To Holders of the Traffic Engineering Manual (TEM):

As of January 17, 2003, Parts 1, 2, 3, 4, 6, 11, 12 and 14 of the Traffic Engineering Manual (TEM) have been revised. Both the revised manual and a revision package are available from either the ODOT Design Reference Resource Center (http://www.dot.state.oh.us/drrc/), using the TEM link or the Traffic Home Page (http://www.dot.state.oh.us/traffic/), using the Publications/Documents link. They may also be accessed directly via the links provided below. The revised pages should be printed as a double-sided document and then inserted into the manual, replacing the existing sheets.

Per ODOT policy, paper copies of the revisions to this manual will no longer be distributed to all holders of the manual. Revisions will only be available through the purchase of a new manual or via the web pages noted above.

The TEM Publication Record on page v of the manual lists the sections involved in this revision. Pages that have been revised are noted by the addition of the date, January 17, 2003, at the bottom of the page. Lists have been developed which detail the changes made. They can be accessed by the links below.

For questions, comments, or concerns please contact either:

Juanita Elliott, P.E., Traffic Standards Engineer or Lisa Mcconnell, Traffic Standards Technician
614-644-8143 or Juanita.Elliott@dot.state.oh.us
or 614-728-9361 or Lisa.McConnell@dot.state.oh.us

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<th>What's New Page</th>
<th>Traffic Home Page</th>
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<td>Full Detail List for the January 17, 2003 TEM Revision</td>
<td>Short Detail List (excludes sections with only editorial changes)</td>
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The following is a detailed list of the changes made in the Traffic Engineering Manual (TEM) as of January 17, 2003:

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<tr>
<td>Cover Page</td>
<td>Change</td>
<td>Added the revision date.</td>
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<tr>
<td>Pub. record</td>
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<td>Table 197-1</td>
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<td>Updated list based on TEM distribution in October 2002.</td>
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<td>205-2.3.1</td>
<td>Editorial</td>
<td>Criteria and Eligible Generators / Signs with a Green Background. In numbered paragraphs 2, 3, 5, 6 and 7, revised “(8 kilometer)” to “(8 kilometers),” and in paragraph 3, revised “school if it is within” to “school is within.”</td>
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<td>208-3</td>
<td>Change</td>
<td>SAFETY BREAK FREE COFFEE Sign (N-62). Corrected the size shown in the chart for the N-62-144 to “144 x 48 (3600 x 1200).”</td>
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<td>3-2</td>
<td>Editorial</td>
<td>Table of Contents. Revised title for Section 342-2 slightly.</td>
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</table>
| 301-1   | 3-6  | 3-6      | Editorial       | Pavement & Curb Markings / General.  
Revised “Parts 340, 350 and 360” to “Sections 340, 350 and 360”; and revised “CMS Items 640 and 740” to “CMS Item 640 and CMS 740,”. |
| 301-3   | 3-6  | 3-6      | Editorial       | Pavement & Curb Markings / Pavement Marking in Incorporated Villages.  
Revised “CMS Item 641.08” to “CMS 641.08.” |
|         | 3-7 and 3-8 | 3-7 and 3-8 | Editorial       | As a result of change on page 3-6, text moved and pages 3-7 and 3-8 had to be reprinted. |
| 302-1   | 3-11 | 3-11     | Editorial       | Raised Pavement Markers / General.  
Revised “CMS Items 621 and 721” to “CMS Item 621 and CMS 721.” |
| 304-1   | 3-14 | 3-14     | Editorial       | Delineators / General.  
Revised “CMS Items 620 and 720” to “CMS Item 620 and CMS 720.” |
| 304-2   | 3-14 | 3-14     | Change          | Delineators / Delineator Types.  
Updated “CMS Item 620.01” to “CMS Item 620.02.” |
| 304-3   | 3-14 | 3-14     | Editorial       | Delineators / Application Guidelines.  
Revised “CMS Item 620.02” to “CMS 620.02.” |
| 304-6   | 3-15 | 3-15     | Editorial       | Delineators / Delineation for Left-Turn Lanes in Medians.  
Revised “Part 303” to “Section 303.” |
| 306     | 3-16 | 3-16     | Editorial       | Barricades and Channelizing Devices.  
Revised “of this TEM” to “of this Manual.” |
| 307     | 3-17 | 3-17     | Editorial       | Barrier Reflectors / General.  
Revised “CMS Items 626 and 720.04” to “CMS Item 626 and CMS 720.04.” |
| 320-4   | 3-18 | 3-18     | Editorial       | Materials and Hardware / Use of Type G Sheeting.  
Revised “CMS Item 730.19” to “CMS 730.19.” |
| 320-5   | 3-18 | 3-18     | Editorial       | Materials and Hardware / Barrier Reflectors.  
Revised “CMS Item 720.04” to “CMS 720.04.” |
| 340-1   | 3-20 | 3-20     | Editorial       | Design Information / General.  
Revised “Part 342” and “Part 343” to “Section 342” and “Section 343,” respectively. |
| 340-2   | 3-20 and 3-21 | 3-20 and 3-21 | Editorial       | Design Information / Pavement Marking.  
In item 4, revised “CMS Item” to “CMS Items”; on page 3-21, revised “Part 304” to “Section 304.” |
Revised “CMS Item 614.11” to “CMS 614.11.” |
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<td>342-2</td>
<td>3-23</td>
<td>3-23</td>
<td>Change</td>
<td>Plan Notes / (202-A) 202 Raised Pavement Markers Removed for Storage. Added “As Per Plan” to title and item description; added a comma in the title and item description after “202”; removed the bold feature from “County Manager”; removed the comma after “Markers” in the title and quantity description; removed “Item” from the quantity description; Inserted “This note” in front of “may” in the Designer Note.</td>
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<tr>
<td>342-3</td>
<td>3-23</td>
<td>3-23</td>
<td>Change</td>
<td>Plan Notes / (621-A) Materials Supplied by the Department. Revised Designer Note to clarify that this note is to be used in conjunction with the two related notes, i.e., 621-B and 621-C. Also added “This note” in front of “should” in the first sentence of the Designer Note; revised “SS” to “Supplement.”</td>
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<td>342-4</td>
<td>3-23</td>
<td>3-23</td>
<td>Change</td>
<td>Plan Notes / (621-B) Return of Non-Performed Raised Pavement Marker Materials Supplied by the Department. Revised Designer Note to clarify that this note is to be used in conjunction with the two related notes. Also added “This note” in front of “should” in the first sentence of the Designer Note.</td>
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<td>342-5</td>
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<td>Plan Notes / (621-C) Loading of Materials Supplied by the Department at the Recycler’s Warehouse. Added Designer Note to clarify that this note is to be used in conjunction with the two related notes.</td>
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<td>343</td>
<td>3-25</td>
<td>3-25</td>
<td>Change</td>
<td>Specifications. Reference to Supplement 829 was deleted. The description of Supplement 1047 was revised to indicate that it “addresses the procedure by which ODOT will maintain a list of pre-qualified pavement marking materials. Revised “covers” to “cover” and added period at end of last sentence.</td>
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<tr>
<td>350-2</td>
<td>3-26</td>
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<td>Editorial</td>
<td>Construction / Work Zone Performance Evaluations. Revised “CMS Item 614.11” to “CMS 614.11.”</td>
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<th>4-3 thru 4-6</th>
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<td>Traffic Control Signals - General / General. Revised “CMS Items 632/732 and 633/733” to “CMS Items 632 and 633, and CMS 732 and 733.”</td>
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<td>Pedestrian Control Features / General. Revised “CMS Items 632 and 732” to “CMS Item 632 and CMS 732.”</td>
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<td>Materials and Hardware / General. Revised “CMS Items 632/732 and 633/733” to “CMS Items 632 and 633, and CMS 732 and 733.”</td>
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<td>Temporary Traffic Control Zone Devices / Special Warning Signs / NO CENTER (EDGE) LINE Sign. Switched the graphics for the OW-167 and 168 signs to show them correctly with the sign codes.</td>
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<td>6-37</td>
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<td>Temporary Traffic Control Zone Devices / Guide Signs / Advance Work Zone Information Signs. Deleted third sentence in item 10. It was redundant.</td>
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<td>Temporary Traffic Control Zone Devices / Special Guide Signs / Exit Ramp Open/Closed Signs. Added section and graphics addressing these signs.</td>
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<td>Due to addition of 605-8.4 text moved enough to affect these other pages.</td>
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<td>605-11.5</td>
<td>6-44</td>
<td>6-44</td>
<td>Editorial</td>
<td>Temporary Traffic Control Zone Devices / Channelizing Devices / Barricades, Tubular Markers and Vertical Panels. Deleted “Items” in the last line of the second paragraph.</td>
</tr>
<tr>
<td>605-11.10.2</td>
<td>6-46</td>
<td>6-47</td>
<td>Editorial</td>
<td>Temporary Traffic Control Zone Devices / Channelizing Devices / Pavement Markings / Conflicting Pavement Markings. Deleted the term “Items” in the last sentence.</td>
</tr>
<tr>
<td>606-2</td>
<td>6-61</td>
<td>6-61</td>
<td>Editorial</td>
<td>Type of Temporary Traffic Control Zone Activities / Typical Applications. Revised “Part” to “Section” in the second paragraph.</td>
</tr>
<tr>
<td>606-12</td>
<td>6-67</td>
<td>6-67</td>
<td>Editorial</td>
<td>Type of Temporary Traffic Control Zone Activities / Work Within the Traveled Way of Multilane, Nonaccess Controlled Highways. Revised “Part” to “Section” in the first paragraph.</td>
</tr>
<tr>
<td>606-14</td>
<td>6-71</td>
<td>6-71</td>
<td>Editorial</td>
<td>Type of Temporary Traffic Control Zone Activities / Work Within the Traveled Way of Expressways and Freeways. Revised “Part” to “Section” in the third paragraph.</td>
</tr>
<tr>
<td>606-15</td>
<td>6-71</td>
<td>6-71</td>
<td>Editorial</td>
<td>Type of Temporary Traffic Control Zone Activities / Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway. Revised “Part” to “Section” in the last paragraph.</td>
</tr>
<tr>
<td>607-40</td>
<td>6-95</td>
<td>6-95</td>
<td>Change</td>
<td>Typical Applications / Median Crossover for Exit Ramp. Added references to OC-45, 45A, 46, 46A; added “related” between the words “the” and “interchange” in item 2; made the last sentence in item 2 into a separate item to be more consistent with MUTCD text; renumbered remaining items.</td>
</tr>
<tr>
<td>607-41</td>
<td>6-95</td>
<td>6-95</td>
<td>Change</td>
<td>Typical Applications / Work in Vicinity of Exit Ramp. Added references to OC-45, 45A, 46, 46A; deleted the word “from” and added “related” between the words “the” and “interchange” in item 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-96 thru 97</td>
<td></td>
<td>Changes in previous sections moved text enough to affect other pages.</td>
</tr>
<tr>
<td>620-3</td>
<td>6-98</td>
<td>6-98</td>
<td>Editorial</td>
<td>Materials and Hardware / Sheeting. Deleted the term “Items” in the second line and “Item” in the third line in the first paragraph.</td>
</tr>
<tr>
<td>620-6.1</td>
<td>6-99</td>
<td>6-99</td>
<td>Editorial</td>
<td>Materials and Hardware / Pavement Markings / General. Deleted the term “Item” in the first line.</td>
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<tr>
<td>620-6.2</td>
<td>6-99</td>
<td>6-99</td>
<td>Editorial</td>
<td>Materials and Hardware / Pavement Markings / General. Deleted the term “Item” in three places.</td>
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<tr>
<td>620-6.3</td>
<td>6-99</td>
<td>6-99</td>
<td>Editorial</td>
<td>Materials and Hardware / Pavement Markings / General. Deleted the term “Item” in the first line.</td>
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<td>640-1</td>
<td>6-102</td>
<td>6-102</td>
<td>Editorial</td>
<td><strong>Design Information / General.</strong> Revised “Part” to “Section” in the second paragraph.</td>
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<tr>
<td>640-8</td>
<td>6-106</td>
<td>6-106</td>
<td>Editorial</td>
<td><strong>Design Information / Detours.</strong> Revised “Parts” to “Sections” in the first paragraph.</td>
</tr>
<tr>
<td>640-11.3</td>
<td>6-107</td>
<td>6-107</td>
<td>Editorial</td>
<td><strong>Design Information / Temporary Roads / Geometrics.</strong> Deleted “Item” in the second line.</td>
</tr>
<tr>
<td>640-11.6</td>
<td>6-107</td>
<td>6-107</td>
<td>Editorial</td>
<td><strong>Design Information / Temporary Roads / Guardrail Offsets and Sideslopes.</strong> Deleted “Item” in the first line.</td>
</tr>
<tr>
<td>640-11.7</td>
<td>6-108</td>
<td>6-108</td>
<td>Editorial</td>
<td><strong>Design Information / Temporary Roads / Pavement.</strong> Deleted “Item” in the first line; added “CMS” in front of “Item” in two places in the third paragraph; deleted last paragraph (it is redundant).</td>
</tr>
<tr>
<td>640-14</td>
<td>6-112</td>
<td>6-112</td>
<td>Change</td>
<td><strong>Design Information / Considering Holidays and Special Events.</strong> Deleted “, and ends at noon on the first normal weekday following the holiday” and three new sentences have been added to this paragraph.</td>
</tr>
<tr>
<td>640-18.2</td>
<td>6-113</td>
<td>6-114</td>
<td>Editorial</td>
<td><strong>Design Information / Speeds in Work Zones / Speed Limit Reductions.</strong> Revised “Part 642” to “Section 642” in the fifth paragraph.</td>
</tr>
<tr>
<td>640-21</td>
<td>6-115</td>
<td>6-115</td>
<td>Editorial</td>
<td><strong>Design Information / Removal of Logo Signs.</strong> Revised “Parts” to “Sections” in the first line.</td>
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<tr>
<td>640-22</td>
<td>6-115</td>
<td>6-115</td>
<td>Editorial</td>
<td><strong>Design Information / Temporary Lighting.</strong> Revised “Part 642” to “Section 642” in the last paragraph.</td>
</tr>
<tr>
<td>640-24.1</td>
<td>6-118</td>
<td>6-118</td>
<td>Change</td>
<td><strong>Design Information / Liquidated Damages.</strong> Deleted the second sentence of the first paragraph; revised “Proposal Note 101-97” to “CMS 108.07.”</td>
</tr>
<tr>
<td>641-2.6</td>
<td>6-120</td>
<td>6-120</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Temporary Traffic Control / Maintenance of Traffic (MOT) Plans / Quantities.</strong> Deleted the term “Item” in the first line.</td>
</tr>
<tr>
<td>641-5.1</td>
<td>6-121</td>
<td>6-121</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Closing Right or Left Lane of a Multilane Divided Highway / General.</strong> Inserted “CMS” in front of “614” in the second paragraph.</td>
</tr>
<tr>
<td>641-5.2</td>
<td>6-122</td>
<td>6-122</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Divided Highway / Advance Warning Sign Groups.</strong> Inserted “Item” in front of “614” in the first and third paragraphs.</td>
</tr>
<tr>
<td>641-5.3</td>
<td>6-122</td>
<td>6-122</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Divided Highway / Advisory Speed Sign.</strong> Inserted “Item” in front of “614” in the second line.</td>
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<tr>
<td>Section Page New Page</td>
<td>Change</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Divided Highway / Pavement Markings. Inserted “Item” in front of “614” in the second line; revised “see Note 12 on SCD MT-95.30” to “see Note 9 on SCD MT-95.40”; revised “CMS Item 614.10” to “CMS 614.11.”</td>
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<tr>
<td>641-5.4 6-122 6-122</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Divided Highway / Bid Items. Inserted “Item” in front of “614” in the second line; inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions.</td>
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<td>641-5.6 6-123 6-123</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Divided Highway / General. Inserted “Item” in front of “614” in the first line; inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions.</td>
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<td>641-6.1 6-123 6-123</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Undivided Highway / General. Inserted “Item” in front of “614” in the first line; inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions.</td>
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<td>641-6.2 6-123 6-123</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Undivided Highway / Bid Items. Inserted “Item” in front of “614.”</td>
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<tr>
<td>641-6.3 6-124 6-124</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Undivided Highway / Advisory Speed Sign. Inserted “Item” in front of “614” in the first line.</td>
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<td>641-6.4 6-124 6-124</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Undivided Highway / Pavement Markings. Inserted “Item” in front of “614” in the second line; deleted “Item” in the fourth line.</td>
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<tr>
<td>641-6.5 6-124 6-124</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closing Right of Left Lane of a Multilane Undivided Highway / Bid Items. Inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions.</td>
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<tr>
<td>641-7.2 6-125 6-125</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closure of a Two-Way Left Turn Lane / Advance Warning Signs Groups. Inserted “Item” in front of “614” in the second line.</td>
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<tr>
<td>641-7.4 6-125 6-125</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closure of a Two-Way Left Turn Lane / Bid Items. Inserted “Item” in front of “614.”</td>
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<tr>
<td>641-8.4 6-125 6-125</td>
<td>Change</td>
<td>Plan Preparation/Production / Closure of Right Lane of Three-Lane Section with Two-Way Left-Turn Lane / Pavement Markings. Added “Item” in front of “614” in the second line; revised “CMS Item 614.10” to “CMS 614.11.”</td>
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<tr>
<td>641-8.5 6-126 6-126</td>
<td>Editorial</td>
<td>Plan Preparation/Production / Closure of Right Lane of Three-Lane Section with Two-Way Left-Turn Lane / Bid Items. Inserted “Item” in front of “614” in the first and last lines; in the last line, also added a comma after “614” and relocated the units to follow the description.</td>
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<tr>
<td>641-9.6</td>
<td>6-127</td>
<td>6-127</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Two-Lane, Two-Way Operation on Four-Lane Divided Highways / Provisions for Reverse Flow and Use of the Shoulder.</strong> Deleted “Items” in the second paragraph.</td>
</tr>
<tr>
<td>641-9.7</td>
<td>6-128 and 6-129</td>
<td>6-128 and 6-129</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Two-Lane, Two-Way Operation on Four-Lane Divided Highways / Bid Item.</strong> Inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions; inserted “Item” in front of “614” in the paragraph after the list and in front of “614 Work Zone Pavement Markings.”</td>
</tr>
<tr>
<td>641-10.4</td>
<td>6-132</td>
<td>6-132</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Signalized Closing, One-Lane of a Two-Lane Highway / Traffic Signal Details.</strong> Inserted “SCD” in front of “MT-96.16” in the second paragraph.</td>
</tr>
<tr>
<td>641-10.5</td>
<td>6-132</td>
<td>6-132</td>
<td>Change</td>
<td><strong>Plan Preparation/Production / Signalized Closing, One-Lane of a Two-Lane Highway / Pavement Marking.</strong> Revised CMS reference to “CMS 614.11.”</td>
</tr>
<tr>
<td>641-10.8</td>
<td>6-133</td>
<td>6-133</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Signalized Closing, One-Lane of a Two-Lane Highway / Bid Items.</strong> Inserted “Item” in front of the item numbers listed; added a comma after each item number; relocated the units to follow the descriptions; in the last line, inserted “Item” in front of “614.”</td>
</tr>
<tr>
<td>641-11</td>
<td>6-134</td>
<td>6-134</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Flagger Closing One Lane of a Two-Lane Highway.</strong> Revised “SCD MT-97.12” in the fourth paragraph to “MT-97.12.”</td>
</tr>
<tr>
<td>641-12</td>
<td>6-134</td>
<td>6-134</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Lane Closure in Deceleration Lane.</strong> Inserted “SCD” in front of “MT-98.12” in the third paragraph; inserted “Item” in front of “614” in the fourth paragraph; in the last line, inserted “Item” in front of “614,” added a comma after “614,” and relocated the units to follow the description.</td>
</tr>
<tr>
<td>641-13</td>
<td>6-135</td>
<td>6-135</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Lane Closure Before Exit Gore.</strong> Inserted “SCD” in front of “MT-98.13” in the third, fifth and seventh paragraphs; inserted “Item” in front of “614” in the eighth paragraph; in the last two lines, inserted “Item” in front of “614,” added a comma after “614,” and relocated the units to follow the descriptions.</td>
</tr>
<tr>
<td>641-14</td>
<td>6-136</td>
<td>6-136</td>
<td>Editorial</td>
<td><strong>Plan Preparation/Production / Lane Closure at Entrance Ramp.</strong> Inserted “SCD” in front of “MT-98.15” in the first line of the third and fourth paragraphs; inserted “Item” in front of “614” in the fifth paragraph; in the last two lines, inserted “Item” in front of “614,” added a comma after “614,” and relocated the units to follow the descriptions.</td>
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</table>
| 641-15  | 6-137| 6-137    | Editorial      | **Plan Preparation/Production / Typical Lane Closures for Ramps.**  
In the first paragraph, inserted “Item” in front of “614”; in the last line, inserted “Item” in front of “614,” added a comma after “614,” and relocated the units to follow the description. |
| 641-16  | 6-137| 6-137    | Editorial      | **Plan Preparation/Production / Traffic Control for Long Line pavement Marking Operations.**  
Deleted “Item” in the second paragraph. |
| 641-17  | 6-138 and 6-139 | 6-138 and 6-139 | Editorial | **Plan Preparation/Production / Freeway/Expressway Ends Closures.**  
In the last two paragraphs on page 6-138, inserted “SCD” in front of MT-99.50 and MT-99.51; inserted “Item” in front of each bid item listed; added a comma after the number of each bid item listed; relocated the units column in the list to follow the descriptions. |
| 641-19  | 6-140| 6-140    | Editorial      | **Plan Preparation/Production / Transition Plans for Use of Shoulder.**  
Inserted “Item” in front of each bid item listed; added a comma after the number of each bid item listed; relocated the units column in the list to follow the descriptions; in the list before the last paragraph, revised “614 Work Zone Pavement Markings” to “Item 614 Work Zone Pavement Markings.” |
| 642-2   | 6-142| 6-142    | Editorial      | **Plan Notes / (M-101) Item 614 - Maintaining Traffic.**  
Revised “CMS tem 614” to “CMS Item 614” in note 2. |
| 642-3   | 6-142| 6-142    | Change         | **Plan Notes / (M-101A) Item 614 - Maintaining Traffic (At All Times).**  
Revised “one lane” in the first line to “___ lane(s)”; revised the Item descriptions to “Item 502 Structure for Maintaining Traffic, Item 615 Pavement for Maintaining Traffic, Item 615 Roads for Maintaining Traffic”; revised “410, 614 and 616” to “Items 414 and 614.” |
| 642-4   | 6-142| 6-142    | Editorial      | **Plan Notes / (M-101B) Item 614 - Maintaining Traffic (Time Limitation on a Detour).**  
Inserted “CMS” in front of “108.07” in the first paragraph; deleted “Item” in the Designer Note. |
| 642-5   | 6-143| 6-143    | Editorial      | **Plan Notes / (M-101C) Item 614 - Maintaining Traffic (Winter Time Limitations).**  
Inserted “CMS” in front of “108.07” in the third line. |
| 642-6   | 6-143| 6-143    | Editorial      | **Plan Notes / (M-101D) Item 614 - Maintaining Traffic (Lanes Open During Holidays or Special Events).**  
Inserted “CMS” in front of “108.07” in the last paragraph before the Designer Note; deleted “Item” in the Designer Note. |
| 642-9   | 6-144| 6-144    | Change         | **Plan Notes / (M-101G) Item 614 - Maintaining Traffic (Contingency Quantities).**  
Capitalized “engineer” in the first paragraph; deleted the item shown for calcium chloride; inserted “Item” in front of the four remaining bid item numbers listed; in the Designer Note, revised “Bituminous” to “Asphalt” and deleted the two references to calcium chloride. |
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<tr>
<td>642-16</td>
<td>6-146</td>
<td>6-146</td>
<td>Change</td>
<td>Plan Notes / (M-105) Concrete Median Barrier Replacement. In the second line, revised “to a ___ linear feet (meter) length” to “to ___ linear feet (meter).”</td>
</tr>
<tr>
<td>642-17</td>
<td>6-146</td>
<td>6-146</td>
<td>Change</td>
<td>Plan Notes / (M-106) Guardrail Replacement. Replaced the text in this section with “This note has been incorporated into the 2002 CMS.” (This note will be deleted at a later time, and the following notes renumbered, if another note doesn’t replace it.)</td>
</tr>
<tr>
<td>642-18</td>
<td>6-146</td>
<td>6-146</td>
<td>Editorial</td>
<td>Plan Notes / (M-107) Item 614 - Law Enforcement Officer (With Patrol Car). Inserted “CMS” in front of “614” in the first line; on page 6-147, in the second paragraph revised “Item 614 - Law Enforcement Officer” to “Item 614, Law Enforcement Officer”; in the last paragraph before the Designer Note, inserted a comma after “Item 614.”</td>
</tr>
<tr>
<td>642-19</td>
<td>6-147</td>
<td>6-147</td>
<td>Change</td>
<td>Plan Notes / (M-108) Dust Control. Deleted “and calcium chloride” in the first line; inserted “Item” in front of “616” in the item description; deleted the item description for calcium chloride; deleted the last sentence in the Designer Note.</td>
</tr>
<tr>
<td>642-20</td>
<td>6-147</td>
<td>6-147</td>
<td>Change</td>
<td>Plan Notes / (M-109) Work Zone Markings and Signs. Revised “as directed” in the first line to “at locations identified”; deleted “Items” in the second line; revised “614.10” to “614.11”; in the Designer Note, inserted “Item” in front of “614” in three places.</td>
</tr>
<tr>
<td>642-21</td>
<td>6-148</td>
<td>6-148</td>
<td>Change</td>
<td>Plan Notes / (M-110) Item 622 - Portable Concrete Barrier, 50” (1270 mm), As Per Plan. Revised “Standard Construction Drawing” in the first paragraph to “SCD”; revised “a” to “an” in the first line of the second paragraph; revised the address for Carsonite International; revised “Syro Glarefoil” to “Trinity Glarefoil,” deleted “Syro Steel Incorporated” and revised “Subsidiary of Trinity Industry” to “Trinity Industry.”</td>
</tr>
<tr>
<td>642-22</td>
<td>6-148</td>
<td>6-148</td>
<td>Editorial</td>
<td>Plan Notes / (M-111) Item 614 - Replacement Sign. Revised “feet” to “foot” in the first line of the second paragraph; inserted a blank space (i.e., ___ ) in the third paragraph between “of” and “square.”</td>
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| 642-24  | 6-149 and 6-150 | 6-149 | Change | **Plan Notes / (M-113) Item 614 - Work Zone Speed Limit Sign.**  
In the second line of the first paragraph, relocated “signs and supports” to follow “(____ speed limit)”; in the first line of the second paragraph, revised “Minimum Speed Limit signs” to “Minimum Speed Limit (R-7A) signs”; added parentheses around the fourth paragraph; in the fourth paragraph, revised “30 days” to “30 consecutive calendar days” and added a period after “first” in the fifth line; in the fifth paragraph, revised “signs (Speed Limit)” in the second and third lines to “(Speed Limit) signs” and in the last line revised “730.19” to “CMS 614.03.”; on page 6-150, revised “Item 630 ground-mounted supports” to “Item 630, Ground Mounted Supports”; revised “614, Work Zone Speed Limit Sign” to “Item 614, Work Zone Speed Limit Sign.” |
| 642-25  | 6-150 and 6-151 | 6-150 | Change | **Plan Notes / (M-114) Designated Local Detour Route.**  
In the listing of pay items, deleted “616, Calcium Chloride” and added an item for “Item 407, Tack Coat”; inserted the term “Item” in front of each bid item listed; deleted the period after “PG” in the bid items listed for 301 and 448; deleted comma after “Concrete” in the item for 448. |
| 642-26  | 6-151 | 6-151 | Change | **Plan Notes / (M-115) Item 614 - Barrier Reflectors And/or Object Markers.**  
Revised “Item 626” to “CMS 626”; revised “25 feet (8 meters)” to “50 feet (15 meters)” ; inserted “, Type B,” after “Item 614 Barrier Reflector” in the fourth line; in the Designer Note inserted “Item” before “614” and revised “or” to “and/or.” |
| 642-27  | 6-151 and 6-152 | 6-151 and 6-152 | Change | **Plan Notes / (M-116) Double Fines in Work Zone Sign.**  
Revised the title to “Construction Zones/ Fines Doubled Sign”; in the second paragraph revised “30 or more days” to “30 or more consecutive calendar days”; revised “730.19” in the last line on page 6-151 to “CMS 614.03”; on page 6-152, revised “Double Fines in Work Zones” and “Double Fines in Work Zone” to “Construction Zone/ Fines Doubled”; revised “at least 30 days” in the second paragraph of the Designer Note to “at least 30 consecutive calendar days.” |
| 642-28  | 6-152 | 6-152 | Change | **Plan Notes / (M-117) Temporary Road Earthwork.**  
Revised the title to “(M117) Earthwork For Maintaining Traffic”; revised the pay item descriptions to “Excavation for Maintaining Traffic” and “Embankment for Maintaining Traffic”; added the following new first sentence in the Designer Note: “This note should be used in conjunction with CMS Item 615, Roads For Maintaining Traffic.” |
| 642-29  | 6-152 | 6-152 | Editorial | **Plan Notes / (M-118) Floodlighting.**  
Revised “Item 614 - Maintaining Traffic” in the second paragraph to “Item 614, Maintaining Traffic.” |
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<th>Section</th>
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<tr>
<td>642-30</td>
<td>6-153 and 6-154</td>
<td>6-153 and 6-154</td>
<td>Change</td>
<td>Plan Notes / (M-119) Item 614 - Work Zone Impact Attenuator (Unidirectional or Bidirectional). On page 6-153, revised “Syro Inc.” to “Trinity Industry”; deleted the reference to the “SS450M” drawing in the second chart; added a new item 3 regarding the GREAT CZ impact attenuator; on page 6-154, revised “Designer’s Notes” to “Designer Notes” and revised note 4 to “Pre-approved shop drawings are reviewed and kept on file. Contact the Office of Roadway Engineering Services for the current Dwg/Rev. and ODOT Approval dates.”</td>
</tr>
<tr>
<td>642-31</td>
<td>6-155 and 6-156</td>
<td>6-155 and 6-156</td>
<td>Change</td>
<td>Plan Notes / (M-120) Item 614 - Work Zone Impact Attenuator, QuadGuard CZ ((Model #), (Unidirectional or Bidirectional)). On page 6-155, revised “Designer’s Notes” to “Designer Notes”; in note 1, revised “24 inches” to “24 inch”; on page 6-156, revised note 4 to “Pre-approved shop drawings are reviewed and kept on file. Contact the Office of Roadway Engineering Services for the current Dwg/Rev. and ODOT Approval dates.”</td>
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<tr>
<td>642-32</td>
<td>6-156</td>
<td>6-156</td>
<td>Change</td>
<td>Plan Notes / (M-121) Item 614 - Portable Water-filled Barrier, Triton (TI2 or TI3). In the title, revised “(TI2 or TI3)” to “(TL2 or TL3)”; revised “TI-3” in the chart to “TL-3”; in the fourth paragraph, deleted “linear” and inserted a comma after “Item 614”; revised “Designer’s Notes” to “Designer Notes.”</td>
</tr>
<tr>
<td>642-33</td>
<td>6-157</td>
<td>6-157</td>
<td>Editorial</td>
<td>Plan Notes / Item 614 - Extra Advance Warning Signs (Note A). Deleted “Item 614 -” in the title; revised “MT-95.40” to “SCD MT-95.40” in the second paragraph; in the fourth paragraph revised “614 Maintaining Traffic” to “Item 614, Maintaining Traffic.”</td>
</tr>
<tr>
<td>642-34</td>
<td>6-157 and 6-158</td>
<td>6-157 and 6-158</td>
<td>Editorial</td>
<td>Plan Notes / Item 614 - Extra Advance Warning Signs (Note B). Deleted “Item 614 -” in the title; revised “MT-95.40” to “SCD MT-95.40” in the second paragraph on page 6-157 and in the first paragraph on page 6-158; in the third paragraph on page 6-158, revised “Item 614 Maintaining Traffic” to “Item 614, Maintaining Traffic.”</td>
</tr>
<tr>
<td>642-35</td>
<td>6-158</td>
<td>6-158</td>
<td>Change</td>
<td>Plan Notes / Item 614 - Work Zone Crossover Lighting System. In the first paragraph, revised “TLTWO” to “two-lane, two-way operation,” revised “Standard Construction Drawing” to “SCD,” revised “713” to “725,” revised “625.22e” to “625.19F,” and revised “working drawing” to “certified drawing”; in the third paragraph, revised, “Work Zone Crossover Lighting System” to “Item 614, Work Zone Crossover Lighting System”; in the last paragraph, revised “Designer” to “Designer Note” and revised “Section 641-11.5” to “Section 641-9.5.”</td>
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<td>Revision Involves:</td>
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</table>
  Deleted “Item 614 -" in the title; in the note with the chart, revised “MT-96.26" to “SCD MT-96.26." |
  Deleted “Item 614 -" in the title; revised “Standard Construction Drawing" to “SCD.” |
  Added parentheses around “for Shoulder Transition” in the title; in the first paragraph, revised “Standard Construction Drawing” to “SCD,” revised “713” to “725,” revised “625.22e” to “CMS 625.19F,” revised “working drawing” to “certified drawing,” and revised “625.04” to “CMS 625.04”; in the second paragraph, revised “work zone lighting system” to “Item 614, Work Zone Lighting System” and revised “drawing” to “SCD”; in the Designer Note, revised “Section 641-11.5” to Section 641-19." |
  In the first paragraph, deleted “project” and capitalized “Engineer”; in the third paragraph on page 6-161, capitalized “Contractor.” |
| 642-40 | 6-160 and 6-161 | 6-160 and 6-161 | Editorial | Plan Notes / Portable Changeable Message Signs, By Type, As Per Plan.  
  In the title, added “Item 614,” and deleted “By Type”; added a sentence in the first paragraph referencing the website location for the list of approved PCMSs; in the fifth paragraph, capitalized “Project Engineer” and enclosed the whole paragraph in parentheses; on page 6-162, enclosed the second paragraph in parentheses, revised “614.07 per 2002 specs.” in the third paragraph to “CMS 614.07,” and added a comma after “Item 614" in the pay item description; on page 6-163, deleted the extra “MARCH” in the sixth line, added a sentence in the first paragraph referencing the pre-qualified list on the website, and moved the third sentence in the first paragraph (about maintenance of the list) to the end of the paragraph. |
| 670-7 | 6-169 | 6-169 | Change | Other Considerations / Rest Area Closures.  
  Corrected the sign size in the second paragraph to “28" x 10" (700 x 250 mm)”; deleted the term “Item” in the last paragraph. |
| Figure 698-3a | 6-213 | 6-213 | Change | Temporary Traffic Control Signs.  
  Added the four sign cuts and cross-reference information for the EXIT OPEN/CLOSED signs. |

**Part 11, Highway Lighting [top of page]**

| 11-4 and 11-5 | 11-4 and 11-5 | Editorial | Table of Contents.  
  Titles changed in some Plan Notes. |
|----------------|----------------|------------|------------------------|
| 1100-1 | 11-7 | 11-7 | Editorial | General / Introduction.  
  Revised “CMS Items 625 and 725” to “CMS Item 625 and CMS 725.” |
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<td>1141-3.1</td>
<td>11-50</td>
<td>11-50</td>
<td>Change</td>
<td>Plan Preparation/Production/Plan Composition/General. In the first paragraph, to reflect current practice, deleted “(prepared by the Office of Production)” and the fourth sentence (i.e., “Where SCDs are listed...”).</td>
</tr>
<tr>
<td>1142-2</td>
<td>11-58</td>
<td>11-58</td>
<td>Change</td>
<td>Plan Notes / Luminaire Removed, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
</tr>
<tr>
<td>1142-3</td>
<td>11-58</td>
<td>11-58</td>
<td>Change</td>
<td>Plan Notes / Luminaire Removed for Salvage, as per plan. In the title and bid description, deleted “as per plan” and revised “Salvage” to “Storage”; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-4</td>
<td>11-58</td>
<td>11-58</td>
<td>Change</td>
<td>Plan Notes / Luminaire Removed for Storage, as per plan. In the title and bid description, deleted “as per plan” and revised “Storage” to “Reuse”; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-5</td>
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<td>11-58</td>
<td>Change</td>
<td>Plan Notes / Light Pole Removed, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-6</td>
<td>11-58</td>
<td>11-58</td>
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<td>Plan Notes / Light Pole Removed for Storage, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-7</td>
<td>11-58</td>
<td>11-58</td>
<td>Change</td>
<td>Plan Notes / Light Tower Removed for Storage, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-8</td>
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<td>11-59</td>
<td>Change</td>
<td>Plan Notes / Light Pole Foundation Removed, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-9</td>
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<td>11-59</td>
<td>Change</td>
<td>Plan Notes / Pull Box Removed, as per plan. Deleted “as per plan” from the title and the bid description in the note; added “202,” to the title; added CMS in front of the specification reference; removed bold from CMS Item reference.</td>
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<td>1142-10</td>
<td>11-59</td>
<td>11-59</td>
<td>Change</td>
<td>Plan Notes / Pull Box Cleaned. Added “625,” to the title; revised “Item Special” to “CMS Item 625.”</td>
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<td>1142-11</td>
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<td>11-59</td>
<td>Change</td>
<td><strong>Plan Notes / Conduit Cleaned.</strong> Revised the title to “625, Conduit Cleaned and Cables Removed”; revised the bid item description to “CMS Item 625, ‘Conduit Cleaned and Cables Removed’”; revised “for each linear foot” to “per foot.”</td>
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<td>1142-12</td>
<td>11-60</td>
<td>11-60</td>
<td>Change</td>
<td><strong>Plan Notes / Disconnect Existing Circuit.</strong> Revised the title to “202, Disconnect Existing Circuit, As Per Plan”; revised the bid item description to “CMS Item 202, ‘Disconnect Existing Circuit, As Per Plan’. “</td>
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<td>1142-13</td>
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<td>11-60</td>
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<td><strong>Plan Notes / Power Service Removed, as per plan.</strong> Revised the title to “202, Power Service Removed, As Per Plan”; revised the bid item description to “CMS Item 202, ‘Power Service Removed, As Per Plan’. “</td>
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<td>1142-14</td>
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<td>11-60</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, High Mast, as per plan.</strong> In the title, revised “as per plan” to “As Per Plan”; revised “CMS Item 713.21” in the first line to “CMS 725.21”; removed bold feature from the company names.</td>
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<tr>
<td>1142-15</td>
<td>11-61</td>
<td>11-61</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, Low Mast, as per plan.</strong> In the title, revised “as per plan” to “As Per Plan”; revised “CMS Item 713.21” in the first line to “CMS 725.21”; removed bold feature from the company names.</td>
</tr>
<tr>
<td>1142-16</td>
<td>11-61</td>
<td>11-61</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, Conventional, as per plan.</strong> Revised the title to “625, Luminaire, Conventional, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Luminaire, Conventional, As Per Plan (add supplemental description)’”; removed bold feature from note text.</td>
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<tr>
<td>1142-17</td>
<td>11-61</td>
<td>11-61</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, Post-top, as per plan.</strong> Revised the title to “625, Luminaire, Post-top, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Luminaire, Post-top, As Per Plan (add supplemental description)’”; removed bold feature from note text.</td>
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<td>1142-18</td>
<td>11-62</td>
<td>11-62</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, Underpass, as per plan.</strong> Revised the title to “625, Luminaire, Underpass, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Luminaire, Underpass, As Per Plan (add supplemental description)’”; removed bold feature from note text.</td>
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<td>1142-19</td>
<td>11-62</td>
<td>11-62</td>
<td>Change</td>
<td><strong>Plan Notes / Luminaire, Installation Only, as per plan.</strong> Revised the title to “625, Installation Only, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Installation Only, As Per Plan’. “</td>
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<tr>
<td>1142-20</td>
<td>11-62</td>
<td>11-62</td>
<td>Editorial</td>
<td><strong>Plan Notes / Lamps.</strong> Removed bold feature from note text.</td>
</tr>
<tr>
<td>1142-21</td>
<td>11-62</td>
<td>11-62</td>
<td>Change</td>
<td><strong>Plan Notes / Light Pole, Re-erected, as per plan.</strong> Revised the title to “625, Re-erect Existing Light Pole, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Re-erect Existing Light Pole, As Per Plan’. “</td>
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<td>1142-22</td>
<td>11-63</td>
<td>11-63</td>
<td>Change</td>
<td>Plan Notes / Light Tower Re-erected, as per plan. Revised the title to “625, Re-erect Existing Light Tower, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Re-erect Existing Light Tower, As Per Plan’.”</td>
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<td>1142-23</td>
<td>11-63</td>
<td>11-63</td>
<td>Change</td>
<td>Plan Notes / Anchor Bolts for Light Poles on Bridges and Retaining Walls. Revised the title to “625, Light Pole Anchor Bolts, Misc.: Set for Pilaster Mounted Light Pole”; revised the bid item description to “CMS Item 625, ‘Light Pole Anchor Bolts, Misc.: Set for Pilaster Mounted Light Pole’.”</td>
</tr>
<tr>
<td>1142-24</td>
<td>11-63</td>
<td>11-63</td>
<td>Editorial</td>
<td>Plan Notes / Light Tower Foundation, as per plan. Revised “as per plan” in the title to “As Per Plan.”</td>
</tr>
<tr>
<td>1142-26</td>
<td>11-65</td>
<td>11-66</td>
<td>Change</td>
<td>Plan Notes / Underdrains for Pull Boxes. Inserted a sentence about animal guards before the last sentence of the note. Revised the item description in the last sentence to “CMS Item 603, ‘4” (102 mm) Conduit, Type E’.”</td>
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<tr>
<td>1142-29</td>
<td>11-66</td>
<td>11-66</td>
<td>Editorial</td>
<td>Plan Notes / Power Service Refurbished, as per plan. Revised the title to “625, Power Service Refurbished, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Power Service Refurbished, As Per Plan’.”</td>
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<td>1142-30</td>
<td>11-66 and 11-67</td>
<td>11-67</td>
<td>Editorial</td>
<td>Plan Notes / Power Service, as per plan. Revised the title to “625, Power Service, As Per Plan”; revised the bid item description to “CMS Item 625, ‘Power Service, As Per Plan’.”</td>
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<td>1142-31</td>
<td>11-67</td>
<td>11-67</td>
<td>Change</td>
<td>Plan Notes / Power Service Fence. Revised the title to “Special, Power Service Fence”; replace “the ODOT Construction and Material Specifications” with “CMS 607”; in the second paragraph revised “enclosured” to “enclosed.”</td>
</tr>
<tr>
<td>1142-34</td>
<td>11-68</td>
<td>11-68</td>
<td>Change</td>
<td>Plan Notes / Padlocks and Keys. Revised “CMS Item 631.08(3)” to “CMS 631.06”; removed bold feature from note text.</td>
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Revised the title to “Special, Maintain Existing Lighting”;  
removed bold feature from the note text. |
| 1143      | 11-70        | 11-70             | Editorial       | Specifications.  
Revised “CMS Items 625 and 725” to “CMS Item 625 and CMS 725.” |
| **Part 12, Miscellaneous** | [top of page] |                                 |                 |                                           |
|           | 12-1         | 12-1              | Editorial       | Table of Contents.  
Updated title of Section 1215. |
| 1215      | 12-16        | 12-16             | Change          | Rumble Strips.  
Revised to clarify that information on shoulder rumble strips is  
being handled by the Office of Roadway Engineering Services;  
updated L&D Manual and SCD references; revised the section  
title to “Rumble Strips in the Roadway”; revised the last  
paragraph to clarify that the RUMBLE STRIPS sign should be  
used with installations in the roadway. |
| **Part 14, Index** | [top of page] |                                 |                 |                                           |
|           | 14-1 thru 14-18 | 14-1 thru 14-18  | Change          | Index.  
Revised to address changes in the other parts; also, deleted  
several terms that were redundant. |
Ohio Department of Transportation
Office of Traffic Engineering
1980 W. Broad St., P.O. Box 899
Columbus, OH 43216-0899

Web addresses:
ODOT: http://www.dot.state.oh.us
Office of Traffic Engineering: http://www.dot.state.oh.us/traffic/
ODOT Publications (Design Reference Resource Center): http://www.dot.state.oh.us/drrc/

The price of this Manual is $50.00.
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ODOT Traffic Engineering Manual


New edition, updating and consolidating information previously published in the ODOT Traffic
Control Application Standards Manual, the Traffic Control Design Information Manual, the
Construction Guidelines for Traffic Control Devices and various separate policies, guidelines and
procedures.

2003  January 17, 2003

Revision consists of the following (as well as related pages needed for double-sided printing of
the revised pages):

a new Cover Sheet, Publication Record, and Table of Contents;
in Part 1, a revised Table 197-1;
in Part 2, a revised Section 208-3, and editorial changes in Section 205-2.3.1;
in Part 3, a revised Table of Content, revised Sections 304-2, 342-2, 342-3, 342-4, 342-5 and
343, and editorial changes in Sections 301-1, 301-3, 302-1, 304-1, 304-3, 304-6, 306, 307,
320-4, 320-5, 340-1, 340-2, 340-3 and 350-2;
in Part 4, a revised Table of Content, revised Sections 442-3, 442-5, 442-9, 442-10, 442-11,
442-15, 442-16 and 442-19, deleted Sections 442-14, 442-17 and 442-18, and editorial
changes in Sections 401-1, 403-1, 420-1, 421-1, 441-9, 442-4, 442-6, 442-7, 442-8,
442-12, 442-13, 443, 450-3.2 thru 450-3.6, 450-4.1, 450-4.3, 450-4.4, 450-6.2, 450-6.3, 450-
8.2, 450-8.5, 450-8.7, 450-8.8, 450-9, 450-10.2 thru 450-10.7 and 450-11.1 thru 450-11.8;
in Part 6, a revised Table of Content, a new Section 605-8.4, revised Sections 605-6.5, 607-
40, 607-41, 640-14, 640-24.1, 641-8.4, 641-10.5, 642-3, 642-9, 642-16, 642-17, 642-19, 642-
20, 642-21, 642-24, 642-25, 642-26, 642-27, 642-28, 642-30, 642-31, 642-32, 642-35, 642-
39, 642-41, 670-7 and Figure 698-3a, and editorial changes in Sections 605-2.1, 605-7.3,
605-11.3, 605-11.4.1, 605-11.5, 605-11.10.2, 606-2, 606-12, 606-14, 606-15, 607-1, 620-3,
640-22, 641-2.6, 641-5.1 thru 641-5.4, 641-5.6, 641-6.1 thru 641-6.5, 641-7.2, 641-7.4, 641-
641-17, 641-19, 642-2, 642-4, 642-5, 642-6, 642-10, 642-12, 642-18, 642-22, 642-29, 642-
33, 642-34, 642-36, 642-37, 642-38 and 642-40;
in Part 11, a revised Table of Content, revised Sections 1141-3.1, 1142-2 thru 1142-19, 1142-21 thru 1142-23, 1142-26, 1142-31, 1142-32 and 1142-34, and editorial changes in
Sections 1100-1, 1142-20, 1142-24, 1142-25, 1142-27 thru 1142-30, 1142-33, 1142-35 and
1143;
in Part 12, a revised Table of Content and revised Section 1215; and
in Part 14, the Index was revised.
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Table 197-1.  ODOT Publication Distribution Coordinators

<table>
<thead>
<tr>
<th>District / C. O. Office</th>
<th>Contact Person</th>
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<tr>
<td></td>
<td>OMUTCD</td>
</tr>
<tr>
<td></td>
<td>SCDs and Others</td>
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<tr>
<td>1</td>
<td>Mary Holmes, Production</td>
</tr>
<tr>
<td>2</td>
<td>Tricia Hines, Planning</td>
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<tr>
<td></td>
<td>Aaron Behrman, Production</td>
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<td>3</td>
<td>Cindy Reynolds, Production</td>
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<td>4</td>
<td>Joe DeFuria, Planning</td>
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<tr>
<td></td>
<td>Ken Greene, Production</td>
</tr>
<tr>
<td>5</td>
<td>Jean Burgess, Roadway</td>
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<td></td>
<td>Gloria Tier, Planning</td>
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<td></td>
<td>Sara Bowers, Production</td>
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<td></td>
<td>Mike McKee, Construction</td>
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<td>6</td>
<td>Sandy Freshour, Production</td>
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<td>Tom Rossman, Roadway</td>
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<td></td>
<td>Berta Sherman, Production</td>
</tr>
<tr>
<td>8</td>
<td>Jay Hamilton, Transportation</td>
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<td></td>
<td>Kay Morris, Production</td>
</tr>
<tr>
<td>9</td>
<td>Richard Chaffin, Planning</td>
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<tr>
<td></td>
<td>Hauke Hille, Production</td>
</tr>
<tr>
<td>10</td>
<td>Johnson Brady, Production</td>
</tr>
<tr>
<td>11</td>
<td>Linda Wenger, Production</td>
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<tr>
<td>12</td>
<td>Gary Benesh, Production</td>
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<tr>
<td>Chief Legal</td>
<td>Beth Dinsmore</td>
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<tr>
<td>Construction Admin.</td>
<td>Gary Angles</td>
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<td>Tim Hill</td>
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<tr>
<td>Estimating</td>
<td>Steve Trendy</td>
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<tr>
<td>Highway Management</td>
<td>Keith Swearingen</td>
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<td>Legislative Services</td>
<td>Sue Bausch</td>
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<tr>
<td>Library</td>
<td>Janet Bix</td>
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<td>Local Programs</td>
<td>Carla Cefaratti</td>
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<tr>
<td>Planning</td>
<td>Leonard Evans</td>
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<tr>
<td>Production</td>
<td>Jeanne Braxton</td>
</tr>
<tr>
<td>Real Estate</td>
<td>David Seasly</td>
</tr>
<tr>
<td>Roadway Eng. Services</td>
<td>Dean Focke</td>
</tr>
<tr>
<td>Structural Engineering</td>
<td>Tim Keller</td>
</tr>
<tr>
<td>Technical Services</td>
<td>Diane Boso</td>
</tr>
<tr>
<td>Traffic Engineering</td>
<td>Gerri Parker</td>
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Table 197-2. OTE Organization and Key Contacts

<table>
<thead>
<tr>
<th>Administration</th>
<th>Area Code 614</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Holstein, P.E.</td>
<td>466-3601</td>
</tr>
<tr>
<td>Dushon Johnson</td>
<td>466-3601</td>
</tr>
<tr>
<td>FAX</td>
<td>644-8199</td>
</tr>
<tr>
<td><strong>Standards, Operations &amp; Safety</strong></td>
<td></td>
</tr>
<tr>
<td>Mohammad M. Khan, P.E.</td>
<td>644-8177</td>
</tr>
<tr>
<td>Juanita D. Elliott, P.E.</td>
<td>644-8143</td>
</tr>
<tr>
<td>Lisa A. McConnell</td>
<td>728-9361</td>
</tr>
<tr>
<td>Albert Antoine, P.E.</td>
<td>644-6624</td>
</tr>
<tr>
<td>Roger U. Dunn</td>
<td>644-8179</td>
</tr>
<tr>
<td>Geraldine Parker</td>
<td>466-4700</td>
</tr>
<tr>
<td>Maintenance of Traffic</td>
<td>466-0139</td>
</tr>
<tr>
<td>Kenneth E. Linger, P.E.</td>
<td></td>
</tr>
<tr>
<td>McCarthy Braxton</td>
<td>752-8829</td>
</tr>
<tr>
<td>Steven H. Barbour, P.E.</td>
<td>752-8846</td>
</tr>
<tr>
<td>Michael Keller</td>
<td>644-8273</td>
</tr>
<tr>
<td>Arthur J. Garrett</td>
<td>644-8159</td>
</tr>
<tr>
<td>Traffic Control</td>
<td></td>
</tr>
<tr>
<td>Homer A. Suter, P.E.</td>
<td>752-9995</td>
</tr>
<tr>
<td>Satya N. Goyal, P.E.</td>
<td>644-8107</td>
</tr>
<tr>
<td>William L. James</td>
<td>466-1290</td>
</tr>
<tr>
<td>Donald R. Snyder</td>
<td>466-4263</td>
</tr>
<tr>
<td>John D. Binns, P.E.</td>
<td>466-5255</td>
</tr>
<tr>
<td>James M. Roth, P.E.</td>
<td>752-0438</td>
</tr>
<tr>
<td>Scott B. Roeder, P.E.</td>
<td>752-6109</td>
</tr>
<tr>
<td>David M. Walters</td>
<td>752-3965</td>
</tr>
<tr>
<td>Sign &amp; Signal Shop</td>
<td></td>
</tr>
<tr>
<td>Paul A. Trapasso</td>
<td>351-2850</td>
</tr>
<tr>
<td>FAX</td>
<td>351-2854</td>
</tr>
<tr>
<td>Automated Directory Assistance</td>
<td>351-2898</td>
</tr>
</tbody>
</table>
bachelors, masters, and/or doctorate degree programs of the traditional academic variety, and is within 5 miles (8 kilometers) of the intersection.

3. **Joint Vocational School.**

A joint vocational school is a public school primarily intended for vocational training for high school juniors and seniors. Signs may be erected when the school is within 5 miles (8 kilometers) of the intersection.

4. **Boarding Schools.**

Signs may be erected when the school provides a traditional academic curriculum and has a substantial portion of the student enrollment comprised of individuals whose permanent residence is not considered to be local to the community in which the school is located. This includes college preparatory schools and military academies.

5. **Major Military Installations.**

Signs may be erected when the military installation has at least 500 permanently assigned personnel or employees and the installation is within 5 miles (8 kilometers) of the intersection.

6. **Privately Owned Non-Profit Campgrounds.**

Signs may be erected when the privately owned non-profit campground is within 5 miles (8 kilometers) of the intersection. This includes scout, church, 4-H, youth, and YMCA/YWCA camps.

7. **Hospice Facility.**

Signs may be erected when the hospice is licensed by the Ohio Department of Health, is within 5 miles (8 kilometers) of the intersection, and is a freestanding facility.

205-2.3.2 **Signs with a Blue Background**

Signs for the following generators shall have a white legend on a blue background:

1. **Law Enforcement Agencies.**

Signs may be erected when the law enforcement agency facility is within 5 miles (8 kilometers) of the intersection, and the agency headquarters approves of or requests the installation.

2. **Motorist Services.**

Signing for hospitals is addressed in Section 207-4 and signing for generic motorist services is addressed in Section 207-5. In addition, signing for tourist information centers is addressed in Section 207-6.

3. **Tourist Oriented Directional Signing (TODS).**

The TODS program is described in Section 207-3.
205-2.3.3 Signs with a Brown Background

Permanent signs may be erected for the following generators provided: (1) the generator is a publicly owned or a privately owned non-profit facility; and (2) the generator has an annual attendance of 100,000 plus 10,000 per mile in urban areas, or 50,000 plus 5,000 per mile in rural areas, where the distance is measured from the generator to the intersection. In rural areas, where generators are less common and more space for generator signing is available, attendance requirements may be reduced by up to 60 percent by the District Deputy Director. Signs for these generators shall have a white legend on a brown background:

1. **Miscellaneous Generators** - Arenas, coliseums, stadiums, auditoriums, convention halls, fairgrounds, parks (national, state, county, municipal, etc.), race tracks and zoos.

2. **Recreation Areas** - Recreation areas (e.g., beaches and lakes). Recreation region boundary signing may also be provided in accordance with the criteria in OMUTCD Section 2S-7.

3. **Tourist Attractions** - Aquariums, arboretums, botanical gardens, geological sites, historical sites, state memorials, restorations, monuments, museums, planetariums and other attractions of historic or cultural interest.

Also, permanent signs may be erected for privately-owned major tourist attractions (e.g., large amusement parks) where the traffic volumes are such as to warrant additional signing to facilitate an orderly flow of traffic to the facility. Signs for these generators shall have a white legend on a brown background.

205-2.4 Generators That Do Not Normally Warrant Signing

Except as covered in the previous paragraph, activities signed for under the Tourist Oriented Directional Signing (TODS) program do not qualify for generator signing under this section.

Also, it has been determined that the following facilities do not normally qualify for signing under these provisions for traffic generators:

1. **Businesses** - Industrial parks, shopping centers, shopping malls, television stations, radio stations and theaters.

2. **Cemeteries** - National, local, state, military, public and private.

3. **Community Facilities** - Churches, civic centers, libraries and subdivisions.

4. **Educational** - Grade schools and high schools (except as provided in Section 205-2.3.1).

5. **Governmental** - Courthouses, disaster assistance facilities, civil defense facilities, drivers license centers, jails, prisons, local government highway buildings, post offices, research facilities, experimental facilities.

6. **Medical** - County homes, fraternal homes, nursing homes, humane facilities (i.e., animal shelters), infirmaries, treatment centers, mental facilities, research facilities, retirement facilities, sanitariums, veteran facilities.

7. **Military** - Armories, arsenals, sites and detachments.

8. **Recreational** - Amusement parks, country clubs and golf courses.
208  REST AREA SIGNS

208-1  General

The OMUTCD addresses signing for rest areas in Sections 2S-21 and 2X-21. Additional signing has been developed over the years for use in ODOT rest areas. For the most part, these address specific requests from the Department of Public Safety (ODPS) or the offices responsible for maintaining the facilities. This section addresses additional signing approved for use in advance of, and within rest areas. Figures 298-6a through 298-6c illustrate Rest Area Signs discussed in this section which are not shown in the OMUTCD.

208-2  REST ROOMS CLOSED Sign (RA-86)

The REST ROOMS CLOSED sign (RA-86) shall be erected on conventional roads and on the mainline of freeways and expressways when rest rooms are closed for other than routine maintenance of short duration. This sign should be erected under the Advance Rest Area sign (RA-1 or RA-12). On freeways and expressways, an additional sign may be erected under the Exit Direction Rest Area sign (RA-2 or RA-3).

If the rest area signs are supplemented with panels, the RA-86 sign should be erected under the bottom panel. If the sign support has a breakaway connection, care must be taken to assure that the RA-86 sign does not interfere with the breakaway action.

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Route Type</th>
<th>Legend</th>
<th>Size Inch (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA-86-48</td>
<td>Freeway &amp; Expressway</td>
<td>REST ROOMS CLOSED</td>
<td>48 x 48 (1200 x 1200)</td>
</tr>
<tr>
<td>RA-86-24</td>
<td>Standard &amp; Major Standard</td>
<td></td>
<td>24 x 24 (600 x 600)</td>
</tr>
</tbody>
</table>

208-3  SAFETY BREAK FREE COFFEE Sign (N-62)

The SAFETY BREAK FREE COFFEE sign (N-62) may be erected when authorized by the District Deputy Director. These signs shall not be easel-mounted and should not be erected on separate supports under normal conditions. If the N-62-144 sign is used, extreme care must be taken to assure that it does not interfere with the breakaway (or yielding) aspect of the supports and that the supports are of sufficient size to accommodate the extra signing area and wind loading.
208-4  NO FACILITIES Sign Panel (RAP-1)

The NO FACILITIES panel (RAP-1) may be used on freeways and expressways when a rest area is constructed with the rest room facilities to be added at a later date. This panel is erected below the Advance Rest Area sign (RA-1). An additional panel may be erected below the Exit Direction Rest Area sign (RA-2 or RA-3).

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Route Type</th>
<th>Legend</th>
<th>Size inch (mm)</th>
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<tbody>
<tr>
<td>N-62-48</td>
<td>All</td>
<td>SAFETY BREAK FREE COFFEE</td>
<td>48 x 60 (1200 x 1500)</td>
</tr>
<tr>
<td>N-62-108</td>
<td>Expressway</td>
<td>SAFETY BREAK FREE COFFEE / PHONE</td>
<td>108 x 36 (2700 x 900)</td>
</tr>
<tr>
<td>N-62-132</td>
<td>Freeway</td>
<td>SAFETY BREAK FREE COFFEE / PHONE</td>
<td>132 x 48 (3300 x 1200)</td>
</tr>
<tr>
<td>N-62-144</td>
<td>Freeway &amp; Expressway</td>
<td>SAFETY BREAK FREE COFFEE</td>
<td>144 x 48 (3600 x 1200)</td>
</tr>
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208-5  Other Rest Area Signs

Additional approved signs for use within the rest area are shown in Figures 298-6a through 298-6c. Color and size information can be obtained by referring to the SDM (see Section 295-2).

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Route Type</th>
<th>Legend</th>
<th>Size inch (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP-1-72</td>
<td>Freeway &amp; Expressway</td>
<td>NO FACILITIES</td>
<td>72 x 36 (1800 x 900)</td>
</tr>
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</table>

208-6  Report Drunk Drivers Sign (N-99)

The N-99 sign is intended to assist the Ohio Department of Public Safety’s campaign to encourage reporting of drunk drivers. The legend on this sign is REPORT DRUNK DRIVERS 1-800-GRAB DUI CELLULAR DIAL *DUI FREE AIR TIME.

This sign should be erected in all ODOT rest areas. It should be erected on separate supports along
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<td>Patented or Proprietary Materials, Specifications or Processes</td>
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<td>Purchasing Materials for Installation and Use by Local Agencies</td>
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<td>Use of Type G Sheeting</td>
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<td>Pavement Marking</td>
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<td>Temporary Pavement Marking Materials</td>
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<td>340-4</td>
<td>Raised Pavement Markers</td>
<td>3-21</td>
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<td>340-5</td>
<td>Object Markers</td>
<td>3-22</td>
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<tr>
<td>342-1</td>
<td>(202-A) 202, Raised Pavement Markers, Removed for Storage, As Per Plan</td>
<td>3-23</td>
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<tr>
<td>342-2</td>
<td>(621-A) Materials Supplied by the Department</td>
<td>3-23</td>
</tr>
<tr>
<td>342-3</td>
<td>(621-B) Return of Non-Performed Raised Pavement Marker Materials Supplied by the Department</td>
<td>3-23</td>
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<td>342-4</td>
<td>(621-C) Loading of Materials Supplied by the Department at the Recycler's Warehouse</td>
<td>3-24</td>
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<td>SPECIFICATIONS</td>
<td>3-25</td>
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<td>350</td>
<td>CONSTRUCTION</td>
<td>3-26</td>
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<td>General</td>
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<td>Work Zone Performance Evaluations</td>
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<td>MAINTENANCE / OPERATIONS</td>
<td>3-27</td>
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<td>OTHER CONSIDERATIONS</td>
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<td>REFERENCE RESOURCES</td>
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</table>
300 GENERAL

300-1 Introduction

The information provided in this Part of the TEM is intended to supplement the OMUTCD by presenting ODOT practices and procedures concerning the design, construction, operations and maintenance of various types of traffic marking devices such as pavement markings, including raised pavement markers, object markers, barrier reflectors and delineators.

300-2 Construction Projects

Section 140 addresses the general application of ODOT standards, specifications and standard construction drawings to construction projects and Section 350 provides additional construction related information specific to traffic control markings.

300-3 Force Account (ODOT Operations) Work

Districts performing force account markings work must comply with the requirements in the OMUTCD and this Manual. It is recommended that the Districts follow the provisions in the applicable markings related SCDs and CMS sections as well. It should be recognized, however, that the information in the CMS and SCDs does not necessarily provide the only method to achieve a given objective.
301 PAVEMENT & CURB MARKINGS

301-1 General

OMUTCD Parts 3A and 3B present information on pavement markings. Sections 340, 350 and 360 of this Manual present additional guidance information, and Standard Construction Drawings TC-71.10, TC-72.20 and TC-73.10 provide additional design and application information. Pavement marking specifications are addressed in CMS Item 640 and CMS 740, and Supplement 1047 addresses testing procedures.

Raised Pavement Markers (RPMs) are a special form of pavement marking addressed in OMUTCD Part 3 and in Part 302 of this Manual.

The general standards for curb markings are addressed in OMUTCD Section 3B-21.

301-2 Selection of Pavement Marking Materials

ODOT currently employs the following material types for pavement markings on ODOT-maintained highways: conventional and fast dry paint, polyester, extruded thermoplastic, epoxy and preformed plastic. Pavement marking materials for application on ODOT-maintained highways should be selected from Table 397-1.

The use of pavement marking materials which are capable of longer service lives than that of traffic paint can result in benefits of reduced frequency of renewal, less exposure of the public and workers to the hazards of the pavement marking operation, and a higher percent of time markings are present on the roadway. Therefore, such pavement marking materials shall be used on ODOT-maintained highways wherever pavement conditions permit the material to achieve its expected service life while providing comparable economy to alternative materials.

For highways not maintained by ODOT, the method of providing long-life pavement marking materials shall be the same as that described herein for ODOT-maintained highways except:

1. Local maintaining agencies shall agree in writing to maintain such markings in-kind in the future.

2. The policy regarding ODOT-maintained highways in Villages is contained in Section 301-3.

301-3 Pavement Marking in Incorporated Villages

ORC Section 5521.01 provides that the Director of Transportation, upon request by, and approval of, the legislative authority of a Village, shall maintain, repair and apply standard longitudinal pavement markings as considered appropriate.

“Request by, and approval of, the legislative authority of a Village” shall be in the form of ODOT Form No. MR-689 (see Form 1396-1) and shall describe the state highway extensions covered by the Ordinance. All such maintenance ordinances (MR-689) shall be filed in the office of the District Deputy Director.

The pavement markings shall be maintained by the District in conformance with the OMUTCD and shall be applied in the course of regularly scheduled pavement marking work. An inventory of these markings shall be maintained in the District.

