

# Evaluation Report for RTMS Echo

## California Department of Transportation (Caltrans)



## Electrical Quality Assurance and Source Inspection (EQASI)



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# 1. INTRODUCTION

## RTMS Echo/ISS Imaging

This document is provided to assist in the evaluation of proposed solutions that support the goals of this project and outlines the proposed process and testing approach. The goal is to be able to measure and confirm the technology's ability to meet Caltrans' desired features and expected performance metrics, helping establish both feature capabilities as well as accuracy of the detection. This includes assessment of product(s) to monitor and record vehicular data with a focus on:

- Traffic statistics, volume by lane
- Road user classification, vehicles by length

These products have been submitted to Caltrans' Product Evaluation Program (PEP). The PEP is dedicated to evaluating new products to add to the Authorized Materials List (AML). These products are being held to the standards of the AML that Caltrans provides publicly, as well as the applicable Caltrans specifications and Non-Standard Special Provisions (NSSPs).

Section 1 introduces the background information about the experiment by describing the objective of the experiment, reviewing the test sites and setup for each different test performed, information regarding the testing equipment, included documentation sent by each vendor upon arrival of the product, and a brief overview of the conclusion.

Section 2 focuses on the experiment itself. It describes each test the radar underwent over the testing period and evaluates how each vendor does in identical conditions. It also addresses how well the dashboard interface works with the device itself, as well as discuss some of its available features.

Section 3 concludes the experiment by giving an overall description of the device's performance throughout the experiment. It includes any additional notes that the observers may have found important, as well as a cost analysis for the product.

Section 4 provides a summary of the results of the experiment. It includes the recommendations for usage of the product based on the data provided.

## 1.1 - OBJECTIVE

The scope of work was limited to conducting the described below and providing a report of the results. Testing was completed in March 2025. The goal of this test was to determine whether these products would be listed on the AML or not.

## 1.2 - TEST SITES AND SETUP

### Sutterville Road Entrance to Interstate 5

To test the accuracy of the counts and classification of the radar, the radar was placed at the onramp from Sutterville Road to the Interstate 5 freeway in Sacramento. It was mounted on a pole next to the onramp which allowed detection of all lanes on the freeway excluding the on-and-off ramps. The radar was tested against 10 different lanes at 5 different time periods for a total of 50 samples. These lanes can be seen in Figure 1-1, which gives an approximate location of the radar from lanes being tested. The Sutterville Road entrance has a greater height from the main lanes than most other locations available for testing. This provided a variety of testing conditions for the radar.

**Figure 1-1**



Figure 1-1 gives the view from the camera that recorded the videos, which is placed slightly above the radar.

**Figure 1-2**



Figure 1-2 shows the mounting of the radar and the camera.

**Figure 2-3**



Figure 1-3 represents the area that the radar captures.

