28) iterations are complete.

3.5.25.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach the plaza at about 45 MPH.

5. Capture Zone Instructions –

    a. Accelerating Vehicle – When you reach the markers, speed up to 60 MPH. The other vehicle in your row will be staying at 45 MPH or slowing down.

    b. Decelerating Vehicle – When you reach the markers, slow down to 25 MPH. The other vehicle in your row will be staying at 45 MPH or speeding up.

    c. Constant Vehicle – Stay at 45 MPH through the gantry. One of the other vehicles will be slowing down while the other speeds up.

6. Stay behind the vehicle before you by at least 5 feet no matter what lane that vehicle is in.

7. Once you get past the gantry, return to the assembly area using. Do not exceed 30 MPH.

8. You will drive 28 laps.

3.5.26 TEST CASE 2026 – STOPPED VEHICLE IN LANE

3.5.26.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when one vehicle is stopped in the capture zone for several seconds while other vehicles briefly stop in the capture zones, simulating stop and go traffic on a road.

3.5.26.2 Description

Vehicles will approach the toll zone in at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, most vehicles will proceed through the rest of the toll zone. Two vehicles will be designated to sit in the capture zone for a longer period of time before proceeding.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

3.5.26.3 Special Conditions

None

3.5.26.4 Special Standards

If a vehicle is stopped in the capture zone for a period longer than the timeout, multiple reads from that vehicle from that lane are acceptable.

3.5.26.5 Iterations

Twenty-five (25)

3.5.26.6 Equipment

Item	Quantity
Compact Car	2
Midsize Car	2
Full-size Car	2
Small SUV	1
Large SUV	1
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.26.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 50.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 50 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 60 – Test Case 2026 Vehicle Grid

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1	MV		LS Stopped				
Row 2	SS				FC		
Row 3	CC				MV		
Row 4			MC		MC Stopped		
Row 5	FC		CC				

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first vehicle will proceed through the approach area at no more than 15 MPH and come to a complete stop in the capture zone for 10 seconds or as appropriate for the RSE configuration before proceeding through the rest of the gantry where appropriate is at least a few seconds less than the configured timeout parameter.

8. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

9. Vehicles will approach the gantry at no more than 15 MPH. The driver must ensure that they remain behind the vehicle in the previous row no matter what lane the previous vehicle is in with the exception of the Hold vehicles.

10. When each vehicle reaches the capture zone, it will come to a complete stop for a period depending on its status before proceeding through the rest of the gantry.

    a. Vehicles with 'Hold' in Table 50 will stay stopped at the gantry for 10 seconds or as appropriate for the RSE configuration before proceeding.

    a. All other vehicles will stop in the capture zone for about a second before proceeding.

11. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 50 following the instructions of the OBU/Vehicle Organizer.

    a. When reassembling, vehicles will need to provide some space for the Hold vehicles to get back into the proper start position.

    b. If it is the last iteration, the vehicles will return to the staging area

12. The vehicles will repeat Steps 7 to 11 until twenty-five (25) iterations are complete.

3.5.26.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignment>. Vehicle <Vehicle Number> will be in Lanes <Assignment>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for at least:

    a. If a Hold vehicle – 10 seconds (or as appropriate for the RSE configuration). Vehicles will pass you while you are sitting here.

    b. All other vehicles – 1 second. You may pass a vehicle stopped in a lane.

8. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

    a. If a Hold vehicle, use lanes 1 or 4 to get back to your correct spot.

b. All other vehicles, provide room for the Hold vehicles to pass by you.

c. If the vehicle before you is a Hold vehicle, make sure there is enough room when you come back around for that vehicle to get back in front of you.

9. You will drive 25 laps.

3.5.27 TEST CASE 2027 – CHANGING LANES TWO VEHICLES 10 MPH

3.5.27.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment with two vehicles changing in or near the capture zone while traveling at low speed.

3.5.27.2 Description

Vehicles will approach the gantry two at a time at a speed of 10 MPH. As they near or enter the capture zone, they will change lanes.

Each vehicle will have a designated travel lane at the beginning and a designated travel lane to switch into. These lanes may be either a striped lane or a straddle lane. The beginning and end lanes may also be different types. E.g. Start in a straddle lane and end in a striped lane. These lanes will be the same for each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.27.3 Special Conditions

None

3.5.27.4 Special Standards

OBUs must be reported once but acceptable lanes to report from include:

- The travel lane the OBU-equipped vehicle started in;
- The travel lane the vehicle ended in; and
- Any striped or straddle lanes between the start and end lanes.

3.5.27.5Iterations

Twenty-five (25)

3.5.27.6 Equipment

Item	Quantity
Compact Car	2
Midsize car	1
Full-size car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.27.7Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 51.

2. OBU/Vehicle Organizers will assign a driver to each vehicle and each driver will move their vehicle from the parking area to the staging area.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 51 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 61 - Test Case 2027 Starting Vehicle Grid Positions

	Lane 1	Lane 2	Lane 3	Lane 4
	Lane 12	Lane 23	Lane 34	
Row 1	SS			MC
Row 2			CC	LS
Row 3		MV	FC	
Row 4	FC			CC
Row 5		MV	LS	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed to the capture zone at 10 MPH.

8. Upon reaching the capture zone, the vehicles will perform the lane changes shown in Table 62 while maintaining a speed of 10 MPH.

Table 62 - Test Case 2027 Lane Changes

	Left Vehicle	Right Vehicle
Row 1	Lane 1 to Lane 2	Lane 4 to Lane34
Row 2	Lane 3 to Lane 2	Lane 4 to Lane 3
Row 3	Lane 23 to Lane 2	Lane 34 to Lane 3
Row 4	Lane 12 to Lane 2	Lane 4 to Lane 3
Row 5	Lane 2 to Lane 1	Lane 34 to Lane 23

9. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

10. The vehicles will approach the capture zone at 10 MPH and remain behind the vehicle in the previous row no matter what lane the previous row is in. Vehicles will not have to be synchronized with the other vehicles in the row.

11. Upon reaching the capture zone the vehicles will perform the lane changes shown in Table 62 while maintaining a speed of 10 MPH.

    The vehicles will be arranged in the pattern shown in Table 53 after they go through the gantry:

Table 63 - Test Case 2027 Final Vehicle Grid Positions

	Lane 1	Lane 2	Lane 3	Lane 4
		Lane 12	Lane 23	Lane 34	
Row 1		SS	MC	
Row 2		CC	LS	
Row 3		MV	FC	
Row 4		FC	CC	
Row 5	MV	LS	

12. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 51 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the parking area.

13. The vehicles will repeat Steps 7 to 12 until twenty-five (25) iterations are complete.

3.5.27.8 DRIVER INSTRUCTIONS

1. You will drive in a <Insert Vehicle Type> in Lane <Insert Assignment>.

2. Vehicle <Insert Number> will be in Lane <Insert Lane>. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>.

3. Go when directed to.

4. Approach the gantry at 10 MPH.

5. Remain behind the vehicles in the previous row no matter what lanes the previous row is in. If in the same lane as you, stay back at least 10 feet.

6. You do not have to be synchronized with the other vehicle in the row.

7. As you reach the capture zone markers, change into Lane <Insert New Lane>. The other vehicle in your row will be shifting into Lane <Insert New Lane>.

8. Once you get past the gantry, return to the assembly area. You can speed up but don't exceed 30 MPH.

9. When you get back around to the assembly area, return to your starting position and lane.

10. You will drive 25 laps.

3.5.28 TEST CASE 2028 – CHANGING LANES TWO VEHICLES 30 MPH

3.5.28.1Purpose

Test that the system can capture and report toll transactions in an ORT environment with two vehicles changing in or near the capture zone while traveling at moderate speed.

3.5.28.2Description

Vehicles will approach the gantry two at a time at a speed of 30 MPH. As they near or enter the capture zone, they will change lanes.

Each vehicle will have a designated travel lane at the beginning and a designated travel lane to switch into. These lanes may be either a striped lane or a straddle lane. The beginning and end lanes may also be different types, e.g. start in a straddle lane and end in a striped lane. These lanes will be the same for each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.28.3 Special Conditions

None

3.5.28.4 Special Standards

OBUs must be reported once but acceptable lanes to report from include:

- The travel lane the OBU-equipped vehicle started in;
- The travel lane the vehicle ended in; and
- Any striped or straddle lanes between the start and end lanes.

3.5.28.5 Iterations

Twenty-five (25)

3.5.28.6 Equipment

Item	Quantity
Compact Car	2
Midsize car	2
Full-size car	1
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	0
Interior OBU	9
Exterior OBU	1

3.5.28.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 54.

2. OBU/Vehicle Organizers will assign a driver to each vehicle and each driver will move their vehicle from the parking area to the staging area.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 54 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 64 - Test Case 2028 Starting Vehicle Grid Positions

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4
Row 1					SS		MC
Row 2			CC				MV
Row 3	MC		LS				
Row 4	LS				FC		
Row 5			CC			MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed to the capture zone at 30 MPH.

8. Upon reaching the capture zone, the vehicles will perform the lane changes shown in Table 65 while maintaining a speed of 30 MPH.

Table 65 - Test Case 2028 Lane Changes

	Left Vehicle	Right Vehicle
Row 1	Lane 3 to Lane 2	Lane 4 to Lane 5
Row 2	Lane 23 to Lane 12	Lane 4 to Lane 3
Row 3	Lane 2 to Lane 3	Lane 5 to Lane 4
Row 4	Lane 12 to Lane 23	Lane 3 to Lane 4
Row 5	Lane 34 to Lane 3	Lane 45 to Lane 4

9. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

10. The vehicles will approach the capture zone at 30 MPH and remain behind the vehicle in the previous row no matter what lane the previous row is in. Vehicles will not have to be synchronized with the other vehicles in the row.

11. Upon reaching the capture zone the vehicles will perform the lane changes shown in Table 65 while maintaining a speed of 30 MPH.

    The vehicles will be arranged in the pattern shown in Table 56 after they go through the gantry:

Table 66 - Test Case 2028 Final Vehicle Grid Positions

	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5
	Lane 12	Lane 23	Lane 34	Lane 45	
Row 1	SS				MC
Row 2	CC		MV		
Row 3			LS	MC	
Row 4		LS		FC	
Row 5			MV	CC	

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 54 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the parking area.

