TECHNICAL REPORT STANDARD PAGE

1. Report No. FHWA/LA.06/402	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Modeling Hurricane Evacuation Traffic: A Mobile Real-Time Traffic Counter for Monitoring Hurricane Evacuation Traffic Conditions	5. Report Date April 2006	
	6. Performing Organization Code	
7. Author(s) Sherif Ishak, Ciprian Alecsandru, Yan Zhang, Dan Seedah	8. Performing Organization Report No. 402	
9. Performing Organization Name and Address Department of Civil and Environmental Engineering College of Engineering, Louisiana State University Baton Rouge, Louisiana 70803	10. Work Unit No.	
	11. Contract or Grant No. LTRC Project Number: 03-1SS State Project Number: 736-99-1116	
12. Sponsoring Agency Name and Address Louisiana Transportation Research Center 4101 Gourrier Baton Rouge, Louisiana 70808	13. Type of Report and Period Covered Final Report, 01/01/03 – 12/31/04	
	14. Sponsoring Agency Code	

15. Supplementary Notes
Conducted in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

In this research report, an investigation was conducted to identify a suitable traffic monitoring device for collecting traffic data during actual emergency evacuation conditions that may result from hurricanes in Louisiana. The study reviewed thoroughly the technical features and capabilities of a set of state-of-the-art traffic monitoring devices produced by different manufacturers. The selection criteria included cost, degree of mobility, ease of installation and calibration, resilience to adverse weather conditions, and real-time communication options. The comparative evaluation showed that the Remote Traffic Microwave Sensor (RTMS) meets all selection criteria when combined with a trailer for mobility and a cellular modem for real-time wireless communication. The mobile RTMS system was acquired and assembled at the Louisiana Transportation Research Center (LTRC) facility to collect traffic measurements in future hurricane-related studies.

17. Key Words Mobile Traffic Counter, Wireless Communication, Traffic Data		18. Distribution Statement Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161.	
19. Security Classif. (of this report) N/A	20. Security Classif. (of this page)	21. No. of Pages: 78	22. Price

Project Review Committee

Each research project will have an advisory committee appointed by the LTRC director. The Project Review Committee is responsible for assisting the LTRC administrator or manager in the development of acceptable research problem statements, requests for proposals, review of research proposals, oversight of approved research projects, and implementation of findings.

LTRC appreciates the dedication of the following Project Review Committee Members in guiding this research study to fruition.

LTRC Administrator/Manager

Chester Wilmot
Planning/Intermodal Research Manager

Members

Michael Boudreaux, LTRC
George Gele, LADOTD
James Mitchell, LADOTD
Peter Allain, LADOTD
Marc Genre, Louisiana Department of Public Safety
Sean Fontenot, Innovative Emergency Management, Inc.

Directorate Implementation Sponsor

William Temple
LADOTD Chief Engineer

Modeling Hurricane Evacuation Traffic: A Mobile Real-Time Traffic Counter for Monitoring Hurricane Evacuation Traffic Conditions

by

Sherif Ishak, Ph.D.
Ciprian Alecsandru
Yan Zhang
Dan Seedah

Department of Civil and Environmental Engineering
Louisiana State University
Baton Rouge, LA 70803

LTRC Project No: 03-1SS
State Project No: 736-99-1116

conducted for

Louisiana Department of Transportation and Development
Louisiana Transportation Research Center

April 2006

ABSTRACT

In this research report, an investigation was conducted to identify a suitable traffic monitoring device for collecting traffic data during actual emergency evacuation conditions that may result from hurricanes in Louisiana. The study reviewed the technical features and capabilities of a set of state-of-the-art traffic monitoring devices produced by different manufacturers. The selection criteria included cost, degree of mobility, ease of installation and calibration, resilience to adverse weather conditions, and real-time communication options. The comparative evaluation showed that the remote traffic microwave sensor (RTMS) met all selection criteria when combined with a trailer for mobility and a cellular modem for real-time wireless communication. The mobile RTMS system was acquired and assembled at the Louisiana Transportation Research Center (LTRC) facility to collect traffic measurements in future hurricane-related studies.

ACKNOWLEDGMENTS

This project was completed under the support of the Louisiana Department of Transportation and Development (DOTD) and the Louisiana Transportation Research Center (LTRC). The research team also gratefully acknowledges the assistance received from the Project Review Committee (PRC) members for their valuable feedback and all other DOTD personnel involved during the course of this project.

IMPLEMENTATION STATEMENT

Currently, there is a lack of portable traffic monitoring devices within the state of Louisiana to provide traffic demand measurements at remote locations during emergency evacuation conditions. Despite the presence of stationary instruments, there is still a pressing need to determine traffic conditions at locations that may fall outside instrumented areas. This created an immediate need to rely on mobile traffic counters that provide the required degree of flexibility in the selection of measurement locations. This research project examined a set of possible devices with various underlying technologies to determine the best portable traffic counter possible. Based on technical and cost assessments of all traffic monitoring devices presented in this report, the research team concluded that the RTMS device, combined with a mobile trailer and cellular wireless communication devices, is the best candidate for data collection and acquisition during emergency evacuation conditions. The device, currently housed at LTRC, was acquired and tested for immediate and future use.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

Currently, the Louisiana Department of Transportation and Development (DOTD) has permanent traffic counting stations around the state that are used to measure traffic demand at specific locations within the state. In addition, DOTD has recently partnered with the United States Geological Survey (USGS) to couple traffic counters with their hydro-watch stations located at over 80 locations near Louisiana waterways. These stations will be capable of providing near real-time traffic counts. However, the USGS stations are stationary and restricted to the locations of current hydro-watch stations. While these stations have the potential to provide valuable sources of information under evacuation conditions, there is still a pressing need to determine traffic conditions at locations that may fall outside current hydro-watch sites. This creates an immediate need to rely on mobile traffic counters that provide the required degree of flexibility in the selection of measurement locations.

Currently, models of hurricane evacuation demand do not incorporate dynamic treatment of traffic conditions on the evacuation network. To develop dynamic demand models, traffic conditions must be observed during the evacuation period at representative locations. To achieve this goal, mobile traffic monitoring devices are required to provide the accuracy and flexibility of collecting high-resolution data during emergency evacuation conditions and under adverse weather conditions. This phase of the project attempts to achieve the goal of identifying and acquiring a suitable traffic measurement device that is capable of streaming real-time information from evacuation locations to a central traffic management facility.

OBJECTIVES

The objective of this research study was to select and acquire a mobile traffic counter capable of providing traffic flow and average speed data in intervals no greater than 15 minutes and transmit the data back to a central location at the termination of each time interval. The counter had to operate on at least 95 percent of the locations on public roads in the state of Louisiana, thus wireless communications were deemed necessary.

SCOPE

The research reported in this document is part of a more comprehensive study addressing other topics related to evacuation planning. These topics are addressed in separate LTRC reports. Specifically, LTRC Technical Report 408 addresses the estimation of time-dependent hurricane evacuation demand and reports on the development of a sequential logit model that estimates whether a household will evacuate or not, and if it does decide to evacuate, when they will choose to leave *[1]*. LTRC Technical Report 400 addresses contraflow as a means of increasing evacuation capacity and reports on research conducted on the effectiveness of alternative initiation and termination configurations of contraflow evacuation systems *[2]*. The development of a methodology to establish hurricane evacuation zones in a systematic and reproducible manner was also conducted as part of this study and is reported in Transportation Research Record 1922 *[4]*. The procedure uses postal Zone Improvement Plan (ZIP) areas as basic building blocks in a GIS-based process that progressively combines these blocks into evacuation zones of similar flooding potential.

This research report documents the investigation into a mobile traffic counter capable of providing real-time traffic flow and speed information at remote locations. It describes the specification, evaluation, and acquisition of a trailer that uses radar detection of volume and speed over multiple lanes and uses a cellular phone to transmit information back to a central location at time intervals of the user's choice. The scope of this part of the study is limited to traffic counting devices that meet the following requirements:

1. The traffic counter should be capable of measuring traffic observations reasonably and accurately.
2. The device must sustain adverse weather conditions (gusty winds and poor visibility) without affecting the quality of data observations.
3. The traffic monitoring device must be easy to move and quick to set up given short evacuation notices.
4. Both capital and operating costs of the device should be reasonable.
5. The device must be capable of operating under its own power and storing traffic data for at least 72 hours.
6. The device should be wirelessly accessible for real-time, or near real-time, retrieval of data.

METHODOLOGY

Review of Traffic Monitoring Devices

The report includes a full investigation of various technological devices that are considered appropriate for collecting traffic data during actual emergency evacuation conditions. The important features, as highlighted earlier, were given more emphasis in the selection process. Such features included mobility, relative ease of site calibration at the onset of data collection, and resilience to adverse weather conditions as anticipated during hurricane evacuation. A few devices were initially selected and compared to evaluate their suitability for this task. The comparison was made to identify which traffic counting equipment would accurately and reliably measure volume, speed, and occupancy of vehicles across multiple lanes in one direction of the roadway under various traffic and weather conditions.

In this report, five types of mobile trailers were investigated from three different manufacturers and compared in terms of reliability, accuracy, mobility, ease of operation, resilience to adverse weather conditions, real-time communication capabilities, and cost. All the information was accumulated from Internet product Web sites, Emails, telephone calls, and facsimiles. The following sections describe the list of mobile trailers that were identified in this project as suitable candidates for collecting traffic information during hurricane evacuation conditions.

Galaxy Radar Message Trailers

Decatur Electronics, Inc. produces the Galaxy series radar signs and trailers. Figure 1 shows a picture of the Galaxy™ Series MT-50. This model has a 14-character, 2-line display that is 77 in. by 32.5 in. The legibility distance to road users is estimated as 750 ft. Figure 2 shows a snapshot of the Galaxy™ Series MT-70, which has a 24-character, 3-line display that is 92 in. by 52 in. Its legibility distance is estimated at 750 ft. The latest model of this series is the Galaxy™ Series MT-100, as shown in Figure 3. It has a 24-character, 3-line display (130 in. by 72 in.). Its legibility distance is up to 1,000 ft.

