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STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

SUPPLEMENTAL SPECIFICATION 906
SPREAD SPECTRUM RADIO

October 15, 2010

906.01 Telemetry Radios. Provide a telemetry radio using an unlicensed frequency hopping spread spectrum in accordance with the following:

Item	Requirement
Frequency Band	902 – 928 Megahertz FCC Part 15 Spread Spectrum Band or 2.400 – 2.4835 Gigahertz FCC Part 15 Spread Spectrum Band. All radios shall be FCC approved.
Data Interface	RS232, Ethernet or both (or as required by the system)
Data Interface Rate	Standard band rates up to 19200 bytes/second, minimum or higher if required by the system
Latency	50 milliseconds maximum
Transmitting Power Output	1 watt maximum, adjustable
Transmitting Max Voltage Standing Wave Radio (VSWR)(No Damage)	Infinite, all phase angles
Receiving Sensitivity	Less than 10^6 at -110 decibels at 9600 bps, -92 db at 1 Mbps, -90 db for baud rates higher than 19,200
Operating Humidity	0 - 95% relative humidity non-condensing
Operating Temperature	- 30° to + 165° F (-34° to + 74° C) with full performance

Provide radios capable of avoiding interference using:

A. CSMA/CD, CA
B. CRC error checking with automatic retransmission (CRC with ARQ)
C. The ability to eliminate zones of the frequency band where excessive interference reduces communication reliability and throughput (a minimum of 8 zones is required).

Insure ethernet radios have a media access control mechanism so there are no data collisions when multiple remote radios attempt to communicate at the same time (report on exception).

Assure telemetry radios provide transparent communications between signal controllers. Install all radio equipment in the signal controller cabinets. Provide radio power supplies meeting all requirements of the radio manufacturer, including power, temperature and humidity. Provide all required interface cables and connectors with the radios.

The radio shall have the capability to monitor receiver signal strength and be programmable through a diagnostic/programming port. Provide configuration and diagnostic software. Provide hardware communication devices.

Furnish radios with 60-month warranties or for the manufacturer's standard warranty, whichever is greater. Ensure that the warranty period begins on the date of shipment to the project. Ensure that each radio has a permanent label or stamp indicating date of shipment.

906.02 Antenna System. Provide a manufacturer recommended antenna system consisting of the omnidirectional antenna or yagi directional antenna, antenna mounts, coaxial cable and surge and lightning protection.

Furnish antennas with 24-month warranties or for the manufacturer's standard warranty, whichever is greater.

A. Omnidirectional Antenna. Assure all omnidirectional antennas meet the following:

Item	Requirement
General Frequency Range	896 – 960 Megahertz
Gain	As required, 8 dbi minimum
Bandwidth at Rated VSWR	64 Megahertz, minimum
VSWR	<2:1
Polarization	Vertical
Maximum Power Input	50 watts, minimum
Connector	N Female
Antenna Housing	Fiberglass Radome
Radiating Element	Brass or Copper
Support Pipe	ASTM 6061-T6 Aluminum
Lightning Protection	Direct Ground
Rated Wind Velocity	100 mph (160 km/h), minimum

B. Yagi Directional Antenna. Assure all yagi directional antennas meet the following:

Item	Requirement
General Frequency Range	896 – 960 Megahertz
Gain	As required, 12 dbi minimum
Tilt Angle	As required
Bandwidth at Rated VSWR	60 Megahertz, minimum
VSWR	<2:1
Polarization	Vertical or Horizontal
Maximum Power Input	50 watts, minimum
Connector	N Female
Radiating Elements	Anodized Welded Aluminum Alloy

Lightning Protection	Direct Ground
Rated Wind Velocity	100 mph (60 km/h), minimum

C. Antenna Mounts. Provide rigid antenna mounts for the specified antenna that will withstand winds of up to 100 mph (160 km/h) minimum. Assure mounts and associated hardware are constructed of galvanized steel, aluminum or stainless steel.

D. RG-8/U Coaxial Cable. Assure all antenna cable is low loss, RG-8/U, Belden 9913 or equivalent coaxial cable in accordance with the requirements listed below. Provide Type N male connectors constructed of silver plated brass with a gold plated pin and soldered center connection.

Item	Requirement
Impedance	50 ohms, nominal
Attenuation @ 900 Megahertz	5.7 decibels/100 ft. (18.7 decibels/100 m), maximum
Overall Diameter	0.405 in. (10.3 mm), nominal
Shield/Outer Conductor	100% Foil Tape/Tinned Copper Braid with 85% minimum coverage
Inner Conductor	0.108 in. (2.62 mm) Copper
Dielectric	Foam Polyethylene
Outer Jacket	Black UV Resistant Polyethylene

E. Antenna Surge and Lightning Protection. Provide a lightning and surge arrestor for the coaxial cable in the controller cabinet. The arrestor shall be bulkhead-mounted or flange-mounted and shall be securely fastened to a grounded metal surface inside the cabinet. Assure the arrestor meets the following:

Item	Requirement
Throughput Energy	<250 µJ for 3kA, 8 x 20 µs waveform
Maximum Surge Current	≥ 5000A
Turn On Voltage	300 - 600 volts
Turn On Response	<5 nanoseconds
Connectors (Both Ends)	N Female
Housing	Aluminum or Stainless Steel
Hardware	Stainless Steel
VSWR	<1.2