14. The vehicles will repeat Steps 7 to 13 until twenty-five (25) iterations are complete.

3.5.28.8DRIVER INSTRUCTIONS

1. You will drive in a <Insert Vehicle Type> in Lane <Insert Assignment>.

2. Vehicle <Insert Number> will be in Lane <Insert Lane>. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>.

3. Go when directed to.

4. Approach the gantry at 30 MPH.

5. Remain behind the vehicles in the previous row no matter what lanes the previous row is in. If in the same lane as you, stay back at least 10 feet.

6. You do not have to be synchronized with the other vehicle in the row.

7. As you reach the capture zone markers, change into Lane <Insert New Lane>. The other vehicle in your row will be shifting into Lane <Insert New Lane>.

8. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

9. When you get back around to the assembly area, return to your starting position and lane.

10. You will drive 25 laps.

3.5.29 TEST CASE 2029 – CHANGING LANES TWO VEHICLES 60 MPH

3.5.29.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment with two vehicles changing in or near the capture zone while traveling at high speed.

3.5.29.2 Description

Vehicles will approach the gantry two at a time at a speed of 60 MPH. As they near or enter the capture zone, they will change lanes.

Each vehicle will have a designated travel lane at the beginning and a designated travel lane to switch into. These lanes may be either a striped lane or a straddle lane. The beginning and end lanes may also be different types. E.g. Start in a straddle lane and end in a striped lane. These lanes will be the same for each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.5.29.3 Special Conditions

None

3.5.29.4 Special Standards

OBUs must be reported once but acceptable lanes to report from include:

- The travel lane the OBU-equipped vehicle started in;
- The travel lane the vehicle ended in; and
- Any striped or straddle lanes between the start and end lanes.

3.5.29.5Iterations

Thirteen (13)

3.5.29.6 Equipment

Item	Quantity
Compact Car	2
Midsize car	2
Full-size car	2
Small SUV	1
Large SUV	2
Minivan	1
Box Truck	0
Interior	9
Exterior OBU	1

3.5.29.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 57.

2. OBU/Vehicle Organizers will assign a driver to each vehicle and each driver will move their vehicle from the parking area to the staging area.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU, record the serial number and plate number of the vehicle.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 57 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 67 - Test Case 2029 Starting Vehicle Grid Positions

	Lane 1	Lane 12	Lane 2	Lane 23	Lane 3	Lane 34	Lane 4	Lane 45	Lane 5
Row 1			LS						CC
Row 2					MC		MV		
Row 3			CC						MC
Row 4	FC				SS				
Row 5			FC						LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area. At the completion of the check the Test Coordinator will record the Test Case and the date and time that vehicle checks completed.

7. Upon command from the Test Coordinator, the first row will proceed to the capture zone at 60 MPH.

8. Upon reaching the capture zone, the vehicles will perform the lane changes shown in Table 68 while maintaining a speed of 60 MPH.

Table 68 - Test Case 2029 Lane Changes

	Left Vehicle	Right Vehicle
Row 1	Lane 2 to Lane 3	Lane 5 to Lane 4
Row 2	Lane 3 to Lane 2	Lane 4 to Lane 5
Row 3	Lane 23 to Lane 3	Lane 5 to Lane 4
Row 4	Lane 12 to Lane 2	Lane 3 to Lane 34
Row 5	Lane 23 to Lane 12	Lane 5 to Lane 4

9. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

10. The vehicles will approach the capture zone at 60 MPH and remain behind the vehicle in the previous row no matter what lane the previous row is in. Vehicles will not have to be synchronized with the other vehicles in the row.

11. Upon reaching the capture zone the vehicles will perform the lane changes shown in Table 68 while maintaining a speed of 60 MPH.

    The vehicles will be arranged in the pattern shown in Table 59 after they go through the gantry:

Table 69 - Test Case 2029 Final Vehicle Grid Positions

	Lane 1		Lane 2		Lane 3		Lane 4		Lane 5
		Lane 12		Lane 23		Lane 34		Lane 45	
Row 1					LS		CC		
Row 2			MC						MV
Row 3					CC		MC		
Row 4			FC		SS				
Row 5	FC						LS		

12. After clearing the gantry and unless it is the last iteration, the vehicles will return back to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 57 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the parking area.

13. The vehicles will repeat Steps 7 to 12 until thirteen (25) iterations are complete.

3.5.29.8 DRIVER INSTRUCTIONS

1. You will drive in a <Insert Vehicle Type> in Lane <Insert Assignment>.

2. Vehicle <Insert Number> will be in Lane <Insert Lane>. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>.

3. Go when directed to.

4. Approach the gantry at 60 MPH.

5. Remain behind the vehicles in the previous row no matter what lanes the previous row is in. If in the same lane as you, stay back at least 10 feet.

6. You do not have to be synchronized with the other vehicle in the row.

7. As you reach the capture zone markers, change into Lane <Insert New Lane>. The other vehicle in your row will be shifting into Lane <Insert New Lane>.

8. Once you get past the gantry, return to the assembly area. Do not exceed 30 MPH.

9. When you get back around to the assembly area, return to your starting position and lane.

10. You will drive 25 laps.

IAG Test Plan Use Cases vs Vendor Recommendations - Equipment Test Cases - Reader

READER PERFORMANCE TESTING OPTIONS

								1 - vehicle instrumented with the following tag mix						2 - Tri-protocol tag	
								TDM Tag Mix		6C Tag Mix		SeGo Tag Mix		Transcore NP2	
2.5	Plaza Test Cases	Test Case (Use for Reference to Test Plan)	New Test Case	Spec Veh	Num of Vehicles	Laps	Vehicle passes	Interior	Bumper	Interior	Head-lamp	Interior	Under Bumper	Interior	Under Bumper
2.5.1	Test Case 1015 – 30 MPH Three Vehicle Travel Lanes	1003	1001		9	25	225	9		9		9		9	
2.5.2	Test Case 1017 – Gated Three Vehicle Simultaneous – Order A	1004	1002		9	25	225	8	1	8	1	8	1	8	1
2.5.3	Test Case 1018 – Gated Three Vehicle Simultaneous – Order B	1005	1003	Y	9	25	225	8	1	8	1	8	1	8	1
2.5.4	Test Case 1020 – 5 MPH Three Vehicle Simultaneous	1006	1004		9	35	315	9		9		9		9	
2.5.5	Test Case 1026 – 30 MPH Three Vehicle Simultaneous	1007	1005	Y	9	35	315	8	1	8	1	8	1	8	1
2.5.6	Test Case 1041 – Three Vehicle Low Speed Acceleration	1008	1006		9	25	225	9		9		9		9	
2.5.7	Test Case 1044 – Three Vehicle Deceleration	1009	1007		9	25	225	9		9		9		9	
2.5.8	Test Case 1045 – Passing	1010	1008		10	25	250	9	1	9	1	9	1	9	1
2.5.9	Test Case 1046 – Braking/Acceleration	1011	1009		10	25	250	9	1	9	1	9	1	9	1
2.5.10	Test Case 1047 – Simulated Manual Interaction	1012	1010		10	25	250	9	1	9	1	9	1	9	1
							2,505	2,345	160	2,345	160	2,345	160	7,035	480
												TRANSACTIONS:	7,515		7,515

								1 - vehicle instrumented with the following tag mix						2 - Tri-protocol tag	
								TDM Tag Mix		6C Tag Mix		SeGo Tag Mix		Transcore NP2	
3.5	ORT Test Cases	Test Case (Use for Reference to Test Plan)	New Test Case	Spec Veh	Num of Vehicles	Laps	Vehicle passes	Interior	Bumper	Interior	Head-lamp	Interior	Under Bumper	Interior	Under Bumper
3.5.1	Test Case 2002 – Stop and Go Four Vehicle	2001	2001	Y	8	35	280	7	1	7	1	7	1	7	1
3.5.2	Test Case 2016 – 30 MPH Three Vehicle	2003	2002		9	35	315	9		9		9		9	
3.5.3	Test Case 2021 – 85 MPH Two Vehicle – Order A	2004	2003	Y	10	35	350	9	1	9	1	9	1	9	1
3.5.4	Test Case 2022 – 85 MPH Two Vehicle – Order B	2005	2004		8	35	280	8		8		8		8	
3.5.5	Test Case 2024 – Straddle Lane Three Vehicle Stop and Go	2006	2005		9	35	315	8	1	8	1	8	1	8	1
3.5.7	Test Case 2036 – Straddle Lane Two Vehicle 85 MPH	2009	2006		10	35	350	10		10		10		10	
3.5.8	Test Case 2048 – Mixed Lane Stop and Go	2011	2007	Y	10	35	350	10		10		10		10	
3.5.9	Test Case 2051 – Mixed Lane 30 MPH	2013	2008	Y	10	35	350	10		10		10		10	
3.5.10	Test Case 2053 – Mixed Lane 60 MPH	2014	2009	Y	10	35	350	9	1	9	1	9	1	9	1
3.5.11	Test Case 2054 – Stop and Go Side-By-Side	2015	2010		10	35	350	9	1	9	1	9	1	9	1
3.5.12	Test Case 2057 – 30 MPH Side-By-Side	2017	2011		10	35	350	10		10		10		10	
3.5.13	Test Case 2059 – 60 MPH Side-By-Side	2018	2012		10	35	350	9	1	9	1	9	1	9	1

3.5.14	Test Case 2065 – 30 MPH Three Vehicle Simultaneous	2020	2013		9	35	315	9		9		9		9	
3.5.15	Test Case 2068 – Two Vehicle Low Speed Acceleration	2021	2014		10	35	350	10		10		10		10	
3.5.16	Test Case 2071 – Two Vehicle Passing	2024	2015		10	35	350	10		10		10		10	
3.5.17	Test Case 2072 – Braking/Acceleration	2025	2016		8	35	280	8		8		8		8	
3.5.18	Test Case 2073 – Stopped Vehicle in Lane	2026	2017		10	35	350	10		10		10		10	
3.5.19	Test Case 2074 – Changing Lanes Two Vehicles 10 MPH	2027	2018		10	35	350	10		10		10		10	
3.5.20	Test Case 2076 – Changing Lanes Two Vehicles 30 MPH	2028	2019		10	35	350	10		10		10		10	
3.5.21	Test Case 2078 – Changing Lanes Two Vehicles 60 MPH	2029	2020		10	35	350	10		10		10		10	
							6,685	**6,475**	**210**	**6,475**	**210**	**6,475**	**210**	**19,425**	**630**
												TRANSACTIONS:	**20,055**		**20,055**

