

**SPECIFICATIONS FOR VDOT ELECTRONIC RFID MARKING**  
**AND GPS BASED UTILITY AS-BUILT**  
**MAPPING SYSTEM**

**I. TYPE 1 ELECTRONIC MARKER LOCATOR FOR LOCATE/READ/WRITE**

**General:**

The locator shall have the capability to write template data into the markers, locate the electronic markers, and read the template data from the electronic markers. Information such as a pre-programmed unique identification number, facility data, owner information, and application type from up to 100 markers shall be stored with date/time stamp, and transmitted back to the user's PC through a standard RS232 serial port. The necessary software shall be included with each electronic marker locator. The electronic marker locator shall include an optional carry bag.

The electronic marker locator shall have the capability of interfacing with handheld GPS devices. The electronic marker locator shall command the GPS/GIS device for real-time mapping of GPS coordinates and electronic marker template data.

**Specifications:**

<b>Operating temperature</b>	-20° C to 50° C (-4° F to 122° F)
<b>Storage temperature</b>	-20° C to 70° C (-4° F to 158° F)
<b>Marker compatibility</b>	All RFID markers (telephone, gas, communication, power, water, wastewater and general purpose)
<b>Dual marker mode</b>	Any two marker frequencies simultaneously
<b>Detection range</b>	Exceeds maximum marker depth specifications
<b>Marker read range</b>	(5 ft.) to all RFID ball markers, (3 ft.) to all RFID near surface markers (peg markers)
<b>Marker write range</b>	(1 ft.)
<b>RFID Marker depth measurement accuracy</b>	+/- 10% +/- 5 cm (2 in.) up to marker depth specifications
<b>Memory storage with date/time stamp</b>	Read marker records 100, Written marker records 100, User defined iD templates 32
<b>Marker depth memory storage</b>	Five with date/time stamp
<b>Power</b>	Battery type: eight AA size, alkaline Typical battery life: 25 hours
<b>Display</b>	Large graphic high-contrast LCD with backlight
<b>Speaker</b>	0.25W
<b>Headphone jack</b>	Standard mini-jack
<b>Serial port</b>	Standard RS232 serial with DB9 connector

## II. TYPE 2 LOCATOR FOR CABLE/PIPE/ELECTRONIC MARKER

The cable/pipe/electronic marker locator shall have the capability to locate, using the portable battery operated transmitter, all types of underground pipes and cables. The locator shall also have the capability to write template data into the markers, locate the electronic markers, and read the template data from the electronic markers. Information such as a pre-programmed unique identification number, facility data, owner information, and application type from up to 100 markers shall be stored with date/time stamp, and transmitted back to the user's PC through a standard RS232 serial port. The software shall be included with each electronic marker locator. The electronic cable/pipe/marker locator shall include an optional carry bag.

The cable/pipe/electronic marker locator shall have the capability of interfacing with handheld GPS devices. The cable/pipe/electronic marker locator interface shall command the GPS/GIS device for real-time mapping of GPS coordinates and electronic marker template data.

### Electrical Specifications:

#### Receiver:

Frequencies: Trace and tone modes, Active: 577Hz, 8kHz, 33kHz, and 200kHz  
Passive power: 50L, 50H, 100, 60L, 60H, 120  
Passive (other): CATV 31.5kHz (LF 9-30 kHz)

Auxiliary: 560, 512, 460, 400, 393, 340, 333, 273Hz

User defined: up to four frequencies (50~999Hz)

Display resolution 0.1 dB

Depth display range 9 m (0 to 30 ft.)

Depth units cm, inch, ft.- in.

Depth accuracy\* +/- 2% +/- 5 cm (3 in.) 1,5 m (0 to 60 in.)

+/- 6% +/- 5 cm (3 in.) 1,5 to 3 m (61 to 120 in.)

+/- 10% +/- 5 cm (3 in.) 3 to 4,5 m (121 to 180 in.)

