

Chapter Ten
PLAN PREPARATION (Electrical)

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Chapter Ten

PLAN PREPARATION (Electrical)

[Chapter Three](#) in Part I addresses issues applicable to all design units involved in the preparation of construction plans, including information on sheet sizes, drafting guidelines, computerized design, etc. Chapter Ten presents guidelines that are specific to the preparation of electrical plans (e.g., traffic signal and highway lighting projects).

10.1 GENERAL GUIDELINES

10.1.1 Example Electrical Plans

When developing a set of construction plans, it is often useful to review an example set. [Part VII “Miscellaneous”](#) provides a typical set of construction plans including electrical detail and plan sheets.

10.1.2 CADD Files for Electrical Plans

10.1.2.1 File Management

When a project is initiated, a file directory is created on the MDT computer system and named using the uniform project control number assigned to the project by the Engineering Management Unit. For organizational purposes, separate subdirectories are created under the project directory for the respective files of each design unit involved in the project. The [MDT CADD Standards Manual](#) provides the subdirectory names that are used for each of the Department Units.

10.1.2.2 File Naming Convention

Refer to [MDT CADD Standards Manual](#) for file naming conventions.

10.1.2.3 File Creation and Initialization

Use the following CADD files to create any working CADD file that will be used to develop electrical sheets:

1. MTSTD:PLANE.REF (US Customary), and
2. MTRDSTD:PLANM.REF and MTSISTD:MTRAFPL.DGN (Metric).

These files contain prototype electrical sheets for 1" = 100' (1:1000) drawing scales. See [Section 10.1.4.1](#) for additional information on drawing scales. The prototype sheets contain information common to all sheets including:

1. standard sheet border and margins,
2. MDT logo, and
3. Project, Revision and Title Blocks.

The Project, Revision and Title Blocks should be placed on electrical sheets. Information for the Project, Revision and Title Blocks are obtained by turning on the proper level depending if it is a metric project or US Customary design.

See [Section 10.1.2.6](#) for information on how to obtain the needed CADD files.

10.1.2.4 MDT Electrical Detail Drawings

The Electrical Unit maintains a file of several ready-to-use sheets that are typically inserted in construction plans. These sheets represent the MDT electrical detail drawings and are contained in the CADD reference file:

1. 9999ELDETENG.DGN – US Customary, and
2. 9999ELDETMET.DGN – Metric.

Each sheet is indexed in the reference file by its view name. The view name is used to select, reference and/or copy a particular detail sheet into the working CADD file. Detail drawings will be placed on:

1. Level "P_DETAIL_DRAWINGS" – US Customary, and
2. Level 11 – Metric.

Other levels exist in order to control features in the drawings. For example, in the detail drawings for "Type 1 Signal Standards," one of the two types of pedestrian heads can be selected by switching the appropriate levels on and off.

See the [MDT CADD Standards Manual](#) for additional guidance on the CADD level symbology used by the Electrical Unit. See [Section 10.1.2.6](#) for information on how to obtain the detailed drawings files.

10.1.2.5 Frequently Used Drawing Elements

The Electrical Unit maintains a file of many ready-to-use drawing elements (e.g., symbols, frames, diagrams, details) that are frequently used in the preparation of electrical detail and plan sheets. These drawing elements are contained in the CADD cell library file ELECTRICALENG.CEL (ELECTRICALENG.CEL – Metric). Most of the drawing elements contained in this file are common from sheet to sheet. Each drawing element is indexed in the cell library file by its cell name. The cell name is used to select and copy a particular drawing element into the working CADD file. This typically is performed to maintain consistency among electrical sheets and to increase drafting efficiency. The MDT CADD Standards Manual presents the cell names for frequently used electrical symbols. Cells in the electrical CADD cell libraries have been created on the appropriate level that should be adhered to when placing cells in a design file. See [Section 10.1.4.1](#) for information on drawing scales and the MDT CADD Standards Manual for additional information on cell libraries. [Section 10.1.2.6](#) provides information on how to obtain the file ELECTRICALENG.CEL (ELECTRICALENG.CEL – Metric).

