

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION NO. 907-655-2

CODE: (IS)

DATE: 05/25/2021

SUBJECT: Highway Advisory Radio

Section 907-655, Highway Advisory Radio, is hereby added to and made a part of the 2017 Edition of the Mississippi Standard Specifications for Road and Bridge Construction as follows.

SECTION 907-655 - HIGHWAY ADVISORY RADIO

907-655.01--Description. This Special provision describes furnishing, installing and integrating a Highway Advisory Radio (HAR) System. The work consists of providing all labor, materials, equipment, and incidentals necessary to furnish, install, test, and make functional the HAR System. The work includes complete Federal Communications Commission (FCC) licensing services and all documentation necessary to operate and maintain the equipment.

The HAR System will provide broadcast up-to-the-minute AM radio traffic advisories and be equipped to allow messages to be changed or transmitted via the communications system.

907-655.02--Materials.

907-655.02.1—General. A HAR system shall consist of but is not limited to the following components and materials.

1. AM radio transmitter,
2. Digital recorder/player,
3. Global Positioning System (GPS) synchronizer,
4. National Oceanic and Atmospheric Administration (NOAA) weather receiver,
5. HAR cabinet,
6. Antenna mounting pole,
7. Antenna and grounding,
8. Power distribution / supply,
9. Battery backup system with recharging subsystem,
10. Surge protection,
11. HAR flashing beacons and remote control, and
12. Communications and control center (hardware and software) equipment.

907-655.02.2--System Capabilities and Performance Requirements. Overall system capabilities and performance requirements include the following.

1. Each HAR subsystem shall have a minimum coverage radius of four (4) miles for broadcasting messages to motorists.
2. The network of HAR subsystems shall be synchronized to provide seamless message receptions from one transmission area (zone) to another.

3. System shall provide digital message recording and storage capabilities.
4. Provide National Weather Service (NWS) transmission/broadcast capabilities.
5. Each HAR transmitter shall be capable of being controlled through an Ethernet port **unless otherwise stated in the plans**.
6. Messages to each HAR transmitter shall be through an Ethernet port **unless otherwise stated in the plans**.
7. Provide battery back-up power for a minimum of 72 hours without primary power source.
8. Provide HAR advisory static signs, flashing beacon lights, solar power subsystem, and **remote control subsystem for flashing**.
9. All HAR structures, including the antenna, shall be able to withstand a steady-state 90-mile per hour (mph) wind and ½-inch ice buildup at a minimum. For projects that are in areas with higher wind standards, the higher standard is required.
10. All HAR systems shall use the same frequency throughout the state unless otherwise approved by the Department.

907-655.02.3--General Requirements. General HAR system requirements include the following.

1. The Contractor is responsible for determining and providing any other equipment that is needed for safe and reliable operation of the HAR system.
2. Prototype equipment will not be acceptable.
3. HAR electronics shall be of solid-state design and modular construction.
4. The HAR system consisting of transmitters, digital recorder players, digital communications controllers, GPS synchronizers, power supplies, and NOAA receiver shall be provided, integrated, and warranted by a single HAR vendor.

907-655.02.4--Frequency Selection and FCC Licensing Services. The Contractor shall determine optimal HAR operational frequency and provide complete and comprehensive FCC licensing services which includes the following.

1. The Contractor is responsible for obtaining all required licenses on behalf of the Department, for the Department to operate the HAR stations.
2. The Contractor shall also perform all necessary testing to select the clearest and most appropriate operating frequency for all HAR transmitters at the proposed locations.
3. All transmitters shall operate at the same frequency throughout the state unless otherwise approved by the ITS Engineer. Frequency selection shall be submitted to the Department for approval prior to application for FCC licenses.
4. The Contractor shall provide all location maps, field strength contour maps, engineering drawings (identifying adjacent commercial stations and other possible HAR system using FCC data bases), and paperwork necessary as part of the FCC licensing process.
5. All FCC licensing effort shall be coordinated with MDOT.

907-655.02.5—Standards. All materials, equipment, supplies, installations and testing shall comply with the project requirements, the latest editions of the following standards and industry practices, as applicable, and all other standards and requirements, industry practices, and any state and local codes or ordinances that may apply.

1. Standards and industry practices shall include, but not be limited to, the following:

- a. Federal Communications Commission (FCC) regulations
 - b. National Electric Code (NEC)
 - c. Underwriters' Laboratories Inc. (UL)
 - d. National Electrical Manufacturer Association (NEMA)
 - e. Institute of Electrical and Electronic Engineers (IEEE)
 - f. American Society of Testing and Materials (ASTM)
 - g. American National Standards Institute (ANSI)
 - h. Lightning Protection Institute (LPI)
 - i. National Electrical Safety Code (NESC)
 - j. Occupational, Safety, and Health Act (OSHA)
2. All materials, equipment, accessories and components that are not in accordance with the specific standards and requirements shall require approval by the Department. The Contractor shall bring any conflicts between referenced industry specifications and this Special Provision to the attention of the Department.
 3. The Contractor shall use the latest version of referenced industry specifications, standards, and practices in force and in existence as of this project's advertisement date unless otherwise noted.
 4. The Contractor shall acquire and use all applicable manuals, guidelines, and standards and practices that apply to the design, construction, and testing activities required to complete this project.

