Special Specification 6437
Fish Eye Detection System (FEDS)

1. DESCRIPTION

Furnish and install a Fish Eye Detection System (FEDS) that monitors vehicles on the roadway via processing of video images; functioning as the stop-bar detector inputs with optional additional advance detector inputs; and form a complete detection system for a traffic signal controller or similar device. The system is to be capable of viewing, capturing, and deriving the following information: vehicle detection and actuation; advance detection; tracking vehicles and pedestrians throughout an intersection; automatic alerts; delivering reports on vehicle counts, classifications, and turning movement counts; and have the capability of transmitting live video from an intersection when connected to a high-speed network.

A FEDS configuration for a single intersection (diamond consists of 2 intersections) will consist of one IP-fish-eye camera and up to four IP-advance detection cameras, mounted at a height capable of encompassing views from all approach vectors; a FEDS processor system; and all associated equipment required to setup and operate in a field environment including cables, junction boxes, surge suppression devices, repeaters, connectors, and camera mounting hardware. All support equipment will be delivered to the City of San Antonio Traffic Signal Shop. The FEDS Processor Unit will have the capability to interface directly with the cabinet shown on the plans (332 detector input file and SDLC communication to a Model 2070 controller.) The actual quantity and proposed location of equipment to be furnished, installed, and made fully functional, as a complete FEDS by the Contractor, is shown on the plans.

The FEDS processor system is composed of these principal items: the FEDS processor units, along with any configuration software; the field communications link between the cameras and the FEDS processor unit; surge suppression devices; IP-repeater modules; and all specialized associated equipment required to setup the FEDS software to communicate with the FEDS processor. Additional data collection and reporting options are available to supplement principal items.

2. DEFINITIONS

2.1. **FEDS Processor Unit**. The electronic unit that processes the video image provided by the cameras, generates vehicle detections for defined zones, and collects vehicular data as specified.

2.2. **Fish-eye Camera Assembly.** A fixed position fish-eyed IP-camera sensor used to collect the visual image that will be processed for stop-bar detection at the intersection. The camera assembly consists of an IP-camera, environmental enclosure, sun shield, temperature control mechanism, surge suppression device, and all necessary mounting hardware.

2.3. **Advance Camera Assembly**. A fixed position IP-camera sensor used to collect the visual image that will be processed for advance detection at the intersection. The camera assembly consists of an IP-camera, environmental enclosure, sun shield, temperature control mechanism, surge suppression device, and all necessary mounting hardware.

2.4. **Power Over Ethernet (POE)**. The POE is typically considered for powering up FEDS camera assemblies. The POE can be internal or external to the FEDS Processor Unit.

2.5. **Ethernet Repeater**. The passive device allowing runs between POE and camera assemblies to be greater than EIA/TIA 100m standard. These enclosures are weatherproof (ip66) and receive 8p8c (RJ-45) connectors on each end. The capacitors inside components allow for the increased transmission lengths of multiple 100m Ethernet cable runs (maximum of two repeaters in-line per run between POE and camera).

2.6. **External Switch Assembly.** A multiport switch allowing for expandability of a single FEDS processor unit to manage more than two cameras. All components internal to the FEDS Processor System need to be endorsed in writing by FEDS Processor Unit manufacturer, for compliance.

2.7. **Surge Suppression Device**. Modular designed component intended to lessen the surges possible on field communication link between camera and processor. This device is intended to sacrifice itself to preserve more expensive components of the system.

2.8. **Field Communications Link**. The communications connection between the camera and the FEDS processor unit. The primary communications link media is typically Ethernet cable.

2.9. **FEDS Processor System**. One or more detection camera units, and one or more FEDS processor units required to handle the number of camera inputs drawn in the design, along with all peripheral equipment necessary to achieve a functioning detection system.

2.10. **Field Setup Computer**. A laptop used to set up and monitor the operation of the FEDS processor unit. If required to interface with the FEDS processor unit, the field setup computer with the associated peripherals described in this Special Specification and a video monitor, also described in this Special Specification, is to be supplied as part of the FEDS.

