

**GROUNDING AND BONDING**

THE REQUIREMENTS OF THE CONSTRUCTION AND MATERIAL SPECIFICATIONS (C&MS) AND THE HL AND TC SERIES OF STANDARD CONSTRUCTION DRAWINGS ARE MODIFIED AS FOLLOWS:

1. ALL METALLIC PARTS CONTAINING ELECTRICAL CONDUCTORS SHALL BE PERMANENTLY JOINED TO FORM AN EFFECTIVE GROUND FAULT CURRENT PATH BACK TO THE GROUNDED CONDUCTOR IN THE POWER SERVICE DISCONNECT SWITCH.
  - A. PROVIDE AN EQUIPMENT GROUNDING CONDUCTOR IN METALLIC CONDUITS (725.04) IN ADDITION TO THE CONDUCTORS SPECIFIED AND BOND THE CONDUIT TO THIS GROUNDING CONDUCTOR.
  - B. WHEN AN EQUIPMENT GROUNDING CONDUCTOR IS REQUIRED IN PLASTIC CONDUIT (725.05), THE INSTALLATION SHALL INCLUDE A SEPARATE EQUIPMENT GROUNDING CONDUCTOR IN ADDITION TO THE CONDUCTORS SPECIFIED.
  - C. METALLIC CONDUIT CARRYING THE LOOP WIRES FROM IN THE PAVEMENT TO THE PULL BOX SPLICE LOCATION WILL ONLY BE BONDED AT THE PULL BOX END, AND WILL NOT CONTAIN AN EQUIPMENT GROUNDING CONDUCTOR.
  - D. METAL PULL BOX LIDS SHALL BE BONDED BY ATTACHMENT OF THE EQUIPMENT GROUNDING CONDUCTOR TO THE FRAME DIAGONAL AS PROVIDED ON HL-30.11.
  - E. IF MULTIPLE CONDUIT RUNS BEGIN AND END AT THE SAME POINTS, ONLY ONE EQUIPMENT GROUNDING CONDUCTOR IS REQUIRED.
  - F. IF AN EQUIPMENT GROUNDING CONDUCTOR IS NEEDED IN CONDUIT BETWEEN SIGNALIZED INTERSECTIONS FOR UNDERGROUND INTERCONNECT CABLE, THE GROUNDING SYSTEM FOR EACH SIGNALIZED INTERSECTION WILL BE SEPARATED ABOUT MIDWAY BETWEEN THE INTERSECTIONS.
  - G. THE MESSENGER WIRE AT SIGNALIZED INTERSECTIONS WILL BE USED AS THE CONDUCTIVE PATH FROM CORNER TO CORNER IF CONDUIT IS NOT PROVIDED UNDER THE ROADWAY. WHEN CONDUIT CONNECTS THE CORNERS OF AN INTERSECTION, AN EQUIPMENT GROUNDING CONDUCTOR SHALL BE USED IN THE CONDUIT.
2. CONDUITS.
  - A. THE 725.04 CONDUIT SHALL HAVE GROUNDING BUSHINGS INSTALLED AT ALL TERMINATION POINTS. THE BUSHING MATERIAL SHALL BE COMPATIBLE WITH GALVANIZED STEEL CONDUIT AND THE GROUNDING LUG MATERIAL SHALL BE COMPATIBLE FOR USE WITH COPPER WIRE. THREADED OR COMPRESSION TYPE BUSHINGS MAY BE USED.
  - B. THE 725.05 CONDUIT SHALL HAVE THE INSIDE AND OUTSIDE DIAMETERS OF THE CONDUIT DEBURRED AT ALL TERMINATION POINTS.
  - C. BOTH ENDS OF METALLIC CONDUIT SHALL BE BONDED TO THE EQUIPMENT GROUNDING CONDUCTOR.
  - D. METALLIC CONDUIT MAY BE BONDED TO METALLIC BOXES THROUGH THE USE OF CONDUIT FITTINGS UL APPROVED FOR THIS TYPE OF CONNECTION, WITH THE BOX BONDED TO THE EQUIPMENT GROUNDING CONDUCTOR.
3. WIRE FOR GROUNDING AND BONDING.
  - A. USE INSULATED, COPPER WIRE FOR THE EQUIPMENT GROUNDING CONDUCTOR. BONDING JUMPERS IN BOXES AND ENCLOSURES MAY BE BARE OR INSULATED COPPER WIRE. WIRE SIZE SHALL BE AS FOLLOWS:
    - I. USE 4 AWG BETWEEN THE POWER SERVICE AND SUPPORTS, POLES, PEDESTALS, CONTROLLER OR FLASHER CABINETS.
    - II. USE A MINIMUM 8 AWG BETWEEN LOOP DETECTOR PULL BOXES AND THE FIRST CONDUIT THAT REQUIRES A LARGER SIZE AS SPECIFIED IN 3.A.I ABOVE.
    - III. USE A MINIMUM 8 AWG BETWEEN THE "PREPARE TO STOP WHEN FLASHING" INSTALLATION (INCLUDING SUPPORT) AND THE FIRST CONDUIT THAT REQUIRES