907-655.02.6--AM Transmitter. The transmitter subsystem shall meet the following minimum specifications.

1. The transmitter shall be FCC certified under CFR Title 47, Section 90.242 and conform to the Traveler Information Service (TIS) requirements in the United States.
2. Capability for adjustment of RF output power and audio input levels through easily accessible controls.
3. A provision for automatic station identification (Automatic ID) shall be included.
4. The HAR AM transmitter unit shall meet the following minimum requirements:
 - a. Operational Frequency Range: 530 kHz to 1700 kHz inclusive
 - b. Modulation Type: Amplitude Modulation (6A3)
 - c. Transmitter Amplifier Type: High Efficiency Class D (80% or Better)
 - d. Radio Frequency Output Power: Adjustable up to 10 Watts
 - e. RF Output Impedance: 50 Ohms (Ω)
 - f. Frequency Stability: $\pm 0.002\%$ (20 PPM) from 32° to 95°F or provided by phase locking to GPS.
 - g. AF Input Impedance: Both, 600 Ω and Hi "Z" (Match Digital Recorder)
 - h. Audio Frequency Response: 20 Hz to 15 kHz ± 1.0 dB maximum
 - i. Audio Distortion: Less than 1.5% from 200 Hz to 3.5 kHz
 - j. Modulation Limiter: Built-in 100% peak modulation limiter
 - k. Audio Filter: Built-in FCC compliance audio filter (-3dB at 3kHz, 18dB/octave roll-off)
 - l. Audio Noise Level: At least 70 dB below 80 percent modulation level
 - m. Operational Temperature Range: -22°F to +165°F
 - n. Operational Humidity: 0% to 95% non-condensing

907-655.02.7--Digital Recorder / Player. A Digital Recording Unit shall be provided with the following minimum features/functions and specifications.

1. Digitally record and store messages, or audio files.
2. Provide direct, local and remote control of all functions.
3. Provide security access codes for local and remote operations.
4. Interface: Provide capability for interfacing with a 10/100 Base-T Ethernet network supporting TCP/IP **unless otherwise specified in the plans.**
5. Provide capability for scheduling of automated broadcasts by day, week, month, year, and time.
6. Store a minimum of 250 distinct digital messages or audio files, with variable length messages, which can be recorded, stored, or deleted independently.
7. Provide a minimum of 80 minutes of total recording time.
8. Sequences of up to 100 messages shall be possible
9. Up to 20 message sequences that can be stored and selected.
10. Allow the recording of a message while another message is being recorded. (Simultaneous record/playback).
11. Allow for multiple modes of operation including:
 - a. Transmitter on or off
 - b. Record a message and monitor the recorded message
 - c. Play pre-recorded message(s) by inputting codes
 - d. Emergency broadcast mode (Live messages)
 - e. NOAA Weather Radio broadcast when emergency alert system event code is activated
12. Provide capability for message retention (indefinitely) without the use of a battery, in the event main site power is lost.
13. Provide the capability for automatic call-sign announcement.
14. The Digital Recorder/Player shall be capable of providing Standard DTMF tones as applicable
15. AF Input Impedance: both, 600Ω and Hi “Z” (Contractor shall provide a compatible microphone)
16. Audio Frequency Response: 20 Hz to 15 kHz ±1.0 dB maximum
17. Audio Distortion: Less than 5% @ from 200 Hz to 3.5 kHz
18. Modulation Limiter: Built-in 100% peak modulation limiter
19. Temperature: -22°F to +165°F; Humidity: 95% non-condensing

907-655.02.8--Simulcast Synchronization. The HAR synchronization subsystem shall meet the following minimum requirements.

1. The system shall be prepared to be part of a wide area broadcasting system with other HAR transmitters as shown in the Plans of the same type for simultaneous broadcast of messages in a synchronized system.
2. This feature shall avoid interference or audio distortion within possible overlapped areas.
3. Each synchronized HAR system shall be equipped with a GPS synchronizer, which shall provide the capability to phase-lock the transmitters to a common reference carrier to minimize heterodyne.

4. The GPS Synchronizer subsystem shall have been successfully tested in conjunction with the transmitter and certified by the FCC in accordance with the provisions of FCC Section No. 90.242.

907-655.02.9--NOAA Weather Receiver. The Contractor shall provide a weather receiver unit meeting the following requirements.

1. The unit shall receive up-to-the-minute information directly from the National Weather Service (NWS).
2. The unit shall work in conjunction with the HAR digital recorder/player to automatically interrupt the current message being broadcast upon receipt of the Emergency Alert System (EAS) event codes from NOAA.
 - a. The system shall have fully programmable EAS entry capability allowing the Department to select only the alerts they specifically need for this specific area and application.
3. The Alert feature (on/off) as well as the feature to set the duration for broadcasting the alert, shall be selectable from within the digital recorder/player's voice prompts
4. The NOAA Weather Receiver module shall comply with the following functionality and requirements:
 - a. Component shall provide selectable frequencies that are selectable through a series of dip switches or push-buttons
 - b. The weather receiver shall provide internal speaker and headphone jack
 - c. Weather alert shall detect 1050 Hz alert tones
 - d. Component shall provide antenna and required cabling
5. The system shall also automatically activate all flashing beacons whenever a NOAA weather message has been broadcast.