2.11. **Remote Communications Link**. The communications connection between the FEDS processor unit and the Traffic Management Center (TMC) (typically cellular modem or fiber optic cable).

2.12. **Intersection Box**. Defined as the internal intersection area, inside of the stop-bars or crosswalks, defining the internal portion of the intersection.

2.13. **Detection Zone**. The detection zone is a selection of lanes or area, selected through the FEDS processor unit, that when occupied by an automobile, bicycle, or pedestrian, transmits a vehicle detection to the traffic controller or freeway management system.

2.14. **Detection Accuracy**. The measure of the basic operation of a detection system (shows detection when a vehicle is in the detection zone and shows no detection when there is not a vehicle in the detection zone).

2.15. **Lux**. The measure of light intensity at which a camera may operate. A unit of illumination equal to one lumen per square meter or to the illumination of a surface uniformly one meter distant from a point source of one candle.

2.16. **Occlusion**. The phenomenon when a vehicle passes through the detection zone but the view from the sensor is obstructed by another vehicle, tree, or alike. This type of occlusion results in the vehicle not being detected by the sensor or when a vehicle in one lane passes through the detection zone of an adjacent lane. This type of occlusion can result in the same vehicle being counted in more than one lane.

2.17. **Glare**. The phenomenon when the sun position (or headlights) on the roadway causes a hot-spot on the image from the view of the sensor. This type of condition results in a false vehicle call being placed by the sensor when occurring in the detection zone. This type of false call can result in the poor actuation control of the signal in more than one lane.

2.18. **Live Video**. Post-processor video viewed at a minimum of 10 frames per second.

2.19. **Video Monitoring.** Video is to be capable of being viewed from a monitor or laptop computer at the cabinet, when connected to the FEDS Processor Unit. Remote video monitoring capabilities will be obtainable when a provided IP connection from a remote computer to the FEDS processor unit is provided, running the processor's IP-decoder software.

3. FUNCTIONAL CAPABILITIES

The system software will be able to detect both approaching and departing vehicles in multiple traffic lanes. A minimum of 16 detector outputs and a minimum of 8 inputs per video processor (fish-eye counts as 4 inputs, advance camera counts as 1 input) module and each module will have a minimum of 16 detection zones. Each zone and output will be user definable through interactive graphics by placing lines and boxes in an image on laptop or monitor. The user is easily able to redefine previously defined detection zones.

The camera must operate while directly connected to FEDS Processor Unit. The FEDS is to provide real time vehicle detection (within 200 ms of vehicle arrival).

The FEDS processor unit must compensate for minor camera movement (up to 2.5% of the field of view) without falsely detecting vehicles. The system must be able to detect the presence of vehicles in a minimum of 16 unique detection zones within the combined field of view of all cameras. Detection zones must be provided that are sensitive to the direction of vehicle travel. The direction to be detected by each detection zone is user programmable.

Once the detector configuration has been downloaded or saved into the FEDS processor unit, the video detection and tracking system must operate with the monitoring equipment (monitor and laptop) disconnected or on-line.

When the monitoring equipment is directly connected to the FEDS processor unit, it must be possible to view vehicle detections in real time as they occur on the field setup computer's color display. When monitoring equipment is disconnected, the FEDS processor unit must contain indications (LED lights), indicating when a vehicle call is being placed on a phase or detector.

3.1. FEDS Vehicle Detection.

3.1.1. **Detection Zone Placement**. The video detection system must provide flexible detection zone placement anywhere within the combined field of view of the image sensors. Preferred presence detector configurations are boxes placed across lanes of traffic or in line with lanes of traffic. A FEDS Processor must be able to replace one or more conventional VIVDS detectors. In addition, detection zones must have the capability of implementing logical functions including presence, extension and delay timing.

3.1.2. **Detection Zone Programming**. Placement of detection zones must be by means of a graphical interface using the video image of the roadway. The video monitoring software must show images of the detection zones superimposed on the video image of traffic while the FEDS processor is running.

The detection zones will be created by using the mouse or keypad to draw detection zones on the monitor. The detection zones must be capable of being sized and shaped to provide optimal road coverage and detection. It must be possible to upload detector configurations to the FEDS processor unit and to retrieve the detector configuration that is currently running in the FEDS processor unit.