Figure 1
Galaxy™ Series MT-50

Figure 2
Galaxy™ Series MT-70

Figure 3
Galaxy™ Series MT-100

Each of the three models depicted here can be attached to a special traffic counter system, referred to as MetroCount Vehicle Classifier System (see Figure 4 and Figure 5). The traffic counting system in Figure 4 combines state-of-the-art traffic logging hardware with powerful, yet easy-to-use software. MetroCount provides a solution to all traffic monitoring issues from routine statistics to the most complex traffic management problems. Matched with the Decatur Electronics' Galaxy Series of Radar/Message Trailers, the MetroCount Vehicle Classifier System in Figure 5 produces a comprehensive traffic safety and vehicle count and classification package.

Figure 4
MetroCount™

Figure 5
Vehicle Classifier System

The waterproof MetroCount system can be mounted inside the Galaxy Radar/Message Trailer or used as a stand-alone product. It can also collect vehicle class, speed, and volume data. In addition to providing 85th speed percentiles, it retains data for every individual vehicle and has a comprehensive system to generate reports and graphs with speed statistics, volumes, vehicle classes, and gaps. The system also allows downloading information to a desktop or laptop computer. *TrafficExecutive* software for Windows is included in the package along with a pneumatic tube sensing method designed to provide better accuracy and reliability. Table 1 shows the price list of the Galaxy^{TM} Series of radar trailers with the MetroCount Vehicle Classifier System.

Table 1
Galaxy radar message trailers

General features of the MT-50, MT-70, and MT-100 Radar Message Trailers:
8 Batteries, 25 Amp chargers, SI-2 Radar, Graffiti Resistant White Powder-coat Paint.

	Unit Price
Galaxy MT-50 2-line Radar Message Trailer 7 amber colored 12”H LED characters, speed limit sign, Display cabinet 77”L X 32.5”H X 9”D.	$16,000.00
Galaxy MT-70 3-line Radar Message Trailer 8 amber colored 12”H LED characters, 220 watt solar panel Display cabinet 92”L X 52”H X 12”D	$20,400.00
Galaxy MT-100 3-line Radar Message Trailer 8 amber colored 18H Led characters, 220 watt solar panel, Display cabinet 130”L X 72”H X 12”D	$25,000.00
Optional Equipment:	
120 Watt Solar Panel Pivot System (MT50)	$1,550.00
Red LED Characters (MT50)	$310.00
Red LED Characters (MT70 and MT100)	$620.00
Combination Ball/Pintle Hitch	$80.00
Motion Alarm System	$310.00
Remote Activation Option:	
PAS System Program Software (one required per fleet with system)	$675.00
Pager activation system	$1,165.00
Cellular Mode	$2,610.0
Statistics Package Option:	
Vehicle Classifier System	$1,495.00
Shipping:	
FOB Arvada, Colorado	$30.00

SpeedTrak Radar Trailer

Another type of traffic monitoring device is the SpeedTrak Radar Trailer manufactured by Sharp Communication, Inc. The device and trailer have the following technical specifications:

1. Motorized Lift*:* Allows the user to raise and lower the speed display and sign for easy setup, take down, and towing by simply holding the toggle switch up or down.

2. Direction Radar*:* Only monitors approaching vehicles and ignores vehicles going in the opposite direction. This gives road users more confidence in the speed displayed.
3. 18 in. High Intensity LED (Light Emitting Diode): Each 18 in. digit contains 246 wide-angle, high intensity LEDs. This allows drivers to see the speed display from long distances and various angles. The trailer can also be placed at different locations since visibility is not a problem.
4. See-Through-Design: Eliminates "blind-spots" at intersections and in neighborhoods, making it safer and easier to see pedestrians, children, cars, etc.
5. Automatic Brightness Control: Automatically adjusts the brightness of LEDs for nighttime and other lighting conditions.
6. Violation Alert with Flashing Speed: Flashes to warn drivers with LEDs that they have exceeded the speed limit. Optional LED warning lights and white strobes are available to give violators a stronger warning.
7. High Speed Cutoff: Blinks the display reading if pre-set speeds are exceeded. The operator can manually set this speed by using thumbwheel controls on the speed display.
8. Three Heavy Duty Batteries: Operates continuously for over 13 days between charging. It comes with three 110 amp heavy-duty deep cell marine type batteries for a total of 330 amp hours of operation. Optional solar panels are available to provide for longer field use.
9. Pro-Charger with Auto Shut Off: Shuts off automatically to prevent over charging, LED lights indicate battery status, and charges each batter independently.
10. Graffiti Resistant Paint: Paints with graffiti resistant epoxy paint.

The trailer also includes 14-in. tires and chrome wheels, four "Bull Dog" type heavy duty stabilizers, and a removable tongue. The SpeedTrak trailer is shown in Figure 6. Table 2 shows the price quotes obtained from the manufacturer for each component in the SpeedTrak Radar Trailer system. The full system of model SST is also depicted in Figure 7.

Figure 6
SpeedTrak trailer

Table 2
SpeedTrak radar trailer

General features of the SpeedTrak radar trailers: directional radar, 18 in. super bright/wide angle amber LED display.

	Unit Price
McCoy's Law Line SpeedTrak Radar Trailer: 3 heavy duty batteries, 14" tires with Chrome wheels	$7,900.00
Radar trailer model SST: 2 deep cell batteries with 110v tow cell charger, 15" radial tires with Chrome wheels	$5,995.00
Optional Equipment: Solar Panel Charging System 24 Hour Timer Anti-Theft Alarm with Remote Control Spare Tire and Wheel Extra Batteries	
Traffic Statistics Package Option: SpeedTrak Data Logger: Data can be stored in a comma delimited ASCII file Data can be sorted to show: Min/max speeds; peak traffic periods; average traffic speed; percent of speed in excess of posted limit; percent of speeds below posted limit; speed to time of day; traffic volume.	$390.00
Shipping	$700.00

Manufacturer
Sharp Communication, Inc.

Figure 7
SpeedTrak radar trailer Model SST

Remote Traffic Microwave Sensor (RTMS)

Another type of traffic monitoring device is the well-known and widely-adopted remote traffic microwave sensor (RTMS) *[1]*. RTMS, manufactured by Electronic Integrated Systems (EIS), Inc., is a low-cost, general-purpose, all-weather traffic sensor that detects presence and measures traffic parameters in multiple independent lanes across one direction of travel. It is a true presence-type traffic detector providing volume, occupancy, speed, and classification information. The coverage area of RTMS may include up to eight

discrete user-defined detection zones over a distance up to 200 ft. Output information is provided to existing controllers via contact pairs and to computer systems via an RS-232 serial communications port. Figure 8 and Figure 9 show snapshots of the RTMS radar device mounted by the roadside.

RTMS (Remote Traffic Microwave Sensor) radar

Figure 8
A snapshot of an RTMS radar device

Figure 9
RTMS solar powered remote counting station

The technical features of RTMS can be summarized as follows:

- Accurate measurements of volume, occupancy, and speed on eight separate lanes (detection zones)
- Very low life-cycle cost due to the use of radar technology
- Quick installation on the side of the road without traffic disruptions
- Very low or no maintenance requirements
- AC, battery, or solar power options
- Data retrieval via direct or modem connection
- Efficient software to download stored data on site and generate report

The RTMS device is well suited for side-fired operations. It is usually mounted on existing roadside poles. The unit is easy to install and remove and is fully programmable to support a variety of applications. The unit requires no maintenance and was proven to be the only multi-zone traffic detector unaffected by any type of weather. In many tests

performed by traffic professionals worldwide, this radar technology has been recognized as the best for almost all traffic management applications. Some of the applications that RTMS devices can be used to support are:

1. Multi-lane intersection control, stop-bar, and mid-block detection
2. Freeway traffic management and incident detection systems
3. Ramp metering
4. Off-ramp queue control and signal control actuation
5. Work zone and temporary intersection control
6. Permanent and mobile traffic counting stations
7. Enforcement of speed and red-light violation

The RTMS is a miniature radar operating in one either of two microwave bands, employing the Frequency Modulated Continuous Wave (FMCW) principle. It transmits a low-power microwave signal of constantly varying frequency in a fixed fan-shaped beam.

The beam "paints" a long elliptical footprint on the road surface. Any non-background targets will reflect the signal back to the RTMS where targets are detected and their range measured.

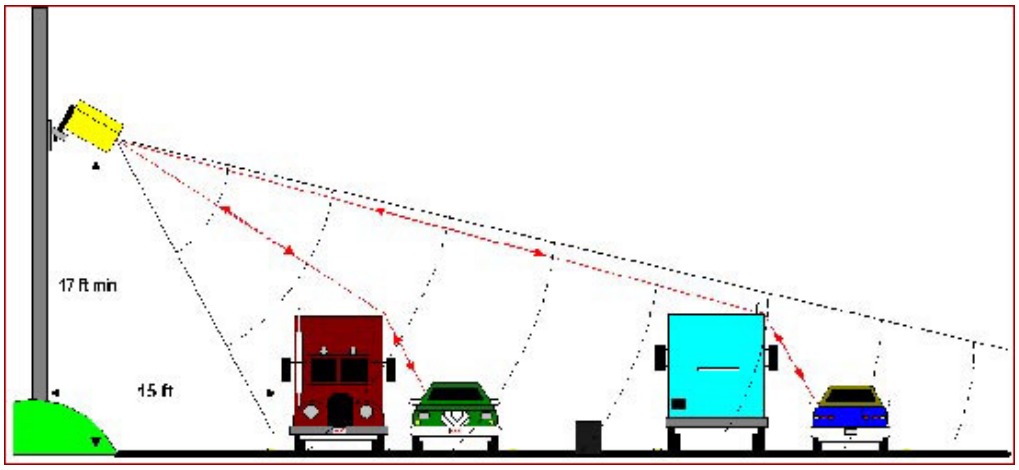


Figure 10
Principles of operation

RTMS devices have been widely adopted in many states, including Louisiana (e.g., I-10 and I-12). RTMS equipment can also tolerate small amounts of movement or vibration, which may be experienced when it is mounted high enough to allow readings across

multiple lanes. The RTMS radar device may also include a remote traffic counting package (RTCP), a queue trailer, and RTMS™ wireless communications. The RTCP is a traffic counting solution for permanent and temporary count stations. It allows counting and storing observations from multi-lane roads. Central PC software is available for downloading stored data via modems and for report generation. RTCP includes the following components:

- One RTMS unit
- Small cabinet
- RTC storage unit
- RTC for Windows software
- RTMS data analyst software

The technical features of RTCP can be summarized as follows:

- Side-fired from existing light poles
- Quick, all-weather installation (in 20 min.)
- Safe installation, no lane closures required
- Fast, easy re-deployment
- Accurate all-weather operation
- Covers up to eight lanes in a 15-200 ft. range
- Per-lane: Volume, Occupancy, Speed, Classification by Length/Headway
- AC or Battery operation—up to one week
- Solar Generator/Charger Options
- No maintenance required, 10-yr. mean time between failures (MTBF)
- High capacity: six months at five-min. intervals
- Power-fail data protection
- User-friendly laptop PC setup program
- Laptop PC or modem data retrieval
- Automatic pre-scheduled remote downloads from many stations into printable raw data files
- Intuitive analysis and report software

Additional equipment may also be added to the package such as:

- RF/line modem
- Battery/solar generator

Radar Vehicle Detector Specifications and Requirements

Environmental condition requirements for the operation of RTMS are -37 to +74°C ambient temperature, 5 percent to 95 percent relative humidity (non condensing), 160 km/h winds, 100 mm/h rain and other precipitation, and ±1 kV power surge (rise time = 1.2 µsec, hold = 50 µsec) [IEC 1000-4-4 and EN 61000-4-5 standards]. Other minimum environmental condition requirements are:

- Temperature compensation to prevent abnormal operation
- Coated circuit boards for protection against humidity
- Noise level emission less than 55 dBa at one-meter distance measurement, except otherwise stated herein for a particular item
- Vibration resistant microwave radar detector [IEC 68-2-30, NEMA TS-1]
- Shock resistant microwave detector [IEC 68-2-27, NEMA TS-1]

Microwave Transmission Specifications

- 10.525 GHz ± 25 MHz frequency band or approved spectral band; compliance with FCC Part 15 for Class A digital device; no known equipment interference; and less than 10 mW power transmitter
- Coverage area is defined by an oval shaped beam with a maximum detection of 40º
- Elevation Beam Width, 15º Azimuth Beam Width, and 10 to 20 ft. range.
- Detection Zones: more than eight detection zones with 7-ft. resolution user-defined range limits.

Functional characteristics requirements are as follows:

- 10-year (or longer) MTBF lifespan when operating continuously with application
- Presence indication of moving or stopping vehicles in detection zones provided by contact closure to existing controllers
- User-defined time intervals for traffic data accumulation in a 10 to 600 sec range; the transmission is via serial communication
- Simultaneous availability of traffic data with detection zone contact closures
- Side-fired configuration data of the following in each of up to eight detection zones (lanes): volume, lane occupancy, average speed, and vehicle classification by length in up to four user-defined classes

- Forward-looking configuration data of the following in one lane: volume, occupancy, average speed, travel direction, per vehicle speed, direct, and length measurements; and volume data binning in up to seven speed bins and up to seven length bins
- User-defined content for transmitted data
- Fail-safe indication by contact pair and by serial data
- Remote indication of input (battery) voltage by serial data
- 95 percent or greater vehicle detection accuracy that is independent of the vehicle's direction of travel through the detection zone
- Provision of a rugged weatherproof box sealed to protect units from up to 90 mph, dust and airborne particles, and exposure to moisture
- Power management features allowing remote shutdown or cyclical shutdown
- Low-voltage disconnect battery protection
- Full duplex asynchronous data communication with NTCIP protocol 1209 support for TSS

Data communication configuration requirements are as follows:

- Opto-isolated RS-485 or RS 232 port at rates of 2,400 up to 115,200 bits per second
- Serial data format: standard binary NRZ 8 bits data, 1 stop bit, no parity
- Support for point-to-point and multi-dropped configurations
- Optional integral Digital Spread Spectrum radio modem
- Optional Ethernet port (TCP/IP)

Electrical Power Specifications are as follows:

Supply

- 12-24 VAC/DC at less than 4.5 W or 95-135 VAC @ 60 Hz

Cable

- Singe, MS connector terminated cable for connection between RVD and cabinet equipment
- 300 V AC/DC, 100 mA rating for power supply to RVD unit and each of the required detection zones and serial data interface
- UV-resistant with provision of multiple twisted pairs of stranded AWG #20 or

#22 wire with a common shield rated at 300 V and 105°C

Enclosure Dimensions Specifications are as follows:

- Maximum overall dimensions, including fittings: 24 x 16 x 18.5 cm (9.5 x 6.25 x 7 in.)
- Maximum weight of the microwave radar detector assembly: 2.2 kg (5 lb.)

The accuracy of RTMS is measured by errors in each observed parameter and differs by the mounting type (side-fired or overhead). Table 3 shows the measurement level errors by mounting type.

Table 3
Measurement error levels

Parameter	Side fired error	Overhead error
Presence	±5%	±2%
Volume	±5%	±2%
Lane Occupancy	±5%	±2%
Average Speed	±10%	±2%
Per Vehicle Speed	N/A	±2%
Length Classification limits	±10%	±10%
Time event	10ms	10ms
Input Voltage	±2%	±2%

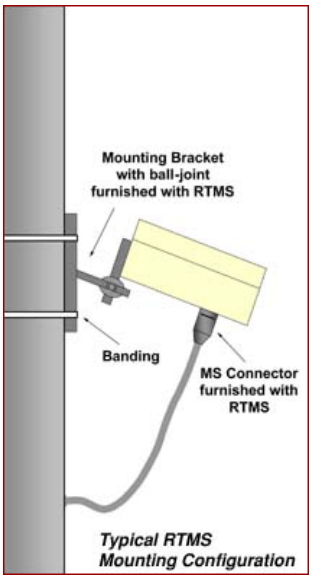


Figure 11
RTMS specifications

RTMS Trailer

This equipment is a trailer-mounted radar unit designed to be placed at a specific location for (1) gathering traffic flow information or (2) advising approaching motorists of their current speed using a lighted message board. Speeds at or below the computer-set speed are indicated by yellow lights. Speeds over the set speed are indicated by flashing red lights. Additionally, the on-board computer can record traffic flows for future analysis.

The mobile RTMS traffic counter is mounted on a trailer equipped with its own power source (a rechargeable battery or a solar system). The device can be mounted on a retractable pole that can extend up to 15 ft. above ground. A picture of the commercially available trailer for RTMS is shown in Figure 12. This trailer has retractable footings for greater stability of the trailer and a cable stay to the top of the pole to reduce sway of the instrument in gusty wind conditions.

Figure 12
RTMS device mounted on trailer (Santa Fe Technologies)

RTMS Setup

The RTMS setup is performed using an IBM-compatible notebook PC. An intuitive, user-friendly setup program allows the user to define the operating mode along with the required number of zones and their locations and to verify correct operation of the unit. As shown in Figure 14, during setup every vehicle within the field of view will be shown on the PC screen as a “blip” at its corresponding range. The user recognizes the blip as belonging to a vehicle he/she sees on the road at that moment and simply moves a zone-box on the screen to surround the blip, thus defining the zone's location. A zone can include one or more lanes. After a zone is defined, its corresponding contact pair will close every time a blip is shown in it. After all zones are defined, a simple observation or manual

count comparison with the RTMS count completes the calibration. A wizard is included in the software to automate the setup process and assist users.

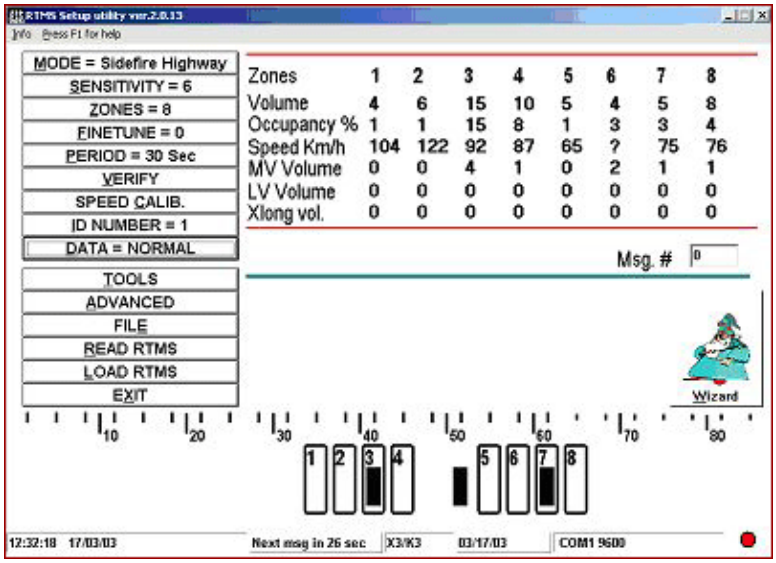


Figure 13
RTMS setup

RTMS Wireless Communication Options

The RTMS Sensor Model X3 may be ordered with a built-in Digital Spread Spectrum Radio Modem. This wireless option simplifies new and older freeway and urban traffic management applications by eliminating fixed communication lines at sensor locations. The radio frequency specifications are as follows:

- Technology: Frequency Hopping Spread Spectrum Radio
- Frequency band: 902-928 MHz ISM ban
- Hopping pattern: 64 pseudo-random sequences selectable
- Transmitter power: 1 mW, 10 mW, 100 mW, or 1W selectable
- Antenna: Integral 9-in. whip or external whip/Yagi antenna
- Range: Up to 30 km depending on power, line of sight, and antenna
- Error Detection: CRC-16
- Network addressing: Up to 65,535 combinations
- Interface: Asynchronous, AT Command set, transparent data set
- Licensing: FCC rules Part 15 approval. License free operation in the US
- Temperature range: -37°C to 70°C