907-655.02.10 HAR Transmitter Cabinet. All HAR shall be designed to operate inside the cabinet described herein. The Contractor shall provide a ground-mounted cabinet for each HAR station. The HAR cabinet shall be included in the cost of the HAR system and shall meet the following minimum specifications.

1. The HAR cabinet shall be approximately the same size as a Type C cabinet as indicated in the Plans.
2. The HAR electronic components shall be housed in a locking, weather resistant, aluminum cabinet that shall completely protect the equipment.
3. The HAR cabinet shall be a NEMA 3R rated aluminum enclosure. It shall provide protection from falling dirt, rain, sleet, snow, windblown dust, splashing water, vandalism and will be undamaged by the external formation of ice on the enclosure.
4. The complete cabinet / enclosure shall be constructed from 0.125-inch thick aluminum alloy type 5052-H32 to provide strong and rigid construction. All exterior seams shall be ground smooth or sealed weather-tight.
5. The door frame/opening shall be designed to help prevent dust and liquids from dropping in the cabinet when the door is opened.
6. The cabinet shall be equipped with adjustable mounting channels to provide versatile positioning of shelves or optional panels or rack mounting angles.

7. The cabinet / enclosure door shall be lockable and provisions for cabinet door handle padlocks shall be included.
8. Provide with an AC power service panel and ground bus.
9. The cabinet shall include a thermostatically controlled ventilation fan to adequately remove heat within the cabinet to prevent performance degradation and reduced reliability. Ventilation fan and filter louver shall be screened against the entrance of dust and foreign matter. A replaceable filter for incoming air shall be provided. The fan shall include a resistor-capacitor network noise suppressor installed across the fan motor power terminals.
10. The cabinet shall include a fluorescent lighting fixture, minimum 15 watt, mounted on the inside top front portion of the cabinet, with a cool white lamp with shatter-proof cover and operated by a normal power factor UL listed ballast. The light shall be door switch controlled. The light shall include a resistor-capacitor network noise suppressor installed across the light fixture power terminals.
11. Provide sunshields and mounting fasteners on all HAR transmitter cabinets. Sunshields and fasteners shall meet the following minimum requirements:
 - a. Sunshields shall be 0.125-inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.
 - b. Cabinets shall be equipped with press-in threaded inserts on the cabinet interior. Sunshields shall be mounted by fasteners and aluminum or stainless steel standoffs tightened into the threaded inserts. Provide a minimum of four inserts/fasteners for top face sunshields.
 - c. Provide a minimum of six inserts/fasteners for any door or side sunshield.
 - d. For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any fasteners.
 - e. Furnish and install a top face sunshield on all cabinets.
 - f. Furnish and install door or side sunshields on any cabinet face that is within 60 degrees in either direction of due south. A minimum of two door or side faces shall have sunshields on any cabinet. A cabinet with a face exactly perpendicular to the south shall have three shields.
12. Provide agency name, device name and ID labels on all cabinets. Labels shall meet the following minimum requirements:
 - a. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch (1") in height.
 - b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.
 - c. The agency name labels shall be "MDOT ITS" in one continuous adhesive sheet.
 - d. The device ID labels shall include the device name as an acronym and a hyphen, and shall be one continuous adhesive sheet.
 - e. The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet.
 - f. The device ID labels shall also include large 3-inch letters on the side of the cabinet that the ground plane is located that states "WARNING: GROUND PLANE LOCATED XXX' FROM CABINET. NO DIGGING"
 - g. Labels shall be installed along the top of the cabinet door , with MDOT ITS label at the top and the device ID labels immediately underneath.
13. Provide a voltage label on all HAR transmitter cabinets in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:

- a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.
 - b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.
 - c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are "120VAC" or "120/240VAC".
 - d. Labels shall be installed on all cabinet doors.
14. Provide door locks for all HAR transmitter, controller and solar power/battery cabinet doors all keyed to the same master. Provide one key with each cabinet.

907-655.02.11--Mounting Pole. The mounting pole shall meet the following minimum requirements.

1. The antenna shall be mounted on a freestanding, vertical pole support utilizing adequate antenna mounting hardware.
2. All mounting hardware used shall be stainless steel except for the anchor bolts, which shall comply with the Plans.
3. The combined height between the pole support and the tip of the antenna element shall not exceed 49.2 feet in height from ground level in order to comply with FCC regulations.
4. The antenna pole support shall have the following physical characteristics:
 - a. Structurally constructed in one continuous piece
 - b. Standard 30 to 35 foot wooden utility pole [that meets the requirements of the plan details and Subsection 722.02.7.](#)
 - c. Withstand severe weather and heavy winds of 90 mph at a minimum. For projects that are in areas with higher wind standards, the higher standard is required.
5. Foundation of the antenna pole shall conform to the detail requirements in the Plans.

907-655.02.12--Antenna Subsystem. The antenna subsystem consists of an antenna and its grounding components and shall meet the following minimum requirements and features.