10.1.2.6 Obtaining CADD Standards

Consultants should request a copy of the CADD Standards from the Consultant Services Bureau or, optionally, download the files directly from the MDT Internet website. See the MDT CADD Standards Manual for information on using CADD reference files.

10.1.3 Organization of Electrical Plans

10.1.3.1 Sheet Sequence

Electrical detail and plan sheets generally are prepared for multi-unit design projects having a scope much broader than electrical work alone (e.g., Road Design projects). When electrical sheets are combined with sheets from other design units, they typically are inserted in the construction plans just after the signing sheets according to the plan sequence presented in [Section 3.1.2.1](#). However, when the Electrical Unit is the project lead on a stand-alone electrical project, the sheet sequence of the plans will be as follows:

1. Title Sheet
2. Table of Contents Sheet (when provided, see [Section 10.2.2](#))
3. Control Diagram
4. Electrical Quantity Summary Sheet

5. Electrical Detail Sheets
6. Plan Sheets

The project type will determine which sheets are required and which design unit is responsible for sheet preparation. For example, when electrical detail and plan sheets are included as part of a Road Design project, the Electrical Unit typically will not prepare a separate Title Sheet nor a separate Table of Contents Sheet for the electrical section of the construction plans.

10.1.3.2 Sheet Numbers

Consistently using the MDT sheet numbering convention is important. Whether for a stand-alone electrical project or as part of a larger multi-unit design project, all electrical sheets will be numbered sequentially beginning with the number one. The sheet number will begin with the letter “E,” to identify electrical work, which will be followed immediately by a hyphen and the sequential number of the electrical sheet (e.g., E-1, E-2).

10.1.4 Drafting Guidelines

10.1.4.1 Drawing Scales

The need to scale drawings on electrical detail sheets will be determined on a sheet-by-sheet basis. At a minimum, drawings on electrical details should be proportionate. When developing electrical plan sheets, use the following guidelines to select an appropriate drawing scale:

1. Traffic Signal Projects. For traffic signal projects, it is desirable to use a drawing scale of 1"= 20' (1:250) on electrical plan sheets.
2. Isolated Intersections. For electrical work at isolated intersections, a drawing scale of 1"= 20' (1:250) is preferred.
3. Lighting Projects. For highway lighting projects, electrical plans should be drawn at a scale of 1"= 50' (1:500).
4. Interchanges. For electrical work at interchanges, electrical plans typically are drawn at a scale of 1"= 100' (1:1000).

The CADD Standard files PLANE.REF (PLANM.REF and MTRAFPL.DGN) contain prototype electrical sheets using a 1"= 100' (1:1000) scale. See [Section 10.1.2.3](#) for additional information on electrical design file creation and initialization.

Scales are for full-size plan sheets. Plans printed on 11"x 17" sheets are one-half the original.

10.1.4.2 CADD Drawing Levels

Because design units other than the Electrical Unit use the information contained in CADD design files, placement of data on the correct CADD drawing level is essential. When developing electrical plans, use the CADD level symbology presented in the MDT CADD Standards Manual.

10.1.4.3 Use of Abbreviations

See [Figure 3.2A](#) for the proper use of abbreviations in electrical plans (e.g., American Wire Gauge — AWG, high pressure sodium vapor — HPSV, pedestrian push button — PPB). Consistently using these abbreviations will conserve drawing space on each sheet and ensure a positive communication of information to the contractor.

10.1.4.4 Annotation Guidelines

To provide uniformity among sheets in electrical plans, use the annotation guidelines presented in the MDT CADD Standards Manual for both the electrical detail sheets and for the electrical plan sheets.

10.2 TITLE SHEET AND TABLE OF CONTENTS SHEET

10.2.1 Title Sheet

The Title Sheet is the front cover of a set of construction plans. It identifies the project type, project location and other pertinent project information. Pre-drafted title sheets are available as CADD reference files; see the [MDT CADD Standards Manual](#) and [Section 10.1.2.6](#). These sheets provide the State map and formatted data-input blocks for design data, project approvals, related projects and associated project agreement numbers. Also included on the Title Sheet are the Department name and the standard data for drawing scales and project length.