**Figure 1-4**

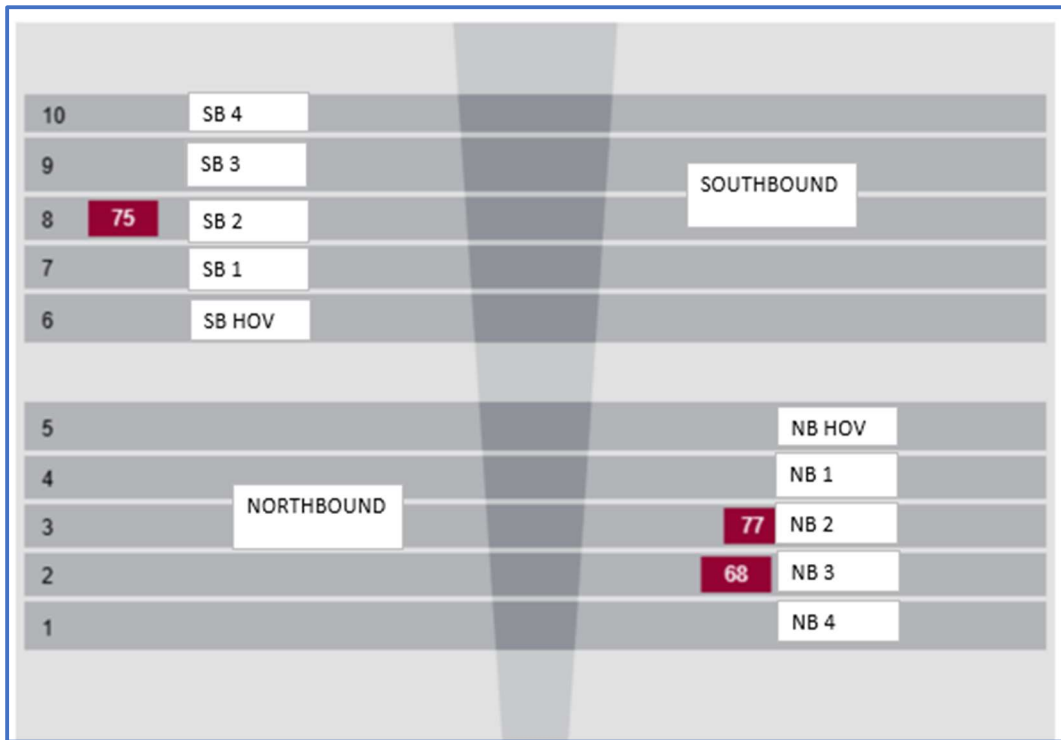


Figure 1-4 shows the online radar application.

**Table 1-1**

| Mounting Details               | RTMS Echo |
|--------------------------------|-----------|
| Distance to Edge of Travel Way | 18'8"     |
| Height                         | 31'       |
| Angle/Tilt                     | 12.5      |

Table 1-1 describes the mounting details of the radar located at Sutterville Road to the Interstate 5 freeway entrance.

**Table 1-2**

| Mounting Details               | RTMS Echo  |
|--------------------------------|------------|
| Distance to Edge of Travel Way | 18'8"      |
| Recommended Height             | 20' to 31' |
| Recommended Angle/Tilt         | -12 to -16 |

Table 1-2 describes the recommended mounting details for the radar based on the distance of the radar from the first lane given by the operations manual.

Any discrepancies between the mounting details of the radar and the recommended mounting details were directly suggested by the vendor.

### **METS Laboratory – 5900 Folsom Boulevard**

For setup, the manufacturers were called in to set up devices for the chosen locations, particularly for the Sutterville test site. This allowed the devices to be tested based on what was best for the individual locations as thought by the vendors.

## **1.3 - TESTING EQUIPMENT**

For evaluations regarding the count and classification features of each device, an observer manually verified the counts and classifications for each period using an AXIS P1468-LE Bullet Camera. The AXIS P1468-LE is a single lens camera, with features that allow for viewing of the footage from a secondary location with timestamps to verify the correct date and time. This camera was mounted on the same pole as the radar, allowing the observer to see the vehicles at a similar perspective as the radar. This was located at the Sutterville test site.

## **1.4 – DOCUMENTATION**

*Table 1-3*

| <b>Document</b>                                                                                                                                                                                                                                                                                                                | <b>Supplied by Vendor?<br/>Vendor #1</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Operation Manual                                                                                                                                                                                                                                                                                                               | ✓                                        |
| Maintenance and Part Replacement Documentation                                                                                                                                                                                                                                                                                 | ✓                                        |
| Troubleshooting Guide and Information                                                                                                                                                                                                                                                                                          | ✓                                        |
| Warranty: <ul style="list-style-type: none"><li>- Replacement against defective or failed material from date of installation</li><li>- Covers all expenses for replacement of parts, technical support, and shipping</li><li>- Must show Caltrans as owner</li><li>- Delivery replacement parts to 5900 Folsom Blvd,</li></ul> | ✓<br>(3 years)                           |

|                                                               |   |
|---------------------------------------------------------------|---|
| Sacramento, CA<br>95819                                       |   |
| Certificate of Compliance<br>and Manufacturer QC Test<br>Data | ✓ |

Table 1-4 describes if the required documentation from the vendor to Caltrans for testing was provided.

## 1.5 - CONCLUSIONS

All functional testing for the RTMS Echo side-fire radar was conducted per the instructions of the Image Sensing System and outlines in the Image Sensing Systems supplied document 'User Guide RTMS Echo and Echo Camera.'

Results for the product were compared against Caltrans specifications outlined in the NSSP (Non-Standard Special Provisions) sections 86-1.01C(11), 86-1.01D(5), and 86-1.02AA.

### Count Accuracy

After completion of the testing and review of the results, the RTMS Echo has been deemed acceptable and added to the Caltrans Authorized Material List Microwave Vehicle Detection System (Type 1 Sidefire).

