Appendix D

Draft Minimum Specifications for ITS Devices

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Acoustic Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

A passive acoustic detector consists of an array of microphones aimed at the stream of traffic. The device detects the sound of a vehicle passing through the detection zone. The primary source of sound is that of the tires of the vehicle against the road. At slower speeds, the sound source is the vehicle motor. They then use sophisticated signal processing techniques to determine whether the sounds are actually a vehicle, and in some instances are able to classify the vehicles. These devices are passive in that they "listen" for the sound energy of the passing vehicles.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for acoustic vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must

have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The acoustic detection system shall include all equipment necessary for proper operation and interfacing with present equipment. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

An LED indicator, one for each detection zone, shall be located on the exterior of the device (visible from the ground), and shall illuminate when a call is present.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include Pulse and True Presence (ability to hold the detection until the zone has cleared). Detection capabilities may also include, but are not limited to, Count, Volume, and Speed detection. The detector may act as a replacement for an inductive loop at an intersection and must be able to perform as such.

Additionally, the detector shall be able to tune out stationary targets (e.g. construction equipment) that may remain within the detection zone for a

programmable amount of time. The detector shall provide an output compatible for use with traffic signal controllers for detection of traffic.

4.2 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV shall be at least 2 lanes, and the number of lanes shall be selectable.

4.3 Sensitivity

The device sensitivity shall be adjusted to provide optimal performance for most applications prior to delivery. The sensitivity may need to be adjusted in certain installations.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Mounting

Due to the fact that these detectors rely on the sound energy of vehicle tires, they achieve optimal performance in a side-fire mount as close to traffic as is possible, median poles being optimal. Additionally, the mounting location usually should be at least 50 feet from bridges, tunnels, or other sources of echoes, though some detectors may compensate for this. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing. The enclosure shall be light-colored

and may include a sun shield to minimize solar heating. The total weight of the detector/enclosure/sun shield shall not exceed 10 lb.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation.

7.0 Electrical System

7.1 Components

Acoustic detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software and hardware (as needed) used to program the detector, connecting cables, manuals and schematics.

7.2 Power Supply

The detector unit shall operate with an input voltage of 110 VAC.

7.3 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

a. Model number
b. Power and Current requirements/consumption
c. Temperature range
d. Weight and Dimensions
e. Mechanical Construction
f. Mounting equipment necessary
g. Operating frequency (FCC approved)
h. Detection Range, Angle, and Pattern (horiz. and vert.)
i. Response time and Sensitivity
j. Software for operation of device
k. Device capabilities as claimed by manufacturer.
l. Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Infrared Vehicle Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

The temperature contrast of a car's surface with the background results in a change of radiation within the Infrared detector's FOV. The Infrared detector is "passive" in that it emits no radiation, but instead detects the infrared radiation emitted as a function of an object's surface temperature. Signal processing and optical filtering discriminate between the desired moving objects (autos, cyclists, and pedestrians) and unwanted signals (from such things as sunlight, clouds, wind, and precipitation). Changes in the intensity of the received signal, caused by objects in the sensor's FOV, are converted into electrical signals (using a highly sensitive photoelectric detector) and are analyzed as to the nature of the object.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for infrared vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high

voltage during installation, operation, adjustment, and maintenance. All devices must have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The infrared detection system shall include all equipment necessary for proper operation and interfacing with present equipment. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

An LED indicator, one for each detection zone, shall be located on the exterior of the device (visible from the ground), and shall illuminate when a call is present.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include Pulse and True Presence (ability to hold the detection until the zone has cleared). Detection capabilities may also include, but are not limited to, Count, Volume, and Speed detection. The detector may act as a replacement for an inductive loop at an intersection and must be able to perform as such. The detector shall provide an output compatible for use with traffic signal controllers for detection of traffic.

4.2 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV must be able to be modified in order to monitor large areas or single lanes with a range of 5-100m.

4.3 Sensitivity

The device sensitivity shall be adjusted to provide optimal performance for most applications prior to delivery. The sensitivity may need to be adjusted in certain installations.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Mounting

Infrared detectors work in either a sidefire or overhead position. They should be mounted at a height that enables distinction between vehicles. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing. The enclosure shall be light-colored and may include a sun shield to minimize solar heating. The total weight of the detector/enclosure/sun shield shall not exceed 10 lb.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation.