Cable current display 0.1 dB resolution or 0.01 mA resolution, Units: dB and mA

Power Battery type: Eight AA size, alkaline

Typical battery life: 30 hours - M-iD units

#### Transmitter:

Output frequencies:

Trace mode 577Hz, 8kHz, 33kHz, 200kHz

Tone mode 577Hz and 200kHz pulsed at 8Hz

Induction mode 33kHz, 200kHz

Tone Normal setting: 10 Vrms, high setting: 60 Vrms

Output power Normal setting: Limited to 0.5W  
High setting: Limited to 3W, or 5W with external DC power  
Output protection 240 Vrms  
Power Battery type: Six C size, alkaline (LR14) cells;  
External DC: 9-18V DC (1A) (5-watt units  
only) Typical battery life Normal output level: 50 hours  
High output level: 10  
hours

\*Note: Locators are tested in model field conditions with no adjacent signals. Actual operating conditions may result in decreased depth accuracy due to outside signal

<b>Operating temperature</b>	-20° C to 50° C (-4° F to 122° F)
<b>Storage temperature</b>	-20° C to 70° C (-4° F to 158° F)
<b>Marker compatibility</b>	All RFID markers (telephone, gas, communication, power, water, wastewater and general purpose)
<b>Dual marker mode</b>	Any two marker frequencies simultaneously
<b>Detection range</b>	Exceeds maximum marker depth specifications
<b>Marker read range</b>	(5 ft.) to all RFID ball markers, (3 ft.) to all RFID near surface markers (peg markers)
<b>Marker write range</b>	(1 ft.)
<b>RFiD Marker depth measurement accuracy</b>	+/- 10% +/- 5 cm (2 in.) up to marker depth specifications
<b>Memory storage with date/time stamp records</b>	Read marker records 100, Written marker records 100, User defined iD templates 32
<b>Marker depth memory storage</b>	Five with date/time stamp
<b>Power</b>	Battery type: eight AA size, alkaline Typical battery life: 25 hours
<b>Display</b>	Large graphic high-contrast LCD with backlight
<b>Speaker</b>	0.25W
<b>Headphone jack</b>	Standard mini-jack
<b>Serial port</b>	Standard RS232 serial with DB9 connector

### III. ELECTRONIC RFID MARKERS

#### MARKER BALLS/NEAR SURFACE PENDANTS:

General: The electronic markers shall be RFID "Programmable" markers. The markers shall be the 4" round ball type, 5ft depth for read/locate/depth or the near surface marker pendant type, 3ft depth for read/locate/depth.

#### Marker Types/Frequencies:

RFiD Ball Marker Telecommunications (orange) , 101.4khz to be used for copper and fiber optic cable systems that connect to the telephone facilities

RFiD Ball Marker Power (red), 169.8khz to be used for all electrical power systems

RFiD Ball Marker Water (blue), 145.7khz to be used for all water mains and services as well

as all appurtenances

RFiD Ball Marker Wastewater (green), 121.6khz to be used for all mains and services.

RFiD Ball Marker Gas (yellow), 83khz to be used for natural gas and liquefied petroleum mains and services.

RFiD Ball Marker Cable TV and communications (black/orange), 77khz to be used for copper and fiber optic cable systems that are independent communications system.

RFiD Ball Marker General purpose and reclaimed water (purple), 66.35khz to be used to identify abandoned facilities and signs as well as other underground and/or above ground facilities that are to be mapped or inventoried.

RFiD Near Surface Peg Marker, Telecommunications (orange), 101.4khz

RFiD Near Surface Peg Marker, Power (red), 169.8khz

RFiD Near Surface Peg Marker, Water (blue), 145.7khz

RFiD Near Surface Peg Marker, Wastewater (green), 121.6khz

RFiD Near Surface Peg Marker, Gas (yellow), 83khz

RFiD Near Surface Peg Marker, Cable TV and communications (black/orange), 77khz

RFiD Near Surface Peg Marker, General purpose and reclaimed water (purple), 66.35khz

The uses of the specific near surface marker pendants shall be the same as the ball markers. The near surface markers are to be used to record the horizontal and vertical location of facilities that are installed by the use of a directional drill or case boring operations

**Packaging:**

Marker balls shall come packaged

30/box.

Marker pendants shall come purchased

50/box.