- IV. THE INSULATION SHALL BE GREEN OR GREEN WITH YELLOW STRIPE(S). FOR 4 AWG OR LARGER, INSULATION MAY ALSO BE BLACK WITH GREEN TAPE/ LABELS INSTALLED AT ALL ACCESS POINTS.
- B. IN A HIGHWAY LIGHTING SYSTEM, THE EQUIPMENT GROUNDING CONDUCTOR SHALL BE THE SAME WIRE SIZE AS THE DUCT CABLE OR DISTRIBUTION CABLE CIRCUIT CONDUCTORS, WITH THE MINIMUM CONDUCTOR SIZE OF 4 AWG. BONDING JUMPERS WILL BE MINIMUM SIZE 4 AWG.
4. GROUND ROD.
  - A. A 3/4 INCH SCHEDULE 40 PVC CONDUIT WILL BE USED IN FOUNDATIONS AND CONCRETE WALLS FOR THE GROUNDING CONDUCTOR (GROUND WIRE) RACEWAY TO THE GROUND ROD. SHOULD METALLIC CONDUIT BE USED, BOTH ENDS OF THE CONDUIT SHALL BE BONDED TO THE GROUNDING CONDUCTOR.
  - B. THE TYPICAL GROUNDING CONDUCTOR (GROUND WIRE) SHALL BE 4 AWG INSULATED, COPPER.
5. THE GREEN CONDUCTOR IN SIGNAL CABLES (CONDUCTOR #4) SHALL NOT BE USED TO SUPPLY POWER TO A SIGNAL INDICATION. IT WILL BE CONNECTED TO THE SIGNAL BODY AS AN EQUIPMENT GROUND IN ALUMINUM HEADS AND IT WILL BE UNUSED IN PLASTIC HEADS. UNUSED CONDUCTORS SHALL BE GROUNDED IN THE CABINET. TYPICAL USE OF CONDUCTORS IS AS FOLLOWS:
 

COND. NO.	COLOR	VEHICLE SIGNAL	PEDESTRIAN SIGNAL
1	BLACK	GREEN BALL	#1 WALK
2	WHITE	AC NEUTRAL	AC NEUTRAL
3	RED	RED BALL	#1 DW/FDW
4	GREEN	EQUIPMENT GROUND	EQUIPMENT GROUND
5	ORANGE	YELLOW BALL	#2 DW/FDW
6	BLUE	GREEN ARROW	#2 WALK
7	WHITE/BLACK STRIPE	YELLOW ARROW	NOT USED
6. POWER SERVICE AND DISCONNECT SWITCH.
  - A. AT THE POWER SERVICE LOCATION, THE GROUNDING CONDUCTOR (GROUND WIRE) FROM THE DISCONNECT SWITCH NEUTRAL (AC-) BAR TO THE GROUND ROD SHALL BE A CONTINUOUS, UNSPLICED CONDUCTOR. IF SPLICED, IT SHALL BE AN EXOTHERMIC WELD BUTT SPICE.
  - B. THE SERVICE NEUTRAL (AC-) SHALL ONLY BE CONNECTED TO GROUND AT THE PRIMARY POWER SERVICE DISCONNECT SWITCH.
    - I. NEMA CONTROLLER CABINETS: IF A POWER SERVICE DISCONNECT SWITCH IS LOCATED BEFORE THE CONTROLLER CABINET, THE NEUTRAL (AC-) AND THE GROUNDING BARS IN THE CONTROLLER CABINET SHALL NOT BE CONNECTED TOGETHER AS SHOWN IN NEMA TS-2, FIGURE 5-4.
    - II. IF SECONDARY DISCONNECT SWITCHES ARE CONNECTED AFTER THE PRIMARY DISCONNECT SWITCH, THE NEUTRAL (AC-) SHALL ONLY BE GROUNDED AT THE PRIMARY SWITCH. EQUIPMENT GROUNDING CONDUCTORS SHALL BE BROUGHT TO THE PRIMARY SWITCH, BUT SHALL BE GROUNDED AT BOTH SECONDARY AND PRIMARY SWITCHES.
7. STRUCTURE GROUNDING: HL-50.21 SHOWS A 1/0 AWG STRANDED COPPER CABLE USED FOR STRUCTURE GROUNDING. ADDITIONALLY, THIS SAME CABLE SHALL BE INSULATED AND ANY CONNECTIONS AND BARE COPPER STRANDS EXPOSED TO CONCRETE SHALL BE COVERED WITH MASTIC TO PREVENT CONTACT WITH THE CONCRETE.
8. PAYMENT.