Communication System Specifications

1. Wide Area Traffic/Event Reporting (WATER)

The RTMS-WATER (see Figure 14 and Figure 15) is a quick-deployment, low-cost, wide-area traffic measurement and reporting system. The RTMS-based system measures traffic at many detection stations and cost-effectively transmits their data in real-time to the traffic operations center (TOC) for analysis, using a combination of phone line and radio modems. The system is scalable by simply adding more detection stations and cluster controllers:

- Up to 30 RTMS sensors per cluster
- Up to 128 cluster controllers per system
- Up to 254 RTMS sensors per system
- Direct or cluster topology
- Date collected in real-time database
- Stand alone transceivers in cluster controller cabinets

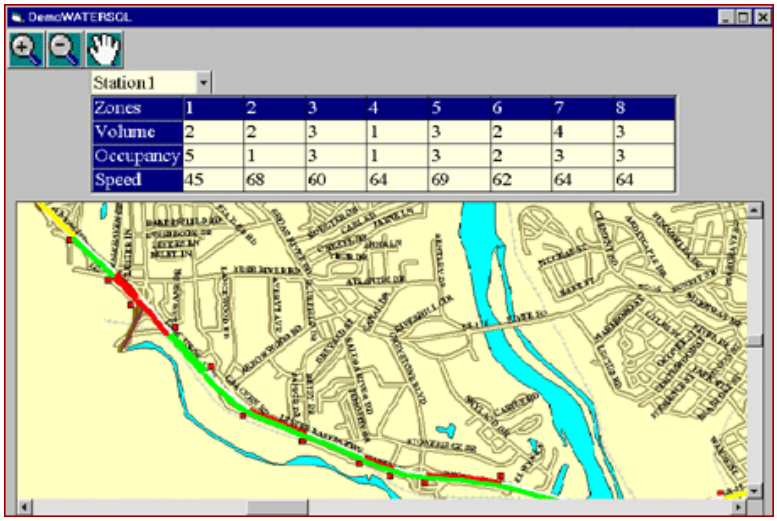


Figure 14
Traffic operations center (TOC) operator screen

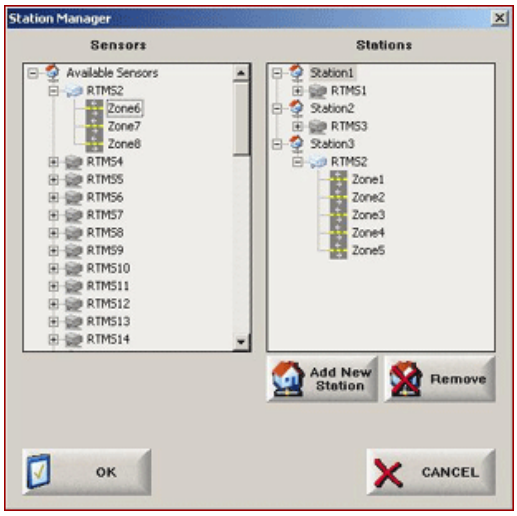


Figure 15
Traffic operations center (TOC) station manager

2. RTMS/NEWS (Node Event Warning System)

RTMS/NEWS is a traffic monitoring solution for permanent or temporary installations (see Figure 16). It performs real-time processing of traffic measurements from multiple RTMS units and provides an output, based upon preprogrammed events, whose criteria are defined by the user (see Figure 17 and Figure 18). Outputs are either contact pair closures (to drive dumb devices) or serial bus messages:

- Up to eight RTMS sensors per NEWS controller
- UP to 128 NEWS controllers per system
- Up to 16 programmed events per controller, each for four conditions
- Failsafe mode
- Stand alone transceivers in NEWS controller cabinets

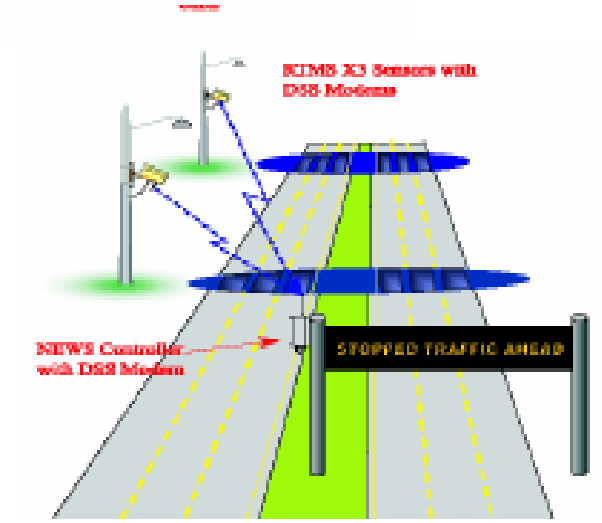


Figure 16
RTMS/NEWS

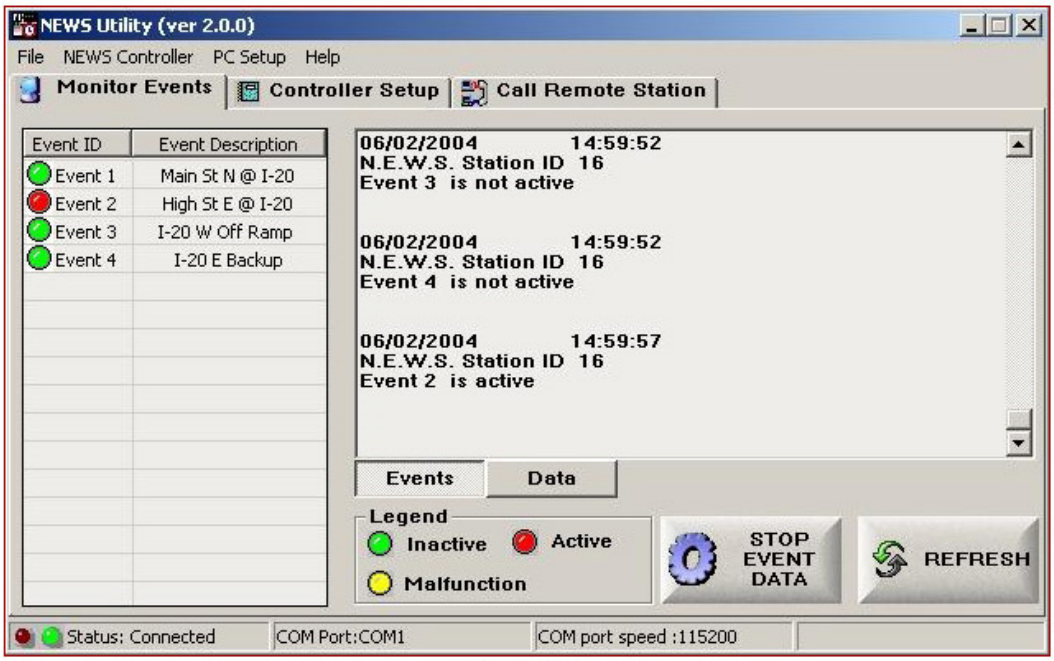


Figure 17
Operator screenshot #1

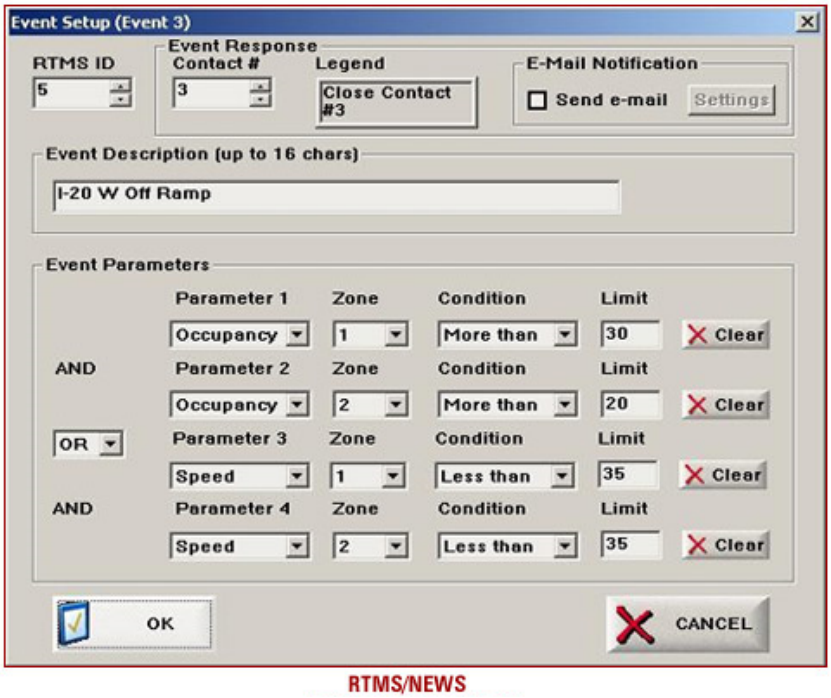


Figure 18
Operator screenshot #2

3. RTMS/SPIDER

The SPIDER system is a low-cost mid-block and system detection solution. A single remote SPIDER controller (typically situated in a controller cabinet) concentrates data from several RTMS Model X3 radar sensors using point-to-multipoint wireless technology, thereby eliminating the requirement for fixed communication lines.

- Up to eight RTMS sensors per wireless SPIDER controller
- Up to eight contact pairs per RTMS
- Up to 32 isolated contact pairs per SPIDER controller
- Compatible with NEMA TS-1, TS-2, 170, and 2070 controllers
- SPIDER controller dimensions 5 in. x 5 in. x 2 in.

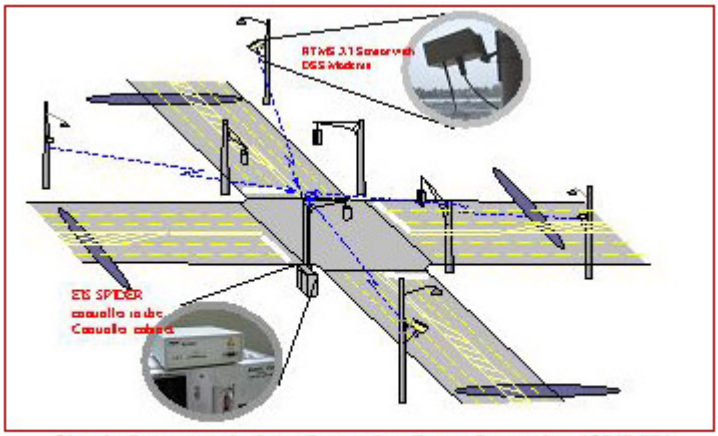


Figure 19
RTMS/SPIDER

4. RTMS/Mobile Freeway Traffic Management System

RTMS/FTMS is a versatile, quick-deployment, low-cost, wide-area traffic data collection and analysis system performing real-time automatic incident detection based on the RTMS.