7.0 Electrical System

7.1 Components

Infrared detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software and hardware (as needed) used to program the detector, connecting cables, manuals and schematics.

7.2 Power Supply

The detector unit shall operate with an input voltage of 110 VAC.

7.3 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

- **a.** Model number
- **b.** Power and Current requirements/consumption
- **c.** Temperature range
- **d.** Weight and Dimensions
- **e.** Mechanical Construction
- **f.** Mounting equipment necessary
- **g.** Operating frequency (FCC approved)
- **h.** Detection Range, Angle, and Pattern (horiz. and vert.)
- **i.** Response time and Sensitivity
- **j.** Software for operation of device
- **k.** Device capabilities as claimed by manufacturer.
- **l.** Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Magnetic Vehicle Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

Passive magnetic devices detect the disruption in the earth's magnetic field caused by a vehicle moving through the detection zone. In order to effectively do so; the devices must be mounted close to the vehicles. This limits installation to within a conduit under the pavement, or in certain instances, side-fire mounts within a few feet of the roadway.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for magnetic vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The magnetic detection system shall include all equipment necessary for proper operation and interfacing with present equipment. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

An LED indicator, one for each detection zone, shall be located on the exterior of the device (visible from the ground), and shall illuminate when a call is present.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include Pulse and True Presence (ability to hold the detection until the zone has cleared). Detection capabilities may also include, but are not limited to, Count, Volume, and Speed detection. The detector may act as a replacement for an inductive loop at an intersection and must be able to perform as such.

Additionally, the detector shall be able to tune out stationary targets that may remain within the detection zone for a programmable amount of time. The detector shall provide an output compatible for use with traffic signal controllers for detection of traffic.

4.2 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV for magnetic devices is small, thus necessitating the proximity to traffic.

4.3. Sensitivity

The detection accuracy for a detector in optimal location shall be within 5 % of inductive loop accuracy.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Installation

Magnetic devices are usually installed beneath the roadway. If the device is installed in a conduit buried beneath the roadway, then the conduit shall be buried at a depth specified by the manufacturer, and shall follow the curvature of the roadway when possible, or have a 1/4" per foot slope so water cannot accumulate within the conduit. Some magnetic devices can also be installed in a side-fire position within a few feet of the roadway. This is acceptable in locations where vandalism is not a concern. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation.

7.0 Electrical System

7.1 Components

Magnetic detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software and hardware (as needed) used to program the detector, connecting cables, manuals and schematics.

7.2 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

- **a.** Model number
- **b.** Power and Current requirements/consumption
- **c.** Temperature range
- **d.** Weight and Dimensions
- **e.** Mechanical Construction
- **f.** Mounting equipment necessary
- **g.** Operating frequency (FCC approved)
- **h.** Detection Range, Angle, and Pattern (horiz. and vert.)
- **i.** Response time and Sensitivity
- **j.** Software for operation of device
- **k.** Device capabilities as claimed by manufacturer.
- **l.** Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Microwave Vehicle Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

Current microwave detectors operate within the range of 1-30 GHz (1 to 30 x 10^9 cycles/sec) as allowed under the FCC, part 15, by transmitting a signal and then analyzing any return signal that occurs due to the reflection off of an object that passes through the device's FOV. Two methods are presently being implemented. One uses a continuous wave of energy and utilizes the Doppler principle to identify any change in frequency in the return signal; these devices are only capable of detecting moving objects since they affect the transmitted beam's "bounced" frequency.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for microwave vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current Minimum Specifications for Traffic Control Signal Devices. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must

have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The microwave detection system shall include all equipment necessary for proper operation and interfacing with present equipment. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

An LED indicator, one for each detection zone, shall be located on the exterior of the device (visible from the ground), and shall illuminate when a call is present.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include pulse detection. Detection capabilities may also include, but are not limited to, count, volume, and speed detection. The detector may act as a replacement for an inductive loop at an intersection and must be able to perform as such.