When a vehicle occupies a detection zone, the detection zone on the FEDS display must indicate the presence of a vehicle, thereby verifying proper operation of the detection system. Fail-safe configuration in the absence of video is to be user defined but will come default as Max Recall. The processor unit will have an LED indicator confirming proper operation of the camera units and of the detection zones.

Detection zones must be configurable to provide calls sensitive to the direction of vehicle travel. The direction to be detected by each detection zone must be user programmable. The vehicle detection zone should not activate a call to the controller if a vehicle traveling any direction other than the one specified for detection occupies the detection zone. Cross-street and wrong way traffic will not cause a false detection.

3.1.3. **Design Field of View**. The video detection system must reliably detect vehicle presence in the design field of view. The design field of view must be defined as the sensor view when the image sensor is mounted 27

ft. or higher above the roadway. Within this design field of view, the FEDS processor unit must be capable of setting up a detection zones for each directional approach.

3.1.3.1. **Fish Eye Camera**. The camera is placed inside the intersection box (inside of all stop-bars) to the edge of the nearest vehicle travel lane. A single camera, placed at the proper mounting height with the proper lens, must be able to monitor and detect a minimum of ten different approach vectors.

3.1.3.2. **Advance Camera**. The camera is placed outside the intersection box (typically top luminaire or on mast-arm extension) to view vehicles approaching greater than 200 ft. back of the stop-bar. A single camera, placed at the proper mounting height with the proper lens, must be able to monitor and detect a minimum of 4 lanes wide, at a distance of 300 ft. behind its mounting location.

3.1.4. **Detection Performance**. Detection accuracy of the video detection system must be comparable to properly operating inductive loops. Detection accuracy must include the presence of any vehicle in the defined detection zone regardless of the lane, which the vehicle is occupying. Occlusion produced by vehicles in the same or adjacent lanes must not be considered a failure of the FEDS processor unit, but a limitation of the camera placement. Detection accuracy (a minimum of 95%) must be enforced for the stop bar views included in the design field of view on a lane by lane and on a time period basis. When specified on the plans, furnish up to 24 continuous hr. of recorded video of all installed intersection cameras within the 30 day test period for verification of proper camera placement, field of view, detection zone placement, processor setup, and operation. Test period will allow for initial 24 hr. processor "learning cycle," allowing for the camera to self-evaluate current setup orientation. The video from each system must show vehicle detections for all zones.

3.1.5. **Equipment Failure**. If either the cameras or FEDS processor unit fails, the result must put in a constant vehicle detection on affected detection zones. This option is programmable in the processor unit and the traffic signal controller.

3.2. **Operation from Central Control**. The central control must transmit and receive all information needed for detector setup, vehicle detection monitoring, and intersection traffic flow monitoring at a display rate of 5 frames per second or greater for high-speed connections (as specified on the plans) and interrogate all required stored data. The remote communications link between the FEDS processor unit and central control may be cellular modem (3rd party provided) or dedicated twisted wire pair communications cable which may be accompanied with coaxial cable or fiber-optic cable, as shown on the plans. Communications with the central control must not interfere with the on-street detection of the FEDS processor. Quality of the video at 5 frames per second rate must be such that the view with the traffic flow is clear and operation of the detection system discernable.

3.3. **Data Collection and Reporting.** When called for on the plans, the FEDS should be capable of providing count data, access to real time data, and system and user defined alerts. The ability to provide this information should be retained for the life of the FEDS once purchased if called for by the plans. The count data should be accessible directly from the processor or from a remote computer with a network connection. The count data will include at least the following type of reports:

- turning movement counts, including U-turns;
- length based vehicle classifications;
- incidents reporting;
- volume;
- 7 day volume;
- occupancy on green;
- occupancy on red;
- percentage of arrivals on green; and
- percentage of arrivals on red.

All reports should be exportable and downloadable in any of the following formats:

- PDF,
- Excel,
- Rich Text Format,
- TIFF Image, and
- Web Archive.