The Title Sheet should contain the following information:

1. State Map. A State map in the upper left-hand corner of the Title Sheet should show the general location of the project in relation to other roads within the State. An arrow labeled "THIS PROJECT" will indicate the project location.
2. Title Information. Show the project title information in the top center of the Title Sheet in the following order:
 - a. Montana Department of Transportation.
 - b. Project construction number as provided by the Fiscal Programming Section. [Figure 10.2A](#) defines the project number codes.
 - c. Project descriptions documented in the Engineering Management System Report.
 - d. Project Name. Common project names include street names, route numbers, intersection street names, interchange names, etc.
 - e. Access control note, if applicable.
 - f. City name/county name.
3. Project Length. Immediately below the title information, show the project length to the nearest tenth of a mile (kilometer) (i.e., 0.1 mi (0.1 km)).
4. Scales. Show the drawing scales used in the plan sheets immediately below the project length.
5. Surfacing Source. If electrical plans are combined with Geometric or Safety sheets that include surfacing quantities, just to the right of the scales, indicate whether or not the surfacing source is contractor furnished.

Project NH1-9(23)565

NH-Funding Designation (see table below)

1 - Route Number

9 - County Designation along the Route (west to east, south to north)

23 - Agreement Number

565 - Reference Point on the Route

Federal-Aid Program	Project Prefix
Interstate Program: Interstate – Maintenance	IM
National Highway System: National Highway	NH
Surface Transportation Program: Secondary Urban Primary (minor arterial) State Flexible (State Highway) Rail/HWY Crossing - Hazard Elimination Rail/HWY Crossing - Protective Devices Hazard Elimination Transportation Enhancements	STPS M, STPU STPP STPX STPRR STPRP STPHS STPE
Bridge Program: Bridge Replacement & Rehabilitation – 20% (Optional) Bridge Replacement & Rehabilitation – 15% (Off-System) Bridge Replacement & Rehabilitation – 65% (On-System)	BR & BH BR & BH BR & BH
Congestion Mitigation & Air Quality Improvement Program: Congestion Mitigation & Air Quality	CM
SPR/PL Program: HWY Planning & Research Research, Development & Technology Transfer Metropolitan Planning	SPR SPR PL
Innovation Projects: DPI Projects (Shiloh & Missoula Interchange)	DPI
Demonstration Projects	HDP
Discretionary Funds: Public Lands	PLH
Forest Highway	FH
State-Aid Program	Project Prefix
National Highway System: National Highway (less Interstate) National Highway (Interstate)	SFCN SFCI
State Primary	SFCP
State Secondary	SFCS
State Urban	SFCU
State Highway (State-maintained)	SFCX

PROJECT CODE DEFINITIONS**Figure 10.2A**

6. Design Data. The need for completing the project design data block in the upper right-hand corner of the Title Sheet will be determined on a project-by-project basis.
7. Letting Date. The letting date recorded in the upper right-hand corner will represent the actual letting date, not the proposed letting date. The designer will generally not provide this data.
8. Layout Map. The layout map is located at the bottom center of the Title Sheet. Reference the layout map from the county maps directory — \\Astro\Maps\. Show only the area necessary for the project. The standard scale for rural layout maps is 1" = 5000' (1:60 000) and should be used if practical. Layout maps for urban-area work should show enlarged views of the affected urban areas.

Clearly show the following information on the layout map:

- a. the location of the project roadway relative to true north, nearby townships, ranges, sections, existing roads, towns, major drainage features, State-optioned borrow and surfacing sources, railroads and buildings;
- b. the beginning and ending stations of the project and the project number;
- c. the numbers and stations of as-built projects onto which the project is tied;
- d. names of interchanges;
- e. signed route numbers for US, State and local highways;
- f. enlarged maps of cities and towns where construction is scheduled through those areas;
- g. the name of the Indian Reservation, when any portion of the project is located within its boundaries; and
- h. separation structures and bridges on the project. A single station number, based on mainline stationing, will represent the approximate center of each structure. Data will indicate the length of each structure, whether it is an overpass or underpass in relation to the mainline, and whether it will be constructed under the contract.