Microwave detection devices shall detect motion of every type of licensed vehicle traveling at least two (2) miles per hour, and provide an output compatible for use with traffic signal controllers for detection of traffic.

In addition, they shall be capable of detecting directional motion (approach or depart), being mounted on the side of a pole or overhead and of continuous operation over the temperature range of –30 to 165 degrees F.

4.2 FOV (field of view)

The FOV must be able to be modified in order to monitor large areas or single lanes with a range of 17 – 325 feet.

Microwave detectors shall have a sixteen (16) degrees cone of detection with a detection range of at least three (3) feet to two hundred (200) feet for automobiles and three (3) feet to three hundred-fifty (350) feet for commercial trucks.

4.3 Sensitivity

Sensitivity for Microwave detection devices shall meet the same requirements set forth for inductive loop detection (MSTCSD Section A660). Detectors shall have a response time of 0.25 seconds and a hold time of 1.5 seconds and shall self-tune to its detection zone with no external adjustments other than physical alignment after initial setup. In addition, the detector shall have a maximum warm-up time of five (5) minutes, and a manual switching mechanism to allow the operator to select "approach" or "depart."

The detector circuit design shall be such that an operating voltage failure or a component failure will result in a fail-safe output condition.

5.0 Installation

All installation and maintenance equipment shall be provided by the manufacturer and shall allow for installation and maintenance/ adjustments without lane closure.

5.1 Mounting

The microwave detector should be mounted in an overhead position with the detector facing traffic. The device shall be furnished with mounting brackets and hardware, as recommended by the manufacturer, to mount directly to a pole or over head mast-arm structure. Mounting hardware shall be fabricated from galvanized steel or a corrosion resistant metal. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing. The enclosure shall be light-colored and may include a sun shield to minimize solar heating. The total weight of the detector/enclosure/sun shield shall not exceed 10 lb.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation. The manufacturer shall test all units to FCC requirements and supply a statement as to the safety of the units to the general public, specifically to pacemakers.

7.0 Electrical System

7.1 Components

Microwave detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software and hardware (as needed) used to program the detector, connecting cables, manuals and schematics.

7.2 Power Supply

The detector unit shall operate with an input voltage of 110 VAC.

7.3 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

a. Model number
b. Power and Current requirements/consumption
c. Temperature range

d. Weight and Dimensions
e. Mechanical Construction
f. Mounting equipment necessary
g. Operating frequency (FCC approved)
h. Detection Range, Angle, and Pattern (horiz. and vert.)
i. Response time and Sensitivity
j. Software for operation of device
k. Device capabilities as claimed by manufacturer.
l. Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Ultrasonic Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

A pulse ultrasonic detector emits pulses of ultrasonic sound energy and measures the return time for the signal to the device. Vehicle presence is indicated by a reduction of the return time.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for acoustic vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The ultrasonic detection system shall include all equipment necessary for proper operation. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

An LED indicator, one for each detection zone, shall be located on the exterior of the device (visible from the ground), shall illuminate when a call is present.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include Pulse and True Presence (ability to hold the detection until the zone has cleared). Detection capabilities may also include, but are not limited to, Count, Volume, and Speed detection. The detector shall act as a replacement for an inductive loop at an intersection and must be able to perform as such. The detector shall provide an output compatible for use with traffic signal controllers for detection of traffic.

4.2 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV for pulse ultrasonic devices is typically a single lane.

4.3 Sensitivity

Ultrasonic detectors are set up in the field by setting the sensitivity so that it detects a vehicle passing under it.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Mounting

Optimal performance for these units is overhead mounted directly above the monitored lane. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing. The enclosure shall be light-colored and may include a sun shield to minimize solar heating. The total weight of the detector/enclosure/sun shield shall not exceed 10 lb.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation. Emissions from this device must not be harmful to humans, domestic animals or wildlife.

7.0 Electrical System

7.1 Components

Acoustic detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software used to program the detector via a laptop computer, connecting cables, manuals and schematics.

7.2 Power Supply

The detector unit shall operate with an input voltage of 110 VAC.