The placing of auxiliary markings shall not be ODOT’s responsibility, but may be included in a contract administered by ODOT. The Village shall bear all project costs of such auxiliary markings. Auxiliary markings shall be defined as all markings described in CMS 641.08, except center lines,
lane lines, edge lines and channelizing lines. However, channelizing line segments of 200 feet (60.0 meters) or less shall be considered auxiliary markings.

301-4 Longitudinal Markings

Longitudinal markings include center lines, two-way left-turn only markings (excluding arrows), lane lines, edge lines and channelizing lines. The standard width for center lines, lane lines and edge lines on ODOT-maintained highways shall be 4 inches (100 millimeters), and the standard width for channelizing lines shall be 8 inches (200 millimeters). However, as noted in O MUTCD Sections 3A-6 and 3A-7 and Figure M-1, slightly wider lines may be used for additional emphasis.

301-5 Stop Lines

The general standards for Stop Lines are addressed in O MUTCD Section 3B-17. For ODOT-maintained highways, Stop Lines shall be 24 inches (600 millimeters) wide. They should be used at all signalized intersections. They should also be used to supplement STOP signs where it is important to indicate the point behind which vehicles are required to stop.

301-6 Crosswalk Markings

The general standards for Crosswalk Lines are addressed in O MUTCD Section 3B-18. For ODOT-maintained highways, the standard width for Crosswalk Lines shall be 12 inches (300 millimeters), except that for a midblock crosswalk they shall be 24 inches (600 millimeters) wide.

301-7 Parking Space Markings

The general standards for parking space markings are addressed in O MUTCD Section 3B-19 and 3B-24. For ODOT facilities, the standard width for parking space lines shall be 4 inches (100 millimeters).

When parking spaces reserved for handicapped persons are provided, in addition to the required signing (MUTCD Section 5E-16), the International Symbol of Access (wheelchair symbol) shall be used to further identify the reserved stall(s). Unless there is a need for additional emphasis, the standard size symbol shall be used (MUTCD Section 3B-24).

The Ohio Building Code and the Americans with Disabilities Act (ADA) of 1991 establish various requirements for the number and design of parking spaces reserved for the handicapped. Additional information is available upon request from the OTE Standards Section.

301-8 Pavement Marking Words and Symbols

As noted in O MUTCD Section 3A-8, all pavement marking words (letters and numerals) and symbols shall be in conformance with FHWA's Standard Alphabet for Highway Signs and Pavement Markings. SCD TC-71.10 establishes placement standards for the words and symbols, as well as providing additional design detail information. The standard pavement marking words and symbols are illustrated in the following O MUTCD figures:

1. M-22 Lane-Use Arrows
2. M-23 Alternate Lane-Use Arrows
4. M-25 Wrong-Way Arrows and Preferential Lane Symbols
5. M-26 Speed Measurement Markings
6. M-27 Railroad Crossing Markings
However, the alternate Lane-Use Arrows shown in OMUTCD Figure M-23 should not be used on ODOT-maintained highways, unless needed to match similar arrows used by another jurisdiction in the same area.

For use in calculating material application rates for these auxiliary pavement markings, Table 397-2 shows the marking area in square feet and in square meters for various words and symbols.

301-9 Two-Way Left-Turn Arrows

OMUTCD Sections 3B-12 and 3B-20 establish standards for the design and placement of pavement marking arrows and SCD TC-71.10 provides detailed dimensions for the left-turn arrows. For uniformity and consistency, the following additional guidelines have been established for spacing two-way left-turn arrows within a two-way left-turn only (TWLTO) lane.

As shown in Figure 398-1, these arrows should be spaced 16 feet (4.9 meters) apart, tip to tip, on TWLTO facilities; and the “wing tips” of the arrows should be placed 4 inches (100 millimeters) from the center of the lane. These arrow sets should be longitudinally spaced at intervals of 500 to 1000 feet (150 to 300 meters) for speeds up to 40 miles per hour, and at intervals of 1500 to 2000 feet (450 to 600 meters) for speeds over 40 miles per hour.

Signing for TWLTO facilities is addressed in OMUTCD Section 2J-19.

301-10 Speed Measurement Markings

Speed Measurement Markings are used to establish Air Speed Check Zones to assist in the enforcement of speed measurements. They shall be 24 inches (600 millimeters) in width, and they shall be installed in accordance with OMUTCD Section 3B-23 and Figures M-26.

The following procedure has been established for installing and maintaining (i.e., replacing after resurfacing), or abolishing Air Speed Check Zones:

1. Local Ohio State Highway Patrol (OSHP) Posts shall submit requests for establishing, maintaining or abolishing Air Speed Check Zones to the OSHP Aviation Section Headquarters on Air speed Check Zone Request Form AZ-1 (Form 396-1).

2. The Aviation Section Headquarters shall determine the necessity of establishing, maintaining or abolishing an Air Speed Check Zone.

3. If the Aviation Section Headquarters approves the request, it shall be forwarded to the appropriate ODOT District Highway Management Administrator.

4. The ODOT District shall evaluate the practicality of establishing or maintaining the zone. If the request is determined to be practical, the District shall complete the requested work. A registered surveyor shall lay out the markings (when originally established and when replaced after resurfacing).

5. Upon completion of the requested work, the District shall:
   a. Update its records, including its Air Speed Check Zone inventory,
   b. Complete the ODOT portion of the request form, and
   c. Return the completed request form to the OSHP Aviation Section Commander, at 2829 W. Dublin-Granville Rd., Don Scott Field, Columbus, Ohio 43235.
302 RAISED PAVEMENT MARKERS

302-1 General

Raised Pavement Markers (RPMs) are a special form of pavement markings described in OMUTCD Sections 3A-10, and 3B-14 through 3B-16. Plowable RPMs were developed for use in states that typically have to deal with snow. CMS Item 621 and CMS 721 establish the specifications for RPMs and Supplement 1062 addresses testing procedures.

As noted in OMUTCD Section 3A-10, RPMs may be used as positioning guides, or to supplement or substitute for the standard pavement markings. ODOT’s RPM program basically uses them as positioning guides.

Temporary raised pavement markers are addressed in Section 605-11.12 and SCD MT-95.70, 96.10 and 101.20.

302-2 Guidelines and Placement Standards

RPMs should be used on ODOT-maintained highways. They should be included in new construction and resurfacing projects on ODOT-maintained highways. They may also be included in the plans at other locations. Recycled RPMs shall be specified for use in ODOT RPM contracts as appropriate.

SCDs TC-65.10, 65.11 and 65.12 detail the placement standards and guidelines for RPMs used with center lines, lane lines, edge lines and channelizing lines in general. Various specific typical situations, such as one-lane bridges, stop approaches, curves, two-way left-turn lanes and intersections are also addressed in these SCDs.

Each District should periodically inspect their RPMs to determine if nighttime reflectivity is still adequate. Reflectors that are cracked, abraded, missing or have marginal optical performance should be scheduled for maintenance. Cracked or loose castings should be removed and replaced as soon as practicable. Systematic replacement of RPM reflectors should be scheduled on a two to four year cycle. A statewide average reflector maintenance rate of 33 percent per year is expected.

302-3 Administrative Responsibilities

Responsibilities for this program are as follows:

1. The Office of Traffic Engineering (OTE) shall:
   a. Develop specifications and standards;
   b. Evaluate new RPM materials; determine the method of RPM installation, maintenance and replacement;
   c. Coordinate the recycling program and centralized storage of refurbished RPMs;
   d. Administer the term purchase contract for RPM materials; and
   e. Conduct Quality Assurance Reviews (QARs) at least every three years in each District.

2. The District shall:
   a. Carry out the RPM program in a manner to install 100 percent of the RPMs on all eligible ODOT-maintained highways;
b. Replace RPMs that are removed/disturbed, for whatever reason, as soon as practicable;

c. Maintain a roadway inventory of all RPMs; and

d. Systematic replace RPM prismatic reflectors.

302-4 Maintenance and Recycling

To be effective, RPMs must be properly maintained to keep prismatic reflectors and castings in good condition. Proper maintenance can be best accomplished by a program which emphasizes replacement of removed/disturbed RPMs as soon as practicable in conjunction with a systematic replacement of RPM reflectors on a two to four year cycle. The length of the replacement cycle would be dependant upon factors such as traffic volumes, traffic composition and environmental conditions. Most highways should have reflectors replaced on a three year cycle. A four year replacement cycle might prove to be adequate for low-volume highways; while heavily traveled freeways and expressways with high volumes of truck traffic might need reflector replacement based on a two year cycle.

RPMs shall be removed for recycling prior to resurfacing in accordance with the ODOT RPM recycling program. RPMs removed from the pavement shall be transported from the job site to the designated District collection site for recycling. The District may deliver these castings to ODOT’s contract recycler or arrange to have them picked up by the recycler. Recycled RPMs shall be specified for use in ODOT RPM contracts as appropriate.

302-5 Raised Pavement Markers in Villages

The District may install the RPMs on state highway extensions in Villages, upon request by and approval of the legislative authority of a Village. “Request by, and approval of, the legislative authority of a Village” shall be in the form of ODOT Form No. MR-689 (see Form 1396-1) and shall describe the state highway extensions covered by the Ordinance. All such maintenance ordinances (MR-689) shall be filed in the office of the District Deputy Director. The installation of RPMs upon request of a Village does not obligate ODOT to maintain them.

302-6 Narrow and One-Lane Bridges

RPMs shall be installed in accordance with SCD TC-65.12 at narrow and one-lane bridges. The center line pavement marking shall be stopped 160 feet (48 meters) in advance of a one-lane bridge. Figure 398-3 illustrates signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in Sections 202-5, 303-2 and 304-5.
303 OBJECT MARKERS

303-1 General

OMUTCD Part 3C and Section 4F-4 establish standards and guidelines for the design and use of object markers. Additional design and application information is provided herein. As noted in Section 340-5, for plan purposes object markers shall be treated as flatsheet signs.

303-2 Narrow and One-Lane Bridge

Type 3 object markers shall be used in accordance with OMUTCD Sections 2N-13 and 3C-3 to mark narrow and one-lane bridges. Figure 398-3 illustrates the signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in Sections 202-5, 302-6 and 304-5.

303-3 Delineation of Left-Turn Lanes in Medians

Delineation is recommended for parallel and tapered left-turn lanes at intersections which are not illuminated. Section 304-6 addresses the use of delineators, Keep Right signs and object markers at these locations. Figures 398-4 and 398-5 illustrate delineation of left-turn lanes in medians.

303-4 Barrier Object Marker

Barrier Object Markers are a special type of marker which is mounted on top of 32-inch (0.81meter) PCB and may be used on other temporary traffic barriers. See Section 605-19 for details.
304 DELINEATORS

304-1 General

OMUTCD Part 3D and Section 4F-5 establish standards and guidelines for the design and use of delineators. Additional design and application information is provided herein, and in SCD TC-61.10, CMS Item 620 and CMS 720. Delineator reflector color shall match that of the nearest edge line.

304-2 Delineator Types

For identification purposes, CMS 620.02 designates the following color of each type of delineator: Type C, rectangular white (or “colorless”); Type D, rectangular yellow; and Type E, rectangular red.

304-3 Application Guidelines

In accordance with the provisions of CMS 620.02, on ODOT-maintained routes, only flexible delineator posts on the prequalified list maintained by the Office of Materials Management shall be installed for roadside delineation.

On ODOT-maintained freeways and expressways, delineators shall be used except as noted below.

Delineators should be used on freeway and expressway tangent sections in snowbelt areas (i.e., District 12 and the northern portions of Districts 3 and 4). In other areas of the State, roadside delineators shall not be placed on roadway tangent sections of expressways, freeways and other multilane divided highways when all the following conditions are met:

1. Raised pavement markers (RPMs) are used continuously on lane lines throughout all curves and on all tangents to supplement pavement markings.

2. Where whole routes or substantial portions of routes have large sections of tangent alignment (where, if roadside delineators were not required on tangents, only short sections of curved alignment would need delineators).

3. Roadside delineators are used to lead into all curves as shown in OMUTCD Figure M-31.

Once delineators are installed, they shall be maintained. Periodic reviews shall be conducted to assure that good appearance and effectiveness are maintained.

304-4 Median Openings for Private Access

When it is determined that delineation of a median opening for private access is needed, a rectangular yellow (Type D) delineator should be erected at the median nose on the centerline of the median, on each side of the opening (see Figure 198-2). If the median width exceeds 40 feet (9 meters), this delineator should be erected 20 feet (6 meters) from the pavement edge. Additional delineators may be erected up to 200 feet (60 meters) upstream from the median nose.

304-5 Narrow and One-Lane Bridges

Type C (white rectangular) delineators should be erected 50 feet (15 meters) apart along both sides of each approach to narrow and one-lane bridges in accordance with OMUTCD Part 3D and SCD TC-61.10. Figure 398-3 illustrates the signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in Sections 202-5, 302-6 and 303-2.
304-6  **Delineation for Left-Turn Lanes in Medians**

Delineation is recommended for parallel and tapered left-turn lanes at intersections which are not illuminated. Delineators should be erected 4 to 6 feet (1.2 to 1.8 meters) from the edge of roadway, but not less than 2 feet (0.6 meter) from the edge of a paved or usable shoulder. This is illustrated in *Figures 398-4 and 398-5*. On curbed sections, the delineators should be erected 2 feet (0.6 meter) behind the face of the curb.

The R-37R-36 Keep Right sign shall be erected only when the median width is 5 feet (1.5 meters) or more at the sign location. When the median width is less than 5 feet (1.5 meters) at the sign location, the R-37R-24 may be erected. If the median width does not permit use of the R-37R sign, an X-2 object marker should be erected 15 to 30 feet (4.5 to 9.0 meters) from the nose of the median.

**OMUTCD Section 2J-31** provides information on the R-37 sign. **Part 3C of the OMUTCD** and **Section 303** of this Manual provide information on object markers.
305  COLORED PAVEMENTS

The use of colored pavement as a traffic control device is addressed in OMUTCD Part 3E. We do not currently have any additional ODOT-specific standards related to colored pavements.

306  BARRICADES AND CHANNELIZING DEVICES

The use of barricades and channelizing devices in Temporary Traffic Control Zones is addressed in OMUTCD Part 7 and Part 6 of this manual. Use of these devices in other situations is addressed in OMUTCD Section 3F. We do not currently have any additional ODOT-specific standards related to this use of these devices.
307  BARRIER REFLECTORS

307-1  General

Although not considered traffic control devices, barrier reflectors are used to help mark guardrail and concrete barriers, including bridge parapets. Specifications for these reflectors are covered in CMS Item 626 and CMS 720.04.

Once barrier reflectors are installed, they should be maintained in good condition.

307-2  Application on ODOT-Maintained Highways

Barrier reflectors shall be erected on all new or reconstructed guardrail, new concrete barrier and new or reconditioned bridge parapets. This applies to all state and/or federally-funded projects regardless of the presence of edge lines, reflectorized glare screens, RPMs or highway lighting.

The color of a barrier reflector shall match that of the nearest edge line.

Barrier reflectors shall also be used on temporary traffic barriers in work zones (see Section 605-19). Although they are paid for under CMS Item 614, these reflectors are identical to those described in CMS Item 626.

310  ISLANDS

As noted in OMUTCD Section 4A-1:

A traffic-control island is a defined area between traffic lanes for control of vehicle movements or for pedestrian refuge. Within an intersection area, a median or an outer separation is considered to be an island. An island may be designated by paint, raised bars, mushroom buttons, curbs, guideposts, pavement edge or other devices.

OMUTCD Part 4 discusses the functions of Pedestrian Refuge, Traffic Divisional and Traffic Channelizing Islands, and end protection and approach treatments for them. L&D Manual Volume One Section 300 includes additional information about medians and curbs.
320 MATERIALS AND HARDWARE

320-1 General

The Office of Material Management maintains the prequalified lists for pavement markings, raised pavement markers and barrier reflectors. The prequalified lists are available on that office’s web page.

Specifications and testing procedures for markings materials are addressed in Section 343. Section 350-2 addresses work zone performance evaluations.

320-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is discussed in Section 1220-3.

320-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using federal funds, a process has been established whereby local agencies can purchase such items through ODOT. The process is described in Section 1220-5.

320-4 Use of Type G Sheeting

Type G reflective sheeting (see CMS 730.19) shall be used on cones, weighted channelizers (see Part 6) and tubular markers used at night, barricades and drums, delineators, object markers, guardrail anchor assemblies and impact attenuators. Information about guardrail anchor assemblies and impact attenuators is provided in L&D Manual Volume One Section 603 and additional information about marking them is noted in Plan Notes R-112, R-113 and R-123 (see L&D Manual Volume Three).

320-5 Barrier Reflectors

There is not a testing procedure for barrier reflectors; however, the following approval process has been established:

Barrier reflectors shall be purchased only from companies on the prequalified list maintained by the Office of Materials Management. The manufacturer shall submit to ODOT a sample of the reflector along with a catalog description showing recommended installation procedures and certified test data from an independent test laboratory. ODOT will evaluate these samples to determine conformance with CMS 720.04. Reflectors meeting the specifications will be included on the prequalified list maintained by the Office of Material Management. Poor field performance or a change in materials will be cause for removal from the prequalified list. Substitutes will not be accepted.
330 PLANNING / PROGRAMMING

This area has been reserved for information regarding planning/programming information related to traffic control markings.
340  DESIGN INFORMATION

340-1  General

Section 140 provides general background regarding design information for ODOT projects, including the three-stage review process typically used for traffic control plans. This part of the TEM provides additional design information specific to markings.

Plan notes for marking-related items are addressed in Section 342. Marking specifications and testing information are addressed in Section 343.

340-2  Pavement Marking

In a pavement marking plan the following information should be included:

1. All markings on the main roadway, ramps, cross streets and new street intersections, where needed and the type of material to be used (see Sections 301-2 and 320).

2. Special details should be shown in the plans for markings not covered by typical layouts included on SCDs TC-71.10, TC-72.20 and TC-73.10. These should be drawn to appropriate scale for the contractor to properly place the markings.

3. Subsummary tabulations shall be made of the various markings, as required in the Construction and Materials Specifications (CMS) and Supplemental Specifications (SS) (i.e., CMS Items 642, 643, 644, 645, 646 and 647). All measurements shall be the length of the completed line, including the gaps, intersections and other sections of pavement not normally marked. Station limits and totals for each item shall be shown as follows:

   a. Edge line (white)
   b. Edge line (yellow)
   c. Lane line
   d. Dotted line, ___ inch (millimeter)
   e. Center line: solid, double
   f. Center line: broken, double
   g. Center line: broken, single
   h. Center line: broken and solid, double
   i. Channelizing line
   j. Stop line
   k. Crosswalk line
   l. Transverse line (white)
   m. Transverse line (yellow)
   n. Curb marking (white)
   o. Curb marking (yellow)
   p. Island marking (white)
   q. Island marking (yellow)
   r. Parking lot stall marking
   s. Lane arrow
   t. Word on pavement, ___ inch (millimeter)
   u. Railroad symbol marking
   v. School symbol marking, ___ inch (millimeter)
   w. Handicap symbol marking

4. Payment for all pavement marking items in the General Summary shall be carried as CMS Items 642, 643, 644, 645, 646 and 647 on a unit bid basis (no lump sum) as follows:
### Description Title | Sum These Items From Sec. 340-2(3) | Unit
--- | --- | ---
Edge Line | a, b | Mile (Kilometer)
Lane Line | c | Mile (Kilometer)
Center Line | e, f, g, h | Mile (Kilometer)
Channelizing Line | i | Linear Foot (Meter)
Stop Line | j | Linear Foot (Meter)
Crosswalk Line | k | Linear Foot (Meter)
Transverse Line | l, m | Linear Foot (Meter)
Curb Marking | n, o | Linear Foot (Meter)
Island Marking | p, q | Square Foot (Square Meter)
Parking Lot Stall Marking | r | Linear Foot (Meter)
Lane Arrow | s | Each
Word on Pavement, _____ inch (millimeter) | t | Each
Railroad Symbol Marking | u | Each
Dotted Line, _____ inch (millimeter) | d | Linear Foot (Meter)
School Symbol Marking, _____ inch (millimeter) | v | Each
Handicap Symbol Marking | w | Each

Typical line widths are described in Section 301 of this Manual and in the specifications, and should not be included in the bid item descriptions. Non-typical line widths, when required and approved, shall use “As Per Plan” in the description.

The outline of crosshatched yellow islands shall be constructed with “center line: solid, double.” The outline of crosshatched white islands shall be constructed with “channelizing line.”

#### 340-3 Temporary Pavement Marking Materials

Temporary pavement markings are addressed in Section 605-11.11 and CMS 614.11.

#### 340-4 Raised Pavement Markers

As noted in Section 302-2, raised pavement markers (RPMs) should be included in new and resurfacing construction projects on ODOT-maintained highways. They may also be included in the plans at other locations as specified in the districtwide RPM plans.

The plans shall call for the removal, for storage and refurbishing, of existing RPM castings which would otherwise be abandoned and paved over, and their return to ODOT.
Testing procedures for RPMs are covered in Supplement 1062.

340-5 Object Markers

For plan purposes, object markers shall be considered flatsheet signs.
342 PLAN NOTES

342-1 General

Typical Plan Notes have been consolidated here for convenience in preparing plans. The number used for the Plan Note will be the same as the section number. When a Plan Note revises the material or contractor requirements from that which is specified in the CMS, both the note and the bid item will be “as per plan.” Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of Plan Notes, various format changes are used here that are not typical throughout the TEM, e.g., the terms Contractor and Engineer are capitalized.

342-2 (202-A) 202, Raised Pavement Markers, Removed for Storage, As Per Plan

The following estimated quantity has been included in the plans to remove raised pavement markers for storage. The County Manager shall be contacted for instructions on where to deliver the raised pavement markers.

Item 202, Raised Pavement Markers Removed for Storage, As Per Plan _______ Each

Designer Note: This note may be used when existing RPMs are removed.

342-3 (621-A) Materials Supplied by the Department

All materials are to be Contractor furnished, except that the Department shall supply raised pavement markers and raised pavement marker castings in the quantities shown herein to the contractor. Pay items for the Department supplied materials shall be indicated as “installation only.” The quantity and type of Department supplied materials are shown on this sheet.

The Contractor shall pick up the Department supplied raised pavement marker materials at the

O.P.I.
315 Phillipi Rd.
Columbus, Ohio 45895

For transport to the work site or to the Contractor's storage facility. The recycled raised pavement marker (RPM) authorization form (Supplement 1082) is to be signed by the District Construction Engineer prior to pick up of the RPMs. The Contractor shall notify the District and/or the parties listed on the authorization form in writing at least five calendar days prior to pick up of the Department supplied materials. The Contractor shall store the RPMs without damage or contamination with foreign matter. A deduction in the amount of the actual cost to the Department shall be made for materials damaged by the Contractor or for castings received by the Contractor which were not installed and were not returned to the Department.

Designer Note: This note should be used on projects where ODOT is supplying recycled RPMs. Use with the notes in Sections 342-4 (621-B) and 342-5 (621-C). These notes should be placed as a group under the heading “Raised Pavement Marker General Notes.”

342-4 (621-B) Return of Non-Performed Raised Pavement Marker Materials Supplied by the Department

Raised pavement marker materials supplied by the Department, that are non-performed, shall be carefully packed or repacked in the boxes supplied by the raised pavement marker recycler. Boxes shall be marked with the recycler's part or catalog number, the ODOT project number, the style of the casting, and the color of the prismatic retro-reflector. The recycler's
catalog or part numbers may be obtained from the Office of Traffic Engineering in Columbus, Ohio. Casting styles shall not be mixed within a box. Any boxes not properly packed or marked will not be accepted at the recycler's warehouse.

The boxes shall be placed on skids or pallets with only one style (low profile or conventional, reflectorized or non-reflectorized) and no more than twenty-one boxes (420 RPMs) on each skid.

Non-performed materials shall be returned, to a location specified by the District Construction Engineer, within thirty calendar days of the completion of the project.

The above work including all labor, equipment, and material needed to perform the work, shall be considered incidental to the respective pay item.

If the Department has to repackage the RPMs correctly, the Contractor will be assessed the actual cost for repackaging the materials by the Department's forces.

**Designer Note**: This note should be used on projects where ODOT is supplying recycled RPMs. Use with the notes in Sections 342-3 (621-A) and 342-5 (621-C).

### 342-5 (621-C) Loading of Materials Supplied by the Department at the Recycler's Warehouse

Trucks shall have a loading height of 48 inches (1200 millimeters) and be able to back up flush to the loading dock. Trucks shall not have any obstructions or protrusions that prevent the loading by a standard forklift or lift truck.

Semi-trucks or 20 foot (6 meter) commercial trucks are the most appropriate trucks for loads in excess of four pallets [one pallet = 21 boxes = 2100 pounds (955 kilograms)].

Stake body trucks are appropriate to load less than four pallets, provided the truck is rated for the load and the load can be safely secured for transport by chaining or strapping down as needed.

Pickup trucks are appropriate for loads of approximately one pallet, provided the pickup truck is rated for the load and the load can be safely secured for transport.

Dump trucks, tilt bed trucks, and non commercial moving vans will not be loaded by the recycler's warehouse.

The warehouse supervisor will refuse to load any truck that is unsafe to load or unsuitable for the load being placed on the truck.

**Designer Note**: This note should be used on projects where ODOT is supplying recycled RPMs. Use with the notes in Sections 342-3 (621-A) and 342-4 (621-B).
343 SPECIFICATIONS

**ODOT** specifications for the furnishing and installation of markings are contained in the following **CMS** sections:

- 620 and 720 Delineators
- 621 and 721 Raised Pavement Markers
- 626 Barrier Reflectors
- 630 and 730 Traffic Signs and Sign Supports
- 640 and 740 Pavement Marking

Individually, the different types of pavement marking material are addressed as follows:

<table>
<thead>
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<th>CMS Item</th>
<th>Description</th>
</tr>
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<tr>
<td>644</td>
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</tr>
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<td>645</td>
<td>Preformed (cold) Pavement Marking</td>
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<tr>
<td>647</td>
<td>Heat-fuse Preformed Plastic Pavement Marking</td>
</tr>
</tbody>
</table>

**CMS** specifications related to specific markings items have been referenced individually as they have been discussed in this Part.

**Supplement 1047** addresses the procedure by which **ODOT** will maintain a list of pre-qualified pavement marking materials. **Supplement 1020** and **Supplement 1062** cover testing procedures for delineator posts and raised pavement markers, respectively.
350-1 General

This information is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices. However, it may also be useful for maintenance personnel performing the same functions.

350-2 Work Zone Performance Evaluations

The performance evaluation described in CMS 614.11 shall be conducted according to the ratings given in Table 397-3 for color, Table 397-4 for night visibility and Figure 398-6 for test line durability.
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400 GENERAL

400-1 Introduction

The OMUTCD defines a highway traffic signal as any power operated traffic control device, other than a warning light or steady burning electric lamp, by which traffic is warned or directed to take some specific action. The various types of traffic signals are discussed in Part 6 of the OMUTCD.

The information provided in this chapter is intended to supplement the OMUTCD by presenting ODOT practices and procedures concerning the design, construction, operation and maintenance of the various traffic signal devices.

400-2 Construction Projects

Section 140 addresses the general application of ODOT standards, specifications and standard construction drawings to construction projects and Section 450 provides additional construction related information specific to traffic control signals.

400-3 Force Account (ODOT Operations) Work

Districts performing force account signal work must comply with the requirements in the OMUTCD and this Manual. It is recommended that the Districts follow the provisions in the applicable signing related SCDs and CMS sections as well. It should be recognized, however, that the information in the CMS and SCDs does not necessarily provide the only method to achieve a given objective.
401  TRAFFIC CONTROL SIGNALS - GENERAL

401-1  General

OMUTCD Part 6B presents information on the design, location and use of traffic control signals. Construction details are shown on the SCDs TC-81.10 through TC-85.20. Traffic signal equipment is specified in CMS Items 632 and 633, and CMS 732 and 733.

401-2  Installation of Traffic Signals on State Highways

Policy 516-002(P) documents ODOT policy regarding installation of traffic control signals and intersection control beacons on state highways. A copy of this policy is posted on the network O drive; however, for convenience, a copy has also been included in the Appendix of this manual (Chapter 13).

401-3  Periodic Review of Signals

As noted in OMUTCD Section 6C-2.1, changing traffic patterns may render an existing traffic signal either inefficient or no longer necessary. Therefore, the responsible agency should periodically conduct a traffic engineering study to evaluate the efficiency and necessity of traffic signals under its jurisdiction and determine if revisions may be needed. This traffic engineering study may lead to changing the signal timing, signal phasing, vehicle or pedestrian detection, roadway geometry, or the complete removal of the traffic signal.

Traffic signal installations that are not properly designed and maintained for current traffic conditions, or are no longer warranted, can result in the following conditions:

1. Excessive traffic delay.
2. Increased disobedience of the signal indications.
3. The use of less adequate routes in order to avoid such signals.
4. Increased accident frequency, especially rear-end accidents.

401-4  Removal of Traffic Signals Under ODOT Jurisdiction

If a traffic engineering study indicates that the traffic signal is no longer justified, the traffic signal should be removed by a uniform procedure that will consider public input, accidents, site considerations and an appropriate replacement type of traffic control device. Therefore, when ODOT determines that an existing traffic signal installation no longer meets signal warrants as contained in the OMUTCD, or is no longer the appropriate form of traffic control, the District shall proceed through the following removal process to document and determine if the signal installation should be removed:

1. To determine if the traffic signal is still needed, the District shall prepare a traffic engineering study for the signal installation documenting the following information, as appropriate:
   a. Warrant analysis summary. If reasons other than the standard warrants were used to justify the signal installation, determine if these reasons are still valid.
   b. Accident history.
   c. Site conditions, especially sight distance problems.
reevaluate if the project should continue. Reasons for retention of existing unwarranted signals shall be documented.

If an existing unwarranted signalized intersection is retained, the following applies:

1. All work and equipment at the intersection shall be at 100 percent local cost. Written confirmation is required from the local agency.

2. If within a system, signal control equipment shall be upgraded to be compatible with the system (same manufacturer for all controller software).

3. If within an area approved for special design considerations (such as mast arms, aesthetically designed poles, etc.), the unwarranted intersection shall be upgraded to these standards.

4. If it is not necessary to upgrade equipment except for the controller, the existing intersection signals, signs and pavement markings shall be in conformance with the OMUTCD. Deficiencies may be corrected by the project (at 100 percent local cost) or by the local maintaining agency. The intersection shall conform to the OMUTCD by the final inspection of the construction project.
403 TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION

403-1 General

OMUTCD Part 6B presents information on the design, location and use of traffic control signals. Construction details are shown on the SCDs TC-81.10 through TC-85.20. Traffic signal equipment is specified in CMS Items 632 and 633, and CMS 732 and 733.

403-2 Vehicle Change Interval

The vehicle change interval (or phase change interval) described in OMUTCD Section 6B-15 consists of the yellow change interval and the all-red clearance interval. The yellow change interval advises drivers that their phase has expired and that they should stop or proceed through the intersection if they are too close to stop. The yellow change interval should be followed by a red clearance interval (all-red phase) of sufficient duration to permit traffic to clear the intersection before conflicting traffic movements are released. For more efficient operations, start-up time for the conflicting movements may be considered when setting the length of the all-red.

The length of the phase change interval can be determined using the following equation, in which \[(W+L) / V\] represents the all red interval:

\[
Y + AR = t + V/(2a + 64.4g) + [(W + L) / V] \quad \text{for English units}
\]

\[
Y + AR = t + V/(2a + 19.6g) + [(W + L) / V] \quad \text{for metric}
\]

Where: 
- \(Y + AR\) = Sum of the yellow and all-red,
- \(t\) = perception/reaction time of driver, (typically assumed to be 1 second)
- \(V\) = approach speed, ft/s (m/s)
- \(a\) = deceleration rate, ft/s² (m/s²) (typically assumed to be 10 ft/s² (3.0 m/s²))
- \(W\) = width of intersection, ft (m) (measured from the near side Stop Line to the far edge of the conflicting traffic lane, along the actual vehicular path)
- \(L\) = length of vehicle, ft (m) (typically assumed to be 20 feet (6.0 meters))
- \(g\) = approach grade, percent of grade divided by 100 (plus for upgrade, minus for downgrade)

Yellow change intervals typically are in the range of three to six seconds, and the typical maximum all-red interval is two seconds.

403-3 Off-Peak Flashing Operation of Traffic Control Signals

Using a flashing operation at a signalized intersection during off-peak or low-volume periods may increase the efficiency of the intersection. It also reduces fuel consumption by the traveling public because of the fewer starts and stops, and helps to improve the environment by reducing air and noise pollution. The signal head itself consumes a significantly lower amount of power during flashing operation as compared to regular signal operation. Flashing operation at a signalized intersection
c. Width of the streets used as routes. For example, is there room for traffic to move off the emergency route?

d. Sight distance at the signalized intersections and listing of any one-way streets in the area.

e. History of emergency or transit vehicles involved in accidents.

f. History of emergency or transit vehicles being delayed in heavy traffic.
404 PEDESTRIAN CONTROL FEATURES

404-1 General

Pedestrian signal indications (see OMUTCD Figure TS-12) are special types of traffic signal indications intended for the exclusive purpose of controlling pedestrian traffic. Pedestrian signals are discussed in OMUTCD Part 6D. Construction mounting details are shown on SCD TC-85.10. Pedestrian signal equipment is specified in CMS Item 632 and CMS 732.

404-2 Push Buttons

OMUTCD Section 6D-6 addresses pedestrian detection, usually accomplished using push buttons.

On actuated signal phases, if there is a reasonable expectation of regular pedestrian use, the phase should be equipped with pedestrian push buttons to provide sufficient time to safely cross the highway.

This is especially important on side-street phases where the signal green time is usually based on a short initial green interval with the green time extended by signal actuations. The initial green interval is usually not long enough to allow a pedestrian to cross the mainline. The pedestrian push button will initiate a guaranteed crossing time without input from vehicular traffic. The push button will also provide the pedestrian with a means to cross the mainline when there is no side-street traffic to initiate the signal phase for the pedestrian crossing.

If the push button is provided, it shall be easily accessible without interference from guardrail, ditches or other obstructions. Pedestrian signal heads are not required to be installed just because pedestrian push buttons are used.

404-3 Audible Pedestrian Signals

Audible Pedestrian Signals supplement visual WALK indications and are designed to aid visually impaired pedestrians.

The installation of Audible Pedestrian Signals at State-maintained traffic signals may be considered when an engineering study has been conducted and the following minimum conditions are met:

1. The proposed intersection crosswalk must be signalized.
2. The audible devices should be retrofittable to the existing traffic signal hardware.
3. The signalized intersection should be equipped with pedestrian push buttons.
4. The selected crosswalk must be suitable for the installation of Audible Pedestrian Signals, in terms of surrounding land use and traffic patterns.
5. There must be a demonstrated need for the audible devices in the form of a request from an individual or group that would use the audible signal.
6. The individual or group requesting the device should agree to train the visually impaired users of the Audible Pedestrian Signals.

The audible devices selected should emit a “Cuckoo” WALK sound for a crosswalk in the North-South direction and a “Peep-Peep” WALK sound for a crosswalk in the East-West direction.
420 MATERIALS AND SIGNAL HARDWARE

420-1 General

Construction details are shown on SCDs TC-81.10 through TC-85.20. Traffic signal equipment is specified in CMS Items 632 and 633 and CMS 732 and 733.

420-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is discussed in Section 1220-2.

420-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using federal funds, Sections 1220-4 and 1220-5 describe processes that have been established whereby local agencies can purchase such items through ODOT.

420-4 Vehicular Signal Heads

420-4.1 General

The standards related to vehicular signal heads are addressed generally in OMUTCD Part 6B.

420-4.2 Signal Head Color

OMUTCD Section 6B-24 indicates that it is desirable for the color of signal head housing to be highway yellow. In ODOT-maintained traffic signal installations, the vehicular signal head housings and the outside of the visors shall be highway yellow.

420-4.3 Signal Lens

Signal lenses may be made of glass or plastic. In ODOT-maintained traffic signal installations, glass signal lenses should be used. At rural ODOT intersections, the signal may dwell in a phase for long periods of time during the night causing heat damage to a plastic lens.

The size of signal lenses may be 8 inch or 12 inch depending on the provisions of OMUTCD Section 6B-8. In ODOT-maintained traffic signal installations, the 12-inch lens should be used. The 8-inch lens is typically used for low-speed, urban applications.

420-4.4 Location of Five-Section Signal Heads

The five-section signal head is used where left (or right) turns can be made in both a protected (green arrow) and a permitted (circular green) signal phase. Because the signal indications in a five-section signal head apply to both the through and turning vehicles, the signal head should be located on an extension of the Channelizing Line that separates the through and turn lanes.

Left-turn lanes on four-lane highways with wide medians are often separated from the through lanes by a large painted channelizing island in order to provide good alignment and sight distance for opposing left-turn vehicles. In this case, the five-section head should be located in front of the left-turn lane with an R-25F sign, LEFT TURN YIELD ON GREEN, next to the signal head. Two additional three-section heads should be provided for the through-traffic lanes. The maintaining agency should monitor accidents for this type of operation with the wide median. ODOT's
experience in some parts of the State showed that left-turning drivers were not yielding on the circular green and the phase operation had to be converted to “protected only.”

420-4.5 Aluminum versus Polycarbonate

Vehicular signal heads are manufactured in either aluminum or polycarbonate plastic. The choice of which material to use will be made by the maintaining agency. Many urban jurisdictions prefer the use of polycarbonate, because they are much lighter and easier to work with. Because of the lighter weight, they are often used when adding left-turn signal heads to an existing signal support system. Polycarbonate signal heads are most often associated with rigid-mounted signal heads on mast arms where wind sway will not be a factor.

In ODOT-maintained traffic signal installations, aluminum signal heads should be used to reduce signal head sway in windy conditions unless rigid mounting or span wire tethers are used.

420-4.6 Programmable Signal Heads

A programmable signal head utilizes a special optical lens that can be “programmed” to provide the signal display to only desired portions of the roadway. The programming is accomplished by masking (with tape) portions of the lens through the rear of the housing. Applications for the use of programmable heads may be severely skewed roadways where the signals may be visible from either approach and closely spaced intersections.

Because the lens is programmed to be visible from certain areas, the signal head should be rigid mounted or tethered. Programmable signal heads are much more expensive than a regular signal head and, if programmed incorrectly, can create an unsafe condition. Signal designers should give careful thought to their use.

See Section 450-9.4 for additional details on optically programmable signal heads.

420-4.7 Signal Indications on the Stem of a T Intersection

For through traffic, a minimum of two signal faces shall be provided and shall be continuously visible per the requirements of OMUTCD Section 6B-12.

On the stem of a T intersection, where there is no through traffic, at least one of the turning movements shall be provided with dual indications. If two three-section heads are used, one with a left-turn green arrow and the other with a right-turn green arrow, the approach does not meet the minimum requirements of the OMUTCD. Two circular greens are sufficient, or two circular greens with one or two arrows (four-section heads) are acceptable. The purpose of providing dual indications is to ensure that if one lamp fails, a second lamp will be provided to the predominant movement.

420-4.8 Signal Head Clearance

The OMUTCD requires that the bottom of the housing of a vehicle signal face suspended over a roadway shall be at least 15 feet, but not more than 19 feet above the pavement grade at the center of the roadway. For new construction, SCD TC-85.20 requires a clearance of 16 to 18 feet. The use of drop pipes is technically acceptable; however, they provide an aesthetically inferior installation.
Detector Loop Placement

Figures 498-3 through 498-5 illustrate suggested loop placements for traffic control signals in the following situations: High-Speed Mainline vs. Large-Volume Generator Side Street, Mainline vs. Ramp/T Intersection, and High-Speed Mainline vs. Low-Speed Side Street. Section 450-10.7 provides additional detail information about loop placement and wiring.

These are intended only as suggestions for detector placement and a naming convention. Actual placement will depend on individual conditions and District practices. Electronic copies of the drawings are available upon request.
421 SIGNAL SUPPORTS

421-1 General

OMUTCD Section 6B-14 presents information on the transverse location of signal supports. Construction details are shown on SCDs TC-21.20, TC-81.10 and TC-81.20. Signal supports are specified in CMS Item 632 and CMS 732.

421-2 Signal Support Inspections

A statewide uniform practice for the periodic inspection of the structural components of ODOT-maintained signal supports is necessary to assure their structural integrity. All strain pole and mast arm supports should be periodically inspected. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked. The use of an inspection form is recommended. See Section 496-1 for a Sample Signal Support Inspection Form which may be used as is or modified by the District as desired.

Supports should be visually inspected from the ground. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means is not necessary on a routine basis, but may be used to more closely examine a defect that has been detected from the ground. Anchor bolts should be tested for structural integrity by sounding with a hammer. Non-destructive testing procedures, such as dye penetrant, ultrasonics, and magnetic particle, are not necessary on a routine basis, but can be used to define the extent of a defect that has been detected by visual means. Written documentation of all inspections should be kept.

Items to be inspected should include, but not be limited to, foundation concrete, soil around foundation, anchor bolts and nuts, structural members and structural connections.

Deficiencies to be inspected for should include, but not be limited to, cracks in concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, and corrosion.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Written documentation of corrective actions should be kept.

All signal supports shall be inspected at a maximum five-year interval. New signal supports shall be inspected at the time of construction.
441-5 **Underground Facilities**

Conduit runs shall usually be limited to 200 feet (60 meters) between pull boxes, but up to 400 feet (120 meters) may be used if the run is straight and not too full.

Conduit crossing bridge structures shall, if possible, be included in parapets. As an alternative, it may be attached to the underside of the parapet by means of clamps. Necessary flexible conduit at expansion joints shall be provided.

Conduit under the roadway shall be a minimum of 3-inch (76 mm) diameter. All conduit shall be of sufficient size to contain the conductors as per the National Electric Code. See Section 450-3.4 for additional information.

441-6 **Quantities**

In the General Summary, all quantities should be shown in whole units of measurement, except concrete which shall be shown to a tenth of a cubic yard (hundredth of a cubic meter) and any pavement marking item measured in miles (kilometers), which shall be shown to a hundredth of a mile (hundredth of a kilometer).

On metric plans, sign area shall be shown in tenths of a square meter and support lengths shall be shown in tenths of a meter.

441-7 **Bid Item Descriptions**

Bid item descriptions are required to exactly match the descriptions published in the "Bid Item Dictionary."

When the standard bid item description is inappropriate, the words "As Per Plan" shall be added to the description, and a note shall be provided to describe the deviation from the standard specifications and/or details. See Section 442 for examples of typical Plan Notes.

441-8 **Signal Support, Detail Design Requirements**

*Figures 498-37 and 498-38* provide examples of tables for presenting signal support information in the plans for support types described in SCDs TC-81.10 and TC-81.20.

Use of the sample tables is recommended as a means of uniformly presenting support information to the contractor or support manufacturer. The support designer should note that the orientation angles consist of:

- A field angle that establishes the angular relationship between the project centerline perpendicular and a pole feature (handhold or mast arm) which serves as an index, and
- Angles for all pole appurtenances that are measured from this index pole feature.

Complete instructions for designing the single arm overhead signal support described in SCD TC-81.20 are contained in Section 440-3. Instructions for the design of two-arm signal supports are contained in Section 440-4.

The following information relates to the detail design of signal supports for Stage 3 plans.

1. Foundation elevations and span wire attachment heights are optional for signal strain poles. Top and bottom foundation elevations should be provided if foundation dimensions are not as shown...
on SCD TC-21.20, or when steep roadside slopes or roadway superelevation would make foundation elevations difficult to otherwise determine.

2. Station and offset information is not necessary for signal strain poles in the strain pole table. Poles should be clearly labeled and locations dimensioned on the signal intersection sheets.

3. Do not give conduit angles for foundations because these will be field located by the contractor according to the plans and field conditions. An exception would be for unused, capped conduit ells for future use.

4. A column may be added to define the street from which the centerline and angles are determined.

5. For a project with many installations, a column for cross reference to the signal or sign plan sheet should be added.

6. Elevation views of the signal spans are optional. However, if elevation views are not used, span dimensions between signal heads and signs shall be shown on each signal intersection sheet.

7. Strain poles (SCD TC-81.10) can typically be located with the base plate either square or at 45 degrees to the roadway centerline. The pole and foundation are designed for loading in any direction and the anchor bolts do not need to be located exactly in line with the resultant span wire load.

8. If two pedestrian signal heads are located on a pole, the designer must choose between a single mounting bracket for two heads or separate mounting brackets for each head. Also, SCD TC-85.10 allows field installation of holes with alternate mounting methods instead of threaded blind half couplings. The maintaining agency's choice of mounting method should be clearly noted in the plans.

9. If luminaire bracket arm attachment plates are required, a column should be listed in the table to show the orientation angles. The plan should note whether one or two plates are required. The power company or maintaining agency should be contacted concerning any special mounting attachment requirements. ODOT standards are shown on SCD HL-10.12.

441-9 Power Service Cable

In CMS 732, power cable and service cable are specified primarily as aluminum conductors. This was done because aluminum is typically most cost effective in these sizes, and more readily available. The specification allows the substitution of copper conductors of one size smaller. This is because the greater conductivity and lower resistance of copper approximately accounts for one wire size. For instance, a #8 AWG copper conductor with an ampacity of 45 AMPs may be substituted when the plan calls for a #6 AWG aluminum conductor which would have an ampacity of 50 AMPs.

This relationship is considered acceptably close for the required usage. The specifications call for appropriate connectors to match wire material.

There is a potential problem if the designer uses a specific size of copper power cable, or copper service cable, out of habit, without recognizing that the change to aluminum has effectively reduced ampacity of these cables by 12 to 25 percent.

A similar relationship exists for cases where long runs of power cable or service cable require consideration of voltage drop.

Under CMS Item 632 and CMS 732, power and service cables should be sized to the following minimums:
Total Control Load (AMPS) | Aluminum Wire Size (AWG)
---|---
20 | #10
30 | #8
45 | #6
65 | #4

Also note that aluminum service cable (duplex or triplex) is not readily available in smaller than #8 AWG.

**441-10 Two-Arm Signal Supports**

*Section 440-4* describes the procedure for designing a two-arm signal support. As noted in that section, the SCD TC-81.20 or TC-12.30 design number for the pole may be used in the plans as reference for the proper pole base and foundation details. SCD TC-81.20 will apply for arm details and arm attachments.

The bid item for the structure should be in the form:

Item 632 (Combination) Signal Support, Type (TC-12.30 or TC-81.20) Design ___ Pole, with Mast Arms TC-81.20 Design ___ and TC-81.20 Design ___

A detailed elevation view and any other special details required for the two-arm support that are not covered by the SCD should be included in the plans.

**441-11 Guarantees**

For projects not requiring detail guaranteeing, the requirements of CMS Item 633 will apply. On traffic control projects or other projects where the cost for traffic control is more than one-third of the total cost, Plan Note based on *Section 442-16* may be included. The period of guarantee should be adjusted in relation to equipment complexity, i.e., 90 days for simple equipment, 120 days for traffic adjusted equipment and a maximum of 180 days for computerized control of many intersections. When the note is included, notice of the fact should be communicated in the transmittal of final tracings to Central Office, so that affected groups may make provision in the proposal for the extended completion date.

**441-12 Alternate Bids**

The use of alternate bidding procedures must be requested and the maintaining agency must agree in writing to the procedure. Alternate bids are typically used for projects where a particular type or brand of equipment is desired, usually the signal controller. *Section 442-16* presents an example of an alternate bid note (Plan Note 442-16) setting up an alternate bid item in the plans. This note should be placed in the plans at the end of the general notes for traffic signal items. In the general summary, the alternate bid item should be at the end of the list of traffic signal items.
442 PLAN NOTES

442-1 General

Typical Plan Notes have been consolidated here for convenience in preparing plans. The number used for the Plan Note will be the same as the section number. When a Plan Note revises the material or contractor requirements from that which is specified in the CMS, both the note and the bid item will be “as per plan”. Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of Plan Notes, various format changes are used here that are not typical throughout the TEM, e.g., the terms Contractor and Engineer are capitalized.

Also, at this time the Plan Note number that has been used is shown in parentheses at the beginning of the title for the note.

442-2 (625-A) Power Supply for Traffic Signals

Electric power shall be obtained from the ___________ at the location indicated on the plans. Power supplied shall be ____ volts.

Designer Note: See Sections 440-2 and 441-4.

442-3 (625-C) 625, Ground Rod, As Per Plan

In addition to CMS Item 625.09, this item shall consist of furnishing and running of a seven strand #4 copper wire from the top of the ground rod and attaching it to the neutral bar in the cabinet.

Payment shall be made at the contract unit price per each.

Designer Note: This note may be used when requested by the maintaining agency.

442-4 (632-A) 632, Removal of Traffic Signal Installation

Traffic signal installations, including signal heads, cable, messenger wire, strain poles, cabinet, controller, etc., shall be removed in accordance with CMS 632.26 and as indicated on the plans. Removed items shall be reused as part of a new installation on the project or stored on the project for salvage by (name of agency receiving stored items) in accordance with the listing given herein.

(Items to be reused)

(Items to be stored)

In the event the items stored on the project for salvage by the local agency are not removed, the Contractor shall, when directed by the Engineer in writing, remove and dispose of the items at no additional cost to the project.

Designer Note: This note shall be included on projects where existing traffic signal installations are being removed. A listing of items to be reused and/or stored must be included.
442-5  (632-B) 632, Interconnect Cable, Misc.: (by Size), with Support Messenger, As Per Plan

The Contractor will be permitted to use either of two types of interconnect cable construction and installation under this item as follows:

1. Integral messenger type interconnect cable meeting the requirements of CMS 732.19. Under this method any sections of cable shown in the plans to be contained in controllers, cabinets, poles, conduits or supported on messenger wire installed for other purposes shall have the supporting messenger and jacket web neatly removed by the use of a tool specifically designed and sized for this purpose. Deviations from the cable routing shown in the plan, for the sole purpose of reducing the amount of messenger to be removed, will not be permitted. The cable shall be installed with approximately one twist for each 15 feet (4.5 meters) of span length.

2. Separate interconnect cable meeting the requirements of CMS 732.19 plus a 1/4 inch (6 millimeters) messenger wire and lashing meeting the requirements of CMS 732.18. Under this method the Contractor will install a separate 1/4 inch (6 millimeters) messenger to support the spans of interconnect cables in all locations where the plans show interconnect cable which is not otherwise supported by a signal messenger wire or other suitable support. Utilization of existing messenger wire, not provided by the project or designated therein as available for use, is prohibited. Deviation from the cable routing shown in the plans, for the purpose of reducing the need for separate messenger wire, will not be permitted.

In either case the number of splice locations shall be kept to a minimum.

Measurement will be based upon the number of feet (meters) of CMS Item 632, "Interconnect Cable, Misc.: (by size), with Support Messenger, As Per Plan" in place in accordance with the method described in CMS 632.29 and no separate payment will be provided for any separate messenger wire used to support interconnect cables.

**Designer Note:** This note may be used on projects with overhead interconnect cable, if acceptable to the maintaining agency.

442-6  (632-C) 632, Loop Detector Units, by Type, As Per Plan

In addition to the requirements of CMS Item 632 and CMS 732.07 or 732.08, loop detector units shall have the following requirements or features:

The output device shall be a relay, and all contacts shall be in the wiring harness.

The unit shall be self-tuning.

The unit's electrical connection plugs or wiring harness shall allow ready replacement with a single channel amplifier as described in CMS 732.07.

Each unit shall be labeled to correspond to its phase and direction.

Delay inhibit shall be connected on all detector harnesses for their respective phase greens.

**Designer Note:** This note should be included for projects which will be maintained by Districts that use NEMA TS-1 controller cabinets.
442-7  (632-D) 632, Vehicular Signal Head, Polycarbonate, by Type, As Per Plan

CMS 732.01 is modified for this project as follows:

1. Signal heads and visors shall be constructed of polycarbonate plastic and meet ITE specifications.

2. Glass lenses shall be used.

3. Pipe, spacers and fittings constructed of polycarbonate plastic may be used in lieu of galvanized steel or aluminum.

4. Proper exterior colors shall be obtained by use of colored plastic material rather than painting.

**Designer Note:** This note should be included when polycarbonate heads are specified.

442-8  (632-E) 632, Pedestrian Signal Heads, by Type, As Per Plan

CMS 732.05 of the specifications is modified for this project as follows:

1. Signal heads and visors shall be constructed of polycarbonate plastic and meet ITE specifications.

2. Plastic lenses shall be used.

3. Pipe, spacers and fittings constructed of polycarbonate plastic may be used in lieu of galvanized steel or aluminum.

4. Proper exterior colors shall be obtained by use of colored plastic material rather than painting.

**Designer Note:** This note should be included when polycarbonate heads are specified.

442-9  (632-F) 632, Loop Detector Lead-In Cable, Direct Burial

This work shall include furnishing and installing loop detector lead-in cable of the type required in CMS 732.19. Installation shall be by cable plow or vibratory cable plow to a minimum depth of 18 inches (450 millimeters). All entries into pull boxes, conduit systems, foundation or other enclosures shall be free of sharp edges and be covered by insulated bushings. Following installation, the ground surface shall be restored to the original contour and surface condition.

**Designer Note:** This method may be considered in lieu of cable in conduit to reduce project costs. It is applicable to long underground runs in tree lawns or grassed roadsides where minimal interference with driveways or utilities is expected, and where disturbance of the area due to construction is not contemplated. If the cable is to be routed up a pole, a conduit riser (extending below ground with an insulated bushing) should be called for and detailed.

442-10  (632-G) 632, Combination Signal Support, Type TC-81.20 and Sign Support, TC- (with Light Pole Extension)

This support shall consist of a TC- Design pole with a TC-81.20 Design signal arm and a TC- Design sign support arm (with light pole extension). All
signal support items required by CMS Item 632 and all sign support items required by CMS Item 630 shall be included as part of this support.

Payment will be at the contract unit price and will be full compensation for all labor, materials, tools, equipment and other incidentals necessary for each support furnished, in place, complete and accepted.

**Designer Note**: This note shall be used when combination traffic signal supports and sign supports are desired. The blanks shall be filled in with appropriate SCD numbers and designs.

### 442-11 (632-H) 632, Combination Strain Pole, Type TC-81.10 and Sign Support, Type TC- (with Light Pole Extension)

This support shall consist of a TC- ________ Design ___ pole with a TC- ________ Design___ sign support arm (with light pole extension). All signal support items required by CMS Item 632 and all sign support items required by CMS Item 630 shall be included as part of this support.

Payment will be at the contract unit price and will be full compensation for all labor, materials, tools, equipment and other incidentals necessary for each support furnished, in place, complete and accepted.

**Designer Note**: This note shall be used when combination traffic signal supports and sign supports are desired. The blanks shall be filled in with appropriate SCD numbers and designs. The following is a bid item example: Combination Strain Pole, Type TC-81.10 and Sign Support, Type TC-12.30 (with Light Pole Extension).

### 442-12 (632-I) Strain Pole Foundation Elevations

Elevations shown in the plans for strain pole foundations are for computational purposes only. The actual elevation of the foundation shall be in accordance with SCD TC-21.20 provided the existing slope is less than 6:1.

At locations where the existing slope is 6:1 or greater, the buried depth of foundation, as shown in SCD TC-21.20 shall apply to the low side of the slope. The top of the foundation shall be set 2 inches (50 millimeters) above the existing surface on the high side of the slope. The additional depth of foundation necessary to meet these requirements shall be added to the formed top.

**Designer Note**: This note shall be used when strain pole foundations are located in slopes of 6:1 or greater.

### 442-13 (632-J) 632, Vehicular Signal Head, by Type, As Per Plan

In addition to the requirements of CMS Item 632 and CMS 732, the following requirements shall apply:

1. All upper signal support hardware and piping up to and including the wire inlet fitting shall be ferrous metal for signal displays of two or more sections.
2. When signal heads are suspended from span wires or mast arms and not rigidly mounted they shall be provided with a pivot and lock balance adjuster.
3. All balance adjusters shall have a minimum three-quarter inch (19 millimeters) eye bolt
and three-quarter inch (19 millimeters) wide slot. Eye bolts are cast from 316 stainless steel and provided with a satin finish. Three-quarter inch (19 millimeters) body halves are cast from a minimum 65-45-12 ductile iron and provided with a bright zinc finish (ZN1). Balance adjusters shall only be used where necessary. Balance adjusters shall be used on one-way heads.

4. Glass lenses shall be used.

5. The entrance fitting shall be of the tri-stud design with serrated rings in order to achieve positive locking.

**Designer Note:** This note should be included for projects which will be maintained by ODOT.

**442-14 (632-L) 632, Power Service, As Per Plan**

Power service shall be as per CMS Item 632 and SCD TC-83.10 with the following exceptions:

1. The meter base mounting height shall be no more than 5 feet (1.5 meters) high to the center of the meter base from the ground.

2. The Contractor shall supply the necessary meter bases.

3. All power services shall be metered. The meter shall have a lever operated bypass.

Disconnect switch enclosures furnished in accordance with CMS Item 632, Power Service, as per plan, shall include a padlock equal to Master no. 4BKA or Wilson Bohannon 660, with lock body of bronze or brass and keying shall be to the state master.

The Contractor shall contact the meter section of the power company for information regarding the meter base installation prior to ordering poles. The Contractor will be responsible for requesting and scheduling any inspections the power company may require for the power service hook up. The Contractor shall be responsible to contact the power company for the electrical service connection. Under no circumstances shall the Contractor splice power cable into the power company’s circuits. The voltage supplied shall be nominally 120 volts. The Contractor is responsible for obtaining any necessary permits and the paying of all fees. The Contractor shall pay all power charges until the signal is accepted by the maintaining agency.

**Designer Note:** This note may be used when requested by the maintaining agency.

**442-15 (633-A) Guarantee**

The Contractor shall guarantee that the traffic control system installed as part of this contract shall operate satisfactorily for a period of _____ days following completion of the 10-day performance test. In the event of unsatisfactory operation the Contractor shall correct faulty installations, make repairs and replace defective parts with new parts of equal or better quality. Equipment, material and labor costs incurred in correcting an unsatisfactory operation shall be borne by the Contractor.

The guarantee shall cover the following items of the traffic control system: controllers and associated equipment, detector units, interconnection items and master control equipment.

Customary manufacturer’s guarantees for the foregoing items shall be turned over to the state or the maintaining agency following acceptance of the equipment.
The cost of guaranteeing the traffic control system will be incidental to and included in the contract unit price of the various items making up the system.

**Designer Note**: See Section 441-11.

### 442-16 (633-D) 633, Alternate Bid Item

633 Controller Unit, Type____, with Cabinet, Type____

(Example of a standard bid item)

633 Controller Unit, Type____, with Cabinet, Type____ (Acme) - Alternate Bid

The controller shall be a Model (xx-99 as manufactured by Acme Signal Company, Santoy, Ohio) and shall incorporate or be furnished with all the design features, auxiliary equipment, accessories, and prewired cabinet features as required in the standard bid item.

Payment will be at the contract unit price for each, in place, all connections made and wiring completed, tested and accepted.

(Example of an alternate bid item)

**Designer Note**: See Section 441-12.
443 SPECIFICATIONS

ODOT specifications for the furnishing and installation of traffic signal equipment are contained in the following CMS sections:

625 and 725 Trench, conduit, ground rods and pull boxes
632 and 732 Traffic signal equipment
633 and 733 Traffic signal controllers

CMS specifications related to specific traffic signal items have been referenced individually as they have been discussed in this Part.
450 CONSTRUCTION

450-1 General

This information is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices and appurtenances. However, it may also be useful for maintenance personnel performing the same functions. Inspection procedures for the various type traffic control devices are outlined, mainly in the form of check lists to assist project personnel in performing their duties. This information points out the various important features of each device and references the applicable specification or standard drawing. Illustrations are used for easy recognition of the device or feature being discussed.

450-2 Foundations

See Section 250-3 for additional information relative to concerns in the installation of foundations for poles and controller cabinets.

450-3 Electrical Appurtenances

450-3.1 General

This section will be used to provide additional information about various electrical appurtenances involved in the traffic signal installations, such as pull boxes, conduit and ground rods.

450-3.2 Pull Boxes

Pull boxes shall be of the specified sizes (see SCD HL-30.11 and the plans), typically 18 inches (460 millimeters) or 24 inches (610 millimeters), and the specified material.

The word on the cover should be “TRAFFIC” when the pull box is part of a traffic signal system unless the plans require the word “ELECTRIC” or other marking. The word shall be formed on the surface or displayed on an attached metal plate in accordance with CMS 725.09.

The location of pull boxes shall be as shown on the plans. However, pull boxes in low drainage areas may be adjusted to eliminate drainage problems, or feasible methods of positive drainage may be used in accordance with CMS Item 603 and details on SCD HL-30.11, with the approval of the project engineer.

Pull boxes located in sidewalks, traffic islands and curbed areas close to the roadway, where wide turning vehicles could drive over them, may be adjusted to eliminate the problem, or a concrete pull box with a heavy duty lid may be used with the approval of the project engineer.

450-3.3 Trench

Trenching shall be in accordance with CMS 625.11 and as shown in Figure 498-7. Any change in dimensions will require approval by the project engineer.

Trenching may be in earth or in paved areas, according to plan details. Trenching and subsequent restoration of surfaces in paved areas shall be in accordance with SCD HL-30.22. Trenching work in paved areas shall be divided into two pavement depths for payment; less than 6 inches (150 millimeters) and 6 inches (150 millimeters) or greater, as described in CMS 625.21.

The trench in paved areas may be 4 inches (100 millimeters) wide when cut by a Vermeer type
trencher. In this case, the trench shall be backfilled with concrete full depth, except that the bottom 4 inches (100 millimeters) above the conduit may be CMS 625.11 tamped backfill.

450-3.4 Conduit

Metal conduit shall comply with CMS 725.04, with sizes according to the plans. It shall be made from domestically produced steel, and the domestic steel content of the conduit shall be certified by the manufacturer or supplier before it is approved for installation.

The routing of loop detector wire in conduit through curb or under shoulder shall be as shown on SCD TC-82.10.

Conduit containing cable and/or wire shall have the terminal at the high end completely sealed in an approved manner, with removable sealing compound or a molded plastic or rubber device compatible with the conduit, cable jacket and wire insulation, according to CMS 625.12(A).

After placement, a conduit which will not have cable or wire pulled into it during construction shall have a pull wire installed in it, and the terminal at the high end shall be sealed with removable sealing compound, a molded plastic or a rubber device, according to CMS 625.12(A).

Difficult pulling and possible jacket skinning may occur when an attempt is made to install too many cables or wires within a given conduit. The reason could be design error in new systems or attempts to insert an excess number or size of cable or wire in existing conduit.

Good electrical practice requires that the combined cross section of all cables and wire within a conduit should be less than (or equal to) 40 percent of the conduit inside area:

\[ a_1 + a_2 + a_3 + \text{etc.} \leq 0.40C_i \]

\[ a = \text{cable or wire across section area, sq. in. (mm}^2) \]

\[ C_i = \text{conduit inside area, sq. in. (mm}^2) \]

A calculation can be made using the above formula. The cross section area of conduit, cable and wire is shown in Table 497-1.

450-3.5 Ground Rod

A ground rod shall be driven below groundline near the foundation of every strain pole and overhead sign or signal support whether there is power in the vicinity or not, as shown on SCDs TC-21.20, TC-32.10 and TC-32.11.
Ground rods shall comply with CMS 725.16 and be installed in accordance with CMS 625.09. A ground wire of insulated 600-volt No. 4 AWG 7-strand soft drawn copper shall be attached by an exothermic weld. The typical exothermic weld procedure is described in Section 450-3.6. Insulating varnish shall be applied to the weld and any exposed conductor.

450-3.6 Exothermic Weld

The following procedure is typical and may be used unless the manufacturer’s instructions differ.

1. The end of the ground wire shall be in an unflattened, unbent, clean and dry condition to assure a good weld.
   a. Bent and out-of-round conductor wire will hold the mold open causing weld material leakage. A cable cutter should be used to make undeformed ends. If a hacksaw is used, the insulation should first be peeled, as the saw tends to coat the cable with plastic material which must be cleaned off.
   b. Corroded cable shall be cleaned. Oily or greasy cable should be cleaned with a solvent that dries rapidly and leaves no residue. Very greasy cable can be “cooked out” by dipping into molten solder.
   c. Wet cable can cause the blowing of molten metal out of the mold, and the cable should be dried by a hand torch or a quick drying solvent such as alcohol.

2. Ground rod ends which have been mutilated in driving can hold the mold open and should be cut off. Rod ends shall be clean and dry.

3. The weld mold shall be clean before use. Damp or wet molds can cause porous welds and should be dried by heating.

4. The cable shall be inserted into the side of the mold so the cable is 1/8 inch (3 millimeters) back from the center of the tap hole. The mold shall be placed on the ground rod so the cable sits on top of the rod (see Figure 498-8). A clamp or locking pliers should be used on the rod to keep the mold from sliding down during the welding process, and the conductor should be marked at the mold surface so it can be verified that the conductor has not shifted before the weld is made.

5. The steel disk shall be inserted into the crucible and the cartridge contents poured on top, being careful that the disk is not upset. The cartridge should be tapped when pouring, to make sure the starting powder comes out and spreads evenly over the welding powder. A small amount of starting powder should be placed on the top edge of the mold under the cover opening for easy ignition.
   a. The proper cartridge size is marked on the mold tag and is the approximate weight of the powder in grams.
   b. If the proper cartridge size is not available, two or more small cartridges or part of a larger cartridge can be used.