Special Vehicle Tests (for Iterations, see same Test Case number above)

								1 - vehicle instrumented with the following tag mix						**2 - Tri-protocol tag**	
								TDM Tag Mix		**6C Tag Mix**		**SeGo Tag Mix**		**Transcore NP2**	
2.5	**Plaza Test Cases**	**Test Case(Use for Reference to Test Plan)**	**New Test Case**		**Num of Vehicles**	**Laps**	**Vehicle passes**	**Interior**	**Roof**	**Interior**	**Head-lamp**	**Interior**	**Under Bumper**	**Interior**	**Under Bumper**
2.5.3	Test Case 1018 – Gated Three Vehicle Simultaneous – Order B	1005	1003		9	20	180	7	2	7	2	7	2	7	2
2.5.5	Test Case 1026 – 30 MPH Three Vehicle Simultaneous	1007	1005		9	20	180	7	2	7	2	7	2	7	2
							360	**280**	**80**	**280**	**80**	**280**	**80**	**840**	**240**
												TRANSACTIONS:	**1,080**		**1,080**

NOTE:

Roof mounts should be mounted on the Bus and Box Truck

								1 - each vehicle instrumented with the following tag mix						**2 - Tri-protocol tag**	
								TDM Tag Mix		**6C Tag Mix**		**SeGo Tag Mix**		**Transcore NP2**	
3.5	**ORT Test Cases**	**Test Case**	**New Test Case**		**Num of Vehicles**	**Laps**	**Vehicle passes**	**Interior**	**Roof**	**Interior**	**Head-lamp**	**Interior**	**Under Bumper**	**Interior**	**Under Bumper**
3.5.1	Test Case 2002 – Stop and Go Four Vehicle	2001	2001		8	15	120	4	4	4	4	4	4	4	4
3.5.3	Test Case 2021 – 85 MPH Two Vehicle – Order A	2004	2003		10	15	150	4	4	4	4	4	4	4	4
3.5.8	Test Case 2048 – Mixed Lane Stop and Go	2011	2007		10	15	150	6	4	6	4	6	4	6	4
3.5.9	Test Case 2051 – Mixed Lane 30 MPH	2013	2008		10	15	150	6	4	6	4	6	4	6	4
3.5.10	Test Case 2053 – Mixed Lane 60 MPH	2014	2009		10	15	150	6	4	6	4	6	4	6	4
							720	**390**	**300**	**390**	**300**	**390**	**300**	**390**	**300**
												TRANSACTIONS:	**2,070**		**690**

NOTE:

Roof mounts should be mounted on the Bus, Box Truck, Large SVU and Small SVU

PLAZA TRANSACTIONS:	**8,595**
ORT TRANSACTIONS:	**22,125**

IAG Test Plan Use Cases vs Vendor Recommendations - Equipment Test Cases - Reader

TOTAL TRANSACTIONS: **30,720**

Specialty Tag Tests

		Test Case			Num of Vehicles	Laps	Vehicle passes
	Switcable Tag				5	10	50
	Feedback Tag				5	10	50
							100

Standard Vehicle Types	**Qty**
Compact Car	2
Midsize Car	2
Full-size Car	2
Small SUV	2
Large SUV	2
Minivan	2
Motorcycle	2
	14

Special Vehicle Types	**Qty**
Box Truck	1
Bus	1
	2

TAG PERFORMANCE TESTING

2.5	Plaza Test Cases	Test Case (Use for Reference to Test Plan)	New Test Case	Spec Veh	Num of Vehicles	Laps	Vehicle passes	Each tag protocol type requires individual runs with mixtures below					
								TDM Tag Mix		6C Tag Mix		SeGo Tag Mix	
								Interior	Bumper	Interior	Head-lamp	Interior	Under Bumper
2.5.1	Test Case 1015 – 30 MPH Three Vehicle Travel Lanes	1003	1001	Y	9	25	225	9		9		9	
2.5.2	Test Case 1017 – Gated Three Vehicle Simultaneous – Order A	1004	1002		9	25	225	8	1	8	1	8	1
2.5.3	Test Case 1018 – Gated Three Vehicle Simultaneous – Order B	1005	1003	Y	9	25	225	8	1	8	1	8	1
2.5.4	Test Case 1020 – 5 MPH Three Vehicle Simultaneous	1006	1004		9	35	315	9		9		9	
2.5.5	Test Case 1026 – 30 MPH Three Vehicle Simultaneous	1007	1005	Y	9	35	315	8	1	8	1	8	1
2.5.6	Test Case 1041 – Three Vehicle Low Speed Acceleration	1008	1006		9	25	225	9		9		9	
2.5.7	Test Case 1044 – Three Vehicle Deceleration	1009	1007		9	25	225	9		9		9	
2.5.8	Test Case 1045 – Passing	1010	1008		10	25	250	9	1	9	1	9	1
2.5.9	Test Case 1046 – Braking/Acceleration	1011	1009		10	25	250	9	1	9	1	9	1
2.5.10	Test Case 1047 – Simulated Manual Interaction	1012	1010		10	25	250	9	1	9	1	9	1
							2,505	2,345	160	2,345	160	2,345	160
							TRANSACTIONS:		2,505		2,505		2,505

NOTE:

Use IAG approved Kapsch MPR to test TDM and 6C tags for performance of read/write
USE IAG approved Transcore MPR to test SeGo tags for performance of read/write
If a "feedback" and/or a switchable tag is offered then at least 1 of each type must replace one of the standard interior tags

3.5	ORT Test Cases	Test Case (Use for Reference to Test Plan)	New Test Case	Spec Veh	Num of Vehicles	Laps	Vehicle passes	Each tag protocol type requires individual runs with mixtures below					
								TDM Tag Mix		6C Tag Mix		SeGo Tag Mix	
								Interior	Bumper	Interior	Head-lamp	Interior	Under Bumper

3.5.1	Test Case 2002 – Stop and Go Four Vehicle	2001	2001	Y	8	35	280	7	1	7	1	7	1
3.5.2	Test Case 2016 – 30 MPH Three Vehicle	2003	2002		9	35	315	9		9		9	
3.5.3	Test Case 2021 – 85 MPH Two Vehicle – Order A	2004	2003	Y	10	35	350	9	1	9	1	9	1
3.5.4	Test Case 2022 – 85 MPH Two Vehicle – Order B	2005	2004		8	35	280	8		8		8	
3.5.5	Test Case 2024 – Straddle Lane Three Vehicle Stop and Go	2006	2005		9	35	315	8	1	8	1	8	1
3.5.7	Test Case 2036 – Straddle Lane Two Vehicle 85 MPH	2009	2006		10	35	350	10		10		10	
3.5.8	Test Case 2048 – Mixed Lane Stop and Go	2011	2007	Y	10	35	350	10		10		10	
3.5.9	Test Case 2051 – Mixed Lane 30 MPH	2013	2008	Y	10	35	350	10		10		10	
3.5.10	Test Case 2053 – Mixed Lane 60 MPH	2014	2009	Y	10	35	350	9	1	9	1	9	1
3.5.11	Test Case 2054 – Stop and Go Side-By-Side	2015	2010		10	35	350	9	1	9	1	9	1
3.5.12	Test Case 2057 – 30 MPH Side-By-Side	2017	2011		10	35	350	10		10		10	
3.5.13	Test Case 2059 – 60 MPH Side-By-Side	2018	2012		10	35	350	9	1	9	1	9	1
3.5.14	Test Case 2065 – 30 MPH Three Vehicle Simultaneous	2020	2013		9	35	315	9		9		9	
3.5.15	Test Case 2068 – Two Vehicle Low Speed Acceleration	2021	2014		10	35	350	10		10		10	
3.5.16	Test Case 2071 – Two Vehicle Passing	2024	2015		10	35	350	10		10		10	
3.5.17	Test Case 2072 – Braking/Acceleration	2025	2016		8	35	280	8		8		8	
3.5.18	Test Case 2073 – Stopped Vehicle in Lane	2026	2017		10	35	350	10		10		10	
3.5.19	Test Case 2074 – Changing Lanes Two Vehicles 10 MPH	2027	2018		10	35	350	10		10		10	
3.5.20	Test Case 2076 – Changing Lanes Two Vehicles 30 MPH	2028	2019		10	35	350	10		10		10	
3.5.21	Test Case 2078 – Changing Lanes Two Vehicles 60 MPH	2029	2020		10	35	350	10		10		10	
							6,685	**6,475**	**210**	**6,475**	**210**	**6,475**	**210**
								TRANSACTIONS:	**6,685**		**6,685**		**6,685**

NOTE:

Use IAG approved Kapsch MPR to test TDM and 6C tags for performance of read/write

USE IAG approved Transcore MPR to test SeGo tags for performance of read/write

If a "feedback" and/or a switchable tag is offered then at least 1 of each type must replace one of the standard interior tags

Special Vehicle Tests (for laps, see same Test Case number above)

								Each tag protocol type requires individual runs with mixtures below					
								TDM Tag Mix		**6C Tag Mix**		**SeGo Tag Mix**	
2.5	**Plaza Test Cases**	**Test Case (Use for Reference to Test Plan)**	**New Test Case**		**Num of Vehicles**	**Laps**	**Vehicle passes**	**Interior**	**Roof**	**Interior**	**Head-lamp**	**Interior**	**Under Bumper**
2.5.3	Test Case 1018 – Gated Three Vehicle Simultaneous – Order B	1005	1003		9	20	180	7	2	7	2	7	2
2.5.5	Test Case 1026 – 30 MPH Three Vehicle Simultaneous	1007	1005		9	20	180	7	2	7	2	7	2
							360	**280**	**80**	**280**	**80**	**280**	**80**

TRANSACTIONS:	360	360	360

NOTE:

Use IAG approved Kapsch MPR to test TDM and 6C tags for performance of read/write
USE IAG approved Transcore MPR to test SeGo tags for performance of read/write
If a "feedback" and/or a switchable tag is offered then at least 1 of each type must replace one of the standard interior tags
Roof mounts should be mounted on the Bus and Box Truck

								Each tag protocol type requires individual runs with mixtures below					
								TDM Tag Mix		6C Tag Mix		SeGo Tag Mix	
3.5	**ORT Test Cases**	**Test Case (Use for Reference to Test Plan)**	**New Test Case**		**Num of Vehicles**	**Laps**	**Vehicle passes**	**Interior**	**Roof**	**Interior**	**Head-lamp**	**Interior**	**Under Bumper**
3.5.1	Test Case 2002 – Stop and Go Four Vehicle	2001	2001		8	15	120	4	4	4	4	4	4
3.5.3	Test Case 2021 – 85 MPH Two Vehicle – Order A	2004	2003		10	15	150	6	4	6	4	6	4
3.5.8	Test Case 2048 – Mixed Lane Stop and Go	2011	2007		10	15	150	6	4	6	4	6	4
3.5.9	Test Case 2051 – Mixed Lane 30 MPH	2013	2008		10	15	150	6	4	6	4	6	4
3.5.10	Test Case 2053 – Mixed Lane 60 MPH	2014	2009		10	15	150	6	4	6	4	6	4
							720	**420**	**300**	**420**	**300**	**420**	**300**
							TRANSACTIONS:		**720**		**720**		**720**

NOTE:

Use IAG approved Kapsch MPR to test TDM and 6C tags for performance of read/write
USE IAG approved Transcore MPR to test SeGo tags for performance of read/write
If a "feedback" and/or a switchable tag is offered then at least 1 of each type must replace one of the standard interior tags
Roof mounts should be mounted on the Bus, Box Truck, Large SVU and Small SVU

PLAZA TRANSACTIONS:	**2,865**
ORT TRANSACTIONS:	**7,405**
TOTAL TRANSACTIONS:	**10,270**

Specialty Tag Tests

		Test Case			Num of Vehicles	Laps	Vehicle passes
	Switcable Tag				5	10	50
	Feedback Tag				5	10	50
							100

Standard Vehicle Types **Qty**

Compact Car	2
Midsize Car	2
Full-size Car	2
Small SUV	2
Large SUV	2
Minivan	2
Motorcycle	2
	14

Special Vehicle Types	**Qty**
Box Truck	1
Bus	1
	2

Attachment 4- Approved Reader List

Below is the list of current Approved Readers in E-ZPass. As new Equipment is Approved and becomes available, this list will be updated as required by the E-ZPass Group.

Manufacture	Equipment	Protocols	Software & Firmware	Date Approved	Notes
Kapsch	Janus Single protocol	IAG		3/15/2013	Changed boot time to 100 seconds
Kapsch	Janus MPR 2.0	IAG		June 2014	Single Protocol only
Kapsch	Janus MPR 2.3	IAG	MPR2.3 Reader Software Version 2015mar07a-MPR2	5/28/2015	Single Protocol only
Kapsch	Janus MPR 2.3	IAG * (&6C)		2/10/2016	Both protocols Tested and passed. due to policy TDM only approved.
Kapsch	Janus MPR 2.3	IAG & 6C	MPR2.3 Reader Software Version 2016feb02a-MPR2na	12/7/2016	NCTA only until FAT completed
Kapsch	Janus MPR 2.3	IAG Read & Write 6C & SeGo Read only Or IAG and 6C Read & Write Or IAG Read & Write	MPR2.3 Reader Software Version 2017Jun23a-MPR2na ▪ MRFMS Module Firmware Version: 2017May12-1033-04	10/17/2017	Approved for 3 protocols with staggered antennas only. Will not meet KPI's if 3 protocols used with inline antennas. TDM only is approved for either inline or staggered Staggered mainline antenna is leading center.
Kapsch	Janus Portable RSE	IAG		9/21/2016 & 11/20/2016	In Nov 16 changed HOV Enforcement page

Attachment 5 – Transponder and Reader Protocol Specifications

https://www.e-zpassiag.com/ | Interoperability | TDM Specifications

https://www.e-zpassiag.com/ | Interoperability | SeGo Specifications

http://6c-toc.com/, "6C TOC AVI Standard Version 3.2 as included below

AVI STANDARD

REQUIREMENTS AND GUIDANCE DOCUMENT

VERSION 3.2

DECEMBER 13, 2019

Document Control

Originator:	6C Coalition
Report Title:	AVI Standard (formerly the "AVI Transponder Programming Standard")
History:	V 0.1 – Initial Draft Release
	V 0.2 – Updates to "State" portion of EPC field Hash Key changed from 16 to 32 bytes Version Code added to Transponder Serial Number Field
	V 0.3 – Existing System Compatibility section added
	V 0.4 – Transponder and Reader Technical Requirements section added
	V 0.5 – Move Technical Requirements Section
	V 0.6 – Update to Barcode format and EPC/Password validation calculation examples
	V 0.7 – Update to User Memory Password validation calculation example and addition of comment regarding HOT declaration in EPC field
6/5/12	V 1.0 – Updated Agency Codes (E-470 changed from 1 to 2); Made the Barcode format optional; Prohibited Read protection of User Data Memory; Allowed optional Write protection of User Data Memory; Updated references to the TID length to allow use of all fully serialized ISO 18000-6C standard transponders
11/20/14	V 2.0 – Updated the name of the document; redesigned memory map; convert from EPCglobal format to ISO format; security update; changes to permit declarable transponders; updated Barcode format
10/26/15	V 3.0 – Fixed encoding details according to ISO requirements, giving more detail as needed. Combined State and Agency fields to be single Agency field and added Agency ID appendix. Clarified UII validation calculation.
1/28/16	V 3.0 Revision 2 – Added logo to cover page; clarified barcode format; corrected sample calculation of UII Validation hashing value.
3/15/16	V 3.0 Revision 3 – Added DSFID (0x3E) to be programmed as initial 2 bytes of UII.

7/22/16	V 3.0 Revision 4 – Added additional Agency codes to Appendix A. Corrected first bullet of 4.2 to reference new DSFID field in UII.
2/9/17	V 3.1 – Document title changed. Revised language in Section 1.1 to address backward compatibility. Deleted reference to backward compatibility in Section 1.2. Inserted Section 1.3 to clarify certification. Created a new Section 3 "Transponder Requirements" by combining previous barcode format and transponder manifest and adding transponder characteristics and environmental requirements. Previous Section 4 "Data Security" has been renumbered as Section 5 and has been edited to clarify Lock Status and Passwords. New Section 4 "Reader Requirements" has been created to clarify optional ISO Reader commands. Section 6 regarding backward compatibility and programming versions used by toll operators has been removed. Appendix A, code for TCA consolidated.
5/11/17	V 3.1 Revision 1 – Edited 3.1 to indicate method for calculating read distances of transponder parameters. Added clarification language to 3.1.1 and 3.1.2. Changed values and units for polarization and pointing loss in 3.1.3. Updated Agency ID list in Appendix A. Edits list of optional reader commands in 4.1
12/13/19	V 3.2 – Incorporated requirements from the 6C Coalition Interoperability Requirements and Certification Framework document (Document A) to a revamped Section 3. Removed requirement for 512bit minimum size of User Data. Formatting updates. Removed Agency ID listing (Appendix A) as it will now be a standalone document. Added new Appendix A (Legacy Toll Transponder Information) and Appendix B (Transponder Filtering).

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to create and maintain a standard based on the 2010 and subsequent version of the ISO/IEC 18000-63 (known as 6C) communication protocol for tolling applications that use automatic vehicle identification (AVI). The guidance is intended for transponder and reader manufacturers, toll lane vendors, system integrators, back-office providers, and other members of the RFID industry. The current programming requirements standards are backward compatible to all previous versions of the standard deployed. A few toll operators have deployed 6C transponders prior to the adoption of Version 1.0 and continue to use their legacy systems. More information on legacy 6C memory maps used by toll operators can be found on the 6C Coalition website and in Appendix A of this document.

1.2 Scope

This document addresses the following areas of interest:

- Transponder Memory Mapping
- Interoperability Requirements
- Barcode Format
- Transponder Manifest Details
- Security and Data Integrity Validation

1.3 Interoperability

This AVI Standard provides a reference that enables device manufacturers to produce interoperable transponders and readers. It also provides a standard that integrators and agencies can use to verify conformance that ensures interoperability. Certification is the primary method of verifying conformance with the 6C Coalition AVI Standard.

1.4 Definitions, Acronyms, and Abbreviations

6C	Refers to the Type C portion of the ISO/IEC 18000-6 Type C UHF standard, including later updates to Type C of the ISO/IEC 18000-63 standard
AFI	Application Family Identifier
CRC	Cyclic Redundancy Check
DSFID	Data Storage Format Identifier
EPC	Electronic Product Code
HOV	High Occupancy Vehicle
IEC	International Electrotechnical Commission

ISO	International Organization for Standardization
NAK	Negative Acknowledgement
PC	Protocol Control
RFID	Radio Frequency Identification
TID	Transponder Identification Gen2 transponder memory bank 10
TSN	Transponder Serial Number
UII	Unique Item Identifier, ISO/IEC 18000-63 (formerly '6C'), transponder memory bank 01
XPC	Extended protocol control

2 TRANSPONDER MEMORY MAPPING

The 6C transponder memory is separated into four memory as shown in Table 1 below.

Table 1: Transponder Memory Map

Bank #	Purpose
Bank 00	Reserved
Bank 01	CRC, PC, UII
Bank 10	TID
Bank 11	User Memory

2.1 Reserved Memory Bank 00 Specification

The Reserved memory shall be programmed by the transponder provider and contents shared with the issuing agency.

2.2 CRC, PC, UII Memory Bank 01 Specification

Memory Bank 01 contains three addressed areas:

1. Stored CRC – This 16-bit long area is stored at memory location **0x00 – 0x0F** and calculated by the transponder.
2. Stored PC – This area is 16 bits long stored at memory location **0x10 – 0x1F**. The PC word contains the Application Family Identifier (AFI) – an 8-bit identifier (value **0xB0**) assigned to the 6C Coalition. This number can be used to filter the responses of V3.0 and later transponders to ensure that only toll transponders are being read. The ISO assigned this protocol control number for tolling, along with the Data Storage Format Identifier (DSFID, value **0x3E** which is programmed into the first byte of the UII memory area) and explicitly describes a transponder belonging to the 6C Coalition.