- A. ALL MATERIALS AND WORK REQUIRED TO COMPLETE THE EFFECTIVE GROUND FAULT CURRENT PATH SYSTEM ARE INCIDENTAL TO THE CONDUCTORS INSTALLED BY CONTRACT.
- B. WORK ON BRIDGES MAY BE INCLUDED IN THE BID ITEM FOR "ITEM 625, STRUCTURE GROUNDING."
- C. IN A 3-WIRE HIGHWAY LIGHTING SYSTEM, THE THIRD CONDUCTOR OF THE DUCT CABLE OR DISTRIBUTION CABLE WILL BE USED AS THE EQUIPMENT GROUNDING CONDUCTOR AND MAY AS SUCH BE PART OF THE CABLE BID ITEM.

**816, VIDEO DETECTION SYSTEM, AS PER PLAN**

IN ADDITION TO THE REQUIREMENTS OF SUPPLEMENTAL SPECIFICATION 816, THIS ITEM OF WORK SHALL CONSIST OF FURNISHING AND INSTALLING A VIDEO DETECTION SYSTEM CAPABLE OF PROVIDING TRAFFIC RESPONSIVE ACTUATION TO A TRAFFIC SIGNAL CONTROLLER. THE VIDEO DETECTION SYSTEM MUST PROVIDE THE NECESSARY DATA TO ALLOW THE SIGNAL SYSTEM TO OPERATE AS SHOWN IN THE PLANS.

PAYMENT SHALL BE MADE AT THE CONTRACT UNIT ITEM PRICE FOR EACH COMPLETE AND IN PLACE INTERSECTION INCLUDING ALL CONNECTIONS TESTED AND ACCEPTED.

THE DETECTORS SHALL INCLUDE PRESENCE/PASSAGE DETECTION OF MOVING AND STOPPED VEHICLES AND SHALL ENABLE DETECTION BASED ON THE DIRECTION OF TRAVEL OR BASED ON WHEN A MOVING VEHICLE STOPS.

THE CAMERA MUST INCLUDE A HEATER TO PREVENT THE FORMATION OF ICE AND CONDENSATION IN COLD WEATHER. THE HEATER SHALL NOT INTERFERE WITH THE OPERATION OF THE IMAGE SENSOR ELECTRONICS, AND IT SHALL NOT CAUSE INTERFERENCE WITH THE VIDEO SIGNAL.

THE VIDEO DETECTION SYSTEM SHALL BE WARRANTED BY ITS SUPPLIER FOR A MINIMUM OF TWO YEARS. ONGOING SOFTWARE SUPPORT BY THE SUPPLIER SHALL INCLUDE UPDATES OF THE SENSOR AND APPLICATIONS SOFTWARE. THESE UPDATES SHALL BE PROVIDED FREE OF CHARGE DURING THE WARRANTY PERIOD.

CONSTRUCTION - LOCATE AND MOUNT DETECTOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE SUFFICIENT NUMBER OF VIDEO CAMERAS TO PROCESS VEHICLE PRESENCE, PASSAGE, AND SYSTEM DETECTOR ZONES FOR A SINGLE INTERSECTION AS INDICATED IN THE PLANS. RELOCATION OF DETECTORS, ADDITIONAL JUNCTION BOXES, CONDUIT, AND CABLE NEEDED TO DETECT PULSE, PASSAGE AND SYSTEM DETECTION ZONES ARE INCIDENTAL TO THE COST OF THE PROJECT.

THE VIDEO DETECTION EQUIPMENT SHALL BE MANUFACTURED BY ECONOLITE CONTROL PRODUCTS, ITERIS, QUIXOTE TRAFFIC CORPORATION OR APPROVED EQUAL.

THE EXTERNAL INTERFACES TO THE SENSOR SHALL INCLUDE: A NETWORK COMMUNICATIONS PORT FOR SETUP, CONFIGURATION, AND COMMUNICATIONS; A DETECTOR PORT SPECIFICALLY TO EXCHANGE REAL TIME DETECTOR DATA WITH A DETECTOR INTERFACE CARD; DIFFERENTIAL COLOR VIDEO OUT; AND 24 VAC/DC POWER TO OPERATE THE SENSOR.