6. The mold cover will be closed and the starting powder ignited with a flint gun. If it is necessary to hold down the cover during the flash of igniting powder, a long tool should be used and the hand should be kept away.
450-4   Power Service for Traffic Signals

450-4.1   General

Power service for traffic signals shall comply with SCD TC-83.10 and the plans. It shall consist of the equipment needed to provide a pole-attached wiring raceway and disconnect switch, for use with separately furnished power cable routed from the service point to the controller cabinet. As shown in Figure 498-9, unless otherwise specified, the equipment includes a weatherhead, a conduit riser with necessary fittings and attachment clamps when required, and a disconnect switch with enclosure (CMS 632.24).

A thorough review of the plans should be made to determine that the specific requirements of the maintaining agency for power service have been satisfied.

A ground wire shall be used as shown on SCD TC-83.10, leading to a ground rod installed in accordance with Section 450-3.5.

The LB type fitting under the controller cabinet (SCD TC-83.10) may have to be installed before erecting the pole because of interference with the foundation.

450-4.2   Electric Meter Base

When required, an electric meter base shall be furnished by the applicable utility and installed by the contractor as part of the power service work.

450-4.3   Conduit Riser and Weatherhead

Power cable is the only type cable or wire permitted through the power service conduit riser.

The conduit riser shall terminate at the meter base, if used; otherwise, termination shall be at the switch enclosure. From there conduit connection to the controller cabinet is as shown on the plans. Conduit connection could be: (a) immediately to the controller cabinet on the same pole; (b) downward by underground conduit and possibly a pull box to a nearby foundation-based controller cabinet; or (c) upward by another riser on the pole to spanwire and a remote cabinet location.

The conduit riser shall comply with CMS 725.04 and the plans, and the weatherhead shall be threaded aluminum or galvanized ferrous metal (CMS 732.16). Risers on painted poles shall be painted to match the poles.

450-4.4   Disconnect Switch

The disconnect switch shall be a UL listed single-throw safety switch or circuit breaker, meeting the voltage and capacity requirements of the specifications. The amperage rating of the fuse or circuit breaker shall be 5 to 10 amperes greater than the peak load rating of the equipment service. The enclosure shall be a UL listed water tight lockable stainless steel NEMA Type 4, supplied with UL listed conduit hubs, and the enclosure shall contain a solid neutral bar normally grounded to the enclosure (CMS 732.21).

450-5   Pole and Support Inspection - General

See Sections 250-4.2, 4.3 and 4.4 for information about pole and support inspection.
450-6 Traffic Signal Supports

450-6.1 General

This section will be used to provide additional information about traffic signal supports. Various types of overhead signal supports are also depicted in Table 497-4.

450-6.2 Strain Pole Type Support

Strain poles shall comply with the manufacturer’s shop drawings, SCD TC-81.10 and the plans. They shall be galvanized unless paint is specified in the plans, and the general features should be inspected in accordance with Section 250-4.2.

When strain poles of the embedded type are specified, they shall include an extension for embedment below groundline and a welded-on ground sleeve. The pole extension shall be sufficient to reach within 3 inches (76 millimeters) of the foundation depth as specified in the table in SCD TC-21.20, or the extension may be a minimum of 6 feet (1.8 meters) if a reinforcement cage is provided as also shown on the SCD. The cage shall overlap at least 24 inches (610 millimeters) of the pole extension and reach to within 3 to 4 inches (76 to 102 millimeters) of the foundation’s specified depth. A special foundation design is required when soil with a load bearing capacity of less than 2,000 pounds per square foot (9700 kilograms per square meter) is encountered. Embedded poles normally do not include a handhole or blind half couplings for internal wiring.

When shown on the manufacturer’s shop drawings, and as permitted by CMS 732.11, strain poles may be tapered tubes with a cross section which is circular or a regular polygon of six or more sides, or may be a type consisting of straight sections with a tapered effect accomplished by the use of reducers.

Strain poles used to support traffic signals or signs (SCD TC-17.10) shall be furnished with one or more span wire clamps with shackles for attachment of messenger wire (see SCD TC-84.20). The messenger wire may be attached by wrapping twice around the pole and securing with a three-bolt clamp, as shown in SCD TC-84.20, when used on round, tapered steel strain poles.

Erection of these poles shall be in accordance with the general procedure given in Section 250-4.6, except as noted in this section.

For the initial rake of strain poles of the anchor base type, leveling nuts shall be adjusted to provide a rake of one-eighth to one-half inch per foot (11 to 42 millimeters per meter) of pole in the direction opposite to the contemplated span wires and are to be made snug tight. Further adjustment may be necessary to assure that the strain poles are essentially vertical after the application of span wire load.

For the initial rake of strain poles of the embedded type, poles shall be embedded in concrete to provide a rake of one-eighth to one-half inch per foot (11 to 42 millimeters per meter) of pole in the direction opposite to the contemplated span wire and braced. The age of the concrete before it is considered cured, before the bracing may be removed, and before the permitted application of span wire load, shall be in accordance with Section 250-3.4.

450-6.3 Single Arm Support

Single arm supports shall comply with the manufacturer’s shop drawings, SCD TC-81.20 and the plans. General features of the support shall be inspected in accordance with Section 250-4.2, and except as noted in this section, erection of the support shall be in accordance with
general procedure given in Section 250-4.6.

Welds shall be inspected according to Section 250-4.3 and the galvanizing inspected according to Section 250-4.4.

For arms of two telescoping pieces, a 15 inch (380 millimeters) overlap is required. The overlapped arms shall be secured with a stainless or galvanized steel through-bolt with hex head or nut(s).

Arm caps shall cover at least 50 percent of the end area (CMS 732.11).

An arm clamp with clevis shall be furnished at each signal position, as well as a hole with a rubber grommet for the outlet of signal cable.

The installation of small signs and their attachment to the arms should be checked. Any possible interference between swinging signals and signs should also be checked.

Blind half couplings shall be located on the pole of the support for mounting pedestrian signal heads or controller cabinets when required by the plans.

Signal heads shall be installed so that their bottom surface is 16 to 18 feet (4.9 to 5.5 meters) above the roadway. The signals shall be installed at essentially the same elevation. Drop pipes should be used only when necessary to maintain the clearance between 16 to 18 feet (4.9 to 5.5 meters). If the clearance without a drop pipe will be slightly over 18 feet (5.5 meters), it is permissible to omit the drop pipe, with the maintaining agency's approval.

Initial rake shall be adjusted so that under the load of signals, the pole will assume an essentially vertical position and the arm rise be within the limits specified on SCD TC-81.20, i.e., 3 inches (76 millimeters) minimum and 12 inches (300 millimeters) maximum.

450-7 Sag and Vertical Clearance

Figure 498-13 illustrates sag guidelines and vertical clearance standards for traffic signals.

450-8 Signal Span Messenger Wire and Appurtenances

450-8.1 General

This section will be used to provide additional information about signal span messenger wire and appurtenances.

450-8.2 Signal Messenger Wire and Cable

Messenger wire and accessories shall comply with SCD TC-84.20 and CMS 732.18. Messenger wire diameter shall be in accordance with the plans.

The height at which the messenger wire is to be attached to the pole will, in some instances, be shown on the plans. In cases where this is not shown, the contractor is responsible for determining the proper attachment height. This determination shall consider the relative elevation of pavement to pole foundation top, the desired clearance between pavement and the bottom of each signal, i.e., 16 to 18 feet (4.9 to 5.5 meters), the sag in the messenger wire (3 to 5 percent), and the height of each signal.

Alternate methods of attaching messenger wire to strain poles may be used, as follows:
1. Span wire clamp with clevis, anchor shackle and thimbles on the messenger wire, or

2. Messenger wire wrapped twice around the strain pole and secured with a three-bolt clamp of the proper size, when used on round, tapered strain poles.

If the messenger wire attachment to strain poles makes use of the alternative with pole clamps and anchor shackles, the wire is to be hooked through the shackle using a thimble and secured with a three-bolt clamp. A preformed guy grip shall not be used for messenger wire attachment at the pole. Guy grips of the proper size may be used at bull rings (aerial corners).

Thimbles with a correct groove size for the messenger wire (or the wire and eye of guy grips) are to be used at anchor shackles and bull rings. When three-bolt clamps are used, the wire tail is to be served as shown in Section 450-8.3. See Section 450-8.4 for the installation procedure for preformed guy grips.

Thimbles with a correct groove size for the messenger wire or the preformed guy grip shall be used to connect to anchor-type shackles or to bull rings at span wire aerial corners.

Messenger wire sag shall comply with CMS 632.22 and Section 450-7.

The signal cable shall be attached to the messenger wire by lengths of preformed lashing rod. The lashing rod shall be the proper internal diameter to snugly hold the cable, but not cut into its jacket. See Section 450-8.6 for further information.

A drip loop shall be formed in the signal cable at each weatherhead, and should extend at least 6 inches (150 millimeters) below the weatherhead (see Figure 498-14).

Cables or groups of cables up to a maximum of four, hanging within pole interiors, shall have their strain relieved by cable support assemblies as described in Section 450-8.7, Figure 498-14 and SCD TC-84.20.

450-8.3 Messenger Wire Served Ends

Messenger wire may be attached to various accessories by looping the wire to make an eye.

The wire end shall be secured by a three-bolt clamp, and the cut wire end or tail shall be “served” with construction wire or clamped with a sleeve device as shown on SCD TC-84.20. The following illustrations show both serving methods for the wire tail:
450-8.4 Preformed Guy Grips

Preformed guy grips are made of helically shaped high-strength steel wire. They are available in sizes fitting the outside diameters of messenger wire and form an eye permitting attachment to various accessories.

As shown in SCD TC-84.20, they should be used at bull rings of span wire aerial corners (see the following illustration). Thimbles are used in the eye of grips in accordance with standard details in the SCD.

Grips are installed on an end of the messenger wire by wrapping a first leg of the grip to the messenger wire. In most cases, the accessory to which the grip is to be attached must be inserted in the eye of the grip with a thimble before the second leg of the grip is wrapped. The second leg is then applied to the combined first leg and messenger wire. The following illustrations show the wrapping sequence:

Guy grips shall not be used on messenger wire used for span wire sign supports. In this application, wind load on the signs can cause failure of the grips (see SCD TC-17.10). Guy grips shall not be used for attachment to signal strain poles (SCD TC-84.20(5)).

450-8.5 Cable and Wire

In certain instances, the plans will assign a color code usage for each cable, or a typical usage by color code. All connections should be made observing these assignments, and any deviations, if determined necessary, should be recorded. When a color code usage is not provided, good electrical wiring practice would still dictate that color code wiring on the project be consistent. Typically, white is reserved for the neutral or common leg of a circuit. The following provides additional information about various types of cable and wire contained in CMS Table 732.19-1:

1. **Signal cable** is used as the electrical connection between signal heads and the controller cabinet at an intersection. The cable may be either IMSA 19-1, which has a jacket of polyvinyl
chloride, IMSA 20-1, which has a polyethylene jacket, or IPCEA S-61-402. The number of conductors and wire gage shall be as specified on the plans. Conductors shall be of copper and stranded, and conductor insulation shall be color coded. Splices are not permitted in signal cable (CMS 632.23), and the cable should be scanned to be sure that there are none. As temperatures decrease, signal cable gets stiffer and harder, becoming brittle when below freezing. In very cold weather, the cable should be handled with care so as not to damage the jacket or insulation when unreeling, flexing and installing. The method of measurement of signal cable is shown in Figure 498-16.

2. **Interconnect cable** is used as the connection between intersections for systems of signals (although there is no significant difference between signal and standard interconnect cable). The cable may be either IMSA 19-1, IMSA 20-1 or IPCEA S-61-402 as in signal cable, or twisted pair/shielded interconnect cable conforming to REA PE-39 may be required by the plans.

Twisted pair/shielded cables are less prone to pick up induced current as a result of nearby electrical devices or magnetic fields, and are necessary for certain types of communication systems which may be used to interconnect signals. The number of conductors and wire gage shall be as specified. It should be noted that in the case of twisted pair/shielded cable, the number of conductors is typically referred to as the number of pairs (pair count), i.e., six-conductor cable would be referred to as a three-pair cable. Conductors shall be of copper and are usually solid.

3. **Interconnect cable of the integral messenger type** is aerial self-supporting cable with a "figure 8" cross section. The cable may be either IMSA 19-3, which has a jacket of polyvinyl chloride, or IMSA 20-3, which has a polyethylene jacket. Shielded versions, IMSA 19-4 and IMSA 20-4, may be required by the plans. The number of conductors and wire gage shall be as specified. Conductors shall be of copper and stranded, and conductor insulation shall be color coded.

Twisted pair/shielded interconnect cable of the integral messenger type conforming to REA PE-38 may also be required by the plans.

4. **Loop detector wire** is laid in turns in saw slots cut into the pavement and routed by the groove to the edge of pavement and to a pull box. The wire is single-conductor No. 14 AWG. The conductor shall be of copper and stranded. Loop detector wire consists of detector wire inserted into a flexible plastic tubing (CMS 732.19) meeting specifications IMSA 51-5. The tubing shall encase the wire completely from the splice at the lead-in cable through the entire loop turns and back to the splice.

5. **Lead-in cable for detector loops** is spliced to loop wire and routed to detector units in the controller cabinet. The cable shall be two-conductor No. 14AWG with jacket of 0.04 inch (1 millimeter) minimum black polyethylene and insulation of polyethylene. Each conductor shall be stranded copper. The conductor pair shall be twisted and shielded.

6. **Lead-in cable for magnetometers** is spliced to the lead which is a part of magnetometer probes and routed to detector units in the controller cabinet. The cable is four-conductor No. 18 AWG with a jacket of 0.026 inch (0.66 millimeter) minimum high density polyethylene and a low capacitance insulation. Each conductor shall be stranded copper, and insulation shall be color coded. The four conductors shall be twisted.

7. **Power cable** is used as the connection between the service pole or service drop and the controller cabinet. The cable normally is two-conductor and UL RHH/RHW/USE type. The wire gage shall be as specified. Conductors shall be color coded, of aluminum and stranded.
Stranded copper may be substituted with an AWG one gage higher (wire one size smaller). When specified, power cable may be three conductor. Single conductor cables may be substituted for a two (or three) conductor cable, but color coding should still be provided.

8. **Service cable** is used to bring power to the vicinity of an isolated intersection. The cable is normally two-conductor (duplex) and XHHW type or cross-linked polyethylene with a 0.045 inch (1.14 millimeter) minimum jacket. The wire gage shall be as specified. The cable is aerial self-supporting with one conductor being an uninsulated ACSR (aluminum conductor, steel reinforced) messenger wire. An insulated conductor of stranded aluminum is twisted around the messenger. Stranded copper with an AWG one gage higher (wire one size smaller) may be substituted for the aluminum conductor. Three-conductor (triplex) may be specified where two insulated conductors are twisted around the messenger wire. The uninsulated messenger serves as the grounded neutral of the power supply.

9. **Ground wire** is used to connect signal or sign supports to ground rods. The wire shall be single-conductor No. 4 AWG made of seven-strand soft drawn copper with white insulation and rated at 600 volts. The wire is used as part of the CMS 625.09 Ground Rod item.

### 450-8.6 Lashing of Overhead Cable

A preformed helical lashing rod shall be of the proper internal diameter to tightly secure overhead cable(s) to the messenger wire. A lashing rod should not be loose or so tight as to be impressed deeply or cut into the cable jacket. If either deficiency is observed, the proper internal diameter may be determined by the following formula: C approx. = (0.85) (D+m), where C is the lashing rod internal diameter, D is the cable jacket diameter and m is the messenger wire gage (all dimensions in inches (millimeters)).

For groups of several cables of varying diameter, the internal diameter of the lashing rod may be best determined by a graphic layout to scale.

Signal cable routed on messenger wire should neatly pass the bull rings in its path. Also, signal cable routed around an aerial corner formed in the span wire at a bull ring should have a radius in its routing small enough to form a tangency with the bull ring.

### 450-8.7 Cable Support Assemblies

As shown in **Figure 498-14**, a cable support assembly makes use of a flexible tubular wire mesh device called a cable grip which has a gentle holding action over its length and which is used to eliminate strain or damage to the jacket of cable(s) hanging in the interior of poles.

The support assembly consists of the grip attached to a single “U” eye support bale and a sling
when necessary. The grip may be used on an individual cable or a group of cables up to a maximum of four (CMS 632.21). The grip shall be the proper size and strength for the cable(s), of stainless steel or tin coated bronze, and may be either a “closed” or “split with rod” type. The split type is used when a cable end is not available. In this application, the grip mesh is not a continuous tubular weave, but is split for wrapping around the cable(s) and is secured by a rod which is inserted through alternate weaves at each side to form a tube.

The support’s bale shall be hung over the pole J-hook if sufficient length is available; otherwise, a sling shall be made of messenger wire, clamps and thimbles. The sling wire is to be passed through the bale eye, adjusted to the proper length and hung on the J-hook.

Pole interiors should be checked by removing pole caps to verify that cable support assemblies are in place, hung on the J-hook and properly adjusted to eliminate cable jacket strain.

450-8.8 Aerial Interconnect Cable

For aerial interconnect cable, the following standards and guidelines apply:

1. Aerial interconnect cable and accessories shall comply with SCD TC-84.20 (illustrated in part in Figure 498-15). Interconnect cable may be supported on separate messenger wire or be the integral messenger self-supporting type with a “figure 8” cross section, if specified on the plans.

2. Metal poles with messenger wire supported interconnect cable are to be furnished with pole clamps. The pole clamp may provide clevis(es) to which the messenger is attached and terminated, or may provide a stud to which a clamp assembly can be bolted.

3. Messenger wire ends are to be looped and secured with three-bolt clamps or a messenger vise, or a preformed guy grip dead end may be used (see Section 450-8.4). If clamps or vises are used, the wire tail shall be served (see Section 450-8.3). Thimbles with a correct groove size for the messenger wire shall be used to connect to the clevis of the pole clamp.

4. When messenger wire is to be grounded to a metal pole, a ground clamp, an insulated ground wire and a bolt tapped into the pole shall be used (also see item 10 in this section).

5. Wood poles with interconnect cable shall be fitted with through-bolts holding a clamp assembly or with a thimble eye-bolt to which the messenger may be attached and terminated.

6. The clamp assembly shall be suitable to the type of cable support, either messenger wire or self-supported cable with “figure 8” cross section. Clamp assemblies for “figure 8” interconnect cable differ slightly from those intended for use with separate messenger, inasmuch as the clamp used with “figure 8” must allow a small gap for the web of the “figure 8” cable which joins the messenger to the cable.

7. When messenger wire or “figure 8” cable is to be grounded on a wood pole, a ground clamp and an insulated ground wire stapled to the pole and covered by a molding shall be used (also see Item 10 in this section). The ground clamp used with “figure 8” cable shall be a type with teeth to penetrate the jacket over the messenger. The ground wire shall be bonded to an existing ground wire or to a ground rod.

8. Standard interconnect cable shall conform to CMS Table 732.19-1 and have the number of conductors and wire gage specified. There is no difference between standard interconnect cable and signal cable, only in the application. Interconnect cable of the shielded type may be specified in the plans. The interconnect cable should be marked with the correct
nomenclature. Solid conductors are not permitted (CMS 732.19) unless specified in the plans. Splices may be used on long lengths of interconnect cable (CMS 632.23) and shall be accomplished only in weathertight splice enclosures. Splice enclosures may be either aerially located on the messenger wire or be a pole-mounted box type (see SCD TC-84.20). Where the aerial enclosure is clamped to the span, it should be within 2 feet (0.6 meter) of a pole to improve accessibility. No measurement allowance is given for splices.

9. Aerial interconnect cable is to have a sag between three to five percent of pole spans or is to match existing utility lines.

10. Messenger wire supporting interconnect cable, and the integral messenger of self-supporting type cable, is to be grounded in cable runs at the first and last poles and on intermediate poles at intervals not to exceed 1200 feet (366 meters) (also see item 4 of this section for grounding on metal poles, and item 7 for grounding on wood poles).

11. As temperatures decrease, interconnect cable gets stiffer and harder, becoming brittle when below freezing. In very cold weather, the cable should be handled with care so as not to damage the jacket or insulation when unreeling, flexing and installing.

12. Standard interconnect cable may be attached to supporting messenger wire by lengths of preformed lashing rod or by spinning wire. Lashing rods shall be of the proper internal diameter to snugly hold the cable but not cut into its jacket (see Section 450-8.6).

13. Aerial interconnect cable of the integral messenger self-supporting type (with a “figure 8” cross section) shall have its wind stability increased by being twisted or spiraled once every 15 feet (4.6 meters) of span. This is done by clamping the tensioned cable to every other pole and then going to intermediate poles and twisting the cable before tightening their attachment clamps.

14. When the interconnect cable is attached to a pole and continues in a relatively straight line past the pole, this is an intermediate support; whereas, if the interconnect cable turns at the pole, it is a corner or turning point. Certain types of clamps may be well suited for intermediate support applications, while other designs are required for corner clamps. The clamps shown on the left side in SCD TC-84.20 are usually not suitable for corner clamps if the change of direction is more than about 10 degrees. See SCD TC-84.21 when the change of direction is more than about 10 degrees.

450-9 Method of Measurement for Cable and Wire

Figures 498-16 through 498-20 illustrate the method of measurement for signal cable, interconnect cable, detector lead-in cable, power cable and service cable, respectively. CMS 632.29 also specifies the method of measurement for cable and wire.

450-10 Signal Equipment and Wiring

450-10.1 General

This section will be used to provide additional information about other signal equipment and wiring.

450-10.2 Controller Cabinet

While the layout of controller cabinets may vary, the following requirements and guidelines apply:

1. The prewired cabinet should be checked against approved catalog cuts, the wiring diagram
2. The cabinet should be fitted with a small door-in-door (police door) unless otherwise specified. The cabinet should be in good condition, revealing no evidence of damage, with its material free of cracks and pinholes. The doors and seals should fit properly. The cabinet exterior should appear as metallic aluminum unless a color is specified. The cabinet interior may be similar to the exterior or may be flat white. The method of cabinet mounting should be as shown on the plans and the cabinet should be securely mounted.

3. Cabinets equipped with solid state controllers shall be provided with a suitable number of sturdy adjustable metal shelves to mount the specified equipment and to provide the required space for designated future equipment (CMS 733.03).

4. The equipment shall be arranged for easy withdrawal and replacement, without the necessity of disturbing adjacent equipment. The permanent location of equipment within the cabinet, as well as the shelves themselves, should allow free circulation of air and not restrict air flow from fan ducts or vents. Components on shelves and devices on the door shall be arranged so that a 1 inch (25 millimeters) minimum space separates them when the door is closed. This minimum space shall not be compromised by plugs, wires, controls or similar items. Terminals and panel-mounted devices with exposed contact points located next to shelf-mounted equipment shall be provided with spacers, shelf lips or other means to assure that component units cannot be accidentally moved into contact with any exposed electrical terminal points. A minimum 4 inches (100 millimeters) clear area from the bottom of the cabinet should be reserved for the routing of cables. No shelf, component or panel-mounted item shall be located in the bottom 6 inches (150 millimeters) of cabinets, with the exception that terminal blocks only in pedestal or pole mounted cabinets may be installed as close as 4 inches (100 millimeters) to the bottom.

5. Ready accessibility should be provided for items such as load switches, flasher, relays, terminal blocks and fuses which are mounted on or plugged into panels on the cabinet back or sides. Switches, controls and indicator lights should be easily operable and visible without having to move equipment from their positions.

6. Major equipment items should bear a name plate, brand or indelible marking for identification as to type, model, catalog number and manufacturer’s name or trademark.

7. The furnished controller unit should be checked for the correct type, number of phases, and available control functions required by the plans. Controller units should be furnished with all auxiliary equipment necessary to obtain the operation shown in the plans.

8. When specified, other equipment may be a part of the prewired cabinet, such as: a coordinator, an on-street master, interconnection equipment, preemption equipment, time clock or weekly programmer, and special relays.

9. Furnished detector units should be checked to see if the correct quantity is installed, and the proper type used with each loop and each detector phase. When multi-channel detector units are furnished, the plans may require the provision of special cabinet wiring and an adapter harness to allow single channel detector units to be readily substituted.

10. The prewired cabinet should also be checked for the following auxiliary equipment:

   a. A forced air ventilating fan automatically controlled by a thermostat shall be furnished.

   b. A conflict monitor shall be furnished. When the plans so specify, according to CMS
733.03(A.2.c.), an increased capability monitor shall be furnished. The minimum number of monitor channels, related to the number of phases for the intersection, should conform to CMS 733.03.

c. Load switches should be provided in sufficient quantity for the interval sequence shown in the plans. The switches shall be solid state NEMA triple signal type with input indicator lamps. The minimum number of load switch sockets furnished, related to the number of phases for the intersection, shall conform to CMS 733.03.

d. A flasher (or flashers) shall be solid state NEMA type.

e. Relays required for the proper operation of the specified equipment shall be furnished.

f. Lightning protection devices shall be furnished for the protection of solid state controllers. They should be located on the incoming power line and on loop detector leads where these connect to the terminal block. When solid state coordinators are furnished, they should be protected by devices across each conductor and ground on the interconnect cable (see CMS 733.03(A.2.f.)).

g. A convenience outlet and lamp shall be furnished. The outlet should contain at least one standard three-wire plug receptacle of the ground-fault circuit-interrupting type. The lamp should be an incandescent type, located in the upper part of the cabinet, and controlled by a switch.

h. A main power breaker shall be furnished. The fan, convenience outlet and lamp should be wired on a branch of the AC+ power line preceding the main breaker, so that these may be operated independently of the main breaker control. This preceding branch should itself contain an auxiliary breaker rated at 15 amp.

i. A radio interference filter should be installed in the incoming AC+ power line between the main breaker and solid state equipment. If the equipment furnished does not provide signal and flasher circuit switching at the zero voltage point of the power line sinusoid wave form, filters should also be provided for the load switches and flasher.

j. A manual control cord with push button should be furnished only when the plans so require (CMS 733.03). The cord should be at least 5 feet (1.5 meters) long.

k. Switches required for the proper operation of specified equipment should be furnished and labeled as to function and setting position. The following switches should be grouped behind the small door-in-door (police door): signal shutdown switch, flash control switch and an automatic/manual transfer switch (when manual control is specified).

l. Terminal blocks should not be obstructed by other equipment. Terminal points should accept spade type wiring terminals except for incoming power terminal points which may be either the type to accept bare wire or spade terminals. Contact between adjacent terminal points may be either by bus bar or by wire jumpers with spade terminals.

11. The incoming power bus should be fed from the line side of the incoming 120 VAC power line after the circuit has passed through the main power breaker. A signal bus relay should control power to the bus supplying power for the signal load switches. The requirement for radio interference filters (CMS 733.03) should be adhered to, with the buses supplying load switches and flashers being filtered if load switches do not switch at the zero voltage point of the power line sinusoid wave form. A common terminal bus insulated from the cabinet should be furnished for the connection of the neutral wire of the incoming 120 VAC power
12. The cabinet should include a ground bus bar with an adequate number (at least three) of ground terminal points (CMS 733.03). This bus bar should be grounded to the cabinet. The ground bus bar will normally be bonded to the common terminal bus using at least a No. 8 AWG copper wire.

13. Wiring bundles should be neatly arranged and grouped as to voltage and function, and they should be lashed or restrained so that they do not interfere with the access to equipment, including terminal blocks or buses. The harnesses should be of sufficient length and should be easily traced through the cabinet. All conductors should be stranded, with labeled spade type terminals or plug connectors. The wiring should be color coded, with solid white for the AC common, black for the AC line side power (AC+), and solid green or white with green stripes for the safety ground.

14. Incoming cable and wire should be identified by tags or bands (CMS 632.05). The size, material and method of tag or band identification should be in accordance with CMS 713.18(B), except that marking may be by indelible pen on plastic tags instead of embossed letters. The identification on the tags or bands should conform to the wiring diagram for the cabinet and its intersection, with typical abbreviations in accordance with the Table in CMS 632.05 (reproduced in Table 497-2).

15. Two copies of the schematic and wiring diagram for each cabinet and its intersection should be furnished by the contractor. The diagrams are to be updated to reflect any changes made during construction. The diagrams should be neat and legible, on durable paper, and folded in a moisture-proof envelope fastened to the cabinet interior.

450-10.3 Cable and Wire Identification

As noted in CMS 632.05, cables and wires shall be identified as shown in Table 497-2.

450-10.4 Vehicular Signal Heads and Wiring

Illustrations of the signal head visors, hangers and wiring discussed herein are presented in Figure 498-21.

1. Signal heads shall conform to the plans, CMS 732.01 and SCD TC-85.20. Signal heads shall have the correct number of faces (one-way, two-way, three-way or four-way) and each face shall be made up of the correct number of optical sections (one, three, four or five). Sections shall be of the correct lens size, i.e., 8 or 12 inches (200 or 300 millimeters), color and ball or arrow configuration. Arrow lenses are only to be the 12 inch (300 millimeter) size. It should be noted that arrow lenses are made in Rights, Lefts and Throughs (up). The use of the proper arrow lens should be checked.

2. Lenses shall be aligned properly in their frames so their optical configuration directs most of the light to the forward sector.

3. As noted in Section 420-4.2, signal heads shall have a yellow finish, unless otherwise specified in the plan.

4. Cutaway type visors (CMS 732.01) shall be fastened to each optical section, unless open bottom tunnel visors or other types are specified, and the interior finish of the visors shall be
flat black.

5. Signals should be clean and the assembly tight. Gaskets should be in good condition and lens door hinges and latches should be in good working order. All openings not used for mounting purposes shall be closed by waterproof caps.

6. Five-section faces, arranged in accordance with SCD TC-85.20 and the plans, are to use galvanized pipe, elbows and tubular hardware, painted to match the signal head.

7. Swinging signals shall be installed in a plumb condition. A balance adjustor should be used only when necessary to achieve plumb (CMS 632.06).

8. Swinging signals suspended from a mast arm shall be fitted with a universal hanger permitting swinging in both longitudinal and transverse directions (CMS 632.06).

9. When specified by the plans, disconnect hangers shall be used with signal heads.

10. Drop pipes, 1 1/2 inch (38 millimeters) diameter galvanized pipe, are a source of trouble and are aesthetically unattractive; therefore, they are intended to be used only when they are necessary to permit signals to be suspended above the roadway within a clearance of 16 to 18 feet (4.9 to 5.5 meters). Signals supported by span wire, with sag required between 3 and 5 percent (SCD TC-84.20), shall be brought to proper clearance by adjusting the attachment height of the span wire to the poles. Because of the 2 foot (0.6 meter) clearance tolerance, drop pipes should not be necessary in most cases.

11. When the plans so specify, backplates shall be fitted to signal heads.

12. Signal cable shall be routed into the interior of heads through the entrance fitting using a grommet. The cable shall be routed to each face’s terminal block, which is typically in the yellow indication section but may be in the green section. Conductors shall be fitted with spade type terminals and shall be fastened securely to the correct terminal points. Conductors shall be identified according to the wiring diagram. Signal cable shall not be spliced, either between signals or in signal face interiors.

13. External signal cable shall to be fashioned into a drip loop extending at least 6 inches (150 millimeters) below the entrance fitting but shall not chafe on the signal.

14. Lamps for 8-inch (200 millimeters) yellow lenses shall be 550 lumens (minimum initial) or 70 watts (maximum input), lamps for 8-inch (200 millimeters) green or red lenses shall be 1260 lumens (minimum initial) or 116 watts (maximum output), and lamps for 12-inch (300 millimeters) lenses shall be 1650 lumens (minimum initial) or 150 watts (maximum input), unless otherwise specified (CMS 732.04(B)). The light center length for lamps suitable for 8-inch (200 millimeters) lenses is 2 7/16 inches (62 millimeters), and for lamps suitable for 12-inch (300 millimeters) lenses, this length is 3 inches (76 millimeters). The light center length is measured from the tip of the base to the approximate center of the filament. Lamps shall have a clear glass envelope and a rated life of 8000 hours. Lamp sockets shall be rotated so as to position the open portion of each lamp filament in an upward position. All vehicular signal lamps shall be prequalified in accordance with CMS 732.04(B).

15. Each face of a signal head shall be oriented to its approach of traffic and its locking device securely tightened. Orientation or aiming of standard signals should be done so that the maximum light intensity from a standard signal is directed slightly below the horizontal center; thus, on a level approach, the face of the signal should be essentially vertical. When an approach to a signal is on a grade, the signal may be tilted slightly to point the signal axis
parallel to the grade of the approach. Horizontal aiming should orient the axis of signal display parallel to the centerline of the approach for straight approaches when the signal is over the roadway. When the approach roadway is curved, or when a signal is not over the roadway, the axis should be directed at a point on the approach which is 175 to 625 feet (54 to 191 meters) in advance of the intersection, the distance being dependent on the speed of approaching traffic. For convenience, OMUTCD Table TS-1 has been reproduced in part as Table 497-3.

16. When a vehicular traffic signal head has been erected and faces approaching traffic, it shall either be in operation as a stop-and-go signal or a flasher, or it shall be covered or bagged. This is an OMUTCD requirement (OMUTCD Section 6B-19) and cannot be ignored. Typically, the plans will contain an item for “Covering of Vehicular Signal Heads” which will require the contractor to cover, maintain the covering, and subsequently remove the covering when the signal is ready to commence operation.

17. Normally, the plans will provide the “covering” item for each new signal head, but will not provide them for any existing heads which are to be removed. The intent is that “covering” will be necessary for the new heads until they and their associated controller and wiring have been checked by circuit testing (see Section 450-10), while any existing signals at the intersection will continue to control traffic. When the new signals are uncovered and placed in operation, the existing signals can be quickly removed. Specific maintenance of traffic requirements in any plan may require a different means to assure the unused signals are not exposed to traffic.

450-10.5 Optically Programmed Signal Heads

Programmed heads (see Section 420-4.6) shall conform to approved catalog cuts, CMS 732.02 and 732.03, and the plans. They are to have the correct number of optical sections making up each face. Programmed heads have many points of similarity to regular heads. Items 2, 3, 5, 11, 12, 13, 16 and 17 of Section 450-10.4 also apply to these signal heads. For more detailed information, see publications by the manufacturer.

Each optical section shall be fitted with a visor (CMS 732.02 and 732.03) and the interior surface of visors shall have a flat black finish.

Programmed heads shall be mounted in a manner permitting little or no motion. If mounted on a mast arm, a rigid adapter shall be used. Heads of more than three vertical sections mounted on a mast arm shall be fitted with pipe backbracing, as shown on SCD TC-85.20. The pipe shall be a minimum of 17 inches (430 millimeters) behind the signal center axis so that adequate clearance is provided for the programming procedure. If heads are supported by span wire, a tether messenger wire shall be attached to a fitting in the bottom of the signal’s lower section.

Customarily the manufacturer’s representative will program the signals, but in accordance with the plans, the contractor is responsible for the correct aiming and masking of the signal so as to be visible to drivers or pedestrians only in the area indicated on the plans.

Signals are pre-tilted to cover most situations. The yellow indication section should be aimed first and the other sections aimed similarly. The housing shall be opened and the lamp collar and diffuser removed. The roadway inverted image should be observed on the surface of the glass with the eye held a distance of 2 feet (0.6 meter) behind. The image observed is where the optics are pointed. The tilt of the integral adapter shall be adjusted so the horizon appears at the lower third of the glass. The adapter screws are then to be tightened. All sections shall be at the same tilt angle.
The signal shall be rotated horizontally so the image on the glass covers the proper roadway lane(s). The bolts of the mounting adapter shall be loosened and the signal rotated around its serrated surface. The movement of traffic should be examined on the glass. When the roadway image appears correct, that is, pointed in the direction where it should be seen, all screws may be tightened. All sections of the signal should now be adjusted and rigid in their mountings, properly aimed and ready for masking.

The yellow indication section of the signal should be masked first since it transmits a brighter image. The other colors can then be masked identically.

Masking requires the use of opaque tape furnished by the manufacturer. The tape shall be applied to the glass, up to the edge, and squeegeed flat to remove air bubbles. The tape initially should be applied horizontally to the glass to cover the image of the sky and that portion of the roadway which is distant. After this is done, tape should be applied to the images on the sides of the lane(s) where the signal is not to be visible. In many cases, signal visibility is desired for a left turn lane only, and visibility to the adjacent through lane should be masked. Excess tape extending beyond the edge of the glass should be trimmed away, taking care not to cut on the surface of the glass.

The reduced area on the glass should be checked to verify that its image is the only area in the roadway which should see the signal. The lamp collar and diffuser may now be replaced and the housing latched.

The boundaries of the area in the roadway where the signal is to be visible should be explored on foot to verify that the head is properly programmed.

450-10.6 Pedestrian Signal Heads

Pedestrian signal heads shall conform to CMS 732.05, approved catalog cuts, the plans and SCD TC-85.10. Signals shall have the correct type of light source and lettering height in accordance with the plans (CMS 632.08).

Housings shall have a black finish, unless otherwise specified (CMS 732.05). Visors shall be fitted over each message, except one type may have the entire face protected by a flat black sunshade fastened close to the lens. The interior surface of visors shall be flat black finish.

Signals should be clean and the assembly tight. Gaskets should be in good condition and lens door hinges and latches in good working order.

Housings shall be positioned with a minimum set back of 2 feet (0.6 meter) from the curb and a height of 8 to 9 feet (2.4 to 2.7 meters) above the sidewalk for adequate clearance. The heads shall be oriented toward their crosswalk and locked securely in position.

Lamps for incandescent signal heads of the 8-inch (200 millimeters) lens type shall be 1300 lumens (minimum initial), and for the 12-inch (300 millimeters) lens type shall be 1650 lumens (minimum initial), unless otherwise specified.

Pedestrian push buttons shall conform to Section 404-2, approved catalog cuts, and CMS 732.06. Push button housings shall have a yellow finish, unless otherwise specified. The push button shall be positioned 3.5 to 4 feet (1.1 to 1.2 meters) above the sidewalk.

Push buttons on metal poles shall be installed over a 3/4 inch (19 millimeters) maximum field drilled hole with edge protected by two coats of zinc-rich paint and a rubber grommet inserted. The push button housing curved back shall be positioned over the hole, wiring routed through to the electrical mechanism and the housing secured by stainless steel screws. Unused holes in the
housing shall be plugged. Push buttons on wooden poles shall have their wiring in conduit connected to a fitting of the signal support.

Signal head supports (conduit and fittings) on wooden poles shall be grounded, using a ground clamp and an insulated ground wire stapled to the pole and covered by a molding.

OMUTCD Section 2L-3 addresses standards for the signs used where push buttons are provided to actuate pedestrian signals. The sign legend shall conform to the plans.

450-10.7 Loop Detector Slot and Wire

Figures 498-23 and 498-24 illustrate details related to the following discussion of loop detector slots and wiring.

1. Slots cut into the pavement forming rectangular detection loops shall be in accordance with the plans and SCD TC-82.10.

2. The slots shall be a minimum of 3/8 inch (9.5 millimeters) in width and shall have a minimum depth of 2 inches (50 millimeters) in concrete and 4 inches (100 millimeters) in asphaltic concrete. SCD TC-82.10 requires that loop corners be made at a drilled or bored hole, about 1 1/4 inches (32 millimeters) in diameter, and with the same depth as the saw slot. Any sharp edges at the saw slots and the holes shall be chiseled out.

3. The slot depth shall accommodate the specified number of turns of wire laid so that the uppermost wire has a covering of at least 3/4 inch (19 millimeters). The number of wire turns shall comply with the plans and the table in SCD TC-82.10 (also shown in Figure 498-23). A separate slot leading from the loop to the pavement edge is typically cut for each loop.

4. When permitted by the project engineer, loops installed in new asphaltic concrete may be sawed and the loop wire(s) embedded with sealant in a subsurface course with subsequent covering by the surface course.

5. Some plans may specify the use of preformed loops placed on the pavement for covering by a surface course of asphaltic concrete.

6. If the problem of loop installations in brick streets is encountered, the project engineer should consult with the local traffic engineer for recommendations.

7. Loop locations may be adjusted to avoid manholes. Loops should not be placed across pavement joints. Instead, lateral and longitudinal adjustments should be considered, with the approval of the project engineer. If joint crossing is unavoidable or major pavement cracks are encountered, the following techniques may be used (see Figure 498-24).

   a. In Technique A, the loop wires are laid over the joint or crack within a 3 inch (75 millimeters) square or circular hole cut to slot depth. The wires are laid in an “S” shape and the hole filled with elastic joint material or asphaltic concrete.

   b. In Technique B, the slot at the joint or crack is saw cut to twice normal width and depth. The wires are laid so as to conform to the deepened slot which is injected with soft-setting butyl rubber up to the depth of the original slot. The original slot depth and the remaining perimeter of the slots are embedded with standard sealant cured to a flexible state.

   c. In Technique C, the slot at the joint or crack is enlarged. The wires are encased in a length of plastic tubing which should be large enough to loosely hold all wires and may
be slit lengthwise to facilitate construction. Before placing it in the slot, the ends and the longitudinal slit are to be taped shut to prevent the entry of loop sealant. The enlarged slot is then filled with loop sealant.

8. Before loop wire is placed, all slots shall be brushed, blown clean of loose material and completely dry.

9. Loop detector wire shall be single-conductor No. 14 AWG insulated wire, type IMSA 51-5 with stranded copper conductors, unless otherwise specified. The wire should be marked at intervals with the wire gage, UL label and type. The detector wire is contained inside a flexible plastic tube, as required by IMSA 51-5.

10. The correct turns of loop wire (Figure 498-23), up to a maximum of four, shall be placed in the slots, to comply with CMS 632.23 and the plans. The wire shall be pushed to the bottom of the slots with a blunt wooden tool (or equivalent) to avoid damaging the insulation.

11. The wires with tubing at the pavement edge or curb shall be led into a conduit of the size shown in SCD TC 82.10. Care should be taken to prevent excessive slack at the point where the wires enter the conduit. The high end of the conduit shall be sealed in accordance with SCD TC 82.10.

12. The detector wire shall be twisted in the conduit leading from the pavement edge to the pull box. The flexible plastic tubing shall cover the wire completely from the splice at the lead-in cable, through the entire loop turns and back to the splice. The tubing provides extra protection from abrasion and allows the wire to slide inside the tubing in case of pavement shift or cracks, thus minimizing the possibility of breakage. Since wire/tubing includes an air pocket, it will tend to float to the surface when sealant is applied to the slot. For this reason it is usually necessary to wedge short lengths of the tubing, or similar devices, into the slot to wedge down the tubing/wire. These are usually needed at 1 to 2 foot (0.3 to 0.6 meter) intervals.

13. The slots shall be completely filled with approved sealant and left undisturbed until cured to a flexible state. Sealants on the ODOT prequalified list shall be used, in accordance with the manufacturer’s recommendations. Materials which set up to a hard or brittle state are not acceptable.

14. Detector loops are measured as “each” loop installed and the item includes wire, pavement cutting and sealant.

450-10.8 Loop Detector Lead-In Cable

Unless otherwise specified, loop detector lead-in cable (CMS Table 732.19-1) shall be two-conductor No. 14 AWG twisted pair shielded, with a jacket of black polyethylene 0.04 inch (1 millimeters) thick minimum, and polyethylene insulation with conductors of stranded copper.

Within the pull box, loop wire ends shall be joined to the conductors of the lead-in cable by soldering and covered with insulating material (see Figure 498-25). An approved, poured epoxy waterproof splice kit shall be used. It is understood that epoxy splice kits are easily damaged by freezing temperatures encountered prior to mixing. Damaged epoxy components may sometimes be recognized if either of the components has turned or is streaked milky white.

Lead-in cable shall be routed to the controller cabinet, fitted with soldered spade type terminals and fastened to the correct points of the terminal block. The lead-in cable’s shielding shall be grounded to the ground bus within the cabinet.
If a pull box is not specified on the plans, the splice between the loop wire and lead-in cable shall be made in the first entered pole or pedestal, except where the controller cabinet is mounted on the pole or pedestal. If the controller cabinet is mounted on the pole or pedestal, the loop wires may be routed directly into the cabinet and no lead-in cable is necessary.

Loop detector lead-in cable is measured in accordance with Section 450-9 and Figure 498-18. The poured epoxy splice in the pull box is included.

450-10.9 Magnetometer Probes and Lead-In

Magnetometer sensor probes (Figure 498-26) may be set in the pavement, or under and in bridge decks in accordance with SCD TC-82.10 at the locations shown on the plans.

Although core drilling may be performed after concrete placement, it is preferred that probe holes in new concrete be formed by pouring concrete around a vertical piece of capped vinyl-chloride or other non-metallic tubing. Probe holes in existing concrete must be core drilled.

Probe installations under bridge decks may be as shown in Figure 498-26. The lead from probes should be in non-metallic conduit. Probes in bridge slabs should be centered in the reinforcing steel grid square which is nearest to the probe’s plan location. The center of a grid square may be located by the use of a Pachometer metal locator. The procedure for use of such an instrument is given in Section 450-10.10.

Probe holes in pavement and bridge decks shall be approximately 3/4 inch (19 millimeters) greater than the probe diameter. The probe shall be set so as to have a covering of at least 1 1/2 inches (38 millimeters). However, deeper placement may be used if recommended in the manufacturer’s instructions.

The probe lead, which is a part of the probe(s), is to be led from the probe(s) to the edge of pavement, to the bridge parapet wall or under the bridge deck, depending on the design used. When in pavement and bridge decks, the slot for the lead shall be a minimum of 3/8 inch (9.5 millimeters) in width and have a depth of 2 inches (50 millimeters) in concrete and 4 inches (100 millimeters) in asphaltic concrete.

Probe holes and slots are to be brushed, blown clean of loose material and completely dry. The probes are to be set and leads pushed to the bottom of slots with a blunt wooden tool (or equivalent) to avoid damaging the insulation. Probe holes and slots are to be completely filled with approved sealant and left undisturbed until cured to a flexible state. The sealant should be the same as for loop detector slots, as given in Section 450-10.7.

Probe leads in slots at the pavement edge or curb shall be led into a 3/4 inch (19 millimeters) conduit connecting to a roadside pull box. Care should be taken to prevent excessive slack at the point where the lead enters the conduit. The high end of the conduit is to be sealed in accordance with SCD TC-82.10.

Unless otherwise specified, lead-in cable (CMS Table 732.19-1) shall be four-conductor No. 18 AWG color coded, twisted, with a jacket of 0.026 inch (0.66 millimeters) minimum high density polyethylene and a low capacitance insulation with conductors of stranded copper.

Within the pull box, the probe lead ends shall be joined to the conductors of the lead-in cable by soldering and covered with insulating material. An approved poured epoxy waterproof splice kit shall be used. The kit should be the same as for loop detector lead-in cable as given in Section 450-10.8.
Lead-in cable shall be routed to the controller cabinet and fitted with soldered spade type terminals and fastened to the correct points of the terminal block. The shielding of lead-in cable shall be grounded to the ground bus within the cabinet.

The installation of magnetometer probes includes: the probe(s) and lead, the provision of probe holes and pavement slots when used, sealant for the probe holes and slots, and plastic conduit where required. Probes are measured as individual units with the attached lead. Several probes may be on a single lead.

Magnetometer lead-in cable is measured in accordance with Section 450-9 and Figure 498-19. The poured epoxy splice in the pull box is included.

450-10.10 Use of Pachometer Instrument

A Pachometer is an instrument used to detect the location of metal such as reinforcement bars under a concrete cover. The instrument is a magnetic detector which operates on the principle of the change in magnetic flux due to the presence of ferrous metal.

A probe is connected to the instrument and is passed over the concrete surface being examined. The instrument will indicate when the pole of the probe is parallel to and directly over the axis of a reinforcing bar. Use of the instrument will, therefore, outline the sides of a grid square for accurate magnetometer probe location in the center.

450-11 Signal Performance Tests and System Checks

450-11.1 General

Traffic control signal components and the entire system shall be tested as required by various specifications to assure proper operation before acceptance. Ground rods shall be tested for satisfactory low resistance to ground. A circuit test should be performed on all conductors to make sure there are no shorts, crosses and high resistance or other improper connections. A cable insulation or megger test shall be performed on all conductors to verify the integrity of the insulation covering. All traffic control equipment in the controller cabinet should be checked for correct settings and all controls manipulated for assurance of an operable system.

Finally, the traffic control system shall successfully pass a ten-day performance test, which will give an opportunity for any hidden flaws to reveal their presence. As a final “housekeeping” check, equipment should be observed for any evidence of unattached ground wire, unlatched or unbolted doors, etc.

The results of the various tests are to be entered by the contractor on test report forms (Form 496-6) as required by CMS 632.28.

450-11.2 Ground Rod Test

All ground rods shall be tested by the contractor for earth resistance to ground, as required by CMS 632.28(B). Testing is to be in accordance with CMS 625.19, except that the measurement need not be made immediately after installation. Testing shall be performed before the ground wire is attached.

The quality of a ground rod installation varies greatly depending on the characteristics of the earth surrounding the rod. Clay or mud provides the best ground connection since they are dense and contain sufficient moisture and metallic salts to make them conductive. Sand or gravel bearing earth is less conductive.
One type of test equipment commonly used consists of two probes connected to an instrument consisting of a modified Wheatstone Bridge for balancing resistances. As shown in Figure 498-27, the probes are pushed into the earth to form, with the rod, a triangle of equal 10 foot (3 meters) sides.

The general range of the rod’s resistance to ground is investigated by initially setting a potentiometer knob to its highest range control knob, selecting the ohm range (1000, 100, 10 or 1) which permits the balance meter pointer to be approximately centered in its dial by adjustment of the potentiometer knob. For this general range selection process, the pointer is activated by depressing the test button to a reduced sensitivity position.

For actual testing, the test button is fully depressed, thereby giving maximum sensitivity for final adjustment of the balancing potentiometer. The pointer is carefully centered in its dial by means of the potentiometer knob, and the rod resistance to ground read in ohms by the position of the potentiometer knob. For example, with the range knob set at 10 and the meter centered with a potentiometer knob setting between 1.2 and 1.3, the rod resistance to ground is 12 ½ ohms.

If the earth resistance exceeds 10 ohms for signal controllers and tower lighting ground rods, and 25 ohms for all other ground rods, the installation is unsatisfactory and the contractor is required to proceed as follows (specified in CMS 625.09):

1. A second rod shall be driven as shown on SCD HL-20.11 and the two rods temporarily connected together with ground wire. The earth resistance for the pair of rods shall be measured.

2. If the earth resistance for the pair of rods still exceeds the maximum, a 10 foot (3 meters) rod shall be exothermically welded to the top of the second rod and driven into the earth to form a continuous 20 foot (6 meters) long rod. The earth resistance for the pair of rods, 10 to 20 foot (3 to 6 meters) long, shall be measured.

3. If the earth resistance still exceeds the maximum, the procedure of lengthening and driving the second rod shall continue until either an acceptable reading is achieved or the extended rod cannot be driven further.

4. If an acceptable reading cannot be obtained after all the steps above, the contractor shall contact the project engineer for instructions.

450-11.3 Short-Circuit Test

Before the performance of any cable insulation (megger) test or the ten-day performance test, a short-circuit test shall be performed by the contractor using a volt-ohmmeter or other approved instrument (Form 496-6 and CMS 632.28(C)). Short-circuit tests shall be conducted with all electrical loads, power sources, equipment grounds, and earth grounds disconnected (see Figure 498–28).

Signal cable routed to signal heads may be tested with connection made to the lamp sockets, but without the lamps being installed.

Each conductor shall be measured against every other conductor and ground to assure that no short-circuits, cross-circuits, or other improper connections exist. Continuity should not exist between any conductor and any other conductor including ground.
450-11.4 Circuit Continuity Test

Each circuit branch shall be disconnected and tested by the contractor for continuity by temporarily jumpering each branch at its termination and measuring the temporarily looped circuit for assurance that no open circuits exist (Form 496-6 and CMS 632.28(D)). This testing is illustrated in Figures 498-29 through 498-32. Each circuit branch should be according to plan, with no high resistance connections and with the proper identification.

Lead-in cable for loop detector wire shall be tested before and after the cable is spliced to the loop wire.

Circuit continuity of signal cable may be done by applying 120 volts to each outgoing circuit and observing that only the specific lamps are lighted.

450-11.5 Cable Insulation Test (Megger Test)

This testing is illustrated in Figures 498-33 and 498-34.

1. Each conductor of cable or wire terminating at the controller cabinet shall be tested by the contractor for insulation resistance measured to ground (Form 496-6 and CMS 632.28(E)). A listing of the resistance reading for each conductor is to be included in the test results furnished to the project engineer.

2. Cable and wire insulation can be faulty but the imperfections can be easily overlooked, leading to eventual electrical failure of the wiring. Weakening of insulation properties may be caused by poor storage conditions and stress due to rough handling during installation. Dirt is especially troublesome, since it is an electricity conductor and can penetrate small cracks in the insulation.

3. Insulation testing shall be performed with all conductors disconnected from their points on the terminal block in the cabinet so there is no chance of any voltage being present, and to prevent damage to any connected equipment. One megger instrument terminal shall be attached to a termination of jumpered together ends of conductors or to the end of a single conductor cable or wire undergoing testing. The other megger instrument terminal shall be attached to the cabinet ground bus bar.

4. Insulation resistance shall be measured for the wire of roadway loops after the embedding of the wire with sealant in slots.

5. The meter pointer of the megger instrument (or equivalent indication) should be adjusted to zero and the test switch activated. Test duration should be as recommended by the instrument manufacturer.

6. The insulation resistance measured to ground for each conductor shall not to be less than 10 megohms. Cable or wire not meeting this reading shall be replaced.

7. After completion of the cable insulation test, all cabinet wiring shall be connected in accordance with the wiring diagram. The contractor shall demonstrate to the satisfaction of the project engineer that all circuits are continuous and operating correctly, free from shorts, crosses and unintentional grounds.
450-11.6  Functional Test

Before energizing the traffic signals the following functional checks should be made:

1. The incoming AC voltage should be checked.

2. Operation of the following equipment should be checked: cabinet ventilating fan, fan thermostat, and convenience outlet with lamp (when furnished). The filter(s) used with the fan should be unobstructed.

3. Timing settings on solid state controllers should be varied over their ranges and all functions activated to verify that the controls are operable without fault.

4. Timing settings in accordance with the plans should now be entered on the controller, time clock, etc. and checked for corrections. On some projects, timing settings will be provided by the maintaining agency and are not listed in the plans.

5. An agreement should be reached with the contractor and the maintaining agency on the procedure to be followed in the event of a signal failure prior to acceptance.

6. Before signals are energized to control traffic, the maintaining agency should be notified and given an opportunity to check the installation and timing settings.

After energizing the traffic signals the following functional checks should be made. In the event the signals are controlling traffic at the time, these checks should be made with caution to protect the safety of workers, pedestrians and drivers.

1. The function of all cabinet switches should be checked, including the power on/off switch and manual control (when furnished).

2. The traffic signals (and controller indicator lights) should be observed to verify that the controller is timing consistently the intervals and phases set into the controls. A stopwatch is suggested, especially to check critical short intervals. All controllers functions should be activated to verify that operation is proper.

3. The detector units should be investigated to determine which pavement loop(s) or other type sensor is associated with which unit. The visual indication of units (light, meter, etc.) should be observed to determine that each vehicle (truck, car, motorcycle, etc.) entering sensor areas is properly detected on the associated unit and that no extraneous calls occur when the sensor area is vacant. When a detector unit is set for "presence," a detection call should continue as long as a vehicle is positioned over the associated sensor. Concurrent with detection, the appropriate controller indicator light should also exhibit the detection.

4. The flasher switch should be activated to cause the signal heads to flash. Their indications should be checked to verify if they are correct. The flasher switch is then to be returned to the normal or signal mode and a check made of the resumption of normal stop-and-go-operation.

5. The conflict monitor should not be activated by normal signal operation or by the manipulation of cabinet switches. If at any time the monitor is activated, the contractor is required to determine the cause of the problem and make appropriate changes and adjustments before beginning the ten-day performance test. The contractor should test the conflict monitor by artificially causing a number of different conflicting indications and
checking that at each test the monitor causes the signals to begin flashing and places the controller in a "stop timing" mode. Artificial conflict may be caused by touching a jumper wire between two load switch outputs that would signal a traffic conflict. Other methods of artificially caused conflicts may be used at the discretion of the contractor.

6. Signals which are interconnected should be observed to determine if offset relationships are maintained in accordance with settings during all periods of the day.

7. When preemption equipment is furnished as part of the cabinet installation, the proper functioning of the equipment should be checked. The equipment should be activated and observations made to determine if the required sequence of intervals and phases is called for in a correct and safe manner.

8. On projects having equipment furnished for future use only, the equipment should be checked to verify that it is properly installed and operable in a correct manner.

Some signal control equipment, such as time clocks (or switches) and weekly programmers, are intended to vary the timing patterns at different periods of the day or days of the week. To determine if these required changes are occurring at the proper times, it is necessary that observations be made to check the operation at transition times over a period of several days. The change in timing shall not be extremely drawn out or abrupt. The accuracy of time clocks and weekly programmers should be checked. Programmed changes should occur within five minutes of scheduled times for clocks of the electromechanical type and within one minute for clocks of the solid state type. No significant cumulative clock error should be noted during the ten-day performance test.

After successful completion of the ten-day performance test, and after a partial or final acceptance of a project, the contractor is to turn over to the project engineer all manuals, diagrams, instructions, guarantees and related material, as required by CMS 632.05. It is recommended that the project engineer list this material in the project diary as a permanent record of the transfer. The project engineer should transfer the material to the maintaining agency. For ODOT-maintained signals the material should be given to the District Roadway Services Manager.

After a traffic control system project has been accepted by ODOT, the project engineer should immediately notify the maintaining agency that as of a certain exact time and date, the agency is responsible for the operation and maintenance of the system.

### 450-11.7 Ten-Day Performance Test

Before acceptance of the traffic control system, the contractor shall furnish all personnel and equipment required to successfully operate the system continuously for ten consecutive days without major malfunction or failure (CMS 632.28(G)).

At least seven days prior to the beginning of the performance test, the contractor shall notify the project engineer of the starting date. The project engineer will notify the maintaining agency (CMS 632.28(G)).

The contractor shall arrange with the utility supplying the power for purchase of the energy required to conduct the test. All costs of personnel, equipment, electrical energy and incidentals required to perform the test are to have been included in the contract unit prices for the respective items tested.

Minor failures such as lamps, a single detector or an individual signal head, etc. shall be
immediately replaced or repaired and will not cause restart of the test.

A major malfunction or failure, such as a master or local controller, interconnect equipment, etc. will cause termination of the test, and after replacement or repair of the malfunctioning or failed equipment, the beginning of a new ten-day test.

Items which have been repaired or which are replacements are to be monitored by the contractor for a period of ten days to provide assurance of their reliability.

The complete test results are to be furnished to the project engineer on test reporting forms in accordance with CMS 625.19. The contractor is to record in the test results the beginning and end of the test, and the method and date of the correction of each fault.

The project engineer should record the following events in the project diary: the date of the beginning of the ten-day performance test, a day-by-day record of faults as they occur during the test, and the date of the successful completion of the performance test.

450-11.8 Final Signal Installation Check

After all wiring is completed and all testing completed and accepted, a final inspection of the traffic control system should be performed to assure a neat and workmanlike appearance.

1. All spare conductors should be connected to the ground bus bar in the controller cabinet.

2. All ground wires should be properly connected.

3. The spade type ends of conductors should be sound. After all testing is completed, they should be reinstalled on their correct points of terminal blocks and tightened.

4. A visual check should be made for any signs of arcing, melted insulation, etc.

5. All debris from wiring work or packaging materials should be cleaned from the bottom of cabinets.

6. Cabinet vents should be checked to assure that they are unobstructed and all filters should be clean and in place.

7. Duct sealing material complying with CMS 625.12 shall be used to seal the conduit entering the cabinet from the base.

8. All doors on the optical sections of vehicular and pedestrian signal heads shall be closed and latched.

9. No wires or cable should be visible under the base plates of poles and pedestals.

10. The handhole covers on poles and end-frames shall be securely fastened.

11. Pedestals with transformer type bases shall have the access door securely fastened.

12. The covers on pull boxes shall be securely bolted.
460 MAINTENANCE / OPERATIONS

460-1 General

Because traffic signals by their very nature provide positive guidance to conflicting traffic movements, it is imperative that they be maintained in order for them to function reliably. The mean time before failure of a traffic signal installation can be dramatically reduced through proper maintenance practices. The consequence of poor maintenance practices are a reduction in safety to road users and an unnecessarily large exposure to liability claims. District Roadway Services personnel and signal maintenance contractors are required to perform maintenance on traffic signals according to a preset schedule.

460-2 Responsibilities

The Office of Traffic Engineering (OTE) shall:

1. Staff and maintain a central repair facility for the purpose of repairing components of electrical traffic control devices.

2. Assist Districts in maintaining reasonable stock levels of all major electrical items, and their appurtenances, required for new installations and maintenance through the management of annual term contracts and spot purchase contracts.

3. Assist the Districts, through procedure manuals, training programs, inspections, and other methods, in providing quality maintenance.

The OTE Signal Shop shall:

1. Repair, check and make serviceable for installation all signal controllers, signal relays, detectors, flashers, conflict monitors and other associated items.

2. Provide the loop detectors and other miscellaneous parts to custom wire as per plan new controller cabinets purchased by the Districts or rewire/refurbish existing controller cabinets.

3. Periodically provide the Districts with technical information concerning old and new equipment, such as: a list of outdated equipment that will not be repaired by the Signal Shop, changes, problems, software updates and etc. for any equipment owned by ODOT, and other tips or tricks that may help the District personnel.

4. Distribute to the Districts, at least once per calendar year, a list of all equipment, parts, and services available from the Signal Shop.

Each District shall:

1. Maintain a stock of traffic control equipment and other spare parts sufficient for normal preventive maintenance and emergency field repairs.

2. Have a plan to support the extraordinary (i.e., severe storm damage) traffic control equipment needs of the District.

3. Evaluate, authorize and maintain records of all changes in the location or operation of electrical traffic control devices.
4. Transport defective controllers, detector relays, detectors, conflict monitors, etc., to the **OTE Signal Shop** (or approved contractor/vendor) for service, maintenance and repair, along with a **Signal Shop Order** and a tag indicating the exact type of malfunction. These units shall **at all times** be properly cushioned to prevent physical damage during shipping and handling.

5. Generate an “as built” drawing for each electrical traffic control device installation, including each new or upgraded intersection control beacon, school flasher or signal. The drawing shall be in MicroStation 5.0 or later format and shall include the following, if appropriate:

   a. Geometrics of the intersection.

   b. Materials list.

   c. Layout and location of the detectors, poles, pull boxes, cable runs, span wire, signal and pedestrian heads, controller, power service, phase diagram, detector operation, date of installation, revision block, and any other information which shows the intended operation.

   d. Changes which affect the geometrics of the intersection and/or the operation of the signal shall be added to the drawing as revisions.

   These electronic files shall be accessible to the **Central Office** in a read-only mode. Signal drawings which exist in a raster or single element format and cannot be modified shall be digitized or converted by other means when revisions become necessary.

6. Perform appropriate engineering studies, as needed, upon which revisions in signal operations, e.g., phasing may be based. When such revisions are required, an engineering report and necessary supporting data shall be submitted for approval to the appropriate **District** staff person.

### 460-3 Preventive Maintenance

#### 460-3.1 General

**ODOT**-maintained traffic signal installations shall be inspected a minimum of one time annually. In addition to the annual traffic signal inspection, the following routine scheduled maintenance shall be performed by either **District Roadway Services** section personnel or a signal maintenance contractor.

#### 460-3.2 Traffic Control Signals and Intersection Control Beacons

Every eighteen months incandescent lamps behind all lenses of Traffic Control Signals and Intersection Control Beacons shall be replaced, and the electrical cable and its connections in and near the signal heads shall be checked.

Every six months controllers, flashers, detectors, external input and output components (i.e., preemption devices, PREPARE TO STOP WHEN FLASHING signs and detector switching) and other accessories shall be checked for malfunctions and replaced as required.

Every six months the conflict monitor shall be tested with an automatic conflict monitor tester.

#### 460-3.3 Other Electrical Traffic Control Devices

For School Flashers, flashing and illuminated signs, and other electrical traffic control devices:

Every twenty-four months incandescent lamps behind all lenses shall be replaced and the
electrical cable and its connections in and near the signal head shall be checked; and

Every four years mercury vapor lamps shall be replaced, and all reflectors, lenses, tubes and/or lamps shall be cleaned.

460-3.4 Signal Support Inspection

All signal supports shall be inspected at a maximum five-year interval. New signal supports shall be inspected at the time of construction. Refer to Section 407-2 for additional information on signal support inspections.

460-4 As Required Maintenance

The following maintenance shall be conducted as required:

At signalized intersections, and for School Flashers and Intersection Control Beacons (overhead flashers):

1. Replace premature failure of incandescent lamp. Clean all reflectors, lenses, tubes and/or lamps.
2. Repaint painted steel poles, controller housings and signal heads as necessary to maintain good appearance and protection.
3. If required by local conditions of smoke, smog, etc., clean all reflectors, tubes and/or lamps using a mild detergent.