For typical CADD symbols that are included on the Title Sheet, see the MDT CADD Standards Manual.

9. Related Projects. Complete the “Related Projects” data block in the lower left-hand corner of the Title Sheet. Typical data include contract units not covered by the contract plans and project numbers financially related to the main project (e.g., projects constructed in stages or units, projects tied for letting).
10. Associated Project Agreement Numbers. Under the data block for related projects, show associated project agreement numbers for right-of-way, incidental construction (utilities), preliminary engineering and the uniform project control number.
11. Project Approval Block. A “Project Approval” data block will be shown in the lower right-hand corner of the sheet. This data block should include:
 - a. the contract plan approval date;
 - b. the Director’s name;
 - c. the Traffic and Safety Engineer’s signature;
 - d. the Traffic and Safety Engineer’s professional registration symbol; and
 - e. where appropriate, the FHWA Division Administrator’s approval.

10.2.2 Table of Contents Sheet

The Table of Contents Sheet will indicate major sheet groups and subgroups. It is provided to facilitate locating design items in the plan set. [Section 3.1.2](#) provides the proper order for listing, numbering and prefixing construction plan sheets. [Section 10.1.3](#) provides information specific to the organization of electrical plans.

For stand-alone electrical projects, a Table of Contents Sheet typically is not needed. However, when plans developed by other design units are combined with electrical plans, a Table of Contents Sheet should be provided.

A separate sheet generally is used for the table of contents. If, the table of contents is combined with project notes on the same sheet, clearly label each group of information (e.g., TABLE OF CONTENTS, NOTES). Place the table of contents on the left side of the sheet and locate any additional notes or data to the right of the table of contents.

Table of Contents for electrical projects may be placed on the Title Sheet if space allows.

10.3 ELECTRICAL QUANTITY SUMMARY SHEET

Include an Electrical Quantity Summary Sheet with each set of electrical plans. This sheet will present a frame of all requisite electrical work and material quantities for the project. The electrical quantity summary frame typically is placed on a separate sheet; however, as deemed appropriate (e.g., for small stand-alone electrical projects), the frame may be placed on a sheet with other electrical details. Use the following guidelines when preparing the Electrical Quantity Summary Sheet:

1. **Frame Format.** The electrical quantity summary frames typically used by the Electrical Unit are contained in the MDT electrical detail drawings (i.e., view names QS1, QS2 and QS3). [Section 10.1.2.4](#) provides information on how to access these sheets, and electrical detailed drawings briefly describes the three frame formats available to the designer. The 2-lane, the 2-lane/4-lane, and rural/urban frame formats are provided primarily to allow quantities to be presented separately for funding purposes.
2. **Frame Adjustments.** The summary frame may need to be adjusted for the project. Additional rows may be required for projects with additional items. Use the CADD drafting guidelines presented in [Section 10.1.4](#) when adjusting any of the electrical quantity summary frames.
3. **Item Number.** An item number is used to specify a particular work or material item. The Electrical Unit describes each electrical bid item with a number which has nine coded digits in the format "123 456 789". The item number, as specified, has a coded meaning. For example, the first three digits (e.g., 123 xxx xxx) references the applicable section in the [MDT Standard Specifications for Road and Bridge Construction](#). Additionally, for those items that may be State furnished (e.g., traffic signal controllers, controller cabinets, signal standards), the sixth digit of the item number (e.g., xxx xx6 xxx) is coded as follows:
 - a. **Contractor Furnished.** If the sixth digit of the item number is 2, 3 or 4, then the bid item is contractor furnished.
 - b. **State Furnished.** If the sixth digit of the item number is 5, then the bid item is State furnished. Note that an asterisk (*) should be used on the Electrical Quantity Summary Sheet to clearly mark items that are State furnished.
 - c. **Other.** If the sixth digit of the item number is 9, the meaning of the code is for accounting purposes only.

As item coding is subject to change, contact the Contract Plan Section for a current list of approved item numbers and their meaning.