1. Omni-directional, vertically polarized antenna providing high efficiency with low radiation angle performance.
2. Manufactured for and tuned to the same frequency as the transmitter.
3. Provide an Effective Isotropic Radiated Pattern (EIRP) of 2.0 mV/m @ 1.5Km (0.93 miles) per FCC regulations.
4. Provide an overall Voltage Standing Wave Ratio (VSWR) 1:4 or better with direct feed (without antenna tuner).
5. Provide direct base feed, Center coil loaded.
6. Antenna height will depend on final selected frequency – approximately 15 feet will be required for 1700 kHz and 25 feet for 530 kHz. The total antenna height (tip) above ground including the mounting pole shall not exceed 49.2 feet as per FCC regulations.
7. Antenna shall be constructed from anodized aluminum with adjustable tip to minimize the standing waves.
8. Antenna subsystem shall be self-supporting and capable of withstanding severe weather conditions with winds of up to 90 miles per hour (steady state) with ½-inch of ice build-up.

9. Antenna subsystem shall include all hardware, mounts, surge protectors, and ground terminals in cabinet/enclosure for a complete subsystem.

907-655.02.13--Grounding. The Contractor shall document and submit to the Department for review and approval, an antenna/grounding subsystem design for this project that meets the grounding requirements defined in the Notice to Bidders entitled "ITS General Requirements" and the following minimum grounding requirements.

1. The antenna/grounding design shall be provided for each proposed HAR site taking into account local site conditions, soil conditions, antenna type and exact location, along with the ground plane designed.
2. The HAR antenna/grounding design and design submittal shall be either conducted by or signed off by the HAR equipment manufacturer. The submittal shall include antenna and grounding details showing design configuration and proposed equipment and materials, supporting design calculations, recommended installation methods/procedures to be utilized, and equipment and proposed material specifications / cut-sheets.
3. The HAR antenna subsystem shall be provided with an efficient ground plane properly tuned to the operational frequency and ground/soil type and conditions.
4. The Contractor shall be responsible to provide a grounding system that provides the overall HAR system performance as described herein.
5. The grounding subsystem shall consist of a set of horizontal radials of heavy gauge wire or radial loops extending outward from the base of the antenna to ensure proper grounding and performance requirements.
6. An alternate ground system method and configuration may be designed and submitted as part the HAR grounding subsystem design submittal depending on site conditions to the Department for review and approval prior to construction.
7. Regardless of the grounding type; the Contractor shall be responsible for providing a complete grounding subsystem that supports the minimum 4-mile transmission radius system performance as described herein.
8. Care shall be taken to minimize disruption to the existing landscape and to avoid possible underground utilities or conduits. After installation the landscape of the site shall be restored to the state that it was in prior to installation of the ground system.

907-655.02.14--Power Supply / Regulation. The power supply subsystem shall meet the following minimum specifications.

1. The equipment proposed shall be capable of operating from a primary power (115-volt, 60 Hz.) source.
2. The equipment shall have fuse protection against internal short circuit and power surges.
3. The electrical power distribution and regulation/conditioning shall be supplied with a power subsystem equipped with an automatic power transfer switch to the battery back-up system for power failure management or equivalent method. The subsystem shall have no interruptions of power or spikes.
4. Provide low voltage battery protection capability.
5. Provide power regulation/conditioning: $\pm 3\%$ output voltage regulation with input voltage variations $\pm 15\%$. Provide noise attenuation and harmonic filtering

6. The subsystem is responsible for distribution of the power required to all components of the HAR system. It shall have built-in visual indicators to show power and alarm status at a minimum.

907-655.02.15--HAR Back-up Battery System. The battery backup system shall meet the following minimum specifications.

1. The Contractor shall provide a battery backup system that will provide sufficient battery power to operate all components of the HAR subsystem, including the AM transmitter operating at 10 watts full power output, for minimum of 72 hours (3 days) without normal 115-volt primary power or other external service.
2. The current draw of each component of the HAR subsystem including the AM transmitter, digital recorder/player, communications equipment and any other electrical loads present during operation shall be measured and provided by the Contractor to the Department for verification of proper sizing of the back-up battery system.
3. The back-up system shall have an automatic charging unit and power changeover with no interruption to HAR transmissions. The system shall also include automatic charging circuitry to prevent overcharging and thermal (overheat) protection.
4. The battery back-up system chargers shall meet all specified requirements while operating between -40 °F to +60 °F, and 95% relative humidity.
5. Batteries shall be maintenance free, industrial, deep-cycle gel cell or absorbed glass mat (AGM) type.
6. The battery charger shall trickle charge the batteries from the normal 115-volt primary power.
7. The back-up system shall not overcharge the batteries and shall include a load controller and a charge regulator in addition to automatic battery temperature compensation. Provide a method (voltsmeters, ammeters) to indicate the current state and rate of charge of the batteries.
8. One set of rechargeable batteries shall be furnished for each local transmitter included in this project.

907-655.02.16--Antenna Cabling. The antenna cabling shall meet the following minimum specifications.