At flashing signs, illuminated signs, and other electrical traffic control devices:

1. Replace premature failure of incandescent lamp. Clean all reflectors, lenses, tubes and/or lamps.
2. Replace premature failure of mercury vapor lamps. Clean all reflectors, lenses, tubes and/or lamps.
3. Maintain and replace all other items as required.

Maintain all signs and pavement markings directly associated with any of these devices.

460-5 Malfunction Response

Each District shall seek the cooperation of the Ohio State Highway Patrol (OSHP), local law enforcement, and ODOT work crews in reporting outages and malfunction of electrical traffic control devices. The District shall provide directions for reporting malfunctions twenty-four hours a day.

Upon becoming aware of a traffic signal malfunction (i.e., single red or yellow outage, power outage, signal on flash, and other malfunctions or damage as deemed necessary), the District shall be reasonably prompt in responding at all times, including outside normal working hours. Other repairs, especially green outages, may be made when practicable.

The District shall establish procedures for addressing malfunction responses. At a minimum these shall include:

1. If necessary, notify the OSHP or other appropriate law enforcement agencies, and ask for immediate assistance with traffic control until operation can be restored to a safe condition.
2. Assure that the signal is examined by a signal electrician or other qualified individual to verify that the signal was not damaged by the outage.

3. When a response is made to a reported traffic signal malfunction, the nature and time of malfunctions and corrective action taken shall be recorded.

4. All maintenance of traffic operations shall follow the requirements of the **OMUTCD** and **Part 6 of the TEM**.

### 460-6 Record Retention

The District shall be responsible for retaining records on all traffic signal maintenance, installations, upgrades, transfers, and removals. These records shall be retained for seven years and then reviewed by the State Archives for possible transfer. If the State Archives determines there is no historical value, they can be destroyed. These records shall include:

1. Date of lamp replacements and a description of all other signal maintenance and repairs preformed.

2. The record response to each reported traffic signal malfunction.

3. Documentation to reflect the history of the signals, shall also be maintained for each location. Copies of the original installation and each revision shall be retained either in paper or electronic form or both.

A current signal timing chart, current “as-built” plan, current programming chart for coordination if necessary, cabinet wiring diagram, and special function device diagrams in each controller housing and in the District office. If laptop computers are used instead of paper copies, a plan for updating all the signal electrician’s laptops shall be developed by the District.

### 460-7 Training

The District shall be responsible for training its personnel. The Office of Training and the Office of Traffic Engineering, in cooperation with the Districts, will make the necessary classes and training available. The schedule for the training classes will depend on the needs for the different level of IMSA certifications needed by the Districts. The following are required classes and training for personnel responsible for the maintenance of electrical traffic control devices:

1. **International Municipal Signal Association (IMSA) Training.**
   a. Work Zone Safety.
   b. Traffic Signal Technician Level I.
   c. Traffic Signal Technician Level II.

2. **Office of Traffic Engineering Training.**

### 460-8 Organizational Performance Index (OPI)

The Traffic Signal Maintenance Organizational Performance Index (OPI) is intended to establish a measurable performance of the District’s traffic signal maintenance. Through the OPI process,
Districts will be identified that are adhering to ODOT’s traffic signal maintenance policies, and the condition of ODOT traffic signal installations will be quantified.

The OPI will provide a snapshot view of the condition of the signal installation when the inspector arrived at the intersection.

For more information on the OPI, refer to the Traffic Signal Maintenance Inspection Manual.

460-9 Signal Databases

460-9.1 General

Two enterprise data systems have been created by the IT Department for traffic-related items. PC based programs have also been developed for accessing and reporting signal information. Internet and Intranet access have been discussed and details will be worked out as the traffic signal databases evolve.

460-9.2 Traffic Signal Maintenance

This database will contain the information from the Signal Inspection Form (Form 496-7) and the resulting OPI points for the measurable maintenance items. This database will allow ODOT to track signal maintenance inspections.

460-9.3 Traffic Signal Inventory

This database will contain detailed information about every traffic signal installation that includes: location, timing, phasing, equipment information, digital pictures, and a repair history of individual pieces of equipment. The inventory will be completely compatible with the GIS system. The inventory will also be used with the Division of Planning’s congestion model as one of ODOT’s initiatives.

460-10 Signal Inspection Items

A sample Signal Inspection Form is presented in Form 496-7. The PC based interface software will print out this form as either a blank form or with the header information filled in, if the signal installation has already been entered into the signal inventory database.

When a traffic signal installation is originally entered into the signal inventory database, an unique number will be generated by the computer system called the “ODOT signal system number.” This number will then become the primary tracking number for all information pertaining to this signal installation. The District may also retain the “signal file number” which has been in use for many years as an internal reference.

If the header information is printed out, the inspector should verify the controller and conflict monitor manufacturer and serial number for inventory purposes.
470 OTHER CONSIDERATIONS

This area is reserved for any material about other considerations that do not fit into the other sections of this chapter.

480 RESEARCH

This area is reserved for discussion of research related to traffic control signals.
495 REFERENCE RESOURCES

495-1 General

Various reference resources that may be useful have been noted in Sections 193, 194 and 195.

495-2 Traffic Signal Maintenance Inspection Manual

This manual outlines the performance measures for the Organizational Performance Index (OPI) for Traffic Signal Maintenance performed by District forces. A discussion of each of the signal inspection items is also presented. This manual is available from the Office of Traffic Engineering.
496 FORMS INDEX

496-1 Signal Support Inspection Form

*Form 496-1* can be used for inspection of signal supports, as noted in *Section 421-2*.

496-2 Traffic Signal Stage 3 Check List

*Form 496-2* is a sample Traffic Signal Stage 3 Check List, as noted in *Section 441-2*.

496-3 Traffic Signal Controller Timing Chart for Actuated Signals

*Form 496-3* is a sample Traffic Signal Controller Timing Chart, as noted in *Section 441-2*.

496-4 Traffic Signal Detector Chart

*Form 496-4* is a sample Traffic Signal Detector Chart, as noted in *Section 441-2*.

496-5 Coordination Timing Chart

*Form 496-5* is a sample Coordination Timing Chart, as noted in *Section 441-2*.

496-6 Report of Electrical Tests

*Form 496-6* is used for reporting the results of the standard electrical tests, as noted in *Sections 450-11.3 and 450-11.4*.

496-7 Signal Inspection Form

*Form 496-7* is the Signal Inspection Form described in *Sections 460-9.2 and 460-10*. 
Intentionally blank.
Form 496-1. Signal Support Inspection Form

Support Information

Support Identifier: ___________________________       Date: _______________________
Route: ____________________________________            Direction: ____________________
Intersection of: _____________________________________and ___________________________
Design No.: _________________________
Support Type: _____ Strain Pole _____ Mast Arm _____ Sign _____ School
               _____ Other: ___________________________________________________

Foundation

_____ Concrete Condition _____ Soil Condition _____ Anchor Bolts/Nuts
Comments: ___________________________________________________________________
__________________________________________________________________________

Support Condition

_____ Galvanized _____ Painted _____ Wood
_____ Structural Members _____ Structural Connections _____ Down Guy
Damage? _____ Yes _____ No        Pitting? _____ Yes _____ No
Surface Rust: _____ Minimal _____ Moderate _____ Severe
Comments: ___________________________________________________________________
__________________________________________________________________________

Inspected by: ___________________________    Date: _______________________

October 23, 2002
Form 496-2. Traffic Signal Stage 3 Check List

A. General:  *Written justification required (see Section F)  (DNA) - Does Not Apply

1. Are the following items being used in the project:
   a) *Optically programmed signal heads
   b) *Mast arms
   c) *Thermoplastic markings (general)
   d) *Thermoplastic markings only at intersections
   e) Special control equipment
      1) *Priority control
      2) RR preemption
      3) *Traffic adjusted master
      4) Interconnection: Type
   f) Combination supports
   g) Overhead lane control supports
   h) Are all Stage 2 comments compiled with or otherwise explained?
   i) Other (list):

2. Who is:
   a) furnishing signs
   b) erecting signs
   c) applying thermoplastic markings
   d) applying painted markings
   e) removing existing signs
   f) removing existing markings
   g) provide, maintain, remove temporary markings

B. Warrants

1. Have signal warrants for all intersections been resolved?

2. Are all unwarranted signals being removed? If answer is no, list intersections and agreed action at each intersection.

3. If unwarranted signals are not being removed, who is doing the upgrading and interconnecting of these signals and when will work be done?

4. Are traffic signal permits involved (i.e., is any signal within a village and on a State Route)? (Village is incorporated area with population of less than 5000.)

C. Utilities

1. Have the utility companies reviewed the plans and approved of the work in writing?

2. Are utility poles being used for interconnect?

3. Is power service by flat rate contract or meter?
4. Are disconnect switches required at power service points?

5. Will the power company run power service to the signal poles or will triplex service cable be run from power pole to signal pole as part of this project?

6. Are high voltage lines present in the area? 10 feet (3.0 meter) minimum clearance may be required. Check with power company for specific requirements.

7. Have proposed support locations been field checked for conflicts with overhead lines and underground facilities?

8. Do any lines go over/under railroad tracks?

D. Right-of-Way

1. Are any work agreements or easements required? (For placement of items such as loop detectors, pavement marking, etc. outside of the right-of-way limits.)

2. Are right-of-way (R/W) lines shown on signal intersection plan sheets for checking pole foundations, conduit runs, etc., and are all items within the R/W? Note: certain procedures require temporary easements, etc., even though actual construction is within the R/W (i.e., jacking conduit usually requires a jacking pit).

E. Equipment Responsibility

1. Existing signal installation - Does anyone besides contractor retain existing equipment? If answer is yes, name other parties involved.

2. Are any equipment items being reused? If yes, are these items clearly defined on plan sheets and has consultant field checked these items?

3. Has ownership of all items to be removed been established (control equipment, poles, luminaires, etc., by city, state, utility companies, etc.)?

4. Is the maintaining agency of each signal clearly discernible on the plans?

F. Justification

1. Is justification needed and who will submit it (refer to Section A)?
   a) Thermoplastic __________
   b) Optically programmed signal heads __________
   c) Mast arm supports __________
   d) Combination supports (commitment on installment of lighting) __________
   e) Traffic adjusted signal systems __________
   f) Justification for proprietary items __________
   g) Preemption __________
   h) Other (list) __________
Form 496-3. Traffic Signal Controller Timing Chart for Actuated Signals

Intersection

Maintaining Agency

<table>
<thead>
<tr>
<th>Start Up</th>
<th>Dual Entry</th>
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<tbody>
<tr>
<td>Start In: &quot;y/r flash or&quot; all red</td>
<td>Rest In Red: Ring 1 &quot; Ring 2 &quot;</td>
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<tr>
<td>Time for Flash or All Red: ________</td>
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<td>First Phases(s): * __________ &amp; * __________</td>
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<td>Color Displayed &quot; Green; &quot; Yellow</td>
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<tr>
<th>Interval or Feature</th>
<th>Controller Movement No.</th>
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<tbody>
<tr>
<td>Intersection Movement</td>
<td>1 2 3 4 5 6 7 8</td>
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<tr>
<td>Minimum Green (Initial)</td>
<td>(Sec.)</td>
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<td>Added Initial *(Sec./Actuation)</td>
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<td>Passage Time (Preset Gap)</td>
<td>(Sec.)</td>
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<td>Time Before Reduction *(Sec.)</td>
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<tr>
<td>Minimum Gap *(Sec.)</td>
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<td>Time To Reduce *(Sec.)</td>
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<td>Maximum Green I</td>
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<td>Maximum Green II</td>
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<td>Yellow Change</td>
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<td>All Red Clearance</td>
<td>(Sec.)</td>
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<td>Walk</td>
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<td>Pedestrian Clearance</td>
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<td>Recall</td>
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<td>Maximum</td>
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<td>Pedestrian</td>
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<td>Memory (On/Off)</td>
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<td>Call to Non Actuated</td>
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* Volume Density Controls
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<tr>
<th>Loop Designation</th>
<th>Size ft. (m)</th>
<th>No. of Turns</th>
<th>Pulse or Presence</th>
<th>Delay (sec.)</th>
<th>Extension (sec.)</th>
<th>Override Phase</th>
<th>Connect to Detector Unit (unit-channel)</th>
<th>Associated Controller Phase</th>
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# Form 496-5. Coordination Timing Chart

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<tr>
<th>Description</th>
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<td>Time Period in Effect</td>
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<td>(1) Offset (reset) No. 1 (sec.)</td>
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<td>(1) Offset No. 2 (sec.)</td>
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<td>Length of Hold-Release or Yield (Permissive) (sec.)</td>
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1. Offsets are measured from incoming master synch pulse time to hold - release (yield) at end of major street phase, which is phase(s) numbered ________. End of major street phase is end of green/beginning of yellow, except where pedestrian timing is provided, in which case it is end of green plus walk/beginning of green - plus flashing don't walk.

2. Force off is measured from the hold - release (yield).
Form 496-6. Report of Electrical Tests

| DATE ___ / ___/ ___ | SHEET ___ OF ___ |
| PROJECT NO. __________ | COUNTY ______ | ROUTE ______ | SECTION _______

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<thead>
<tr>
<th>Short Circuit Test 632.28(C)</th>
<th>Circuit Continuity Test 632.28(D)</th>
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<tr>
<td>(Zero or Negligible Ohms Required)</td>
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### Cable Insulation (Megger) Test 632.28(E) (All Conductors of Cables Jumpered Together)

<table>
<thead>
<tr>
<th>Locations</th>
<th>Type of Cable</th>
<th>MegOhms 10 Min.</th>
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### Ground Test For Traffic Signals 632.28(B) and 625.19

<table>
<thead>
<tr>
<th>Ground Rod Location: Station of Pole or Cabinet</th>
<th>Resistance Ohms</th>
</tr>
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### Functional Test: 632.28(F)

- **OK**
- **G**

- Incoming AC 120 Volts
- Cabinet Fan, Thermostat, Convenience Outlet, and Lamp Operation
- Controller timing set as per plan or approved by the Engineer
- Switches
- Controller functions
- Detector Units detect all vehicles
- Detector Units do not give extraneous calls
- Flash Switch Transfer
- Monitor is not activated by normal operations
- Monitor is not activated by manipulation of cabinet switches
- Monitor activated by artificial conflict
- Signal transfers to flash when monitor is disconnected
Form 496-7. Signal Inspection Form

<table>
<thead>
<tr>
<th>TRAFFIC SIGNAL FILE NUMBER:</th>
<th>LOCATION:</th>
</tr>
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<tbody>
<tr>
<td>COUNTY AND ROUTE NUMBER:</td>
<td>ODOT SIGNAL SYSTEM NUMBER:</td>
</tr>
<tr>
<td>DATE INSPECTED: <strong>/</strong><em><strong>/</strong></em>___</td>
<td>Points: ______</td>
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<tr>
<td>TIME REQUIRED: __________</td>
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<tr>
<td>CONTROLLER TYPE: ________________</td>
<td>ODOT NUMBER: __________</td>
</tr>
<tr>
<td>MONITOR MODEL: ________________</td>
<td>CM: ☐</td>
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<tr>
<td>MMU: ☐</td>
<td>COORDINATION TYPE: ______</td>
</tr>
<tr>
<td>INSCRIBED BY: ____________________________</td>
<td>TITLE: ____________________</td>
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<tr>
<td>INSCRIBED BY: ____________________________</td>
<td>TITLE: ____________________</td>
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</tbody>
</table>

1 TRAFFIC SIGNAL HEAD

<table>
<thead>
<tr>
<th>Satisfactory</th>
<th>Unsatisfactory</th>
<th>N/A</th>
<th>Repaired</th>
<th>Points</th>
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<tbody>
<tr>
<td>1.1 Alignment **</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>1.2 Date re-lamp **</td>
<td>Date re-lamped <strong>/</strong><em><strong>/</strong></em>___</td>
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<tr>
<td>1.3 Clearance Height**</td>
<td>Clearance Ft.______ In.________</td>
<td>☐</td>
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<tr>
<td>1.4 Condition including the following:</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td></td>
<td>lens (dirty, burns, holes), lamp orientation, visors, lamps (all burning), signal head cable condition(splices/wear), Prepare to Stop When Flashing sign, above ground detection, water leaks</td>
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2 OVERHEAD SIGNAL SUPPORT SYSTEM

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<tr>
<td>2.1 Condition including the following:</td>
<td>☐</td>
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<td></td>
<td>messenger wire for rust, grips, 3-bolt clamps, pole clamp bolts tight, wire entrance and pin wear, span wire signing, pole clamp assembly and clevis pin wear, lashing rods, signal cable</td>
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3 CONTROLLER & CABINET

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<tr>
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<th>Points</th>
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<tr>
<td>3.1 Intersection documentation**</td>
<td>☐</td>
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<td>3.2 Conflict Monitor or MMU (6 mo. inspection) **</td>
<td>Date: <strong>/</strong><em><strong>/</strong></em>___</td>
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<td>3.3 All detection operational**</td>
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<td>3.4 Wires and cables labeled</td>
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<td>3.5 Cabinet sealed to foundation</td>
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<td>3.6 Lock condition (including Power Service)</td>
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<td>3.7 Filter Clean (Size____X____X____)</td>
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<td>3.8 Cabinet lamp working</td>
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<td>3.9 GFRC receptacle (test)</td>
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<td>3.10 Wire terminations tight</td>
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<td>3.11 Prepare To Stop When Flashing</td>
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<td>Timing (Ph._= ___<em>sec.) (Ph.</em>= ____sec.)</td>
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<td>3.12 Load switch indicators lighting</td>
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<td>3.13 Preemption</td>
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<td>3.14 Cabinet earth ground (___ohms)</td>
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<td>3.15 Lightning arresters</td>
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<td>3.16 Housing conduit sealed</td>
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<td>3.17 Cabinet fan / thermostat</td>
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<td>3.18 Cabinet clean? need vacuuming?</td>
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<td>3.19 Cabinet hinges, need lubricated?</td>
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** USED IN DISTRICT OPI RATING**
### 4 SIGNAL STRAIN AND WOOD POLES

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<th>Item</th>
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<td>4.1</td>
<td>Anchor bolts tight</td>
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<td>4.2</td>
<td>Hand hole covers in place</td>
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<tr>
<td>4.3</td>
<td>Pole grounds</td>
</tr>
<tr>
<td>4.4</td>
<td>Pole cap in place</td>
</tr>
<tr>
<td>4.5</td>
<td>Concrete foundation</td>
</tr>
<tr>
<td>4.6</td>
<td>Down guys</td>
</tr>
<tr>
<td>4.7</td>
<td>Wood pole condition</td>
</tr>
</tbody>
</table>

#### 5 POWER SERVICE

5.1 Condition including:
- Weather head
- Wire chaffing
- Splices at top of pole
- Switch box condition
- Meter box

#### 6 LOOP DETECTORS & SEALANT

6.1 Cracks filled with sealant

6.2 No exposed wires

6.3 No pavement cracks (Note crack repair in comments for crack sealant repair crew scheduling)

#### 7 PEDESTRIAN OPERATION

7.1 Including:
- Pedestrian head aim/alignment
- Pedestrian head working

#### 8 PULL BOXES

8.1 Condition including:
- All located
- Lids on all
- Draining properly
- Wires and cables labeled
- Wires and conduit in good shape
- Conduit sealed
- Lid marked “Traffic”
497 TABLES INDEX

497-1 Cross Section Area of Conduit, Cable and Wire

Table 497-1 is used as described in Section 450-3.4 to size conduit based on the number and size of the conductors contained in the conduit.

497-2 Cable and Wire Identification

Table 497-2 is referenced in Section 450-10.3 and is a reproduction of CMS Table 632.05-1.

497-3 Minimum Visibility Distance for Traffic Signals

Table 497-3 is referenced in Section 450-10.4 and is a reproduction of Table TS-1 from OMUTCD, Section 6B-12.

497-4 Types of Overhead Signal Supports

Table 497-4 depicts various types of overhead signal supports and is referenced in Sections 440-3, 440-4 and 450-6.1.

497-5 Load Factors for Signal Heads

Table 497-5 presents load factor used in Sections 440-3 and 440-4 in designing overhead signal supports.
Intentionally blank.
Table 497-1. Cross Section Area of Conduit, Cable and Wire

<table>
<thead>
<tr>
<th>Specification or Material</th>
<th>No. of Conductors AWG</th>
<th>Cross Section Area, Sq. In.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMSA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-1 or 20-1</td>
<td>2/C # 14</td>
<td>.10</td>
</tr>
<tr>
<td></td>
<td>3/C # 14</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>4/C # 14</td>
<td>.16</td>
</tr>
<tr>
<td></td>
<td>5/C # 14</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>7/C # 14</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>9/C # 14</td>
<td>.33</td>
</tr>
<tr>
<td></td>
<td>12/C # 14</td>
<td>.41</td>
</tr>
<tr>
<td></td>
<td>15/C # 14</td>
<td>.48</td>
</tr>
<tr>
<td></td>
<td>18/C # 14</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>25/C # 14</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>2/C # 12</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>3/C # 12</td>
<td>.16</td>
</tr>
<tr>
<td></td>
<td>4/C # 12</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>5/C # 12</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>7/C # 12</td>
<td>.30</td>
</tr>
<tr>
<td></td>
<td>9/C # 12</td>
<td>.40</td>
</tr>
<tr>
<td></td>
<td>12/C # 12</td>
<td>.50</td>
</tr>
<tr>
<td></td>
<td>15/C # 12</td>
<td>.58</td>
</tr>
<tr>
<td></td>
<td>18/C # 12</td>
<td>.74</td>
</tr>
<tr>
<td></td>
<td>25/C # 12</td>
<td>1.00</td>
</tr>
<tr>
<td>UL: RHH/RHW/USE</td>
<td>1/C # 14</td>
<td>.053</td>
</tr>
<tr>
<td></td>
<td>1/C # 12</td>
<td>.061</td>
</tr>
<tr>
<td></td>
<td>1/C # 10</td>
<td>.075</td>
</tr>
<tr>
<td></td>
<td>1/C # 8</td>
<td>.107</td>
</tr>
<tr>
<td></td>
<td>1/C # 6</td>
<td>.138</td>
</tr>
<tr>
<td></td>
<td>1/C # 4</td>
<td>.173</td>
</tr>
<tr>
<td></td>
<td>1/C # 2</td>
<td>.229</td>
</tr>
<tr>
<td>Belden</td>
<td>2/C # 14</td>
<td>.08</td>
</tr>
<tr>
<td>PE Jacket, Shielded</td>
<td>2/C # 14</td>
<td>.11</td>
</tr>
</tbody>
</table>

Conduit Cross Section Area

<table>
<thead>
<tr>
<th>Nominal Diameter, in.</th>
<th>1/2</th>
<th>3/4</th>
<th>1</th>
<th>1 1/4</th>
<th>1 1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside Diameter, in.</td>
<td>.622</td>
<td>.824</td>
<td>1.049</td>
<td>1.380</td>
<td>1.610</td>
</tr>
<tr>
<td>Inside Area, sq. in.</td>
<td>.30</td>
<td>.53</td>
<td>.86</td>
<td>1.50</td>
<td>2.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nominal Diameter, in.</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>3 1/2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside Diameter, in.</td>
<td>2.067</td>
<td>2.469</td>
<td>3.068</td>
<td>3.548</td>
<td>4.026</td>
</tr>
<tr>
<td>Inside Area, sq. in.</td>
<td>3.36</td>
<td>4.79</td>
<td>7.39</td>
<td>9.89</td>
<td>12.73</td>
</tr>
</tbody>
</table>
Table 497-2. Cable Wire and Identification

<table>
<thead>
<tr>
<th>Cable</th>
<th>Tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground</td>
<td>GND</td>
</tr>
<tr>
<td>Power (2 wire) 1 φ 120 volt</td>
<td>AC+</td>
</tr>
<tr>
<td></td>
<td>AC- or ACN</td>
</tr>
<tr>
<td>Power (3 wire) 1 φ 120/240 volt</td>
<td>AC+1</td>
</tr>
<tr>
<td>Neutral wire</td>
<td>AC+2</td>
</tr>
<tr>
<td></td>
<td>AC- or ACN</td>
</tr>
<tr>
<td>Phase A</td>
<td>φ A</td>
</tr>
<tr>
<td>Phase 1</td>
<td>φ 1</td>
</tr>
<tr>
<td>Phase 1 northbound left turn lanes</td>
<td>φ 1 NBLT</td>
</tr>
<tr>
<td>Phase A, pedestrian signal</td>
<td>φ A PD</td>
</tr>
<tr>
<td>Overlap, phase A + C</td>
<td>φ A + C</td>
</tr>
<tr>
<td>Overlap, phase 1 + 6</td>
<td>φ 1 + 6</td>
</tr>
<tr>
<td>Detector lead-in, phase A</td>
<td>DET A</td>
</tr>
<tr>
<td>Detector lead-in, phase 1</td>
<td>DET 1</td>
</tr>
<tr>
<td>Detector lead-in, phase 1 northbound left turn lanes</td>
<td>DET 1 NBLT</td>
</tr>
<tr>
<td>Detector lead-in, phase A (call type)</td>
<td>DET A CALL</td>
</tr>
<tr>
<td>Detector lead-in, phase 1 (call type)</td>
<td>DET 1 CALL</td>
</tr>
<tr>
<td>northbound thru lanes</td>
<td>NB-THRU</td>
</tr>
<tr>
<td>Detector harness *</td>
<td>DET A</td>
</tr>
<tr>
<td>Interconnect</td>
<td>IC</td>
</tr>
<tr>
<td>Preemption, fire</td>
<td>PE FIRE</td>
</tr>
<tr>
<td>Preemption, railroad</td>
<td>PE RR</td>
</tr>
</tbody>
</table>

* For the detector harness, the tag shall be placed next to the MS plug at the detector amplifier.
### Table 497-3. Minimum Visibility Distance for Traffic Signals

<table>
<thead>
<tr>
<th>85&lt;sup&gt;th&lt;/sup&gt; Percentile Speed miles/hour</th>
<th>Minimum Visibility Distance feet (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>175 (54)</td>
</tr>
<tr>
<td>25</td>
<td>215 (66)</td>
</tr>
<tr>
<td>30</td>
<td>270 (83)</td>
</tr>
<tr>
<td>35</td>
<td>325 (100)</td>
</tr>
<tr>
<td>40</td>
<td>390 (119)</td>
</tr>
<tr>
<td>45</td>
<td>460 (140)</td>
</tr>
<tr>
<td>50</td>
<td>540 (165)</td>
</tr>
<tr>
<td>55</td>
<td>625 (191)</td>
</tr>
<tr>
<td>60</td>
<td>715 (218)</td>
</tr>
</tbody>
</table>
Table 497-4. Types of Overhead Sign Supports

<table>
<thead>
<tr>
<th>Support Type</th>
<th>Allowable Sign Area, Sq. Ft.</th>
<th>Span or Arm Length, Ft.</th>
<th>Configuration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC-81.20 Signal Support Single Arm</td>
<td>(Small signs may be mounted.)</td>
<td>25 to 48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC-81.20 Combination Signal Support</td>
<td>-----------------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May be used to add a highway lighting and/or signing function to TC-81.20.</td>
</tr>
<tr>
<td>TC-81.10 Strain Pole &amp; Messenger Wire</td>
<td>(Small signs may be mounted.)</td>
<td>------------------------</td>
<td></td>
<td>See SCD TC-84.20 for messenger wire details.</td>
</tr>
<tr>
<td>Supported Signals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC-81.10 Combination Strain Pole</td>
<td>(Small signs may be mounted.)</td>
<td>------------------------</td>
<td></td>
<td>May be used to add a highway lighting and/or signing function to TC-81.10.</td>
</tr>
</tbody>
</table>
### Table 497-5. Load Factors for Signal Heads

<table>
<thead>
<tr>
<th>Signal Head Type (note a)</th>
<th>Aluminum (inches/mm)</th>
<th>Polycarbonate (note b) (inches/mm)</th>
<th>Optically Programmed (inches/mm)</th>
<th>Rigid Attach. (note c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches (mm)</td>
<td>8 (203)</td>
<td>8 (203)</td>
<td>8 (203)</td>
<td>8 (203)</td>
</tr>
<tr>
<td></td>
<td>12 (305)</td>
<td>12 (305)</td>
<td>12 (305)</td>
<td>12 (305)</td>
</tr>
<tr>
<td>1 section</td>
<td>20 (9.1)</td>
<td>15 (6.8)</td>
<td>18 (8.2)</td>
<td>46 (20.9)</td>
</tr>
<tr>
<td></td>
<td>25 (11.3)</td>
<td>25 (11.3)</td>
<td>34 (15.4)</td>
<td>50 (22.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>76 (34.5)</td>
<td>88 (40.0)</td>
<td>+19 (+8.6)</td>
</tr>
<tr>
<td>3 sections</td>
<td>40 (18.1)</td>
<td>25 (11.3)</td>
<td>34 (15.4)</td>
<td>76 (34.5)</td>
</tr>
<tr>
<td></td>
<td>55 (24.9)</td>
<td>34 (15.4)</td>
<td>88 (40.0)</td>
<td>+25 (+11.3)</td>
</tr>
<tr>
<td>4 sections</td>
<td>50 (22.7)</td>
<td>30 (13.6)</td>
<td>42 (19.1)</td>
<td>92 (41.8)</td>
</tr>
<tr>
<td></td>
<td>70 (31.8)</td>
<td>30 (13.6)</td>
<td>107 (48.6)</td>
<td>+28 (+12.7)</td>
</tr>
<tr>
<td>5 sections vertical</td>
<td>60 (27.2)</td>
<td>35 (15.9)</td>
<td>50 (22.7)</td>
<td>107 (48.6)</td>
</tr>
<tr>
<td></td>
<td>85 (38.6)</td>
<td></td>
<td></td>
<td>126 (57.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+31 (+14.1)</td>
</tr>
<tr>
<td>5 sections</td>
<td></td>
<td>90 (40.8)</td>
<td>55 (24.9)</td>
<td></td>
</tr>
<tr>
<td>5 sections mixed</td>
<td>75 (34.0)</td>
<td>45 (20.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Intentionally blank.
400 TRAFFIC SIGNAL Traffic Engineering Manual

498 FIGURES INDEX

498-1 Emergency Traffic Signals Guidelines

Figure 498-1 illustrates the cross-corner sight distance criteria suggested for use in reviewing requests for Emergency Traffic Signals, as described in Section 406-2.

498-2 Local Government Agency/Utility Force Account Work

Figure 498-2 illustrates the process described in Section 400-4 for administering force account work by a local government agency or utility to an active construction project.

498-3 Suggested Loop Placement for High-Speed Mainline vs. Large-Volume Side Street

Figure 498-3 illustrates suggested loop detector placements as described in Section 408-3 for the intersection of a high-speed mainline with a large-volume side street.

498-4 Suggested Loop Placement for High-Speed Mainline vs. Ramp/T Intersection

Figure 498-4 illustrates suggested loop detector placements as described in Section 408-3 for the intersection of a high-speed mainline with a ramp or T intersection.

498-5 Suggested Loop Placement for High-Speed Mainline vs. Low-Speed Side Street

Figure 498-5 illustrates suggested loop detector placements as described in Section 408-3 for the intersection of a high-speed mainline with a low-speed side street.

498-6 Concrete Pull Box

Figure 498-6 illustrates a concrete pull box as described in Section 450-3.2.

498-7 Trench Details

Figure 498-7 illustrates details of the different types of trench that are described in Section 450-3.3.

498-8 Exothermic Weld

Figure 498-8 illustrates the equipment used for an exothermic weld as described in Section 450-3.6.

498-9 Power Service

Figure 498-9 illustrates the mounting details for the power service components as described in Sections 440-2 and 450-4.

498-10 Strain Pole Supports

Figure 498-10 illustrates details for signal strain poles as described in Section 450-6.1.

498-11 Strain Pole Attachment Details

Figure 498-11 illustrates details for the attachment of span wires to a signal strain pole as described in Sections 450-6.2 and 450-8.
498-12 Single Arm Support

*Figure 498-12* illustrates a mast arm signal support as described in *Sections 441-2 and 450-6.3*.

498-13 Single Arm Support

*Figure 498-13* illustrates sag and vertical clearance and is referenced in *Section 450-7*.

498-14 Cable Support Assembly

*Figure 498-14* illustrates the use of a cable support assembly to relieve cable strain inside of a pole as described in *Sections 450-8.2 and 450-8.7*.

498-15 Aerial Interconnect Cable

*Figure 498-15* illustrates attachment details for aerial interconnect cable as described in *Section 450-8.8*.

498-16 Method of Measurement for Signal Cable

*Figure 498-16* illustrates the calculation method for the measurement of signal cables as described in *Sections 450-8.5 and 450-9*.

498-17 Method of Measurement for Interconnect Cable

*Figure 498-17* illustrates the calculation method for the measurement of interconnect cable as described in *Sections 450-8.5, 450-8.8 and 450-9*.

498-18 Method of Measurement for Detector Lead-In Cable

*Figure 498-18* illustrates the calculation method for the measurement of detector lead-in cables as described in *Sections 450-8.5, 450-9 and 450-10.8*.

498-19 Method of Measurement for Power Cable

*Figure 498-19* illustrates the calculation method for the measurement of power cable as described in *Sections 450-8.5 and 450-9*.

498-20 Method of Measurement for Service Cable

*Figure 498-20* illustrates the calculation method for the measurement of service cable as described in *Sections 450-8.5 and 450-9*.

498-21 Vehicular Signal Heads

*Figure 498-21* illustrates the hardware and wiring for signal heads as described in *Section 450-10.4*.

498-22 Pedestrian Signal Heads

*Figure 498-22* illustrates the mounting of pedestrian signal heads as described in *Section 450-10.6*.

498-23 Loop Detector Placement and Installation

*Figure 498-23* illustrates the installation details for loop detectors as described in *Section 450-10.7*.
498-24 Loop Detector Slots and Wiring

*Figure 498-24* illustrates the installation details for loop detectors as described in Section 450-10.7.

498-25 Loop Detector Wiring

*Figure 498-25* illustrates miscellaneous wiring details for loop detector wiring as described in Section 450-10.8.

498-26 Magnetometer Probes and Lead-In

*Figure 498-26* illustrates installation details for magnetometer probes as described in Section 450-10.9.

498-27 Ground Rod Testing

*Figure 498-27* illustrates the layout of the test probes for the ground rod test as described in Section 450-11.2.

498-28 Short-Circuit Test

*Figure 498-28* illustrates the connections for the short-circuit test as described in Section 450-11.3.

498-29 Circuit Continuity Test of Loop Wire (Before Splice to Lead-In Cable)

*Figure 498-29* illustrates the connections for the continuity circuit test on loop detector wire as described in Section 450-11.4.

498-30 Circuit Continuity Test of Loop Wire and Lead-In Cable

*Figure 498-30* illustrates the connections for the continuity circuit test for the entire loop wire and lead-in cable installation after splicing as described in Section 450-11.4.

498-31 Circuit Continuity Test of Signal Cable Disconnected from Heads or Other Cable

*Figure 498-31* illustrates the connections for the continuity circuit test for signal cable disconnected from the signal heads and other cables as described in Section 450-11.4.

498-32 Circuit Continuity Test of Signal Cable (With Cable Connected to the Signal Heads and Lamps Installed)

*Figure 498-32* illustrates the connections for the continuity circuit test for signal cable connected to the signal heads (with lamps installed) as described in Section 450-11.4.

498-33 Cable Insulation Test (Loop Detector Wire)

*Figure 498-33* illustrates the connections for the cable insulation test for loop detector wire as described in Section 450-11.5.

498-34 Cable Insulation Test (Signal Cable)

*Figure 498-34* illustrates the connections for the cable insulation test for signal cable as described in Section 450-11.5.
498-35 **SCD TC-81.20 Signal Support Design Chart**

*Figure 498-35* presents the of the SCD TC-81.20 signal support design chart for mast arms as described in *Section 440-3.*

498-36 **Plan Details for Strain Poles**

*Figure 498-36* presents a sample angle orientation chart for signal strain pole (SCD TC-81.10) appurtenances as described in *Section 441-7.*

498-37 **Plan Details for Signal Supports - Arm Lengths**

*Figure 498-37* presents a sample chart for mast arm signal supports (SCD TC-81.20) appurtenances as described in *Section 441-7.*

498-38 **Plan Details for Signal Supports - Mast Arm Orientation**

*Figure 498-38* presents a sample angle orientation chart for mast arm signal support (SCD TC-81.20) appurtenances as described in *Section 441-7.*
Figure 498-1. Emergency Traffic Signal Guidelines

<table>
<thead>
<tr>
<th>Approach Speed (MPH)</th>
<th>Distance “S”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40’ (12.2m)</td>
</tr>
<tr>
<td>25</td>
<td>230</td>
</tr>
<tr>
<td>30</td>
<td>280</td>
</tr>
<tr>
<td>35</td>
<td>330</td>
</tr>
<tr>
<td>40</td>
<td>370</td>
</tr>
<tr>
<td>45</td>
<td>420</td>
</tr>
<tr>
<td>50</td>
<td>460</td>
</tr>
<tr>
<td>55</td>
<td>510</td>
</tr>
<tr>
<td>60</td>
<td>560</td>
</tr>
</tbody>
</table>
Figure 498-2. Local Government Agency/Utility Force Account Work

1. Submission to District
2. Evaluate
3. Draft Agreement and Send to Agency for Signature
4. Send to Contract Sales for Director's Signature and Encumbrance No.
5. Return Copy of Signed Agreement and Formal Approval to Local Agency or Utility
6. Work Performed
7. Billings Submitted to District
8. Reviewed by District
9. Submit to Business & Human Services Administrator for Payment

If Required, Send to FHWA for Approval.
Figure 498-3. Suggested Loop Placement for High-Speed Mainline vs. Large-Volume Side Street

<table>
<thead>
<tr>
<th>LOOP DETECTOR CHART</th>
<th>MODE</th>
<th>NOTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>L2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>L3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>L4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>L5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>L6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

**Notes:**
- L1 through L6 are used to extend main line green.
- L7 and L8 are placed to mitigate high-speed dilemma zone conflicts.
- L9, L10, and L11 are used to extend main line green.
- L12 and L13 are used to extend side street green.

**Legend:**
- X: FT (m) - Speed (mph):
  - 40 or less: 60
  - 40-50: 65
  - 50-60: 70
  - 60-70: 80
  - 70-80: 90

**Diagram Notes:**
- L1 through L6 are used to extend main line green.
- L7 and L8 are placed to mitigate high-speed dilemma zone conflicts.
- L9, L10, and L11 are used to extend main line green.
- L12 and L13 are used to extend side street green.

**Diagram Instructions:**
- L1 through L6 are used to extend main line green.
- L7 and L8 are placed to mitigate high-speed dilemma zone conflicts.
- L9, L10, and L11 are used to extend main line green.
- L12 and L13 are used to extend side street green.
Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection

1. Through L4 are used to extend mainline green. L1, L2, and L3 are placed to mitigate main speed deceleration zone conflicts. L4 and L5 are used to mitigate slower speed deceleration zone conflicts.

2. For perimeter mainline, L1 can be used to extend mainline green. Designers should check with the local ADM and traffic patterns to determine if it is desirable to extend mainline green with L1 and then L5. If it is not desirable, L2 can be omitted.

3. For protected turn mainline, L2 is used to pull and extend protected turn arrow phases. It is flexible to switch detector outputs detection switches in order to use L2 to extend the main line green phase permitted after the protected turn phase has terminated.

4. L2 can be placed up to 100 ft away and the stop line of protected/left turn signal is used for vehicle detection.

5. L5 is located at the designer's discretion. Typical placement is for a 30 mph design speed. This applies the slowing condition at a ramp/T intersection.

6. L5 and L8 are placed in delay. After the delay time has expired, these loops call the ramp/T intersection green phase, and delay time for these loops is not started. This keeps L5 and L9 from extenuating the green phase.

7. L9 is on delay, this prevents the loop from calling the green phase. Once the green phase is called in by L9 and L10, the loop is delay and thus L9 is used to extend the ramp/T intersection green phase.
Figure 498-5. Suggested Loop Placement for High-Speed Mainline vs. Low-Speed Side Street

**Loop Detector Chart**

<table>
<thead>
<tr>
<th>Loop</th>
<th>Size (m)</th>
<th># Loops</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.8</td>
<td>1</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>0.8</td>
<td>1</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>0.8</td>
<td>2</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L4</td>
<td>0.8</td>
<td>2</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L5</td>
<td>0.8</td>
<td>3</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L6</td>
<td>0.8</td>
<td>3</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L7</td>
<td>0.8</td>
<td>4</td>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>L8</td>
<td>0.8</td>
<td>4</td>
<td>pulse</td>
<td></td>
</tr>
</tbody>
</table>

**Conditions for Loop Placement**

- A large delay signal may give vehicles a chance to turn right or left.
- A small delay may help keep left turning vehicles from entering the street crossing/intersection.

**Notes:**

- 1. Loop signals can help slow vehicles at an intersection.
- 2. Loop signals can help slow vehicles at an intersection.
- 3. Loop signals can help slow vehicles at an intersection.
- 4. Loop signals can help slow vehicles at an intersection.
- 5. Loop signals can help slow vehicles at an intersection.
- 6. Loop signals can help slow vehicles at an intersection.
- 7. Loop signals can help slow vehicles at an intersection.
- 8. Loop signals can help slow vehicles at an intersection.

**Diagram Notes:**

- L1 through L8 are used to extend main line green.
- LL1, LL2, and LL3 are used to mitigate high-speed volume issues.
- L4, L5, and L6 are used to mitigate low-speed volume issues.
- L1 through L8 are used to extend main line green.
- LL1, LL2, and LL3 are used to mitigate high-speed volume issues.
- L4, L5, and L6 are used to mitigate low-speed volume issues.
- L1 through L8 are used to extend main line green.
- LL1, LL2, and LL3 are used to mitigate high-speed volume issues.
- L4, L5, and L6 are used to mitigate low-speed volume issues.
- L1 through L8 are used to extend main line green.
- LL1, LL2, and LL3 are used to mitigate high-speed volume issues.
- L4, L5, and L6 are used to mitigate low-speed volume issues.
- L1 through L8 are used to extend main line green.
- LL1, LL2, and LL3 are used to mitigate high-speed volume issues.
- L4, L5, and L6 are used to mitigate low-speed volume issues.

**Speeds:**

<table>
<thead>
<tr>
<th>Speed</th>
<th>Mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>72</td>
</tr>
<tr>
<td>60</td>
<td>96</td>
</tr>
<tr>
<td>75</td>
<td>120</td>
</tr>
<tr>
<td>85</td>
<td>136</td>
</tr>
<tr>
<td>100</td>
<td>160</td>
</tr>
<tr>
<td>120</td>
<td>192</td>
</tr>
</tbody>
</table>

**498-5 Loop Notes:**

- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
- 498-5 Loop Notes
Figure 498-6. Concrete Pull Box
Figure 498-7. Trench Details

TRENCH

TRENCH IN PAVED AREAS

NARROW SLIT TYPE TRENCH
Figure 498-8. Exothermic Weld

- **Completed Weld**
- **Cover**
- **Starting Powder**
- **Powder**
- **Steel Disk**
- **Tap Hole**
- **1/8" (3 mm)**
- **Weld Cavity**
- **Mold**
- **Cable or Conductor**
- **Ground Rod**

Diagram illustrating the components and process of an exothermic weld.
Figure 498-9. Power Service
Figure 498-10. Strain Pole Supports
Figure 498-11. Strain Pole Attachment Details

- J Hook
- Pole Cap with Set Screws
- Thimble
- Anchor Shackle
- 3-Bolt Clamp
- Signal Cables
- Drp Loop
- Weatherhead in Pole or on Conduit Riser
- Cable Support Assembly
- Servo with Wire or Strand Sleeve
- Bullring (Aerial Corners)
- Preformed Guy Grips

- J Hook
- Extended Strain Pole
- Handhole
- Span Wire Clamp
- Roadway Lighting Luminaire Arm (Not Included)

Combination Pole
Figure 498-12. Single Arm Support
Figure 498-13. Sag and Vertical Clearance Diagram

PERCENT SAG = \frac{SAG}{SPAN} \times 100

ALLOWABLE SAG IS 3 TO 5 PERCENT OF SPAN

CLEARANCE
18 FT. (5.5 m) MAX.
16 FT. (4.9 m) MIN.

SAG FOR SIMPLE SPANS
Figure 498-14. Cable Support Assembly

- "J" Hook
- Pole Cap with Set Screws
- 3-Bolt Clamp
- Anchor Shackles
- Thimble
- Serve with Wire or Strand Sleeve
- Bullring (Aerial Corners)
- Prefomed Guy Grips
- Signal Cables
- Drip Loop
- Weatherhead in Pole or on Conduit Riser
- Cable Support Assembly
Figure 498-15. Aerial Interconnect Cable
Figure 498-16. Method of Measurement for Signal Cable

Calculation for Pole Mounted Cabinet:
LENGTH = 5 FT. (1.5 m) + A + 10 FT. (3 m) + B + CI + 5 FT. (1.5 m)

Calculation for Ground Mounted Cabinet:
LENGTH = 5 FT. (1.5 m) + A + 10 FT. (3 m) + B + C2 + D + E + 5 FT. (1.5 m)
Figure 498-17. Method of Measurement for Interconnect Cable

**Example with 5 Poles**

**Calculation for Pole Mounted Cabinet:**

\[
\text{Length} = 5 \times \text{ft. (1.5 m)} + C + D + E + F + G + H + 5 \times \text{ft. (1.5 m)}
\]

**Calculation for Ground Mounted Cabinet:**

\[
\text{Length} = 5 \times \text{ft. (1.5 m)} + A + D + C + D + E + F + G + H + 5 \times \text{ft. (1.5 m)}
\]
Figure 498-18. Method of Measurement for Detector Lead-In Cable

CALCULATION FOR POLE MOUNTED CABINET:
LENGTH = 5 FT. (1.5 m) + A + B + C + D1 + 5 FT. (1.5 m)

CALCULATION FOR GROUND MOUNTED CABINET:
LENGTH = 5 FT. (1.5 m) + A + B + C + D2 + E + F + 5 FT. (1.5 m)
Figure 498-19. Method of Measurement for Power Cable

**Calculation for Pole Mounted Cabinet:**

\[ \text{Length} = 5 \text{ ft.} \times (1.5 \text{ m}) + A_1 + 5 \text{ ft.} \times (1.5 \text{ m}) \]

**Calculation for Ground Mounted Cabinet:**

\[ \text{Length} = 5 \text{ ft.} \times (1.5 \text{ m}) + A_2 + B + C + 5 \text{ ft.} \times (1.5 \text{ m}) \]
Figure 498-20. Method of Measurement for Service Cable

Example with 3 Service Poles

Calculation:

Length = 5 ft. (1.5 m) + A + B + C + 5 ft. (1.5 m)
Figure 498-21. Vehicular Signal Heads

Cutaway  Open Bottom Tunnel  Without Balance Adjustor  Balance Adjustor  Universal (on mast arm)

Tunnel  Louvered  Hangers for Signal Heads

Visors for Signal Heads

Wiring a Signal Head

150 mm (6") min.
Figure 498-22. Pedestrian Signal Heads
Figure 498-23. Loop Detector Placement and Installation

---

**Loop Construction**

<table>
<thead>
<tr>
<th>Loop Perimeter</th>
<th>Number of Turns</th>
</tr>
</thead>
<tbody>
<tr>
<td>feet (meters)</td>
<td></td>
</tr>
<tr>
<td>40 (less than 12)</td>
<td>4</td>
</tr>
<tr>
<td>40-160 (12 to 49)</td>
<td>3</td>
</tr>
<tr>
<td>over 160 (over 49)</td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 498-24. Loop Detector Slots and Wiring

Technique A:
- Cut out pavement and joint material to depth of saw cut approximately 3 in. (75 mm) square or 3 in. (75 mm) diam.
- Lay wires in "S" shape.
- Fill with elastic joint material or asphalt.

Technique B:
- Loop wires and pour soft-setting butyl rubber type sealant injected in loop section or groove over wire.

Technique C:
- Use 3/4" (19 mm) rigid plastic conduit.
- Fill with filler compound.
Figure 498-25. Loop Detector Wiring

**CONDUIT DRILLED HOLE DETAIL**

**SPLICE ENCLOSURE DETAIL**
Figure 498-26. Magnetometer Probes and Lead-In

- Saw cut and holes filled with epoxy
- Probe
- Sealant
- Pull box
- Splice
- Conduit
- Typical Probe Install
- Sensor probe and lead
- Triple
- Double
- Single
- Alternate location
- Probe installation
Figure 498-27. Ground Rod Testing

[Diagram showing ground rod testing setup with probes and measurement points.]
Figure 498-28. Short-Circuit Test

Testing is to be done with all electrical loads, power sources, equipment grounds and earth grounds disconnected.

<table>
<thead>
<tr>
<th>Wire Connected</th>
<th>Pairs Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>White/Red</td>
</tr>
<tr>
<td></td>
<td>White/Orange</td>
</tr>
<tr>
<td></td>
<td>White/Green</td>
</tr>
<tr>
<td></td>
<td>White/Black</td>
</tr>
<tr>
<td>Red</td>
<td>Red/Orange</td>
</tr>
<tr>
<td></td>
<td>Red/Green</td>
</tr>
<tr>
<td></td>
<td>Red/Black</td>
</tr>
<tr>
<td>Orange</td>
<td>Orange/Green</td>
</tr>
<tr>
<td></td>
<td>Orange/Black</td>
</tr>
<tr>
<td>Green</td>
<td>Green/Black</td>
</tr>
</tbody>
</table>

Conductors may be jumped together for testing to ground. If a short is revealed, individual conductors may then be tested to ground to isolate the faulty conductor.
Figure 498-29. Circuit Continuity Test of Loop Wire
(Before Splice to Lead-In Cable)

TURN FUNCTION SELECTOR TO RESISTANCE. A RESISTANCE OF ZERO OHMS SHOULD BE INDICATED. IF A HIGH RESISTANCE IS FOUND, THE LOOP INSTALLATION IS UNACCEPTABLE.
Figure 498-30. Circuit Continuity Test of Loop Wire and Lead-In Cable
Figure 498-31. Circuit Continuity Test of Signal Cable Disconnected from Heads or Other Cables Such as Interconnect and Loop or Magnetometer Lead-In

TEMPORARY JUMPERED TOGETHER THE WHITE AND RED CONDUCTORS. REPEAT TEST JUMPERING ALL OTHER CONDUCTORS WITH THE WHITE IN TURN.

CONNECT TO WHITE CONDUCTOR.

TEMPORARY CONNECTED TO THE RED. REPEAT TEST CONNECTING ALL OTHER CONDUCTORS IN TURN TO THE METER, LEAVING THE WHITE CONNECTED TO ONE TERMINAL.

TURN FUNCTION SELECTOR TO RESISTANCE. A RESISTANCE OF ZERO OHMS SHOULD BE INDICATED. IF A HIGH RESISTANCE IS FOUND THE LOOP INSTALLATION IS UNACCEPTABLE.
Figure 498-32. Circuit Continuity Test of Signal Cable With Cable Connected to the Signal Heads and Lamps Installed
Figure 498-33. Cable Insulation Test (Loop Detector Wire)
Figure 498-34. Cable Insulation Test (Signal Cable)
Figure 498-35. SCD TC-81.20 Signal Support Design Chart
<table>
<thead>
<tr>
<th>From Sheet No.*</th>
<th>Reference Street*</th>
<th>Pole No.</th>
<th>Design No.</th>
<th>Pole Height (ft)</th>
<th>Foundation Elev. *</th>
<th>Span Wire Attach. Ht.*</th>
<th>Pedestrian Signals</th>
<th>Pedestrian Push buttons</th>
<th>Controller</th>
<th>Power Service</th>
<th>Cable Entrance 12&quot; (0.3 m) from Top</th>
<th>Luminaire Bracket</th>
<th>Interconnect</th>
<th>Pole Splice Box</th>
<th>Index Line Angle (Deg)</th>
<th>Pole Height (ft)</th>
<th>Foundation Elev. *</th>
<th>Span Wire Attach. Ht.*</th>
<th>Pedestrian Signals</th>
<th>Pedestrian Push buttons</th>
<th>Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* See Section 41-8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. All angles are measured clockwise.
2. The index line goes through the center of the handhole.
Figure 498-37. Plan Details for Signal Supports - Arm Lengths
   (table is continued in Figure 498-38)

<table>
<thead>
<tr>
<th>Support No.</th>
<th>Design No.</th>
<th>Pole Height (ft. (m))</th>
<th>L (ft. (m))</th>
<th>L1 (ft. (m))</th>
<th>L2 (ft. (m))</th>
<th>L3 (ft. (m))</th>
<th>L4 (ft. (m))</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

18' TO 18'
(4.9 TO 5.5 M)
CLEARANCE
Notes:
1. All angles are measured clockwise.
2. Base plate is oriented square to Mast Arm A (largest arm) even if the support has two arms.

<table>
<thead>
<tr>
<th>Mast Arm A Angle (Deg.)</th>
<th>Orientation Angles (Deg.) from Mast Arm A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mast Arm B</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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604-6 Flagger Stations

Except as noted below for a single flagger at a “spot” location, flagger stations shall be located far enough ahead of the work space, so that approaching traffic has sufficient distance to stop before entering the work space (see OMUTCD Section 7H-5). Table 697-10 provides guidelines for determining the distance of the flagger station in advance of the work space. These distances may be increased for downgrades and other conditions that affect stopping distance.

The flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. A flagger should only stand in the lane being used by moving road users after the road users have stopped. The flagger should be clearly visible to the first approaching road user at all times. The flagger should also be visible to other road users. The flagger should be stationed sufficiently in advance of the workers to warn them (for example, with audible warning devices such as horns, whistles, etc.) of approaching danger by out-of-control vehicles. The flagger should stand alone, never permitting a group of workers to congregate around the flagger station.

At “spot” lane closures where adequate sight distance is available for the safe handling of traffic, the use of one flagger may be sufficient (see Figure 698-21 and Section 607-18). At such a “spot” obstruction, a position may have to be taken on the shoulder opposite the barricaded section to operate effectively.

Flagger stations should be preceded by proper advance Warning Signs. Under certain geometric and traffic situations, more than one flagger station may be required for each direction of traffic. At night, flagger stations should be illuminated.
605 TEMPORARY TRAFFIC CONTROL ZONE DEVICES

605-1 General

The design and application of temporary traffic control devices used in temporary traffic control zones should consider the needs of all road users. All traffic control devices used on street and highway construction, maintenance, utility, or incident management operations shall conform to the applicable provisions of the OMUTCD. Additional information on the standards and guidelines for the design and use of these devices is included in this part of the TEM.

The traffic control devices discussed herein include signs, pavement markings, raised pavement markers, channelizing devices, lighting devices, beacons, warning lights, traffic signals, and other devices used to regulate, warn or guide traffic.

Section 607 provides additional information on the use of these devices in typical applications, Section 640 provides additional design and plan preparation information, Section 650 addresses construction issues, Section 660 addresses maintenance issues, and Section 670 addresses various other considerations.

Crashworthiness and crash testing information on temporary traffic control devices are found in AASHTO’s Roadside Design Guide (RDG) (see Section 193-12). Additional materials and hardware information related to temporary traffic control zone devices is addressed in Section 620.

As noted in OMUTCD Section 7A-3, where the color orange is required, fluorescent red-orange or fluorescent yellow-orange colors may also be used. The fluorescent version of orange provides higher conspicuousness than standard orange, especially during twilight.

605-2 General Characteristics of Signs

605-2.1 General

Temporary traffic control zone signs convey both general and specific messages by means of words or symbols and have the same three categories as all road user signs: regulatory, warning and guide described in OMUTCD Part 2.

The most commonly used work zone signs are discussed in detail in OMUTCD Part 7 and Sections 605-2 through 605-10. Illustrations of temporary traffic control signs that are discussed in this Manual, but not shown in the OMUTCD are provided in Figures 698-3a and 698-3b.

The OMUTCD and this chapter also provide examples of common applications of these signs. ODOT standards for application of work zone signing on construction projects are provided in the SCDs and this Manual, and material requirements are addressed in Section 620 and CMS 614. Also see Part 2 of this Manual for further signing information.

When standard orange flags or flashing warning lights are used in conjunction with signs, they shall not block the sign face.

605-2.2 Design

The colors for Regulatory Signs shall follow the standards in OMUTCD Sections 2H through 2L. Warning Signs in temporary traffic control zones shall have a black legend on an orange background, except for the Railroad Advance Warning Sign, which shall have a black message and border on a yellow background, and except for signs that are permitted in OMUTCD Part 2.
605-6.3 SHOULDER DROP-OFF Sign (OW-155)

The SHOULDER DROP-OFF sign (OW-155) is intended for use when a shoulder drop-off, adjacent to the travel lane, exceeds 3 inches (76 mm) in depth and is not protected by a portable barrier. Where the sign is appropriate, it shall be installed by the end of the day in which the drop-off is created.

Guidance for proper protection under such conditions in active work zones is provided in the Plan Insert Sheet (PIS) No. 2010190, Drop-Offs in Work Zones, which is available from the Office of Traffic Engineering web page. If the Guidance in the Plan Insert sheet is followed, there will be no need for the OW-155 sign.

<table>
<thead>
<tr>
<th>Type</th>
<th>Code No.</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>Std. &amp; Maj. Std.</td>
<td>OW-155</td>
<td>36 x 36 (900 x 900)</td>
</tr>
<tr>
<td>Exp. &amp; Freeway</td>
<td>OW-155</td>
<td>48 x 48 (1200 x 1200)</td>
</tr>
</tbody>
</table>

605-6.4 UNEVEN LANES Sign (OW-171)

The UNEVEN LANES sign, OW-171 should be used during operations that create a difference in elevation between adjacent lanes. Sizes for this sign are the same as shown for the OW-155 (Section 605-6.3).

<table>
<thead>
<tr>
<th>Type</th>
<th>Code No.</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. &amp; Maj. Std.</td>
<td>OW-171</td>
<td>36 x 36 (900 x 900)</td>
</tr>
<tr>
<td>Exp. &amp; Freeway</td>
<td>OW-171</td>
<td>48 x 48 (1200 x 1200)</td>
</tr>
</tbody>
</table>

605-6.5 NO CENTER (EDGE) LINE Sign (OW-167, 168)

The NO CENTER (EDGE) LINE sign should be used when the work obliterates the center (or edge) stripe. This sign should be placed at the beginning of the zone and repeated at 2-mile (3.2 kilometers) intervals in long zones to remind the road users. It should also be used at major connections, traffic generators, and/or at appropriate intervals as determined by the project engineer, to advise road users entering within the zone. For acceptable temporary pavement marking standards see Section 605-11.11.

<table>
<thead>
<tr>
<th>Type</th>
<th>Code No.</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>Standard</td>
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<td>36 x 36 (900 x 900)</td>
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<tr>
<td></td>
<td>OW-168</td>
<td>36 x 36 (900 x 900)</td>
</tr>
<tr>
<td>Maj. Std., Exp. &amp; Freeway</td>
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<td>48 x 48 (1200 x 1200)</td>
</tr>
<tr>
<td></td>
<td>OW-171</td>
<td>48 x 48 (1200 x 1200)</td>
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</tbody>
</table>
605-7 Guide Signs

605-7.1 General

Guide Signs in temporary traffic control zones are addressed in OMUTCD Part 7E. This section will be used to provide additional information about Guide Signs discussed in the OMUTCD if needed. Information about Guide Signs used in temporary traffic control zones that are not currently addressed in the OMUTCD are discussed in Section 605-8.

If a temporary traffic control zone requires guidance information different from that existing, the existing permanent Guide Signs shall be removed or covered and superseded by the appropriate temporary Guide Signs.

605-7.2 DETOUR Signs and Markers (OC-14, 29, 29A, 30, OM-14, 23)

Each detour shall be adequately marked with standard temporary Route Markers and destination signs.

The DETOUR sign (OC-29) should be used for unnumbered highways, for emergency situations, for periods of short durations, or where, over relatively short distances, traffic may be guided along the detour and back to the desired highway without Route Markers. A Route Marker or Street Name sign should be placed above or incorporated in the DETOUR sign to indicate the name of the route being detoured.

An End Detour sign (OM-14 or OC-30) may be used to indicate that the detour has ended. When the END DETOUR sign (OC-30) is used on a numbered highway, the sign should be mounted above a Route Marker after the end of the detour.

<table>
<thead>
<tr>
<th>Sign</th>
<th>Dimensions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM-14</td>
<td>24” x 12”</td>
<td>600 mm x 300 mm</td>
</tr>
<tr>
<td>OC-29A</td>
<td>30” x 24”</td>
<td>750 mm x 600 mm</td>
</tr>
<tr>
<td>OC-30</td>
<td>24” x 18”</td>
<td>600 mm x 450 mm</td>
</tr>
</tbody>
</table>

605-7.3 Advance Work Zone Information Signs

Advance Work Zone Information Signs may be required as part of the maintenance of traffic plan for major construction projects. The need for these signs is usually determined by the corridor management team during their review of the project. The signs are fixed message types and advise the road user of alternate routes, possible delays, etc. The signs are generally located at extreme distances form the work area.

To insure uniformity in the design and application of these signs, the following guidelines will apply:

1. These signs shall be shown in the plans whether supplied by the contractor or by others (this choice shall be clearly indicated in the plans). The normal procedure is for the contractor to provide the signs.

2. The location of the signs shall be field checked by the designer to insure that there are no conflicts with existing features and other signs in the area. The designer will assure that signs
are not blocked by being too close to other signs and that the road user has sufficient time to read, understand and act on the information provided by all of the signs.

3. The plans shall indicate the legend, level and size of the signs. The signs shall be considered Supplemental Guide Signs as described in OMUTCD Section 2V-4.

4. The signs shall be black on orange (including a black border). The layout shall conform to the OMUTCD and ODOT Guide Sign design standards.

5. Where appropriate, advance work zone information signs shall make use of the same exit numbers, route numbers, directions and destinations as shown on the permanent Guide Signs.

6. In some instances, instead of providing separate installations, it may be desirable to modify existing overhead guide signs. These changes are accomplished by providing black-on-orange overlays to cover portions of the existing signs. Letter size on these overlays should be the same as on the existing signs. When lane arrows are to be covered, rather than using a blank overlay, the legend “LANE CLOSED” shall be used. When a ramp is being closed, rather than using a blank overlay to cover the entire sign, the legend “CLOSED” shall be used on a diagonal overlay (lower left to upper right) on the sign. The size of lettering on overlays and the size of the overlay shall be indicated in the plans. The minimum letter size for “LANE CLOSED” shall be 10-inch (254-millimeter) E.

7. When regulatory information is provided, it shall be displayed separately as a standard black-on-white sign. Mixing black-on-white regulatory information on a black-on-orange information sign is prohibited.

8. If the road user is being detoured, or if an alternate route is provided, the route should be signed with assemblies consisting of the appropriate black-on-orange (DETOUR OR ALT) markers with a standard Route Marker and arrow plate. If more target value is desired, this trailblazer information may be shown on an orange panel (M-45 type, see OMUTCD Section 2W-3).

Route Marker assemblies shall be sized according to the type of road on which they are located in accordance with the OMUTCD.

9. Supports for sign installations shall conform to all existing standards for permanent signs. These signs should not be attached to existing supports.

10. All advance work zone information sign installations located outside of the project work limits shall be paid for under appropriate 630 Items (signs, supports, concrete, breakaway connection, overlays, removals, etc.). They shall not be included in the lump sum bid for Item 614. This requirement does not apply to Advance Warning Signs or to sign installations within the work limits.

605-8 Special Guide Signs

605-8.1 General

This section is intended to address signs developed for use on ODOT-maintained highways that are not currently addressed in the OMUTCD. As noted in OMUTCD Section 7E-1, there may be a need for various “special” Information (Guide) Signs that are not in the OMUTCD. They may eventually be incorporated into the OMUTCD; however, if their use is limited they may not be incorporated into that manual. Special Guide Signs should conform to the general requirements.
of color, shape and alphabet size and series. The sign message should be brief, legible and clear.

605-8.2 TRUCK Marker (OM-15)

This sign shall be used with standard Detour signs when it is necessary to establish a detour for truck traffic, but not other vehicles.

605-8.3 Notice of Closure Signs (OC-60A, 60B)

Notice of Closure signs, OC-60A and OC-60B, are intended to give advance notice to the road user of a scheduled road closure. The information provided on these signs includes the scheduled date of closure and the number of days of scheduled closure. Additionally, OC-60A provides a telephone number for information and is the preferable sign. The selected sign should be erected at the point of closure except that more flexibility is acceptable in locating the signs on ramps. The sign should be erected at least one week in advance of a scheduled road or ramp closure and shall be erected on the right-hand side of the road or ramp, facing traffic. Additional details on placement of the Notice of Closure signs is provided in Section 642-8 (Plan Note 642-8).

605-8.4 Exit Ramp Open/Closed Signs OC-45, OC-45A, OC-46, OC-46A)

Use of these signs is described in Sections 607-40, 607-41 and Figures 698-43 and 698-44.

605-9 Portable Changeable Message Signs (PCMSs)

605-9.1 General

Portable Changeable Message Signs (PCMS) are traffic control devices with the flexibility to display a variety of messages to fit the needs of road and street authorities. Each message
consists of one or more displays. These signs are used most frequently on high density, urban freeways, but have applications on all types of highways where highway alignment, traffic routing problems or other pertinent conditions require advance warning and information.