### Classification Accuracy

RTMS Echo Performance – quick overview

## 2. VENDOR SPECIFICATIONS AND EXPECTED PERFORMANCE

To develop the test plan for evaluation of the products, vendors and evaluation personnel communicated to decide what should be expected from the product. After discussion, these were the expected capabilities of each device:

### RTMS Echo and Expectations

1. Counts for vehicles
2. Classification for vehicles by length

Accuracy levels for each device can change based on sample size. The vendor has provided an expected level of accuracy from prior experiences before this evaluation.

For the device, there is an expected accuracy of at least 90% for all tests.

## 3. DATA COLLECTION

### 3.1 - SAMPLE IDENTIFICATION

*Table 3-1*

| Device                                          | Model / Part Number | Serial Number | Test Conducted                            |
|-------------------------------------------------|---------------------|---------------|-------------------------------------------|
| One (1) RTMS Echo Pole- Mounted Sensor & Camera | RTMS Echo           | 20690-2205    | Count Accuracy<br>Classification Accuracy |

*The results of this test apply only to the units identified in this Engineering Report by device identifier and model/ part number, or serial number.*

### 3.3 - TIME FRAMES

#### 1. Counts and Classifications

There are five time periods used to test counts, each spanning fifteen minutes long. These time periods are aimed to cover a variety of conditions to test the versatility of the radar in different conditions. These time periods consist of:

1. AM Peak – 7:45 AM – 8:00 AM
2. Afternoon – 2:30 PM – 2:45 PM
3. PM Peak – 5:00 PM – 5:15 PM
4. After Sunset – 7:00 PM – 7:15 PM
5. Twilight – 2:00 AM – 2:15 AM

There are five time periods used to test classification, each spanning five minutes long. These time periods consist of:

1. AM Peak – 7:55 AM – 8:00 AM
2. Afternoon – 2:30 PM – 2:35 PM
3. PM Peak – 5:00 PM – 5:05 PM
4. After Sunset – 7:00 PM – 7:05 PM
5. Twilight – 2:00 AM – 2:05 AM

### 3.4 - COUNT ACCURACY EVALUATION

**Purpose:** Show that the unit can meet Caltrans NSSP for accuracy percentage on individual lane counts.

**Brief test description:** To test this, a camera was mounted directly below the radar on a pole that covered a section of the freeway that had no entries or exits. With this camera, several fifteen-minute video clips were recorded. This was used for a manual count of the number of cars in each lane of the freeway (not including on or off ramps). These counts represent the ground truth value (GTV) for each lane. The radar has their own count of the number of vehicles that appeared in each lane for the fifteen-minute interval. These counts represent the detection value (DTV) for each lane. Using the ground truth and detection values collected, the absolute error (AE) was calculated through the formula:

$$AE = | GTV - DTV |$$

This represents the difference between the ground truth value collected and the detection value collected. Using the absolute error, the % accuracy for each lane was calculated using the formula:

$$\% \text{ Accuracy} = \left( 1 - \frac{AE}{GTV} \right) * 100$$

For volume-based evaluations of the radar, the % accuracy should be at least 90%.

**Table 3-3**

| AM PEAK (7:45 AM 8:00 AM) |        |        |      |        |        |        |        |        |        |        |
|---------------------------|--------|--------|------|--------|--------|--------|--------|--------|--------|--------|
|                           | NB4    | NB3    | NB2  | NB1    | NBHOV  | SBHOV  | SB1    | SB2    | SB3    | SB4    |
| <b>Caltrans</b>           | 326    | 356    | 342  | 419    | 252    | 92     | 293    | 238    | 215    | 172    |
| <b>RTMS Echo</b>          | 322    | 258    | 342  | 425    | 251    | 94     | 308    | 247    | 203    | 159    |
| <b>Absolute Error</b>     | 4      | 2      | 0    | 6      | 1      | 2      | 15     | 9      | 12     | 13     |
| <b>% Accuracy</b>         | 98.77% | 99.77% | 100% | 98.56% | 99.60% | 97.82% | 94.88% | 96.21% | 94.41% | 92.44% |

Table 3-3 details the data collected for the 7:45 AM to 8:00 AM timeframe. This data reflects the number of cars manually counted compared to the number of cars that the radar counted.

For this timeframe, all the zones meet the required percent accuracy.