1. The Contractor shall use high quality, low-loss transmission cable to connect the antenna, inline lightning suppressor, and transmitter. Belden 9913 or Times LMR-400 low-loss coaxial cable or equivalent.
2. The coax cable shall be recently manufactured and certified for having factory testing performed to verify the cable design characteristics.
3. The Contractor shall provide weatherproofing for the transmission cable/connector ends, suitable for direct environmental exposure.

907-655.02.17--Surge Protection. The HAR system shall be provided with surge protection on all input and output audio lines, antenna lines and power feeds, in order to protect the equipment during inclement weather conditions and common transients (transient voltage surges and induced current) along the primary power source.

The surge protection equipment shall meet the following minimum requirements.

1. The surge protectors shall include but are not limited to the following types and requirements:
 - a. Power Line Surge Protector Response: Surge suppression in cabinet shall meet all equipment manufacturers' recommendations.
 - b. Antenna Surge Projector Response: < 4.0 ns @ 18,000 Amp
2. All surge protection devices shall be UL listed.
3. Radio surge protectors shall introduce low insertion losses (≤ 0.1 dB)

907-655.02.18--HAR System Software Application. If called for in the plans, the Contractor shall provide a network-ready, client-server HAR control and monitoring application software package that operates over the existing TMC Network. In areas where HAR systems exist the Contractor shall integrate new HAR stations with existing HAR server software and hardware.

907-655.02.18.1--HAR Client Software Requirements. The HAR software application shall provide centralized operator control and monitoring of dispersed HAR and flashing beacon subsystems with the following minimum features and capabilities.

1. Shall be responsible for serving as the user interface to view and control the HARs.
2. Shall be installed on each of the existing TMC workstations.
3. Shall allow the TMC Operator to select, display, schedule, and modify messages, transmit messages, list diagnostic information, and control of HAR field stations via the network.
4. Shall support message recording through external audio sources and by a microphone via audio line inputs in the workstations.
5. Shall support review, selection, scheduling and playback of recorded messages from a HAR message library.
6. Shall support control of flashing beacons over an Ethernet-based subsystem and any other communication subsystem stated in the plans.
7. Shall provide for multiple modes of operation as follows:
 - a. Transmitter control
 - b. Record and monitoring of messages
 - c. Playing of pre-recorded messages
 - d. Emergency broadcast mode (live)
 - e. NOAA weather radio broadcast when alert is activated.
8. Shall provide the capability for user-definable HAR groups and HAR Sign groups that will allow the user to execute commands on the entire Group with a single command.
9. Shall provide status information based on control commands sent to indicate which HAR Signs with Flashing Beacons are currently activated.
10. Shall be capable of importing audio files created externally and shall log updates
11. Shall be able to convert typed text into voice that can be used for a clear understandable message.
12. Provide the capability to group signs and then click an icon to issue an on or off command to the group.
13. The HAR system operators shall be able to toggle the beacon state within the client software, turning the devices off or on.

907-655.02.18.2--HAR Server Software Requirements. The HAR Server is responsible for management of all HAR device configuration and communications. The HAR Server Software shall meet the following minimum requirements.

1. Shall support control of flashing beacon controllers over a **Ethernet**-based subsystem **and any other communication subsystem stated in the plans.**
2. Shall support and be licensed for a minimum of fifteen (15) HAR clients.
3. Shall support up to 40 HAR stations on a single server without additional software or upgrades. The Contractor shall provide a current HAR Server software license for a minimum of 10 HARs.
4. Shall allow devices to be added, removed or modified any time after the initial software installation and configuration.
5. Shall generate a dynamic geographic map viewable from the HAR Clients. The map shall include the following features:
 - a. Displays icons for HARs and HAR Signs with Flashing Beacon locations.
 - b. Capability to zoom in or out.
 - c. When a HAR location is selected, associated HAR Sign with Flashing Beacons shall be highlighted.
 - d. Shall allow the capability for placing dynamic icons representing installed HARs and Flashing Beacons in their appropriate locations.
 - e. Other ITS device icons shall be statically placed on the same site map for TMC Operator reference.
6. All software configurations shall be through a graphical user interface.
7. Shall prevent more **than** one user to simultaneously control the same HAR or HAR groups.
8. Shall support communication to HAR transmitters through **cellular**, dial-up lines and through the IP/ Ethernet network.

907-655.02.18.3--HAR Software System Configuration. The Contractor shall fully configure the HAR Control System for operation. At a minimum, this shall include the following.

1. Install and configure map of the project area with HAR locations and HAR Sign locations. The map image must be approved by the Engineer prior to installation and configuration.
2. Configure the HAR Server communications and establish and test service to all HAR and HAR signs.
3. Install and configure all HAR stations and flashing beacon controllers.
4. Configure a minimum of fifteen (15) users (provide capability to support local and remote users).
5. Duplicate configurations shall be made at both the Regional TMC location and the Statewide TMC location in Jackson, MS.

907-655.02.18.4--Hardware Requirements. When called for in the plans or a Notice to Bidder, the Contractor shall provide and configure one server at the Regional TMC and another server at the Statewide TMC in Jackson, MS. The server shall meet or exceed the minimum server requirements specified by the HAR software vendor.

907-655.02.19--HAR Flashing Beacons and Control Subsystems. The flashing beacon shall meet

the following minimum requirements.