Vehicle detection stations (VDS) spaced every 984 ft.-1,640 ft. are side-fired and installed on existing road-side poles, delivering data to a PC via radio frequency (RF) or land-line modems.

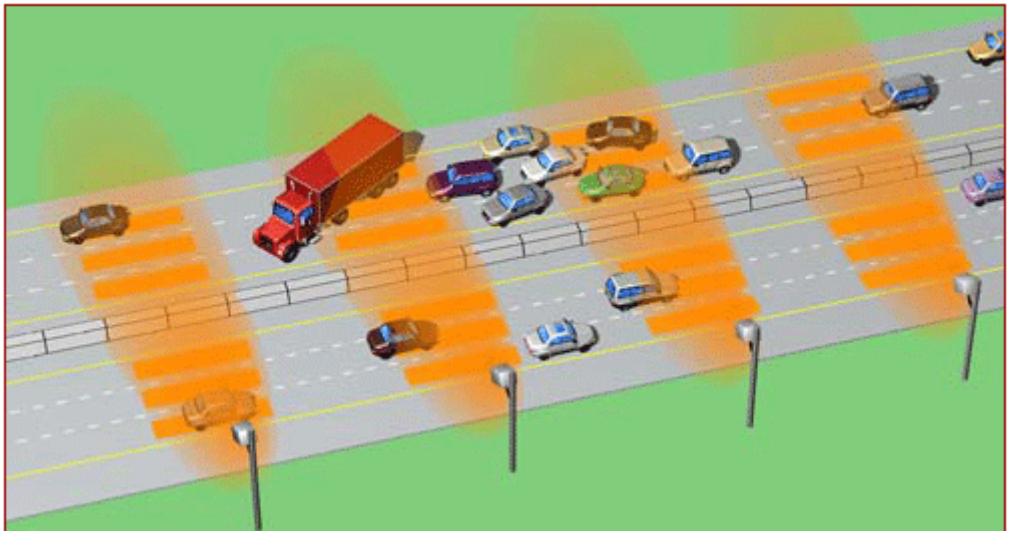


Figure 20
RTMS/FTMS multi-zone detection

Figure 21
RTMS multi-zone detection

Figure 22
Queue trailer

Real Time Communication Issues

Researchers also investigated a suitable communication method that allows the transmission of data from the mobile traffic counter to a central location that could operate several miles away from the data collection site. Three alternatives were investigated in this aspect. First, the possibility of using the digital radio transmission system used by the Louisiana State Police to communicate digital information, such as number plate and driver's license information, from their patrol cars anywhere in the state to the Department of Public Safety in Baton Rouge was considered. This option, however, requires access privileges to the DOTD communication network before transmitting traffic data over the radio signal. Second, the possibility of using satellite-based cellular telephones was also investigated. Satellite-based cellular telephones do not experience the same degree of overload as regular land-based systems do in emergency situations. However, satellite communication equipment is generally costly, and transmission charges for satellite-based wireless telephone are approximately $1 per minute. While the size of data packets to be transmitted in real time is expected to be small, the communication with field devices must be made in real time and, therefore, will become cost prohibitive. The third

communication option is to use cellular-based wireless networks with one of the existing cellular service providers. This option requires using a cellular modem so that the RTMS device may be accessible through a dial-up connection from a PC with a land phone line.

The first option was ruled out because it does not permit direct access to the traffic monitoring device since the radio systems are only accessible through the DOTD network. The second option was also ruled out because it is less cost effective than the third option. Moreover, satellite communication may not be available at all times and therefore, is likely to be less reliable than current cellular communication. It should be also noted that cellular communication technologies have made significant advancements in the past few years, and therefore, are now more reliable than before. This led to the recommendation of the third option, which was found to be the most cost-effective and feasible solution to be integrated with the adopted RTMS system.

Description of the Wireless Cellular-Based Communication Option

Real-time wireless communication with the RTMS mobile counter system can be made through cellular connections between a remote PC and the RTMS unit in the field. A cellular modem is required to serve as a dial-up server and to provide communication with the RTMS data storage device. This allows users to download data collected by RTMS in real-time at the frequency desired. The cellular modem that was proven to be compatible with RTMS is AirLink Raven GPRS. The modem serves as a data platform that enables real-time, two-way communications with RTMS. The modem operates with the AirLink Embedded Operating System (ALEOS) that has its own embedded TCP/IP (transmission control protocol/internet protocol) stack. This enables transmission of serial data from non-IP devices. Because GSM/GPRS networks do not utilize static IP addresses, ALEOS, in conjunction with the AirLink IP Manager, enables applications to address remote devices by name (e.g., remote1.dnsmobile.com). This dynamic domain name system (DDNS) function is done automatically and securely any time the IP of the device changes. The AirLink IP Manager then updates a DNS server. ALEOS can update IP assignment to host applications in addition to or instead of the AirLink IP Manager. Mobile Electron offers a hosted service, called DNSMobile, that manages modem hostnames for a small yearly fee.

Figure 23
AirLink Raven GPRS wireless modem

The unique intelligence within ALEOS enables virtually any type of remote device to connect via the public GSM/GPRS network. It can be used to replace existing landlines, private radio, cellular digital packet data (CDPD), and circuit-switched installations. Applications that may benefit from this wireless communication service include:

- **Utilities**
  - Natural Gas Wellhead Monitoring
  - C&I Meters
  - Transmission Line Flow Meters
  - Energy Management Systems
- **Transportation**
  - Traffic Measurement
  - Traffic Control
  - Variable Message Signs
- **Atmospheric/Environmental**
  - Weather Monitoring
  - Irrigation Control
  - Seismic Monitoring
  - Water Level Monitoring
- **Financial**
  - Automated Teller Machines
  - Point-of-Sale
  - Lottery Machines
- **Technical Specifications:**
  RF Features:
  - Network: 1,900/850 MHz GPRS
  - Transmit frequency: 1,850-1,910 MHz and 824-849 MHz

- Transmit power range at antenna port: 1.0 W for 1,900 MHz and 0.8W for 850 MHz
- Transmitter can reduce output power when near a base station as per GSM specifications
- Receiver frequency: 1,930-1,990 MHz and 869-894 MHz
- Receiver sensitivity: typical -107 dBm (2.439 percent bit error rate)
- Multislot Class 8
- Circuit Switched Data Capable (14,400 Transparent and Non-Transparent Modes)

Power Management Features:

- Advanced Power Management Features
- Low Power Consumption
- Input Voltage: 10 VDC to 28 VDC
- Input Current: 40 mA to 200 mA
- Typical Receive: 200 ma at 12 VDC
- Typical Transmit: Approximately 200 ma at 12 VDC
- Dormant Connection [idle for 10-20 seconds]: 40 ma at 12 VDC

Environmental:

- Operating ranges: -30°C to +70°C
- 10 percent duty cycle limit above 60°C
- Humidity: 5 to 95 percent non-condensing

Physical Characteristics:

- Weight: < 1 lb.
- Size: 3 in. wide x 1 in. high x 5.1 in. long
- Status LEDs
- RF Antenna Connector: 50 Ohm TNC
- Serial Interface: RS232 DB-9F

RTMS Trailer Setup Procedure

The RTMS trailer acquired for this project is stored in the LTRC gated parking facility. Figures 27 through 29 show the left-side, right-side, and front views of the RTMS trailer. Instructions on how to setup the RTMS trailer in the field and how to perform initial calibration can be found in the Appendix. A copy of the certificate of origin is also attached to this report.

Figure 24
RTMS trailer (left-side view)

Figure 25
RTMS trailer (right-side view)

Figure 26
RTMS trailer (front view)

DISCUSSION OF RESULTS

Based on the information collected from each of the traffic monitoring devices presented in this report, the critical specifications and desired features were summarized in Table 4. In terms of reliability, accuracy, mobility, ease of operation, and self-power, the technical specifications provided by the manufacturer showed no difference in performance. This claim, however, should be verified by testing each device against ground truth data, and therefore, this task is beyond the scope of this study. The table also shows that all devices are capable of providing vehicle classification and real-time communication capabilities, except the SpeedTrak trailer. Resiliency to adverse weather conditions was only reported by RTMS. Also, RTMS is the only device that is capable of measuring speed, volume, and lane occupancy in traffic data. As far as procurement cost is concerned, the RTMS trailer was the most cost effective unit.

Table 4
Comparative evaluation of the traffic monitoring devices

Attributes	Galaxy Series MT-50	Galaxy Series MT-70	Galaxy Series MT-100	SpeedTrak Trailer	RTMS Trailer
Reliability	Yes	Yes	Yes	Yes	Yes
Accuracy	Yes	Yes	Yes	Yes	Yes
Data	Speed Volume	Speed Volume	Speed Volume	Speed	Speed Volume Lane Occupancy
Vehicle Classification	Yes	Yes	Yes	No	Yes
Mobility	Yes	Yes	Yes	Yes	Yes
Ease of Operation	Yes	Yes	Yes	Yes	Yes
Resiliency to Weather Conditions	Unknown	Unknown	Unknown	Unknown	Yes
Real-Time Communication	Yes	Yes	Yes	Unknown	Yes
Self-Powered	Yes	Yes	Yes	Yes	Yes
Cost	$17,495	$21,895	$26,495	$15,000	$12,080

CONCLUSIONS AND RECOMMENDATIONS

Based on a review of technical specifications, cost of procurement, and operation of the set of traffic monitoring devices presented in this report, the research team concluded that the RTMS device, combined with a mobile trailer and cellular wireless communication devices, is the most appropriate for data collection and acquisition during emergency evacuation conditions. A purchase requisition was made in late February 2005 for the following items: a SECO-portable traffic monitor, a trailer, and batteries with charger and cable. A detailed description of the technical specifications can be found in the Appendix The RTMS mobile counter system was acquired and tested in the field during May 2005. The process of assembling and calibrating the system was relatively simple and fast (roughly 30 minutes or less for experienced users). The system was also supplemented with a wireless cellular modem and a cellular antenna that facilitate communication with the RTMS device in real-time using a dial-up service over a wireless data connection.

