

Electronic Distance Recorder Testing Procedures

Introduction

From time to time, on behalf of the NZ Transport Agency, Waka Kotahi, Robinson Instruments Ltd (RIL) is called upon to evaluate various Electronic Distance Recorders (EDR) as they are submitted by potential and/or existing Electronic System Providers (ESP) for approval.

Electronic Distance Recorders are used to facilitate the collection of road user charges or RUC on behalf of the New Zealand Government.

A Code of Practice (COP) for electronic road user charges management systems outlines the processes and requirements for operating electronic systems to collect RUC.

The COP requires that each EDR is independently tested to ensure that it is fit for purpose.

According to the current Code of Practice, any Electronic Distance Recorder should be tested and shown to be Reliable, Accurate, Secure and Tamper Proof. RIL also checks that display features meet the requirements of the code of practice.

Test Philosophy

In applying ourselves to the task of testing EDR's for NZTA, we play the role of a dishonest truck owner, endeavour to reduce our RUC liability, that is, we try anything and everything we can, to misrepresent the distance our vehicle has travelled, without being caught. While it's not quite that simple, plus we have the luxury of being caught, changing our plan of attack and trying again, this goal is always in the back of our minds as we develop and work through our testing program. The reality is, we need time to become familiar with the characteristics of each EDR and the ESP's back-office compliance procedures.

General Test Procedure and Plan

The EDR trial starts with the ESP's device being fitted to a test vehicle. For a short period of time, we observe how the meter works, before we embark on the trial proper.

Once we are sure that the installation is correct and the EDR is functioning correctly we proceed to the next stage, testing for reliability, accuracy, security and tamper proofness. That is, we test that the EDR meets the requirements of the Code of Practice.

Throughout this period, we maintain a log of all trips undertaken recording, distance travelled, distance recorded, what tests were applied, location and start and finish times, recording all pertinent observations and ESP responses.

We conclude the trial with an analysis of the data we have collected, reporting on the accuracy, reliability, security and responses to all tamper events. We then summaries our findings and offer a conclusion and recommendation as to the suitability of the EDR as an ERuc Distance Record.

Trial

The EDR trial starts with the ESP's device being fitted to a suitable test vehicle, this is usually a private motor vehicle. Preferably the installation is undertaken by the ESP's own installer.

For an initial period of time, we don't embark on any specific tests. The purpose of this period is to familiarize ourselves with the meter, understanding its key characteristics and generally observe how it functions, making sure that it is doing what it should do.

Each EDR has its own design characteristics, and these need to be understood and critiqued. A thorough understanding of the implications of these design characteristics and features is required, to enable exploration of their impact on the reliability, accuracy, security and tamper proof nature of the device.

We also check that the display and housing meet the requirement of the code of practice. That is, it displays vehicle registration, distance travelled, a compliant RUC label and a suitable fault alert system. We also check that the housing is physically tamperproof and has adequate security features.

Once we are confident that the meter is performing to the ESP's stated claims, that is, distance is being recorded, display is functioning correctly and any alert symbols are displaying and functioning as they should, we then proceed to the test proper where we test the functionality of the meter against the Code of Practice. Throughout the period of testing a detailed log is kept of each trip made and the specific test conditions under which the trip is made.

We conclude with an analysis of the vehicle's web portal checking that, trip distances, location mapping and tamper alerts correlate with our data.

Reliability

Throughout the trial period we look for signs or issues that would suggest that the EDR is unreliable. We expect the EDR to be commercially fit for purpose, that is, go the distance without having to be replaced or upgraded during the trial period.

There are two aspects to testing for reliability.

Firstly, hardware failure such as:

- Unacceptable battery life.
- Screen failure.
- In adequate GNSS and SMS antenna gain.
- Mounting failure.
- RUC label updates.

Secondly, software and firmware reliability.

This not so easy to be specific about, but there are occasions where software and firmware programs are faulty and require further testing and modifying, or they have missed a specific scenario which means that data is not correctly recorded.

In the past we have allowed for software upgrades or minor hardware changes, this will no longer be the.

Accuracy

The Code of Practice requires that all EDRs have a display accuracy of +/- 2%. We verify this using surveyed measured distances, 3rd party GPS odometer, and cross checking against the test vehicles odometer and trip meter.

We expect to travel between 2,000 to 3,000 kilometres.

Accuracy testing is run concurrently with Reliability, Tamper and Security tests. In other words, for the entirety of the test program we pay close attention to the distance recorded on every trip no matter how small. In essence tampering attempts serve two purposes. Firstly, to make sure that they are detected, but secondly, to make sure they don't negatively or positively impact on the distance recorded. So, every tamper attempt is also an accuracy test.

With a greater dependence on GNSS positioning for recording distance, the importance of a reliable GPS Antenna has become more critical than it was in the past. Testing for accuracy in the future will require a greater focus on the impact of GPS jamming and GPS data manipulation.

Other factors that we watch carefully are:

- The correlation between Vehicle Speed Sensor (VSS) data and GPS positioning data.
- GPS errors caused by shadowing.
- GPS location confusion.
- Off road recording

With the increased prevalence of GPS as the primary means of determining distance travelled and the replacement of conventional vehicle speed sensors, with ABS derived CANBUS data, we will be exploring options to enable us jam, manipulate and simulate this data.

We present the accuracy data in several ways.

1. Accuracy of the entire Test Program.
2. Accuracy excluding trips negatively effected by tampering events.
3. We highlight and comment on individual trips for which accuracy has become an issue.

Tampering

The COP for electronic road user charges management systems states that the electronic distance recorder should have enough security mechanisms to mitigate the risks of physical and electronic tampering.