In addition to the guidelines noted herein and in OMUTCD Section 7G-8.1, guidelines for use of PCMSs can be found in ATSSA’s Guidelines for the Use of Portable Changeable Message Signs. Portable Changeable Message Signs will typically be placed in advance of any other temporary traffic control zone signing and should not replace any required signing.

A list on the ODOT web site at http://www.dot.state.oh.us/testlab/applists/misc/pcms.htm shows portable changeable message signs approved for use on ODOT jobs.

605-9.2 Design

PCMSs shall automatically adjust their brightness under varying light conditions, to maintain legibility.

The components of a PCMS should include message sign panel, control systems, power source, and mounting and transporting equipment.

1. Message Sign Panel

Portable Changeable Message Signs should subscribe to the principles established in the OMUTCD, and to the extent practical, with the design (i.e., color, letter size and shape, and borders) and applications prescribed in the OMUTCD, except that the reverse colors for letters and the background are considered acceptable.

Each message shall consist of no more than two displays. Typically, a display shall consist of up to three lines of eight characters per line. The text of the message shall not scroll or travel horizontally or vertically across the face of the sign. Messages should be designed taking into account the following factors:

a. Each display should convey a single thought.

b. If the message can be shown in one display, the top line should present the problem, the center line should present the location or distance ahead, and the bottom line should present the recommended driver action.

c. The message should be as brief as possible.

d. When a message is longer than two phases, additional PCMSs should be used.

e. When abbreviations are used, they should be easily understood. A list of common abbreviations is provided in MUTCD Tables 1A-1 and 1A-2.

The front face of the sign should be covered with a protective material. The color of the elements should be yellow or orange on a black background.

The signs should be visible from one-half mile (0.8 kilometer) under both day and night conditions. The message should be legible from a minimum distance of 650 feet (200 meters). The message panel should have adjustable display rates, so that the entire message can be read at least twice at the posted speed, the off-peak 85th percentile speed prior to work starting, or the anticipated operating speed.
The message sign panel may vary in size.

Under low light level conditions, the sign shall automatically adjust its light source so as to meet the legibility requirements and not impair the drivers' vision.

2. Control System

The control system shall include a display screen upon which messages can be reviewed before being displayed on the message sign. Also, the control system shall be capable of maintaining memory when power is unavailable.

3. Power Source

The PCMSs shall be equipped with a power source and a battery backup to provide continuous operation when failure of the primary power source occurs. Diesel powered PCMSs should not be used in residential areas at night.

4. Mounting

The mounting of the PCMS shall be such that the bottom of the message sign panel shall be a minimum of 7 feet (2.1 meters) above the roadway when it is in the operating mode.

605-9.3 Application

PCMSs have a wide variety of applications in temporary traffic control zones, including roadway, lane or ramp closures, crash or emergency incident management, width restriction information, speed reduction, advisories on work scheduling, road user management and diversion, warning of adverse conditions, and operation control. PCMSs should be used as a supplement to and not as a substitute for conventional signs and pavement markings.

The primary purpose of PCMSs in temporary traffic control zones is to advise the driver of unexpected traffic and routing situations. Some typical applications include the following:

1. Where speed of motor vehicle traffic is expected to drop substantially;
2. Where significant queuing and delays are expected;
3. Where adverse environmental conditions are present;
4. Where there are changes in alignment or surface conditions;
5. Where advance notice of ramp, lane or roadway closures is needed;
6. Where crash or incident management is needed; and/or
7. Where changes in the road user pattern occur.

When PCMSs are used for route diversion, they should be placed far enough in advance of the diversion to allow road users ample opportunity to exit the affected highway. The PCMSs should be sited and aligned to ensure legibility. Multiple PCMSs should be placed on the same side of the roadway, separated from each other at distances based on Table 697-11.

PCMSs should be placed on the shoulder of the roadway or, if practical, further from the traveled lane. They should be delineated with retroreflective temporary traffic control devices or when
within the clear zone, shielded with a barrier or crash cushion. When PCMSs are not being used, they should be removed; if not removed, they should be shielded; or if the previous two options are not feasible, they should be delineated with retroreflective temporary traffic control devices.

The location of the PCMS may have to be adjusted to keep the sign an appropriate distance in advance of traffic queues. Instead of relocating, an additional PCMS may be employed.

PCMS trailers should be delineated on a permanent basis by affixing retroreflective material, known as conspicuity material, in a continuous line on the face of the trailer as seen by oncoming road users.

605-10 Arrow Panels

605-10.1 General

An arrow panel is a sign with a matrix of elements capable of either flashing or sequential displays. This sign shall provide additional warning and directional information to assist in merging and controlling road users through or around a temporary traffic control zone.

Arrow panels are used primarily on multi-lane highways to notify road users of the need to exit the presently occupied lane due to lane closure. The panels can be used on two-lane highways only in the caution mode.

A list posted on the ODOT web site at http://www.dot.state.oh.us/testlab/applists/misc/faps.htm shows solar powered arrow panels approved for use on ODOT jobs.

An arrow panel should be used in combination with appropriate signs, channelizing devices, or other temporary traffic control devices. Arrow panels will not solve difficult traffic problems by themselves, but can be very effective when properly used to reinforce signs and other traffic control devices. Necessary signs, barricades and traffic control devices shall be used in conjunction with the arrow displays.

An arrow panel should be placed on the shoulder of the roadway or, if practical, further from the traveled lane. It should be delineated with retroreflective temporary traffic control devices, or when within the clear zone, shielded with a barrier or crash cushion. When an arrow panel is not being used, it should be removed; if not removed, it should be shielded; or if the previous two options are not feasible, it should be delineated with retroreflective temporary traffic control devices.

Diesel powered panels should not be used in residential areas at night.

605-10.2 Design

Arrow panel shall meet the minimum size, legibility distance, number of elements, and other specifications shown in OMUTCD Section 7G-8, Table 7-7 and SCD MT-35.10.

Type A arrow panels are appropriate for use on low-speed (< 40 miles per hour) urban streets. Type B arrow panels are appropriate for intermediate-speed (40 to 50 miles per hour) facilities and for maintenance or mobile operations on high-speed (> 45 miles per hour) roadways. Type C arrow panels are intended to be used on high-speed, high-volume roadways. Type D arrow panels are intended for use on authorized vehicles.

Type A, B and C arrow panels shall have solid rectangular appearances. A Type D arrow panel shall conform to the shape of the arrow. All arrows shall be finished in nonreflective black.
The arrow panel shall be mounted on a vehicle, a trailer, or other suitable support. A vehicle-mounted arrow panel should be provided with remote controls. The minimum mounting height of an arrow panel should be 7 feet (2.1 meters) from the roadway to the bottom of the panel, except on vehicle-mounted panels, which should be as high as practical.

Arrow panel elements shall be capable of at least a fifty percent dimming from full brilliance. Full brilliance should be used for daytime operation of arrow panels, and the dimmed mode shall be used for nighttime operation of arrow panels.

The arrow panel shall have suitable elements capable of the various operating modes. If an arrow panel consisting of a bulb matrix is used, the elements should be recess-mounted or equipped with an upper hood of not less than 180 degrees. The color presented by the elements shall be yellow.

The minimum element on-time shall be fifty percent for the flashing mode, with equal intervals of twenty-five percent for each sequential phase. The flashing rate shall be not less than twenty-five, nor more than forty, flashes per minute.

An arrow panel shall have the following three mode selections:

1. A flashing arrow, sequential arrow or sequential chevron mode,
2. A flashing double arrow mode, and
3. A flashing caution mode.

605-10.3 Application

The placement of arrows can be very critical to traffic operation. Of particular importance is a placement that insures the required legibility distance specified in OMUTCD Section 7G-8, Table 7-7 and SCD MT-35.10. Also, care must be taken in the placement to avoid driver confusion in the vicinity of ramps, median crossovers and side road intersections.

An arrow panel in the arrow or chevron mode shall be used only for stationary or moving lane closures on multilane roadways.

An arrow panel shall be used only in the caution mode for shoulder work, blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway.

For a stationary lane closure, the arrow panel should be located on the shoulder at the beginning of the shifting or merging taper. Where the shoulder is narrow, the arrow panel should be located in the closed lane.

A single arrow panel shall not be used to shift traffic laterally more than one lane. When arrow panels are used to close multiple lanes, a separate arrow panel shall be used for each closed lane. If the first arrow panel is placed on the shoulder, the second arrow panel should be placed in the first closed lane at the beginning of the second merging taper. When the first arrow panel is placed in the first closed lane, the second arrow panel should be placed in the second closed lane at the downstream end of the second merging taper.

For mobile operations where a lane is closed, the arrow panel should be located to provide adequate separation from the work operation to allow for appropriate reaction by approaching drivers. A vehicle displaying an arrow panel shall be equipped with rotating lights or strobe lights.
605-11 Channelizing Devices

605-11.1 General

Channelizing devices guide road users through the work zone, indicate hazardous areas, and exclude road users from the actual work space. The following sections provide information on channelizing devices that is in addition to the standards and guidelines provided in OMUTCD Part 7F. For information on barriers, see OMUTCD Section 7F-12.1 and Sections 605-11.7 and 605-14.

Channelizing devices for use in temporary traffic control applications include cones, tubular markers, vertical panels, reflectorized plastic drums, barricades, direction indicator barricades, weighted channelizers and barriers. Portable concrete and plastic water-filled barriers may also be used as channelizing devices. Intermixing of various types of channelizing devices (e.g., drums and cones) is not permitted.

Channelizing devices and their application shall conform to the OMUTCD, the following TEM sections and the SCDs. Temporary barriers are discussed in further detail in Section 605-14. Crash cushions are discussed in Section 605-15. Temporary impact attenuators are discussed in Section 605-15.3. Also see Section 640-2 for a discussion of some exceptions.

605-11.2 Placement

As noted in OMUTCD Section 7F-17, the spacing of channelizing devices in a taper should not exceed a distance in feet equal to the speed limit in miles per hour. For example, if the taper is on a roadway with an existing 55 miles per hour speed limit, the devices should be spaced at about 55 feet.

To keep traffic out of a closed lane on a tangent section, channelizing devices should be spaced a distance in feet of no more than two times the speed limit in miles per hour.

Also, when channelizing devices have the potential of leading motor vehicle traffic out of the intended motor vehicle traffic space, the devices should be extended a distance in feet of two times the speed limit in miles per hour beyond the end of the transition area. As noted in Section 607-38, this situation is illustrated for the “southbound” traffic in Figure 698-41. In this typical application, the line of channelizing devices used for the “southbound” left-lane closing has been extended to help avoid the possibility that the devices used to delineate the crossover may also lead the traffic moving back into the “southbound” left lane into the median area.

All channelizing devices used in maintaining traffic should have a minimum lateral offset from the edge of the traveled lane of 1.5 feet (0.5 meter). A lateral offset of less than 1.5 feet (0.5 meter) may be used in instances when the project length is short. However, attempts to provide larger offsets should be made whenever possible.

605-11.3 Cones

This section addresses requirements for traffic cones that are in addition to those found in OMUTCD Sections 7F-5 and 7F-6.

Cones shall be predominantly orange, fluorescent red-orange or fluorescent yellow-orange, and when used at night, they shall be reflectorized with white bands of Type G reflective sheeting (CMS 730.191).

Except for pavement marking operations, the minimum height for cones shall be 28 inches.
Cones used to protect the line during a pavement operation may be 18 inches (see SCD MT-99.20).

The use of cones on freeways and other high-speed highways (≥ 45 mile per hour) shall be limited to short-term stationary lane closures.

Cones shall not be used at night on freeways and other high-speed highways. However, the weighted channelizer, similar to a large cone but reflectorized more like a drum, may be used at night on freeways and other high-speed highways. See Section 605-11.14 for information about the weighted channelizer.

605-11.4 Drums

605-11.4.1 General

This section addresses requirements for drums used for traffic warning or channelization that are in addition to those found in OMUTCD Sections 7F-7 and 7F-8.

Drums shall be ballasted in accordance with the manufacturer’s recommendations.

Drums shall be kept clean so that reflectivity is not compromised. Concrete sawing operations splash residue on sheeting, rendering it ineffective.

Owner identification markings on construction drums shall be no more than 1 inch (25 millimeters) in character height and located at least 2 inches (50 millimeters) below the reflectorized band or on the top or bottom horizontal surfaces of the drum.

Drums shall be reflectorized with Type G reboundable sheeting complying with the requirements of CMS 730.191. Additional information regarding use of drums is available in CMS 614.03.

605-11.4.2 Lights on Drums

ODOT’s use of warning lights (OMUTCD Section 7G-6 and TEM Section 605-12.5) on drums is limited to Type A flashing lights for identification of spot hazards. ODOT does not use Type C steady-burning warning lights on drums. Research projects sponsored by ODOT and FHWA demonstrated that benefits from steady-burning warning lights mounted on reflectorized drums are insignificant. Therefore, the use of these lights on reflectorized drums used as channelizing devices was terminated at the end of the 1991 construction season.

ODOT will not fund steady-burning (Type C) warning lights on drums used for the purpose of channelization on ODOT-administered projects. If a local agency desires to include lights on drums for channelization, the additional cost of the lights must be funded with local funds.

605-11.5 Barricades, Tubular Markers and Vertical Panels

This section addresses requirements for barricades, tubular markers and vertical panels that are in addition to those found in OMUTCD Sections 7F-2 through 7F-6 and 7F-9.

Faces of barricades and vertical panels shall be reflectorized with Type G or Type H sheeting complying with CMS 730.19 and 730.192.

As with cones (Section 605-11.3), all tubular markers shall be reflectorized with bands of Type G sheeting. For details on band widths and sequencing see OMUTCD Section 7F-5.
605-11.6 Direction Indicator Barricade

The Direction Indicator Barricade (see MUTCD Figure 6F-4) shall consist of a retroreflective horizontal arrow top panel and a striped retroreflective bottom panel, both mounted horizontally to the ground. It may be used in tapers, transitions and other areas where specific directional guidance to road users is necessary. However, if used, Direction Indicator Barricades should be used in series to direct road users through the transition and into the intended travel lane.

The arrow panel shall be black on an orange background. The stripes on the bottom panel shall be alternating orange and white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass. The stripes shall be 4 inches (100 millimeters) wide. The arrow panel shall be 24 x 12 inches (600 x 300 millimeters). The bottom panel shall have a length of 24 inches (600 millimeters) and a height of 8 inches (200 millimeters).

The Direction Indicator Barricade should be crashworthy.

605-11.7 Barrier Used as a Channelizing Device

Temporary traffic barriers shall not be used solely to channelize road users, but also to protect the work space. When used for channelization, temporary traffic barriers should be of a light color for increased visibility. For nighttime use, the temporary traffic barrier shall also be supplemented with delineation (see Sections 605-14.1, 605-14.4.2 and 605-19). For additional information on temporary traffic barriers see OMUTCD Section 7F-12.1 and Section 605-14.

Temporary traffic barriers should not be used for a merging taper except in low-speed urban areas. Temporary traffic barriers should not be used for a constricted/restricted temporary traffic control zone.

When it is necessary to use a temporary traffic barrier for a merging taper in low-speed urban areas or for a constricted/restricted temporary traffic control zone, the taper shall be delineated and the taper length should be designed to optimize road user operations considering the available geometric conditions.

605-11.8 Temporary Raised Islands

Temporary raised islands shall be used only in combination with pavement markings and other suitable channelizing devices.

A temporary raised island may be used to separate motor vehicle traffic flows in two-lane, two-way operations on roadways having a motor vehicle traffic volume range of 4,000 to 15,000 average daily traffic (ADT) and on freeways having a motor vehicle traffic volume range of 22,000 ADT to 60,000 ADT.

Temporary raised islands also may be used in other than two-lane, two-way operations where physical separation of motor vehicle traffic from the temporary traffic control zone is not required.

Temporary raised islands should have the basic dimensions of 4 inches (100 millimeters) high by 18 inches (450 millimeters) wide and have rounded or chamfered corners.

The temporary raised islands should not be designed in such a manner that they would cause a driver to lose control of the vehicle if the vehicle inadvertently strikes the temporary raised island. If struck, pieces of the island should not be dislodged to the extent that they could penetrate the occupant compartment or involve other vehicles.
605-11.9 Opposing Traffic Lane Divider

The Opposing Traffic Lane Divider sign is an upright, retroreflective orange-colored sign placed on a flexible support and sized at least 12 inches (300 millimeters) wide by 18 inches (450 millimeters) high. It is a delineation device used in a series to separate opposing motor vehicle traffic on a two-lane, two-way operation. A design is available upon request from the Office of Traffic Engineering (OTE).

605-11.10 Pavement Markings

605-11.10.1 General

This section provides additional information and support for information in OMUTCD Section 7F-12. The provisions of this section of the TEM shall not be considered applicable for short-term, mobile or incident management temporary traffic control zones.

Either permanent or temporary pavement markings shall be in place prior to opening the road or lane to road users. See Section 605-11.11 for additional information on temporary pavement markings.

Adequate pavement markings shall be maintained along paved streets and highways in temporary traffic control zones. The intended vehicle path should be defined in day, night, and twilight periods under both wet and dry pavement conditions. The work should be planned and staged to provide the best possible conditions for the placement and removal of the pavement markings.

Road users should be provided pavement markings within a temporary traffic control zone comparable to the pavement markings normally maintained along such roadways, particularly at either end of the temporary traffic control zone. The following guidelines set forth the level of adequate markings, delineation and obliteration for various temporary traffic control zone situations.

1. All pavement markings shall be in accordance with OMUTCD Parts 3A and 3B, except as indicated in Section 605-11.11.

2. Pavement markings shall be maintained along highways in all long- and intermediate-term stationary temporary traffic control zones (see Section 606-3). The pavement markings shall match the markings in place at both ends of the temporary traffic control zone. Particular attention should be given to ramp gore areas.

3. Pavement markings shall be placed, along the entire length of any surfaced detour or temporary roadway prior to the detour or roadway being opened to road users.

4. Markings should be provided in intermediate-term stationary work areas.

5. Warning Signs, channelizing devices and delineation shall be used to indicate required road user paths in temporary traffic control zones where it is not possible to provide a clear path by pavement markings.

6. For long-term stationary operations, pavement markings in the temporary traveled way that are no longer applicable shall be removed or obliterated as soon as practical. Pavement marking obliteration shall leave a minimum of pavement scars and shall remove old marking material. Painting over existing pavement markings with black paint or spraying with asphalt shall not be accepted as a substitute for removal or obliteration.
Removable, nonreflective, preformed tape may be used where markings need to be covered temporarily (see Section 605-11.10.2).

7. All markings and devices used to delineate road user paths shall be carefully reviewed during daytime and nighttime periods.

605-11.10.2 Conflicting Pavement Markings

Conflicting pavement markings shall be removed by an approved method which will not scar the pavement or may be covered with removable, nonreflective, preformed tape which blends in with the existing pavement surface. Should it be decided to use the removable tape, the tape must be closely monitored, as it may be displaced due to traffic passing over it or inclement weather conditions. See Section 620-6 and CMS 614.10 and 641.10 for additional information.

605-11.11 Temporary Pavement Markings

As noted in Section 605-11.10.1, either permanent or temporary pavement markings shall be in place prior to opening the road/lane to traffic.

Temporary, or interim, pavement markings are those that are allowed to remain in place until the earliest date when it is practical and possible to install pavement markings that meet the O MUTCD Part 3 standards for pavement markings. They should not be left in place for more than twenty-one days unless justified by an engineering study.

In areas of long line work such as resurfacing, where the roadway or lane remains open during construction, the new pavement marking shall be placed within fourteen days of removal or obliteration of the existing line(s). NO EDGE LINES (R-167) signs shall be erected at locations lacking necessary edge lines.

All temporary pavement markings, including pavement markings for No-Passing Zones, shall conform to the requirements of O MUTCD Parts 3A and 3B with the following exceptions:

1. All interim broken-line pavement markings shall use the same cycle length as permanent markings and be at least 4 feet (1.2 meters) long, except that half-cycle lengths with a minimum of 2-foot (0.6-meter) stripes may be used for roadways with severe curvature (see O MUTCD Section 3A-6). This applies to white lane lines for traffic moving in the same direction and yellow center lines for two-lane roadways when it is safe to pass.

2. The center line shall either be full dimensional for No-Passing Zones or an abbreviated Class II center line may be used for a maximum of three consecutive calendar days as long as NO PASSING (R-33) and PASS WITH CARE (R-34) signs are erected as required by CMS 614.04. At the end of the three day time period, a center line consisting of full dimensional no passing markings must be installed. Also, signs may be used instead of pavement markings on low-volume (as defined in Section 500) roads for longer periods. These signs should be placed in accordance with O MUTCD Sections 2J-21, 2J-22 and 2N-37.

3. Edge lines shall be provided except for short periods at locations where another form of identification is provided, such as drums or cones.

4. Interim gore marking shall be continuous 4 inch (100 millimeters) lines placed at the theoretical gore of an exit ramp or diverging roadway.
605-11.12 Raised Pavement Markers

Retroreflective or internally illuminated raised pavement markers, or nonretroreflective raised pavement markers supplemented by retroreflective or internally illuminated markers, may replace or supplement markings prescribed in OMUTCD Parts 3A and 3B.

Raised pavement markers should be considered for use along surfaced detours or temporary roadways, and other changed or new travel-lane alignments.

If raised pavement markers are used to substitute for broken line segments, at least two retroreflective markers shall be placed, one at each end of a segment of 2 feet (0.6 meter) to 5 feet (1.5 meters). For segments over 5 feet (1.5 meters), a group of at least three retroreflective markers shall be equally spaced at no greater than N/8. The value of N for a broken or dotted line shall equal the length of one line segment plus one gap.

The value of N referenced for solid lines shall equal the N for the broken or dotted lines that may be adjacent to or may be an extension of the solid lines (see OMUTCD Part 3B).

The use of temporary raised pavement markers is addressed in SCDs MT-95.70, 95.80, 96.10, 96.11 and 101.20.

605-11.13 Delineators

As noted in OMUTCD Section 7F-11, delineators may be used in temporary traffic control zones to indicate the alignment of the roadway and to outline the required vehicle path through the temporary traffic control zone. When used, delineators shall be used in combination with, or be supplemental to, other traffic control devices.

Delineators shall be mounted on crashworthy supports so that the reflecting unit is approximately 4 feet (1.2 meters) above the near roadway edge. The standard color for delineators used along both sides of two-way streets and highways and the right side of one-way roadways shall be white. Delineators used along the left side of one-way roadways shall be yellow. Spacing along roadway curves should be as set forth in OMUTCD Section 3D-4, and should be such that several delineators are always visible to the driver.

605-11.14 Weighted Channelizers

The weighted channelizer may be used on ODOT-maintained highways in accordance with this section. The weighted channelizer shall be predominantly orange, fluorescent red-orange or fluorescent yellow-orange in color and shall be made of a lightweight, flexible, and deformable material. It shall be at least 42 inches (1.1 meters) in height with a weighted base. It may have some sort of “handle” or lifting device which extends above the 42-inch (1.1-meter) minimum height.

The retroreflective markings on the weighted channelizer shall be horizontal, circumferential, alternating orange and white retroreflective stripes 6 inches (150 millimeters) wide. Each weighted channelizer shall have a minimum of two orange and two white stripes. Any non-retroreflective spaces between the horizontal orange and white stripes shall not exceed 2 inches (50 millimeters) in width. The weighted channelizer shall have a 4-inch (100-millimeter) minimum width, regardless of orientation.

Use of weighted channelizers on ODOT-maintained highways shall be as follows:

1. On freeways and multilane highways, the use of weighted channelizers shall be limited to
operations of twelve hours or less, for either day or night. Upon completion of work within this
time period, the weighted channelizers shall be removed. The weighted channelizers may
again be placed on the highway when the work is to resume on the following day or night. Any lane closure using channelization devices, expected to remain for more than twelve
hours, shall require the use of drums or barriers.

Night use of weighted channelizers on freeways and multi-lane highways shall be limited to
that portion of the closure which is beyond the transition taper area. Night channelization of
such transition taper shall be by use of drums.

2. On other highways, there are no restrictions on the duration of work for use of weighted
channelizers, day or night. On these roadways, night use of the weighted channelizer is
permitted along the entire zone, along the transition taper and beyond.

Maximum spacing of the weighted channelizer should be 40 feet (12 meters).

Steps should be taken to ensure that the weighted channelizers will not be blown over or
displaced by wind or moving traffic. Ballasts should not present a hazard if the weighted
channelizers are inadvertently struck, nor should they affect the visibility of the weighted
channelizer. All ballasts used should be in accordance with the manufacturer’s specifications.

605-12 Lighting Devices

605-12.1 General

Lighting devices (OMUTCD Part 7G) should be provided in temporary traffic control zones based
on engineering judgment. They may be used to supplement retroreflectorized signs, barriers and
channelizing devices.

Four types of lighting devices are commonly used in temporary traffic control zones. They are
floodlights, flashing warning beacons, warning lights and steady-burn electric lamps.

During normal daytime maintenance operations, the functions of flashing warning beacons are
adequately provided by rotating lights or strobe lights on a maintenance vehicle. Vehicle hazard
warning lights are permitted to be used to supplement rotating or strobe lights; however, they
shall not be used instead of rotating or strobe lights.

605-12.2 Floodlights

Utility, maintenance or construction activities on highways are frequently conducted during
nighttime periods when motor vehicle traffic volumes are lower. Large construction projects are
sometimes operated on a double-shift basis requiring night work. When nighttime work is being
performed, floodlights should be used to illuminate the work area, flagger stations, equipment
crossings and other areas.

Floodlighting shall not produce a disabling glare condition for approaching road users. The
adequacy of the floodlight placement and elimination of potential glare should be determined by
driving through and observing the floodlighted area from each direction on all approaching
roadways after the initial floodlight setup, at night, and periodically.

Lighting is often provided to illuminate the roadway at locations of significant geometric change.
For example:

1. All temporary crossover areas shall be illuminated as shown in SCD MT-100.00.
2. When a lane shift will be used for over fourteen consecutive days and existing lighting is not available, consideration may be given to providing a temporary lighting system along the tapers. Illumination of shift areas is illustrated in SCD MT-102.10.

3. Lighting shall be provided along tapers on high-speed highways which are not permanently lighted if the taper rate does not meet the minimum requirements called for in Table II of SCD 102.10. Continuous lighting of the work areas between tapers is only required when the tapers are provided with temporary lighting and the distance between the tapers is less than 2000 feet (610 meters).

605-12.3 Flashing Warning Beacons (Flashing Electric Lights)

Flashing Warning Beacons are also known as Flashing Electric Lights or Hazard Identification Beacons (see OMUTCD Section 7G-3). They are often used to supplement a temporary control device.

Design, operation and placement information for this device are addressed in OMUTCD Sections 7G-3, 7G-4 and 7G-5, and Part 6E.

As noted in OMUTCD Section 7G-3, the temporary terminus of a freeway is an example of a location where Flashing Warning Beacons alert drivers to the changing roadway conditions and the need to reduce speed in transitioning from the freeway to another roadway type.

605-12.4 Steady-Burning Electric Lamps

Steady-Burn electric lamps are a series of low-wattage, yellow, electric lamps, generally hard-wired to a 110-volt external power source. They may be used in place of Type C steady-burning Warning Lights (see Section 605-12.5).

605-12.5 Warning Lights

As noted in OMUTCD Section 7G-6, warning lights are portable, lens-directed, enclosed, low wattage, normally battery-powered yellow lights which may be mounted on barricades, drums, vertical panels or other suitable supports. They may be used in either flashing (Type A or B) or steady (Type C) modes. The light weight and portability of warning lights are advantages that make these devices useful as supplements to the retroreflectorization on signs and channelizing devices. The flashing lights are effective in attracting road users' attention.

Warning lights shall be in accordance with the current ITE Purchase Specification for Flashing and Steady-Burn Warning Lights (see OMUTCD Section 1G). When warning lights are used, they shall be mounted on signs or channelizing devices in a manner that, if hit by an errant vehicle, they will not be likely to penetrate the windshield. The maximum spacing for warning lights should be identical to the channelizing device spacing requirements.

When used to delineate a curve, Type C warning lights should only be used on devices on the outside of the curve, and not on the inside of the curve.

For additional information about this device see OMUTCD Section 7F-6. Also see Section 605-11.4.2 for additional information about the use of steady-burning warning lights with drums.
605-13 Temporary Traffic Control Signals

605-13.1 General

It is often necessary to install temporary traffic signals in order to maintain traffic through temporary traffic control zones. As noted in OMUTCD Section 7H-10, temporary traffic control signals used to control road user movements through temporary traffic control zones and in other temporary traffic control situations shall meet the applicable provisions of OMUTCD Part 6. This chapter provides additional information on the use of traffic signals in temporary traffic control zones. Part 4 of this Manual should also be reviewed for applicable information.

Temporary traffic control signals are typically used in work zones such as temporary haul road crossings; temporary one-way operations along a one-lane, two-way highway; temporary one-way operations on bridges, reversible lanes, and intersections. Figure 698-16 and the SCDs MT-96.10, 96.11 and 96.21 address the use of temporary traffic signals to maintain two-way traffic in a single lane (see Section 641-10).

Guidance on the design of temporary traffic control signals is provided in SCDs MT-96.10, 96.11 and 96.21, Section 605-13.2 and in the Plan Insert Sheets available at the OTE web site. Additional guidance in design of traffic signals is provided in OMUTCD Part 6 and Part 4 of this Manual.

For common procedures for maintaining traffic signals during construction, see the maintenance of traffic signals and flasher notes found in Section 642.

One-lane, two-way motor vehicle traffic flow (OMUTCD Section 7H-10) requires an all-red interval of sufficient duration for road users to clear the portion of the temporary traffic control zone controlled by the traffic control signals. Safeguards shall be incorporated to avoid the possibility of conflicting signal indications at each end of the temporary traffic control zone.

When temporary traffic control signals are used, conflict monitors typical of traditional traffic control signal operations shall be used.

Temporary traffic control signals may be portable or temporarily mounted on fixed supports.

Temporary traffic control signals should only be used in situations where temporary traffic control signals are preferable to other means of traffic control, such as changing the work staging or work zone size to eliminate one-way motor vehicle traffic movements, using flaggers to control one-way or crossing movements, using STOP or YIELD signs, and using warning devices alone.

Factors related to the design and application of temporary traffic control signals include the following:

1. Safety and road user needs;
2. Work staging and operations;
3. The feasibility of using other temporary traffic control strategies (for example, flaggers, providing space for two lanes, or detouring road users);
4. Sight distance restrictions;
5. Human factors considerations (for example, lack of driver familiarity with temporary traffic control signals);
6. Road-user volumes including roadway and intersection capacity;
7. Affected side streets and driveways;
8. Vehicle speeds;
9. The placement of other temporary traffic control devices;
10. Parking;
11. Turning restrictions;
12. Pedestrians;
13. Legal authority;
14. Signal phasing and timing requirements;
15. Full-time or part-time operation;
16. Actuated, fixed-time, or manual operation;
17. Power failures or other emergencies;
18. Inspection and maintenance needs;
19. Need for detailed placement, timing, and operation records; and
20. Operation by contractors or by others.

Although temporary traffic control signals can be mounted on trailers or lightweight portable supports, fixed supports offer superior resistance to displacement or damage by severe weather, vehicle impact, and vandalism.

Other temporary traffic control devices should be used to supplement temporary traffic control signals, including Warning and Regulatory Signs, pavement markings, and channelizing devices.

The design and placement of temporary traffic control signals should include interconnection to other traffic control signals along the subject roadway.

Temporary traffic control signals not in use should be covered or removed.

**605-13.2 Portable Traffic Signals (PTS)**

Temporary Traffic signals which will be in continuous operation for fourteen days or less shall be designed, operated and installed in accordance with SCDs MT-96.10, 96.11, 96.21, 96.25 and 96.26 *(see Section 641-10)* with the following exceptions and qualifications:

- Luminaires for area illumination are not required.
- Temporary pavement markings and temporary raised pavement markers are not required for signalized operations lasting less than thirty-six hours.
When signalized operation will last less than thirty-six hours, removal of existing conflicting pavement markings is not required if drums (or cones during daylight hours only) provide continuous positive guidance for vehicles.

Signal systems of this type shall not be used for situations where traffic, including contractors vehicles, will be entering the traffic stream, from the work site, between signals.

The traffic signal system may either be constructed of standard signal components conforming to SCDs MT-96.10, 96.11, 96.21, 96.25 and 96.26 (Section 641-10), or it may be a portable traffic signal (PTS) which is essentially self contained and mounted on trailers. The PTS shall conform to the following criteria:

1. The PTS shall conform to all OMUTCD requirements for traffic control signals including Section 6B-4 which in part states, “A Portable Traffic Control Signal must meet the physical and operational requirements of conventional traffic control signals described herein.”

2. Each signal head shall have three 12-inch vehicular indications (red, yellow and green) and their candlepower distributions shall not be less than specified for standard 12-inch signal heads in the ITE Standard for Adjustable Face Traffic Signal Heads.

3. The systems may be powered by engine driven generators or by stored battery charge. The systems, including batteries, shall be designed to provide electrical energy which will maintain the above described candlepower distribution for at least twenty-four hours at full output.

4. The dimming of a PTS shall be permitted in accordance with the OMUTCD. The unit may include a photocell and circuitry which will permit the yellow lens of the PTS light output to be reduced by up to fifty percent during night hours. The amount of dimming, and the choice of not dimming shall be operator selectable.

5. The signal unit generator battery and electronic controls shall be completely inaccessible to unauthorized access, and protected by a sturdy lockable metal enclosure.

6. Signal supports shall consist of sturdy brackets attached to a trailer. The erected assembly shall be designed to solidly support the roadside signals at the specified heights and be designed for 40 mile per hour (65 kilometers per hour) wind loads. Signal head configurations for each approach shall be one post-mounted signal at 8 foot (2.4 meter) minimum height on the right side of the road, plus another signal cantilever mounted over the right-hand traffic lane at a minimum height to 15 feet (4.5 meters); or two post-mounted signal heads, each erected at 8 foot (2.4 meter) minimum height on both sides of the road. The lateral spacing between signals shall be not less than 8 feet (2.4 meters).

7. The trailer and supports shall be orange. The signal heads shall be yellow.

8. The control portion of the PTS shall meet NEMA environmental standards. An independent laboratory test report shall be provided to verify compliance with the NEMA environmental standards.

9. The PTS shall be capable of operating in manual, fixed-time and traffic-actuated modes.

10. The controllers for the PTS system shall electronically communicate to each other by cable, radio or other method approved by the Director.

11. It shall not be possible even under manual control: (1) to program the yellow clearance interval for less than three seconds; or (2) for the green interval to be displayed for less than
five seconds.

12. All timing intervals shall be set in increments of one second or less.

13. The controller shall provide a variable all red clearance interval from zero to six hundred seconds.

14. The controller shall provide a method for insuring that the pairs of signal heads cannot display conflicting indications. This shall include at least a system which will identify, as a conflict, the display of a green in one direction while: (1) displaying a green in the conflicting direction; (2) displaying a yellow in the conflicting direction; or (3) displaying the all-red clearance interval for a conflicting approach. Further, a controller will be determined to be in conflict if a displayed green is less than five seconds or a displayed yellow is less than three seconds. Upon determination that a conflict exists, all signal heads shall display flashing red as described in item 15.

15. The controller shall provide a red flash cycle that shall be flashed continuously at a rate of not less than fifty nor more than sixty times per minute. The illuminated period of each flash shall be not less than half, nor more than two-thirds, of the total flash cycle.

16. The controller shall have circuitry which will detect low voltage and prevent the occurrence of an unsafe signal indication. This “brown out” circuit shall hold the signal safe until adequate voltage is resumed. If a microprocessor is utilized, appropriate circuitry shall be included that will reset the processor when needed while holding the signal in an all-red condition. When the processor is removed from the circuitry, the signal shall default to a safe condition.

17. If the PTS utilizes radio transmission equipment:
   a. The transmitter shall be an accepted FCC-type and shall not exceed 1 watt output per FCC Part 90.17. The manufacturer shall also comply with all specific limitations noted in FCC Part 90.17.
   b. In case of radio interference or failure, the PTS shall display all red.
   c. If an FCC license is required, a copy shall be kept on file with the contractor.

18. The contractor shall inspect the PTS at least once each hour for the first eight hours after it is set up or reconfigured. Thereafter, he shall inspect it at least every twenty-four hours, including weekends. The inspections are to determine that it is operating correctly and efficiently, signals properly aimed and that the battery charge remains sufficient.

19. The contractor or supplier shall submit a letter signed by the manufacturer certifying that the candidate PTS complies with each of the above requirements. The letter shall also convey detailed engineering information, drawings and descriptions which describe how each requirement is satisfied.

Each PTS determined to meet this specification will be shown on a prequalified list maintained by the Office of Traffic Engineering.

605-14 Temporary Traffic Barriers

605-14.1 General

Temporary traffic barriers are devices designed to help prevent penetration by vehicles while
minimizing injuries to vehicle occupants, and designed to protect workers, bicyclists and pedestrians. A typical use is where one side of a bridge is closed for deck repair. They are also used for certain special events or in other temporary traffic control contexts where separation and channelization of vehicle and pedestrian movements are needed. More specific information on the use of temporary traffic barriers is contained in Chapters 8 and 9 of AASHTO’s Roadside Design Guide (see Section 193-12).

Temporary traffic barriers, including shifting portable or movable barrier installations to accommodate varying directional motor vehicle traffic demands, may be used to separate two-way motor vehicle traffic.

Because the protective requirements of a temporary traffic control situation have priority in determining the need for temporary traffic barriers, their use should be based on an engineering study. When serving the additional function of channelizing motor vehicle traffic, temporary traffic barriers should be a light color for increased visibility.

Temporary traffic barriers shall be supplemented with standard delineation, pavement markings or channelizing devices for improved daytime and nighttime visibility if they are used to channelize motor vehicle traffic (Sections 605-11.7, 605-14.4.2 and 605-19). The delineation or pavement marking color shall match the applicable pavement marking color. Warning lights or steady-burn electric lamps may also be mounted on temporary traffic barrier installations.

In order to mitigate the effect of striking the end of a temporary traffic barrier, the end shall be installed in accordance with AASHTO’s Roadside Design Guide by flaring until the end is outside the acceptable clear zone or by providing crashworthy end treatments.

605-14.2 Movable Barrier

A movable barrier is a linear system of connected barrier segments that can rapidly be shifted laterally by using a specially designed transfer vehicle. The transfer is accomplished in a manner that does not interfere with motor vehicle traffic in adjacent lanes. Applications of movable barriers include the following:

1. Closing an additional lane during work periods while maintaining the advantage of having the travel way separated from the work space by a barrier;
2. Closing an additional lane during off-peak periods to provide extra space for work activities without adversely impacting motor vehicle traffic flow; and
3. Creating a temporary reversible lane, thus providing unbalanced capacity favoring the major direction of motor vehicle traffic flow.

For more information on this device see MUTCD Figure 6H-45 and Section 606-18.

605-14.3 Temporary Guardrail

All guardrail used as a temporary barrier in maintenance of traffic applications shall conform to the same standards required for permanent guardrail in L&D Manual Volume One, Section 603.1.1.

Guardrail should be as detailed in the current Roadway Standard Construction Drawings. Any variation from these standards shall be submitted for approval by the Office of Roadway Engineering Services at the design stage, on a case-by-case basis.
Delineation of guardrail shall be by use of barrier reflectors *(Section 605-19)* mounted at 50-foot (15.2-meter) spacing.

### 605-14.4 Portable Concrete Barrier (PCB)

#### 605-14.4.1 Design and Use

The decision to use portable concrete barrier (PCB) is based upon characteristics of the work zone and engineering judgment. The use of PCB should be required during construction in any area where penetration or deflection permitted by other traffic control devices cannot be tolerated. See *Section 640-23.3* for detail information about the design of a PCB installation. Additional guidance is provided in the SCDs MT-95.40, 95.41, 95.70, 99.51 and 102.10.

#### 605-14.4.2 Barrier Reflectors and Object Markers

Delineation of PCB shall be provided by use of barrier reflectors and object markers. Barrier reflectors shall be mounted on all PCB. Barrier object markers shall be mounted on top of 32-inch (810-mm) PCB.

Maximum spacing for barrier reflectors and object markers shall be 50 feet (15.2 meters) as shown in *SCD MT-102.10*. Where both barrier reflectors and object markers are provided on the same device, these items shall be staggered. See *Section 605-19* for further information on barrier reflectors and object markers.

### 605-14.5 Triton Portable Water-filled Barrier

See *Table 697-7* and *Section 642-32* for information on this device.

### 605-15 Crash Cushions

#### 605-15.1 General

Crash cushions are systems that mitigate the effects of errant vehicles that strike obstacles, either by smoothly decelerating the vehicle to a stop when hit head-on, or by redirecting the errant vehicle. The two types of crash cushions that are used in temporary traffic control zones are stationary crash cushions and truck-mounted attenuators. Crash cushions in temporary traffic control zones help protect the drivers from the exposed ends of barriers, fixed objects, shadow vehicles and other obstacles. Specific information on the use of crash cushions can be found in AASHTO’s Roadside Design Guide *(see Section 193-12)*.

Crash cushions shall be crashworthy. They shall also be designed for each application to stop or redirect errant vehicles under prescribed conditions. Crash cushions shall be periodically inspected to verify that they have not been hit or damaged. Damaged crash cushions shall be promptly repaired or replaced.

#### 605-15.2 Stationary Crash Cushions

##### 605-15.2.1 General

Stationary crash cushions are used in the same manner as permanent highway installations to protect drivers from the exposed ends of barriers, fixed objects and other obstacles. Stationary crash cushions shall be designed for the specific application intended.
605-15.2.2 QuadGuard CZ

The QuadGuard CZ is a redirective, non-gating, crash cushion manufactured by Energy Absorption Systems, Inc. It is similar in design to the QuadGuard used in permanent locations, except the CZ has lifting brackets and a different anchoring system. It is typically used to terminate Type 5 Barrier Design Guardrail, concrete median barrier and other narrow hazards. It can be installed on a concrete pad or asphalt pavement in unidirectional and bidirectional configurations. The bidirectional configuration requires appropriate transitions.

The QuadGuard CZ comes in three widths, 24 inches (610 millimeters), 30 inches (760 millimeters) and 36 inches (915 millimeters).

The six-bay unit is 22'-1" (6.74 meters) long and can be used in work zones where speeds are over 40 miles per hour.

The three-bay unit is 13'-1" (4.00 meters) long and can be used in work zones where speeds are 40 miles per hour and lower.

If cross slopes are steeper than 8 percent or vary be more than 2 percent over the length of the unit, a leveling pad may be used.

*Table 697-8* presents resource information on QuadGuard devices for use when selecting crash cushions. See *Sections 642-30 and 642-31* for related Plan Notes and additional information.

605-15.2.3 TRACC

The TRACC (Trinity Attenuating Crash Cushion) is a redirective, non-gating, crash cushion manufactured by Syro/Trinity, Inc. It is 21'-0" (6.4 meters) long and 2'-7" (0.8 meter) wide and comes to the site preassembled. The TRACC can be installed on a new or existing concrete or asphalt pad with 27 anchor studs. The length of the anchor studs depends upon the type and thickness of the supporting pad. Unidirectional and bidirectional configurations are available; however, the bidirectional configuration requires appropriate transitions.

*Table 697-7* presents resource information on TRACC devices for use when selecting crash cushions. Also see *Section 642-30* for a related Plan Note and additional information.

605-15.2.4 Sand Barrels

Sand barrel arrays may be used in work zones to provide temporary protection for wide hazards. For ease of moving, they may be mounted on pallets or skids that are 4 inches (100 millimeters) or less in height. See *L&D Manual Volume One, Section 603.4.4* for additional information.

605-15.3 Truck-Mounted Attenuators

Truck-mounted attenuators shall be energy-absorbing devices attached to the rear of shadow trailers or trucks and they should be used in accordance with the manufacturer’s specifications. If used, they shall be located in advance of the work area, workers or equipment to reduce the severity of rear-end crashes from errant vehicles.

Chapter 9 of *AASHTO’s Roadside Design Guide (see Section 193-12)* and *Section 602-8* contain additional information regarding the use of shadow vehicles.
For more detail see L&D Manual Volume One, Section 603.2.

605-16 Vehicle-Arresting Systems

Vehicle-arresting systems are designed to prevent penetration into activity areas while providing for smooth, safe deceleration for the errant vehicles. They can consist of portable netting, cables and energy-absorbing anchors. When used, a vehicle-arresting system should be used in accordance with the manufacturer’s specifications, and should be located so that vehicles are not likely to penetrate the location that the system is designed to protect.

605-17 Rumble Strips

Rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that alert drivers to unusual motor vehicle traffic conditions. Through noise and vibration they attract the driver’s attention to such features as unexpected changes in alignment and to conditions requiring a stop.

Rumble strips should be placed transverse to motor vehicle traffic movement. They should not adversely affect overall pavement skid resistance under wet or dry conditions. The first rumble strip pad should be placed before the advance warning devices. The last pad should be placed a minimum of 250 feet (75 meters) in advance of the traffic condition.

Intervals between rumble strips may be reduced as the distance to the approached conditions is diminished in order to convey an impression that a closure speed is too fast and/or that an action is imminent.

A RUMBLE STRIPS sign (OW-172) warning drivers of the onset of rumble strips may be placed in advance of any rumble strip installation.

Rumble strip pads should not be used on sharp horizontal or vertical curves. In urban areas, even though a closer spacing might be warranted, care should be taken not to promote panic braking or erratic steering maneuvers by drivers.

Although the intent of the rumble strips is to alert the road user, the noise may also attract the attention of non-road users on adjacent property. This would be unacceptable in residential areas.

605-18 Screens

Screens are used to block the road users’ view of activities that can be distracting. Screens might improve safety and motor vehicle traffic flow where volumes approach the roadway capacity because they discourage gawking and reduce headlight glare from oncoming motor vehicle traffic. They can also help contain the work area and reduce the accumulation of dust and debris on the pavement.

Screens may be mounted on the top of temporary traffic barriers that separate two-way motor vehicle traffic. However, they should not be mounted where they could adversely restrict motorist visibility and sight distance and adversely affect the safe operation of vehicles.

Design of screens should be in accordance with Chapter 9 of AASHTO’s Roadside Design Guide (see Section 193-12).

On ODOT-maintained highways a glare screen shall be used at all crossover locations.

The upper portion of the 50-inch (1270-millimeter) portable concrete barrier (PCB) serves as a glare screen (see SCD RM-4.1 for details).
Paddle, or intermittent, type glare screens may be mounted on the top of 32-inch (810-millimeter) PCB.

See Section 642-21 (Plan Note 642-21), L&D Manual Volume One, Section 604 and SCD MT-95.70 for additional guidance.

The choice of 32-inch (810-millimeter) PCB, with screen, or 50-inch (1270-millimeter) is often left to the contractor.

Glare screen can be a maintenance problem. If PCB will be in place over the winter during plowing operations, or if the PCB is otherwise expected to be hit a lot, the 50-inch (1270-millimeter) PCB should be specified. Plowing over the top of a 50-inch (1270-millimeter) PCB is possible; however, it is not preferred.

605-19 Barrier Reflectors and Object Markers

As noted in Section 605-14.4.2, barrier reflectors shall be mounted on all PCB on ODOT-maintained highways, and barrier object markers shall be mounted on all 32-inch (810-millimeter) PCB. They may also be used on other temporary traffic barriers.

The minimum reflective surface area for the reflector portion of a barrier reflector should be 7 square inches (4500 square millimeters).

The reflectors shall be mounted on the face of the barrier with the top of the reflector approximately 26 inches (650 millimeters) above the base and at a maximum spacing of 50 feet (15.2 meters).

Attachment of the reflector shall be by a suitable corrosion resistant fastener, bracket or adhesive. Barrier reflectors shall be the same color as the adjacent edge line. When adjacent to a reversible traffic direction lane, yellow and white reflectors shall be paired back-to-back.

Barrier Object Markers shall be 9 inches (225 millimeters) wide and at least 15 inches (375 millimeters) high. They shall have orange (fluorescent red-orange or fluorescent yellow-orange) retroreflectorized sheeting. If used with two-way traffic, back to back markers shall be used.

Barrier object markers shall be mounted on the top of the PCB. The markers are spaced at 50 foot (15.2 meters) maximum centers midway between the face-mounted reflectors. When adjacent to a reversible traffic direction lane or between opposing traffic flows, they shall be mounted in pairs facing traffic from each direction.

605-20 Future and Experimental Devices

The States, FHWA, AASHTO, the Transportation Research Board (TRB), and other organizations conduct research and experimentation on new traffic control and safety devices. Users of this Manual are encouraged to stay abreast of these current efforts and to use such devices with care so as to avoid presenting road users with unusual or confusing situations that might be abnormal or unexpected.

New traffic control devices shall conform to the provisions for design, use, and application set forth in the OMUTCD. New traffic control devices that do not conform with the provisions in the OMUTCD shall be subject to experimentation, documentation, and adoption following the provisions of OMUTCD Section 1F and MUTCD Section 1A.10.

The TEM may be used to distribute information on experimental devices that have been approved for use, and on new devices that have yet to be incorporated into the OMUTCD.
606 TYPE OF TEMPORARY TRAFFIC CONTROL ZONE ACTIVITIES

606-1 General

Each temporary traffic control zone is different. Many variables, such as location of work, road type, geometrics, vertical and horizontal alignment, intersections, interchanges, road user volumes, road vehicle mix (buses, trucks, and cars), and road user speeds affect the needs of each zone. The goal of temporary traffic control in work zones is safety with minimum disruption to road users. The key factor in promoting temporary traffic control zone safety is proper judgment.

Previous sections in this chapter have reviewed general policies, standards and guidelines regarding temporary traffic control zones and the related devices. Tables 697-1a through 697-1f provide a review of various options available in choosing the appropriate temporary traffic control. Section 606 provides a general discussion about various types of temporary traffic control activities. The following major section (Section 607) and Figures 698-5 through 698-47 provide more detailed guidelines about specific typical applications of temporary traffic control. Sections 640, 641, 642 and 643 include additional information intended to aid in preparing Temporary Traffic Control (Maintenance of Traffic or MOT) Plans.

The discussion in this section regarding types of temporary traffic control activities has been organized into the following categories:

1. Work Duration.
2. Location of the Work.
4. Work Outside of the Shoulder.
5. Work on the Shoulder with No Encroachment.
7. Work Within the Median.
8. Work Within the Traveled Way of Two-Lane Highways.;
10. Work Within the Traveled way of Multilane, Nonaccess Controlled Highways.
11. Work Within the Traveled Way at an Intersection.
12. Work Within the Traveled Way of Expressways and Freeways.
13. Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway.
15. Interchanges.
606-2 Typical Applications

The typical applications of temporary traffic control zones addressed in this chapter are organized according to duration, location, type of work and highway type. The Figures Index (Section 698) provides an index of these typical applications. As noted in Section 607-1, the typical applications addressed in this chapter include the use of various temporary traffic control methods, but do not include a layout for every conceivable work situation.

Typical applications for which Traffic SCDs have been prepared are discussed in Section 641.

The typical applications should be modified, as necessary, to fit the conditions of a particular temporary traffic control zone. Other devices may be added to supplement the devices shown in the typical applications, while others may be deleted. The sign spacings and taper lengths may be increased to provide additional time or space for driver response.

Decisions regarding the selection of the most appropriate typical application to use as a guide for a specific temporary traffic control zone require an understanding of each situation. Although there are many ways that work zone applications could be categorized, four factors are used in this chapter to generally characterize the typical applications addressed in Section 607 and Figures 698-5 through 698-47. Those four factors are: work duration, work location, work type and highway type.

606-3 Work Duration

606-3.1 General

Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. The duration of a temporary traffic control zone is defined relative to the length of time a work operation occupies a spot location.

The five categories of work duration and their time at a location shall be:

1. Long-term stationary is work that occupies a location more than three days.
2. Intermediate-term stationary is work that occupies a location more than one daylight period up to three days, or nighttime work lasting more than one hour.
3. Short-term stationary is daytime work that occupies a location for more than one hour, but less than twelve hours.
4. Short duration is work that occupies a location up to one hour.
5. Mobile is work that moves intermittently or continuously.

606-3.2 Long-Term Stationary

At long-term stationary temporary traffic control zones, there is ample time to install and realize benefits from the full range of temporary traffic control procedures and devices that are available for use. Generally, larger channelizing devices, temporary roadways and temporary traffic barriers are used.

Since long-term operations extend into nighttime, retroreflective and/or illuminated devices shall be used in long-term stationary temporary traffic control zones.
Inappropriate markings in long-term stationary temporary traffic control zones should be removed and replaced with temporary markings.

606-3.3 Intermediate-Term Stationary

In intermediate-term stationary temporary traffic control zones, it may not be feasible or practical to use procedures or devices that would be desirable for long-term stationary temporary traffic control zones, such as altered pavement markings, temporary traffic barriers and temporary roadways. The increased time to place and remove these devices in some cases could significantly lengthen the project, thus increasing exposure time. In other instances, there might be insufficient pay-back time to economically justify more elaborate temporary traffic control measures.

Since intermediate-term operations extend into nighttime, retroreflective and/or illuminated devices shall be used in intermediate-term stationary temporary traffic control zones.

606-3.4 Short-Term Stationary

Most maintenance and utility operations are short-term stationary work. As compared to stationary operations, mobile and short-duration operations are activities that might involve different treatments. Devices having greater mobility might be necessary, such as signs mounted on trucks. Devices that are larger, more imposing, or more visible can be used effectively and economically. The mobility of the temporary traffic control zone is important. Maintaining safe work and road user conditions is a paramount goal in carrying out mobile operations.

606-3.5 Short Duration

During short-duration work, it often takes longer to set up and remove the temporary traffic control zone than to perform the work. Workers face hazards in setting up and taking down the temporary traffic control zone. Also, since the work time is short, delays affecting road users are significantly increased when additional devices are installed and removed. Considering these factors, simplified control procedures may be warranted for short-duration work. However, safety in short-duration or mobile operations should not be compromised by using fewer devices simply because the operation will frequently change its location. Appropriately colored or marked vehicles with rotating/strobe lights, perhaps augmented with signs or arrow panels, may be used in place of signs and channelizing devices for short-duration or mobile operations.

606-3.6 Mobile

Mobile operations often involve frequent short stops for activities such as litter cleanup, pothole patching or utility operations, and are similar to short-duration operations. Warning Signs, rotating/strobe lights on a vehicle, flags and/or channelizing devices should be used and moved periodically to keep them near the mobile work area. Flaggers may also be used for mobile operations.

Mobile operations also include work activities where workers and equipment move along the road without stopping, usually at slow speeds. The advance warning area moves with the work area.

When mobile operations are being performed, a shadow vehicle equipped with an arrow panel or a sign should follow the work vehicle, especially when motor vehicle traffic speeds or volumes are high. Where feasible, Warning Signs should be placed along the roadway and moved periodically as work progresses. Under high-volume conditions, consideration should be given to scheduling mobile operations work during off-peak hours. If there are mobile operations on a high-speed travel lane of a multilane divided highway, arrow panels should be used.
directed onto a temporary roadway or alignment placed within or adjacent to the right-of-way. Typical applications for detouring or diverting road users on two-lane highways are shown in Figures 698-11, 698-12 and 698-13 and discussed in further detail in Sections 607-8 through 607-10. Figure 698-11 illustrates the controls around an area where a section of roadway has been closed and a diversion has been constructed. Channelizing devices and pavement markings are used to indicate the transition to the temporary roadway.

When an entire roadway is closed, as illustrated in Figure 698-12, a detour should be provided and road users should be warned in advance of the closure. If local road users are allowed to use the roadway up to the closure, one of the Road Closed Ahead signs (R-76) should be used. The portion of the road open to local road users should have adequate signing, marking and delineation.

Detours should be signed so that road users will be able to traverse the entire detour route and back to the original roadway as shown in Figure 698-13. When a detour is long, DETOUR Marker (OM-23) or DETOUR signs (OC-29) should be installed to remind and reassure road users periodically that they are still successfully following the detour.

606-11 Work Within the Traveled Way of Urban Roads/Streets

In urban temporary traffic control zones, decisions are needed on how to control motor vehicle traffic, such as how many lanes are required, whether any turns should be prohibited at intersections, and how to maintain access to business, industrial and residential areas.

Pedestrian traffic needs separate attention. If the temporary traffic control zone affects the movement of pedestrians, adequate pedestrian access and walkways shall be provided. Section 603, Figures 698-31 and 698-32, and Sections 607-28 and 607-29 contain information regarding controlling pedestrian movements near work zones.

If the temporary traffic control zone affects the movement of bicyclists, adequate access to the roadway, bicycle paths or shared-use paths shall be provided. If a designated bicycle route is closed because of the work being done, a signed alternate route should be provided. Bicyclists should not be directed onto the path used by pedestrians. Additional information on bikeways may be found in OMUTCD Part 9, Part 9 of this Manual, the Guide for the Development of Bicycle Facilities and from the Office of Local Projects.

Utility work takes place both within and outside the roadway to construct and maintain services such as power, gas, light, water or telecommunications. Operations often involve intersections, since that is where many of the network junctions occur. The work force is usually small, only a few vehicles are involved, and the number and types of temporary traffic control devices placed in the temporary traffic control zone is usually minimal. However, as discussed under short-duration projects, the reduced number of devices in utility work zones should be offset by the use of high-visibility devices, such as rotating lights or strobe lights on work vehicles. Also, all temporary traffic control devices shall be retroreflective or illuminated if utility work is performed during nighttime hours.

606-12 Work Within the Traveled Way of Multilane, Nonaccess Controlled Highways

Work on multilane highways can be divided into right-lane closures, left-lane closures, interior-lane closures, multiple-lane closures and closures on five-lane roadways. Related Traffic SCDs are discussed in Section 641.

When a lane is closed on a multilane road, a transition area containing a merging taper shall be used.

When justified by an engineering study, temporary traffic barriers should be used to prevent incursions of errant vehicles into hazardous areas or work space. When temporary traffic barriers are
placed immediately adjacent to the traveled way, they shall be equipped with appropriate channelizing
devices, delineation and/or other temporary traffic control devices. For lane closures, the merging
taper shall use channelizing devices and the temporary traffic barrier shall be placed beyond the
transition area.

As noted previously in this chapter, although temporary traffic barriers are shown in several of the
figures showing typical applications, they are not considered to be temporary traffic control devices
in themselves.

_Figure 698-37_ illustrates a lane closure in which temporary traffic barriers are used, and _Section 607-
34_ provides additional information about this typical. There are four primary functions of temporary
traffic barriers:

1. To keep motor vehicle traffic from entering work areas, such as excavations or material storage
   sites;
2. To separate workers, bicyclists and pedestrians from motor vehicle traffic;
3. To separate opposing directions of motor vehicle traffic; and
4. To separate motor vehicle traffic, bicyclists and pedestrians from the work area, such as false
   work for bridges and other exposed objects.

When the right lane is closed, temporary traffic control similar to that addressed in _Figure 698-36_ and
_Section 607-33_ may be used for undivided or divided four-lane roads.

If morning and evening peak hour motor vehicle traffic volumes in the two directions are uneven and
the greater volume is on the side where the work is being done in the right lane, consideration should
be given to closing the inside lane for opposing motor vehicle traffic and making the lane available
to the side with heavier motor vehicle traffic, as shown in _Figure 698-34_ and discussed further in
_Section 607-31_.

If the larger motor vehicle traffic volume changes to the opposite direction at a different time of the
day, the temporary traffic control should be changed to allow two lanes for opposing motor vehicle
traffic by moving the devices from the opposing lane back to the centerline. When it is necessary to
create a temporary centerline that is not consistent with the pavement markings, channelizing devices
should be used and closely spaced.

When closing a left lane on a multilane undivided road, as motor vehicle traffic flow permits, the two
interior lanes may be closed to provide drivers and workers additional lateral clearance and to provide
access to the work space (see _Figure 698-33_ and _Section 607-30_).

When only the left lane is closed on undivided roads, channelizing devices shall be placed along the
center line as well as along the adjacent lane.

When an interior lane is closed, an adjacent lane should also be considered for closure to provide
additional space for vehicles and materials, and to facilitate the movement of equipment within the
work space.

When multiple lanes in one direction are closed, a capacity analysis should be made to determine the
number of lanes needed to accommodate motor vehicle traffic needs. Motor vehicle traffic should be
moved over one lane at a time. As shown in _Figure 698-40_, the tapers should be separated by a
distance of 2L, with L being determined by the formulas in _Table 697-9_. Also see _Section 607-37_ for
additional information.
A typical application for shifting motor vehicle traffic lanes around a work space is addressed in Figure 698-38 and Section 607-35. Traffic control for lane shifts are also addressed in SCDs MT-102.10 and 102.20.

Temporary traffic control for multiple and interior lane closures on a freeway is shown in Figures 698-39 and 698-40 and discussed further in Sections 607-36 and 607-37. The method for closing an interior lane when the open lanes have the capacity to carry motor vehicle traffic should be as noted in Figure 698-39 and Section 607-36. When the capacity of the other lanes is needed, the method shown in Figure 698-40 and discussed further in Section 607-37 should be used.

Traffic SCDs have been developed to address lane closures on freeways and expressways. Lane closure procedures are discussed in Section 641.

Table 697-9 provides information on the length of the merging and shifting tapers. Taper rates for shifts are also addressed in Section 602-5.3.

See Policy 516-003 (P) Traffic Management in Work Zones - Interstate and Other Freeways.

606-15 Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway

Two-lane, two-way operation (TLTWO) on one roadway of a normally divided highway is a typical procedure that requires special consideration in the planning, design and work phases, because unique operational problems (for example, increasing the risk of head-on crashes) can arise with the two-lane, two-way operation.

When two-lane, two-way traffic control must be maintained on one roadway of a normally divided highway, opposing motor vehicle traffic shall be separated with either temporary traffic barriers (concrete safety-shape or approved alternate) or with channelizing devices throughout the length of the two-way operation. The use of markings and complementary signing, by themselves, shall not be used.

Figure 698-41 and Section 607-38 address the procedure for two-lane, two-way operation. Treatments for entrance and exit ramps within the two-way roadway segment of this type of work are shown in Figures 698-42 and 698-43 and discussed further in Sections 607-39 and 607-40. Related Traffic SCDs are discussed in Section 641.

606-16 Crossovers

Crossover construction refers to the concept of maintaining two-way traffic operation on one side of a divided highway while the contractor performs his work on the other side of the roadway. As noted in Section 641-9.2, design of crossover roadways is addressed in Section 640-12. For additional guidance on the use of crossover construction, see the OMTUD, Section 607-38, Figure 698-41 and SCD MT-95.70.

Crossover construction provides safety for both the contractor and the driver, and allows the contractor to perform his work more efficiently.

The following are considered good guiding principles for the design of crossovers:

1. Tapers for lane drops should be separated from the crossovers, as shown in Figure 698-41.

2. Crossovers should be designed for speeds no lower than 10 miles per hour below the posted speed, the off-peak 85th percentile speed prior to the work starting, or the anticipated operating speed of the roadway, unless unusual site conditions require that a lower design speed be used.
3. A good array of channelizing devices, delineators, and full-length, properly placed pavement markings should be used to provide drivers with a clearly defined travel path.

4. The design of the crossover should accommodate all motor vehicle traffic, including trucks and buses.

Temporary traffic barriers and the excessive use of temporary traffic control devices cannot compensate for poor geometric and roadway cross-section design of crossovers.

One disadvantage of crossover construction is that in order to provide entrance and exit ramp access in the direction of travel of the shifted traffic, temporary pavement will be necessary at each interchange. Crossover construction is most beneficial on projects where ramp access is not mandatory.

For advantages and disadvantages of crossover construction, see the compendium of options presented in Tables 697-1a through 697-1f.

606-17 Interchanges

Access to interchange ramps on limited-access highways should be maintained even if the work space is in the lane adjacent to the ramps. Access to exit ramps should be clearly marked and delineated with channelizing devices (see Figures 698-42 and 698-43, and Sections 607-39 and 607-40). For long-term projects, conflicting pavement markings should be removed and new ones placed. Early coordination with officials having jurisdiction over the affected cross streets and providing emergency services should occur before ramp closings.

If access is not possible, ramps may be closed by using signs and Type III barricades. As the work space changes, the access area may be changed, as shown in Figure 698-44. A temporary traffic control zone in the exit ramp may be handled as addressed in Figure 698-45 and Section 607-42.

When a work space interferes with an entrance ramp, a lane may need to be closed on the freeway. A temporary traffic control zone in the entrance ramp may require shifting ramp motor vehicle traffic. Temporary traffic control for both operations is addressed in Figure 698-46 and Section 607-43.

The SCD MT-98 series addresses methods for closing lanes at exit and entrance ramps.

606-18 Movable Barriers

MUTCD Figure 6H-45 and Section 6G.17 address a temporary reversible lane using movable barriers.

If the work activity in Figure 698-37 permits, a movable barrier may be used and relocated to the shoulder during nonwork periods or peak-period motor vehicle traffic conditions.
Section 607 provides more detailed information about typical applications for a variety of situations commonly encountered. In addition to the figures shown in OMUTCD Part 7, Figures 698-5 through 698-47 illustrate typical applications of temporary traffic control. This section provides additional guidance to be used in conjunction with these figures. Related sections of this Manual, the OMUTCD, SCDs and CMS 614 should also be reviewed when using any of these applications.