ACRONYMS, ABBREVIATIONS & SYMBOLS

ALEOS	AirLink Embedded Operating System
CDPD	Cellular Digital Packet Data
DDNS	Dynamic Domain Name System
DNS	Domain Name System
EIS	Electronic Integrated Systems
FMCW	Frequency Modulated Continuous Wave
LADOTD	Louisiana Department of Transportation and Development
LTRC	Louisiana Transportation Research Center
MTBF	Mean Time between Failures
RF	Radio Frequency
RTMS	Remote Traffic Microwave Sensor
SPIDER	Simple Presence In-Lane Detection Event Reporting
TOC	Traffic Operation Center
USGS	United States Geological Survey
VDS	Video Detection Station
WATER	Wide Area Traffic/Event Reporting

REFERENCES

1. Radar Vehicle Detector User Manual, Electronic Integrated Systems Inc., 2003.

APPENDIX

Request for Quotation

LOUISIANA STATE UNIVERSITY
AND AGRICULTURAL & MECHANICAL COLLEGE

BATON ROUGE, LA 70803
TELEPHONE # **225-578-4846**_____ FAX #**225-578-8652**____

REQUEST FOR FAX QUOTATION

NUMBER OF PAGES (including cover): **3** DATE: **Wednesday, February 23, 2005**

INSTRUCTIONS/GENERAL CONDITIONS

QUOTATION # 05-2089 DUE DATE/TIME / / [__:____**am / pm]**

TITLE: A portable traffic monitoring system

1. Quotations for furnishing the items and/or services specified, subject to the conditions stated herein and/or attached hereto, are hereby invited and will be received by the department stated above, until the specified due date and time. **QUOTES MUST BE SIGNED.**
2. ALL PRICES MUST BE FIRM AND ARE TO BE QUOTED COMPLETE AND FOB LSU, BATON ROUGE, LA, INCLUSIVE OF ANY DELIVERY/FREIGHT/HANDLING CHARGES, unless otherwise stated by the University. **Bids other than FOB LSU may be rejected. Any invoiced shipping/freight/handling charges that are not quoted and itemized on the University purchase order are subject to rejection and non-payment.**
3. Quotations shall be binding for 30 calendar days from due date, unless otherwise specified.
4. Do not include State Sales Tax or Federal Excise Tax; same will be added if applicable.
5. University payment terms are Net 30 days.
6. The University reserves the right to award the order by individual items, related items, or by total, whichever it deems to be in its best interest and the University also reserves the right to reject any and all quotations and to waive informalities.
7. Unless otherwise called for in the specifications, all products are to be new, current model, and of best quality as measured by acceptable standards of the trade, and any defects in any product may cause its rejection. WHEREVER MANUFACTURER'S TRADE OR BRAND NAMES APPEAR IN THE SPECIFICATIONS, IT IS TO BE ASSUMED THAT EQUAL PRODUCTS WILL BE CONSIDERED UNLESS OTHERWISE SPECIFIED BY THE UNIVERSITY. ANY BIDDER PROPOSING EQUAL PRODUCTS IS TO SUBMIT WITH QUOTATION COMPLETE INFORMATION, INCLUDING SPECIFICATION AND PICTURES DEPICTING PROPOSED EQUALS. QUOTATIONS NOT SPECIFYING BRAND NAME AND MODEL NUMBER SHALL BE CONSIDERED AS OFFERING THE EXACT PRODUCT SPECIFIED. Where applicable, all products are to be covered by standard factory warranty unless otherwise specified by University.
8. **Telephone inquiries are to be directed to the department stated above with above quotation number for reference.**

ALL QUOTING VENDORS ARE TO PROVIDE THE FOLLOWING INFORMATION:

SHIPMENT WILL BE MADE FROM **SHREVEPORT, LA.** WITHIN **60** DAYS AFTER RECEIPT OF ORDER.
SHIPMENT IS TO BE FOB LSU, BATON ROUGE, AND PRICES INCLUSIVE OF ANY DELIVERY/FREIGHT/HANDLING CHARGES.

BIDDER **SIGNAL EQUIPMENT CO. – SOUTH** ADDRESS **P.O. BOX 78172**
(COMPANY NAME) (STREET OR P.O. BOX)

BY John L Vaughn **SHREVEPORT, LA. 71137**
(SIGNATURE) (CITY, STATE, ZIP CODE)

TITLE **VICE-PRESIDENT** PHONE NUMBER (**318**) **222 7373**

FEDERAL TAX I.D. # **72-0867642** FAX NUMBER (**318**) **222-7376**

EMAIL: **secosouth@secosouth.net**

NOTE: By accepting a purchase order resulting from this Request for Quotation, non-resident firms certify they have paid all taxes duly assessed by the State of Louisiana and its political subdivisions, including franchise taxes, privilege taxes, sales taxes, and all other taxes for which they are liable, to the state and its political subdivisions.

In accordance with L.R.S. 39:1594(C) (2) (D), the person signing the quotation must be: 1) a current corporate officer, partnership member or other individual specifically authorized to submit quotations as evidenced in appropriate records on file with the Secretary of State; or 2) an individual authorized to bind the vendor, as evidenced by an accompanying corporate resolution, certificate or affidavit. By signing this quotation, the bidder certifies compliance with the above.

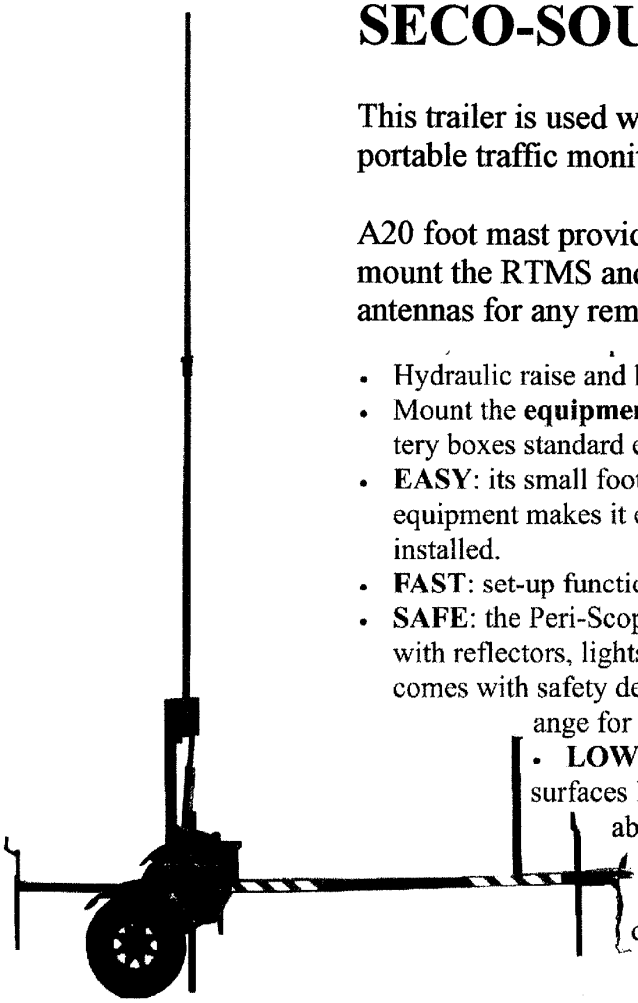
Quotations submitted are subject to provisions of the laws of the State of Louisiana including, but not limited to, L.R.S. 39:1551-1736; purchasing rules and regulations; executive orders; standard terms and conditions; special conditions; and specifications listed in this solicitation.

LOUISIANA STATE UNIVERSITY DEPARTMENT/OFFICE:

Date: 2 / 23 / 2005 Quotes Obtained by: _____ Quote ____ of ____			REQUEST FOR QUOTATION IF Description field does not provide sufficient space, additional specifications may be attached.			Requisition Number: _____	
Item No.	**Qty**	**Unit**	**Description**	**Model No.**	**MFR/Brand**	**Unit Price**	**Ext. Amount**
1	**1**	**EA**	**SECO-PORTABLE TRAFFIC MONITOR**	SECO-PTM1	SECO	$12,080.00	$12,080.00
			INCLUDED ARE: TRAILER LESS SOLAR PANEL MOUNTS, RTMS AND CABLE,				
			BATTERIES WITH CHARGER AND CABLE, PER ATTACHED SPECIFICATIONS				
			EDUCATIONAL DISCOUNT				INCLUDED
			Shipping & Handling ("Firm"amount or a "Not To Exceed" amount)				INCLUDED
			Inside Delivery Charge (if not included in Shipping & Handling)				INCLUDED
			Quoting vendor to fill out fields marked by shaded areas.			**Total:**	**$12,080.00**

Mobile Counter Trailer

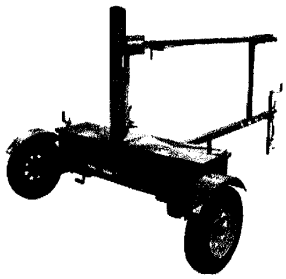
SECO-SOUTH PTM-1



This trailer is used with an RTMS for portable traffic monitoring requirements.

A20 foot mast provides the platform to mount the RTMS and communication antennas for any remote monitoring.

- Hydraulic raise and lower via a manual jack.
- Mount the **equipment of your choice** - battery boxes standard equipment.
- **EASY**: its small footprint and hydraulic equipment makes it easily stored, towed and installed.
- **FAST**: set-up functions are simple.
- **SAFE**: the Peri-Scope Jr. is ready to tow, with reflectors, lights and safety chains. It comes with safety decals in place. It is orange for high visibility.
- **LOW MAINTENANCE**: All surfaces likely to experience abrasion in normal operation are plated. The rest are powder-coated for durability.