The alerts or notifications package for purchase should include at a minimum the following types of alerts:

- wrong way vehicle detection,
- loss of visibility event, and
- volume exceeded.

4. MATERIALS

Provide components necessary for FEDS installation. A FEDS installation should consist of the following components when called for by the plans:

- FEDS Processor Unit,
- camera assembly (1 or more), and
- the field communication link.

4.1. **FEDS Processor Unit**.

4.1.1. **Cabinet Mounting**. The FEDS processor unit must provide a self-mounted and rack mountable option. The FEDS Processor Unit will have the capability to interface directly with the cabinet shown on the plans (2070 controller using the SDLC port, 332 detector input file, ITS, ATCv2.0, TS2, TS1, etc.).

4.1.2. **Environmental Requirements**. The FEDS processor unit must be designed to operate reliably in the adverse environment found in the typical roadside traffic cabinet. It must meet the environmental requirements set forth by the latest NEMA (National Electrical Manufacturers Association) Traffic Signal standards (TS2) as well as the environmental requirements for Type 170, Type 179, and 2070 controllers. Operating temperature must be from -29°F to +165°F at 0% to 95% relative humidity, non-condensing.

4.1.3. **Electrical**. The FEDS must have a modular electrical design. The FEDS must operate within a range of 89 to 135 VAC, 60 Hz single phase. Power to the FEDS processor must be from the transient protected side of the AC power distribution system in the traffic control cabinet in which the FEDS is installed.

FEDS Processor unit must be IP-configurable. Communications to the field setup computer must be through an Ethernet port. This port must be able to download the real-time detection information needed to show detector actuations and configure the FEDS processor.

The unit must offer a raw video output option. This output must be capable of corresponding to the video inputs, as selected remotely via the field setup computer. Connector for video output must be located on the front of the processor unit. Any other video formats used must have prior approval by the Municipality's Signal Operations Engineer.

The unit software and the supervisor software must include diagnostic software to allow testing the FEDS functions. This must include the capability to set and clear individual detector outputs and display the status of inputs to enable setup and troubleshooting in the field.

4.2. **Camera Assembly**.

4.2.1. **Camera**. The video detection system must use an IP-based camera for real time vehicle detection. The cameras must be approved for use with the FEDS processor unit by the manufacturer of the FEDS. Use water resistant connectors to the camera sensor, for rapid replacement. As a minimum, each camera must provide the following capabilities.

4.2.1.1. Images must be produced with an IP-based primary sensor camera. Camera must return images to the processor in real time with color and be usable for configuration and diagnostics.

4.2.1.2. Useable video and resolvable features in the video image must be produced when those features have luminance levels as low as 0.1 lux for black and white, and as low as 1.0 lux for color, for night use.

4.2.1.3. Useable video and resolvable features in the video image must be produced when those features have luminance levels as high as 10,000 lux during the day.

4.2.2. **Camera and Lens Assembly**. The camera and lens assembly must be housed in an environmental enclosure that provides the following capabilities.

4.2.2.1. The enclosure must be waterproof and dust tight to the latest NEMA 4 specifications.

4.2.2.2. The enclosure must allow the camera to operate satisfactorily over an ambient temperature range from -29°F to +165°F while exposed to precipitation as well as direct sunlight as experienced when installed.

4.2.2.3. The enclosure must compensate or allow the camera horizon to be rotated in the field during installation.

4.2.2.4. The enclosure must include a provision for connection of POE IP-video connection cables fabricated at the factory. Input power to the environmental enclosure must have associated surge protection device.

4.2.2.5. A thermostatically controlled heater must be at the front of the enclosure to prevent the formation of ice and condensation. The heater must not interfere with the operation of the camera electronics, and it must not cause interference with the video signal.

4.2.2.6. The enclosure must be light colored or unfinished and must include a sun shield to minimize solar heating and phenomenon of glare. The front edge of the sunshield must protrude beyond the front edge of the environmental enclosure and must include provision to divert water flow to the sides of the sunshield. The amount of overhang of the sun shield must block the view of potential above horizon, direct sunlight from entering the lens.