4. Quantity Rounding. Use the criteria presented in [Chapter Four](#) when specifying and rounding electrical quantities.
5. Lump-Sum Items. Desirably, lump-sum items should not be specified on a project; however, there will still exist cases when this will be necessary. Only specify lump-sum items when the scope of work for the item is clearly defined and is unlikely to change during construction (e.g., remove and salvage, remove and reset). Lump-sum items are specified as one unit quantity.
6. Quantity Placement. Quantities normally should be centered within each cell of the electrical quantity summary frame. For readability, separate each item specified in the frame with a blank row.

10.4 ELECTRICAL DETAILS AND DETAIL SHEETS

A complete set of electrical plans includes sufficient information for the contractor to successfully bid and complete the electrical scope of the project. This includes scaled plan views of the facilities (i.e., plan sheets) and all details necessary to adequately describe the requisite electrical work and materials. See [Section 10.5](#) for information on electrical plan sheets. Details that are typically provided in electrical plans include:

1. schedules for signal and luminaire poles, conduit and wire, and detector loop;
2. service wiring diagrams for signals, controllers and luminaires;
3. conduit installation and underground service wiring details;
4. pull box, pole base and watertight connection details;
5. details of photo-electric control installation and wiring;
6. signal and luminaire standard, pole base and foundation details;
7. signal head and luminaire mounting and assembly details;
8. controller mounting, assembly, wiring, conversion and foundation details; and
9. details of detector loop installation.

The following sections provide guidelines for preparing the details and detail sheets that are typically included in electrical plans.

10.4.1 Organization and Placement of Details and Detail Sheets

Electrical details typically should not be repeated in the plan set. Rather, combine and organize commonly related details on separate detail sheets and reference the sheets as appropriate. The MDT electrical detail drawings are a good example of this practice as they typically are used from project to project. See [Section 10.4.2](#) for additional information on the MDT electrical detail drawings.

Electrical detail sheets, including the MDT electrical detail drawings, should be inserted in the plans according to the sheet sequence discussed in [Section 10.1.3](#). MDT electrical detail drawing sheets should be grouped together and placed after the Electrical Quantity Summary Sheet. Other electrical detail sheets that are developed for the project should immediately follow the electrical detail drawings.

It is desirable to place associated electrical details on the plan sheets to which they apply. However, if space is limited on a plan sheet, logically group the details on a separate sheet and insert the sheet in the plan set between the MDT electrical detail drawings and the electrical plan sheets. For example, it may be necessary to use an entire sheet for a luminaire pole schedule; however, for a signalized intersection, it is typical practice to place all associated drawing elements (e.g., details, schedule) on the plan sheet itself. The arrangement of electrical details on any particular sheet and the

number and order of electrical detail sheets will vary from project to project. [Section 10.1.2.5](#) provides information on frequently used electrical detail drawing elements.

10.4.2 MDT Electrical Detail Drawings

The Electrical Unit has prepared a set of commonly used electrical detail drawings. Each sheet contains a logical group of associated electrical details that are frequently needed in electrical projects. See [Section 10.1.2.4](#) for additional information on the MDT electrical detail drawings. When developing electrical plans for a project, the designer is encouraged to review these sheets for their applicability. If a particular sheet is applicable, it should be prepared for inclusion in the plans according to the guidelines presented in [Section 10.1](#). Although a particular sheet may be applicable, showing all details on the sheet may not be appropriate. In these instances, it is preferable to delete unrelated details.

10.4.3 Schedule Frames

The following sections discuss schedule frames that are typically used in electrical plans. [Section 10.1.2.5](#) provides additional information on schedule frames and other frequently used drawings elements.

10.4.3.1 Signal and Luminaire Pole Schedules

The Electrical Unit has developed standard frames for signal and luminaire pole schedules that are maintained in the Unit's CADD cell library (i.e., cell names PS2 and LPS). [Section 10.1.2.5](#) discusses how they may be accessed. Frame PS2 typically is used for signal projects. Frame LPS is appropriate for highway lighting projects. Frame adjustments are allowed provided they are made according to the drafting guidelines presented in [Section 10.1.4](#). Where practical, place schedule frames on the plan sheets to which they apply. Use the following guidelines when preparing signal and luminaire schedules:

1. **Pole No.** Pole No. is a numerical index (e.g., 1, 2, 3, ..., 96, 97) that is used to identify signal and luminaire poles. The pole-number index begins with "1" and ends with the total number of poles required for the project (i.e., different pole types are not indexed separately in the plans). On the plan sheets, each pole number is circumscribed by a circular symbol that is placed near the location where the pole is to be set. It is desirable to index poles in the order of increasing stationing along the mainline facility. If, however, there is significant electrical work at an intersection, side road or interchange, the continuous

stationing of the mainline electrical plan sheets will be interrupted to present the electrical work for these facilities. Poles at these locations should be numbered in a sequence consistent with the presentation of the plan sheets.