**Table 3-4**

| AFTERNOON (2:30 PM 2:45PM) |        |      |        |        |        |        |        |      |        |        |
|----------------------------|--------|------|--------|--------|--------|--------|--------|------|--------|--------|
|                            | NB4    | NB3  | NB2    | NB1    | NBHOV  | SBHOV  | SB1    | SB2  | SB3    | SB4    |
| <b>Caltrans</b>            | 222    | 262  | 263    | 284    | 168    | 318    | 428    | 293  | 246    | 242    |
| <b>RTMS Echo</b>           | 218    | 262  | 266    | 289    | 161    | 302    | 409    | 293  | 239    | 237    |
| <b>Absolute Error</b>      | 4      | 0    | 3      | 5      | 7      | 16     | 19     | 0    | 7      | 5      |
| <b>% Accuracy</b>          | 98.19% | 100% | 98.85% | 98.23% | 95.83% | 94.96% | 95.56% | 100% | 97.15% | 97.93% |

Table 3-4 details the data collected for the 2:30 PM to 2:45 PM timeframe. This data reflects the number of cars manually counted compared to the number of cars that the radar counted.

For this timeframe, all the zones meet the required percent accuracy.

**Table 3-5**

| PM PEAK (5:00 PM 5:15 PM) |        |      |      |        |        |       |        |        |        |        |
|---------------------------|--------|------|------|--------|--------|-------|--------|--------|--------|--------|
|                           | NB4    | NB3  | NB2  | NB1    | NBHOV  | SBHOV | SB1    | SB2    | SB3    | SB4    |
| <b>Caltrans</b>           | 214    | 265  | 245  | 287    | 108    | 410   | 492    | 388    | 361    | 333    |
| <b>RTMS Echo</b>          | 212    | 265  | 245  | 281    | 107    | 369   | 463    | 368    | 330    | 281    |
| <b>Absolute Error</b>     | 2      | 0    | 0    | 6      | 1      | 41    | 29     | 20     | 31     | 52     |
| <b>% Accuracy</b>         | 99.06% | 100% | 100% | 97.91% | 99.07% | 90%   | 94.10% | 94.84% | 91.41% | 84.38% |

Table 3-5 details the data collected for the 5:00 PM to 5:15 PM. This data reflects the number of cars manually counted compared to the number of cars that the radar counted.

For this timeframe, all the zones meet the required percent accuracy except for the farthest lane from the radar.

**Table 3-6**

| AFTER SUNSET (7:00 PM 7:15 PM) |      |        |      |        |        |       |        |        |        |        |
|--------------------------------|------|--------|------|--------|--------|-------|--------|--------|--------|--------|
|                                | NB4  | NB3    | NB2  | NB1    | NBHOV  | SBHOV | SB1    | SB2    | SB3    | SB4    |
| <b>Caltrans</b>                | 121  | 174    | 168  | 139    | 70     | 100   | 223    | 215    | 194    | 148    |
| <b>RTMS Echo</b>               | 121  | 176    | 168  | 142    | 68     | 97    | 221    | 208    | 183    | 143    |
| <b>Absolute Error</b>          | 0    | 2      | 0    | 3      | 2      | 3     | 2      | 7      | 11     | 5      |
| <b>% Accuracy</b>              | 100% | 98.85% | 100% | 97.84% | 97.14% | 97%   | 99.10% | 96.74% | 94.32% | 96.62% |

Table 3-6 details the data collected for the 7:00 PM to 7:15 PM. This data reflects the number of cars manually counted compared to the number of cars that the radar counted.

For this timeframe, all the zones meet the required percent accuracy.

**Table 3-7**

| TWILIGHT (2:00 AM 2:15 AM) |     |     |     |     |       |       |     |     |     |     |
|----------------------------|-----|-----|-----|-----|-------|-------|-----|-----|-----|-----|
|                            | NB4 | NB3 | NB2 | NB1 | NBHOV | SBHOV | SB1 | SB2 | SB3 | SB4 |
| <b>Caltrans</b>            | 21  | 38  | 26  | 21  | 1     | 5     | 20  | 36  | 28  | 19  |

|                       |      |      |        |      |      |     |      |      |        |        |
|-----------------------|------|------|--------|------|------|-----|------|------|--------|--------|
| <b>RTMS Echo</b>      | 21   | 38   | 27     | 21   | 1    | 2   | 20   | 36   | 31     | 18     |
| <b>Absolute Error</b> | 0    | 0    | 1      | 0    | 0    | 3   | 0    | 0    | 3      | 1      |
| <b>% Accuracy</b>     | 100% | 100% | 96.15% | 100% | 100% | 40% | 100% | 100% | 89.28% | 94.73% |

Table 3-7 details the data collected for the 2:00 AM to 2:15 AM timeframe. This data reflects the number of cars manually counted compared to the number of cars that the radar counted.