Temporary traffic control applications are presented in OMUTCD Part 7 and in the SCD MT series. Applications shown in the OMUTCD present minimum standards permitted within Ohio. Traffic control applications presented in the SCDs are intended for use on ODOT administered projects, and are more restrictive than the applications presented in the OMUTCD. Additional guidance in proper application of temporary traffic control devices is presented in CMS 614.

Some typical applications have been included in this chapter which may have little, if any, use on ODOT-maintained highways, e.g., those involving low-volume and/or low-speed streets and highways. Since this material is not currently in the OMUTCD, it has been included here for reference as needed.

While not every situation is addressed, the information illustrated can generally be adapted to a broad range of conditions. In many instances, an appropriate temporary traffic control plan is achieved by combining features from various typical applications. For example, work at an intersection might present a near-side work zone for one street and a far-side work zone for the other street. These treatments are found in two different typical applications, while a third typical application shows how to handle pedestrian crosswalk closures.

Procedures for establishing temporary traffic control zones vary with such conditions as road configuration, location of the work, work activity, duration of work, road user volumes, road vehicle mix (buses, trucks, and cars) and road user speeds. Examples presented in the OMUTCD and this chapter are guides showing how to apply principles and standards. Applying these guidelines to actual situations and adjusting to field conditions requires judgment. In general, the procedures illustrated represent minimum solutions for the situations depicted.

Other devices may be added to supplement the devices and device spacing may be adjusted to provide additional reaction time or delineation. Fewer devices may be used based on field conditions.

Figures and tables found in OMUTCD Part 7 and this chapter provide information for the development of temporary traffic control plans. Table 697-9 is used for the determination of taper lengths, while Table 697-11 can be used for sign spacing for various area and roadway types. The typical applications illustrated in this chapter generally fall into the following categories: Work Outside the Shoulder; Work on the Shoulder; Work Within the Traveled Way of Two-Lane Highways; Work Within the Traveled Way of Urban Roads/Streets; Work Within the Traveled Way at an Intersection; Work Within the Traveled Way of Multilane Undivided Highways; Work Within the Traveled Way of Expressways and Freeways; and Work in the Vicinity of Highway-Rail Grade Crossings. The legend for the symbols used in Figures 698-5 through 698-47 is provided in Figure 698-4. In many of the typical applications, sign spacings and other dimensions are indicated by letters using the criteria provided in Table 697-11. Most of the typical applications show temporary traffic control devices for only one direction.
607-2 Work Beyond the Shoulder (Figure 698-5)

Figure 698-5 and OMUTCD Figure C-11, depict traffic control for a situation involving work beyond the shoulder. The following additional guidelines should be used with these figures:

1. The SHOULDER WORK AHEAD sign (OW-132) may be omitted where the work space and the work vehicle are behind a barrier, more than 2 feet (0.6 meters) behind the curb, or 15 feet (4.5 meters) or more from the edge of any roadway.

2. If the work space is in the median of a divided highway, an advance Warning Sign should also be placed on the left side of the opposing traffic.

3. For short-term, short-duration or mobile operation, all signs and channelizing devices may be eliminated if a vehicle with an activated flashing or rotating yellow lights or strobe lights visible for one-quarter mile (0.4 kilometer) is used.

4. Although vehicle hazard warning signals can be used to supplement the rotating lights or strobe lights, they shall not be used instead of rotating lights or strobe lights.

607-3 Blasting Zone (Figure 698-6)

Figure 698-6 depicts traffic control for a blasting zone situation. The following additional guidelines should be used with this figure:

1. Whenever blasting caps are used within 1,000 feet (300 meters) of a roadway, the signing shown shall be used. On a divided highway, the signs should be mounted on both sides of the directional roadways.

2. The signs shall be covered or removed when there are no explosives in the area, or when the area is otherwise secure.

3. Whenever a side road intersects the roadway between the BLASTING ZONE AHEAD sign (OW-129) and the END BLASTING ZONE sign (OC-28), or a side road is within 1,000 feet (300 meters) of any blasting cap, similar signing, as on the mainline, shall be erected on the side road.

4. Prior to blasting, the blaster in charge shall determine whether road users in the blasting zone will be endangered by the blasting operation. If there is danger, road users shall not be permitted to pass through the blasting zone during blasting operations.

607-4 Work on Shoulders (Figure 698-7)

Figure 698-7 and OMUTCD Figure C-12, depict traffic control for a situation involving work on the shoulder. The following additional guidelines should be used with these figures:

1. SHOULDER WORK AHEAD signs (OW-132) on intersecting roadways may be omitted where drivers emerging from those roadways will encounter another advance Warning Sign prior to the activity area.

2. A SHOULDER WORK AHEAD sign (OW-132) should be placed on the left side of the roadway for a divided or one-way highway only if the left shoulder is affected.

3. Workers symbol signs (OW-162) may be used instead of SHOULDER WORK AHEAD signs (OW-132).
7. When a temporary traffic barrier is used to separate opposing motor vehicle traffic, the Two-Way Traffic signs (OW-71) and the DO NOT ENTER signs (R-41B) may be eliminated.

607-40 Median Crossover for Exit Ramp (Figure 698-43)

*Figure 698-43* depicts traffic control for a median crossover to maintain access to an exit ramp. The following additional guidelines should be used with this figure:

1. This typical application should be used for carrying an exit ramp across a closed directional roadway of a divided highway. The design criteria contained in the *AASHTO Policy on the Geometric Design of Highways and Streets* (see Section 193-2) should be used for determining the curved alignment.

2. The EXIT RAMP OPEN (OC-45) and EXIT RAMP OPEN AHEAD (OC-45A) signs should be used to indicate that the ramp is open, and where the temporary ramp is located. Conversely, if the ramp is closed, the EXIT RAMP CLOSED (OC-46) and EXIT RAMP CLOSED AHEAD (OC-46A) signs should be used to indicate that the ramp is closed.

3. A black on orange EXIT CLOSED panel should be placed diagonally across the related interchange/intersection Guide Signs.

4. In the situation (not shown) where channelizing devices are placed along the mainline roadway, the devices’ spacing should be reduced in the vicinity of the off ramp to emphasize the opening at the ramp itself. Channelizing devices and/or temporary pavement markings should be placed on both sides of the temporary ramp where it crosses the median and the closed roadway.

5. Advance Guide Signs providing information related to the temporary exit should be relocated or duplicated adjacent to the temporary roadway. Guide Signs referring to the exit may need to be relocated to the median.

6. A temporary EXIT sign (OW-96) shall be located in the temporary gore. For better visibility, it shall be mounted a minimum of 7 feet (2.1 meters) from the pavement surface to the bottom of the sign. The temporary EXIT sign may be either black on orange or white on green.

7. Where possible, a temporary deceleration lane should be provided to facilitate the exiting maneuver.

8. When a temporary traffic barrier is used to separate opposing motor vehicle traffic, the Two-Way Traffic signs (OW-71) may be omitted.

607-41 Work in Vicinity of Exit Ramp (Figure 698-44)

*Figure 698-44* depicts traffic control for a situation involving work in the vicinity of an exit ramp. The following additional guidelines should be used with this figure:

1. The EXIT RAMP OPEN (OC-45) and EXIT RAMP OPEN AHEAD (OC-45A) signs should be used to indicate that the ramp is open, and where the temporary ramp is located. Conversely, if the ramp is closed, the EXIT RAMP CLOSED (OC-46) and EXIT RAMP CLOSED AHEAD (OC-46A) signs should be used to indicate that the ramp is closed.

2. A black on orange EXIT CLOSED panel should be placed diagonally across the related interchange/intersection Guide Signs.
3. The design criteria contained in the AASHTO’s Policy on the Geometric Design of Highways and Streets should be used for determining the curved alignment (see Section 193-2).

4. A temporary EXIT sign (OW-96) shall be located in the temporary gore. For better visibility, it shall be mounted a minimum of 7 feet (2.1 meters) from the pavement surface to the bottom of the sign.

5. An alternative procedure is to channelize exiting motor vehicle traffic onto the right shoulder and close the lane as necessary.

6. If a paved shoulder having a minimum width of 10 feet (3 meters) and sufficient strength is available, the left and center lanes may be closed and motor vehicle traffic carried around the work space on the right lane and a right shoulder. If the shoulder cannot adequately accommodate trucks, trucks may be directed to use the travel lanes.

7. A buffer may be used.

SCDs MT-98.12, 98.13 and 98.14 address applications of this treatment (see Sections 641-12 and 641-13).

607-42 Partial Exit Ramp Closure (Figure 698-45)

*Figure 698-45* depicts traffic control for a situation involving work that partially closes an exit ramp. The following additional guidelines should be used with this figure:

1. Truck off-tracking should be considered when determining whether the 10-foot (3-meter) minimum lane width is adequate.

2. An additional ROAD WORK AHEAD sign (OW-134) should be added, if traffic backs up onto the mainline.

607-43 Work in Vicinity of Entrance Ramp (Figure 698-46)

*Figure 698-46* depicts traffic control for a situation involving work in the vicinity of an entrance ramp. The following additional guidelines should be used with this figure:

1. An acceleration lane of sufficient length should be provided whenever possible as shown in the left diagram of *Figure 698-46*.

2. For the information shown on the right diagram of *Figure 698-46*, where inadequate acceleration distance exists for the temporary entrance, the YIELD sign (R-2) shall be replaced with STOP signs (R-1) (one on each side of the approach).

3. When used, the YIELD or STOP sign (R-2 or R-1) should be located so that ramp motor vehicle traffic has adequate sight distance of oncoming mainline motor vehicle traffic to select a safe gap in the mainline motor vehicle traffic flow. Also, a longer acceleration lane should be provided beyond the sign to reduce the gap size needed. If insufficient gaps are available, consideration should be given to closing the ramp.

4. Where STOP signs (R-1) are used, a temporary Stop Line should be placed across the ramp at the desired stop location. A Type B high-intensity warning flasher with a red lens may be placed above the STOP sign.

5. The right lane should be closed sufficiently in advance to stabilize motor vehicle traffic flow before encountering the merge.
6. The mainline merging taper with the arrow panel at its starting point should be located sufficiently in advance so that the arrow panel is not confusing to drivers on the entrance ramp, and so that the mainline merging motor vehicle traffic from the lane closure has the opportunity to stabilize before encountering the motor vehicle traffic merging from the ramp.

7. If the ramp curves sharply to the right, Warning Signs with Advisory Speed plates located in advance of the entrance terminal should be placed in pairs (one on each side of the ramp).

8. Where the acceleration distance is significantly reduced, a supplemental plaque may be placed below the Yield Ahead sign (OW-46A) reading NO MERGE AREA (OW-159).

**SCDs MT-98.15 and 98.16** address applications of this treatment *(see Section 641-14).*

**607-44 Work in Vicinity of Highway-Rail Grade Crossing (Figure 698-47)**

*Figure 698-47* depicts traffic control for a situation involving work near a highway-rail grade crossing. The following additional guidelines should be used with this figure:

1. When highway-rail grade crossings exist either within or in the vicinity of roadway work activities, extra care should be taken to minimize the probability of conditions being created, either by lane restrictions, flagging or other operations, where vehicles might be stopped within the highway-rail grade crossing, considered as being 15 feet (4.5 meters) on either side of the closest and farthest rail.

2. If the queuing of vehicles across active rail tracks cannot be avoided, a law enforcement officer or flagger shall be provided at the highway-rail grade crossing to prevent vehicles from stopping within the highway-rail grade crossing (as described in Note 1), even if automatic warning devices are in place.

3. Early coordination with the railroad company should occur before work starts.

4. In the example depicted in *Figure 698-47,* the buffer space of the activity area should be extended upstream of the highway-rail grade crossing (as shown) so that a queue created by the flagging operation will not extend across the highway-rail grade crossing.

5. The **DO NOT STOP ON TRACKS** sign (R-85) should be used on all approaches to a highway-rail grade crossing within the limits of a temporary traffic control zone.

6. Flashing warning lights and/or flags may be used to call attention to the advance Warning Signs.

7. **A BE PREPARED TO STOP** sign (OW-154) may be added to the sign series. When used, the **BE PREPARED TO STOP** sign should be located before the Flagger symbol sign (OW-163).

8. Lighting should be provided as needed to adequately illuminate flagger stations at night.
620 MATERIALS AND HARDWARE

620-1 General

Many features along a roadway and particularly within work zones present an active hazard to the traveling public. These may be fixed objects, drop-offs, severe slopes, opposing traffic, construction materials and equipment, etc. In these instances, a positive means of separating traffic from these hazards must be employed. Portable concrete barrier, portable water-filled barrier, or guardrail are appropriate positive barriers for maintenance of traffic applications.

The use of these positive barriers must be carefully considered on non-freeway / expressway routes due to property access concerns.

620-2 Safety Criteria

620-2.1 National Cooperative Highway Research Program (NCHRP) 350 Criteria

Work zone safety features, including barriers and impact attenuators, installed on the National Highway System (NHS) must demonstrate satisfactory crashworthy performance to be accepted by FHWA. The dates for mandatory compliance vary with different types of equipment. The NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features should be consulted in order to determine the compliance date for a particular item.

ODOT has determined that the NCHRP 350 criteria shall apply to any ODOT-maintained highway regardless of whether or not the highway is on the NHS. The NCHRP safety criteria can be found on the FHWA web site under the Programs handled by the Safety Section, see Table 197-3.

620-2.2 Other Safety Criteria

In addition to the NCHRP 350 criteria, any work an ODOT-maintained highway shall meet the requirements of the OMUTCD and TEM.

Materials and equipment used on projects in the State of Ohio which are neither on the NHS nor on the state highway system must meet the criteria of the OMUTCD.

620-3 Sheeting

Faces of construction signs shall be reflectorized with Type G or Type H sheeting complying with CMS 730.19 and 730.192. The background color of all construction Warning Signs (OW) and all construction Guide Signs (OC) shall be fluorescent orange as per CMS 614.03. For information regarding sheeting on other signs, see Section 220.

Standards for sheeting quality are provided in ATSSA’s Quality Standards for Work Zone Traffic Control Devices (Section 695-4).

620-4 Temporary Sign Supports

Temporary sign supports shall meet NCHRP 350 guidelines (Section 620-2) as well as the requirements of SCDs MT-105.10 and MT-105.11.
620-5  **Roll-Up Signs**

Roll-up signs shall conform to **ASTM D 4956 Type VI**, and shall be retroreflective fluorescent orange. The wind resistant sign supports shall meet the crash testing requirements in the **NCHRP Report 350**, and be approved for use by **FHWA**.

620-6  **Pavement Markings**

620-6.1  **General**

Work zone pavement markings shall conform to **CMS 614.10**. Additional information on pavement markings in temporary traffic control zones is provided in **OMUTCD Section 7F-12** and **Sections 605-11.10 and 605-11.11**.

620-6.2  **Materials**

Either **CMS 642** (temporary paint) or **CMS 740.06** (temporary tape) may be used on any surface which will either be removed or covered by another surface in a subsequent maintenance of traffic phase. Temporary pavement marking which would conflict with final traffic lanes shall be removable **CMS 740.06** (Type I tape).

620-6.3  **Dimensions**

The line dimensions shall be as specified in **CMS 614.10**. Line dimensions wider than those specified may be used in cases where increased delineation is necessary.
630-1 General

The following sections are provided to assist planners and designers in the planning phase of a project or work assignment. There are a lot of tools available for temporary traffic control and this information is intended to help in making the choice of which tool to use and how.

630-2 Compendium of Traffic Control Options

*Tables 697-1a through 697-1f* provide a summary of various traffic control strategies/options used to maintain traffic through work zones or to direct traffic around work zones, along with advantages and disadvantages of these strategies. These options should be reviewed in the initial stages of any project.

630-3 Detours

Because temporary traffic control is an essential part of the overall project design and can often affect the design of the facility itself, the decision to either maintain traffic on the existing facility or to utilize a detour must be made early in the planning process. Some of the items that should be considered are:

1. Type of project.
2. Length of project.
3. Duration of project.
4. Volume and type of traffic.
5. Availability of detours or alternate route.
8. Geometric requirements.
10. Effect on local activities and residents.
11. Construction techniques.
12. Pavement types.
13. Economics.
15. Adequacy of adjacent highways for use as detours, and the prohibition of construction and maintenance work along the detours while in use.
16. Railroad Grade Crossings.

In general, projects with detours shorten construction time, are less expensive to construct, and are safer for construction personnel. On the other hand, maintaining traffic generally is more convenient for the user and has a less detrimental effect on local activities.

630-4 Permitted Lane Closure Maps

Lane closures on Interstate and other freeways shall meet the minimum criteria presented in Policy 516-003(P) (see Sections 601-2 and 1311).

On the basis of this policy, ODOT has developed a series of lane closure maps/schedules. These maps/schedules indicate the hours of the day in which a lane closure is permitted at a subject work zone location. Maintenance of traffic plans shall be in conformance with the permitted lane closure map/schedule (PLCM). Exceptions may be permitted, as discussed in the policy, based on results of a queue length study or by waiver from the Multi-lane Coordinator (MLC) (see Sections 601-2 and 1311).

If it is found that lane-closure requirements cannot be met at a reasonable cost at the subject work zone, the District has the option of applying to the Multi-Lane Coordinator (MLC) for a waiver or modification of the lane closure restrictions at the site. If such waiver is not approved, the maintenance of traffic plans shall be revised to meet the requirements of the PLCM.

The lane-closure schedule will be available on the OTE web site.
640 DESIGN INFORMATION

640-1 General

The goal of any maintenance of traffic strategy should be to safely route traffic through or around a construction area while providing room for the contractor to work effectively. Ideally this should be done while keeping the geometrics and traffic control as close to those for normal operating conditions as possible. This frequently requires the engineer to balance the needs of the contractor to construct the project with the needs of the traveling public to minimize delay, maintain safety and maximize cost-effectiveness. In order to adequately serve both the contractor and the traveling public, various maintenance of traffic strategies should be analyzed before determining the final strategy. These plans should have some built-in flexibility to accommodate delays or unforeseen changes in the work schedule, field conditions or traffic patterns. The impact on land owners must also be considered.

This section provides guidelines and references used in designing the maintenance of traffic portion of a highway construction plan. If traffic is to be maintained on the existing facility during construction, the construction plan should include a Traffic Control, or Maintenance of Traffic, Plan that references the related SCDs and shows details, notes, sequences, procedures, limitations, equipment, materials and other items required to maintain traffic. Section 641 provides additional design information related to specific typical applications and SCDs. Standard Plan Notes for temporary traffic control items are provided in Section 642.

Capacity constraints are vital considerations in preparing Maintenance of Traffic Plans. In the following sections, capacity constraints are discussed for various types of facilities. The traffic volumes used in each discussion of capacity are maximum values for which the corresponding lane closures can be used. Where traffic exceeds the constraining volumes, consideration should be given to limiting work to non-peak hours, establishing alternate routes or using the shoulder as a traffic lane. See other appropriate sections, including Section 630-4 (Permitted Lane Closure Maps/Schedule), for further discussion on these considerations.

The designer must use engineering judgment in combining these guidelines with site-specific conditions to create a safe and efficient work zone environment.

L&D Manual Volume Three, Section 1306 also provides the designer some guidance in developing a set of Maintenance of Traffic plans.

640-2 Geometrics

The following discussion of geometrics should be used as a guide where maintenance of traffic is to be accomplished using the existing facility. Geometric criteria to be used in designing and utilizing temporary roads is discussed in Section 640-11.

It is desirable to maintain lane widths equal to those on the existing facility. A reduction in the lane width will result in a reduction in lane capacity. The desired lane width on freeways and expressways is 12 feet (3.6 meters). A 1 ½ foot (0.45 meter) clearance from the edge line to the channelizing devices is also desirable.

If lane width reduction on freeways and expressways is necessary, it is desirable to maintain a minimum width of 11 feet (3.3 meters). Widths should not be less that 10 feet on any highway unless the lane widths on the existing facility are less than 10 feet (3 meters). In no case shall the lane width be less than 9 feet (2.7 meters). See Table 697-4 for required lane widths when the degree of curvature exceeds 10 degrees (horizontal curve radius is less than or equal to 500 feet (150 meters)).
During any sequence of operations where traffic is to be maintained within 2 feet (0.6 meters) of the edge of the paved shoulder, the graded shoulder area adjacent to the paved shoulder should be considered for strengthening. A bituminous aggregate base placed 8 inches (200 millimeters) deep, or a composition with similar structural characteristics, should be specified for 2 feet (0.6 meters) beyond the edge of the temporary traveled lane. This treatment should be placed in conjunction with final graded shoulder treatments when such shoulder use is required on final surface course pavements. This treatment may be left in place.

Part-width use of shoulders may be required when either work or channelizing devices encroach upon the traveled lane adjacent to the shoulder.

640-5.3 Emergency Pull-Offs

When shoulders are used to maintain traffic over long distances, consideration should be given to providing emergency pull-offs areas in an attempt to minimize capacity reduction due to vehicle malfunction. This is particularly important when traffic is limited to only one lane in each direction. Signing for such pull-offs shall be erected in order to provide advance notice to the road user of the emergency pull-offs. These signs should be rectangular in shape, with black legend on orange background.

640-5.4 Existing Rumble Strips on Shoulders

Permanent, longitudinal rumble strips are often provided on freeway shoulders to alert the road user who diverts from the travel lane. Longitudinal rumble strips create a dilemma when providing lane-shifts in temporary traffic control zones. It may be necessary to remove or resurface longitudinal rumble strips when providing lane shifts. Or, if the temporary lanes can be aligned such that the wheels of the vehicles can straddle the rumble strip, it may be adequate to limit the rumble strip removal to the shift tapers.

640-6 Work Zone Drop-Offs

A pavement edge drop-off occurs when there is a vertical difference in height between adjacent road surfaces. Treatments for pavement edge drop-offs in construction work zones are shown on Traffic Plan Insert Sheet 2010190. The drawing may be used as a designer's tool for determining the appropriate measures to specify in the plans for treatment or protection of drop-off conditions. The designer may also use it to develop designs or sequences of operations that would avoid or minimize drop-offs.

The treatments indicated on the Plan Insert Sheet are intended for high-volume projects. For low-volume situations, a one-level drop in protection may be used, e.g., use drums instead of PCB. For low-speed situations, protection may not be needed. In all situations, engineering judgment should be used to select the most appropriate treatment for each work zone.

Maintenance of traffic Plan Notes should address the treatment of any anticipated open trench areas. Whenever possible, it should be stipulated that trench excavating operations will not remove any more material than can be replaced by the end of each day's work. In areas where this is not possible, or where adverse conditions prevent it, overnight trench openings shall be temporarily backfilled. See Plan Notes 642-14 and 642-15 in Part 642 for additional information.

640-7 Ramp Closure

640-7.1 Volume Considerations

In urban areas, consideration may be given to closing some entrance ramps. This can reduce
the volume of traffic using the highway and to minimize the negative effect on mainline traffic capacity caused by the ramp traffic merging onto the highway. Such closures could significantly improve traffic flow on the freeway; however, detours must be provided on the surface street system to handle the diverted traffic volume.

640-7.2 Geometric Considerations

Geometric conditions on ramps often make it difficult to perform work on the ramp while maintaining traffic. Consideration should be given to temporarily closing ramps and providing detours in such cases.

640-8 Detours

When a detour has been designated for a project (see Section 602-6), provisions must be made for erecting adequate Detour signing along with other appropriate traffic control devices. The plans shall specify all necessary detour traffic control in accordance with the OMUTCD and this Manual (also see related typical applications in Sections 607 and 698). The plans shall provide the appropriate traffic control information, for installation by ODOT. On local or other projects where detour traffic control cannot be provided by the maintaining agency, the plans shall provide for installation by the contractor.

Reassurance detour signing in rural areas should be erected at intervals not to exceed 2 miles. In urban areas, detour signing should be spaced no more than two blocks apart.

640-9 Contractor Access

Work zones requiring barrier protection of the work area can, if not properly addressed, create circumstances which either prohibit contractor access to the work area or make such access unnecessarily difficult.

When barriers are used to maintain traffic, designers should address access to the work area, especially when it is perceived that lack thereof could be an unreasonable burden on the contractor.

Where the highway is closed to traffic, barricades and gates shall be provided as shown in SCD MT-101.60.

640-10 Private Driveway Access

Except as noted herein, where private drives exist within the work area, access to the drives shall be maintained. It may be necessary to adjust the work procedures to work around the drives as much as possible and to provide temporary access to the drives when normal access cannot be provided.

At urban residential locations, access to residential driveways may be denied for a few hours at a time after adequate advance notice of closure has been provided to the residents of the property involved.

640-11 Temporary Roads

640-11.1 General

A temporary road is any crossover, runaround, ramp, roadway, etc., whose sole purpose is to temporarily maintain traffic during construction. After construction is complete, temporary roads are typically removed.

Temporary roads are required when the existing roadway is inadequate to properly accommodate both the work and the traffic. They may also be required in certain cases where bridge
construction or reconstruction does not facilitate part-width construction or realignment to the extent that the existing facility can serve as the temporary road. The use of runarounds and temporary structures in such cases shall be evaluated by the designer for cost-effectiveness and public service.

640-11.2 Design Speed

The design speed used in designing temporary roads shall be that which is discussed in Section 640-18.1.

640-11.3 Geometrics

The geometric design of temporary roads should be commensurate with the chosen design speed. Pavement design criteria is provided under CMS 615. Typical roadway plans for temporary roadway are provided in L&D Manual Volume Three, Figures 1306-6s and 1306-7s.

The horizontal alignment of temporary roads shall comply with the criteria discussed in L&D Manual Volume One, Sections 202.1 and 202.2. Superelevation of temporary roads is discussed in the following section. Spirals are not required.

Crest and sag vertical curves on temporary roads should comply with L&D Manual Volume One, Section 203.3 using minimum criteria. Maximum allowable grades are the values shown in L&D Manual Volume One, Figure 203-1 under hilly terrain for the appropriate design speed.

Stopping sight distances shall meet or exceed the minimum criteria discussed in L&D Manual Volume One, Section 201.1 and pavement cross slopes shall be as discussed in L&D Manual Volume One, Section 301.1.5.

The designer shall also ensure that vertical clearances in conformance with L&D Manual Volume One, Section 302.1 (existing structures to remain) are provided.

Additional general information regarding geometric design is provided in Section 640-2.

640-11.4 Superelevation

Except as noted in Section 640-12.1, superelevation on temporary roads should conform to the requirements shown in L&D Manual Volume One, Figure 202-11 for design speeds greater than or equal to 50 miles per hour (80 kilometers per hour) and L&D Manual Volume One, Figure 202-5 for design speeds less than 50 miles per hour (80 kilometers per hour).

640-11.5 Lane Width

Lane widths of temporary roads should conform to the requirements discussed in Section 640-2.

Where horizontal curve geometrics are less than adequate for the temporary road conditions \(D_c > 10\) degrees), curve widening should be provided as called for in the Table 697-4.

640-11.6 Guardrail Offset and Sideslopes

CMS 615.04 permits a minimum guardrail offset of 1.5 feet (0.5 meter) and a maximum side slope of 1.5:1. These dimensions are appropriate for absolute minimum design, but design above these values should be provided when feasible. For design speeds over 40 miles per hour (70 kilometers per hour), a minimum shoulder width and guardrail offset of 6 feet (1.8 meters) is desired and 4:1 side slopes are desired where right-of-way is available.
Barrier placement along temporary roads shall conform to the appropriate requirements of L&D Manual Volume One, Section 600.

640-11.7 Pavement

CMS 615.05, provides Class A and Class B pavement designs for temporary roads. These designs are intended to be specified on projects with large traffic volumes where the proposed project pavement design is stronger than either of these two designs. A temporary road pavement should not normally be stronger than the permanent pavement design of the project.

For a temporary road pavement design that is weaker than Class A or B, the design should be based on the anticipated total equivalent 18-kip single axle-load applications and determined from information contained in the Pavement Design Manual published by the Office of Materials Management.

For temporary road pavement that is to be used for a short time (less than two months) by moderate traffic volumes (2000 ADT or less), CMS Item 410 Traffic Compacted Surface, stabilized with CMS Item 616, may be provided.

640-12 Crossover Construction

640-12.1 General

For general information regarding crossover construction, see Section 606-16. Further detail information on traffic control for crossovers is provided in this section and in Sections 607-38 and 641-9, Table 697-14, Figures 698-41, 698-48 and 698-49, and SCD MT-95.70.

All temporary crossover areas shall be illuminated as shown on SCD MT-100.00.

All temporary crossovers shall be removed at the completion of the current proposed work unless retention for future use is recommended and justified by the District. Any crossover which is to remain for future use or left in place without use between construction seasons shall be camouflaged with an earth overlay so that the crossover area appears as part of the normal median.

640-12.2 Traffic Separation

Adjacent lanes, carrying traffic flowing in opposite directions on what are normally multi-lane divided highways, shall be separated by concrete barrier as shown in SCD MT-95.70.

The use of breaks in the traffic separation runs, to permit access, should not normally be allowed. For unusual circumstances where breaks are necessary, each end of the barrier shall be protected by a temporary impact attenuator.

640-12.3 Considerations for Reversed Flow

When a traffic diversion requires that two-way operation be maintained on a roadway which normally carries one-directional traffic, as is the case in crossover construction, the designer shall provide temporary barrier protection from obstacles to accommodate the reversed movement. The designer should evaluate the project for locations requiring barrier and/or bridge terminal assemblies and specify the appropriate protection (see SCD MT-95.82).
The Intermediate Output provided by this program is expected capacity in vehicles per hour of day.

The program’s Final Output provides:

1. Length of queue by hour of day. This is not used for ODOT queue calculation; ODOT spreadsheet used instead.

2. Cost of delay to traveling public as a result of the traffic queue caused by a reduction in the number of traffic lanes. Since this is not relevant to the calculation of queue length, it is used only to determine liquidated damages, see Section 640-24.

The capacity calculation provided by the QUEWZ92 or QUEWZ98 program as an Intermediate Output is used in the spreadsheet program to calculate the expected queue length. This spreadsheet program can be obtained by contacting the OTE Maintenance of Traffic Section. This volume is entered as both the free-flow work zone capacity and the queued work zone capacity.

The number of lanes of queued vehicles must also be entered. The designer should take into consideration the need for including the lane being closed in queue development. Observations have found locations in which there was very little volume stored in the lane being closed. At other locations the queue in the closed lane was the same length as the queue in the open lanes. In other cases, the closed lane carried only a fraction of the volume carried by the open lanes. The engineer must determine individually how to account for the volume carried by the closed lane of a specific project.

640-14 Considering Holidays and Special Events

The designer should, in conjunction with the District Work Zone Traffic Manager, investigate the use of lane closure restrictions on Interstates and other freeways during holiday and other significant events.

The plan shall require the contractor to have all existing lanes (a number of traffic lanes equal to the existing highway) open to traffic during specifically designated periods. These requirements are in addition to the requirements identified in the Permitted Lane Closure Maps discussed in Section 630-4 and the requirements identified in ODOT Policy 516-003(P) (Section 1311).

Lane closure restriction schedules for urban locations may differ from schedules for rural locations. Where rural location would be expected to carry high traffic volumes during holiday weekends, some urban routes, such as radial freeway segments leading to a central business district, may be found to carry less traffic during holiday weekends. An analysis of traffic patterns shall be made to determine whether or not it is appropriate to restrict lane closures for designated periods including holiday weekends.

The designated "lane closure restriction" periods shall be identified in the plan and may include, but are not limited to:

1. National holidays and holiday weekends:
   
   New Years,
   Memorial Day,
   Fourth of July,
   Labor Day,
   Thanksgiving, and
   Christmas.
2. Weekends with greater than normal travel:

   Easter,
   Mother's Day, and
   Other weekends, or periods, when regional travel is significant.

3. Periods involving local events having attendance greater than 75,000 persons per day or event, or a lesser attendance for events producing mass arrivals or departures, such as football games.

4. Periods when snow accumulation is probable. During these periods daily isolated lane closures may be used during non-peak hours, weather permitting.

A "holiday weekend," for traffic maintenance purposes, begins at noon on the last normal weekday preceding the weekend. Traditionally, the "holiday weekend" has been considered to end at noon on the first normal weekday following the holiday, however the designer should review the traffic patterns at the specific location. Traffic data shows that at many locations, the traffic on the following weekday morning is not significantly different from a typical weekday morning. In such cases it is suggested that the holiday weekend be considered to end at 6:00 AM or earlier to allow the contractor a full day of normal operation. A day between the holiday and Saturday or Sunday is considered part of the weekend.

Section 630-4 contains information regarding Permitted Lane-Closure Maps/Schedules which are intended for use in the scheduling of part-time lane closures.

640-15 Project Length Restrictions

Although ODOT has no written policy limiting the length of lane closures, consideration should be given to potential effects on traffic flow, and the potential negative public reaction to closures of extensive length. These factors are of concern primarily where only a single lane remains open in each direction of travel. In rolling to hilly terrain where underpowered vehicles tend to slow traffic flow, the length of one-lane operations should be minimized. In flat terrain, the length of reduced-lane operations is less critical; however, the designer should give consideration to the type of activities to be performed, and what effect these activities might have on traffic movement. Access to accident sites by tow trucks and emergency vehicles on one-lane operations may become especially difficult if concrete barrier is present on both sides of the lane. Sections of open roadway between adjacent lane closures should meet the lengths suggested in Section 640-4.

The public reacts negatively to seeing lane closures in areas of no activity. To avoid such situations on projects of considerable length, it may be desirable to concentrate activity in one section of the project at a time, and to minimize the lengths of lane closures accordingly. On multi-year projects, concentrating work in a portion of the project each construction season may allow an added benefit of opening the entire highway during the inactive winter months.

The designer should not overlook the advantage of scheduling adjacent corridor improvements simultaneously, if this would minimize the time period for inconveniencing motor vehicle traffic. For example, two adjacent projects, requiring only one season each to construct, could be constructed in the same construction season (rather than in consecutive seasons) to minimize the inconvenience to one season rather than two.

640-16 Work on Detour and Alternate Routes

Work along designated detours and alternate routes is strongly discouraged. These routes carry volumes which may be significantly increased over the volumes carried under normal conditions. The potential for traffic queue development would be greater than if the work were performed prior to
implementation, or following elimination of, the detour or alternate route.

Work along a designated detour or alternate route can also create a negative public response. Under such conditions the motorist would be directed around one construction project, only to be directed through another one. See Section 640-17 regarding project coordination.

640-17 Coordination With Adjacent Projects

Coordination of signing between adjacent projects is recommended in order to minimize presenting misleading information to the motorist. If proper location of advance signing for one project results in this signing being located within the limits of another construction project, then consideration should be given to treating the two projects as one project for the purpose of signing.

If two projects implementing the speed-reduction and the double-fines policies are located adjacent to each other or are separated by less than 1 mile (1.6 kilometer), the projects should be treated as one project for the purpose of placing Regulatory Signs. (Also, see Section 640-18 and Section 600-2.)

640-18 Speeds in Work Zones

640-18.1 Design Speed

The design speed for maintaining traffic through a construction zone should remain the posted legal speed limit, except as indicated in Section 640-18.2. Where maintaining the legal speed limit is not feasible or practical, the maintenance of traffic design speed may be decreased below the posted speed limit, with the minimum design speed being 25 miles per hour. Reductions in design speed should be accomplished gradually, in increments of 10 miles per hour or less. Sudden changes in design speed and the related geometrics should be avoided. Advisory speed signing should be provided in accordance with the OMUTCD. Posted speed reductions are discussed in Section 640-18.2.

Whenever a speed reduction is to be used, the design speed for maintenance of traffic items shall remain at the original posted speed limit on approaches to the work zone and shall be the temporary reduced speed limit within the work zone.

640-18.2 Speed Limit Reductions

A 10 mile per hour reduction in the speed limit shall be implemented in construction projects on freeways and expressways and on rural four or more lane highways. The speed limit for any other type of facility should not be changed.

Speed limit reductions shall only apply to projects lasting thirty consecutive calendar days or more where traffic is to be maintained. Speed limit reduction is not intended for use with bridge rehabilitation/repair work or night-only lane closures, and is generally not suitable for use on projects of less than one-half mile in length.

Whenever a lowered speed limit is to be used within a section that has more than one original posted speed, the lowest temporarily reduced speed required by the above discussion should apply as the speed limit for the entire length of the project. The speed limit reduction shall be accomplished in 10 mile per hour increments.

Exceptions to the above criteria must be submitted to the Office of Traffic Engineering for approval.
When a speed reduction during construction is required, it shall be accomplished by a statement preceding the Director’s signature on the plan title sheet and by plan note. For the Plan Note, see Section 642, Plan Note 642-24. For the statement intended to precede the Director’s signature, see L&D Manual Volume Three, Section 1302.12. The Plan Note shall be worded to require that the revised Speed Limit signs be erected or uncovered no earlier than four hours prior to the actual start of work, and removed or covered no later than four hours following restoration of all lanes to traffic with no restrictions.

For projects on which the activity is limited to one section of the site for at least thirty days and then is moved to another section of the site upon completion of work in the first portion, the speed limit reduction shall be limited to only the active portion of the site at the given time. Signing for a speed limit reduction, as well as all other advance construction signing, shall be relocated when the concentration of activity is relocated. For projects on which the activity is scheduled for thirty days or more, with day-to-day variation in activity location, possibly performing a sequence of activities, the speed limit reduction, if applied to the project, should apply to the entire length of project for its entire duration.

For a project which lasts more than one construction season, if all lanes are open to traffic during the winter months and no restrictions exist, the speed limit shall return to the original posted speed, and temporary Speed Limit signs shall be removed or covered no later than four hours following restoration of all lanes to traffic with no restrictions for the winter. Temporary Speed Limit signs may be re-erected or uncovered no earlier than four hours prior to resumption of work.

The first temporary Speed Limit sign shall be placed either 500 feet (150 meters) in advance of the lane reduction taper or at the point where construction begins (dual mounted for divided highways), whichever comes first. See Plan Note 642-24 in Part 642 for information on locating Work Zone Speed Limit Signs. Signing shall be repeated immediately after each entrance ramp within the zone, at every 1 mile (1.6 kilometers) for 55 mile per hour zones, and at every one-half mile (800 meters) for 45 miles per hour zones. The sign may also be repeated in advance of intermediate lane closures. The REDUCE SPEED AHEAD sign (R-11A) shall be placed in advance of the beginning point of the speed reduction zone; at 1000 feet (300 meters) ahead on freeways and expressways and at 500 feet (150 meters) ahead on other rural four-lane divided highways. The R-10 Speed Limit sign should be erected at the point where the legal speed is resumed, typically 500 feet (150 meters) beyond the end of work, excluding traffic control devices. On divided highways, Speed Limit signs should be dual-mounted.

Where adjacent projects exist, the speed reduction should be continuous from one project to the adjacent project. The project engineer, or other responsible ODOT representative, shall insure that speed reduction signing is limited to the first project in the series and legal speed resumption signing is limited to the last project in the series in the direction of flow of the traffic. This procedure should also be applied to projects which are separated by a non-construction zone of up to 1 miles (1.6 kilometers).

640-19 Law Enforcement Officers (LEOs)

LEOs with patrol cars are effective for slowing traffic speed through work zones. Their use shall be specifically identified in the construction plans.

In general, LEOs should be positioned to direct traffic at the point of lane restriction or road closure and to manually control traffic movements through intersections in work zones. Their primary purpose is to ensure the safe, efficient and orderly movement of traffic. They are not to be used for the convenience of the contractor at ODOT expense.

For lane closures, the use of LEOs should be required during initial set up periods, tear down periods,
substantial shifts of a closure point or when new lane closure arrangements are initiated. Use of LEOs is required during the entire advance preparation and closure sequence where complete blockage of traffic is required. LEOs should not be used where the OMUTCD intends that flaggers be used.

Use of LEOs by contractors other than the uses specified above will generally not be permitted at project cost. LEOs may be used to circulate through the work area, with flashing lights off, to provide a general slowing of traffic.

For projects specifying the use of LEOs by municipalities, the designer shall contact the cities that are to provide the LEO to ensure that the necessary patrol services will be available. If the municipality cannot guarantee the availability of services, the plans should be modified to use other available LEOs from either the sheriff department or OSHP or eliminate the LEO from the plans.

State Highway Patrol Officers may be specified on rural Interstate projects. They shall not be used exclusively on other projects when local LEOs are available.

640-20 Temporary Traffic Control Devices

The design and application of standard traffic control devices are addressed in OMUTCD Part 7, Part 605, 607, 641 and 642, in the Traffic SCDs and in CMS 614.04.

640-21 Removal of Logo Signs

As noted in Sections 650 and 660, Logo signs (which include establishments for Gas, Food, Lodging, Camping and Attractions) are the property of Ohio Logos, Inc. and are not to be removed or replaced by ODOT staff or by contractors working for ODOT. The contractor shall notify Ohio Logos (toll-free 1-800-860-LOGO) at least sixty days prior to the date of desired removal. If maintenance work necessitates removal of the LOGO sign, Ohio Logos must be given reasonable time to remove the sign. Failure by Ohio Logos to respond in reasonable time may necessitate removal by ODOT staff.

640-22 Temporary Lighting

On contract work, the contractor is responsible for obtaining power for temporary lighting. Power shall not be obtained from an existing nearby highway lighting system.

For additional guidance in use of temporary lighting, see SCDs MT-100.00, MT-102.10 and MT-102.20, and Plan Note 642-29 in Section 642. OMUTCD Part 6G and Part 11 of this Manual provide additional guidance for general lighting design principles.

640-23 Temporary Traffic Barrier

640-23.1 General

The various types of temporary traffic barrier are addressed in Section 605-14. Additional design details are provided in this section.

640-23.2 Length of Need

The method used to design the length and location of barrier for maintenance of traffic applications should be as discussed in L&D Manual Volume One, Sections 602.1.2 and 602.1.3 for determining barrier length.

Length of need typically does not include attenuators, thus work zone design must take this into account.
640-23.3 Portable Concrete Barrier (PCB)

640-23.3.1 General

The decision to use PCB is based upon characteristics of the work zone and engineering judgment. As noted in Section 605-14.4.1, the use of PCB should be required during construction in any area where penetration or deflection permitted by other traffic control devices cannot be tolerated.

Since the possible number of encroachments into the work zone increase over longer periods of time, PCB should be considered for use where long-term work zones will exist. Also, work zones which will have heavy equipment or dangerous obstacles near the traveled way should be considered for PCB protection. Where the work zone involves drop-off areas, the information in Section 640-6 should be used to determine where to use PCB.

As noted in Section 640-12.2, PCB is required to separate opposing traffic on high-speed highways (≥ 45 miles per hour) which are normally separated by a median.

Glare screen should be considered for use on PCB in accordance with L&D Manual Volume One, Section 604.1. See Section 605-18 for additional information about screens.

PCB is also required on bridge decks where the parapet or guardrail is removed. SCDs PCB-91M and PCB-DDM provide additional information for Bridge Mounted Portable Concrete Barrier.

640-23.3.2 End Treatment

The exposed end of the PCB should be located at a distance from the edge of the traveled way equal to the clear zone distance for the facility as discussed in L&D Manual Volume One, Section 600.2. When this is not practical, impact attenuators shall be provided on the exposed ends of PCB located within the clear zone.

Exposed ends of PCB located outside the clear zone shall be tapered. If two PCB runs overlap, with the first PCB protecting the road user from the leading end of the second, that leading end does not need to be tapered.

For acceptable flare rates for PCB, see L&D Manual Volume One, Figure 602-1 and the SCDs.

See Section 620-2 for information on the NCHRP 350 requirements.

640-23.3.3 Anchoring PCB

Anchoring of PCB may be considered to prevent excessive deflections of the barrier. For example, where a deflection by one vehicle could relocate the PCB into the path of opposing traffic, or on bridge decks where a deflection could cause the PCB to fall from the deck. Anchoring of PCB located on bridges is required as shown in SCD PCB-91.

640-23.3.4 PCB Connections

The hinged connection and J-J Hook connection for PCB currently meet NCHRP Report 350 Test Level 3 (TL3) crash test criteria. For additional information, see SCD RM 4.1M and RM 4.2M.
640-23.4 Plastic Water-Filled Barrier

A plastic water-filled barrier provides positive separation and redirective capability in work zones; however, it deflects substantially upon impact. For this reason, it cannot be used as an alternate in all situations to PCB. The designer must ensure that there is adequate clearance behind the barrier to accommodate expected deflections.

For portable water-filled barriers, the minimum length of need recommended by the manufacturer should be provided if it is greater than the calculated length of need (Section 640-23.2). In locations where the water-filled barrier is used primarily as a visual channelizing device, the length of the barrier is determined in a manner similar to that for drums.

Plastic water-filled barriers may have advantages over PCB in the following situations:

1. Intermediate-term work zones.
2. Emergency management situations.
3. Moving operations, particularly on low-speed urban roadways.
4. Locations with limited vertical clearance, due to equipment needed to place.
5. Locations requiring restricted dead loads, i.e., bridge decks

They may also provide a higher level of channelization at certain locations where drums would normally be used, such as at exit ramps.

640-23.5 Triton

The Triton is a specific plastic, water-filled, portable, longitudinal barrier manufactured by Energy Absorption, Inc.

Segments are 78 inches (1981 millimeters) long, 32 inches (813 millimeters) high and 21 inches (533 millimeters) wide. The NCHRP Report 350 Test Level 2 (TL2) version can be used in work zones where speeds are 40 miles per hour and lower. The NCHRP Report 350 Test Level 3 (TL3) version is created by adding two pedestal supports under each segment of the TL2 design. This increases the effective height of the barrier to 39 inches (991 millimeters) and enables it to be used in work zones where speeds are greater than 40 miles per hour.

The minimum length of an installation of the TL3 design is thirty interconnected units totaling 195 feet (59.5 meters). The length of need shall begin at the 11th segment from the end of the installation. The minimum length of an installation of the TL2 design is sixteen interconnected units totaling 104 feet (30 meters). The length of need shall begin at the 5th segment from the end of the installation.

The Triton barrier is approved as its own non-redirective end treatment when the last segment on the end contains no water and the retaining pin is left out of the exposed (free) joint. For TL3 this section also must be turned upside down and supported by a 5 inches (130 millimeters) modified pedestal. During cold weather, the next nine sections of the TL3 and the next four sections of the TL2 should have enough anti-freeze in them to prevent the water from freezing. The rest of the barrier can freeze without sacrificing performance.

A clear unobstructed runout area is needed behind the terminal segments for optimal performance.
The Triton barrier should not be used in locations where impacts by trucks heavier than 4400 pounds (2000 kilograms) are a significant concern.

When used solely as a visual channelizing device, the TL2 design should be specified regardless of the speed and the minimum length of need requirement shall be waived.

When removing liquid from water-filled barriers, water/anti-freeze mixtures shall be disposed of properly. Various types of anti-freeze are available, each with differing degrees of potential environmental harm. Local ordinances regarding environmental issues should be checked.

See Plan Note 642-32 in Section 642-32 for additional information.

640-24 Liquidated Damages

640-24.1 Requirements/Guidelines

CMS Item 108.07 provides a table of liquidated damages which are designed to be assessed against the contractor for failure to complete his work on schedule. The liquidated damages presented in this table are based on the cost to administer the project and do not take into account road-user costs.

If ODOT desires to assess liquidated damages in excess of those shown in CMS Item 108.07, ODOT must show the revised liquidated damages are reasonable, based upon costs incurred by the public as a result of the contractor’s delay in completing the project. Various methodologies are available for analyzing the cost incurred by the public depending on the specific circumstances.

640-24.2 Calculating Costs of Delay (QUEWZ Software)

One methodology, which is frequently used on Interstate and other freeway reconstruction projects where the number of existing traffic lanes is reduced for maintenance of traffic purposes during construction, is to determine the cost of the additional delay to the road user as a result of the reduction in the number of available traffic lanes. As an aid, the computer program known as QUEWZ-92 or QUEWZ-98 (see Section 640-13.2), can be used to calculate queue lengths in work zones and the associated costs of delay attributed to the reduction in available lanes.

The cost of delay calculated by the QUEWZ program, or some lesser amount, may be used as the cost of liquidated damages.

640-24.3 Other Considerations

Additional methods available to encourage the contractor to complete his work on schedule include Lane Rental, Incentive/Disincentives, and A + B Bidding. Guidelines on use of these concepts is presented in the Compendium of Traffic Control Options in Section 630-2 and Tables 697-1a through 697-1f.

The Lane Rental concept calls for the contractor to be charged for keeping a lane closed longer than called for in the plans.

The incentive/disincentive concept is typically applied to the completion of a phase of a project.

With A + B Bidding, the contractor bids on the cost of the project and on the time required to complete the project.
640-25 Pedestrian Considerations

Planning and design for maintaining pedestrian traffic should consider both the characteristics of that traffic and the type of construction activities. An analysis of trip origins, destinations and travel paths is useful for providing adequate temporary facilities.

Pedestrian accommodations within work zones should be provided: where sidewalks existed prior to construction; where the work zone is located along a route to a school or park; where there is evidence of pedestrian usage (where well-worn paths exist, for example); or where existing land use generates pedestrian traffic.

In residential and commercial areas, adequate pedestrian access should be provided to properties abutting a work zone.

Use of increased pedestrian crossing times at signalized intersections (based on a walking speed of 3 feet per second (1 meter per second)) may be necessary, particularly in locations where the percentage of elderly pedestrians is expected to be significant. See Section 603-2 for additional information on pedestrian issues that should be considered.

The following general principles should be followed when designing pedestrian facilities:

1. If a sidewalk or bridge that carries pedestrians is closed, provide a temporary walkway (concrete or asphalt) around the work area or direct the pedestrians to an alternate route. Do not force pedestrians to walk through the work area or into traveled lanes.

2. Passageways for pedestrians, especially elderly and disabled, should be well defined and safe for use by these groups. Ramps should be provided for access to streets.

3. All signs or devices should be set up so that they do not cause a hazard for pedestrians. All signs mounted near or over sidewalks should have a minimum 7 foot (2.1 meter) vertical clearance.

4. Minimum width of walkway shall be 5 feet (1.5 meters). Wider walkways are required in areas of high pedestrian activity.

5. Pedestrian walkways shall be free of any obstructions or hazards (holes, debris, mud, etc.). It is especially important to cover or repair any holes and to have broken or damaged sidewalks repaired quickly.

6. Lighting should be provided for temporary walkways if the existing facility was lighted.

7. Fixed walkway and canopy-type pedestrian protection should be provided in the case of long-duration building projects involving construction, demolition and repair activities located close to the street.

8. The design of a temporary pedestrian structure shall be approved by the Office of Structural Engineering. The following criteria shall be used:

   a. Live Loading - 85 psf (4.0 kPa)
      Maximum Allowable Live Load Deflection - 1/800 of the span with no allowable increase for temporary structure.

   b. Minimum Width - 5 feet (1.5 meters) face to face of railing.
      Railing - 5 feet (1.5 meters) high with chain link fence fabric.
641 PLAN PREPARATION / PRODUCTION

641-1 General

The L&D Manual Volume Three describes ODOT plan preparation and production guidelines and standards. Maintenance of Traffic (MOT) plans are addressed in Section 1306 of that manual. Additional information specific to MOT plans is provided in this section and Section 640. The detail needed in Maintenance of Traffic plans depends on the complexity of the project. Adjustments in the field may be necessary when unforeseen circumstances arise.

The following sections provide information about various components of the Temporary Traffic Control Plan, including detail information about Traffic SCDs and PISs.

641-2 Temporary Traffic Control / Maintenance of Traffic (MOT) Plans

641-2.1 General

As noted in Section 602-2, Temporary Traffic Control (or Maintenance of Traffic) Plans are used to describe the temporary traffic control measures that are to be used for facilitating the road users through a work zone. These plans play a vital role in assuring a continuity of safe and efficient traffic flow through the work zone.

641-2.2 Plan Sheets

The traffic control plan may include plan sheets for each sequence of operation, to show all temporary signing and pavement marking applicable to the phase. Additionally, removal or covering of non-applicable signs should be indicated on the plan.

641-2.3 Plan Notes

Standard maintenance of traffic Plan Notes are in Section 642. Additionally, the designer must provide notes to explain any requirements of the contractor which are not covered in the standard notes or elsewhere in the plans or the specifications.

641-2.4 Sequence of Operation Notes

The designer should also provide sequence of operation notes in order to insure that the traffic is maintained as may have been agreed upon by ODOT and the public. For additional information regarding development of a sequence of operation, see Section 640-3.

641-2.5 Designer Notes

In addition to the information found throughout this chapter, Designer Notes specifically related to the Standard Construction Drawings (SCDs) have been included in this section. Designer notes have also been included with the Plan Notes in Section 642.

641-2.6 Quantities

As shown in CMS 614 and in the Item Master, many of the traffic control quantities should be itemized, including signing, pavement marking and concrete barriers. (The Item Master and the Summary of Contracts Awarded are both available from the Office of Estimating.) Non-itemized quantities will be paid for as Item 614 Maintaining Traffic.
641-2.7 Plan Reviews

The Maintenance of Traffic plan for all projects on Interstates and Interstate look-alikes with construction cost expected to exceed $10,000,000 shall be submitted to the Multi-Lane Coordinator (MLC) at each stage of development as per Policy 516-003(P), Section II B1(c). This policy is included in Section 1311.

Other MOT plans may be submitted to the Office of Traffic Engineering (OTE) Maintenance of Traffic Section for review/advice.

641-2.8 Waiver Approval

Lane closures shall meet the requirements of the permitted lane-closure schedule provided in Section 630-4. Any request for exception to this lane-closure schedule shall be submitted for waiver approval to the MLC. Any waiver request, if not submitted for review and approval during the planning stage, should be submitted as soon as possible during the design stage so that the maintenance of traffic plan can be developed accordingly.

641-3 Traffic Plan Insert Sheets (PISs)

Traffic PISs are addressed in general in Section 104. They are addressed as appropriate throughout the text of this Manual; and this section also provides specific information about the application of most of the traffic-related Traffic PISs. Traffic PISs are used in a plan as a plan sheet. They can be used as is or modified as needed. They are available in electronic format from the ODOT web site from the Design Reference Resource Center (DRRC).

641-4 Standard Construction Drawings (SCDs)

SCDs are addressed in general in Section 103. They are addressed as appropriate throughout the text of this Manual; and this section also provides specific information about the application of most of the traffic-related SCDs. A list of applicable SCDs is to be included on the title sheet. The Traffic SCDs are available in electronic format from the ODOT web site from the Design Reference Resource Center (DRRC).

641-5 Closing Right or Left Lane of a Multilane Divided Highway (MT-95.30 and 95.40)

641-5.1 General

MT-95.30 depicts traffic control for closing the right or left lane of a multilane divided highway using drums. MT-95.40 is used when construction procedure or the condition requires that the work area be protected by portable concrete barrier (PCB) in accordance with L&D Manual Volume One.

The designer should check the existing median width to determine if sufficient width exists for erection of the median signs. If not, a smaller size median sign should be specified in CMS 614 Maintaining Traffic.

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), truck-mounted or self-contained impact attenuators. When required, these units must be specifically identified in the plans. When included, these items shall have separate notes and/or details as well as separate pay item.
641-5.2 Advance Warning Sign Groups

SCDs MT-95.30 and 95.40 allow the designer to require extra Advance Warning Sign Groups (AWSGs) when traffic is expected to back-up beyond the standard advance Warning Signs. Whenever this SCD is specified in a plan, the designer should analyze the anticipated traffic demand, peaking characteristics, capacity and expected queue lengths, and include this analysis with the preliminary Maintenance of Traffic submission. If the queue is expected to extend beyond the normal ROAD WORK AHEAD sign (OW-134), extra AWSGs should be specified in the Item 614 Maintaining Traffic Plan Note (see Sections 642-2 and 642-33). The first extra AWSG should be located a distance, in whole miles, in advance of the lane taper which is at least equal to the longest anticipated queue length. Additional AWSGs should be located at 1 to 2 mile (1.6 to 3.2 kilometer) intervals between the first AWSG and the normal Warning Signs location. AWSGs would typically be specified for 2 miles (3.2 kilometers), 3 miles (4.8 kilometers), 5 miles (8 kilometers) and 8 miles (12.8 kilometers) up to the distance needed to deal with the anticipated queue.

If the construction will extend over a holiday period, or any other anticipated period of unusually high traffic demand, a separate queue length analysis should also be made for that period. This condition may require more AWSGs and Plan Note 642-34 (Section 642-34) would be used.

The Plan Note (Section 642-33 or 642-34) added within Item 614 Maintaining Traffic should specify the distance (in whole miles) on the OW-145A Distance plate which is placed below the RIGHT/LEFT LANE CLOSED AHEAD sign (OW-122.123). This sign should be located approximately 1 mile (1.6 kilometers) in advance of the calculated end of the queue. The distance shown on the plate should be the distance to the beginning of the lane taper.

641-5.3 Advisory Speed Sign (OW-143)

The designer may also specify the use of the Advisory Speed sign (OW-143) by a Plan Note in Item 614 Maintaining Traffic. Unless specified, this sign would only be used when directed by the project engineer. The designer may also specify the speed to be shown (see OMUTCD Section 7D-25). A speed reduction, if any, would normally be 10 miles per hour. If the speed is not specified, the speed is as directed by the project engineer. If the regulatory speed limit has been altered by establishment of a lower legal speed limit for the construction activity, the Advisory Speed sign should not be used.

641-5.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) is used only when specified by the plans. The use should be specified in the Item 614 Maintaining Traffic Plan Note with an estimated quantity carried to the General Summary. See Note 11 on SCD MT-95.30 (see Note 9 on SCD MT-95.40) and CMS 614.11 for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure, sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, the type of work, the geometrics in the area, and the relative cost of paint and work zone tape.

641-5.5 Illumination

In cases of unusual horizontal/vertical curvature, the designer may want to provide illumination of the taper area(s) depending on traffic volumes, accident history or patterns (particularly those involving crossing of the center line).
641-5.6 Bid Items

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums, Flashing Arrow Panel, Warning Lights and Protection Vehicle.

The following items will be shown as a separate quantity in the plans, when required:

- **Item 614**, Work Zone Edge Line, Class 1 (By Type) Mile (Kilometers)
- **Item 622**, Portable Concrete Barrier, ___" (____ mm) Foot (Meter)
- **Item 614**, Barrier Reflector Each
- **Item 614**, Work Zone Impact Attenuator Each
- **Item 614**, Object marker, ____-way Each

641-6 Closing Right or Left Lane of a Multilane Undivided Highway (MT-95.31, 95.32 and 95.41)

641-6.1 General

**SCD MT-95.31 and 95.32** depict traffic control for closing the right and left lane, respectively, of a multilane undivided highway using drums. **MT-95.41** is used to close the right or left lane on a multilane undivided highway when construction procedure or the condition requires that the work area be protected by portable concrete barrier (PCB) in accordance with **L&D Manual Volume One**.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics (including lane and shoulder widths), the type of work being performed during the various construction stages and any additional width required for location of drums or cones and for work zone edge line when used. Depending upon the available lane width of the right lane, for the left-lane closing in **SCD MT-95.32**, it may be necessary to shift traffic onto the shoulder using drums or cones and/or work zone edge line. In this case, consideration should be given to removal of the existing right edge line.

For the right- and left-lane closings shown in **SCD MT-95.31 and 95.32**, if the traffic or any of the traffic control devices are expected to encroach on or over the center line, it may be necessary to close the left lane of opposing traffic, in accordance with **MT-95.32**. For short-term daylight closures, it may be possible to narrow the opposing lanes or shift them onto the shoulder using cones for guidance. Engineering judgment is necessary to determine the best solution. This evaluation should include consideration of the geometrics, traffic volumes and speeds, traffic composition and duration of the work.

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), truck-mounted or self-contained impact attenuators. These units when required must be specifically itemized in the plans. When included, these items shall have separate notes and/or details as well as separate pay item.

641-6.2 Advance Warning Sign Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis should indicate the need for this group, see **Section 641-5.2**. In this case, **SCD MT-95.30** would have to be included in the plan with a reference in the **Item 614 Maintaining Traffic Plan Note** requiring additional AWSGs as shown on **MT-95.30** as part of the signing required for **MT-95.31** with the exception that median-mounted signs would not be used.
641-6.3 Advisory Speed Sign (OW-143)

The designer may specify the use of the Advisory Speed sign (OW-143) by a note in Item 614 Maintaining Traffic (Section 642-2). Unless specified, this sign would only be used when directed by the project engineer. The designer may also specify the speed shown (see OMUTCD Section 7D-25). A speed reduction, if any, would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer. If the regulatory speed limit has been altered by establishment of a lower legal speed limit for the construction activity, the Speed Advisory plates should not be used.

641-6.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) is used only when specified by the plans. The use should be specified in the Item 614 Maintaining Traffic Plan Note (Section 642-2) with an estimated quantity carried to the General Summary. See Note 5 on SCD MT-95.31 and CMS 614.11 for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure, sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, the type of work, the geometrics in the area, and the relative cost of paint and work zone tape.

641-6.5 Bid Items

The following items would normally be included with the lump sum bid for 614 Maintaining Traffic: Signs, Cones, Drums, Flashing Arrow Panel, Warning Lights and Protection Vehicle.

The following items will be shown as a separate quantity in the plans, when required:

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<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
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<tr>
<td>614</td>
<td>Work Zone Edge Line, Class 1 (By Type)</td>
<td>Miles (Kilometers)</td>
</tr>
<tr>
<td>622</td>
<td>Portable Concrete Barrier, <strong><strong>” (</strong></strong> mm)</td>
<td>Foot (Meter)</td>
</tr>
<tr>
<td>614</td>
<td>Barrier Reflector</td>
<td>Each</td>
</tr>
<tr>
<td>614</td>
<td>Work Zone Impact Attenuator</td>
<td>Each</td>
</tr>
<tr>
<td>614</td>
<td>Object marker, _____-way</td>
<td>Each</td>
</tr>
</tbody>
</table>

641-7 Closure of a Two-Way Left Turn Lane (MT-95.60)

641-7.1 General

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), truck-mounted or self-contained impact attenuators. When required, these units shall have separate notes and/or details as well as separate pay items.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics (including lane and shoulder widths), the type of work being performed during the various construction stages and any additional width required for the location of drums or cones and temporary edge lines when used. Depending upon the available lane width of the right lane, it may be necessary to shift traffic onto the shoulder using drums or cones and/or a temporary edge line. In this case, consideration should be given to removal of the existing right edge line.

641-7.2 Advance Warning Signs Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis indicates the need for this group, it would have to be included in the plan with a reference
in Item 614 Maintaining Traffic that the additional AWSG(s) shall be included as part of the signing required for SCD MT-95.60 (see Section 641-5.2).

641-7.3 Advisory Speed Sign

The designer may specify the use of the Advisory Speed sign (OW-143) by a Plan Note in Item 614 Maintaining Traffic. Unless specified, this sign would only be used when directed by the project engineer. The designer may also specify the speed to be shown (see OMUTCD Section 7D-25). A speed reduction would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer.

641-7.4 Bid Items

The following items would normally be included with the lump sum bid for 614 Maintaining Traffic: Signs, Cones, Drums, Warning Lights and Shadow Vehicles.

641-8 Closure of Right Lane of Three-Lane Section with Two-Way Left-Turn Lane (MT-95.61)

641-8.1 General

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), truck-mounted or self-contained impact attenuators. When required, these units shall have separate notes and/or details as well as separate pay items.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics, including lane and shoulder widths, the type of work being performed during the various construction stages, and any additional width required for the location of drums or cones and work zone edge lines, when used. Depending upon the available lane width of the lane, it may be necessary to shift traffic onto the shoulder using drums or cones and/or work zone edge line. In this case, consideration should be given to removal of the existing right edge line.

641-8.2 Advance Warning Signs Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis indicates the need for this group, it would have to be included in the plan with a reference in 614 Maintaining Traffic that the additional AWSG(s) shall be included as part of the signing required for SCD MT-95.61 (see Section 641-5.2).

641-8.3 Advisory Speed Sign

The designer may specify the use of the Advisory Speed sign (OW-143) by a Plan Note in 614 Maintaining Traffic. Unless specified, this sign would only be used when directed by the project engineer. The designer may also specify the speed to be shown (see OMUTCD Section 7D-25). A speed reduction would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer.

641-8.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) is used only when specified by the plans. The use should be specified in the Item 614 Maintaining Traffic Plan Note with an estimated quality carried to the General Summary. See Note 8 in SCD MT 95.61 and CMS 614.11 for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure,
sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, type of work, geometrics in the area, and the relative cost of paint and work zone tape.

641-8.5 Bid Items

The following items would normally be included with the lump sum bid for Item 614 Maintaining Traffic: Signs, Cones, Drums, Warning Lights and Shadow Vehicle.

The following item will be shown as a separate quantity in the plans, when required: Item 614, Work Zone Edge Line, Class I (By Type) Mile (Kilometer)

641-9 Two-Lane, Two-Way Operation (TLTWO) on Four-Lane Divided Highways (MT-95.70, 95.82 and 100.00)

641-9.1 General

The two-lane two-way operation (TLTWO) using continuous PCB, as shown in SCD MT-95.70, is a relatively sophisticated method of traffic control which is only suited to certain types of construction activities. TLTWO crossovers should be lighted, either by an existing lighting system or by provision of a temporary lighting system (MT-100.00). SCD MT-95.82 also provides additional information for this operation. These traffic control and lighting drawings supplement the temporary roadway plans for the crossovers.

TLTWO providing two lanes in each direction may be utilized on six or more lane freeway sections where necessary to provide adequate traffic capacity.