1. Static signs will be used with stationary HAR systems as shown in the Plans. The bottom of the sign will notify motorists that information is on a specific AM RF. The top of the sign will have a yellow background and the words "URGENT MESSAGE WHEN FLASHING" in black letters. This message refers to the two flashing beacons that will be located on top of the sign.
2. The two beacons shall require their own power, control and cabinet components. All beacons shall be DC-powered. The DC-powered beacons shall have PV solar arrays and a battery subsystem as described in Subsection 907-655.02.20.
3. The beacons shall be turned on or off remotely with controller components as shown in the plans. A control cabinet shall house the beacon control and power components.
4. HAR flashing beacons shall be constructed in accordance with the Plans for HAR static signs and flashing beacons.
5. The beacon component shall include two (2) beacon housings of polycarbonate construction.
6. The LED beacon lens/heads located on highways/freeways shall be one (1) foot in diameter.
7. The beacons shall have a flash rate as specified in the Federal Highway Administration (FHWA) Manual on Uniform Traffic Control Devices (MUTCD).
8. The flashing beacon shall be activated via TCP/ IP over cellular network or fiber optic cable, as shown in the plans. The controller shall be used to remotely control the flashing beacons.
9. The flashing beacon system shall include an adjustable automatic shutoff timer that will automatically turn off the flashers in a predetermined amount of time if when done through the paging system.
10. All beacon control and power components (except batteries) shall be housed in a minimum NEMA 3R type aluminum cabinet/enclosure. The cabinet/enclosure shall be constructed from 0.125-inch thick aluminum alloy type 5052-H32. The cabinet/enclosure door shall be lockable and provisions for cabinet door handle padlocks shall be included.

907-655.02.19.1--Pager Control Subsystem. The pager-based control subsystem, if required per the plans, shall meet the following minimum requirements.

1. The Contractor shall be responsible for establishing and setting up an account with a local Service Provider providing paging services as required for the HAR subsystem operations. All activation and operational / monthly billing costs shall be paid by the Contractor during the test phases. Upon Final Acceptance the account will be transferred to the MDOT.
2. The Contractor shall verify pager service is available and FCC license is approved for that particular site prior to construction.
3. HAR system operators shall be able to simply call a designated pager number and enter touch-tone control functions, turning the device off or on.
4. The flashing beacon, pager-based controller shall provide the following capabilities:
 - a. Pager based controller shall operate at the 900 MHz frequency range.
 - b. Support minimum baud rate of 1200.
 - c. Support Post Office Code Standardization Advisory Group (POCSAG) line (numeric service).

- d. Single pager number shall control multiple devices, if supported by local paging service.
 - e. Operate with a solar power subsystem described herein.
 - f. Internal relay shall provide contact closure for control of flashing beacons.
 - g. The pager controller shall be housed in the beacon control and power cabinet.
 - h. The flashing beacon controller shall be compatible with and controlled by the HAR central control software through the pager control subsystem.
5. The Contractor may propose an alternative pager based control system for review and approval by the Department.

907-655.02.19.2--Cellular Control Subsystem. The cellular-based control subsystem shall meet the following minimum requirements.

1. The Cellular Control Subsystem shall include cellular modem, TCP/ IP controlled relay, and all associated parts and equipment for fully functional installation.
2. The Contractor shall be responsible for establishing and setting up an account with the DOT Service Provider facilitating cellular services as required for the HAR control subsystem operations. All activation and operational / monthly billing costs shall be paid by the Contractor during the test phases. Upon Final Acceptance the account will be transferred to the MDOT.
3. The Contractor shall verify cellular service is available and approved for that particular site prior to construction.
4. The cellular-based controller, cellular modem shall adhere to the following:
 - a. The cellular modem shall utilize wireless TCP/ IP
 - b. The cellular modem shall support networking protocols: TCP, UDP, DNS, DHCP, HTTP, SNMP, and Modbus.
 - c. It shall be provided with a built-in web user interface providing remote configuration and control.
 - d. The cellular modem shall provide the following interfaces:
 - i. 10/100 Base-T Ethernet port connection
 - ii. RJ-45/ DB9 Serial port connection.
 - iii. RS-232 Serial port connections. Baud rates up to 230 Kbps.
 - e. The cellular modem shall be capable of supporting connection, remote communication, programming, and diagnostics via the Internet.
 - f. The controller subsystem shall have all necessary hardware such as communications cables, and controller interface.
5. The cellular-based controller, TCP/ IP controlled relay shall adhere to the following:
 - a. It shall be IP addressable and configurable via built-in web user interface.
 - b. Shall provide 12 Amp/ 120VAC relay to be connected to the contact closure of the flashing beacons.
 - c. Network Interface: RJ45 10/100 Base-T Ethernet port connection.
 - d. Shall be controllable by simple text commands or XML.
6. The cellular-based control subsystem components shall be compatible with and controlled by the HAR beacon client and server software.
7. The cellular modem and IP controlled relay shall be housed in the beacon control and power cabinet.