The Stored PC is encoded during chip initialization and is dependent on the type of chip being encoded, not on data within an individual transponder.

3. Unique Item Identifier (UII) – This area contains at least 96 bits of information beginning at memory location **0x20**. Any memory in excess of 96 bits remains undefined for this standard but usable by the issuing agency. However, the additional memory shall not interfere with any of the functionality contained in this document. The UII shall provide read-only access to users. The issuing agency may lock write access permanently or may allow write access by a password maintained by the issuing agency.

2.2.1 Memory Bank 01 Mapping

The following tables describe the memory mapping for Bank 01. The tables and values within the tables appear in Memory Address (hex value) order ascending.

Table 2: Stored CRC Memory Bank 01 Mapping

#	Memory Address	Section	Description	Values
1-16	00h-0Fh (16 bits)	Calculated	Calculated value based on other transponder memory values per ISO 18000-63 specification	Varies

Table 3: Stored PC Memory Bank 01 Mapping

#	Memory Address	Section	Description	Values
1-5	10h-14h (5 bits)	Length	Number of 16-bit words in the UII	00110 = 6 words (indicates 96-bit UII) Varies based on UII length
6	15h (1 bit)	User Memory	Indicates status of the User Memory	0 = No user memory 1 = User memory available
7	16h (1 bit)	XPC	Indicates status of extended transponder features	0 = No XPC 1 = XPC available
8	17h (1 bit)	Numbering System Indicator	Indicates whether transponder coded as EPC or ISO	0 = EPC 1 = ISO (correct value for 6C Coalition applications)
9-16	18h-1Fh (8 bits)	AFI	Application Family Identifier for 6C Coalition – B0h	1011 0000 = 6C Coalition AFI (B0h)

Table 4: UII Memory Bank 01 Mapping

#	Memory Address	Section	Description	Values
1-8	20h-27h (8 bits)	DSFID	Data Storage Format Identifier for 6C Coalition – 3Eh	0011 1110 = 6C Coalition DSFID (3Eh)

#	Memory Address	Section	Description	Values
9 -21	28h–34h (13 bits)	Agency Use	Individual agencies may add agency specific information here.	Assigned by agency
22-33	35h-40h	Classification	Classification is taken directly from EZPass Inter-Customer Service Center Interface File and Reporting Specifications, Appendix C and includes:	
	(1 bit)	Class	The first bit indicates if the transponder has been assigned a classification value. If 0 is selected, the following 11 bits shall be ignored.	0 = No class value assigned (default) 1 = Class value assigned
	(5 bits)	Vehicle Type	This field indicates the type of vehicle.	00000 = Undefined (default) 00001 = Automobile 00010 = Motorcycle 00011 = Pickup truck 00100 = Van (seats 1-9) 00101 = Minibus (seats 10-15) 00110 = Bus (seats 16+) 00111 = Recreational vehicle 01000 = Truck 01001 = Auto transporter (≤ 65’) 01010 = Auto transporter (>65’) 01011 = Tractor & trailer (≤48’) 01100 = Tractor & trailer (>48’) 01101 = Tractor & dual trailers each (≤28.5’) 01110 = Tractor & dual trailers each (>28.5’) 01111 = Tractor & dual trailers each (one ≤28.5’ other >28.5’) 10000 = Undefined 10001 = Tractor/mobile home combination 10010-11111 = Undefined
	(4 bits)	Vehicle Axles	This field indicates the number of axles.	0000 = Undefined (default) 0001 = Undefined 0010 = 2 axles 0011 = 3 axles 0100 = 4 axles 0101 = 5 axles 0110 = 6 axles 0111 = 7 axles 1000 = 8 axles 1001 = 9 axles 1010 = 10 axles

#	Memory Address	Section	Description	Values
				1011 = 11 axles 1100 = 12 axles 1101 = 13 axles 1110 = 14 axles 1111 = 15 axles
	(1bit)	Vehicle Weight	This field indicates the weight of vehicle.	0 = ≤ 7,000 lbs. (default) 1 = > 7,000 lbs.
	(1 bit)	Vehicle Rear Tires	This field indicates the number of rear tires.	0 = Single rear tires (default) 1 = Dual rear tires
34-36	41h-43h (3 bits)	HOV Declaration	These three bits indicate the declaration status of the transponder. All single mode transponders shall be assigned the default value – 000, unless they are carpool specific transponders.	000 = Single mode (default) 001 = SOV (non-carpool) 010 = HOV 2+ 011 = HOV 3+ 100 = Carpool (as defined by roadway) 101 = Reserved for future use 110 = Reserved for future use 111 = Reserved for future use
37-40	44h-47h (4 bits)	Version	Allows for 16 possible values to indicate the version of the programming standard used on the transponder.	0000 = Unassigned 0001 = Ver. 1.0 0010 = Ver. 2.0 0011 = Ver. 3.0
41-52	48h-53h (12 bits)	Agency	Allows for up to 4,096 agencies.	See 6C Coalition Table of Agencies (separate document)
53-80	54h-6Fh (28 bits)	Transponder Serial Number	Identifies the transponder within the agency. This space accommodates 268,435,456 values.	Assigned by agency
81-96	70h-7Fh (16 bits)	UII Validation (Hash Value)	Calculated value using the first 80 UII bits and 32-byte key. Example appears in Section 6.	Assigned at the time of transponder manufacturer. Calculated as per Section 6.

2.3 TID Memory Bank 10 Specification

The Transponder Identification (TID) memory has no specific value but is assumed to be unique and constant for all 6C transponders, per the 6C standard. The TID length can vary per the 6C specification and the length of a transponder's TID serial number is indicated on each transponder, in bits 0x20 – 0x22 of the TID. For fully serialized tags, the complete header and serialized portion of the TID can be anywhere from 96 - 192 bits, given the allowable serial number length of 48 - 144 bits. Transponders which are not fully serialized (that is, have at least a 48-bit unique serial number) should not be used for interoperable 6C tolling deployments.

2.4 User Memory Bank 11 Specification

As of the publication date of this version, none of the current members of the 6C Coalition write to their transponders, nor do any of them read the User memory. It is anticipated that this memory bank may be

required to accommodate future group members or affiliates. The following general specifications shall apply.

The User memory bank shall be designated as a temporary data field, where facilities may read and write whatever information is necessary, recognizing the data may be overwritten at any time. For example, an agency operating a closed ticket type of system may choose to use this bank and write trip start date, time, location, and price as the trip begins and read this information at the conclusion of the trip. This could be used to compute the correct toll.

Any agency-specific use of User memory outside the specifications in this document should be closely coordinated to reduce the risk of future conflicts.

2.4.1 DSFID – Data Storage Format Identifier

The DSFID defines the data format for the data in User Memory. It is a value set by ISO as part of the AFI process. ISO has assigned the DSFID value **`0x3E`**, indicating the data is defined by the 6C Coalition.

The User Memory portion of the transponder shall have the format defined in Table 5 below.

Table 5: User Memory Bank 11 Mapping

#	Memory Address	Section	Description	Values
1-8	00h-07h (8 bits)	DSFID	Data Storage Format Identifier	0011 1110 = 6C TOC DSFID (3Eh)
9-20	08h-23h (12 bits)	Agency	Agency Code of agency writing to this memory bank.	See 6C Coalition Table of Agencies (separate document)
21-27	24h-1Ah (7 bits)	Plaza ID	7-bit Plaza ID. Each operator may choose.	Defined by agencies using this field.
28-32	1Bh-1Fh (5 bits)	Lane ID	5-bit Lane ID. Each operator may choose.	Defined by agencies using this field.
33-57	20h-38h (25 bits)	Day/Time	25-bit Day/Time. Each operator may choose. (seconds since Jan 01 00:00:00)	Defined by agencies using this field.
58—60	39h-3Bh (3 bits)	Occupancy Setting	3-bit Occupancy. Each operator may choose.	Defined by agencies using this field.
61+	3Ch -	Undefined	The remaining bits defined as individual agency needs arise.	

3 INTEROPERABILITY REQUIREMENTS

3.1 Overview

The purpose of these requirements is to have all compliant transponders and readers operate as seamlessly as possible from one installation to the next. They create a basis for the development and refinement of testing methods used in a certification process. The 6C Coalition uses a third party to administer and conduct the certification program.

Interoperability testing demonstrates in lab and field conditions (replicating a reference toll environment) that transponders and readers operate predictably together. Agencies and integrators purchasing these products should be assured of basic equipment interoperability, but it does not substitute for performance testing in specific tolling installations. Due to the unique nature of each tolling installation, site-specific conditions, vehicle types, environmental conditions, etc., it is incumbent upon purchasers of equipment to test and tune for desired interoperability performance levels.

All transponders that conform to this 6C Coalition standard should be operable in any AVI system using a reader that conforms to this standard, as well as supporting other aspects relevant to the procurement and management of transponders. This necessitates that:

- All transponders conform to the same 6C air interface protocol physical layer.
- All transponders must support the full mandatory set of communications from the referenced 6C air interface protocol and must operate at all mandatory data rates supported by the protocol.
- Transponder performance must be reliable, and the communication zone should be within bounded limits for common or reference systems, which includes but is not limited to RF requirements such as operating on vehicles at the same field strength and under similar RF geometries defined by the 6C Coalition.

All readers that conform to this 6C Coalition standard should be operable with all types of transponders that conform to this standard. This necessitates that:

- All the protocol communications used by the reader must conform to the referenced 6C air interface protocol. However, this does not require that all the functions or commands that are mandatory for generic interrogators in the air interface protocol be supported by toll readers.
- The reader commands NAK, Kill, and Lock are optional for readers.
- Readers can report and be limited to reporting transponders coded as 6C toll transponders, using coding as defined in this document in the presence of other 6C transponders. See Appendix B for additional information regarding filtering of legacy 6C tolling transponders.