7.3 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (that will be specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

a. Model Number
b. Power and Current requirements/consumption
c. Temperature range
d. Weight and Dimensions
e. Mechanical Construction
f. Mounting equipment necessary
g. Operating frequency (FCC approved)
h. Detection Range, Angle, and Pattern (horiz. and vert.)
i. Response time and Sensitivity
j. Software for operation of device
k. Device capabilities as claimed by manufacturer.
l. Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Radar Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

Radar devices use a pulsed, frequency modulated, or phase-modulated signal to determine the delay time of the return signal, there by calculating the distance to the detected vehicle. Radar devices also possess a range finding ability that allows them to detect multiple zones and the presence of stopped vehicles.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements and basic installation procedures for acoustic vehicle detection devices for use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The acoustic detection system shall include all equipment necessary for proper operation and interfacing with present equipment. This includes the detection device, mounting brackets, wiring, control modules, setup equipment, and hardware.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

If needed, manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each detection system. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

For areas not defined in this document, good practice as shown by the industry standards shall apply.

4.0 Performance Standards

4.1 Capabilities

Detection capabilities shall include Pulse and True Presence (ability to hold the detection until the zone has cleared). Detection capabilities may also include, but are not limited to, Count, Volume, and Speed detection. The detector may act as a replacement for an inductive loop at an intersection and must be able to perform as such.

Additionally, the detector shall be able to tune out stationary targets (e.g. construction equipment) that may remain within the detection zone for a programmable amount of time. The detector shall provide an output compatible for use with traffic signal controllers for detection of traffic.

4.2 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV must be able to be modified in order to monitor large areas or single lanes with a range of 5-100m.

4.3 Sensitivity

The device sensitivity shall be adjusted to provide optimal performance for most applications prior to delivery. The sensitivity may need to be adjusted in certain installations.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Mounting

Radar detectors should be mounted in a sidefire or overhead position at a height that enables distinction between vehicles. Special instructions for mounting must be provided by the manufacturer.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Physical Requirements

1) Cabinet Hardware: All hardware shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.
2) Detector: The detector shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The detector shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing. The enclosure shall be light-colored and may include a sun shield to minimize solar heating. The total weight of the detector/enclosure/sun shield shall not exceed 10 lb.

6.2 Operations

This device must comply with any applicable FCC regulations concerning its operation. This device may not cause harmful effects to pacemakers.

7.0 Electrical System

7.1 Components

Acoustic detection devices shall consist of the detector unit with all mounting brackets and hardware, an interface panel suitable for mounting in a small cabinet, software and hardware (as needed) used to program the detector, connecting cables, manuals and schematics.

7.2 Power Supply

The detector unit shall operate with an input voltage of 110 VAC.

7.3 Interface

This area will describe the interface to be used between the ITS cabinets and monitoring devices and the detection device. The interface shall be compatible with existing cabinets.

8.0 Other Specifications (that will be specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

a. Model number
b. Power and Current requirements/consumption
c. Temperature range
d. Weight and Dimensions
e. Mechanical Construction
f. Mounting equipment necessary
g. Operating frequency (FCC approved)
h. Detection Range, Angle, and Pattern (horiz. and vert.)
i. Response time and Sensitivity
j. Software for operation of device
k. Device capabilities as claimed by manufacturer.
l. Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.

Florida Department of Transportation
Traffic Engineering Research Laboratory
FAMU-FSU College of Engineering
Tallahassee, FL

Video Detection Devices
Draft 05/00

1.0 Introduction

Because the Florida Department of Transportation does not currently have standards and specifications for vehicle detection devices other than inductive loop detectors and because of the problems encountered with any "in-the-pavement" detection method, the Department has been evaluating overhead or other "non-in-the-pavement" types of vehicle detection to be used for intersection vehicle detection. For these reasons, the Traffic Engineering Research Lab (TERL) was given the task to help the Traffic Engineering Office develop the necessary criteria so the selection of these devices can be made easier and with more confidence.

The process included two phases. Phase one has been completed and involved the compilation of information concerning the various types of vehicle detection, including inductive loop detectors, for the purpose of developing a draft standard.

The second phase is to identify the needs and requirements of the Department that concern vehicle detection, to perform the various testing and evaluation needed on these devices, and to determine if in fact these various detection technologies meet those needs and requirements.