SECO – SOUTH

1517 Corporate Drive
Shreveport, LA 71107

(318) 222 7373
(318) 222 7376
www.secosouth.net
sales @ secosouth.net

General Specifications for Portable Traffic Monitoring Systems

GENERAL DESCRIPTION:

This specification is for a portable unit that provides accurate traffic counts of eight lanes and can be located adjacent to highway traffic lane using radar vehicle detectors. Positioning and setup of the unit shall not require additional equipment or material that is not part of the unit. These specifications provide detail requirements for conventional 120VAC power operation. Communication to the system is not detail within these specifications.

TRAILER CHASSIS:

The basic components of the chassis are axle, suspension, wheels, cabinet, tongue, hitch, outrigger, leveling jacks, anchors, cabinet, RVD mast, and solar panel mount.

The chassis shall provide structural separation between two torsion sprung stub axles with a minimum rated capacity of 1000# each. Hubs shall be mounted on each axle providing four studs for attaching the wheels. Wheels shall be for B78 x 13" high speed rated tires with a minimum load rating of 1100#. Fenders shall be attached to the chassis and cover each wheel and tire and shall have splashguards against the chassis.

The tongue of the chassis shall extend perpendicular from the center of the wheel and have a quick-lock trailer coupler attached to the free end. The coupler shall be sized for a 2" maximum ball size and have a minimum rating for a 2000 GVW trailer with trigger release lever for hitching that can be padlocked.

Two cabinets shall be installed on the chassis between the wheels. Each cabinet shall be designed to contain (for size and weight) four group 27 batteries. Each cabinet shall have a haspand ring to accept a 3/8" loop pad lock.

Four leveling jacks shall be installed on the chassis. Each jack shall be rated a minimum of 1000# capacity for leveling and lifting. One jack shall be mounted on the trailer tongue adjacent to the hitch. A second jack shall be mounted on the free end of the outrigger. The other two jacks shall be mounted in front of and adjacent to the trailer tires.

The outrigger shall be extendable and retractable from the center of the chassis toward the rear of the unit.

Stabilization and leveling of the unit shall be part of the setup using the equipment that is part of the unit.

All necessary standard dot trailer lights shall be provided. Conspicuity markers shall be permanently attached to the chassis positioned on both sides, front and read of the trailer. . Viewing shall not be hampered by any part of the unit in the folded or opened positioned.

RVD MAST:

The mast shall be centered at the rear of the trailer chassis. A manual hydraulic ram shall be provided for raising and lowering the mast. It shall be capable of reaching 20 feet in height and have a payload capacity of 20 pounds. The unit shall reasonably accommodate the mounting of communications and/or vehicle sensor equipment, as specified within this document. Mounting holes or threaded bosses shall be provided to mount the RVD at four positions above the roadway pavement, two positions seventeen feet, (17") and two twenty feet (20"). Each position shall provide for two brackets to be mounted on the sides of the mast, (perpendicular to the trailer tongue). Two mounting holes shall be 3/8" in diameter and 8-1/8" center to center for the RVD bracket to center the RVD at the two levels stated above. The mast shall be raised to the fully upright position by the hydraulic ram. While the mast is being lowered the hydraulic ram shall limit the speed of travel using a manually controlled value restricting hydraulic flow in the ram. The flow value shall have a maximum flow rate that will prevent the mast from being lowering 90 degrees in less than 30 seconds. The location of the value shall be adjacent to the lowering lever control. The lowering lever shall control the hydraulic system at a variable rate ensuring that a trained operator can gently "feather" the system while lowering the mast. The chassis and mast shall be clearly labeled via decals to designate pinch points, electrical hazards and potential contact with overhead power lines. The primary pivot point of the mast, when fully extended, shall have a positive mechanical lock or pin to ensure that the mast remains upright. All other joints of the mast shall have positive mechanical locks or pins to prevent the collapse or unauthorized movement or dismantling of the mast.

DIMENSIONS & CAPACITIES:

In the folded position, the unit shall not exceed the following over-all dimensions: 85" wide, 139" length and 70" height. The hitch will be available with standard hitch arrangements as specified by the end user. the unit shall not exceed 1000# in weight, excluding any batteries or auxiliary equipment. The unit shall be powder coated a highway safety orange, (Omaha Orange), and have reflective decals placed appropriately to enhance the visibility of the unit to traffic when installed. Assuming a maximum of three square feet of wind loading at 20 feet of height, the unit shall withstand 80 mph wind gust via its outrigger and battery weight alone when placed per manufacturer's requirements. The wind gust rating assumes that the entire weight of the unit is carried by the jack stands, that the unit is level, and that the jack stands are on clean, drive pavement.

CABLING:

All cabling shall be provided to employ each electrical/electronic device provide on the trailers. Each cable as specified below shall be weather resistant. Connectors for the equipment and though cabinets walls shall make waterproof seals against the cable. Cables shall be secured to holders on the trailer along the cable route that will prevent the cable being damaged during the setup, traveling, in operation, or storage from weather or parts of the trailer. All of the trailer electrical markers shall be wired properly and a connector shall terminate the circuits at the trailer hitch, (stop lights, turn indicators, and markers).

RVD:

GENERAL INFORMATION

* The purpose of this specification is to describe the minimum requirements of a Radar Vehicle Detector (RVD).

* The RVD shall be easy to install and remove, and shall be fully programmable to support a variety of applications.

All Equipment and component parts furnished shall be new, be of the latest design and manufacture, and be in an operable condition at the time of delivery and installation. All parts shall be of high quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.

The design shall prevent reversed assembly or improper installation of connectors, fasteners, etc. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

The designed Mean Time Between Failures (MTBF) of the RVD unit, operating continuously in their application, shall be 10 years or longer.

The manufacturer of the RVD must provide three references to show that it has been deployed in operational systems for over five years.

ENVIRONMENTAL CONDITIONS AND PROTECTION

Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any combination of the following:

- Ambient temperature range of -37 to +74 degrees C
- Relative humidity from 5 to 95 percent, non-condensing
- Winds up to 100 MPH
- Rain and other precipitation up to 100mm/h
- Power surge of ± 1kV surge (rise time = 1.2 μsec, hold = 50μsec) applied in differential mode to all lines, power and output, as defined by IEC 1000-4-5 and EN 61000-4-5 standards.

The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range.

Printed Circuit boards shall be conformally coated for protection against humidity

Except as may be otherwise stated herein for a particular item, no item, component, or subassembly shall emit a noise level exceeding the peak level of 55 dBa when measured at a distance of one meter away from its surface.

The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent.

The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test a), NEMA TS-1 (Section 2.1.13), or approved equivalent.

MICROWAVE TRANSMISSION

The microwave radar detector shall transmit on a frequency band of 10.525 GHz +/-25 MHz or another approved spectral band. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The RVD shall not interfere with any known equipment. Transmitter power shall not exceed 10 milliwatts.

AREA OF COVERAGE

The RVD's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall be as follows:

- Elevation Beam Width 40 degrees
- Azimuth Beam Width 15 degrees
- Range 10 to 200 feet

DETECTION ZONES

The maximum number of detection zones defined shall be no less than eight (8). The range limits of each zone shall be user defined in 7-ft. resolution.

FUNCTIONAL CHARACTERISTICS

CAPABILITIES

The RVD shall be a true presence detector. It shall be suitable for mounting on roadside poles or on overhead structures and provide the following:

- Presence indication of moving or stopped vehicles in its detection zones, provided by contact closure to existing controllers
- Traffic data, periodically accumulated over user defined time intervals in a 10 to 600 sec range, transmitted via serial communications lines to other systems.
- Traffic data shall be available simultaneously with detection zone contact closures
- Side-fired configuration data shall include the following in each of up to eight (8) detection zones (lanes):
  - Volume
  - Lane occupancy
  - Average speed
  - Vehicle classification by length in up to 4 user defined classes.
- RVD on overhead structures (forward-looking configuration) shall monitor traffic in one lane and be capable of providing the following data:
  - Volume, occupancy, average speed and travel direction in the lane
  - Per vehicle speed, direction and length measurements
  - Binning of Volume data in up to 7 speed bins and up to 7 length bins
- RVD shall allow the user to define the contents of transmitted data
- RVD shall provide Fail-Safe indication by a contact pair and by serial data

- RVD shall provide remote indication of input (battery) voltage by serial data

MEASUREMENT ACCURACY

The detector shall identify vehicle presence within each detection zone with a 95% accuracy or greater, independent of the vehicle's direction of travel through the detection zone. The following error levels shall be achievable, depending on mounting configurations.

Parameter	**Sidefired error**	**Overhead error**
Presence	±5%	+/-2%
Volume	±5%	+/-2%
Lane Occupancy	±5%	+/-2%
Average Speed	±10%	+/-2%
Per Vehicle Speed	NA	+/-2%
Length Classification limits	±10%	+/-10%
Time event	10ms	10ms
Input Voltage	±2%	+/-2%

MECHANICAL

The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (NEMA type 3R enclosure).

Max. overall dimensions, including fittings: 24x16x18.5 cm (9.5 x 6.25 x 7 in.)
Max. weight of the microwave radar detector assembly 2.2kg (5 pounds)

The mounting assembly shall have all coated steel, stainless steel, or aluminium construction, and shall support a load of 20 pounds. The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be tilted in both axes then locked into place, to provide the optimum area of coverage.

ELECTRICAL

The RVD unit shall be operable from either 12 - 24 VAC/DC dissipating no more than 4.5W, or 95 - 135 VAC @ 60 Hz.. Power supply shall be obtained from the power distribution assembly within the controller cabinet, or any convenient power source.

The RVD unit shall include Power Management features, allowing remote shutdown or cyclical shutdown of the unit.

The RVD unit shall include a Low-Voltage disconnect feature for battery protection

CABLE

Connection between the RVD and the cabinet equipment shall be provided by a singe, MS connector terminated cable.

The cable shall provide power to the unit, output contact closure wire pairs rated at 300V AC/DC 100 mA for each of the required detection zones and serial data interface.