4.2.2.7. The total weight of the image sensor in the environmental enclosure with sunshield must be less than 10 lb.

4.2.2.8. When operating in the environmental enclosure with power and video signal cables connected, the image sensor must meet FCC class B requirements for electromagnetic interference emissions.

4.2.3. **Camera Mounting Hardware**. The camera and lens assembly must be mounted at a minimum of 27 ft. on signal mast arm or 30 ft. min. on corner luminaire arm above the traffic roadway for both fish-eye and advance cameras. Provide mounting brackets and poles necessary to mount the cameras in the best locations for optimal design field of view.

For the fish-eye camera, mount inside intersection box, in-front of all the stop-bar locations. Mounting options will include mast arm, luminaire, and offset.

For the advance camera, mounting options range, but directionality will include designed view for 200 ft. behind stop-bar, or under overpass exposure. Ensure expected field of view from the camera mounting locations are free from obstructions. Mounting options will include mast arm, luminaire, and offset. For each of the mounting options, the IP-cameras will have a disconnect means by way of an enclosure, for ease of testing field communications link, and for ease of replacement of cameras. This enclosure may double as a secondary grounding point to minimize noise for the video.

Mast arm mounts will include Pelco astro-brac assembly to mount a 15 ft. L-shaped pole to connect the optimal location for the fish-eye deployment. Luminaire mounts will include Pelco tenon-brac assemblies to mount a 5 ft. straight pole to the cantilever luminaire arm, or standard pole, ensuring height and location in-front of stop-bars. Offset mounts will include dual Pelco astro-brac assemblies, with 10 ft. offset arms to existing strain-pole, ensuring height and location in-front of stop-bars.

A camera surge protection device should be mounted inside the cabinet, capable of being mounted to sidewalls of a controller cabinet must be provided for protection of the FEDS processor unit and camera from bi-directional surges. This surge suppression device should be easily replaced if or when damaged by transients.

4.3. **Field Communication Link**. Cabling and devices installed between the camera and the processor. The primary communications link media is typically Ethernet cable. All components for the link will be pre-approved by the FEDS manufacturer, or equivalent. All connection cables must be continuous from the equipment cabinet to the camera, or equipment-to-equipment. No splices of any type will be permitted. Continuous runs will be terminated using TIA/EIA-568-B. Nearly always, 8P8C modular connectors (often referred to as RJ45 connectors). All cables will be straight though (no-crossovers), and devices plugged in to them will be auto-negotiating. All cables will be configured such that each link may be tested using a standard Ethernet tester. The following requirements must govern for the various types of field communications link media described on the plans.

4.3.1. **Twisted Wire Pairs**. The field communications link must be ANSI/TIA/EIA-568 Category 5e cable (Cat5e) high performance shielded direct burial data capable of 350MHz bandwidth applications. The cabling will consist of 24 AWG solid bare copper wire with 8 conductors in a gel filled core. The jacketing should be UV resistant rated for outdoor direct-burial installation, and not exceed 6.5 mm outer diameter. Cable will be rated for minimum 50V and must be approved in writing from manufacturer of FEDS processor unit.

4.3.2. **Surge Suppression Devices**. Install lightning and transient surge suppression devices on the processor side of the field communications link to protect the peripheral devices. Install the suppression devices no more than 3 ft. from the processor. Devices will provide protection against a transient pulse with a pulse shape of 8/20µs and a max current of 75A. Lightning protection is not required for fiber optic communication lines, but the power line to the cameras should have surge protection installed. The devices must not interfere with the communications lines during normal operation. These devices are designed to sacrifice and preserve the expensive camera and processor units, and will be easily replaceable in cabinet.

4.3.3. **IP POE repeaters**. EIA standard twisted pair distances limit the effective transmittal run length to 300 ft. For runs close to or exceeding these limits, provide IP POE repeater devices, rated for outdoor use, and pre-approved by the FEDS manufacturer, or equivalent.

4.3.4. **Fiber Optic Cable**. If specified by the plans, furnish fiber optic cable in accordance with the Special Specification for fiber optic cable. Ensure cable is of single-mode and is terminated with connectors complying with FEDS manufacturer's fiber optic receptacles.