Operations involving two lanes in each direction, or which are forced to include a ramp or other complicating factor should usually result in the use of a Plan Insert Sheet specifically modified to show the individual situation.

Normally, the Scope of Services will define the need for TLTWO.

Portable concrete barrier (PCB) details shall be included in the plan by reference to SCD RM-4.2.

641-9.2 Crossover Design

The design of crossover roadways is addressed in Sections 606-16 and 640-12. Careful choice of crossover locations is extremely important to the safe and efficient operation of this system. They should be located in tangent, level sections with both roadways on about the same profile elevations. They should avoid bridges, other structures and should be well spaced from interchanges, rest areas or other ramps. Existing signs in the area may have to be relocated, covered or overlaid. All crossover sites should be field checked to the extent that crossovers, tapers and advance signing are approximately located in the field. Crossovers are normally located as a pair to facilitate their use on adjacent construction sections, but they may be separated in order to provide improved operational locations. Consideration should be given at this time to the extent of backups expected and any extra advanced warning which may be necessary due to queues of slow moving traffic.

641-9.3 Advisory Speed sign

The Advisory Speed signs (OW-143) shown in SCD MT-95.70 and discussed in Note 3 on that drawing, will not normally be used on a project. Current practices make a strong effort to assure that the design (i.e., speed of the crossover) is comparable to the statutory or revised legal speed
of the highway.

641-9.4 Pavement Markings

Notes in the drawing address the need to maintain appropriate pavement markings and eliminate conflicting ones. See Sections 605-11.10 and 605-11.11 and CMS Item 614.10 for additional information on work zone pavement markings. Also, see Section 605-11.12 and SCD MT-101.20 for information about work zone raised pavement markers.

641-9.5 Illumination

The designer should review the probable location of crossover lighting units in the field to assure reasonable placement with respect to ditches or other features. When temporary crossover lighting is to be provided, Plan Note 642-35 (Section 642-35) is recommended.

SCD MT-100.00 provides for non-breakaway poles located a minimum of 30 feet (9 meters) (preferably 40 feet (12.2 meters)) from the edge of pavement. This is acceptable only if fill slopes do not exceed 8:1, which they do not on most Interstate and other divided highways. If side slopes of greater than 8:1 are encountered without existing guardrail, see L&D Manual Volume One for increased setback.

641-9.6 Provisions for Reverse Flow and Use of the Shoulder

The reverse traffic flow will be exposed to obstacles which do not affect the normal traffic flow direction (see SCD MT-95.82). Downstream bridge parapet ends, guardrail ends, etc. must be treated. Normally, additional lengths of temporary guardrail, turn-down anchors and appropriate guardrail to bridge parapet connections will be needed and should be provided separately in the plans. Normally temporary guardrail of this type will be removed to minimize future guardrail maintenance costs. Keep in mind that some existing guardrail-to-bridge parapet connections which are suitable for normal traffic flow direction are unsafe when traffic flow is reversed. Lap joints on existing guardrail need to be reset to correspond with the flow of traffic. Also, the new approach end of the guardrail needs to be refit with an approved end treatment. Turn-down end treatments are not allowed in the clear zone. When replacing the guardrail ends, the run of guardrail will also need to be replaced.

Where traffic flow is reversed, additional Type 3 Object Markers (X-6) and barrier reflectors should be provided to guide this traffic. The Type 3 Object Marker, also known as Bridge End Markers, are addressed in OMUTCD Section 3C-1; and barrier reflectors are addressed in more detail in Sections 307 and 605-19 and CMS 626 and 720.04.

The designer shall field review the section of road since traffic will be flowing in the opposite direction from normal, and if a paved shoulder will be used as a traffic lane, the review should determine:

1. If any bridge parapets, safety curbs, etc. restrict the width available for the lane throughout the remainder. If this construction would bring the available lane width to less than 10 feet (3 meters), the shoulder should not normally be used. Even if 10-foot (3-meter) or more lanes are still provided, the obstruction should be well delineated. Bridge End Markers (X-6) and barrier reflectors on guardrail or parapets will usually be desirable and may be reduced to 25 foot (7.6 meter) spacing when very close to the traffic lane. When old style safety curbs are encountered, they should be painted (reflectorized curb markings) on the approach ends and trailing ends, and barrier reflectors should be applied to the top of the curb to delineate it.

2. If existing signs need to be moved. Existing signs within 12 feet (3.6 meters) of the temporary
lane should be reviewed.

a. Signs behind guardrail: Those at least 4 feet (1.2 meters) behind face of guardrail will not be a problem, and probably as little as 2 feet (0.6 meter) behind rail will be acceptable. Signs closer than 1 or 2 feet (0.3 or 0.6 meter) to face of rail and less than 6 feet (1.8 meter) from the temporary lane are likely to be damaged and, if possible, should be moved further from the road.

b. Signs not behind guardrail: Major signs on breakaway supports (not behind guardrail) are usually located 30 feet (9 meters) or more from the edge of the through lane and will not normally be a problem. Any major sign which is closer than 12 feet (3.6 meters) to a temporary lane should be considered for moving back to 30 feet (9 meters) or more from the permanent lane if conditions permit. Since moving signs back enhances overall safety, this work should not be considered incidental to maintaining traffic but should be defined with normal permanent sign plan requirements (elevation views, bid items, removal of sign, removal of support, (new) sign support, signs, breakaway connections, etc.).

c. Major signs in the median: Major signs on breakaway supports located in the median will not function properly if struck by counter-flow traffic. When these signs are within 30 feet (9 meters) of traffic lanes and not otherwise shielded from counter-flow traffic the following steps should be considered:

i. In many cases, the legend may not be considered essential during construction (County or City Limit signs, etc.) and the sign can be removed, safely stored and later reerected.

ii. Some breakaways can be modified by replacing the hinge plates with additional fuse plates (fuse plates on both sides of beam).

d. Minor signs (on drive posts) are normally located 6 feet (1.8 meters) from edge of shoulder and this is considered adequate. Any found to be less than 6 feet (1.8 meters) from the paved shoulder should be considered for relocation.

In some cases, signs can be relocated longitudinally to put them behind guardrail provided for other purposes.

3. If the shoulders are adequate. Shoulders which will be used for traffic flow should be checked to determine if they will support the anticipated loads without becoming too rough to be serviceable. Overlays, and possibly full-depth shoulder replacement, may be needed.

When two lanes will be provided in one direction by using the shoulder, the line separating them will be coincidental with the permanent edge line. Rather than require a contractor to remove parts of an existing white edge line to convert it to a standard dashed lane line, it is permissible to allow it to remain as a solid white lane line (OMUTCD Section 3B-2).

641-9.7 Bid Items

It is intended that separate bid items be included for the following items:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 614</td>
<td>Object Marker, ____-way</td>
<td>Each</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Pavement Markings (by type)</td>
<td>Foot (Meter)</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Raised Pavement Marker</td>
<td>Each</td>
</tr>
<tr>
<td>Item 614</td>
<td>Temporary Impact Attenuator</td>
<td>Each</td>
</tr>
<tr>
<td>Item 622</td>
<td>Portable Concrete Barrier, <em><strong><strong>” (</strong></strong></em> mm)</td>
<td>Foot (Meter)</td>
</tr>
</tbody>
</table>
Item 622, Portable Concrete Barrier, with Glare Shield or 50” (1270 mm) high Foot (Meter)

Item 614, Work Zone Crossover Lighting System Each
Item 614, Barrier Reflectors (by type) Each
Item 630, Signs (Permanent)
Item 630, Supports (Permanent)

The lump sum for Item 614 Maintaining Traffic will cover all other work needed to place, maintain and remove the TLTWO including the following items:

Temporary Signs and Supports
Drums and other channelizing devices
Flashers and lights on signs
Flashing arrow panels
Removal and replacement of raised pavement marker reflectors
Removal of conflicting existing or work zone pavement markings (this is specifically incidental to Item 614 Work Zone Pavement Markings).
Temporary Guardrail, Type 5
Temporary Bridge Terminal Assemblies

641-10 Signalized Closing, One-Lane of a Two-Lane Highway (MT-96.10 and 96.11)

641-10.1 General

This standard is to be used where it is necessary to close one lane of a two-lane highway and where the longer length of time of the closure would not lend itself to the use of a flagger. The hazard protected should be commensurate with the protection provided. SCD MT-96.10 uses drums to close the lane, and SCD MT-96.11 uses portable concrete barrier (PCB). A typical application for MT-96.11 would be a bridge deck overlay project. Typical applications for MT-96.11 would be part width bridge construction, bridge deck edge or parapet replacement or a condition determined by the designer to be so hazardous to the workers or road users that the PCB protection would be required.

The end of a concrete barrier, if not treated properly, can represent the most hazardous part of the installation. Therefore, when MT-96.11 is used, wherever practical, the exposed end of the PCB should be terminated outside the clear zone. When the design speed is greater than 40 miles per hour and the barrier is located within the clear zone, consideration should be given to terminating the barrier with a work zone impact attenuator.

In the majority of the cases, it will be necessary to construct temporary pavement or rebuild the shoulders to maintain a minimum desirable lane width. This lane width should be the width of the approach lane, but in no case less than 10 feet (3 meters). Wherever possible the lane width shall be in addition to a 1 foot (0.3 meter) offset (preferably 2 feet (0.6 meter)) from any guardrail or concrete barrier. A separate sheet will be required in the plan to show the details necessary to construct the temporary pavement, as well as the actual width of the pavement to be closed.

These signalized closing treatments provide high visibility of one side of the single lane (drums, WZRPMs in MT-96.10 and PCB, reflective panels, WZRPMs, barrier reflectors and object markers in MT-96.11). However, similar night visibility is not assured for the roadside away from the work (only WZRPMs). If a hazard beyond the shoulder, or a constriction such as a bridge parapet or guardrail, exists on that side, additional devices (reflective panels, barrier reflectors, etc.) should be specified on that side also to provide a more balanced outline of the maintained lane.

If adequate room is not available to set up the zone because of driveways or intersections,
revision will be required as a separate Maintenance of Traffic Plan Sheet, with the provisions of the SCD being adhered to wherever possible.

Where pedestrians are likely to try to pass through the construction area, reasonable provision shall be made for them. If pedestrian traffic is significant, a designated path may be necessary. See Sections 603-2 for further information on accommodating pedestrians.

641-10.2 Duration of Work / Portable Traffic Signals

As noted in Section 605-13.2, temporary traffic signals which will be in continuous operation for fourteen days or less shall be designed, operated and installed in accordance with SCDs MT-96.10, 96.11, 96.21, 96.25 and 96.26 with the following exceptions and qualifications:

1. Luminaires for area illumination are not required.

2. Temporary pavement markings and temporary raised pavement markers are not required for signalized operations lasting less than thirty-six hours.

3. When signalized operation will last less than thirty-six hours, removal of existing conflicting pavement markings is not required if drums (or cones during daylight hours only) provide continuous positive guidance for vehicles.

4. Signal systems of this type shall not be used for situations where traffic, including contractors vehicles, will be entering the traffic stream, from the work site, between signals.

The traffic signal system may either be constructed of standard signal components conforming to SCDs MT-96.10, 96.11, 96.21, 96.25 and 96.26, or it may be a portable traffic signal (PTS) which is essentially self contained and mounted on trailers (see Section 605-13.2).

641-10.3 Capacity and Flow Rates

The maximum length of one-lane operation for one-way traffic signal control is determined by the capacity required to handle the peak-hour demand. Table 697-2 summarizes these conditions.

The hourly rate of flow figures shown in Table 697-2 may not be readily available during the initial analysis of signal timing. In those cases ADT data, as is readily available from reports published by the Office of Technical Services, may be used to develop hourly rates of flow. Two factors should be used in this conversion: the peak hour factor (PHF) and "K."

The peak hour factor (PHF) relates the average peak hourly flow to the peak 15-minute flow during the peak hour. If other information is not available, PHF= .90 may be assumed.

"K" relates the peak hour volume to the average daily traffic. If other information is not available, K=0.10 may be assumed.

Using these factors, an approximate hourly rate flow can be determined:

Approximate Hourly Rate of Flow = ADT x K/PHF

EXAMPLE: 9000 (ADT) x 0.1(k)/0.9 (PHF) = 1000 vehicles per hour

This flow rate can then be used in Table 697-2 by finding the approximate hourly rate of flow in the proper column which defines the length of the one-lane operation (from Stop Line to Stop Line). Moving to the left in the table, the total signal cycle length is determined. If the cycle length
is considered acceptable, it can be used to help determine the individual signal interval times.

A more accurate method of determining hourly rates of flow is necessary when the closure length is long or traffic volumes are high. When the estimated traffic ADT and closure length exceeds that shown in Table 697-12, collection of more detailed traffic data and more refined analysis of signal timing is recommended.

In these cases, actual current traffic counts should be obtained and analyzed to identify various peak periods for weekdays and weekends, noting particularly any directional imbalances occurring during the peaks. Where traffic patterns are determined to be repetitious and there is significant disparity between peak and off-peak traffic, or there are major differences between various peak periods, then a signal controller capable of adjusting timing to suit the anticipated traffic flows should be selected.

This can be accomplished in either of two ways:

1. Use of a multi-plan, time-of-day (TOD) controller and time clock to provide preselected timing patterns to suit the various peaks and off-peak times. As compared to the following alternate, this system is less expensive in terms of hardware and installation, but it requires more accurate (and expensive) traffic data collection and analysis to choose appropriate timing patterns and their hours of operation. One, or perhaps two weeks of hourly, directional counts may be needed to develop reasonably reliable timing plans. Once implemented, this system will usually be relatively maintenance free, but if traffic patterns change during construction, additional data collection and retiming may be necessary. The District should be prepared to monitor the system operation and provide data collection and timing changes when warranted.

2. A traffic-actuated controller with detectors in advance of each end of the work zone will also compensate for changing traffic patterns. Fully traffic-actuated operation is normally employed once carefully selected controller timing is implemented. The units should adapt to most changes in traffic volume and provide good operation. When compared to the first alternate above, the hardware and installation costs for detection will increase initial installation costs. Also, detectors can be expected to fail or require readjustment during construction, thus increasing maintenance costs. On the other hand, unexpected changes in peak-period demand or timing will usually be accommodated automatically, thus negating the need for signal retiming. The District should still be prepared to monitor the signal operation for failure or inappropriate timing.

Where analysis of the traffic data shows that peak periods are not predictable in terms of magnitude, predominant direction of flow or time of occurrence, actuated operation will be the most appropriate choice.

Any existing traffic signals within one-half mile (0.8 kilometers) must be taken into account when determining the effect of signal operation. Coordination, or modification of the existing signal, may be appropriate in cases where queues from one signal may interfere with the operation of the other.

Analysis of signal timing and traffic capacity should assure that the anticipated traffic can be accommodated, or signalized operation of this sort should not be included in the project.

Plan Notes 642-36 and 642-37 (Sections 642-36 and 642-37) should be included in the plans to obtain multi-plan, time-of-day or an actuated controller when appropriate.
641-10.4 Traffic Signal Details

SCD MT-96.21 and either MT-96.25 or 96.26 will be required when either MT-96.10 or 96.11 is used.

Under light traffic the signal will normally operate in a pretimed mode using a simple pretimed controller as described in the upper portion of Detail B of SCD MT-96.21, or using an actuated control in a pretimed mode (no detectors, recalls on). However, under certain conditions it may be desirable/necessary to use actuated control with detection or to require a multi-plan pretimed control (see SCD MT-96.26).

The plan shall show necessary signal timing (see Tables 697-3 and 697-6).

641-10.5 Pavement Markings

Work Zone pavement markings and work zone raised pavement markers (WZRPMs) are required in all cases as follows:

1. Work Zone Stop Lines, Class I: at each end of the work.
2. Work Zone Center Lines, Class I: double solid for 150 feet (46 meters) from each Stop Line.
3. WZRPMs: used as a two-way edge line through the work area on both sides as shown. A painted line is not sufficient due to the differing edge line color required.

The requirements for work zone pavement markings are contained in CMS 614.11 and the requirements and layout of WZRPMs are contained in SCD MT-101.20.

641-10.6 Driveways and Side Roads

Driveways and side roads intersecting within or close to the one-lane portion of the temporary traffic control zone should be considered and treated uniformly. The following alternatives should be considered, with the earlier being considered more desirable than those later on the list:

1. If the drive or street is very close to one end of the one-lane, two-way segment, determine if the signals and Stop Line can be relocated sufficiently to place the intersection outside of the one-lane area.
2. Where drives or streets have low to moderate traffic volumes, consider erecting signs (a STOP sign plus a No Left/Right Turn sign) to allow traffic to only turn away from the central area of the work zone. This treatment is only feasible if cross-corner sight distance in both directions is good and if the near-end of the one-lane segment can be easily seen.
3. Where a residential drive or minor commercial drive is involved and if the work length is very short (perhaps less than 200 feet (60 meters)) and a driver stopped on the drive has good visibility to both ends of the work and both approaches, it may be reasonable to impose only stop control on the drive traffic.
4. Where a public road or alley is involved, consider closing that approach to the intersection, or possibly making it one way away from the work area. This will require discussion with the local agency in charge of the side road. Provisions shall be made for additional ROAD CLOSED signs, Detour signs, ONE WAY signs, DO NOT ENTER signs and other Regulatory Signs.
5. If a driveway serves a business, group or property which also has another usable drive, close the drive in question, after informing owners and tenants of the intended action. Minor widening or improvement of the alternate drive may be considered to provide similar access and to avoid major complaints or litigation.

6. Provide a temporary driveway or minor relocation of the side street to move the entering traffic away from the one-lane segment.

7. If less intrusive methods are not feasible, consider providing another actuated signal phase, complete with at least two signal heads, for the side street or drive. Prior to approval of this method, the designer must obtain projected hourly traffic data for a typical weekday (and weekend if traffic is critical) in order to perform capacity analysis for critical periods. Capacity analysis resulting in poor levels or service will normally preclude use of this treatment.

8. Provision of flagger or police control.

641-10.7 Field Reviews

A field review, by the designer, is required to verify the proposed locations of PCB, drums, pavement markings, signal heads, signs and other features for each phase of the project. Each element shall be tentatively located according to the requirements of the SCD and plans to assure adequate visibility and to assure that the controls will be effective. Signal heads shall be visible no less than 215 feet (66 meters) in advance for 25 mile per hour approaches, 325 feet (99 meters) for 35 mile per hour; 460 feet (140 meters) for 45 mile per hour and 625 feet (190 meters) for 55 mile per hour approaches. Signs shall be visible at least 250 feet (76 meters) in advance. Reviews should consider the effects of summer foliage. Any existing traffic controls or other physical features which will detract from safe and efficient operation should be dealt with in the plans. The field check shall also verify that there will be adequate room to perform construction behind barriers or channelizing devices, and that available pavement widths will be sufficient to maintain traffic. The need for temporary pavement or pavement strengthening to carry maintained traffic shall be considered. Changes deemed necessary as a result of this field check shall be incorporated into the Maintenance of Traffic plans by providing details or descriptive notes in the plans. These may include revised locations for signs, signals, pavement markings, PCB or other devices. They may also include requirements to use overhead-mounted signals or additional signals or other control devices and could include requirements to remove foliage on the right-of-way. When overhead-mounted signals are necessary, Plan Note 642-37 (Section 642-37) should be included in the plans:

641-10.8 Bid Items

In an effort to obtain consistency in the bidding procedure the following pay items should be used, as required:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 615</td>
<td>Pavement for Maintaining Traffic, Class _____</td>
<td>Sq. Yd. (Sq. Meter)</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Raised Pavement Marker</td>
<td>Each</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Edge Line, Class I</td>
<td>Mile (Kilometer)</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Center Line, Class I</td>
<td>Mile (Kilometer)</td>
</tr>
<tr>
<td>Item 614</td>
<td>Work Zone Stop Line, Class I</td>
<td>Foot (Meter)</td>
</tr>
<tr>
<td>Item 622</td>
<td>Portable Concrete Barrier, <em><strong><strong>&quot; (</strong></strong></em> mm)</td>
<td>Foot (Meter)</td>
</tr>
<tr>
<td>Item 614</td>
<td>Barrier Reflector</td>
<td>Each</td>
</tr>
<tr>
<td>Item 614</td>
<td>Object Marker, _____-way</td>
<td>Each</td>
</tr>
</tbody>
</table>

All other items will be included in Item 614 Maintaining Traffic.
641-11 Flagger Closing One Lane of a Two-Lane Highway (MT-97.10, 97.11 and 97.12)

SCDs MT-97.10 depicts a typical application using a flagger to close one lane of a two-lane highway for a stationary operation. The distance provided from the Flagger Ahead sign (OW-125/OW-163) to the flagger assumes light to moderate traffic with no substantial back-up, thus the distance allows for a typical back-up of cars plus adequate distance to slow from the approach speed to a stop at the end of the queue. Other locations with heavier traffic or a longer work area will increase the queue length build-up just before traffic is released. The designer should increase this distance (“B”) by Plan Note when calculations show the need. Further, Note 1 in MT-97.10, allows the project engineer to increase distance “B” based on expected or actual field conditions at any time.

SCDs MT-97.11 and 97.12 were developed specifically for use during a paving operation on a two-lane road. Therefore, one shall be included with each two-lane resurfacing plan.

The purpose of these two drawings is to provide guidance for traffic going through a paving operation by the use of flaggers and traffic cones. They provide for the use of cones which are placed laterally across the lane being paved at roads intersecting the closure. They attempt to keep the work area length to a minimum and keep the advance signing and the flagger grouped together.

SCD MT-97.11 should be used with all non-federal two-lane resurfacing projects. MT-97.12 shall be used with all federal two-lane resurfacing projects.

All items shown on these drawings will be included in the lump sum bid for Item 614 Maintaining Traffic.

641-12 Lane Closure in Deceleration Lane (MT-98.12)

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gore. The designer should check the speed of any proposed advisory Exit or Ramp Speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

The opening leading from the freeway/expressway to the ramp shall have a minimum length of 200 feet (61 meters) as shown in Note 4 of SCD MT-98.12 (this is the distance within which the exiting vehicle must shift laterally to the right to enter the exit ramp). Based on the 1985 Highway Capacity Manual, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour.

SCD MT-98.12 shows an opening of 320 feet (98 meters) each, which is associated with a 55 miles per hour exiting speed. Openings longer than 320 feet (98 meters) should be used whenever conditions permit. When conditions will not allow a 320 feet (98 meters) opening, shorter values (but not less than 200 feet (61 meters)) may be used. When shorter openings (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (OW-143) shall be provided. See OMUTCD Section 7F-17 and Section 602-5 for a discussion of taper rates.

The following items would normally be included with the lump sum bid for Item 614 Maintaining Traffic: Signs, Cones, Drums and Warning Lights.

The following items will be shown as separate quantities in the plans, when required:
Item 614, Work Zone Edge Line, Class I (By Type) Mile (Kilometer)
641-13 Lane Closure Before Exit Gore (MT-98.13 and 98.14)

**SCD MT-95.30**, which pertains to closing the lane in advance of the exit gore, shall be used as a companion drawing whenever **SCD MT-98.13 or 98.14** is used.

The designer should exercise care when using **SCD MT-95.30** in the area of an interchange immediately upstream of the work site. The placement of signs shown in **MT 95.30** for closing the right lane may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition prevails, the designer shall provide positive guidance for the exiting road user. This may include showing the exact placement of all signs and tapers noted in **MT-95.30** within both interchanges on a separate drawing, rather than relying on the **SCD**.

The designer shall also use **SCD MT 98.13** when the optional project work shown on the ramp and beyond the exit gore on the freeway/expressway does not exist.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gore. The designer should check the speed of any proposed advisory exit or ramp speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

The opening leading from the freeway/expressway to the ramp shall have a minimum length of 200 feet (61 meters) as shown in **SCD MT-98.13 (Note 2)** and **MT-98.14 (Note 6)** (this is the distance within which the exiting vehicle must shift laterally to the right to enter the exit ramp). Based on the **1985 Highway Capacity Manual**, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour.

The **SCD MT-98.13** shows an opening and a taper of 320 feet (98 meters) each, which is associated with a 55 miles per hour exiting speed. Openings and tapers longer than 320 feet (98 meters) should be used whenever conditions permit. When conditions will not allow both a 320 feet (98 meters) opening and taper, shorter values (but not less than 200 feet (61 meters)) may be used. When shorter openings and tapers (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (OW-143) shall be provided. See **OMUTCD Section 7F-17** and **Section 602-5** for a discussion of taper rates.

If the paved shoulder must be used to achieve minimum lane width on the ramp, as noted in **SCD MT-98.13 (Note 6)** and **MT-98.14 (Note 5)**, it may be necessary to reconstruct or strengthen the shoulder to accommodate the additional load. A separate sheet would be required in the plan detailing this shoulder work.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

The following items will be shown as separate quantities in the plans, when required:

- **Item 614, Work Zone Edge Line, Class I (By Type) Mile (Kilometer)**
- **Item 614, Work Zone Channelizing Line, Class I (By Type) (Required for closure greater than one day.) Foot (Meter)**
641-14 Lane Closure at Entrance Ramp (MT-98.15 and 98.16)

SCD MT-98.15 (Plan A) generally addresses a lane closure for a situation where the work is in the through lane adjacent to the entrance ramp. SCD MT-98.16 (Plan B) generally involves a lane closure on the mainline for work in the entrance ramp/acceleration lane area. SCD MT-95.30, which pertains to closing the lane in advance of the entrance, shall be used as a companion drawing whenever MT-98.15 or 98.16 is used.

The designer should exercise care when using SCD MT-95.30 in the area of an entrance ramp. The placement of signs for closing the right lane contained in MT-95.30 may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition prevails, the designer shall provide positive guidance for the road user. This may involve showing the exact placement of all signs and tapers noted in MT-95.30 within both interchanges on a separate drawing, rather than relying on the SCD.

If the paved shoulder must be used to achieve minimum lane width (SCD MT-98.15, Note 1 and 98.16, Note 2), it may require that the shoulder to be reconstructed or strengthened to accommodate the additional load. A separate sheet would be required in the plan detailing the shoulder work.

In order to work on an entire on-ramp, it will be necessary to use both SCD MT-98.15 and 98.16. Traffic operation under MT-98.16 is significantly restricted, and poorer operation is anticipated. Therefore, the design and project implementation should attempt to do as much of the work as possible under MT-98.15. This should minimize the time and traffic restrictions involved when MT-98.16 is used.

The following items would normally be included with the lump sum bid for Item 614 Maintaining Traffic: Signs, Cones, Drums and Warning Lights.

The following item will be shown as a separate quantity in the plans, when required:

| Item 614, Work Zone Edge Line, Class I (By Type) | Mile (Kilometer) |
| Item 614, Work Zone Gore Marking, Class II (By Type) | Foot (Meter) |

641-15 Typical Lane Closures for Ramps (MT-99.17, 99.18 and 99.19)

SCD MT-98.17 shall only apply when work along an exit ramp leaves at least one lane open to ramp traffic and the work is in the inside portion of the ramp curve.

SCD MT-98.18 shall only apply when work along an exit ramp leaves at least one lane open to ramp traffic and the work is in the outside portion of the ramp curve.

SCD MT-98.19 shall be used when work requires that the exit ramp be closed. If one lane on the exit ramp is open to traffic, either MT-98.17 or 98.18 shall be used.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gore. When the ramp will remain open, the designer should check the speed of any proposed advisory exit or ramp speed signs to avoid contradictory speed posting with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

When SCD MT-98.19 is included in plans, treatment of the permanent Guide Signs in accordance with the guidelines for Advance Work Zone Information Signs shall be considered. The need for a detour and related signing must also be addressed.

Advance Warning Signs should be placed in such locations that provide adequate sight distance for
the existing vertical and horizontal roadway alignment. Use Table 697-11 to determine dimensions A, B and C.

The following items would normally be included with the lump sum bid for Item 614 Maintaining Traffic; Signs, Cones, Drums and Warning Lights.

For an exit ramp closure (MT-98.19), the following item will be shown as a separate quantity in the plans, when required:

Item 614, Work Zone Edge Line, Class I, (By Type) Mile (Kilometer)

641-16 Traffic Control for Long Line Pavement Marking Operations (MT-99.20)

SCD MT-99.20 is applicable to all projects with long line markings (center, edge or lane line), except in the following situations:

1. Where the markings will be applied while the area is closed to traffic for other reasons;
2. Where the work area is so short (+/- one-half mile (0.8 kilometer)) that the required sequence of vehicles cannot be assembled while the marking vehicle travels the length of project; or
3. Where the plans require another form of protection.

Also see CMS 614.11 for additional traffic control requirements for long line pavement marking operations.

If the work will require a lane closure as designated in the table on SCD MT-99.20, the plans should include the appropriate lane closure details.

The 18-inch (457-millimeters) cones are permissible only to protect a wet painted line. The larger, 28-inch (711-millimeters) cones shall be provided if they will be used to close off a lane (in daylight), either in the closure transition or through the work area.

641-17 Freeway/Expressway Ends Closures (MT-99.50 and 99.51)

SCDs MT-99.50 and 99.51 are designed to be used where a section of freeway/expressway will terminate at an unopened or unconstructed portion requiring traffic to leave the facility at the last exit.

MT-99.50 should be used when the duration of the closure is six months or less, and when traffic volumes are less than 1300 vehicles/hour/lane for eight hours of the day.

MT-99.51 should be used when the duration of the closure exceeds six months, or when traffic volumes exceed 1300 vehicles/hour/lane for eight hours of the day.

These closures will normally be left in place when the contractor has completed his work and the responsibility to check and maintain them will usually revert to the maintaining agency. The plans should clearly indicate if the terminal treatment will remain in place at the completion of the contractor’s work and become the property of the maintaining agency, or if the contractor will be required to remove the terminal.

Typically, the major Guide Signs for the exit will be located in approximately the same location as the W-55-144, W-54B-144 and W-54A-144 signs as noted on the drawings. It is preferred that the major Guide Signs be overlaid with these messages, if possible. Where overhead Guide Signs exist, it is not necessary to have dual-mounted signs on each side of the directional roadway as noted on the
drawing. If existing supports are not available, breakaway supports or supports behind guardrail shall be individually designed.

If a freeway/expressway has three or more directional lanes and it is necessary to close more than one lane, insert a tangent section (equal to twice the taper) between the end of the first lane closure and the beginning of the second. Dual ground-mounted W-54A-144 signs shall be placed at the beginning of the taper for the second lane closure. If additional lanes are closed, the same process shall be repeated.

If the signs shown as dashed at the ramps do not exist, the designer may require them or similar signs as a part of the work.

**MT-99.51** provides three distinct treatments for the upstream end treatment of the PCB. Wherever permanent concrete median barrier does not exist, the preferred end treatment is to use an impact attenuator as shown. Detail A shall be used whenever permanent concrete median barrier is encountered. The designer may choose to use the treatment as shown in Detail B considering the following:

1. The impact attenuator treatment can be used on any median width; Detail B can only be used on medians wider than 60 feet (18 meters).
2. The impact attenuator treatment does not reduce the clear zone in advance of the impact attenuator; Detail B restricts the clear zone for the 450-foot (137-meter) taper in the median.
3. The impact attenuator treatment will typically not require any additional grading of the median; Detail B requires the median to have foreslopes 10:1 or flatter from the edge of the left shoulder to the median. This may require drainage changes.
4. The impact attenuator treatment should typically be more economical.
5. The 30 feet (9 meters) offset to the beginning of the PCB, as shown in Detail B, may not always be sufficient (see L&D Manual Volume One, Section 307). If the roadway curves to the right and the curvature exceeds 2.5 degrees (radius is less than 4100 feet (1250 meters)) the offset shall be increased in accordance with Table 697-13.

The length of PCB beyond the shoulder shall also be increased proportionately to maintain the 15:1 taper relative to edge of pavement.

The designer, not the contractor, must determine when to use each type of end treatment and note this in the Maintenance of Traffic Plan.

For **SCD MT-99.50**, all items will be included for payment under Item 614 Maintaining Traffic, except the following:

- Item 630, Sign, Extrusheet Square Foot (square meter)
- Item 630, Sign, Overlay Square Foot (square meter)
- Item 630, Ground Mounted Supports, _______ Beam Foot (Meter)
- Item 630, Breakaway Beam Connection Each
- Item 630, Ground Mounted Beam Support Foundation Each
- Item 614, Work Zone Edge Line, Class I (By Type) Mile (kilometer)
- Item 614, Work Zone Raised Pavement Marker Each

For **SCD MT-99.51**, all items will be included for payment under Item 614 Maintaining Traffic, except the following:
641-18 Gates and Barricades (MT-101.60)

The type of closure shown in SCD MT-101.60 will typically be used in two different situations:

1. The closure seals off a road from which through traffic has been detoured upstream. In this case, only local traffic is expected on the approach to the closure, although this traffic might still be appreciable if the detour begins some distance upstream. Any traffic approaching the closure must be adequately warned and given an ample opportunity to stop. The minimum advance warning treatment is three signs. They are supplemented with Type A flasher warning lights. The signs will be dual installations on a four-lane divided road and the designer may insert a Plan Note requiring dual installations on other roads.

2. The closure is used with an adjacent run-around or on a limited access highway. All of the traffic is required to exit upstream of the physical closure, such as is shown on SCDs MT-99.50 and 99.51, thus removal of all traffic from the approach is accomplished away from the gates and barricades closure and no other advance warning is needed adjacent to the closure. The appropriate advance Warning Signs for the detour should be shown in the plans.

When a closure will be implemented on a road with exceptionally wide right-of-way (i.e., two-lane road on future four-lane divided right-of-way) it may be prudent to limit the width of the barricades by Plan Note.

All elements of the gates and barricades closure, including any advance Warning Signs, will be included in the lump sum of Item 614 Maintaining Traffic.

641-19 Transition Plans for Use of Shoulder (MT-102.10 and 102.20)

When the work involves closing a lane(s) and a capacity analysis indicated that it is necessary to maintain more lanes of traffic than would remain after closing the lane(s), this drawing provides for use of the shoulder to maintain traffic. If the encroachment into the traveled lane is 2 feet (0.6 meters) or less use a lane width reduction.

Lane use cross sections should be shown in the plan indicating the number of lanes and the width of each. Normally, all lanes should be shifted.

To help keep the traffic in the proper lanes, Work Zone Solid Lane Lines are used through the transition area.

SCD MT-102.10 addresses the use of this shoulder transition to maintain traffic when portable concrete barrier (PCB) is used and SCD MT-102.20 addresses the use of this traffic control when drums are used to close off the work area. The criteria between using PCB or drums should be based on the expected traffic flow and the length of the closure.
on the drop-off policy as well as consideration of traffic volumes, truck volumes, speed, duration of work and consideration of the degree of hazard.

The transition should be designed to maintain, as much as possible, the existing speed limit; however, if available space is limited, and a local speed reduction is desired, Speed Advisory signs can be added to the OW-5A, OW-5B, OW-6A or OW-6B.

The existing shoulders must be checked for smoothness, structural adequacy and clearance to structures. Reconstruction may be necessary to assure that they are adequate for the traffic. Plans should provide details of the shoulder work needed. Appropriate bid items shall be included in the plan.

When existing lighting is not available and the transition plan will be used for over fourteen days, a temporary lighting system shall be used for the tapers. Continuous lighting of the work area between tapers is only required when the tapers are provided with temporary lighting and the distance between lighted tapers (X) is less than 2000 feet (610 meters). Plan Note 642-39 (Section 642-39) should be used.

It is intended that separate bid items be included for the following items:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>614</td>
<td>Work Zone Solid Lane Lines, Class I, (By Type)</td>
<td>Mile (Kilometer)</td>
</tr>
<tr>
<td>614</td>
<td>Work Zone Edge Lines, Class I, (By Type)</td>
<td>Mile (Kilometer)</td>
</tr>
<tr>
<td>622</td>
<td>Portable Concrete Barrier, <strong><strong>, (</strong></strong> mm)</td>
<td>Foot (Meters)</td>
</tr>
<tr>
<td>614</td>
<td>Work Zone Lighting System</td>
<td>Each</td>
</tr>
<tr>
<td>614</td>
<td>Barrier Reflector (By Type)</td>
<td>Each</td>
</tr>
<tr>
<td>614</td>
<td>Work Zone Curb Marking</td>
<td></td>
</tr>
<tr>
<td>614</td>
<td>Object Marker</td>
<td>Each</td>
</tr>
</tbody>
</table>

The lump sum for Item 614 Maintaining Traffic will cover all other work needed to place, maintain and remove the shoulder transitions including:

- Temporary signs and supports
- Drum and other channelizing devices
- Flashers and lights on signs
- Removal and replacement of raised pavement marker reflectors
- Removal of conflicting existing or work zone pavement markings
   (this is specifically incidental to Item 614 Work Zone Pavement Markings)

When traffic will be on a shoulder near to structure parapets or guardrail, plan quantities may also be needed for Bridge End Markers, additional barrier reflectors (spacings of 25 feet (7.6 meters) when traffic is close to these barriers).

641-20 Temporary Sign Support (MT-105.10 and 105.11)

SCDs MT-105.10 and 105.11 provide requirements for temporary sign supports. These drawings shall be used on all projects.

Normally, all temporary sign support items will be incidental to the lump sum bid for Item 614 Maintaining Traffic.

The designer should field check proposed sign locations which may be required to implement the various traffic control schemes shown in the plans. The check should determine if the site will be adequate for an appropriate temporary support and should consider any potential conflicts with existing signs. The plans may require the removal, covering or modification of the legend of existing signs, particularly overhead signs which establish lane use.
641-21 Detour of Pedestrians (MT-110.10, 110.20 and 110.30)

Pedestrian considerations are addressed in Section 603-2 and 640-25. When it has been determined that a detour should be provided for pedestrian traffic, SCDs MT-110.10, 110.20 and/or 110.30 shall be used.

641-22 New or Revised Traffic Control Signals (MT-120.00)

Prior to activating a new traffic signal, the public shall be given advance notice of the activation by use of special signing. This signing is shown in SCD MT-120. MT-120 is to be provided in all plans which require the activation of a new traffic signal.
642 PLAN NOTES

642-1 General

Typical Plan Notes have been consolidated here for convenience in preparing plans. The number used for the Plan Note will be the same as the section number. When a Plan Note revises the material or contractor requirements from that which is specified in the CMS, both the note and the bid items will be “as per plan.” Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency. Each note is accompanied by a “Designer Note” in an attempt to give some guidance as to when the note should be used.

As an interim measure the old Plan Note numbers have been shown in parentheses with the title of each Plan Note.

In keeping with the traditional format of Plan Notes, various format changes are used here that are not typical throughout the TEM, e.g., the terms Contractor and Engineer are capitalized.

642-2 (M-101) Item 614, Maintaining Traffic

The text of this note will depend on specifics of the project.

Designer Note: Most traffic control plans should include an “Item 614, Maintaining Traffic” note that contains the following:

1. A description of how traffic will be maintained throughout the construction life of the project, including any limitations or restrictions

2. Descriptions of all items that are to be performed under CMS Item 614.

3. A closing paragraph indicating the method of payment (see Plan Note 642-12).

642-3 (M101A) Item 614, Maintaining Traffic (At All Times)

A minimum of ___ lane(s) of traffic in each direction shall be maintained at all times by use of the existing pavement, the completed pavement, Item 502 Structure for Maintaining Traffic, Item 615 Pavement for Maintaining Traffic, Item 615 Roads for Maintaining Traffic, and temporary surfaces using Items 410, and 614.

Designer Note: This note should be edited to include only items pertinent to each specific project.

642-4 (M101B) Item 614, Maintaining Traffic (Time Limitation on a Detour)

A minimum of one lane of traffic in each direction shall be maintained at all times, except for a period not to exceed _____ consecutive calendar days, when through traffic may be detoured as shown on sheet _____. Liquidated damages shall be assessed (in accordance with CMS108.07) (in the amount of $ ______ per day) for each calendar day the roadway remains closed to traffic beyond the specified limit.

Designer Note: This note shall be used if there is a time limitation placed on the detour. Liquidated damages per CMS 108.07 are normally specified. If a larger amount is desired, written documentation of the reason and justification for the amount shall be submitted for review. The appropriate wording in parentheses should be used in the note.
642-5  (M101C) Item 614, Maintaining Traffic (Winter Time Limitations)

All existing lanes shall be open to traffic between November _____ and April ______. November ______ shall be considered to constitute an interim completion date and liquidated damages shall be assessed in accordance with CMS 108.07 for each calendar day that all lanes are not open and available to traffic.

Designer Note: This note shall be used when winter traffic limitations are required.

642-6  (M101D) Item 614, Maintaining Traffic (Lanes Open During Holidays or Special Events)

No work shall be performed and all existing lanes shall be open to traffic during the following designated holidays or events:

- Christmas
- New Years
- Memorial Day
- Fourth of July
- Labor Day
- Thanksgiving
- (Other Holiday or Event)

The period of time that the lanes are to be open depends on the day of the week on which the holiday or event falls. The following schedule shall be used to determine this period:

<table>
<thead>
<tr>
<th>Day of the Week</th>
<th>Time All Lanes Must Be Open to Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>12:00N Friday through (12:00N or 6:00 AM) Monday</td>
</tr>
<tr>
<td>Monday</td>
<td>12:00N Friday through (12:00N or 6:00 AM) Tuesday</td>
</tr>
<tr>
<td>Tuesday</td>
<td>12:00N Monday through (12:00N or 6:00 AM) Wednesday</td>
</tr>
<tr>
<td>Wednesday</td>
<td>12:00N Tuesday through (12:00N or 6:00 AM) Thursday</td>
</tr>
<tr>
<td>Thursday</td>
<td>12:00N Wednesday through (12:00N or 6:00 AM) Monday</td>
</tr>
<tr>
<td>Friday</td>
<td>12:00N Thursday through (12:00N or 6:00 AM) Monday</td>
</tr>
<tr>
<td>Saturday</td>
<td>12:00N Friday through (12:00N or 6:00 AM) Monday</td>
</tr>
</tbody>
</table>

No extensions of time shall be granted for delays in material deliveries, unless such delays are industry-wide, or for labor strikes, unless such strikes are area-wide.

Should the Contractor fail to meet any of these requirements, the Contractor shall be assessed liquidated damages in (the amount of $ ____ per day)(in accordance with CMS 108.07).

Designer Note: This note shall be used when lanes must be open to traffic during holidays or special events. Liquidated damages per CMS 108.07 are normally specified. If a larger amount is desired, written documentation of the reason and justification for the amount shall be submitted. The appropriate wording in parentheses should be used in the note.
642-7  **(M101E) Item 614, Maintaining Traffic (Lane Closure/Reduction Required)**

Length and duration of lane closures and restrictions shall be at the approval of the Engineer. It is the intent to minimize the impact to the traveling public. Lane closures or restrictions over segments of the project in which no work is anticipated within a reasonable time frame, as determined by the Engineer, shall not be permitted. The level of utilization of maintenance of traffic devices shall be commensurate with the work in progress.

**Designer Note:** This note shall be added to the Item 614 Maintaining Traffic note (Section 642-2) if lane closures, or restrictions are required.

642-8  **(M101F) Item 614, Maintaining Traffic (Notice of Closure Sign)**

Notice of Closure signs, as detailed in these plans, shall be erected by the Contractor at least one week in advance of the scheduled road or ramp closure. The signs shall be erected on the right-hand side of the road/ramp facing traffic. They shall be placed so as not to interfere with the visibility of any other traffic control signs. On roadways, they should be erected at the point of closure. The signs may be erected anywhere on ramps as long as they are visible to the motorists using the ramp. On entrance ramps, the sign shall be erected well in advance of the merge area to avoid distracting motorists.

**Designer Note:** The use of Notice of Closure signs in the plan and this note is at the discretion of the designer. Details of these closure signs must be in conformance with the OMUTCD and be included in the plans. The last line of the sign shall list a phone number which a motorist may call for additional information. This is to be a specific office within the District (or municipality) rather than the general switch board number. The person answering this phone should have a one-page summary of critical project data, and possibly a portion of a map showing the closure and planned detour route. Information shown would normally include such information as: contract identification, scheduled completion, type of improvement, why the closure is necessary, other closures or lane reductions planned as a part of the project and their timing and other data which would help a motorist deal with the construction period.

642-9  **(M101G) Item 614, Maintaining Traffic (Contingency Quantities)**

The following estimated quantities have been included in the General Summary for use as directed by the Engineer for the maintenance of traffic.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>410</td>
<td>Traffic Compacted Surface, Type A or B</td>
<td>Cu. Yd. (Cu. Meter)</td>
</tr>
<tr>
<td>410</td>
<td>Traffic Compacted Surface, Type C</td>
<td>Cu. Yd. (Cu. Meter)</td>
</tr>
<tr>
<td>614</td>
<td>Asphalt Concrete for Maintaining Traffic</td>
<td>Cu. Yd. (Cu. Meter)</td>
</tr>
<tr>
<td>616</td>
<td>Water</td>
<td>M. Gal. (Cu. Meter)</td>
</tr>
</tbody>
</table>

**Designer Note:** This note shall be used when quantities of CMS Items 410, 614, 616, or other items, are added to the plan as contingency quantities. Contingency quantities for maintaining traffic are normally required when through or local traffic is being maintained on a facility during construction. Quantities of CMS Item 614 Asphalt Concrete or CMS Item 410 will depend on the number of drives and pavement cuts required because of drainage or utilities. Generally, every 50 cubic yards of CMS Item 410 will require 1 M. Gal. of CMS Item 616, Water (minimum of 50 M. Gal.) (every 40 cubic meters of CMS Item 410 will require 4 cubic meters of CMS Item 616, Water (minimum of 200 cubic meters)).
642-10 (M101H) Item 614, Maintaining Traffic (ROAD CLOSED Sign)

The Contractor shall provide, erect and maintain standard 48 x 30 inches (1200 x 750 millimeters) ROAD CLOSED signs, sign supports, barricades, gates and lights, as detailed in SCD MT-101.60 at the following locations during periods in which the affected roads are closed to traffic.

(List locations, example - Loyal Road just West of SR 1000 intersection.)

**Designer Note:** Unless shown in a detail elsewhere in the plan, this note should be included in the Item 614 Maintaining Traffic note (Section 642-2) on projects where ROAD CLOSED signs are to be used on major relocation projects in rural areas where crossroads are located an appreciable distance from the project. Normally, these signs are positioned at the first crossroad on each side of the relocation.

642-11 (M101J) Item 614, Maintaining Traffic (Signs and Barricades)

The Contractor shall provide, erect and maintain signs and sign supports, as detailed in the Ohio Manual of Uniform Traffic Control Devices, and Type III barricades of the type and location as follows:

(List type and locations.)

**Designer Note:** Unless shown in a detail elsewhere in the plan, this note should be included in the Item 614 Maintaining Traffic note (Section 642-2) on projects where signs and barricades are to be provided.

642-12 (M101K) Item 614, Maintaining Traffic (Closing Paragraph for Note)

All work and traffic control devices shall be in accordance with CMS 614 and other applicable portions of the specifications, as well as the Ohio Manual of Uniform Traffic Control Devices. Payment for all labor, equipment and materials shall be included in the lump sum contract price for Item 614, Maintaining Traffic, unless separately itemized in the plan.

**Designer Note:** This note should be used as a closing for the Item 614 Maintaining Traffic note (Section 642-2).

642-13 (M102) Placement of Asphalt Concrete

Two-way traffic shall be maintained at all times except that one-way traffic will be permitted for minimum periods of time consistent with the requirements of the specifications for protection of completed asphalt concrete courses.

**Designer Note:** This note shall be used on projects involving resurfacing while traffic is maintained.

642-14 (M103) Trench for Widening

Trench excavation for base widening shall be only on one side of the pavement at a time. The open trench shall be adequately maintained and protected with drums or barricades at all times. Placement of proposed subbase and base material shall follow as closely as possible behind excavation operations. The length of widening trench which is open at any one time shall be held to a minimum and shall at all times be subject to approval of the Engineer.

**Designer Note:** This note shall be used on widening projects where traffic is maintained. The
designer should refer to the Traffic Plan Insert Sheet (PIS) 2010190. Dropoffs in Work Zones, to
determine the necessary treatment or protection to be specified in the plan. This Traffic PIS
is available from the Office of Traffic Engineering and can be accessed from the Traffic web
page or the Design Reference Resource Center (DRRC).

642-15 (M104) Overnight Trench Closing

The base widening shall be completed to a depth of no more than _____ inches (millimeters)
below the existing pavement by the end of each work day. No trench shall be left open overnight
except for a short length (25 feet or less (7.5 meters or less)) of a work section at the end of the
trench. In case work must be suspended because of inclement weather or other reasons, the
trench for the uncompleted base widening shall be backfilled at the direction of the Engineer.

Designer Note: This note shall be used for projects involving base widening where traffic is
maintained. The allowable depth is calculated to the bottom of the first surfacing course. The
designer should refer to the Traffic PIS 2010190, Dropoffs in Work Zones, to determine the
necessary treatment or protection to be specified in the plan. This Traffic PIS is available from
the Office of Traffic Engineering and can be accessed from the Traffic web page or the Design
Reference Resource Center (DRRC).

642-16 (M105) Concrete Median Barrier Replacement

Removing, grading and installing the replacement barrier in a continuous operation shall be
limited to _____ linear feet (meter) and shall at all times be subject to the approval of the
Engineer. The Engineer shall be satisfied that all installations will afford maximum protection for
traffic.

Designer Note: This note shall be used when replacing existing concrete median barrier. The
length of this operation should be decided in conjunction with the District Highway Management
Administrator.

642-17 (M106) Guardrail Replacement

This note has been incorporated into the 2002 CMS.

642-18 (M107) Item 614 - Law Enforcement Officer (With Patrol Car)

In addition to the requirements of CMS 614 and the Ohio Manual of Uniform Traffic Control
Devices (OMUTCD), a uniformed law enforcement officer (and official patrol car with working top-
mounted emergency flashing lights) shall be provided for controlling traffic for the following tasks:

- For lane closures: during initial set-up periods, tear down periods, substantial shifts of a
closure point or when new lane closure arrangements are initiated.

- During the entire advance preparation and closure sequence where complete blockage of
traffic is required.

- During a traffic signal installation.

Law enforcement officers (LEOs) should not be used where the OMUTCD intends that flaggers
be used. The LEOs are considered to be employed by the Contractor and the Contractor shall
be responsible for their actions. Although they are employed by the Contractor, the Engineer shall
have control over their placement. The official patrol car shall be a public safety vehicle as
required by the Ohio Revised Code. The Contractor shall make arrangements for these services
with: (list law enforcement agency, address and telephone number).
Law enforcement officers (with patrol car) required by the traffic maintenance tasks above shall be paid for on a unit price (hourly) basis under Item 614, Law Enforcement Officer (With Patrol Car). The following estimated quantities have been carried to the General Summary.

| Item 614, Law Enforcement Officer | ______ Hours |
| Item 614, Law Enforcement Officer With Patrol Car | ______ Hours |

The hours paid shall include minimum show-up time required by the law enforcement agency involved.

If Contractors wish to utilize LEOs for flagging and traffic control other than for that required in these plans, they may do so at their own expense. Payment for the excess above the contract requirements will be included under Item 614, Maintaining Traffic.

**Designer Note:** See L&D Manual Volume One, Section 502.17 for additional information. The three tasks shown are generalizations. The plans shall clearly specify when and where the LEO is to be utilized. This note should be edited to conform with the project requirements.

### 642-19 (M108) Dust Control

The Contractor shall furnish and apply water for dust control as directed by the Engineer. The following contingency quantities have been included for dust control purposes:

| Item 616, Water | ______ M. Gal. (Cu. Meter) |

**Designer Note:** For every cubic yard (cubic meter) of earthwork (embankment plus excavation), use between 0.002 M. Gallon (0.01 cubic meter) and 0.004 M. Gal (0.02 cubic meter) of water. The lower rate should be used for small and/or rural projects and the larger rate should be used for large and/or urban projects.

### 642-20 (M109) Work Zone Markings and Signs

The following estimated quantities have been carried to the General Summary for use at locations identified by the Engineer for work zone pavement markings and signs per the requirements of CMS 614.04 and 614.11.

**Designer Note:** A breakdown of the various types of signs and pavement markings should be included (examples: Item 614, Work Zone Marking Sign; Item 614, Work Zone Lane Line, Class _____, _____. Item 614, Work Zone Stop line, Class _____, _____. etc.).

### 642-21 (M110) Item 622, Portable Concrete Barrier, 50" (1270 mm), As Per Plan

This work shall consist of furnishing, installing, maintaining, and subsequently removing a 50 inch (1270 millimeter) Portable Concrete Barrier at the locations shown on the plans. For details, see SCD RM-4.1.

Portable Concrete Barrier, 32 inches (813 millimeters) high with an 18 inch (457 millimeter) minimum height glare screen may be used at the option of the Contractor. The glare screen shall be constructed using one of the following systems or an approved equal:

- Carsonite Modular Glare Screen
- Carsonite International
- 605 Bob Gifford Blvd.
- Early Branch, South Carolina 29916
- 702-883-5104 or 800-648-7974
Paddle or intermittent type glare screens shall be designed using a 20 degree cut-off angle based on tangent alignment. That spacing shall be used throughout the barrier length without regard to barrier curvature.

The glare screen system shall be securely fastened to the 32-inch (813 millimeter) Portable Concrete Barrier using the hardware and procedures specified by the manufacturer.

Payment shall include all labor, material, and equipment necessary to perform the work and shall be paid for at the contract price per foot (meter) for Item 622, Portable Concrete Barrier, 50 inch (1270 millimeter), as per plan.

**Designer Note:** A plan detail will be required for this item. Additional information may be obtained by contacting the *Office of Roadway Engineering Services*.

**642-22 (M111) Item 614, Replacement Sign**

Flatsheet signs furnished by the Contractor in accordance with the requirements of the plans, specifications and proposal which become damaged by traffic for reasons beyond the control of the Contractor shall be replaced in kind when ordered by the Engineer. Replacement signs shall be new. Other materials may be in used, but good, condition subject to approval by the Engineer.

Payment for the new signs shall be made at the contract price per square foot (square meter) for Item 614, Replacement Sign, and shall include the cost of removing and disposing of damaged signs, hardware and supports, and providing the necessary replacement hardware, supports, etc.

An estimated quantity of _____ square feet (square meters) has been provided in the General Summary.

**Designer Note:** This note shall be used on all four-lane, high-speed projects which will last longer than six months, and on other projects where there is a high probability that a number of signs will be damaged during construction.

**642-23 (M112) Item 614, Replacement Drum**

Drums furnished by the Contractor in accordance with the requirements of the plans, specifications and proposal which become damaged by traffic for reasons beyond the control of the Contractor shall be replaced in kind when ordered by the Engineer. Replacement drums shall be new.

Payment for the new drums shall be made at the contract price per each for Item 614, Replacement Drum, and shall include the cost of removing and disposing of the damaged drum, and providing and maintaining the replacement drum in accordance with the contract requirements for the original drum.

An estimated quantity of _____ each has been provided in the General Summary.

**Designer Note:** This note shall be used on all four-lane high-speed projects which will last longer than six months, and on other projects where there is a high probability that a number of drums
will be damaged during construction.

642-24 (M113) Item 614, Work Zone Speed Limit Sign

The Contractor shall furnish, install, maintain, cover during suspension of work, and subsequently remove Work Zone Speed Limit (R-10) (______ speed limit) signs and supports within the work limits in accordance with the following requirements:

The Contractor shall cover or remove any existing Speed Limit or Minimum Speed Limit (R-7A) signs within the reduced Speed Zone. These signs shall be restored during suspension or termination of the reduced speed limit. The expense of covering or removal and restoration of existing Speed Limit or Minimum Speed Limit signs shall be included in the pay item for the Work Zone Speed Limit signs.

The Work Zone Speed Limit signs may be erected or uncovered no more than four hours before the actual start of work. The signs shall be removed or covered no later than four hours following restoration of all lanes to traffic with no restrictions, or sooner as directed by the Engineer. Temporary sign covering and uncovering due to temporary lane restorations shall be guided by the four-hour limitations stated above. Such lane restorations should be expected to remain in effect for 30 or more days, such as during winter shut-downs.

(The Contractor shall erect a Work Zone Speed Limit sign in advance of any lane restriction expected to last at least 30 consecutive calendar days, or as directed by the Engineer. The sign shall be mounted on both sides of divided highways. The first work zone speed limit sign shall be placed 500 feet (150 meters) in advance of the lane reduction taper or at a point wherever construction begins, whichever comes first. The sign shall be mounted on the right side, 250 feet (75 meters) in advance of the lane reduction taper on undivided highways. The sign shall be repeated, on the side nearest traffic, every 1 mile (1.6 kilometers) for 55 mph zones and every one-half mile (0.8 kilometers) for 50 mph and 45 mph zones. These signs shall also be erected immediately after each open entrance ramp within the zone.)

A sign(s) to indicate the resumption of the statutory speed limit shall be erected at the end of any reduced Speed Zone. R-10 (Speed Limit) signs shall be used on undivided roadways. R-10 (Speed Limit) and R-9A (Speed Limit) signs shall be used on divided roadways. When used the R-10 and R-9A signs shall be mounted side-by-side on separate supports. The Contractor may use signs and supports in used, but good, condition provided the signs meet current ODOT specifications. Sign faces shall be reflectorized with Type G sheeting complying with the requirements of CMS 614.03.

Work Zone Speed Limit signs shall be mounted on two Item 630, Ground Mounted Supports, No. 3 posts.

Work Zone Speed Limit signs and supports will be measured as the number of sign installations, including the signs and necessary supports. If a sign and support combination is removed and reerected at another location within the project due to changes in the Speed Zone directed by the Engineer, it shall be considered another unit.

Payment for accepted quantities, complete in place, will be made at the contract unit price. Payment shall be full compensation for all materials, labor, incidentals and equipment for furnishing, erecting, maintaining, covering during suspension of work, and removing the signs and supports.

Item 614, Work Zone Speed Limit Sign ________ Each
The signs will be placed at the following locations:

**Designer Note:** This note shall be included in projects where speed limits are reduced in accordance with Section 640-18.2.

When this note is used, it should be accompanied by the *Prima Facie Speed Limit Note* on the Title Sheet (L&D Manual Volume Three, Section 1302.12.4).

The fourth paragraph shall only be used when the sign locations are not itemized in the note.

Sufficient numbers of the Work Zone Speed Limit signs shall be included to cover the entire project at the spacing required by the note plus one for each entrance ramp, for each direction. For example, for a 2.33 mile (3.75 kilometer) project on an urban Interstate freeway:

Spacing = 0.5 miles (800 meters)
2.33/0.5 = 4.66 signs or 5 signs (3750/800 = 4.69 signs or 5 signs)
Both sides of roadway = 5 x 2 = 10 signs
Both directions of roadway = 10 x 2 = 20 signs
Plus entrance ramps = 20 + 4 = 24 signs
Total number of Work Zone Speed Limit signs = 24

**642-25 (M114) Designated Local Detour Route**

In addition to the official, signed Detour Route, a local route has been determined to be the secondary, unsigned Detour Route or “designated local Detour Route.” This route is shown on Sheet No. ____. During the time that traffic is detoured, the Contractor shall maintain this route in a condition which is reasonably smooth and free from holes, ruts, ridges, bumps, dust and standing water. Once the detour is removed and traffic returned to its normal pattern, the designated local Detour Route shall be restored to a condition that is equivalent to that which existed prior to its use for this purpose. All such work shall be performed when and as directed by the Engineer.

The following estimated quantities are provided for use as directed by the Engineer to maintain and subsequently restore the designated local Detour Route.

| Item 301, Asphalt Concrete Base, PG 64-22 | ______ Cu. Yd. (Cu. Meter) |
| Item 304, Aggregate Base | ______ Cu. Yd. (Cu. Meter) |
| Item 448, Asphalt Concrete Surface Course, Type 1, PG 64-22 | ______ Cu. Yd. (Cu. Meter) |
| Item 407, Tack Coat | ______ Gal. (Liter) |
| Item 408, Prime Coat | ______ Gal. (Liter) |
| Item 614, Asphalt Concrete for Maintaining Traffic | ______ Cu. Yd. (Cu. Meter) |
| Item 616, Water | ______ M. Gal. (Cu. Meter) |
| Item 617, Compacted Aggregate, Type A | ______ Cu. Yd. (Cu. Meter) |
| Item 617, Water | ______ M. Gal. (Cu. Meter) |
| Item 642, Center Line | ______ Mile (Kilometer) |

**Designer Notes:**

1. Procedures relative to Detours and designated local Detour Routes are set forth in SOP OPS-103, Detours and SOP OPS-104, Maintenance & Repair of Local Roads and Streets Used as Official Detour Routes, Designated Local Detour Routes, or Haul Roads.

2. The list of payment items is included for example purposes only. It is not meant to be all-inclusive of the Items that might be required. The designer must provide items for each
individual project as may be appropriate for the work involved.

3. All pay items listed in the above note should be carried to the General Summary under the Maintenance of Traffic heading.

642-26 (M115) Item 614, Barrier Reflectors And/or Object Markers

Barrier Reflectors and/or Object Markers shall be installed on all Portable Concrete Barrier used for traffic control. Barrier Reflectors, Object Markers and their installation shall conform to CMS 626, except that the spacing shall be 50 feet (15 meters). An estimated quantity of _____ each of Item 614 Barrier Reflector, Type B and _____ each of Item 614 Object Marker, ____-way have been provided and carried to the General Summary.

**Designer Note:** This note shall be added when Item 614, Barrier Reflectors and/or Object Markers are specified.

642-27 (M116) Construction Zones/ Fines Doubled

R-180-48 signs shall be furnished, erected, and maintained in good condition and/or replaced as necessary and subsequently removed by the Contractor. Signs shall be mounted at the appropriate offsets and elevations as prescribed by the Ohio Manual of Uniform Traffic Control Devices. They shall be maintained on supports meeting current safety criteria.

The signs may be erected or uncovered no more than four hours before the actual start of work. The signs shall be removed or covered no later than four hours following restoration of all lanes to traffic with no restrictions, or sooner as directed by the Engineer. Temporary sign covering and uncovering due to temporary lane restorations shall be guided by the four-hour limitations stated above. Such lane restorations should be expected to remain in effect for 30 or more consecutive calendar days, such as during winter shut-downs.

(The signs shall be dual mounted. The first sign shall be placed between the ROAD CONSTRUCTION AHEAD (OW-128) sign and the next sign in the sequence. Signs shall be erected on each entrance ramp and every 2 miles (3 kilometers) through the construction work limits.)

The Contractor may use signs and supports in used, but good, condition provided the signs meet current ODOT specifications. Sign faces shall be reflectorized with Type G sheeting complying with the requirements of CMS 614.03.

Construction Zone/ Fines Doubled signs and supports will be measured as the number of sign installations, including the sign and necessary supports. If a sign and support combination is removed and reerected at another location as directed by the Engineer, it shall be considered another unit.

Payment for accepted quantities, complete, in place will be made at the contract unit price. Payment shall be full compensation for all materials, labor, incidentals and equipment for furnishing, erecting, maintaining, covering during suspension of work and removal of the sign and support.

Item 614, Construction Zone/ Fines Doubled Sign _____ Each

Construction Zone/ Fines Doubled Sign Zone signs will be placed at the following locations:

**Designer Note:** This note should be used on projects that have high traffic volumes, a high
percentage of speeders and/or a reduced legal speed.

The sign may be erected for construction zones only if the planned work length is at least 0.50 miles (0.80 kilometers) long and the work will last for at least 30 consecutive calendar days.

The third paragraph shall only be used when the sign locations are not itemized in note.

642-28 (M117) Earthwork for Maintaining Traffic

The following quantities have been included in the plan for information only:

Excavation for Maintaining Traffic ______ Cu. Yd. (Cu. Meter)
Embankment for Maintaining Traffic ______ Cu. Yd. (Cu. Meter)

Designer Note: This note should be used in conjunction with CMS Item 615, Roads for Maintaining Traffic. The calculations for the above quantities may be shown on the cross-sections or on a separate letter-size sheet that is attached to the LD-4 form.

642-29 (M118) Floodlighting

Floodlighting of the work site for operations conducted during nighttime periods shall be accomplished so that the lights do not cause glare to the drivers on the roadway. To ensure the adequacy of the floodlight placement, the Contractor and the Engineer shall drive through the work site each night when the lighting is in place and operative prior to commencing any work. If glare is detected, the light placement and shielding shall be adjusted to the satisfaction of the Engineer before work proceeds.

Payment for all labor, equipment and materials shall be included in the lump sum contract price for Item 614, Maintaining Traffic (Section 642-2).

Designer Note: The note shall be used on projects that will have work performed during the nighttime hours.

642-30 (M119) Item 614, Work Zone Impact Attenuator (Unidirectional or Bidirectional)

This item shall consist of furnishing and installing either of the following impact attenuators:


The length of the six-bay QuadGuard CZ is 20'-9" (6.33 meters). Installation shall be at the locations specified in the plans, in accordance with the manufacturer’s specifications as detailed on the following pre-approved shop drawings:
### Drawing Numbers and Names

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<thead>
<tr>
<th>Drawing Number</th>
<th>Drawing Name</th>
<th>Drawing/Revision Date</th>
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<td>35-40-10</td>
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<td>35-40-16</td>
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<td>7/30/99 Rev. F</td>
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<td>354051z</td>
<td>QuadGuard CZ System Nose Assembly, CZ, QG, 24, 30, 36</td>
<td>5/17/99</td>
<td>8/27/99</td>
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<td>35400260</td>
<td>QuadGuard System PCMB Anchor Assembly</td>
<td>11/19/97 Rev. C</td>
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2. The TRACC (Trinity Attenuating Crash Cushion) manufactured by Trinity Industry, 1170 N. State Street, Girard, Ohio 44420 (telephone: 330-545-4373).