The following report was developed from information received and compiled from resources such as other state Departments of Transportation (or the equivalent) and the various vehicle detection device manufacturers.

2.0 Theory of Operation

A video detection device uses video image processing software, signal processing firmware, and complex algorithms to analyze video images transmitted at frame rates approaching 30 frames/sec. The analyzed imagery is digitized via computer hardware and the pertinent information is saved to the local data storage area/device. Video devices typically consume vast quantities of data storage area and bandwidth along the transmission line. Some devices only record or send data when noticeable changes occur in the FOV of the device.

3.0 General

The purpose of this report is to describe the minimum acceptable design and operating requirements for video vehicle detection devices for the evaluation, certification and use in the state of Florida.

All equipment and components provided shall meet or exceed the requirements set forth. The devices presented must have verification from an independent laboratory that the equipment meets all environmental requirements included in section A615 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Equipment presented shall be new, and in operable condition at the time of delivery and installation. The equipment shall be designed to prevent improper or potentially hazardous installation and maintenance, protecting personnel from exposure to high voltage during installation, operation, adjustment, and maintenance. All devices must

have FCC certification, when required by the FCC. This report was developed based on test data and reports from the Minnesota Guidestar/SRF Consulting Group.

3.1 Hardware

The video detection system (VDS) shall consist of at least one camera per two approaches. An automatic control unit (ACU) shall also be supplied, which may be either a central controlling unit (one per installation) or a modular controlling unit (one per camera) and shall be housed in the control cabinet. All required setup equipment (e.g. a supervisor computer, monitor, etc) shall be supplied if needed (i.e. only one may be needed for multiple installations). All connecting cables and mounting hardware must also be supplied.

The following shall also apply.

- All materials and workmanship shall conform to the standards of the ASTM (American Society for Testing Materials) and the ANSI (American National Standards Institute) where applicable.
- All electrical components shall conform to the standards of the Underwriter's Laboratories (UL) or another OSHA listed Nationally Recognized Testing Laboratory (NRTL), and the Electrical Industries' Association (EIA), where applicable.
- Detection devices must be Federal Communications Commission (FCC) certified if necessary, and its FCC-ID must be displayed on an external label.
- The use of silicone gels or any other material that will deteriorate under prolonged exposure to ultraviolet rays is not acceptable.

3.2 Software

VDS manufacturer software shall be provided for detection zone programming and operation. One software package shall be provided for each VDS. Software updates/revisions shall be provided to the FDOT as updated by the manufacturer at no additional charge.

3.3 Functional

A modular ACU shall be capable of simultaneously processing video information from one video source including, but not limited to, a CCTV camera and a video cassette player.

A central ACU shall be capable of simultaneously processing video information from a minimum of four synchronous video sources including, but not limited to, CCTV cameras and video cassette players.

A modular system shall detect the presence of vehicles in a minimum of 8 detection zones per module.

A central system shall detect the presence of vehicles in a minimum of 32 detection zones within the combined field of view of the cameras.

The ACU shall be able to emulate stop-line detectors and presence detectors.

Once the ACU has been set up using the required setup equipment it shall be possible to disconnect the setup equipment. The ACU shall then detect as a stand-alone unit. When the supervisor computer or monitor is online, it shall be possible to view the vehicle detection in real time.

3.4 Location

Two general types of locations exist in which the VDS will be installed. For the purposes of this specification, these locations shall be defined as Type I and Type II.

- **Type I Location**

  A Type I location is defined as an installation position overlooking the roadway where the video camera is mounted 30 ft. (10 m) or higher above the roadway, where the camera is over or adjacent to the desired area of coverage, and the FOV is not greater than four times the mounting height of the camera. Although optimal detection may be obtained when the camera is directly above the roadway, the camera need not be mounted directly above the traveled lanes to obtain accuracies necessary for this specification. The camera shall be equipped with a lens to match the road width and minimize lane vehicle occlusion. The mounting height will be at the top of the pole or structure specified by the plans.

- **Type II Location**

  A Type II location is defined as an installed position that does not overlook the roadway directly. The video camera should be mounted on a pole up to 80 ft in length whose closest distance to the roadway (shoulder or emergency lane) is at least 10 ft. The camera shall be equipped with a lens to match the road width and minimize lane vehicle occlusion. The mounting height will be at the top of the pole or structure specified by the plans.