3.2 Conformance Testing

Conformance testing shall prove devices operate in accordance with the 6C PHY (Physical) and MAC (Medium Access Control) layers. All transponders and readers shall meet the conformance requirements defined in Table 6 below.

Table 6: Conformance Testing Requirements

#	Category	Requirement
1.1	Regulatory Approvals	Meet all applicable FCC compliance requirements for Part 15 and 90
1.2	Protocol Compliance	Conform to the 6C PHY (Physical) and MAC (Medium Access Control) layers, in accordance with ISO 18047-6 or EPCglobal Conformance test methods. For transponders - include mandatory modulation rates supported by the transponder (i.e., as per ISO 18047-6) and verification of QUERY and ACK as per ISO 18047-6 or equivalent. For readers –limited to only modulation rates that the reader manufacturer specifies (i.e., as per ISO 18047-6).
1.3	Frequency Range	Operate in the 902-928 MHz frequency range.
1.4	Regulatory Verification	Meet necessary regulatory and safety certifications specified by the FCC, vendor, or 6C Coalition as required/applicable.

3.3 Baseline Testing

Baseline Testing verifies that a device meets the minimum required performance for basic functionality, RF performance, and environmental performance in a lab environment.

3.3.1 Functional Baseline Tests

Functional Baseline Tests shall verify that the transponders comply with the 6C Coalition specifications. Transponders are tested to ensure that the various memory banks are properly programmed and can be written to as specified. Readers are tested to ensure transponders are properly read and transmitted to a higher-level system (e.g., lane controller).

Functional Baseline Tests are conducted in a laboratory environment to ensure that a transponder and a reader communicate via RFID commands. Testing of transponders for commands (executed with standardized parameters and transponder user data) may be embedded in automated test scripts run on the reference reader. There shall be enough tests to ensure that all commands and parameters function correctly, and that transponder data is read/written correctly and secured. For reader testing, the vendor shall state the set of commands used for toll operation. This testing shall verify through these commands the reader's capability to select, filter, and properly read 6C Coalition transponders.

Commands and Parameters – Transponders and readers shall be tested to make sure they can transition between all internal states while executing commands. A transponder must also demonstrate additional capabilities such as Lock, Kill, EPC re-programmability via secure access, and the ability to accept write directives. A reader must demonstrate the ability to filter only 6C Coalition transponders in the read zone.

Test Parameters – Antenna height, transponder height, and distance between transponder and antenna shall be held constant.

Test Approach - A reader submitted for testing shall be tested against reference transponders. A transponder submitted for testing shall be tested against reference readers.

3.3.2 Environmental Performance

Environmental baseline testing shall verify performance of transponder under various environmental conditions.

3.3.3 RF Performance

RF Performance Baseline Tests will verify RF performance of transponders in controlled free space to ensure interoperability between devices based on the transponder characteristics specified by the 6C Coalition's requirements. Transponder testing will determine transponder minimum activation energy, backscatter range, antenna polarization, and pointing loss. The tests are conducted in a simulated operational environment, which is not meant to substitute for toll operators conducting performance accuracy testing in a real-world toll application. The EPCglobal test document titled, *Tag Performance Parameters and Test Methods Version 1.1.3*, shall serve as the basis for testing:

1. Read range (EPCglobal test document Section 8.1)
2. Orientation tolerance (EPCglobal test document Section 8.2)
3. Frequency tolerance (EPCglobal test document Section 8.3)
4. Backscatter range (EPCglobal test document Section 8.5)

All values are measured per the EPCglobal *Tag Performance Parameters and Test Methods Version 1.1.3* test protocol, limited to the 902 – 928 MHz frequency range and modified as follows:

1. Use a horizontally, linearly polarized test antenna
2. Transponders mounted on material applicable for the intended location on the vehicle

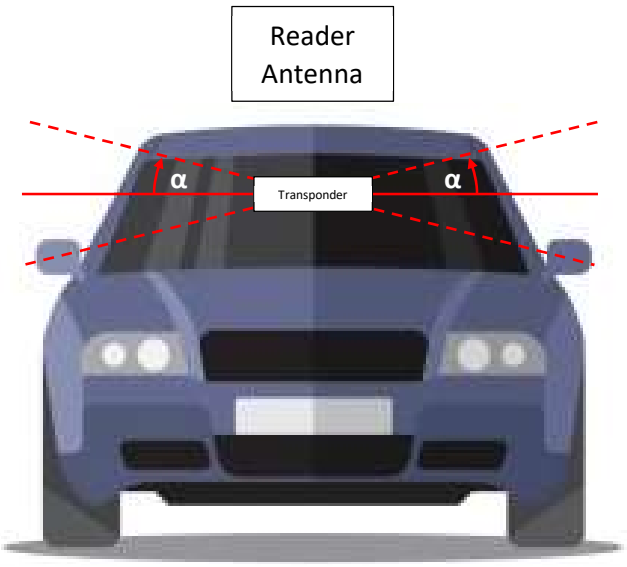
3.3.4 Transponder Requirements

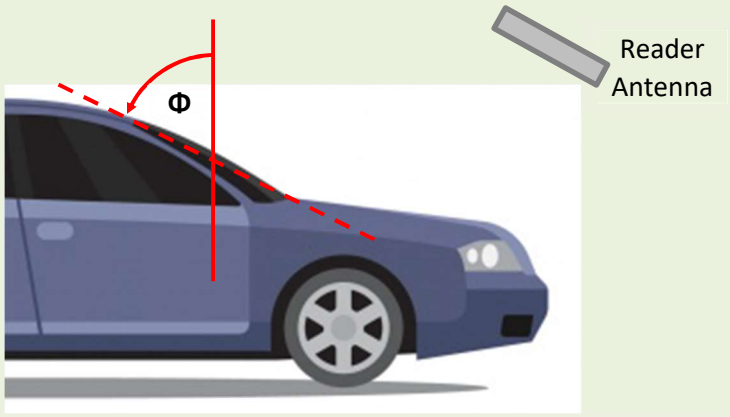
Transponders shall meet the baseline testing requirements shown in Table 7 below.

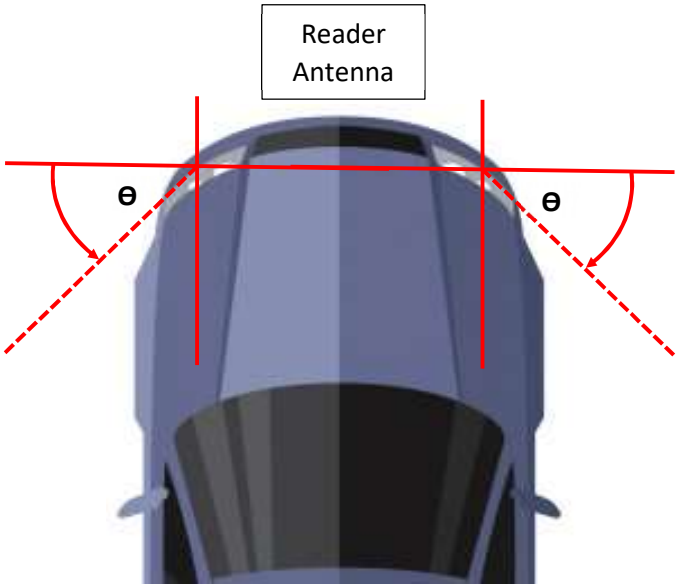
Table 7: Transponder Baseline Testing Requirements

#	Category	Requirement
2.1	Functional - Memory Bank 10	Contain a minimum of 64 bits (8 byte) unique chip ID programmed by the chip manufacturer (TID)
2.2	Functional – Memory Bank 01	Programmed per section 2.2.1 of this document
2.3	Functional - Memory Bank 11	Contains at minimum 128 bits
2.4		Programmed with the DSFID (00h-07h) set to 3Eh, 0011 1110 = 6C Coalition DSFID (3Eh)
2.5		Programmed unused and undefined bits with zeros

#	Category	Requirement
2.6	Functional - Memory Bank 00	See section 2.1 of this document
2.7	Environmental	All interior transponders – able to be subjected to and operated in 95% humidity, non-condensing environments
2.8		All exterior transponders – able operate in 100% humidity, condensing environments.
2.9		All interior transponders – able to operate at temperatures between – 40° F and +185° F.
2.10		All exterior transponders – able to operate at temperatures between – 40° F and +140° F.
2.11		All transponders – perform consistently under Ultraviolet (UV)/direct sunlight as well as in overcast conditions.
2.12	RF Performance - Minimum Activation Energy	All transponders - have a Minimum Activation Energy (forward link range) resulting in a baseline test read range between 7 m and 12 m.
2.13	RF Performance - Return Signal Strength (Backscatter Range)	All transponders - have a return signal strength/backscatter range (reverse link range) resulting in a baseline test read at a minimum of 14 m.

#	Category	Requirement
2.14	RF Performance - Antenna Polarization and Pointing Loss	All transponders - have a minimum activation energy (forward link range) for "Tilt from Horizontal" resulting in a baseline test read range, between 5 m and 12 m, when tilted +/- 15 degree horizontally (see Figure 1) from the installation reference angle defined by the transponder manufacturer. Facing the reader antenna, “Tilt from Horizontal” is the angle α from the horizontal mounting of a transponder. This represents transponders that are not installed horizontally level (“crooked”). **Tilt from horizontal reference plane (roll angle) = α**  *Figure 1: Diagram depicting roll angle between transponder and reader antenna*

#	Category	Requirement
2.15	RF Performance - Antenna Polarization and Pointing Loss	All transponders - have a minimum activation energy (forward link range) for "Tilt from Vertical" resulting in a baseline test read range between 5 m and 12 m, when tilted up to 45 degrees from vertical. Looking from the side, "Tilt from Vertical" is the angle Φ showing the difference of the mounted transponder from perfectly vertical as shown in Figure 2. This represents windshield angles between steeply sloped windshields (sports car) and near vertical windshields (semi-tractor trailers). **Tilt from vertical reference plane (pitch angle) = Φ**  *Figure 2: Diagram depicting pitch angle between transponder and reader antenna*

#	Category	Requirement
2.16	RF Performance - Antenna Polarization and Pointing Loss	All transponders - have a minimum activation energy (forward link range) for "Rotation from Horizontal" resulting in a baseline test read range between 5 m and 12 m, when rotated +/- 18 degrees from the horizontal plane (see Figure 3) from horizontal. Looking top down, Rotation from Horizontal is the rotation angle Θ from the horizontal plane of the transponder face away from the reader antenna. This represents transponder mounting locations on flat windshields versus curved windshields and headlights. **Rotation from horizontal reference plane (yaw angle) = Θ**  *Figure 3: Diagram depicting yaw angle between transponder and reader antenna*

3.3.5 Reader Requirements

Readers shall meet the baseline testing requirements shown in Table 8 below.