5. EQUIPMENT

Provide the machinery, tools, and equipment necessary for proper prosecution of the work. All machinery, tools, and equipment used should be maintained in a satisfactory and workmanlike manner.

6. CONSTRUCTION

Install FEDS in accordance with the details shown on the plans and the requirements of this Item.

6.1. **Installation and Inspection**. The supplier of the video detection system must have certified supervisors during installation and testing of the video and processor equipment. A factory certified representative must be on site during installation. Formal levels of factory authorized training are required for installers, Contractors, and system operators. All training must be certified by the manufacturer.

Instruction personnel are required to be certified by the equipment manufacturer. The User's Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency. In the event the field setup computer is furnished by the contracting agency, such installation and testing must be done at the time that training is conducted.

6.2. **FEDS Set-Up System**. The minimum FEDS setup system, as needed for detector setup and viewing of vehicle detections, must consist of a field setup computer and Windows-based interface software (if required) or a video monitor with interface software built-in to the FEDS processor unit. Live video (10 frames per second) must be available on the field setup computer to determine proper operation of detectors. The field set-up computer as a minimum, must have an Ethernet input port to connect directly to the processor unit.

If specialty interface software on a field setup computer is required for system setup, it must be supplied by the supplier of the FEDS.

The field setup computer (or monitor) must include all necessary cabling and a Windows-based program to interface with the FEDS processor unit. This software must provide an easy to use graphical user interface and support all models or versions of the supplied FEDS. Live video with the detection overlaid is required for field verification of the system.

6.3. **Warranty, Training, Maintenance, and Support**. The video detection system must be warranted to be free of defects in material and workmanship for a period of 3 yr. from date of shipment from the supplier's facility. During the warranty period, the supplier must repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect provided the product is returned FOB to the supplier's factory or authorized repair site. Return product repair or replaced under warranty by the supplier with transportation prepaid. This warranty does not apply to products damaged by act-of-god, accident, improperly operated, abused, serviced by unauthorized personnel, or unauthorized modification.

During the warranty period, technical support must be available from the supplier via telephone within 6 hr. of the time a call is made by a user, and this support must be available from factory certified personnel or factory certified installers.

Ongoing software support by the supplier must include updates of the FEDS processor unit and supervisor software (if a field setup computer is required for set up). Provide these updates free of charge during the warranty period. The supplier must maintain a program for technical support and software updates following expiration of the warranty period. Make this program available to the contracting agency in the form of a separate agreement for continuing support.

The supplier must maintain an ongoing program of technical support for the wireless camera system. This technical support must be available via telephone or personnel sent to the installation site. The supplier must maintain an adequate inventory of parts to support maintenance and repair of the camera system.

Certified training must be available when requested and scheduled for the supplier, Contractor, installer, and agency. The bid unit will provide up to 1 day of training to the contracting agency personnel in the operation, setup and maintenance of the video detection system. Provide instruction and materials for a maximum of 10 persons and conduct at a location selected by the contracting agency. The contracting agency will be responsible for any travel and room and board expenses for its own personnel.

7. MEASUREMENT

7.1. The FEDS will be measured as each major system component furnished, installed, made fully operational, and tested in accordance with this Special Specification or as directed.

7.2. The FEDS field communication cable will be measured by the foot of the appropriate media type furnished, installed, made fully operational, and tested in accordance with this Specification, other referenced Special Specifications or as directed.

8. PAYMENT

8.1. The work performed and materials furnished, in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit price bid for each item listed in, "Bid Items." These prices are full compensation for furnishing, placing, and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages, supplies, support, personnel training, shop drawings, documentation, and incidentals.

8.2. The Contractor will furnish 1 FEDS Processor Unit for each intersection as shown on the plans, (typically includes 1 or 2 FEDS fish-eye Camera Assemblies per processor unit).

8.3. These prices also include any and all interfaces required for the field and remote communication links along with any associated peripheral equipment, including cables; all associated mounting hardware; and associated field equipment required for a complete and fully functional Fish Eye Detection System.