4.0 Performance Standards

4.1 Capabilities

The video detection system must provide signalized intersection control. Devices capabilities may also include, but are not limited to:

- Vehicle counting
- Vehicle classification
- Per vehicle data acquisition
- Speed measurement
- Incident detection

4.2 Optional output parameters

The VDS's optional detection parameters are as follows:

- Volume – number of vehicles detected during the specified time interval
- Speed – time mean and space mean vehicle speed in MPH or KM/H
- Occupancy – lane occupancy measured in percent of time
- Flow rate – vehicles per hour per lane
- Density – average flow divided by space mean speed expressed in vehicles per mile or vehicles per kilometer
- Vehicle classification – number of vehicles in each of at least three categories:
    1) Vehicles less than 25 ft long.
    2) Single unit trucks longer than 25 ft and shorter than 45 ft.
    3) Tractor-trailer trucks longer than 45 ft.
- Alarm – for incident detection, output is triggered by abnormal activity such as continuous presence on a detector or detection against the flow of traffic.

4.3 FOV (field of view)

The field of view is the effective range of the detector's sensing ability. The FOV must be able to be modified in order to monitor large areas or single lanes with a range of 5-100m.

4.4 Functional Accuracy Requirements

The performance of a VDS shall be comparable to that of an inductive loop detection system under the following environmental and installed location conditions:

- During both day and night periods as well as transitions from dark to dawn and daylight to dusk
- Under all weather conditions normally experienced
- Type I and Type II locations

The accuracy specifications that follow are for the output parameters listed above and are a minimum requirement for the output parameters though certain installations may require more stringent requirements. Parameters that are computational derivations of fundamental detection parameters shall have the same accuracy as the fundamental parameters (i.e. percentage calculations). Testing of a VDS to determine and verify accuracy shall be conducted for at least two separate 4 hour periods which encompass a transition from night to day and day to night, except as may be amended below.

1) Detection

Average vehicle detection during a testing period shall have a 95% overall accuracy in Type I locations and 90% in Type II locations. This accuracy shall be accomplished with traffic volume of 500 vehicles per hour per lane. Verification of compliance with the accuracy requirement shall be confirmed by performance of a video tape recording (and/or

manual or mechanical count) of at least 1000 vehicles passing through each camera's FOV. Significantly occluded vehicles shall not be used in determining the accuracy of the VDS. For testing purposes, significant occlusion is defined as a vehicle's image that has been occluded by 50% or more.

2) Volume

Average vehicle count during a testing period shall have a 95% overall accuracy in Type I locations and 90% in Type II locations. These accuracies shall be accomplished with traffic volume of 500 vehicles per hour per lane. Verification of compliance with the accuracy requirement shall be confirmed by performance of a video tape recording (and/or manual or mechanical count) of at least 1000 vehicles passing through each camera's FOV. Significantly occluded vehicles shall not be used in determining the accuracy of the VDS.

3) Speed

Average vehicle speed throughout the camera's FOV shall meet an overall accuracy of 90% in Type I locations and 85% in Type II locations. These accuracies shall be valid for traffic moving between 10 and 75 MPH. This test shall be performed by use of video tape recording or other electronic means (i.e. radar gun) at the department's discretion.

Tests shall be conducted at three speed ranges: 1) slow moving rush hour traffic (10 – 30 MPH), 2) moderate flow during non-rush hour conditions (30 – 50 MPH), and 3) unimpeded flow (50 – 75 MPH).

4) Occupancy

Lane occupancy calculation for each detector within a camera's FOV shall have an accuracy of 90% for Type I locations and 85% for Type II locations. Verification of accuracy requirement shall be similar as that for speed.

5) Flow Rate

Flow rate determination shall be equivalent to accuracies for volume determination.

6) Density

Density shall be determined with 90% accuracy for Type I and 85% for Type II locations. Verification of density calculation accuracy shall be considered valid when volume, speed, classification and occupancy accuracies have been determined to be "within specification" and the vendor has provided certification of the density calculation to the department. For this purpose, vendor certification shall contain a detailed description of the density calculation to include all pertinent variables.