For this timeframe, eight out of the ten zones meet the percent accuracy requirement. The Southbound High-Occupancy Vehicle Lane is slightly covered by median barrier between the two highway directions, which could impact the accuracy results. The Southbound 3 Lane is the second farthest out from the radar and had a smaller sample size than the other timeframes.

### 3.5 - CLASSIFICATION ACCURACY EVALUATION

**Purpose:** Show that the unit can meet Caltrans NSSP for accuracy on classifying vehicles by their length.

**Brief test description:** To test this, a camera was mounted directly below the radar on a pole that covered a section of the freeway that had no entries or exits. With this camera, a five-minute video clip was recorded. This was used for a manual count of the number of each type of vehicle in each lane of the freeway (not including on or off ramps). The radar classifies vehicles based on the length that the radar detects. For the purpose of this evaluation, Caltrans has listed the following classifications and lengths:

Road user classification, vehicles

- Motorcycles (0 – 10 ft)
- Small trucks and cars (10 ft – 35 ft)
- Busses (35 ft – 50 ft)
- Semi-Trucks and trailers (50 ft+)

**Table 3-8**

|                           | Motorcycles<br>(0 ft 10 ft) | Small trucks and<br>cars (10 ft 35 ft) | Busses<br>(35 ft 50 ft) | Semi Trucks & trailers<br>(50 ft+) |
|---------------------------|-----------------------------|----------------------------------------|-------------------------|------------------------------------|
| PM PEAK (5:00 PM 5:05 PM) |                             |                                        |                         |                                    |
| <b>Caltrans</b>           | 1                           | 884                                    | 9                       | 46                                 |
| <b>RTMS Echo</b>          | 9                           | 838                                    | 9                       | 42                                 |

|                       |         |       |        |       |
|-----------------------|---------|-------|--------|-------|
| <b>Absolute Error</b> | 8       | 46    | 0      | 4     |
| <b>% Accuracy</b>     | -700.00 | 94.80 | 100.00 | 91.30 |

Table 3-8 represents the classification data from the 5:00 PM to 5:05 PM timeframe. It compares the manual count to the counts collected from the RTMS Echo.

The RTMS Echo, as noted in Table 3-8, meets the required accuracy for cars, small trucks, buses, semi-trucks, and trucks with trailers. However, it does not meet the accuracy requirement for motorcycles, with a percent accuracy of -700.00%. The RTMS Echo found a total of nine motorcycles over the five-minute period, when there was a total of one motorcycle present. Upon further investigation, it appears the RTMS echo did not pick up the singular motorcycle that was present, but it saw smaller cars as ten feet or less. From Figure 3-1, shown below, a motorcycle is spotted in lane seven, at the time 17:00:36. However, from Table 3-9, no motorcycle is detected on the RTMS Echo, with the smallest vehicle detected being twelve feet.

**Figure 3-1**



Figure 3-1 highlights a motorcycle sighting and the time it occurred at.

**Table 3-9**

| Zone | Time                    | Speed | Length | Direction |
|------|-------------------------|-------|--------|-----------|
| 7    | 03/10/2025T17:00:30.501 | 80    | 15     | L         |
| 7    | 03/10/2025T17:00:31.618 | 80    | 14     | L         |
| 7    | 03/10/2025T17:00:33.379 | 78    | 13     | L         |

|   |                         |    |    |   |
|---|-------------------------|----|----|---|
| 7 | 03/10/2025T17:00:36.431 | 79 | 15 | L |
| 7 | 03/10/2025T17:00:38.391 | 78 | 12 | L |
| 7 | 03/10/2025T17:00:40.071 | 77 | 16 | L |

Table 3-9 provides a snippet from the per-vehicle data for this timeframe to show that the motorcycle from Figure 3-1 was not detected on the RTMS Echo.