2. Item No. See [Section 10.3, Item # 3](#) for information on Item No.
3. Type. Use the “Type” column in the frame to identify the type of pole required (e.g., 10-A-500-4).
4. Line. The “Line” column is used to identify the station line where the pole will be tied (e.g., Ramp D1, I 90, Jackrabbit Ln.).
5. Station. Use the “Station” column to identify the facility’s station number in the plans where the pole is to be set (e.g., 351+40).
6. Offset \varnothing Pole. The “Offset” column is used to identify the lateral offset, in feet (meters), from the station line of the facility to the center of the pole at the station where the pole is to be set (e.g., 9.0 ft RT. (2.8 m RT.)). Right and left descriptors are in the direction of increasing stationing.
7. Coordinate. In these columns, identify the N or Y coordinate and the E or X coordinate. Each coordinate should be shown to the nearest 0.0001 (0.01).
8. Type Pole Base. In this column, specify the type of pole base required (e.g., breakaway, anchor).
9. Foundation (Diameter x Depth). This column is used to specify, in feet and inches (millimeters), the size of the pole foundation required (e.g., 2'-0" x 6'-0" (610 mm x 1800 mm)).
10. Pedestrian Push Button. Use this column to specify the quantity of pedestrian push buttons required on a signal standard (e.g., 1). See [Section 10.1.2.5](#) for additional information on the Electrical Unit’s cell library.
11. Signal Mast Arm. This column is used to specify the length, in feet (meters), of the signal mast arm (e.g., 50 ft (15 m)).
12. Luminaire Mast Arm. Use this column to specify the length, in feet (meters), of the luminaire mast arm (e.g., 15 ft (4.5 m)).
13. Luminaire Height. Use this column to specify the mounting height, in feet (meters), of the luminaire (e.g., 45 ft (13.7 m)).

14. Luminaire Type. This column is used to identify the type of luminaire required (e.g., 400 W HPSV).

10.4.3.2 Detector Loop Schedule

The Electrical Unit has developed a standard frame for detector loop schedules that is maintained in the Unit's CADD cell library (i.e., cell name LDB). [Section 10.1.2.5](#) provides information on how to access this frame. Frame LDB typically is used for actuated signal projects. Frame adjustments are allowed provided they are made according to the drafting guidelines presented in [Section 10.1.4](#). Where practical, place schedule frames on the plan sheets to which they apply. Use the following guidelines when preparing the detector loop schedule:

1. Loop No. Use the "Loop No." column to identify the detector loops required. Sequentially index the loops in a logical manner. Loops typically are indexed L1, L2, L3, etc. at each signalized location. For each loop on the plan sheet, place the index number inside a square symbol at the loop's installation location.
2. Loop Dimensions. Use this column to specify the dimensions, in feet (meters), of each detector loop (e.g., 6.0 x 6.0 (1.8 x 1.8)).
3. Number of Turns in Loop. This column is used to specify the number of turns of wire in each loop (e.g., 4 for a square or rectangular loop, 3-6-3 for a quadrupole loop).
4. Type of Loop. Use this column to specify the type of detector loop required (e.g., square, rectangular, quadrupole).
5. Loop Connections. Schematically designate the loop connection configuration at the pull box (e.g., series) and at the controller (e.g., to amplifier).
6. Associated Vehicular Phase. Use this column to designate the vehicular phase associated with the detector loop (e.g., $\phi 4$, $\phi 7$ future, $\phi 6$ & counter).