A junction box or cabinet to house the data interface connector must be located within sight of the desired detection zones in order to initially set up the sensor or to alter the set-up at a later date.

The cable shall be UV-resistant and provide eleven (11) twisted pairs of stranded AWG #20 or #22 wire with a common shield rated at 300V with a temperature rating of 105° C.

The MS connector pins must be crimped to the cable conductors and assembled and tested prior to installation and pulling of cable on site.

ELECTRICAL ISOLATION AND SURGE PROTECTION

All power lines, contact closures and serial port shall be isolated. Power lines and serial port shall be surge protected within the unit.

DATA INTERFACE

Data communications shall be full duplex asynchronous, able to support the NTCIP protocol 1209 for TSS. It shall be configurable as:

- Opto-isolated RS-485 or RS-232 port at rates from 2400 up to 115200 bits per second.
- Serial data format shall be standard binary NRZ 8 bits data, 1 stop bit, no parity.
- Both point-to-point and Multi-dropped configurations are supported
- An integral Digital Spread Spectrum radio modem shall be available as an option
- Ethernet port (TCP/IP) shall be available as an option

INSTALLATION

The RVD shall be mounted in either Side-fired or Forward-looking configuration on poles or sign structures at the specified locations, using the supplied mounting brackets. The brackets shall be attached to the mast using 1.)- 5/16" bolts, 2.)- approved 3/4-inch wide, .025-inch thick, stainless steel bands or 3.)- to a concrete wall/bridge using 2 stainless steel expansion bolts of sufficient length and diameter to support 100 pounds.

The detector unit shall be installed at the height of 17-20 feet above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified elevation angle as suggested by the manufacturer. In the Forward-look configurations the detector will be mounted over the center of each lane. The mounting bracket shall allow replacement of unit without the need for re-aiming

The RVD mode of operation, detection zones and other calibration and set up will be performed using a MS-Windows-based software and a Notebook PC. The software shall be user friendly, good visibility outdoors in bright sunny days, allow verification of correct setup, and diagnostics. It shall include facilities for saving verification data and collected data as well as saving and retrieving sensor setup from disk file.

BATTERIES:

The batteries shall be sealed construction to eliminate periodic watering, corrosive acid fumes and spills. Electrolyte will not stratify, require no equalization of charge, and promotes faster charging. The battery design shall increase durability and deep cycle ability for heavy demand. Less than 2% per month stand loss means little deterioration during transport and storage. The case design and manufacture shall provide easier and safe transports and ensure reliable service and support.

CHARACTERISTICS

Voltage	12 volts
Plate alloy	lead calcium
Post	T876
forged terminals and bushings	
Container/Cover	Polypropylene
Charge Voltage @ 68° F	Cycle 2.3 to 2.35 Float 2.25 to 21.3 vdc
Specific Gravity	21.28
Electrolyte	Sulfuric acid thixotropic gel
Vent	Self-sealing (2 PSI operation)
Resistance	4.0 Milliohms (full charge)
Operating Temperature	Fully charged range:-76° F to 140° F
Ampere Hour Capacity	109 AH

BATTERY CHARGER: (FOR 120VAC OPERATION)

The battery charger shall be designed for chrging three battery banks simultaniously and ideal for deep cycle batteries with commerial power of 90 to 135 VAC at 60 Hz. The design shall utilize high frequency power conversion, microprocessor control, multi-step charging, wide input voltage range, battery tyep selector switch and an extensive array of pretection features.

Product Features

- 20 amp output
- Microprocessor controlled, multistage charging
- Charges up to three battery banks simultaneously
- Independent settings for AGM, flooded or gel lead-acid batteries
- Wide voltage range operation (90–135 VAC, 50/60 Hz)
- Optional remote LED panel to indicate battery and charge status
- Automatic 21 day top-up
- Durable and corrosion resistant chassis
- One year warranty

Protection Features

- Over-temperature shutdown and overload projection
- Adjustable temperature sensitive charging for optimal battery charging
- Transformer isolated for safety and to protect against electrolysis
- Reverse polarity protection (internal fuses open)
- Short-circuit and surge protection
- Ignition protected
- Equalization mode conditions batteries for longer life

Options

- Battery temperature sensor

Electrical Specifications

- Output current 20 A @ 14.5 V nominal
- Output voltage (nominal, depending on settings)
- Charge 13.8–14.8 VDC
- Float 13.1–14.2 VDC
- Equalize 15.5 VDC @ 5 A maximum
- DC output connections Three
- AC input voltage 90–135 VDC, 50/60 Hz
- Temperature compensation 3 settings or optional remote sensor
- Charger efficiency 85% approx.
- Recommended battery size 100Ah to 400Ah

General Specifications

Operating temperature 0°C – 30°C
Storage temperature -25°C – 70°C
Battery connection 3 pos. terminals, 1 neg. terminal

Dimensions (HxWxL) 2.75 x 6.
15.1" (70 x 172 x 385 mm)
Weight 6.9 lb (3.1 kg)
Warranty One year

Three-stage Charging

Multistage charging ensures batteries receive optimum charging, but with minimal wear regulating the voltage and current delivered to the batteries in three automatic stages:

Bulk: Replaces 70-80% of the battery's state of charge at the fastest possible rate

Absorption: Replenishes the remaining 20-30% of charge, bringing the battery t charge at a slow, safe rate.

Float: Voltage is reduced and held constant in order to prevent damage and keep batteries at a full charge.

Battery Charge Times (Based on a recommended 50% discharge)

Battery Group	Approx. amp hours	Charge time (hours)
27	100	3
4D	200	6.5
8D	230	7.5
Two 8D	460	15

Power Cable

A weather resistance three conductor cable shall be provided to connect the battery charg standard 120VAC receptal. The cabel shall have an SO type jacket and a three prong plu a minimum of twenty-five (25') feet long.

TRAINING:

Work under this item shall consist of providing qualified instructors and all materials for Department's and other designated personnel in the operation and maintenance of the RVD. All sessions shall be conducted locally.

Training shall consist of formal classroom lectures as well as "hands-on" training, working with t equipment. One day shall be provided for a training session.

A "day" of training shall consist of 7 hours. The attendance of each session shall be of no more than people.

Certificate of Origin of Trailer

O.M.J.C. SIGNAL, INC.
P.O. BOX 1594
WATERLOO, IA 50704-1594
403 CHESTNUT ST
WATERLOO, IA 50703-3824
800-776-5999 or 319-236-0200
FAX: 319-236-1554
EMAIL: sales@omjcsignal.com
WEBSITE: www.omjcsignal.com

May 18, 2005

Certificate of Origin of OMJC Peri-Scope Jr.

Sold to:

Seco South, 1517 Corporate Drive Shreveport, LA 71107

This is to certify that the OMJC Peri-Scope Jr., Serial No. 1076, was manufactured by OMJC Signal during the year of 2005 and shipped on April 20th, 2005.

Sincerely,

Keith Niehaus
Sales/Production

Manual for Trailer

PERI-SCOPE JUNIOR (PJ) PORTABLE TRAFFIC SENSOR MAST MANUAL

MANUFACTURED BY
OMJC SIGNAL, INC.

MANUAL DATE
MARCH 2004

The purpose of the manual is to describe the safety and operational instructions for the use of the OMJC Peri-Scope Junior—hereafter called the OMJC PJ—portable traffic sensor mast.

The trailer is like any other trailer in terms of care. Items of normal care include the axle and signal / tail lights. The trailer needs to be hitched up with the normal care of any towed trailer. Before transporting the trailer, check the hitch, lights, & plugs to make sure all are hooked up & working correctly.

Before taking the trailer at the project site be sure to check the state of battery charge.

Deployment of basic PJ

1. *Park PJ & unhitch*
    a. Stay out from under overhead power lines

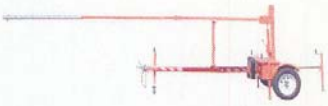
2. *Extend rear outrigger and rotate rear jack into position*

3. *Extend drop-legs of all 4 jacks*

4. *Use the 4 jacks to level the PJ – use the bull's-eye level as your guide*

5. *Unfold the mast*

6. *Extend the outer sleeve of the mast if you need more than 20 feet of height*



7. *To attach your sensor to the sleeve, rotate the sensor to the proper direction, strap it on the sleeve and wire it to the battery for power*

8. *Using the mast jack, raise the mast to the vertical position and pin it in place.*

9. *To prepare the PJ for transport, simply reverse the above procedure. Use caution when lowering the mast jack!*

PJ Power Options

The PJ comes with one of three power options:

Battery Only

The PJ always comes with at least four group 24 AGM maintenance-free batteries, for a total of 500 amp hours at 12 VDC. This is often adequate for low power draw, short-term applications.

Solar Boost

The Solar Boost option comes with two 20-watt solar panels, each mounted horizontally on the top of a battery box. This extends the time in the field between charges, and in the best solar months (May, June, July) will often allow unlimited deployment time in a low power draw application. Plus, since the panels are always deployed and "on," they will continue to recharge the batteries even when the PJ is sitting in the parking lot.

Solar Power

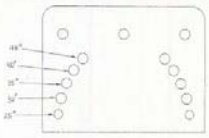
The Solar Power Option comes with a solar mount that can adjust for direction and latitude, and with from 80 to 250 watts of solar panel, depending upon the needs of the particular application. See below for deployment instructions.

Deployment Instructions for Solar Power Option

1. **Once you have completed the deployment of the basic Peri-Scope, Jr., or PJ, determine which direction is south.**

2. **Un-pin the base plate of the Solar Mast and rotate the mast until one* of the solar panels faces south. Then pin the base plate in the nearest hole.**

3. **Determine the best solar angle based upon the latitude chart to the right.**



4. **Deploy the panel that faces south at the best angle and pin it in place.**

5. **Now deploy the second panel by swinging it up so that it is in the same plain as the panel that you just deployed. This will give you the maximum sun exposure for your latitude.**

6. **To store the solar panels for transport, simply reverse the process.**

Lower wattage units come with only one panel. This panel may need to be rotated to the north initially, depending upon the position of the trailer.