7) Classification

Accuracy of length determination shall be within two feet. Correct identification testing shall be accomplished using vehicles of known lengths in each category passing through the camera's FOV. Each test vehicle's length shall be two feet or greater from a class length boundary.

8) Alarm

The VDS shall detect wrong-way and stopped vehicles to at least 95% accuracy for Type I and 90% for Type II locations for each defined detector within the camera's FOV. Verification of accuracy compliance shall be conducted using a stopped vehicle on the shoulder or in the emergency lane. The test shall be conducted for both day and night periods lasting at least 1 hour each. For safety purposes, the department may elect to test only stopped vehicle detection or to test wrong way detection at slower speeds within the shoulder or emergency lane as traffic permits.

4.5 Local Data Storage

The ACU shall retain detector data in a non-volatile, zero-powered RAM or E^2PROM, which shall be available for data transfer to the supervisor computer over an RS232 connection. There shall be a minimum of 4 MB of memory available for data storage. When the entire storage memory is full, the ACU shall continue to store data by writing over the oldest information.

The time interval used for data storage shall be user-selectable, and shall include 30 seconds, 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes.

Data shall be retrievable from the ACU over an RS232 communications port. The vendor shall provide documentation detailing the protocol utilized to access this information. The protocol shall not be proprietary, and can be used by any FDOT system integrator to interface to the equipment. The software manuals shall include data scope outputs illustrating the various commands and return messages.

5.0 Installation

All special installation and maintenance equipment must be provided by the vendor and should allow for adjustments without lane closure.

5.1 Mounting

1) Mast Arm Installation

Mast arm installation shall be accomplished using bands and hardware conforming to Section A601 of the Department's current *Minimum Specifications for Traffic Control Signal Devices*. Installation shall be done at sufficient height to prevent occlusion from cross traffic between the stop bar and the mast arm on which the camera is installed. A six-foot maximum length of internally reinforced tubing shall be attached

to the mast arm for camera mounting above the mast arm. The camera shall be mounted on the tube with the manufacturer's recommended bracket. The camera bracket shall provide adjustments for both vertical and horizontal positioning of the camera, and securely fasten the camera to the tube to prevent the setup from falling into the path of traffic. The cameras and associated pole/arm attachment shall be designed to withstand a wind load of 90 MPH with a 30% gust factor.

2) Luminaire Arm Installation

Luminaire arm installation shall be accomplished on the luminaire arm with the vendor's recommended bracket, and shall allow for horizontal and vertical adjustment of the camera's position. Camera installation and brackets shall be designed to securely fasten the camera to the luminaire arm. The cameras and associated pole/arm attachment shall be designed to withstand a wind load of 90 MPH with a 30% gust factor.

5.2 Powering

Required amplifiers must be provided by the manufacturer.

5.3 Calibration and Aiming

All calibration and aiming shall be done with the device mounted in place, without interruption of traffic. Adjustments will be made according to manufacturer's recommendations.

6.0 Mechanical

6.1 Automatic Control Unit (ACU)

1) Size: The nominal size for the ACU shall be sufficient for shelf or rack mount within the control cabinet.

2) Environmental: The ACU shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.

6.2 Cameras

The camera shall be housed in an environmental enclosure that is waterproof and dust-tight to NEMA-4 specifications. The camera shall meet the environmental requirements defined by the NEMA TS1 and TS2 specifications. Operating temperatures shall be from -35° C to 74° C at 0% to 95% relative humidity, non-condensing.

A heater shall be incorporated in the camera to prevent the formation of condensation, as well as to insure proper operation of the lens' iris mechanism.

The heater shall not interfere with the operation of the camera's electronics, and it shall not cause interference with the video signal.

The enclosure shall be light-colored and shall include a sun shield to minimize solar heating. The front edge of the shield shall protrude beyond the front edge of the enclosure and shall include provisions to divert water around to the sides of the sun shield. The amount of overhang of the sun shield shall be adjustable to prevent direct sunlight from entering the lens.

The total weight of the camera/enclosure/sun shield shall not exceed 10 lb.