**Installation:**

The RFID markers are placed at 25' increments, when there is a horizontal/vertical line change, change in pipe size or number of conduits. They will also be placed at crossings of existing utilities, ends of casings, specified fittings and as determined by the Engineer. The ball markers will be placed during the backfill operation of the facility with a 3' minimum cover for roadway applications and a 5' maximum depth; near surface markers are placed at the end of every other rod length for directional drilling operations with a minimum depth of 1' in non-roadway applications and a maximum depth of 3' in roadway crossings. During the test pitting for the directional drilling operation, ball markers will be placed on the existing utility crossings. Ball/near surface markers will be placed on conduit sweeps at 10' increments which is the minimum spacing for all types of markers of the same frequency.

The frequency of the RFID Marker is based upon the specific utility that is being installed as identified in Section III.

The information that is programmed into the RFID attribute of the ball or near surface marker will be established and agreed upon by the specific Utility Company and/or the Department prior to installation.

#### IV. HANDHELD GPS DEVICES:

The contractor shall use a handheld GPS device to provide a data base of electronic markers and matched GPS coordinates of each marker with sub-foot accuracy. The handheld GPS devices shall have integrated software to facilitate mapping the marker template information in DGN for as an overlay to the MicroStation Plans, ESRI Shape Files for ARCGIS, KML using Google Earth/Map as the base mapping then copied as a PDF format or other as required by the Engineer. This electronic as- built information will be provided to the Department within 10 days of the completion and acceptance of the utility system. The handheld GPS devices shall include the components as required.

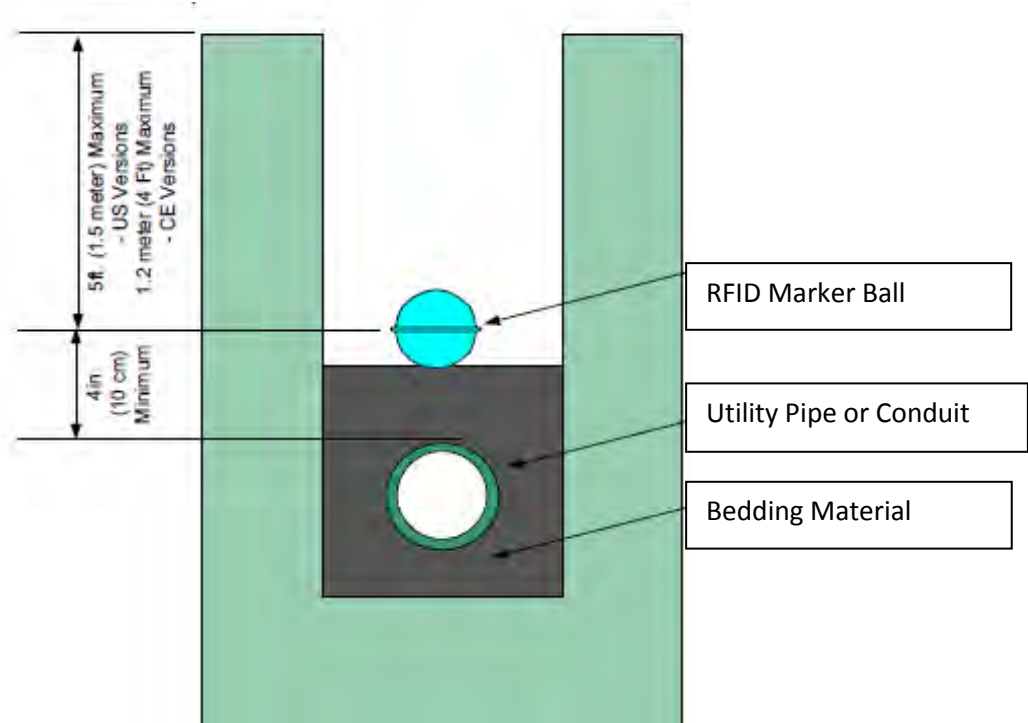
#### V. CENTRAL MAPPING SOFTWARE:

A Central Mapping Software shall be used by the Department to import data from the handheld GPS devices that contains data collected from the field operations. The specific software and format will be determined by the Engineer.