## 3.8 - SOFTWARE DEMONSTRATION AND DASHBOARD EVALUATION

*Table 3-10 (Dashboard Navigation and Reports Results)*

| Demonstration                                                                                                                   | Meets Expectations?<br>RTMS Echo |
|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Programming, traffic data retrieval, and remote access software must be compatible with current version of Microsoft Windows OS | ✓                                |
| System setup and configuration process can be performed remotely or locally by any third-party trained technician               | ✓                                |
| System capable of recovering from errors, such as through a system reset able to be done remotely                               | ✓                                |
| Accessible online through either application or web browser                                                                     | ✓                                |
| Provides time that system is set to verify that it has accurate date and time                                                   | ✓ Based off of GPS               |
| Configure and detect at least 12 lanes from the dashboard                                                                       | ✓                                |
| Collect raw data from dashboard and export them to third-party programs (such as Excel)                                         | ✓                                |

## 4. SUMMARY

### 4.1 - COUNTS AND CLASSIFICATION

#### Counts

From Tables 3-3 through 3-7, there are three samples out of the fifty total samples that do not meet the 90% accuracy threshold. One of these samples is from Table 3-5 for the South Bound 4 Lane, which is the farthest lane from the radar. It is likely that the distance and change in elevation from the radar is a factor in the accuracy of that lane, as the other lanes from this timeframe all meet the accuracy threshold. The other two samples come from Table 3-7, which is the earliest timeframe and has the smallest total sample size. The first lane that does not meet the accuracy requirement is the South Bound High-Occupancy Vehicle Lane, which is partially blocked by the barrier between the northbound and southbound lanes. The other lane that does not meet the threshold is the South Bound 3 Lane, which is the second farthest lane from the radar.

The radar was tested to push the normal parameters and has performed exceptionally well. Overall, EQASI considers the RTMS Echo to meet the 90% accuracy specification requirement.

### **Classification**

The RTMS Echo, as noted in Table 3-8, meets the required accuracy for cars, small trucks, buses, semi-trucks, and trucks with trailers. The radar struggled classifying and identifying motorcycles.

## **4.3 - DASHBOARD AND INTERFACE**

### **Lane Configuration**

The initial setup of the RTMS Echo through the web interface has proven to be straightforward and user-friendly. The system features an "auto-detect" function during the lane configuration process, allowing the radar to run for approximately 15 minutes. During this initial run, the radar maps out the lanes based on the vehicles it detects. After completing the setup, users have the ability to edit individual lanes, adjust their locations, or add and remove lanes as needed. Once the lane configuration is finalized, users can verify that the vehicles detected in live traffic are accurately represented within the dashboard's lane configuration.

### **Data Collection**

The radar has several options for collecting data including interval data, occupancy, classification (length based), classification (binned by speed), gap (average), headway (average), per-vehicle data, speed 85<sup>th</sup> percentile, average speed, binned speed, volume, and volume. The user can adjust the timeframe they are pulling the data from, and which lanes need to be included in the collection.

The ease of use in the configuration and data collection on the web interface is a strong attribute and allows for easy training among the EQASI team.

## **4.4 – CONCLUDING IDEAS**

**Table 4-1**

| Pros                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Cons                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>- Easy configuration</li><li>- Data is customizable</li><li>- Web-based application, where firmware upgrades and configuration can be completed remotely</li><li>- Can be installed on pre-existing poles</li><li>- Single RJ-45 connection required</li><li>- Factory reset can be done remotely on the application</li><li>- Configuration can be backed up and restored remotely</li><li>- Vendor was available to help throughout configuration for any additional concerns</li></ul> | <ul style="list-style-type: none"><li>- Does not always detect motorcycles</li><li>- Requires an additional purchase for more features</li><li>- Storage may be limited in areas with high traffic volume</li></ul> |

Cost Analysis: RTMS Echo Side-Fire Hi Resolution radar unit w/ Camera, includes mounting bracket and 50 feet of Cat5 cable, Surge Panel, Din Rail Mount (For RTMS Echo & Camera): \$6,810

## **5. APPENDIX**

### **5.1 - DIRECT INTERACTION**

Points of note for direct interaction:

- Responsive
- Accessible
- Cooperative
- Helpful

Vendor was responsive and cooperative. They provided suggestions for setup and modifications to improve accuracy of the radar after initial testing.

Vendor came out to the test site to help configure the radar. This included providing recommendations from the original set-up and verifying configuration once the radar had created the zones for each lane.

### **5.2 - CHALLENGES/ISSUES**

Once the data is maxed out, the user can determine if they want old data to be overwritten or tell the radar to stop collecting live data.

Testing occurred in clear weather conditions. There may be different results if tested in varying weather conditions.