10.4.3.3 Conduit and Wire Schedule

If sheet space is available, conduit and wire schedules typically are placed on the plan sheets to which they apply. In the schedule, each conduit run is described by a block of text that is offset and denoted by a capital letter which is enclosed in a triangular symbol. Conduit runs are sequentially indexed A, B, C, etc. on each separate electrical plan sheet, and the location of the conduit run is designated by the same triangular icon used in the schedule. [Figure 10.4A](#) illustrates typical conduit run descriptors.

CONDUIT AND WIRE SCHEDULE	
△ A	2 OF 2 in (53 mm) PLASTIC CONDUIT 2 OF 9 AWG NO. 14 SIGNAL CABLE 4 OF DETECTOR LOOP CABLE 4 OF AWG NO. 4 CONDUCTOR (LIGHTING) 2 OF AWG NO. 10 CONDUCTOR (GROUND)
△ B	2 in (53 mm) PLASTIC CONDUIT 1 OF 9 AWG NO. 14 SIGNAL CABLE 4 OF AWG NO. 4 CONDUCTOR (LIGHTING) 1 OF AWG NO. 10 CONDUCTOR (GROUND)

TYPICAL CONDUIT RUN DESCRIPTORS

Figure 10.4A

10.4.4 Service Wiring Diagrams and Other Details

Service wiring diagrams are used to schematically illustrate the electrical service wiring of signals, signal controllers and luminaires. [Section 10.1.2.5](#) briefly discuss these and other frequently used electrical details (e.g., signal mounting, loop placement, volume count diagrams). In general, electrical details should be placed on the sheets to which they apply. If, however, space is not available on the sheet, they should be organized and placed according to the guidelines presented in [Section 10.4.1](#).

Variations or modifications in wiring diagram should be added to the Standard Detail.

10.5 ELECTRICAL PLAN SHEETS

Electrical plan sheets are the basic design sheets used to illustrate the types and locations of electrical components (e.g., signals, controllers, luminaires, conduit runs) to be installed, removed, reset or replaced. Therefore, ensure that these sheets are drawn clearly and simply to provide the contractor with the information necessary to successfully complete the requisite work. Use the following guidelines when preparing electrical plan sheets:

1. Number of Sheets. The number of electrical plan sheets will depend on the length and nature of the project. Consider the following guidelines:
 - a. Signals. Where signal work is to be performed, it is preferable to use one plan sheet for each signalized location.
 - b. Flashing Beacons. Use one plan sheet for each location where flashing beacons are to be installed or otherwise modified.
 - c. Lighting. It is desirable to use one plan sheet for the lighting work of interchanges and isolated intersections. The number of plan sheets required for lighting mainline facilities will depend on the length of the project.
2. Sheet Sequence. Generally, plan sheets are presented in the order of increasing stationing (e.g., along the mainline, intersection to intersection). If there is significant electrical work at an intersection, side road or interchange, continuous mainline stationing may be interrupted to present the electrical plans for these facilities. Present intersection, side road or interchange plan sheets after the mainline plan sheets on which they appear. Clearly label all plan sheets. See [Section 10.1.3](#) for additional information on the organization of electrical plans.
3. Sheet Layout. The drawing scale selected for the plan view will determine how much of the facility can be presented on a single sheet (see Item #5). Use match lines for sheet breaks. There should be no sheet overlap between successive sections of the facility. When smaller scales (e.g., 1" = 100' (1:1000)) are used (e.g., for interchanges), it may be appropriate to break the facility into two logical sections using a match line and show both sections on the same sheet.
4. CADD Files. See [Section 10.1.2](#) for information on CADD files for electrical plans.
5. Drawing Scale. Selecting an appropriate drawing scale will depend on the type and scope of electrical work. Provide a scale that will clearly show the work to be

performed. Use the guidelines presented in [Section 10.1.4.1](#) when selecting drawing scales for electrical plans.

6. Electrical Details. If not common to the electrical plan set or applicable to multiple plan sheets, it is desirable to place electrical details on the plan sheets to which they apply. The following details typically are placed on electrical plan sheets:
 - a. pole schedules,
 - b. signal indications,
 - c. phase diagrams,
 - d. detector loop schedules and placement details,
 - e. service wiring diagrams,
 - f. lighting wiring diagrams, and
 - g. conduit and wire schedules.