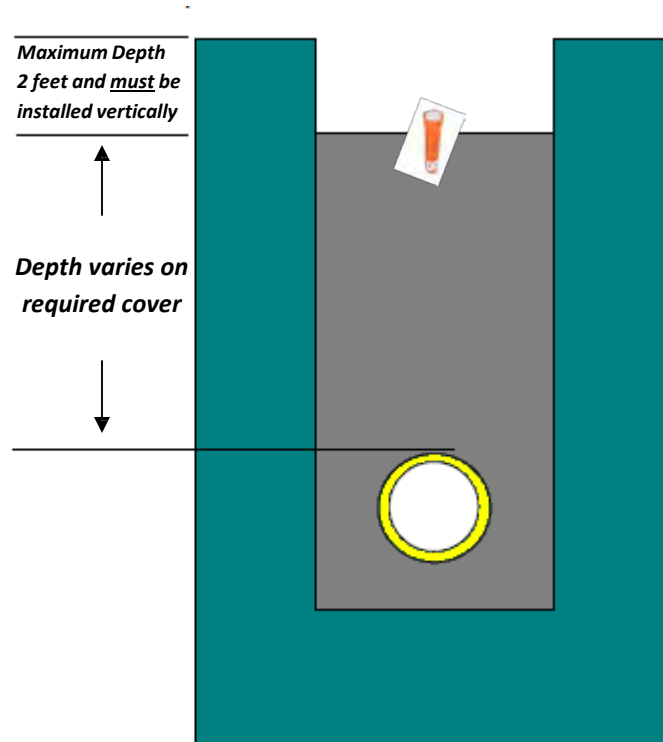
#### VI. DETAIL CUT SHEETS FOR RFID MARKER BALLS AND NEAR SURFACE PENDANTS

Electronic Marking System			
<b>Near Surface</b> • 2 ft depth  RFID Option	<b>Ball Marker</b> • 5 ft depth  RFID Option	<b>Disk Marker</b> • 5 ft depth  RFID Option	<b>Vault Marker</b> • 5 ft depth 
<b>Duct Marker</b> • 2 ft depth 	<b>Mid Range</b> • 6 ft depth 	<b>Full Range</b> • 8 ft depth  RFID Option	

## RFID Marker Ball



## Near Surface Marker



VIRGINIA DEPARTMENT OF TRANSPORTATION  
SPECIAL PROVISION FOR

**INTELLIGENT TRANSPORTATION SYSTEM (ITS) – CONDUIT**

**1.01 Description**

This work shall consist of furnishing and installing intelligent transportation systems (ITS) conduit in accordance with these special provisions and as shown on the plans or as directed by the Engineer.

**1.02 Materials**

Furnish and install ITS conduit in accordance with these special provisions. ITS Conduit shall be Polyethylene (PE) meeting the applicable requirements of Section 238 for PE conduit, as amended below.

**(a) Conduit**

- PE conduits shall be SDR 11 meeting ASTM D 3035 standards.
- Provide one (1) 1 ¼" orange and one (1) 1 ¼" white conduit for fiber optic/ITS communications cable installations, where shown in the Plans.
- Power conduits shall be grey. Size power conduits in accordance with NEC requirements for conductors to be used.
- The conduit shall include all required fittings and incidentals necessary to construct a complete installation.

**(b) Utility RFID Marker Balls and Pendants**

- Utility ball markers shall conform to APWA uniform color coding for marking underground utility lines and industry standard frequency for detection. Communications (orange) 101.4 khz; Power (red) 169.8 khz
- Marker balls shall be able to be detected at a depth of 5' below grade and shall be between 4" to 4.5" in diameter. Pendant Markers shall be detectable at a depth of 2' below grade and 3 to 4" in length.
- Marker balls and pendants shall have a passive antenna circuit and therefore not need an internal power source to be functional.
- Markers and pendants shall be a polyethylene, weather resistant enclosure, or an approved equivalent.
- Marker and pendants will be preprogrammed by the Department prior to the installation by the Contractor.

**1.03 Construction Methods:**

**(a) Fiber/ITS Conduit Installation Requirements**

PE conduit shall be installed in continuous unspliced runs between enclosures/junction boxes, unless otherwise approved by the Engineer. The



installation of the fiber optic backbone conduit shall be placed in front of the tree line as far from the travel lane as possible (while trying to maintain a straight run) and outside of any ditches or retention areas. A minimum distance of 10' shall be maintained from the edge of pavement unless otherwise approved by the Engineer. Install conduit a minimum of 30 inches below grade, except where bedrock is encountered whereby an installation depth of at least 18" may be permitted with the Engineer's approval. All conduit installations shall be within the existing right of way.