THERE SHALL BE A FIELD NETWORK COMMUNICATIONS PORT TO CONFIGURE AND PROVIDE GENERAL COMMUNICATIONS AND DATA RETRIEVAL. THE SENSOR SHALL USE A FULL OR HALF DUPLEX, RS-485, 4-WIRE ELECTRICAL NETWORK TO FACILITATE COMMUNICATIONS TO A LOCAL WINDOWS COMPUTER RUNNING THE COMMUNICATIONS SERVER. THIS PORT SHALL BE USED TO UPDATE THE EMBEDDED SOFTWARE WITH A NEW SOFTWARE RELEASE AND TO INTERACT WITH APPLICATIONS SOFTWARE FOR

ALL THE VARIOUS DETECTION REQUESTS SUPPORTED BY THE SENSOR. EACH SENSOR SHALL BE IP ADDRESSABLE USING THE UDP/IP MESSAGE PACKET AND ROUTING STANDARD.

THE SENSOR DETECTOR PORT SHALL USE A DEDICATED, RS-485 2-WIRE, HALF-DUPLEX INTERFACE BETWEEN THE SENSOR AND AN OPTIONAL DETECTOR INTERFACE CARD ALSO KNOWN AS A DETECTOR PORT MASTER (DPM). THE REAL-TIME STATE OF TRAFFIC CONTROLLER PHASE INPUTS SHALL BE TRANSMITTED TO THE SENSOR. THE DETECTOR PORT MASTER INTERFACE CARD SHALL SUBSEQUENTLY TRANSLATE THE DETECTION STATES, IN AN ELECTRICALLY COMPATIBLE MANNER, TO A TRAFFIC SIGNAL CONTROLLER.

A COMMUNICATIONS INTERFACE PANEL SHALL BE PROVIDED WITH EACH SENSOR FOR INSTALLATION. THE COMMUNICATIONS INTERFACE PANEL SHALL PROVIDE A TERMINAL BLOCK FOR TERMINATING POWER (THREE WIRES), AS WELL AS TERMINATIONS FOR TWO, TWISTED-PAIR WIRES FOR NETWORK COMMUNICATIONS TO THE SENSOR. THE PANEL SHALL ALSO PROVIDE TERMINATIONS FOR ONE, TWISTED-PAIR WIRE FOR DETECTOR PORT COMMUNICATIONS FROM THE SENSOR. THERE SHALL ALSO BE TWO SETS OF TERMINATIONS FOR TWO, TWISTED-PAIR WIRES FOR A POINT-TO-POINT FIELD NETWORK, ONE UPSTREAM TOWARD THE CENTRAL SYSTEM AND ONE DOWNSTREAM TOWARDS MORE FIELD EQUIPMENT. THE COMMUNICATIONS INTERFACE PANEL SHALL ALSO PROVIDE TRANSIENT PROTECTION FROM ALL COMMUNICATION AND VIDEO TERMINATIONS, A DB9 CONNECTOR FOR NETWORK COMMUNICATIONS WITH THE SENSOR, AND A DB9 CONNECTOR FOR AN OPTIONAL TRAFFIC SIGNAL CONTROLLER INTERFACE CARD/DETECTOR PORT MASTER.

THE SYSTEM SHALL USE A DEFINED COMMUNICATION PROTOCOL (DETECTOR PORT PROTOCOL) BETWEEN THE SENSORS AND THE MINI-HUB, OR TS2 MINI-HUB. THE PROTOCOL SHALL BE USED TO COMMUNICATE TSI INPUT PINS, TSI OUTPUT PINS, TSI DETECTOR STATES, AND TS2 PHASE STATES.

THE DETECTOR INTERFACE CARD SHALL BE THE MASTER OF THE DETECTOR PORT (DPM) AND THE SENSORS SHALL BE THE NODES. THE DPM SHALL USE A COMMAND FOR A SINGLE OR UP TO EIGHT (8) SENSORS TO RESPOND. THE DPM SHALL POLL FOR THE CURRENT STATE OF DETECTORS OR FOR CHANGES TO THESE DETECTORS SINCE THE LAST POLL. EACH POLL REQUEST SENT BY THE DPM SHALL CONTAIN THE STATE OF THE INPUTS. DEPENDING ON THE TYPE OF INFORMATION REQUESTED BY THE DPM, THE SENSOR SHALL SEND EITHER THE CURRENT STATE OF ALL DETECTORS OR ANY TIME-STAMPED CHANGES THAT HAVE OCCURRED IN ANY OF THE DETECTORS SINCE THE LAST POLL.

ALL ITEMS NECESSARY TO PROVIDE A COMPLETE VIDEO DETECTION SYSTEM FOR ALL APPROACHES AT EACH INTERSECTION SHALL BE INCLUDED IN THE PAY ITEM. PAYMENT SHALL BE MADE AT THE CONTRACT UNIT PRICE FOR EACH ITEM 632 - SIGNALIZATION MISC.: VIDEO DETECTION SYSTEM IN PLACE AND FULLY OPERATIONAL AS SHOWN IN THE PLANS FOR EACH INTERSECTION.

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**TRAFFIC CONTROL GENERAL NOTES**

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