Performance shall not be impaired by vibration when mounted on an 80-ft or shorter pole. The video camera and enclosure shall maintain functional capability and physical integrity when subjected to a vibration of 5 to 30 Hz up to 0.5 gravity applied to each of three mutually perpendicular axes (NEMA TS1 – 1989 (R1994), section 2.1.12).

7.0 Electrical System

7.1 Automatic Control Unit (ACU)

The ACU shall run off of an input voltage of 120 VAC @ 60 Hz. The ACU shall automatically adapt to the input power level. Surge ratings shall be set forth in NEMA TS1 and TS2 specifications.

The ACU shall be equipped with a NEMA TS2, SDLC detector interface for 32 detector outputs (8 outputs for a modular type). Output level shall be compatible with the NEMA TS1, NEMA TS2 type 2, type 170, and type 179 standards. A 37 pin "D" subminiature connector on the front of the ACU shall be provided for interfacing to these outputs. This connector shall not be installed in the cabinets where the controller is provided with SDLC interface. These connectors shall be provided to the user and remain in the cabinet. All equipment necessary to interface the controller as either a TS1 installation or as a TS2 (SDLC) installation shall be provided to the controller supplier for installation in the traffic control facility, complete with manuals and shop drawings. The controller manufacturer shall incorporate these components in the cabinet print diagram using the SDLC termination connection. The WAVVD supplier shall provide the SDLC harness and make all cabinet connections in accordance with NEMA and controller design parameters. All connections and device programming shall be provided for all eight phases in every cabinet.

The central type of ACU shall be equipped with four RS-170 (B&W)/NTSC (color) composite video inputs, so that the signals from four cameras or other synchronous or asynchronous video sources can be processed in real time. The modular type of ACU shall be equipped with one RS-170 (B&W)/NTSC (color) composite video input. An additional video input may be

provided to allow connection of a local surveillance camera or other non-detection video source. The video from this auxiliary video input shall not be processed for detection. BNC connectors on the front of the ACU shall be used for all video input.

The ACU shall be equipped with a single RS-170/NTSC composite video output. This output shall be capable of being switched to correspond to any of the video inputs, as selected remotely via the supervisor computer or front panel switch. Multiple video outputs requiring external cabling to create a combined single video output shall not be acceptable. A BNC connector on the front of the ACU shall be used for video output.

7.2 Cameras

1) Input voltage: 120 VAC @ 60 Hz. Power conductors shall allow for no more than 3% voltage drop between source and camera.

2) Video standard: RS- 170A compliant

3) Iris: Automatic, with damping. The video camera shall be equipped with an auto-iris lens with an 8-48mm adjustable focal length lens. The aperture shall be pre-focused at infinity, and the aperture size shall be determined by the vendor based on the specific site locations and conditions to meet the overall detection and accuracy requirements of this VDS specification.

4) Synchronization: Crystal or AC line lock.

5) Automatic Gain Control (AGC): 20 dB minimum, 1 second damped. AGC shall not be applied until automatic iris control has fully opened the aperture.

6) Gamma Correction: 1.0 required for optimal image processing capability.

7) Adjustments: AGC and automatic iris controls shall be adjusted to provide: disserve

8) Black Level: 0 IRE units (~0.3 V peak video signal)

9) No-Contrast Image: 50 IRE units (~0.65 V peak video signal)

10) 100% Video Level: 100 IRE units (1 V peak)

11) The automatic iris shall operate in a damped manner with a time constant of 0.25 seconds or longer.

12) Electromagnetic Interference (EMI): FCC part 15, subpart J, Class A device requirements apply for cameras and associated equipment in their installed location.

8.0 Other Specifications (that will be specific to each manufacturer)

8.1 Technical Data:

The manufacturer shall provide the following:

a. Model number
b. Power and Current requirements/consumption
c. Temperature range
d. Weight and Dimensions

e. Mechanical Construction
f. Mounting equipment necessary
g. Operating frequency (FCC approved)
h. Detection Range, Angle, and Pattern (horiz. and vert.)
i. Response time and Sensitivity
j. Software for operation of device
k. Device capabilities as claimed by manufacturer.
l. Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

9.0 List of Known Manufacturers:

To be completed.