907-655.02.20--Solar Power System for Flashing Beacons. The Contractor shall provide required solar power equipment to provide power to the flashing beacons **if shown in the plans** as per the following guidelines. The photovoltaic power supply shall include but is limited to the battery, photovoltaic modules and all required peripherals. The solar power generated should be able to optimally operate the Flashing Beacons as intended. The solar power system shall meet the requirements **of the Notice to Bidders entitled "ITS General Requirements."**

907-655.02.21—HAR Sign Materials and Sign Supports. The HAR Sign layout (size, font, lettering, etc.) shall be as shown in the plans. All sign materials and sign supports shall conform to the requirements of Subsection 630.02 and Section 721. Sign locations shown on the plans are approximate and may need to be adjusted at the direction of the Engineer. The Contractor will be required to stake out proposed HAR sign locations and gain approval from the Project Engineer prior to proceeding with installation. Beam lengths shown on the plans are estimated only and shall be field verified by the Contractor. The Contractor shall submit shop drawings with the proposed sign layout and final beam lengths to the Engineer for approval.

907-655.03--Construction Requirements. All equipment shall be installed according to the manufacturer's recommendations, the Plans, and as follows.

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
2. The equipment shall be designed to prevent reversed assembly or improper installation of connectors, fasteners, etc. Each item of equipment shall be designed and installed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
3. The Contractor shall furnish and install all supports, clamps, cables, connections and other materials to secure the HAR transmitter and antenna at the selected locations. The type of mounting poles to be supplied and the location of their installation shall be as specified herein and depicted in the Plans.
4. The Contractor shall be responsible for locating possible utility conflicts prior to excavating and installing the ground-plane system. In case of space limitations or structural modification constraints, the Department shall be informed prior to site construction.
5. The Contractor shall perform detailed pre-installation site surveys and frequency tests to determine the adequacy of each HAR transmitter site (e.g., power, grounding, communications, etc.) for the intended purpose and performance criteria and shall submit recommendations to the Department for alternative site(s) if a selected site is unsuitable. The Contractor shall locate and configure the HAR System to maximize the broadcast and overall performance for each HAR location.
6. Do not install electrical service or electronic devices in the HAR transmitter cabinet or connect to the cabinet until cabinet and antenna grounding systems have been successfully completed and accepted, and the cabinet ground connection has been installed.
7. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.
8. Installation of HAR signs shall conform to construction requirements set forth in Subsection 630.03.

9. The solar power panels for the flashing beacons shall be properly oriented to maximize exposure to the sun during the shortest days of the year at the latitude and longitude of the site.
10. The HAR Signs shall be covered at all times until the HAR system begins full operation from the TMC. The covering shall be a rugged, non-transparent material that is attached to the sign in a secure manner. The material and attachment methods shall be submitted to MDOT for approval prior to purchase and use.
11. The Contractor shall provide the MDOT with a written inventory of items received and the condition in which they were received. Inventory shall be inclusive of make, model, and serial numbers, MAC address, and installation GPS coordinates. All equipment shall be installed according to the manufacturer's recommendations or as directed by the MDOT.
12. Any new, additional or updated drivers required for the existing ATMS software to communicate and control new HAR installed by contractor shall be the responsibility of the contractor.

907-655.03.1--Testing. All equipment associated with the HAR sites shall undergo testing to verify conformance to requirements of the plans and these special provisions. The Contractor shall conduct a Project Testing Program as required in the Notice to Bidders entitled "ITS General Requirements.". All costs associated with the Project Testing Program shall be included in the overall contract price; no separate payment will be made for any testing.

907-655.03.1.1--HAR Stand Alone Test (SAT). In addition to the requirements set forth in the Notice to Bidders entitled "ITS General Requirements", the Contractor shall, at a minimum, demonstrate compliance with all requirements specified herein and include the following minimum test requirements.

1. The test equipment should include a power/VSWR meter suitable for AM broadcast band (530 ~ 1,700 kHz), a fifty ohms (50Ω) dummy load and a Hi-Z hand held frequency counter with telescopic antenna.
2. The Contractor must demonstrate full coverage clear reception throughout the project limits as shown on the Plans. The testing process shall include, but not be limited to, the following types of tests:
 - a. Remote HAR field tests,
 - b. Remote flashing beacon field tests,
 - c. Central HAR control tests including GPS synchronization tests for frequency and audio,
 - d. Central flashing beacon remote control tests,
 - e. Remote HAR to central communications tests, and
 - f. Signal strength at the HAR beacon signs
3. The Contractor shall verify that the transmitter operates at 10 watts or less and that the field strength does not exceed the 2mV/m at 0.93 miles.
4. Verify that the HAR transmitter RF power output, as well as VSWR; are within acceptable specified limits as specified herein.
5. Verify proper non-modulated Carrier frequency alignment.
6. Verify modulated carrier does not exceed 6k Hz. Bandwidth (with Side Bands) as per FCC Part 97.
7. Verify proper audio level adjustment as per manufacturer recommendations when

performing local recordings with provided microphone via XLR, ¼-inch Phono jack or mini-plug as well as remote recordings dial-up based network.

907-655.03.2--Submittals. The submittal requirements defined in the Notice to Bidders entitled “ITS General Requirements” shall be met. All costs associated with submittals shall be included in the overall contract price; no separate payment will be made for any documenting and submitting.