Table 8: Reader Baseline Testing Requirements

#	Category	Requirement
3.1	Power Level	Have a maximum power/field strength allowed by local regulatory authority.
3.2	Interference	Provide interference mitigation for use with other readers at a toll plaza in single protocol reader and multiple protocol reader modes.
3.3	Transponder Filtering	Able to filter and report 6C Coalition coded transponders and information.

#	Category	Requirement
3.4	Transponder Filtering	Able to filter out non-6C Coalition transponders.
3.5	Reporting Transponder Data	Verify that reader can correctly read transponder data and supply it to a higher-level system (e.g. lane controller).

3.4 Field Testing

Field Testing shall use a simulated field environment to evaluate device performance at different ranges, speeds (up to 85 mph), windshield angles, and lane placement. For both transponder and reader testing, reader frequency may be any frequency within the 902 – 928 MHz range and reader power or field strength can be up to the maximum allowed by local regulatory authorities.

3.4.1 Transponders

Tests occur in various toll operating environments (varied ranges, speeds and transponder densities). Transponders are tested using reader reference test systems set up per vendor instructions. Vehicle passages will cover both the mainline path and lane edges.

Transponder performance shall meet the field-testing requirements described in Table 9 below.

Table 9: Transponder Performance Requirements

#	Category	Requirement
4.1	Transponder Height	Above ground for car windshield mountings: 36”-48” (0.91m-1.2m) Above ground for medium truck windshield mountings: 48”-65” (1.2m-1.6m) Above ground for Large truck (Straight and Tractor) windshield mountings: 72”-108” (1.8m-2.7m)
4.2	Transponder orientation (3-D)	Tilt horizontal α = +/- 15 degrees (roll angle) Tilt vertical Φ = 0 to - 45 degrees (pitch angle) Rotation horizontal θ = +/- 18 degrees (yaw angle)
4.3	Transponder Speed	Speed of 0, 15, 85 MPH
4.4	Transponder Mounting	Windshield (Ford F150 4’x6’ portion) Headlight (Ford F150 full headlight assembly) Bumper (metal or plastic according to vendor instructions) Other mounting type per vendor instructions

#	Category	Requirement
4.5	Interrogator antenna orientation	Fixed reference system with horizontal linear polarization and antenna 15 degrees from horizontal facing oncoming traffic pattern
4.6	Antenna Height	Fixed reference system with lowest portion of antenna assembly 19’ above center point of travel lane

3.4.2 Readers

Reader systems are configured as single lane or multiple lane ORT per the vendor recommended toll configuration setup.

Readers shall meet the field-testing requirements described in Table 10 below.

Table 10: Reader Field-testing Requirements

#	Category	Requirement
5.1	Transponder Population	Filter one 6C Coalition transponder (programming consistent with version 3.1 of this standard or higher) from nine non-6C Coalition transponders. Filtering information can be found in Appendix A Table 11 of this document (AFI, DSFID and Version values available to be filtered upon).
5.2	Transponder Lane Placements	Pass multiple reference transponders through the read zone on vehicles using in-line positions and cross-over (lane change) locations, and will include multiple simultaneous vehicles in the ORT configuration
5.3	Transponder Height	Above ground for car windshield mountings: 36”-48” (0.91m-1.2m) Above ground for medium truck windshield mountings: 48”-65” (1.2m-1.6m) Above ground for Large truck (Straight and Tractor) windshield mountings: 72”-108” (1.8m-2.7m)
5.4	Transponder orientation (3-D)	Tilt horizontal α = +/- 15 degrees (roll angle) Tilt vertical Φ = 0 to - 45 degrees (pitch angle) Rotation horizontal θ = +/- 18 degrees (yaw angle)
5.5	Transponder Speed	Speed of 0, 15, 85 MPH
5.6	Transponder Mounting	Windshield (Ford F150 4’x6’ portion) Headlight (Ford F150 full headlight assembly) Bumper (metal or plastic according to vendor instructions) Other mounting type per vendor instructions
5.7	Interrogator antenna orientation	Per vendor recommendation and using vendor antenna

#	Category	Requirement
5.8	Antenna Height	Per vendor recommendation and using vendor antenna

3.5 Multiprotocol Environments

The 6C protocol will be used in conjunction with other protocols, therefore:

1. Multiprotocol transponders – Transponders with multiple protocols that incorporate the 6C protocol are required to meet the minimum 6C protocol performance prescribed in this document.
2. Multiprotocol readers – Readers with multiple protocol functionality that read the 6C protocol are required to meet the minimum 6C protocol performance described in this document.

4 BARCODE FORMAT

The transponder barcode includes the Agency Code, the Transponder Serial Number, and a check digit. The barcode shall be printed using EPC Code 128 and the code data digits shall be in decimal format **AAAATTTTTTTTTTL** where **AAAA** is the Agency Code as a 4-digit number with leading zeros, **TTTTTTTTTT** is the Transponder Serial Number (TSN) as a 10-digit number with leading zeros and **L** is the Luhn check digit computed using only the last 2 digits of the Agency Code and all 10 digits of the TSN.

Below the barcode the Agency Code, the TSN and the check digit shall be displayed in the following decimal format:

<AA>AA TTTTTTTTTT L

The printed Agency Code shall NOT contain leading zeros and shall be separated from the TSN by a double space, where **<AA>AA** is the Agency code excluding leading zeros. The TSN shall include the leading zeros (to fill all 10 digits) and shall be separated from the check digit number **L** by a double space. The check digit **L** is Luhn (mod10) coded – calculated based upon **<AA>AA** (third and fourth digits only) and **TTTTTTTTTT** (all ten digits).

For example, a transponder with serial number 12 for agency 77 would return **007700000000123** as the barcode content and the printed information below the barcode would contain:

77 0000000012 3

Similarly, for agency 449, a transponder with serial number 12 would return **044900000000122** as the barcode content and the printed information below the barcode would contain:

449 0000000012 2

5 TRANSPONDER MANIFEST DETAILS

Accompanying an order of transponders, it is suggested that tag manufacturers provide a file including an entry for each transponder delivered to facilitate loading of data into back office systems. This should include both the UII programmed value and TID programmed value. Each transponder entry should appear on a new line as shown in the example below:

12_Byte_UII_Memory,TID (length varies)

0101CE00010000000101CE8C,E2003412012EC0FFEE041392

6 SECURITY AND DATA INTEGRITY VALIDATION

6.1 Overview

Transponder security is critical to the toll industry. It is anticipated that as more security features become available, they will be evaluated and deployed, as appropriate. The following security measures are currently employed.

6.2 Memory Bank Security

6.2.1 Reserved Memory Bank

1. The Access Password shall have a Lock Status of locked with an Access Password known to and secured by the transponder issuing agency.
2. The Kill Password and its Lock Status shall be configurable by the transponder issuing agency. It is recommended that the transponder issuing agency configure transponders to permanently disable the ability to kill their transponders.

6.2.2 UII Memory Bank

1. The transponder issuing agency shall be the only entity authorized to change the encoded bits on the transponder. The UII memory bank shall have a Lock Status of locked.
2. UII Authentication/Validation – The UII memory data should be authenticated with two hashed validation bytes. The UII Validation bytes can be used for transponder data verification and can also provide some level of transponder authentication. Further details are contained in Section 6.4.

6.2.3 TID Memory bank

The transponder identification number shall be uniquely assigned by the manufacturer. It shall be readable without a password, cannot be altered and must be unique.

6.2.4 User Memory Bank

1. Password – The User memory shall be writable without a password. The User memory bank shall have a Lock Status of unlock.
2. Authentication/Validation – Authentication and validation shall not be used.

6.3 Encryption

Under development.

6.4 UII Validation

Below is example of how the UII validation bytes shall be calculated using:

1. The first 10 bytes of the UII (starting with the "DSFID" field)
2. The 32-byte key (determined by the transponder issuing agency)
3. The bytes of the transponder TID (length varies - see footnote)

For ensuring interagency interoperability and consistency between transponders manufactured by different vendors the open standard SHA1 hashing algorithm shall be used. The hashing sequence shall be:

1. Concatenate the 10 UII memory bytes, the 32-byte key and the TID bytes to form a single byte sequence
2. Determine the SHA1 hash of this byte sequence above
3. For UII Validation the first 2 bytes from the 40-byte hash result shall be used.

UII Validation Reference Calculation is provided below:

UII 10 byte: **0xFFFFFFFFFFFFFFFFFFFF**

Key 32 byte:

0xABABABABABABABABABABABABABABABABABABABABABABABABABABABABABABABAB

TID (12-byte example): **0x000000000000000000000000**

Result 20-byte hash value: **0x167F9C5B3933148B68AAD51EE3C4B5F858166451**

UII Validation bytes: **0x167F**

The 12 UII bytes shall be encoded as: **0xFFFFFFFFFFFFFFFFFFFF167F**

For fully serialized tags, the complete header and serialized portion of the TID (which can be anywhere from 96 - 192 bits, given the allowable serial number length of 48 - 144 bits) will be used for the indicated calculations.

7 APPENDICES

Appendix A Legacy 6C Toll Transponder Information

The programming standard described in this document intends to enable consistent tag programming among the member agencies. However, developing the standard required several iterations before achieving a steady state in Version 3.1. Thus, slight differences exist between the current version and previous versions. This appendix explains how to determine the programming standard used and the forward compatibility of the Agency Codes.