While testing an EDR, we will do our best to tamper with the devise, with a view to misrepresenting the distance travelled and thus reducing the amount of RUC that should be paid.

While testing any EDR, we will evaluate the impact of, but not limited to, the following tampering events:

- Cutting ignition feed.
- Cutting battery feed.
- Disconnecting the speed sensor.
- Altering the speed pulse.
- Loss of GPS signal.
- Tampering or manipulating GPS data
- Application of a GPS Jammer.
- Loss of Mobile data Communications.
- Opening or Tampering with the EDR.
- Removal of the EDR from the vehicle.
- Wireless Communications

These will be applied both individually and in various combinations. (See sample Tamper Test Matrix).

Our principal concern is that, firstly, each and all, of the above events are detected and are accurately reported to RIL, with due weight given to the seriousness of the event.

Secondly, we are checking to see that none of the above events can be used to reduce the recorded distance travelled and as a consequence the amount RUC due, or if they can, they don't go undetected and are dealt with by the ESP in an appropriate manner.

We expect RIL to be treated as any other client of an ESP. That is, as far as possible, all and any of the simulated events should be correctly reported back to RIL, in the same way that the ESP would respond to any independent truck owner or fleet owner. These responses should be in accordance with the ESP's EDR owner's manual.

Tamper Event Guide

	Cutting Ignition Feed	Cutting Battery Feed	Disconnecting Speed Sensor	Altering the Speed Pulse	Loss of GPS Signal	Tampering GPS Data	Application of GPS Jammer	Loss of Mobile Data Communications	Opening or Tampering with the EDR	Removal of the EDR from the Vehicle	Wireless Communication		
Test												Date	Details
Test 1	●												
Test 2		●											
Test 3			●										
Test 4				●									
Test 5					●								
Test 6						●							
Test 7							●						
Test 8								●					
Test 9									●				
Test 10										●			
Test 11											●		
Test 12	●	●					●						
Test 13			●				●						
Test 14				●	●								
Cont.													

The purpose of the Matrix is to make sure we cover off all possible tampers. While at first glance this looks straight forward, simple to follow and implement, the reality is that it is not. Experience has shown us that once we get beyond single tamper events, things get messy. But it is in these combination tamper attempts that we, generally, find the problems.

Security Features

As stated above any EDR must also be physical tamper proof. That is, it must be able to detect, unauthorised, breaches of its case or housing. It must also have sufficient back up battery power to maintain the electrical systems and internal memory until power is restored. Both these form part of our test procedures.

Test Report Sheet

While testing an EDR is nothing like a Warrant of Fitness test, we have created a single page summary sheet, like a WOF inspection report that summarises the results of our testing regime. While this is not intended to replace the main written report, it helps to summarise our findings on a pass or fail basis. Listed below are the key elements of the test program we run. We have incorporated these into a single page Test Report or Inspection Report so that ESP's can see, on a single page, the outcome of our tests.

In some instances, in particular, those relating to tampering, the Inspection Report will have two characteristics we will check. First is the impact on accuracy and secondly, ESP's compliance teams' response to the tamper event.

Pre-Test Checks and Observations

- Installation
- Documentation
- Web Portal Access
- Displays Features:
 - Vehicle registration
 - Distance travelled
 - RUC Licence label
 - RUC Bar Code
 - RUC distance update
 - Fault/Tamper Alert Indicators
- Web Access

Tampering

- Cutting ignition feed.
- Cutting battery feed.
- Disconnecting the speed sensor.
- Altering the speed pulse.
- Loss of GPS signal.
- Tampering or manipulating GPS data
- Application of a GPS Jammer.
- Loss of Mobile data Communications.
- Opening or Tampering with the EDR.
- Removal of the EDR from the vehicle.
- Wireless Communications.
- Combinations of the above.

Accuracy

- Accuracy of the entire Test Program.
- Accuracy excluding trips negatively effected by tampering events.
- Tampering Accuracy.
- Distance Travelled.
- Accuracy.

Other Observation

- Vehicle Speed Sensor (VSS) data
- GPS positioning data.
- GPS errors caused by shadowing.
- GPS location confusion.
- Off road recording

Security Features

- Physical Tamper security.
- Battery Life.
- Back Office monitoring of tamper events.
- Back Office communications.
- Mounting Security.

Reliability

- Battery life.
- Screen failure.
- In adequate GNSS and SMS antenna gain.
- RUC label updates.
- RUC min/max details
- Wireless Tethering
- Software and Firmware functionality.

Other

- Web Portal -
 - Mapping
 - Alerts
 - Sign Offs

What Robinson Instruments Requires of the ESP

The following is a list of requirements that will assist RIL undertake the evaluation of any new EDR.

- Confidentiality Agreement – If required.
- Design Scope of EDR
- Installer's Manual
- Owner's Manual
- Understanding of how exception alerts are conveyed and dealt with
- Briefing explaining the characteristics of the EDR, functionality, special features
- Liaison person assigned for the project to assist with technical issues
- Customer contact who deals with breaches of operational protocols
- Access to web portal for owner's asset logs, RUC logs, activity logs, etc.
- Access to web portal for detailed trip analysis, special alerts, etc.
- Agreement over a suitable test vehicle

Timing

This process will run for approximately 3 months.

Start Date: The start date will be the day after EDR is installed in the Test Vehicle.

Observation Period: Two Weeks.

Test Period: Two Months

Preparation and presentation of written report: Two weeks.

Final Word

It's important to note that RIL's role is to independently test, on the behalf of NZTA, any new EDR. It is not to help ESP's iron out any undetected faults.