907-655.03.3--Quality Assurance. The quality assurance requirements defined in the Notice to Bidders entitled “ITS General Requirements” shall be met. All costs associated with the quality assurance requirements shall be included in the overall contract price.

907-655.03.4--Warranty. At a minimum, the warranty requirements defined in the Notice to Bidders entitled “ITS General Requirements” shall be met. All costs associated with the warranty requirements shall be included in the overall contract price.

907-655.03.5--Training. The minimum training requirements shall be as defined in the Notice to Bidders entitled “ITS General Requirements.”

907-655.04--Method of Measurement. The Highway Advisory Radio System will be measured in units of each.

The HAR Sign with Flashing Beacons of the type specified will be measured per each installation.

The HAR System Servers will be measured as a lump sum unit.

The HAR System Software will be measured as a lump sum unit.

The HAR Training will be measured as a lump sum unit.

907-655.05--Basis of Payment. Highway Advisory Radio System, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing, installing, FCC licensing application, coordination and acquisition, pager and cellular service activation and monthly billing costs (only during testing and where required), HAR antenna/grounding design submittal, system integration, all documentation and submittals, warranties, and testing of a complete HAR Subsystem and software including the HAR equipment/components as specified herein including the AM radio transmitter, digital recorder/player, global positioning system synchronizer, NOAA weather receiver, antenna mounting pole, antenna and grounding, power distribution/supply, battery backup system with recharging subsystem, surge protection, the cabinet, all cabling, connections to support structures (includes all incidental components, attachment hardware, mounting brackets, bolts, straps, or any other items to mount the HAR equipment / components as intended), all required software, and satisfactory completion of testing requirements and all work, equipment and appurtenances as required to effect the full operation including remote and local control of HAR sites complete in place and ready to use. It shall also include all labor, tools, materials, equipment and incidentals necessary to complete the work and quality assurance.

Progress payments for Highway Advisory Radio System shall be paid as follows:

- 1) 30% of the contract unit price upon approval of Pre-Installation test results;
- 2) An additional 40% of the contract unit price upon approval of Stand Alone Site Test results;
- 3) An additional 20% of the contract unit price upon approval of Conditional System Acceptance test results; and
- 4) Final 10% of the contract unit price upon Final System Acceptance.

HAR Sign with Flashing Beacons, measured as prescribed above, will be paid for at the contract unit price bid per each, which price shall be full compensation for designing, furnishing, installing, system integration, and testing of a complete HAR Sign with Flashing Beacons including the sign materials, sign supports, support foundations, flashing beacons, solar power system, controller, pager controller, cellular controller, and battery cabinets, cabling, connections and satisfactory completion of testing and training requirements and all work, equipment and appurtenances as required to effect the full operation including remote and local control of HAR Sign with Flashing Beacons sites complete in place and ready to use. The price bid shall also include system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams and other materials necessary to document the operation of the HAR with Flashing Beacons. This also includes all labor, all documentation and submittals, warranties, testing, tools, materials, equipment, and incidentals necessary to complete the work and quality assurance.

Progress payments for the HAR Sign with Flashing Beacons shall be paid as follows:

- 1) 30% of the contract unit price upon approval of the Pre-Installation test results;
- 2) An additional 40% of the contract unit price upon approval of Stand Alone Site Test results;
- 3) An additional 20% of the contract unit price upon approval of Conditional System Acceptance test results; and
- 4) Final 10% of the contract unit price upon Final System Acceptance.

The HAR System Servers, measured as prescribed above, will be paid at the contract lump sum price, which price shall be full compensation for furnishing, installing, system integration and testing of the servers. The price bid shall include all necessary servers at both the Regional TMC and Statewide TMC. This also includes all labor, all documentation and submittals, warranties, testing, tools, materials, equipment and incidentals necessary to complete the work and quality assurance.

Progress payments for the HAR Servers shall be paid as follows:

- 1) 30% of the contract unit price upon approval of Stand Alone Test;
- 2) An additional 60% of the contract unit price upon approval of Conditional System Acceptance test results; and
- 3) Final 10% of the contract unit price upon Final System Acceptance.

The HAR System Software, measured as prescribed above, will be paid at the contract unit price as a lump sum item. This price shall be full compensation for all labor, all

documentation and submittals, warranties, testing, tools, materials, equipment, quality assurance, and all incidentals necessary to complete the work.

Progress payments for the HAR Software shall be paid as follows:

- 1) 30% of the contract unit price upon approval of Stand Alone Test;
- 2) An additional 60% of the contract unit price upon approval of Conditional System Acceptance test results; and
- 3) Final 10% of the contract unit price upon Final System Acceptance.

Highway Advisory Radio System Training, measured as prescribed above, will be paid for at the contract unit lump sum price, which price shall be full compensation for all training costs including coordination, materials, labor, training location costs, and all incidentals required to complete the training as described in the Notice to Bidders entitled "ITS General Requirements."

Payment will be made under:

907-655-A: Highway Advisory Radio System	- per each
907-655-B: HAR Sign with Flashing Beacons *	- per each
907-655-C: HAR System Servers	- lump sum
907-655-D: HAR System Software	-lump sum
907-655-E: HAR System Training	- lump sum

* Additional description may be added