A.1 Assumptions

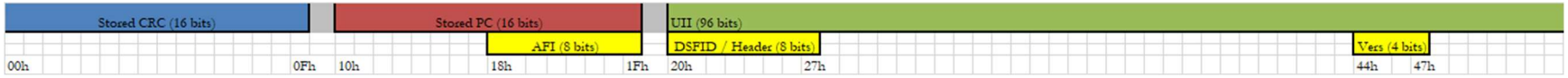
1. All values discussed appear in hexadecimal, except where noted.
2. This appendix only discusses Memory Bank 01 (CRC, PC, and the UII) described in section 2.2

A.2 Determining the Tag Programming Standard

Use the AFI, Header/DSFID, and Version values to validate the tag and determine the Programming Standard used. Figure 4 illustrates the location of the bits.

- AFI - Memory Address **18h – 1Fh**
- Header/DSFID - Memory Address **20h – 27h**
- Version - Memory Address **44h – 47h**

Figure 4: Snip of Memory Map - Highlights the location of key identification bits



For a tag to comply as an interoperable 6C Coalition tag, one of the following statements must apply:

0. [AFI] contains no value, [Header] contains **35**, and [Version] contains **0**, the tag uses Programming Standard Version 0.9.
1. [AFI] contains no value, [Header] is **35**, and [Version] is **1**, the tag uses Programming Standard Version 1.0. – no longer used
2. [AFI] contains no value, [Header] contains **B0**, and [Version] contains **2**, the tag uses Programming Standard Version 2.0.

3. [AFI] contains **B0**, [Header] contains no value, and [Version] contains **3**, the tag uses Programming Standard Version 3.0.
4. [AFI] contains **B0**, [DSFID] contains **3E**, and [Version] contains **3**, the tag uses Programming Standard Version 3.1.

The following table provides a summary of the values discussed above:

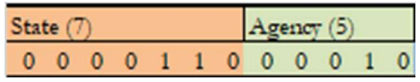
Table 11: Programing Standard Identification

	AFI (8 Bits) **Memory Address:** 18h – 1Fh Bits 9-16 of the Stored PC Hex Digits 3-4 of the Stored PC		**DSFID / Header (8 Bits)** **Memory Address:** 20h – 27h Bits 1-8 of the UII Hex Digits 1-2 of the UII		**Version (4 Bits)** **Memory Address:** 44h – 47h Bits 37-40 of the UII Digit 10 of the UII	
Version	**Binary**	**Hex**	**Binary**	**Hex**	**Binary**	**Hex**
3.1	1011 0000	B0	0011 1110	3E	0011	3
3.0	1011 0000	B0	N/A	N/A	0011	3
2.0	N/A	N/A	1011 0000	B0	0010	2
1.0	N/A	N/A	0011 0101	35	0001	1
0.9	N/A	N/A	0011 0101	35	0000	0

A.3 Identifying Agencies

For Versions 0.9 and 1.0, a combination of the State Code (7 bits) and the Agency Code (5 bits) identified an agency. This concept allowed a single state or region to have multiple agencies (Figure 5).

Figure 5: Version 0.9 and 1.0 State and Agency Code



Version 2.0 replaced the separate State Code and Agency Code with a single Agency Code (12 bits), using the same Memory Address (Figure 6). This code design allows forward compatibility. For example, in Version 0.9/1.0, the Colorado E-470 Public Highway Authority had a State Code of 6 for Colorado and an Agency Code of 2 for E-470. As depicted in Figure 5, the binary code **0000110** equals decimal value 6 and the binary code **00010** equals decimal value 2.

In Version 2.0 and above, the Agency Code uses the entire 12 bits and all Agency Code values have 12-bit values. Using the example from above, E-470 has a decimal value of 194 as shown in the figure below.

Figure 6: Version 2.0, 3.0, and 3.1 Agency Code – Currently used

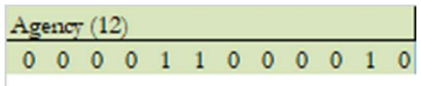


Figure 7 provides a reference chart comparing the different programming standards by version.

Figure 7: Programming Summary by Version

Version	1.0				2.0				3.0 Rev 2				3.1			
Area	**#**	**Memory Address**	**Bits**	**Section**	**#**	**Memory Address**	**Bits**	**Section**	**#**	**Memory Address**	**Bits**	**Section**	**#**	**Memory Address**	**Bits**	**Section**
Stored CRC	1-16	00h - 0Fh	16	N/A	1-16	00h - 0Fh	16	N/A	1-16	00h - 0Fh	16	Calculated	1-16	00h - 0Fh	16	Calculated
Stored PC	1-5	10h - 14h	5	N/A	1-5	10h - 14h	5	N/A	1-5	10h - 14h	5	Length	1-5	10h - 14h	5	Length
	6	15h	1	N/A	6	15h	1	N/A	6	15h	1	User Memory	6	15h	1	User Memory
	7	16h	1	N/A	7	16h	1	N/A	7	16h	1	XPC	7	16h	1	XPC
	8	17h	1	N/A	8	17h	1	N/A	8	17h	1	Numbering System Indicator	8	17h	1	Numbering System Indicator
	9-16	18h - 1Fh	8	N/A	9-16	18h - 1Fh	8	N/A	9-16	18h - 1Fh	8	AFI (B0 = 1011 0000)	9-16	18h - 1Fh	8	AFI (B0 = 1011 0000)
UII	1-8	20h-27h	8	Header (0011 0101)	1-16	20h-2Fh	16	Header (B0 = 1011 0000 xxxx xxxx)	1-21	20h-34h	21	Agency Use	1-8	20h-27h	8	DSFID (3E = 0001 1110)
	9-36	28h-43h	28	General Manager Number									9-21	28h-34h	13	Agency Use
					17-21	30h-34h	5	Reserved Space								
					22	35h	1	Classification Code	22	35h	1	Class	22	35h	1	Class
					23-27	3Ah	5	Vehicle Type Code	23-27	3Ah	5	Vehicle Type	23-27	3Ah	5	Vehicle Type
					28-31	3Bh-3Eh	4	Vehicle Axles	28-31	3Bh-3Eh	4	Vehicle Axles	28-31	3Bh-3Eh	4	Vehicle Axles
					32	3Fh	1	Vehicle Weight	32	3Fh	1	Vehicle Weight	32	3Fh	1	Vehicle Weight
					33	40h	1	Vehicle Rear Tires	33	40h	1	Vehicle Rear Tires	33	40h	1	Vehicle Rear Tires
					34-36	41h-43h	3	HOV Declaration	34-36	41h-43h	3	HOV Declaration	34-36	41h-43h	3	HOV Declaration
	37-40	44h-47h	4	VersionCode	37-40	44h-47h	4	Version	37-40	44h-47h	4	Version	37-40	44h-47h	4	Version
	41-52	48h-4Eh	7	State Code	41-52	48h-53h	12	Agency	41-52	48h-53h	12	Agency	41-52	48h-53h	12	Agency
	48-52	4Fh-53h	5	Agency Code												
	53-80	54h-6Fh	28	Vehicle Code	53-80	54h-6Fh	28	Transponder Serial Number	53-80	54h-6Fh	28	Transponder Serial Number	53-80	54h-6Fh	28	Transponder Serial Number
	81-96	70h-7Fh	16	UII Validation (Hash Value)	81-96	70h-7Fh	16	UII Validation (Hash Value)	81-96	70h-7Fh	16	UII Validation (Hash Value)	81-96	70h-7Fh	16	UII Validation (Hash Value)

Appendix B Transponder Filtering

The 6C standard allows 'filters' to be implemented by readers to separate a population of tags based on values of certain areas of the tag memory. This is useful in tolling environments to allow readers to only read/report 6C transponders that are programmed as tolling tags, as opposed to reading all 6C tags that may pass through a lane (e.g. tags used for retail, asset tracking, etc). To effectively filter all tolling tags in use as of August 2019 (with minor exceptions), three filters are required, detailed below:

1. Stored PC bits 9-16 = **0xB0** (6C Coalition V3.0 and all later versions)
2. UII bits 1-8 = **0xB0** (WSDOT V2.0 tags)
3. UII bits 1-8 = **0x35** (SRTA [old tags] and E470 [all])

With the following exceptions all tags are programmed to version 3.0 or above:

- SRTA tags prior to 2017 (~400k) are an older version that was the basis for V1 published by the 6C TOC
- All E-470 tags are very similar to these older SRTA tags
- WSDOT has about 750k version 2.0 tags distributed
- Utah DOT has a unique programming standard and may replace their tags prior to joining an IOP hub

Table 12: Legacy Toll Tag Information

Agency	6C Coalition Programming Version	Estimated Count (as of August 2019)
E470	Version 0.9	1,600,000
WSDOT	Version 2.0	800,000
SRTA	Version 0.9 (400K), 3.0 (350K)	750,000
UDOT	Unique to UDOT	60,000

Attachment 6 – E-ZPass Group Reader Performance Matrix

E-ZPass Group Reader Performance Matrix

Proposers should provide the following information if readily available. Responses to this section will not be scored or impact contract award for antenna layouts outside the Proposer's acceptable layouts. If required performance is not met for a performance requirement, the Proposer should provide the minimum performance that can be met, if available, in the Comments column.

Antenna Layout	R/W or Read-Only	Protocols in Operation			Meets Performance Requirements (Y/N)					Comments
		TDM	6C	SeGo	Capture Rate	Read Accuracy	Write Accuracy	Lane Allocation	Lane Assignment	
Staggered	R/W	X								
Staggered	R/W		X							
Staggered	R/W			X						
Staggered	R/W	X	X							
Staggered	R/W	X		X						
Staggered	R/W	X	X	X						
Staggered	Read-Only	X					N/A			
Staggered	Read-Only		X				N/A			
Staggered	Read-Only			X			N/A			
Staggered	Read-Only	X	X				N/A			
Staggered	Read-Only	X		X			N/A			
Staggered	Read-Only	X	X	X			N/A			
In-Line	R/W	X								
In-Line	R/W		X							
In-Line	R/W			X						
In-Line	R/W	X	X							
In-Line	R/W	X		X						
In-Line	R/W	X	X	X						
In-Line	Read-Only	X					N/A			
In-Line	Read-Only		X				N/A			
In-Line	Read-Only			X			N/A			
In-Line	Read-Only	X	X				N/A			
In-Line	Read-Only	X		X			N/A			
In-Line	Read-Only	X	X	X			N/A			