Exclude water and debris from entering conduit riser above ground during construction by sealing conduit with tape or any other approved protective measure.

Conduits for power can be run in the same trench line or bore as for the fiber optic / ITS communication conduits, but the power conduits must be run into separate junction boxes/vaults from the fiber optic / ITS communication conduit.

The conduit system shall allow the fiber optic cable to maintain the minimum bend radius after installation.

Fiber shall be installed in the orange conduit and tone wire shall be installed in the white spare conduit.

Install pull tape in all conduits.

PE conduit may be installed by trenching, plowing, boring, and/or as indicated on the plans. Submit a conduit installation plan to the Engineer for approval prior to the start of construction that details where each of the three installation methods will be used. Conduits shall be installed by boring for any locations where the conduit shall cross existing pavement or other existing facilities unless otherwise approved by the Engineer.

Conduit shall terminate horizontally into pull boxes at a maximum depth of 18 inches. All conduit terminations in pull boxes junction boxes, cabinets, etc. shall be sealed using a method and materials approved by the Engineer.

**(b) RFID Marker Ball/Peg Installation Requirements**

Locator tape shall be installed 6 to 8" below finished grade.

RFID Markers balls shall be placed in open trench operations below the locator tape, 12" below finished grade. RFID Marker Pendants shall be placed in pilot holes 18" below finished grade and above the conduits that are installed by directional drilling operations

Orange RFID Markers shall be used to mark communication and telephone for ITS/fiber conduits.

Red RFID Markers shall be used to mark power conduits when run in a separate trench and in joint trench applications for ITS electrical distribution systems.

RFID Marker balls shall be placed every 50' in instances where minimum utility conflict is involved and where route deviation is minimal.

The standard placement of the RFID Marker Balls is at 25' increments for open trench operations. RFID Near Surface Pendants are to be installed in pilot holes above the conduits at 20' increments or at every other rod length with directional boring applications. In areas where conduit routing significantly changes and higher utility conflicts are involved such as traffic intersections and interchanges, marker balls shall be placed every 25' unless directed by the Engineer.

RFID Marker balls shall be placed at every change in direction of the conduit/cable and with 5' offsets to boxes and vaults. RFID Near Surface Pendants can be substituted for RFID Marker Balls when approved by the Engineer.

There shall be a minimum of two marker balls per each utility trench.

(c) **GPS Mapping**

The contractor shall use a handheld GPS device to provide a data base of electronic markers and matched GPS coordinates of each RFID Marker with sub-foot accuracy. The handheld GPS devices shall have integrated software to facilitate mapping the marker template information in DGN format as an overlay to the MicroStation Plans, ESRI Shape Files for ARCGIS and KML using Google Earth/Map as the base mapping then copied as a PDF format or other as required by the Engineer. This electronic as-built information will be provided to the Department within 10 days of the completion and acceptance of the utility system. The handheld GPS devices shall include the components as required.

**1.04 Testing:**

After installation of conduits and upon completion of tamping and backfilling, perform a mandrel test on each conduit to ensure no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit between junction boxes/enclosures. Ensure pull tape, locator tape, and marker balls are re-installed.

**1.05 Measurement and Payment:**

**ITS Conduit (Material / Size)** will be measured in linear feet and will be paid for at the contract unit price per linear foot. The price shall include installation of both orange and white conduit, trenching, plowing, backfilling, restoration materials, conduit bodies, fittings, bonding systems, pull ropes, duct plugs, warning tape, marker balls, marker pendants, as-built map, pull tapes, plastic spacers, tone wire when required, pull or splice boxes with an area of 512 cubic inches or less, supports, and protective metal shields. For installations by directional boring, the unit price per foot of directional bore shall be paid for separately in accordance with standard pay items and specifications. Conduit for power will be incidental to the contract and will not be paid separately.

Payment will be made under:

**Pay Item**  
**ITS Conduit (HDPE / 1 1/4")**

**Pay Unit**  
**Linear Feet**