Details related to ADA criteria are typically placed on separate sheets. See [Section 10.4](#) for additional information on electrical details and electrical detail sheets.

7. Electrical Symbols. The symbols used on electrical plan sheets are used to identify the location and orientation of items such as:
 - a. service and pull boxes,
 - b. controller cabinets,
 - c. vehicular and pedestrian signal heads and indications,
 - d. pedestrian push buttons,
 - e. railroad flashers,
 - f. emergency vehicle detectors, and
 - g. changeable message signs.

The following provides additional guidance on the use of electrical plan symbols:

- a. **Signal and Luminaire Poles**. Each signal or luminaire pole is identified by a number that is enclosed in a circular symbol, which is placed near the location where the pole is to be set. [Section 10.4.3.1](#) provides information on signal and luminaire pole schedules and pole numbers.
- b. **Detector Loops**. Each loop is identified by a number that is enclosed in a square which is placed at the loop's installation location. See [Section 10.4.3.2](#) for information on detector loop schedules and loop numbers.

- c. Conduit Runs. A triangular symbol typically is used to identify a conduit run. [Section 10.4.3.3](#) provides information on conduit and wire schedules and conduit run indexing.
- d. Signal Heads. A hexagonal symbol typically is used to identify a signal head. The signal heads are sequentially indexed (e.g., 1, 2, 3) on each sheet they appear. The index number is enclosed in the hexagonal symbol.

See [Section 10.1.2.5](#) for additional information on the Electrical Unit's CADD cell library and other frequently used electrical drawing elements.

- 8. Notes. Consistently use notes to provide a clear and concise explanation of the electrical work to be performed. Notes should not be used where elements are addressed elsewhere in the Standard Specifications, Supplemental Specifications or Special Provisions. Notes should be placed at locations that are close to where they apply. The types of notes required will vary from project to project and from sheet to sheet. Information appropriately covered by notes includes:
 - a. descriptions of items to be removed by non-contractor personnel;
 - b. instructions for the contractor regarding items not to be disturbed;
 - c. special instructions for underground and overhead electrical service;
 - d. descriptions of items for future operation (e.g., spare signal conductors);
 - e. references to other sheets; and
 - f. references to other projects.
- 9. Drafting Guidelines. Line work for facilities should include centerline, curb and gutter, medians, edge of traveled way, shoulder, railroad centerline and clearance, and any other feature deemed necessary. When preparing the electrical plan sheets, use the drafting guidelines provided in [Section 10.1.4](#).
- 10. Horizontal Alignment Data. As needed, include equations at intersections to correct any stationing differences that may occur along the centerline.
- 11. Station Call Outs. Provide station call outs at the following locations:
 - a. beginning and ending points of the project,
 - b. 100 ft (100 m) station increments, and
 - c. at other locations where deemed appropriate.

Tick marks between station call outs should be provided at every tenth station (20 m) increments.

12. North Arrow. The North arrow should be shown next to the plan view and should be consistent from sheet to sheet.
13. Topography. Topography generally is not needed on electrical plans. However, where deemed necessary, topography that is shown should only include topographic features pertinent to the electrical work.
14. Right-of-Way. Clearly show right-of-way limits on the plans. Where necessary, note breaks in the right-of-way alignment by centerline station and offset distance. Easements, construction permits and control of access limits, as applicable, should be clearly shown. Where control of access limits do not coincide with right-of-way limits, each should be clearly labeled.
15. Utility Facilities. As needed for electrical work, clearly show and label all affected utility facilities.
16. Buildings and Parcel Access. As appropriate, clearly show and label access points to land parcels and outside limits of buildings and ancillary structures that may interfere with electrical work.
17. Guardrail and Culverts. The locations of new and existing guardrail and culverts should be shown on the plans if applicable to the placement of electrical equipment (e.g., poles, conduit runs).
18. Pavement Markings. As appropriate for signal projects, clearly show the pavement markings for stop lines, lane lines, median lines, lane designation arrows, marked crosswalks and railroad crossings.