The TRACC is 21'-0" (6.4 meters) long and 2'-7" (0.8 meter) wide. Installation shall be at the locations specified in the plans, in accordance with the manufacturer’s specifications as detailed on the following pre-approved shop drawings:

<table>
<thead>
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<tr>
<td>SS450</td>
<td>Crash-cushion Attenuating Terminal Plan, Elevation &amp; Sections</td>
<td>3/12/99 Rev. 1</td>
<td>8/27/99</td>
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<tr>
<td>SS455</td>
<td>TRACC Transition to W-beam Median Barrier Plan, Elevation &amp; Sections</td>
<td>2/18/99</td>
<td>8/27/99</td>
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<tr>
<td>SS461</td>
<td>TRACC Transition to Concrete Safety Shape Barrier Plan, Elevation &amp; Sections</td>
<td>6/30/99 Rev. 1</td>
<td>8/27/99</td>
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<tr>
<td>SS462</td>
<td>TRACC Transition to Concrete Barrier Single Slope Plan, Elevation &amp; Sections</td>
<td>6/30/99</td>
<td>8/27/99</td>
</tr>
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</table>

3. The GREAT CZ impact attenuator manufactured by Energy Absorption Systems, Inc.

This attenuator may be used until January 1, 2007 if the item was purchased before October 1, 1998 and is in the Contractor’s inventory.

The Contractor shall provide a replacement unit when an impact is severe enough to require complete replacement of the attenuator. The Contractor shall have a spare parts package.
available on the project site at all times when an attenuator is in place. The Contractor shall provide a minimum of one complete spare parts package for every one to six units installed on the project site. For example, five installed units require one spare parts package and seven installed units require two spare parts packages.

When bidirectional designs are specified, the Contractor shall supply appropriate transitions. Payment for the above work shall be made at the unit price bid for Item 614, Work Zone Impact Attenuator, (Unidirectional or Bidirectional), Each, and shall include all labor, tools, equipment and materials necessary to construct, maintain, repair, replace or relocate a complete and functional impact attenuator system, including all related backups, transitions, leveling pads, hardware and grading, not separately specified, as required by the manufacturer.

Designer Notes:

1. This note should be used for temporary protection of Type 5 Barrier Design Guardrail, Concrete Median Barrier, PCB and other narrow hazards (24 inches (610 millimeters) or less in width) located in work zones where speeds are over 40 miles per hour. When a work zone impact attenuator is needed to protect wider hazards or in work zones where speeds are 40 miles per hour or lower, the designer should specify Item 614 Work Zone Impact Attenuator, QuadGuard CZ [(model #), (Unidirectional or Bidirectional)] and add the corresponding note to the plans.

2. The length of need point is at the nose of the system; therefore, the entire length of the unit can be deducted from the calculated length of need for the barrier.

3. The attenuator can be installed on a concrete pad or asphalt pavement. Consult the manufacturer’s specifications for minimum pavement thicknesses.

4. Pre-approved shop drawings are reviewed and kept on file. Contact the Office of Roadway Engineering Services for the current Dwg/Rev. and ODOT Approval dates.

5. The QuadGuard CZ and TRACC are non-gating systems.

6. If cross slopes are steeper than 8 percent (12:1), or if the cross slope varies by more than 2 percent (1 degree) over the length of the unit, a leveling pad may be used.

7. Provisions shall be made for the rear fender panels to slide 30 inches (762 millimeters) rearward upon impact.

8. Bidirectional should be specified for locations where traffic is expected to be in opposing directions on either side of the attenuator. Unidirectional shall be specified when traffic is expected to move in the same direction on both sides of the attenuator.

642-31 (M120) Item 614, Work Zone Impact Attenuator, QuadGuard CZ ((Model #), (Unidirectional or Bidirectional))

This item shall consist of furnishing and installing a QuadGuard CZ work zone impact attenuator manufactured by Energy Absorption Systems, Inc., One East Wacker Drive, Chicago, IL 60601 (telephone: 312-467-6750).

Installation shall be at the locations specified in the plans, in accordance with the manufacturer’s specifications as detailed on the following pre-approved shop drawings:
The Contractor shall provide a replacement unit when an impact is severe enough to require complete replacement of the attenuator. The Contractor shall have a spare parts package available on the project site at all times when an attenuator is in place. The Contractor shall provide a minimum of one complete spare parts package for every one to six units installed on the project site. For example, five installed units require one spare parts package and seven installed units require two spare parts packages.

When bidirectional designs are specified, the Contractor shall supply appropriate transitions. Payment for the above work shall be made at the unit price bid for Item 614, Work Zone Impact Attenuator, QuadGuard CZ ((Model #), (Unidirectional or Bidirectional)), Each, and shall include all labor, tools, equipment and materials necessary to construct, maintain, repair, replace or relocate a complete and functional impact attenuator system, including all related backups, transitions, leveling pads, hardware and grading, not separately specified, as required by the manufacturer.

**Designer Notes:**

1. This note should be used for temporary protection of Type 5 Barrier Design Guardrail, Concrete Median barrier, PCB and other fixed objects located in work zones where speeds are 40 miles per hour or lower and for the protection of hazards wider than 24 inches (610 millimeters), but less than 36 inches (915 millimeters) in work zones where speeds are over 40 miles per hour.

   As shown in *Table 697-8*, the QuadGuard CZ comes in three widths, 24 inches (610 millimeters), 30 inches (760 millimeters), and 36 inches (915 millimeters). The six-bay unit is 22'-1" (6.74 meters) long and can be used in work zones where speeds are over 40 miles per hour. The three-bay unit is 13'-1" (4.00 meters) long and can be used in work zones where speeds are 40 miles per hour and lower.

   When a 24 inch (610 millimeters) wide six-bay QuadGuard CZ is needed, the designer should specify Item 614, Work Zone Impact Attenuator, (Unidirectional or Bidirectional) and add the corresponding note to the plans.
2. The length of need point is at the nose of the system; therefore, the entire length of the unit can be deducted from the calculated length of need for the barrier.

3. The QuadGuard CZ can be installed on a concrete pad or asphalt pavement. Consult the manufacturer’s specifications for the minimum pavement thicknesses.

4. Pre-approved shop drawings are reviewed and kept on file. Contact the Office of Roadway Engineering Services for the current Dwg/Rev. and ODOT Approval dates.

5. The QuadGuard CZ is a non-gating system.

6. If cross slopes are steeper than 8 percent (12:1) or if the cross slope varies by more than 2 percent (1 degree) over the length of the unit, a leveling pad may be used.

7. Provisions shall be made for the rear fender panels to slide 30 inches (762 millimeters) rearward upon impact.

8. Bidirectional should be specified for locations where traffic is expected to be in opposing directions on either side of the attenuator. Unidirectional shall be specified when traffic is expected to move in the same direction on both sides of the attenuator.

642-32 (M121) Item 614, Portable Water-filled Barrier, Triton (TL2 or TL3)

This work shall consist of furnishing, installing, maintaining, relocating and subsequently removing a Triton Portable Water-filled Barrier manufactured by Energy Absorption Systems, Inc., One East Wacker Drive, Chicago, IL 60601 (telephone: 312-467-6750).

Segments are 78 inches (1981 millimeters) long, 32 inches (813 millimeters) tall and 21 inches (533 millimeters) wide. The Triton shall serve as its own end treatment.

Installation shall be at the locations specified in the plans, in accordance with the manufacturer’s specifications as detailed on the following pre-approved shop drawings:

<table>
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<th>Drawing Number</th>
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<tr>
<td>35-95-02</td>
<td>Barrier Section Assembly, Triton Barrier</td>
<td>10/25/96 Rev. G</td>
<td>8/27/99</td>
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<tr>
<td>3595361</td>
<td>Triton Barrier TL-3 End Treatment</td>
<td>1/12/98 Rev. a</td>
<td>8/27/99</td>
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Payment shall include all labor, material, water, anti-freeze and equipment necessary to perform the work, and shall be paid for at the contract price per foot (meter) for Item 614, Portable Water-filled Barrier, Triton (TL2 or TL3).

Designer Notes:

1. The Triton can be used as a barrier or as a channelizing device, i.e. a substitute for drums. When used as a barrier, the TL3 design should be specified for work zone speeds greater than 40 miles per hour. The TL2 design should be specified for work zone speeds less than or equal to 40 miles per hour.

2. The TL3 design requires a minimum of 30 interconnected units for a total length of 195 feet (59.5 meters) with a suggested lateral clearance to hazard of 22.5 feet (6.9 meters). The TL2
design requires a minimum of 16 interconnected units for a total length of 104 feet (30 meters) with a suggested lateral clearance of 13 feet (3.9 meters). The suggested lateral clearances are based upon a 25-degree impact angle. In locations where the encroachment angles are expected to be smaller, actual deflections may be less. Consult the manufacturer or the Office of Roadway Engineering Services for additional guidance.

3. When used solely as a channelizing device (not as a barrier), the TL2 design should be specified and the minimum length and lateral offset requirements shall be waived.

4. The Triton serves as its own end treatment. The length of need point is at the 11th segment from the end for the TL3 design, and at the 5th segment from the end for the TL2 design. Measurement of the pay length of barrier shall include the segments that serve as the end treatment.

642-33 Extra Advance Warning Signs (Note A)

An Extra Advance Warning Sign Group consists of two OW-134 (ROAD WORK AHEAD) signs, two OW-122 (OW-123) (RIGHT / LEFT LANE CLOSED AHEAD) signs with OW-145A Distance plates, and two OW-166 (WATCH FOR STOPPED TRAFFIC) signs and required warning lights.

The Contractor shall provide, erect, maintain and remove Extra Advance Warning Sign Groups as shown on SCD MT-95.40 at the following distances in advance of the lane tapers with the appropriate OW-145A distance plates:

1) Lane Taper No. ______, Station ________, Phases ______ & ______; provide sign groups at ______ miles (kilometers) ______ miles (kilometers) and ______ miles (kilometers).

2) Lane Taper No. ______, Station ________, Phases ______ & ______; provide sign groups at ______ miles (kilometers), ______ miles (kilometers), ______ miles (kilometers), and ______ miles (kilometers).

(Optional paragraph - The Contractor shall have an additional Extra Advance Warning Sign Group (6 signs and 2 distance plates) available for use when directed by the Engineer. The distance plates for this group shall be able to be modified in the field to show appropriate whole miles to the lane taper.)

Payment for providing, erecting, maintaining and removing Extra Advance Warning Sign Groups shall be included in the lump sum bid for Item 614, Maintaining Traffic.

Designer Note: As noted in Section 641-5.2, this note should be used to require extra Advance Warning Sign Groups if the queue resulting from a lane closure on a multilane divided highway is expected to extend beyond the normal ROAD WORK AHEAD sign (OW-134). See Section 641-5.2 for further information.

642-34 Extra Advance Warning Signs (Note B)

An Advance Warning Sign Group consists of two OW-134 (Road Work Ahead) signs, two OW-122 (OW-123) (Right/Left Lane Closed Ahead) signs with OW-145A distance plates, and two OW-166 (Watch for Stopped Traffic) signs and required flashing lights.

The Contractor shall provide, erect, maintain and remove an Extra Advance Warning Sign Group as shown on SCD MT-95.40. The OW-145A Distance plates shall read "_______ MILES". The Right (Left) Lane Closed Ahead signs shall be located _________ miles (kilometers) from the
beginning of the lane taper. Spacing of the other signs shall be as shown on SCD MT-95.40.

The Contractor shall provide, erect, maintain and remove an additional Extra Advance Warning Sign Group to provide additional warning for the anticipated traffic increase during the following national holidays: (appropriate holidays to be filled in as defined by policy and the specific needs of the project). These signs shall be erected no later than 1:00 p.m. the third day preceding the holiday or holiday weekend and not removed before 9:00 a.m. the third day subsequent to the holiday or holiday weekend. The signs shall be removed during the periods between holidays. The OW-145A Distance plates shall read "________ MILES" with the OW-122 (OW-123) signs located ______ miles (kilometers) from the beginning of the lane taper. Spacing of the other signs shall be as shown on SCD MT 95.40.

(Optional paragraph - The contractor shall have a third Extra Advance Warning Sign Group (6 signs and 2 distance plates) available for use when directed by the Engineer. The distance plates for this group shall read "___________ MILES.")

Payment for providing, erecting, maintaining and removing Extra Advance Warning Sign Groups shall be included in the lump sum bid for Item 614, Maintaining Traffic.

Designer Note: As noted in Section 641-5.2, this note should be used to require extra Advance Warning Sign Groups in situations involving work that will extend over a holiday or any other anticipated period of unusually high traffic demand, if the queue resulting from a lane closure on a multilane divided highway is expected to extend beyond the normal ROAD WORK AHEAD sign. See Section 641-5.2 for further information.

642-35 Item 614, Work Zone Crossover Lighting System

This work shall consist of furnishing, erecting, operating, maintaining and removing a work zone lighting system for a single crossover, or overlapping a pair of crossovers on a two-lane, two-way operation. The system shall be as shown on SCD MT-100.00. The Contractor shall arrange for and pay for power. All materials and construction shall comply with applicable portions of 625 and 725 except: The Performance test of 625.19F, and certified drawing requirement of 625.04, are waived and used materials in good condition are acceptable.

Poles may be less than 30 ft (9 m) from the edge of pavement when behind guardrail. Additional pole lines, cables and appurtenances necessary to furnish power to the lighting system shall be included in this item. Service poles shall be positioned with the same constraints as the lighting poles as a minimum.

Payment will be made at the unit price per each for Item 614, Work Zone Crossover Lighting System throughout all phases of work when the crossover roadways are used.

Designer Note: As noted in Section 641-9.5, this note should be included in the plan when a work zone crossover lighting system is provided.

642-36 Multi-Plan, Time-of-Day Operation of Work Zone Signal

The work zone signal control required for this project and shown on sheets _________ and SCDs MT-96.10 or 96.11, 96.21, and 96.25 or 96.26 shall be capable of providing multiple timing patterns chosen on a time of day basis.

Traffic control equipment shall be capable of time-of-day/day-of-week programming; with a minimum of three-dial, three offsets and three splits, or a minimum of fifteen separate timing plans.
**Timing Plan (Seconds)**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northbound Green</td>
<td>31*</td>
<td>41</td>
<td>16*</td>
</tr>
<tr>
<td>Northbound Yellow</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Northbound All Red</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>(Internal Clearance)</td>
<td>30</td>
<td>20</td>
<td>3.5</td>
</tr>
<tr>
<td>Southbound Green</td>
<td>3.5</td>
<td>3.5</td>
<td>19</td>
</tr>
<tr>
<td>Southbound Yellow</td>
<td>19</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Internal Clearance)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total Cycle Length</td>
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<td>105.0</td>
<td>75.0*</td>
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* Provide Timing Appropriate for the Signal Location Under Consideration

**Time of Day**

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>SUN</th>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THUR</th>
<th>FRI</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midnight - 7:00 a.m.</td>
<td>C*</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C*</td>
</tr>
<tr>
<td>7:00 a.m. - 9:00 a.m.</td>
<td>C</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>9:00 a.m. - 4:00 p.m.</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>4:00 p.m. - 6:00 p.m.</td>
<td>C</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>6:00 p.m. - Midnight</td>
<td>C*</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

Payment is incidental to the lump sum bid for Item 614, Maintaining Traffic.

**Designer Note:** This note should be included in the plan when a signalized one-lane, two-way closing is used.

**642-37 Fully-Actuated Operation of Work Zone Traffic Signal**

The work zone signal control required for this project and shown on sheets __________ and SCDs MT-96.10 or 96.11, 96.21 and 96.26 shall be fully traffic-actuated and operate in a manner similar to that described in Section 733.02 of the Construction and Material Specifications.

The initial controller timing shall be as follows:

```
<table>
<thead>
<tr>
<th>Phase</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
</table>
| Initial | 7 +/- | 10   | 8    | 10+/-
| Vehicle | 4    | 3    | 4    | 3    |
| Maximum | 11   | 30   | 12   | 30   |
| Yellow  | 3    | 3.5  | 3    | 3.5  |
| All Red | 2    | 2    | 2    | 2    |
| Recall  | ON +/-| OFF  | ON   | OFF +/-|
```

*Phases as shown on SCD MT-96.26 for Actuated Control

+/- Provide timing for the signal location under consideration.
The Contractor shall also design, furnish, install and maintain a traffic detector on each traffic approach which will reliably detect all legal traffic approaching (but not leaving) the signal as it passes or waits in the designated detector zone shown in the plans. Detector designs which do not provide reliable detection, free from false calls, shall be immediately replaced by the Contractor.

**Designer Note:** This note should be included in the plan when a signalized one-lane, two-way closing is used.

**642-38 Overhead-Mounted Work Zone Signals**

Signals shall be overhead mounted in accordance with the details shown on SCD MT-96.21.

**Designer Note:** This note shall be used when overhead-mounted signals are used.

**642-39 Item 614, Work Zone Lighting System (for Shoulder Transition)**

This work shall consist of furnishing, erecting, operating, maintaining and removing a work zone lighting system for an area involving use of the shoulder for through traffic, as well as the areas leading into and out of this section. The system shall be as shown on SCD MT-102.10 (MT-102.20). The Contractor shall arrange for and pay for power and any costs of providing service. All materials and construction shall comply with applicable portions of CMS 625 and 725 except: The Performance Test of CMS 625.19F, and certified drawing requirement of CMS 625.04 are waived and used materials in good condition are acceptable. A photocell shall turn on the lighting when ambient light is below 3 foot candles. All overhead wiring shall be #4 AWG minimum. Down guy anchors shall be provided at both ends of overhead spans. All wires crossing the roadway shall have a minimum height of 20 feet (6.1 m).

Payment will be made at the unit price per each Item 614, Work Zone Lighting System which will include erection, operation, maintenance, removal and power for all lighting required by SCD MT-102.10 (MT-102.20).

**Designer Note:** As noted in Section 641-19, this note should be used when existing lighting is not available and a transition plan which uses the shoulder to maintain traffic will be in use for more than fourteen days. In this situation a work zone lighting system shall be used for the tapers; however, continuous lighting of the work area between the lighted tapers is only required when the tapers are provided with work zone lighting and the distance between lighted tapers is less than 2000 feet (610 meters).

**642-40 Maintenance of Canoe Traffic**

Canoe traffic shall be maintained throughout construction of the project either through existing river channel or through portage trail approved by the Engineer.

Adequate signing both upstream and downstream shall be installed and maintained by the contractor. The following type signs are considered to be minimum treatment:

1. Approximately 1/4 mile (0.6 kilometer) upstream, advanced warning type signs on both banks
2. Approximately 300 feet (90 meters) upstream, signs specifying actions required of canoeist on both banks
3. Approximately 1/4 (0.6 kilometer) mile downstream, advance warning type signs on both banks
4. Approximately 300 feet (90 meters) downstream, signs specifying actions required of canoeist of both banks

The above signing shall be mounted in such a way as to be a minimum of 4 feet (1.2 meters) above the water level, unobstructed by tree branches, and properly angled for maximum visibility from the main clear channel. The method of supporting the signs shall be approved by the engineer prior to installation. Upon completion of the project, the signs and support systems shall be completely removed from the river channel. The contractor shall notify local canoe liveries using this portion of the river at least 10 days prior to any changes affecting canoe traffic.

Portage trails if used shall be constructed and maintained by the Contractor with the least possible disturbance to the surrounding area. The trail shall be adequately marked in both directions. The contractor shall be responsible for obtaining the right-of-way for the portage trails if required.

In the event pipes are used to divert or carry river water, both the inlet and outlet ends shall be adequately protected by grates or fence so that people or canoes are not drawn through or held by them.

642-41 Item 614, Portable Changeable Message Signs, As Per Plan

The Contractor shall furnish, install, maintain and remove, when no longer needed, a changeable message sign, on site, for the duration of the project. The sign shall be of a type shown on a list of approved PCMS units maintained by the Director (Office of Materials Management). This list is available on the ODOT website at http://www.dot.state.oh.us/testlab/applists/misc/pcms.htm. The list currently contains Class I, II, and III units with minimum legibility distances of 1250 ft., 850 ft. and 650 ft., respectively.

Each sign shall be trailer-mounted and equipped with a functional dimming mechanism, to dim the sign during darkness, and a tamper and vandal proof enclosure. Each sign shall be provided with appropriate training and operation instructions to enable on-site personnel to operate and troubleshoot the unit. The sign shall also be capable of being powered by an electrical service drop from a local utility company. PCMS trailers should be delineated on a permanent basis by affixing retroreflective material, in a continuous line on the face of the trailer as seen by oncoming road users.

The probable PCMS locations and work limits for those locations are shown on sheet(s) ____ of the plan. Placement, operation, maintenance and all activation of the signs by the Contractor shall be as directed by the Engineer. The PCMS shall be located in a highly visible position yet protected from traffic. The Contractor shall, at the direction of the Engineer, relocate the PCMS to improve visibility or accommodate changed conditions. When not in use, the PCMS shall be turned off. Additionally, when not in use for extended periods of time, the PCMS shall be turned, facing away from all traffic, and shall display one or more high-intensity yellow reflective sheeting surfaces of 9-inch by 15-inch minimum size facing traffic.

The Engineer shall be provided access to each sign unit and shall be provided with appropriate training and operation instructions to enable ODOT personnel to operate and troubleshoot the unit, and to revise sign messages, if necessary.

(The Contractor shall implement a system whereby changeable messages will be implemented within ______ hours following telephone notification from the Project Engineer to a designated phone.)

All messages to be displayed on the sign will be provided by the Engineer. A list of all required
pre-programmed messages will be given to the Contractor at the project preconstruction conference. The sign shall have the capability to store up to 99 messages. Message memory or pre-programmed displays shall not be lost as a result of power failures to the on-board computer. The sign legend shall be capable of being changed in the field. Three-line presentation formats with up to six message phases shall be supported. PCMS format shall permit the complete message for each phase to be read at least once.

The PCMS shall contain an accurate clock and programming logic which will allow the sign to be activated, deactivated or messages changed automatically at different times of the day for different days of the week.

(The PCMS shall contain a cellular telephone data link which will (in active cellular phone areas) allow remote sign activation, message changes, message additions and revisions to time of day programs. The system shall also permit verification of current and programmed messages. One remote data input device (laptop computer plus modem or equivalent) shall be furnished for use by the District Traffic Engineer, or equivalent, and shall be insured against theft.)

The PCMS unit shall be maintained in good working order by the Contractor in accordance with the provisions of CMS 614.07. The Contractor shall, prior to activating the unit, make arrangements, with an authorized service agent for the PCMS, to assure prompt service in the event of failure. Any failure shall not result in the sign being out of service for more than 12 hours, including weekends. Failure to comply may result in an order to stop work and open all traffic lanes and/or in the Department taking appropriate action to safely control traffic. The entire cost to control traffic, accrued by the Department due to the Contractor's noncompliance, will be deducted from moneys due, or to become due the Contractor on his contract.

The Contractor shall be responsible for 24-hour-per-day operation and maintenance of these signs on the project for the duration of the phases when the plan requires their use.

Payment for the above described item shall be at the contract unit price. Payment shall include all labor, materials, equipment, fuels, lubricating oils, software, hardware and incidentals to perform the above described work.

Item 614, Portable Changeable Message Sign, as per plan ________ Sign-Month

Designer Note: Portable changeable message signs (PCMSs) are trailer-mounted programmable message units which can be utilized to provide advance information about upcoming traffic conditions or diversion routing schemes to road users (see Section 605-9). PCMS units are supplemental information devices and shall not be utilized as alternates to standard fixed signing or flashing arrow panels.

On major construction projects, PCMS units, although costly ($1,000 to $2,500 per sign-month), can provide real benefits to road users. These benefits include increased work zone capacity resulting from advance warning of lane closures, and improved corridor capacity resulting from diversion schemes implemented in reduced capacity situations.

PCMSs are intended to have a high impact on the motorist and to convey timely, pertinent, driver oriented information which could not be provided by fixed-message signs. For this reason, if no important message needs to be displayed, the sign shall be turned off. The display of non-priority messages is discouraged as drivers tend to become familiar with these and overlook priority messages displayed later.

The use of PCMS should be reserved for situations where signs must be changed frequently and/or where the next required message cannot be predicted in advance. When a message is
known in advance or when it could be determined before there is a need to display it, then a fixed-message sign is appropriate. Certainly, messages such as LEFT/RIGHT LANE CLOSED AHEAD should not be considered for PCMS display because there are standard signs readily available for this purpose and emphasis can be added with flashers or flags at a nominal cost. Similarly, non-standard messages such as ROAD WORK WILL CLOSE TWO (2) LANES BEGINNING MARCH 25, 2003 can normally be determined well in advance of need and included in the plans as fixed-message signs. Even where sign messages must change periodically, a fixed-message sign with flip-up panel may be more appropriate.

Sign messages shall be limited to a maximum of two sequential displays or phases, each consisting of a maximum of three, eight-character lines. The pre-qualified list of PCMS is provided on the ODOT website at http://www.dot.state.oh.us/testlab/applists/misc/pcms.htm. This list contains the PCMS approved for use on ODOT projects. The pre-qualified list currently contains three classes of PCMS. The Class I unit is an ideal design providing a minimum of 1250 feet of legibility distance, or 13 seconds of legibility at 65 miles per hour. The Class II unit provides a minimum of 850 feet of legibility distance, or 8.9 seconds of legibility at 65 miles per hour. The Class III unit, which is the original basic design, provides a minimum of 650 feet of legibility distance, or 8 seconds of legibility at 55 miles per hour. Eventually the Class III units will be dropped from most projects in favor of the more legible Class II and above units. The pre-qualified list is maintained by the Director (Office of Materials Management).

When specifying the number of sign-months required, care should be exercised to require that the contractor furnish a specific number of units on site, for the duration of each phase, or for the duration of the entire project if appropriate, rather than merely having “X” units available. If standby units are needed, they shall be so specified along with a time interval in which a malfunctioning unit must be replace.

The fifth paragraph in this Plan Note is optional. This paragraph is to be included in the plans when it is intended that time-of-day/day-of-week programming capability is to be provided. This feature allows for certain messages to be pre-selected for anticipated critical times, and also allows the unit to be automatically turned off when there is no significant message to convey.

The eighth paragraph in this Plan Note is also optional. This paragraph is to be used when it is necessary to require cellular phone data link programming of PCMS operation and messages. This should be included only when potential maintenance of traffic problems justify its use; and only when procedures have been developed to assess travel problems on a current basis and an operating agency (e.g., District Traffic Department, City Traffic Department, OSHP or City Police Department) is prepared to monitor and operate the system on a real-time basis with current information. Further, the cellular phone option should not be invoked unless the designer has assured that cellular phone services are available in the proposed sign area. Generally, PCMS units should be located well in advance of the situation to which they relate. In the case of diversion schemes, the PCMS units should be located well in advance of the upstream interchange where the alternate route begins. The desired location(s) for deployment of PCMS units shall be established by means of a Plan Note listing the specific locations where the contractor is to install, maintain and remove the PCMS units(s) and the duration the PCMS unit is to function. Designers should field review potential sites to find those with good visibility and a level, accessible area, preferably behind existing guardrail. The Plan Note also permits the project engineer to relocate the sign to improve visibility or to accommodate changing conditions.
643 SPECIFICATIONS

ODOT specifications discussed in this chapter for furnishing and installing temporary traffic control devices and material for work zones are contained in the following CMS sections:

108 Prosecution and Progress
410 Traffic Compacted Surface
614 Maintaining Traffic
615 Roads and Pavements for Maintaining Traffic
622 Concrete Barrier
641 Pavement Marking - General
630 and 730 Traffic Sign and Support Material
631 and 731 Sign Lighting and Electrical Signs
ramps should be implemented as shown in MT-98 series of SCDs.

670-7 Rest Area Closures

Rest areas shall not be closed to the public without approval of the District Deputy Director. Approvals of temporary rest area closures called for within construction projects become effective with the District Deputy Director’s signature on the title sheet.

All advance Rest Area signs (RA-1 through RA-4) shall have the action message covered by an overlay bearing the legend “CLOSED.” This panel shall have a black legend on a reflectorized orange background. The overlay for the RA-1 and RA-3 signs shall be 8 x 1.5 feet (2.4 x 0.15 meters). The overlay for the RA-2 and RA-4 signs shall be 4 x 1.5 feet (1.2 x 0.46 meters). Supplemental panels (TELEPHONE, TOURIST INFO., Handicapped symbol, etc.) located under mainline Rest Area signs shall be removed or covered when the rest area is closed. On conventional highways, the overlay panel size shall be 28 x 10 inches (700 x 250 mm).

Distance information provided on the NEXT REST AREA XX MILES sign (RA-5), located in advance of the upstream rest area, shall be modified to provide the distance to the next open downstream rest area. This modification shall be accomplished by providing a black on orange overlay to cover the distance provided on the sign.

As shown in SCD MT-98.19, the entrance ramp to the rest area shall be closed by use of drums, as per CMS 614.03. The exit ramp from the rest area shall be closed in a similar manner. On major standard highways where a median opening may exist to permit access to and from the rest area, this opening shall also be closed in a similar manner.

Where rest area lighting exists, it shall be maintained in proper condition to provide optimum illumination.

670-8 Restroom Closures

Rest areas shall not be closed because of restroom failure. If restrooms are closed because of mechanical failure or any other reason except routine maintenance, the REST ROOMS CLOSED sign (RA-86), black legend on reflectorized orange background, shall be used to inform the road user of the closure. On freeways and expressways the RA-86-48, 48 x 48 inches (1.2 x 1.2 meters) sign shall be installed below the Advance Rest Area sign (RA-1), and may be installed below the RA-2 and RA-3 signs; however, it shall not be installed at the RA-4 gore sign. On conventional highways, the RA-86-24 sign, 24 x 24 inches (0.6 x 0.6 meters), shall be installed below the Advance Rest Area sign (RA-12) and may be installed below the RA-10 sign.

670-9 Railroad Crossings

An important design consideration in the development of temporary traffic control plans involving railroad grade crossings is the potential for vehicles queuing onto the railroad tracks. Adjusting the transition area and/or buffer space might be appropriate so that downstream congestion caused by a lane drop, for example, does not reach the railroad crossing.

When the grade crossing is equipped with an active traffic control system, the normal sequence of highway intersection signal indications should be preempted upon approach of trains to avoid entrapment of vehicles on the crossing by conflicting aspects of the highway traffic signals and the grade crossing signals. Temporary traffic control signals near grade crossings should be operated so that vehicles are not required to stop on the tracks. See OMUTCD Section 6F-1 and Part 8 of this Manual for additional information.
Guidance on traffic control near railroad crossings is provided in Figure 698-47 and Section 607-44.

670-10 Transit Considerations

Provision for effective continuity of transit service needs to be incorporated into the temporary traffic control planning process. Oftentimes, public transit buses cannot efficiently be detoured in the same manner as other vehicles (particularly for short-term maintenance projects). On transit routes, the traffic control plan (Section 602-2) should provide for features such as temporary bus stops, pull-outs and waiting areas for transit patrons.
Figure 698-3a. Temporary Traffic Control Signs

- **STAY IN LANE** (R-179, Fig. 698-39)
- **CONSTRUCTION ZONE FINES DOUBLED** (R-180, Sec. 605-4.3)
- **DETOUR** (OC-29L, Sec. 605-7.2)
- **DETOUR** (OC-29R, Sec. 605-7.2)
- **END DETOUR** (OC-30, Sec. 605-7.2)
- **EXIT RAMP OPEN** (OC-45, Sec. 605-8.4)
- **EXIT RAMP CLOSED AHEAD** (OC-45A, Sec. 605-8.4)
- **EXIT RAMP CLOSED** (OC-46, Sec. 605-8.4)
- **ROAD WILL BE CLOSED MONDAY FOR 27 DAYS INFO: 555-555-1212** (OC-46A, Sec. 605-8.4)
- **ROAD WILL BE CLOSED MONDAY FOR 27 DAYS ODOT DEPT. OF TRANSPORTATION** (OC-60A, Sec. 605-8.3)
- **NEW SIGNAL WILL BEGIN STOP-AND-GO MON NOV 08** (OC-61, Sec. 641-29)
- **OW-5A** (Sec. 607-31)
- **OW-5B** (Sec. 607-36)
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prior to using the nomograph. The normal tower foundation diameter shall be 36 inches unless the
tower anchor base plate and bolt circle requires a diameter of 42 inches.

Since the foundation embedment obtained from the nomograph is the depth below the resisting
surface of the earth and not from the ground line, the total required foundation length can be obtained
by increasing the graph value by 1 or 2 feet. For design purposes, the foundation length determined
from the graph should be increased to the next longer length that is a multiple of five.

The foregoing design procedure provides a suitable design method for determining the required
caisson length as functions of soil classification, shear force and overturning moment. The soils likely
to be encountered have been categorized into six values of allowable lateral soil pressures. Where
existing soils information will permit identification for strength and classification, it will not be
necessary to use refined design procedures involving extensive soil exploration.

Table 1197-11 presents recommended tower foundation depths calculated for structures with round
tapered shafts designed in accordance with the 1975 AASHTO Standard Specifications for
Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 90 miles per hour
wind zone when supporting the following load:

- Six cylindrical luminaires with projected area of 3.5 square feet ($C_D = 0.5$) and weighing 75 lbs.
each.

- One cylindrical head frame assembly with projected area of 5.3 square feet ($C_D = 1.0$) and 340
lbs. top latched lowering device.
1141 PLAN PREPARATION / PRODUCTION

1141-1 General

The L&D Manual Volume Three generally describes ODOT plan preparation and production guidelines and standards, including plan sheet format (sheet layout, text size, symbols, line weights, file-naming conventions, etc.). For reference, Figures 1314-8S through 1314-10S of the Sample Construction Plans produced by the Office of Production are sample Lighting Plan sheets. Additional information is provided in this Section and Section 1140 regarding lighting items in plans.

1141-2 Coordination with Utilities

If the lighting plan is part of a complete highway construction plan, existing underground and overhead utility locations will generally be requested by the roadway designers through the Ohio Utility Protection Service (OUPS) early in the design process. Utilities which are not members of OUPS must be contacted directly. The information retrieved is incorporated into the roadway plan and must be shown on the lighting plan as well. Proposed underground utilities (e.g., storm, sewer, and water) must also be shown to avoid conflicts with proposed light poles, pull boxes and control centers. If the lighting plan constitutes the entire plan, the lighting designer must contact OUPS and any non-member utilities.

The power company which will be supplying power should be contacted early in the design process to confirm the location(s) being requested for the control center site(s) as well as the power requirements, ownership, meter requirements and any electrical energy charges which the contractor will incur for establishing the new power service(s). Confirmation of the proposed control center location will allow the designer to proceed with the circuit design.

1141-3 Plan Composition

1141-3.1 General

A normal set of highway lighting plans should contain Plan Notes, quantities, detailed drawings and layout sheets in sufficient detail to allow ODOT to process the plans for contract to the lowest qualified bidder and to allow the successful low bidder to construct the proposed lighting system without additional reference material. Clarity, completeness and conciseness are essential so as to avoid misinterpretation. Special Proposal Notes which cover unusual contingencies (such as options to jack conduits under pavements) and the Construction and Materials Specifications (CMS) are considered to be part of the plans, as far as this discussion is concerned. Where official ODOT publications, such as the OMUTCD, are referenced within the plans, they are understood to be incorporated by reference.

A highway lighting plan is usually a portion of a complete highway construction project. In such cases, the lighting plans will simply be incorporated into the roadway plans with appropriate sheet number references included in the index; however, when the highway lighting design constitutes the entire project, the normal plan composition requirement discussed below must be satisfied to the extent that the lighting plans can stand alone as a contractual document. In such cases, special consideration should be given to such items as field offices, construction layout stakes, maintenance of traffic during construction, etc. Typical traffic maintenance layouts are included in the SCD MT series.

A set of lighting plans usually consists of the following consecutively numbered subdivisions; however, when the lighting plan is to be awarded to contract without a related roadway plan, a title sheet shall be added.
1141-3.2 General Notes

General Notes should be limited to explanations required to clarify details or proposed work which is not satisfactorily covered elsewhere in the plans, specifications, or standard drawings. When a portion of a design varies from the standard (making it an “as per plan” item) or an “item special” is required for a unique situation, a description of the work, materials, and special instructions should be included in a general note to inform the contractor of what is included in the price bid for that particular item. General Notes are also commonly used for standard bid items which require supplemental information not otherwise shown in the plans or specifications, such as the size of field offices or the method of maintaining traffic or temporary lighting. The designer should contact the appropriate District or the Office of Traffic Engineering Lighting Section for current sample notes commonly used in lighting plans.

1141-3.3 General Summary and Subsummaries

The General Summary of lighting quantities is an extension of the project General Summary and should include the same separations for financial participation, Federal Project Numbers, and Federal Construction Code types as occur on the project General Summary. Whenever practical, bid items should be listed in standard units as described in the current publication of the ODOT Item Master. Pay item descriptions and item extension numbers should also be in accordance with the Item Master. As in all General Summaries, a blank line should be left between groups of no more than five pay items. Also, the sheet numbers across the top of the sheet should be the sheet numbers of each Subsummary Sheet and not the sheet numbers of the individual plan sheets. Cross reference to other General Summary sheets in the plan should be included after the end of the item descriptions (e.g., “FOR ROADWAY (TRAFFIC CONTROL, STRUCTURE, RETAINING WALL) QUANTITIES, SEE SHEET XX.”).

Subsummary Sheets provide compilations of quantities for convenient portions of plans or for similar types of quantities, and their totals should always be carried to the lighting General Summary which is used as the basis for competitive bidding on the construction contract. See L&D Manual Volume Three Sample Plan Sheets Figure 314-10S for a sample lighting Subsummary Sheet. Note that the quantities from each plan sheet are totaled and that the quantities carried to the lighting general summary are from the individual plan sheets (i.e., more than one set of quantity totals may be carried to the General Summary from one Subsummary Sheet).

1141-3.4 Circuit Schematic and Plan Sheet Layout

Schematic plans for circuits are required for each project. Where lighting is limited to simple diamond interchanges in rural areas, or where all circuits served by a given control center can be shown on the same sheet, the normal schematic plan may also serve as the circuit schematic.
plan, provided the delineation of circuits is clear and the schematic plan sheet is not excessively burdened with other details. When this is not the case, separate schematic plans for circuits should be prepared. The calculated voltage at each sign, at each “wye” in the circuit, and at each terminal point should be shown on the circuit schematic plans as shown on Table 1197-8. The Control Center Data chart (Figure 1198-1) should also be completed and shown on the circuit schematic.

If space precludes adding the Control Center Data chart and the Lighting Load listing to the schematic plan, they should be located on the first plan layout sheet. It is desirable to include a plan sheet layout on the schematic plan to more easily navigate through the lighting plan. See the L&D Manual Volume Three Sample Plan Sheets, Figure 1314-8S for a partial sample Schematic & Sheet Layout plan sheet.

1141-3.5 Plan Sheets

Plan sheets are normally prepared at a scale of 1 inch equals 50 feet; however, plan sheets for tower lighting are usually prepared at a scale of 1 inch equals 100 feet, and lighting plans may be prepared to scales which have been approved for basic roadway plans to avoid the need of repeating basic layouts at different scales. See L&D Manual Volume Three Sample Plan Sheets, Figure 1314-9S for a typical plan sheet. Each plan sheet should include the following information:

1. Pavement and paved shoulder edges.
2. Curb lines, curb ramps and raised medians or similar channelizations.
3. Number of lane indication, either by showing lane lines or by use of lane arrows (one for each directional lane).
4. Bridge structures and retaining walls, including pier and abutment locations, and length of approach slabs, for all bridges.
5. Structure numbers and location of each structure ground.
6. Existing and proposed overhead electrical and communication lines and underground utilities and culverts which affect the proposed lighting unit locations. Show width and/or boundaries of the utility right-of-way or easement and fence grounding points where overhead electrical lines are involved.
7. Type, wattage or lumen rating, and ownership of existing lighting in the project area, and planned disposition thereof.
8. Corporation lines and other quantity separation boundaries.
9. Future lighting unit locations, when applicable.
10. A north arrow, located on the upper right corner of the sheet.
11. A legend, or reference to the plan layout sheet showing the legend. The legend shall indicate by appropriate symbol the various types of light poles, light towers, pull boxes, conduits, etc., to be installed.
12. The location of each light pole foundation, conduit crossover, pull box, control center, tower,
3. General Notes.
   a. Are the Plan Notes listed in Section 1142 included, when applicable?
   b. Where trade name or catalog references are made, have at least two manufacturers plus the phrase “or equal approved by the Engineer” been shown?
   c. Where there are median mounted poles, is the barrier conduit note included, along with necessary plan details and standard drawing references?

4. Details.
   a. Are voltage and type of service furnished by the power supplying agency shown?
   b. Has the control center data table been shown?
   c. Are poles on bridges and shortened poles on walls, etc., included?
   d. Where fencing is required around a control center, have the necessary dimensions, notes, and special details required been shown? This work should be paid for under CMS Item 607 and the quantities carried forward to the Roadway Quantities in the General Summary.
   e. Are sizes and locations of all cable clearly shown?
   f. Are specification references shown for all conduits included in lump sum bid items?
1142 PLAN NOTES

1142-1 General

This area is reserved for sample/typical Plan Notes that have been developed for highway lighting.

1142-2 202, Luminaire Removed

This item of work shall consist of removing an existing luminaire. The luminaire shall become property of the contractor and shall be properly disposed of off of the project site.

Payment will be made at the unit price bid under CMS Item 202, "Luminaire Removed" for each luminaire removed which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-3 202, Luminaire Removed for Storage

This item of work shall consist of removing an existing luminaire and properly storing it on the project site for pick up by ODOT forces.

Payment will be made at the unit price bid under CMS Item 202, "Luminaire Removed for Storage" for each luminaire removed which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-4 202, Luminaire Removed for Reuse

This item of work shall consist of removing an existing luminaire and properly storing it on the project site for re-erection.

Payment will be made at the unit price bid under CMS Item 202, "Luminaire Removed for Reuse" for each luminaire removed and stored which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-5 202, Light Pole Removed

This item of work shall consist of removing an existing light pole. The light pole shall become the property of the contractor and shall be properly disposed of off of the project site.

Payment will be made at the unit price bid under CMS Item 202, "Light Pole Removed" for each pole removed which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-6 202, Light Pole Removed for Storage

This item of work shall consist of removing an existing light pole including the bracket arm(s), transformer base (if any) and properly storing this assembly on the project site until re-erected.

Payment will be made at the unit price bid under CMS Item 202, "Light Pole Removed for Storage," for each pole removed and stored which shall be full compensation for all labor, materials and incidentals to complete this item in a satisfactory and workmanlike manner.

1142-7 202, Light Tower Removed for Storage

This item of work shall consist of removing an existing light tower, including lowering device and
properly storing it on the project site for re-erection.

The tower shall be properly supported to prevent bending of the pole or damage to the lowering device during storage on the project site.

Towers which are not being re-erected as part of this project will be picked up and moved to offsite storage by ODOT forces.

Payment will be made at the unit price bid under CMS Item 202, “Light Tower Removed for Storage” for each tower removed and stored and shall be full compensation for all labor, materials and Incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-8 202, Light Pole Foundation Removed

This item of work shall consist of removing an existing light pole foundation to a minimum of 1 foot below finished grade, or removing the foundation completely, backfilling the resultant depression with compacted soil and restoring the disturbed area.

Payment shall be made at the unit price bid under CMS Item 202, “Light Pole Foundation Removed” for each foundation removed which shall be full compensation for all labor, materials and Incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-9 202, Pull Box Removed

This item of work will consist of removing and properly disposing of an existing pull box. The resultant opening shall then be backfilled to grade with suitable compacted soil and restored to match the surrounding area.

Payment will be made at the unit price bid under CMS Item 202, “Pull Box Removed” for each pull box removed which shall be full compensation for all labor, materials and Incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-10 625, Pull Box Cleaned

This item of work shall consist of cleaning an existing pull box by removing any existing cables not being reconnected, and debris so that new cables can be installed. Any unused openings shall be closed. Disturbed areas near the pull box shall be cleared of weeds or debris and shall be fully restored. Material removed shall become the property of the contractor and shall be properly disposed of off of the project site.

Payment will be made at the unit price bid under CMS Item 625, “Pull Box Cleaned” for each pull box cleaned which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-11 625, Conduit Cleaned and Cables Removed

This item shall consist of cleaning an existing conduit by removing existing cables, mud and debris so that new cable can be installed. Incidental to the cleaning is the installation of bushings and/or couplings on the ends of existing conduit as required. Materials removed shall become the property of the contractor for proper disposal off of the project site. Disturbed areas shall be properly restored.

Payment will be made at the unit price bid under CMS Item 625, “Conduit Cleaned and Cables Removed” per foot of conduit cleaned which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.
1142-12 202, Disconnect Existing Circuit, As Per Plan

This item of work shall consist of the disconnection of an existing light circuit at a pull box or transformer base.

Disconnection at a pull box shall involve cutting the existing circuit and removing all splice kits. Any cable that is to be abandoned shall be terminated from the pull box so that no cable is left in the box.

Disconnection at a transformer base shall involve cutting the existing circuit and removing all connector kits. All duct-cable not to be reused shall be removed from the transformer base and the existing conduit in the foundation shall be cleaned of all cable and debris so that the new duct-cable can be installed. All existing cable to remain active shall be cut in a manner so that there is sufficient cable left for re-connection.

Those wires that are to remain on active circuits shall have a water-resistant seal at the cut end. The water-resistant seal shall be accomplished by plugging the deactivated port of an existing connector kit or by installing a cable splice kit on the cut end of the cable.

Payment shall be made at the unit bid price under CMS Item 202, “Disconnect Existing Circuit, As Per Plan” at each location where disconnection is required which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-13 202, Power Service Removed, As Per Plan

This item of work shall consist of the removal and disposal of an existing power service.

Included for removal will be all power service components such as the wood pole, weather head and all above grade wiring, control center enclosure, photoelectric cell and all other appurtenances. The cable enclosed in the 2-inch conduit which runs into the ground shall be cut where it exits the 2-inch conduit, approximately 2 feet below the ground, and shall be removed with the 2-inch conduit. The remaining buried cable shall be abandoned. All disturbed areas shall be restored to match the surrounding area.

All power service components including the control center, pole, photoelectric cell, 2-inch conduit, weather head and all above-ground wiring shall become the property of the contractor and shall be properly disposed of off the project site.

This item will also compensate the contractor for coordinating with the power company to insure that the company disconnects the service, and that items which belong to the power company and are removed by the contractor such as the meter base shall be returned to the power company.

Payment will be made at the unit price bid under CMS Item 202, “Power Service Removed, As Per Plan” for each service removed which shall include all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-14 Luminaire, High Mast, As Per Plan

The luminaire arrays and associated illumination test areas specified in CMS 725.21 are hereby waived. Instead, the luminaires for high-mast lighting shall meet the following requirements:

Luminaires for high-mast lighting units with symmetric distribution shall be Holophane "HMST"
with photometric distribution 36383, General Electric "HM" with photometric distribution 6312, or Cooper "HMX" with photometric distribution HMX4SDW.

Luminaires for high-mast lighting units with asymmetric distribution shall be Holophane "HMST" with photometric distribution 46973, General Electric "HM" with photometric distribution 7349, or Cooper "HMC" with photometric distribution HMC4S3D.

Luminaires for high-mast lighting units with long narrow distribution shall be Holophane "HMST" with photometric distribution 36801, General Electric "HM" with photometric distribution 8946, or Cooper "HMC" with photometric distribution HMC4S1DL.

In addition, other luminaires will be considered if the designed intensity and uniformity are provided using the designed pole locations and the designed number and type of fixtures per pole.

1142-15 **Luminaire, Low Mast, As Per Plan**

The luminaires shall be as specified for high-mast luminaires in CMS 725.21 except that the luminaire arrays and associated illumination test areas are hereby waived. In addition, the luminaires for low-mast lighting shall meet the following requirements:

Luminaires for low-mast lighting units with symmetric distribution shall be Holophane "HMST" with photometric distribution 36383, General Electric "HM" with photometric distribution 6312, or Cooper "HMX" with photometric distribution HMX4SDW.

Luminaires for low-mast lighting units with asymmetric distribution shall be Holophane "HMST" with photometric distribution 46973, General Electric "HM" with photometric distribution 7349, or Cooper "HMC" with photometric distribution HMC4S3D.

Luminaires for low-mast lighting units with long narrow distribution shall be Holophane "HMST" with photometric distribution 36801, General Electric "HM" with photometric distribution 8946, or Cooper "HMC" with photometric distribution HMC4S1DL.

In addition, other luminaires will be considered if the designed intensity and uniformity are provided using the designed pole locations and the designed number and type of fixtures per pole.

1142-16 **625, Luminaire, Conventional, As Per Plan**

In addition to the requirements of the ODOT’s Construction and Material Specifications, luminaires for conventional lighting units shall be as follows:

Luminaires for conventional lighting units with an IES II-M-SC distribution and 200 Watt high pressure sodium lamps shall be American Electric “Series 126” with photometric distribution AE3849I, Cooper “OVD” with photometric distribution OVD2S2F, General Electric “M-400” with photometric distribution 1014, or equal as approved by the Engineer.

Payment will be made at the unit bid price for each CMS Item 625, “Luminaire, Conventional, As Per Plan (add supplemental description)” for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-17 **625, Luminaire, Post-top, As Per Plan**

In addition to the requirements of the ODOT’s Construction and Material Specifications, luminaires for post-top lighting units used in green spaces of rest areas shall be as follows:
Luminaires shall be American Electric “Contempo Series 245/246” with photometric distribution P5236, Cooper “USA Style King” with photometric distribution USA1S55, General Electric “PM16/PM17” with photometric distribution 6928, or equal approved by the Engineer.

Luminaires refractors may be of glass, polycarbonate, or acrylic.

Payment will be made at the unit price bid under CMS Item 625, “Luminaire, Post-Top, As Per Plan (add supplemental description)” for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-18 625, Luminaire, Underpass, As Per Plan

In addition to the requirements of the ODOT’s Construction and Material Specifications, luminaires for underpass lighting units shall be as follows:

Luminaires for underpass lighting units shall be American Electric “Sidelight series 582” with photometric distribution AE2081I, Cooper “Wall Light” with photometric distribution WPK15SXX, General Electric “Versaflood II Wallighter” with photometric distribution 8578, Holophane “Wallpack II” Test with photometric distribution 33263, or equal as approved by the Engineer.

Luminaires for underpass lighting unit which are wall mounted shall shall be furnished with an integral fuse holder and 10-ampere fuses.

Payment will be made at the unit price bid under CMS Item 625, “Luminaire, Underpass, As Per Plan (add supplemental description)” for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-19 625, Luminaire, Installation Only, As Per Plan

This item of work shall consist of installing a luminaire either removed from a previous location on the project site or supplied to the project site by others.

Payment shall be made at the unit price bid under CMS Item 625, “Luminaire, Installation Only, As Per Plan” for each luminaire installed which shall include all labor, materials and incidentals required to perform this item of in a satisfactory and workmanlike manner.

1142-20 Lamps

High pressure sodium lamps shall be General Electric “Lucalox,” Osram Sylvania “Lumalux,” Philips “Ceramalux,” or equal approved by the Engineer.

1142-21 625, Re-erect Existing Light Pole, As Per Plan

This item of work shall consist of re-erecting an existing light pole removed from a previous location on the project site. The light pole will be installed on a new foundation as indicated in the plan.

Where the pole will be installed on a new foundation, new anchor bolts shall be furnished.

In addition, the existing light pole identification decal shall be removed, and a new decal for the new identification number furnished and installed.
Payment shall be made at the unit price bid under CMS Item 625, “Re-erect Existing Light Pole, As Per Plan” for each pole re-erected which shall include all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-22 625, Re-erect Existing Light Tower, As Per Plan

This item of work shall consist of re-erecting an existing light tower previously removed and stored by this project.

When required, additional luminaire bracket arms shall be added to the existing luminaire brackets relocated along with the necessary adjustments and additions to the luminaire wiring to enable the luminaires to be mounted symmetrically around the luminaire mounting ring.

Where the tower will be installed on a new foundation, new anchor bolts shall be furnished.

The tower and lowering mechanism shall be cleaned and lubricated.

Any repairs and adjustments necessary to return the tower and mechanism to good operating condition shall be made.

The existing light tower identification decal shall be removed, and a new decal for the new identification number furnished and installed.

Payment shall be made at the unit price bid under CMS Item 625, “Re-erectExisting Light Tower, As Per Plan” for each tower re-erected which shall include all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-23 Light Pole Anchor Bolts, Misc.: Set for Pilaster Mounted Light Pole

When a light pole is mounted on a pilaster on a bridge parapet or on a retaining wall, the required anchor bolts may differ in length and/or shape from those required when the pole is mounted on a cast-in-place drilled shaft foundation. The cost differential for furnishing such bolts is included herein.

In addition, there is no foundation construction item in which to include the setting of the anchor bolts. Thus, the setting of the anchor bolts into the pilaster is also part of this work.

Payment will be made at each such pole location at the unit price bid for each CMS Item 625, “Light Pole Anchor Bolts, Misc.: Set for Pilaster Mounted Light Pole” and shall be full compensation for furnishing and placing the set of anchor bolts required.

1142-24 Light Tower Foundation, As Per Plan

In lieu of the settings shown in the standard drawings, set the tops of light tower foundations, with or without maintenance platforms, to project 6 to 12 inches (152.4 to 304.8 millimeters) above finished grade or platform floor on the up-slope side of foundation. This projection shall be included in the total depth of the foundation.

1142-25 Light Pole Painting

The painting of light poles shall be a five-part process consisting of a two-part surface preparation followed by a three-coat paint system.
The contractor shall take all necessary precautions to comply with pollution laws, rules or regulations of Federal, State or local agencies. The materials and work specified can be hazardous to the health of the applicator if the manufacturer's instruction are not followed. The Contractor shall follow the data sheet and the label on the paint containers. These precautions shall include the use of respirators and eye and skin protection as specified. The Contractor shall also insure that his operations and locations will not endanger or adversely affect the public in general. The Engineer shall be notified 24 hours prior to any cleaning or coating operations so that inspection services can be provided.

The proposed cleaning and coating operations shall be performed only when the ambient temperature is 50 degrees F or above. The two-part surface preparation system shall consist of a solvent cleaning followed by an abrasive blast cleaning.

Surface preparation shall be done under the conditions of temperature and humidity specified by the manufacturer of the epoxy-prime coat material to be applied immediately after the preparation operations.

Existing, weathered, galvanized steel shall be prepared for coating by a solvent cleaning conforming to specification SP-1 published by the Steel Structures Painting Council (SSPC) followed by a commercial blast cleaning (SSPC-SP6).

New, unweathered galvanized steel shall be prepared for coating by a solvent cleaning (SSPC-SP1) followed by a brush-off blast cleaning (SSPC-SP7).

The prime coat shall be applied before the prepared surface degrades from the prescribed standards. In every case, the surface shall be coated with epoxy prime coat on the same day as the surface preparation.

The three-coat paint system shall consist of an epoxy prime coat, an epoxy intermediate coat and a urethane top coat, with each coat being a different color.

Paint shall not be applied when the relative humidity is greater than 85 percent. Paint shall not be applied when the steel surface temperature is less that 5 degrees F above the dew point. Paint shall not be applied to wet, damp, frosted or ice-coated surfaces, nor shall it be applied during rain, fog or mist.

Before each coating is applied, it shall be mixed with an approved power mechanical mixer to a uniform consistency which shall be maintained during its application. Thinning of paint is strictly prohibited. Paint not capable of being applied as specified shall not be used.

Each coat shall be applied in a workmanlike manner as a continuous film of uniform thickness which is free of holidays, pores, runs or sags. All coats shall be applied by brush. The coating shall penetrate all joints and connections.

The prime coat shall consist of the application of one coat of an epoxy primer. The total dry film thickness of this coat shall be between 1.5 to 2.0 mils. If more than one pass is necessary to obtain the required thickness, the cost shall be borne by the Contractor. The color of this coat shall be noticeably different from the base material and other proposed coats.

The epoxy prime coat shall in all cases be applied over surfaces that were prepared earlier that same day.

The intermediate coat shall consist of the application on one coat of epoxy. The total dry film thickness of this coat shall not be less than 6 mils. If more than on pass is necessary to obtain
the required thickness, that cost shall be borne by the Contractor. The color of this coat shall be light grey.

At least twenty-four hours, but no more than three days, shall elapse after the application of the epoxy prime coat and before the application of the epoxy intermediate coat. Surfaces shall in all cases be clean before the intermediate coat is applied.

The top coat shall consist of the application of one coat of urethane to support sections. The total dry film thickness of this coat shall not be less than 1.5 mils. If more than one pass is necessary to obtain the required thickness, that cost shall be borne by the Contractor. The color of this coat shall be medium grey.

At least twenty-four hours, but no more than three days, shall elapse after the application of the epoxy intermediate coat and before the application of the urethane top coat. Surfaces shall in all cases be clean before the top coat is applied.

Painted items shall be carefully handled and stored to prevent any scraping, marring or other damage to the painted surfaces. The coating materials used shall be those listed from one of the following manufacturers:

<table>
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<th>Intermediate Coat</th>
<th>Top Coat</th>
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<tr>
<td>Ameron</td>
<td>Amercoat 71</td>
<td>Amerlock 400 (Light Grey)</td>
<td>Amercoat 450 HS (Medium Grey)</td>
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<tr>
<td>210 North Berry Street</td>
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<tr>
<td>Brea, California 92621</td>
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<tr>
<td>The Glidden Company</td>
<td>GLID-Guard Corrosion</td>
<td>GLID-Guard Corrosion Resistant HS</td>
<td>GLID-Thane II Polyurethane 6200</td>
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<tr>
<td>16651 Sprague Road</td>
<td>Resistant HS Epoxy No. 5465</td>
<td>Resistant HS Epoxy No. 5466</td>
<td>Series</td>
</tr>
<tr>
<td>Strongsville, OH  44136</td>
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<tr>
<td>Porter Paint Company</td>
<td>Porter Paints MCR 4300</td>
<td>Porter Paints MCR 4300 (Off-White)</td>
<td>Porter Paints Hythane</td>
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<tr>
<td>400 South Thirteenth St.</td>
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<td></td>
<td></td>
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<tr>
<td>Louisville, KY  40201</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Poly-Carb, Inc.</td>
<td>Mark-60 Ultrapox</td>
<td>Mark-60 Ultrapox (Light Gray)</td>
<td>Mark-73 Ultrakote (Medium Gray)</td>
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<tr>
<td>33095 Bainbridge Road</td>
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<tr>
<td>Cleveland, OH  44139</td>
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<tr>
<td>Sherwin Williams Co.</td>
<td>Tile-Clad II Hi-Build Primer</td>
<td>Hi-Solids Catalyzed Epoxy (Pure White) (Slate Gray)</td>
<td>Hi-Build Aliphatic Polyurethane Enamel</td>
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<tr>
<td>761 Beta Drive Mayfield Village, OH  44143</td>
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All three coats of the system shall be manufactured by the same company to insure compatibility among coats.

Prior to use, the Contractor shall submit to the Director copies of the manufacturer’s certified test data showing that the material complies with the requirements of this specification. The test data shall include the brand name of the paint, name of manufacturer, number of the lot tested and date of manufacture. ODOT reserves the right to sample and test delivered lots for compliance.

Payment will be made at the contract bid price for each pole painted and shall be full compensation for all labor materials and equipment required to paint the pole, bracket arm and
1142-26  **Underdrains for Pull Boxes**

Reference is made to the standard drawings for details of draining pull boxes. Underdrains for pull boxes shall be used as directed by the Engineer and shall be provided where the length required for a satisfactory outlet does not exceed approximately 20 feet (6.1 meters). An animal guard shall be included at the outlet end of the drain. An estimated quantity of CMS Item 603, “4” (102 mm) Conduit, Type E” is included at each pull box for this purpose.

1142-27  **625, Junction Boxes, As Per Plan**

The junction box shall have an embossment in the back of the box that shall be drilled and tapped for a 1/4” - 20 cap screw for connection of grounds.

When encased in concrete, the junction box shall have inward flanged covers and may have in lieu of bossed drilled and tapped connections, slip holes field drilled to accommodate the conduits entering the box so long as each metallic conduit is equipped with a grounding bushing jumped to the box itself.

When surface mounted, the junction may have in lieu of bossed drilled and tapped connections, field installed hubs to accommodate the conduits entering the box.

1142-28  **Conduit Expansion and Deflection**

Expansion fittings shall be OZ Type AX, Crouse Hinds Type XJG, Appleton Type AX, or equal approved by the Engineer. Each expansion fitting shall provide either 4” or 8” total movement as specified by the plan details and shall have an external copper bonding jumper, unless specified otherwise by the plan details.

Deflection couplings shall be OZ Type DX, Crouse Hinds Type XD, Appleton Type DF, or equal approved by the Engineer. Each deflection coupling shall have an external copper bonding jumper, unless specified otherwise by the plan details.

1142-29  **625, Power Service Refurbished, As Per Plan**

This item of work shall consist of the removal of those portions of an existing power service not being reused and the installation of new power service components in accordance with the contract documents.

All existing lighting circuit cables and splices shall be removed from the adjacent existing pull box and from conduit between the pull box and the power service enclosure. Where existing conduit is to be reused, the conduit shall be cleaned of mud and debris. The enclosure and other related components of the power service shall be cleaned of all mud, debris and existing fuses shall be removed and discarded.

The existing control transformer, photocell and contactor coil shall be removed and shall be replaced with a new line voltage contactor coil and a new photo cell. The power service shall be wired as shown in standard drawings and as detailed in the plans.

The ground area in the vicinity of the power service shall be free of all debris, and shall have grass trimmed.

Payment will be made at the unit price bid for each CMS Item 625, “Power Service Refurbished,
As Per Plan” and shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory workmanlike manner.

1142-30  625, Power Service, As Per Plan

In addition to the requirements of the Specifications, the following is added.

The power supplying agency for this project is:

Power Company ____________________________
Address ____________________________
Phone # ____________________________
Contact Name ________________________

The Contractor shall be responsible for any charges made by the power company for work by the company in conjunction with the establishment of the required service.

Electrical energy from existing power services shall continue to be charged to the maintaining agency. The contractor shall pay electrical energy charges for new power services established by this project. After acceptance of the lighting, the power service electrical energy account shall be transferred to the maintaining agency noted in the plans.

This shall include new power service established by this project as well as reassignment of existing service due to work performed by this project.

Payment will be made at the unit bid price for each CMS Item 625, “Power Service, As Per Plan” which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-31 Special, Power Service Fence

This item of work shall consist of installing a new chain link fence, with gate, around a power service. The fence and gate shall be installed as specified in CMS 607 and in the plan. The fence shall be 8 feet in height, and one gate of 4 feet in width shall be included, except as specified herein unless detailed otherwise in the plan.

Where the power service is adjacent to the right-of-way fence and there is reasonable access to the power service from outside the highway right-of-way, the fence around the power service shall utilize the right-of-way fence line as a portion of the fence line of the enclosed area. The right-of-way portion of the fence shall include a second access gate.

The gate hasp of each gate shall be secured by a steel rod, with one end drilled for the maintaining agency padlock and the opposite end drilled for the power company padlock.

Payment will be made at the unit price bid under Item Special, “Power Service Fence” for each area fenced which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-32  625, High Voltage Test

A lump sum for performing the high voltage test required by CMS 625.19.E has been included
in the general summary.

1142-33 **High Voltage Test Waived**

The high voltage test shall not be performed on the circuits constructed by this project, since the test could damage the portion of the completed circuit which has been in service prior to this project.

1142-34 **Padlocks and Keys**

Padlocks furnished shall be either brass or bronze, equal to Master No. 4BKA or Wilson Bohannan 660A, and shall be keyed in accordance with CMS 631.06. Payment shall be included in the bid for the item(s) being locked.

1142-35 **Special, Maintain Existing Lighting**

Existing roadways which are to remain open to traffic during construction of this project and which are lighted shall have the lighting maintained as described herein.

Before any work is started in the immediate vicinity of the existing lighting circuits, representatives of ODOT, the Maintaining Agency and the Contractor shall make a visual inspection of the existing roadway lighting circuits to be maintained. During this inspection, a written record of the condition of existing lighting shall be made by ODOT’s representative. This written report shall note individual luminaires which are not in working order, individual poles which are standing, and individual circuits which are not in working order. The completed report shall be signed by the representatives of ODOT, the Maintaining Agency and the Contractor.

If, as a result of this inspection, it is determined that the condition of the existing system is below that required for the safety of the traveling public, then the Maintaining Agency shall make the repairs necessary to return the system to an acceptable condition. Following these repairs, the system shall again be inspected and a report shall be made and signed as outlined herein.

When the existing system is in an acceptable condition, it shall be turned over to the Contractor who shall then be required to maintain the existing lighting to the condition outlined in this report with the exception of knockdowns due to traffic accidents.

Replacement of knocked downed units shall be done only when the Engineer has determined that the replacement of the knocked down unit is necessary and shall be paid separately on a unit basis.

Betterments shall be covered in items of work pertaining to the construction of permanent improvement.

When the sequence of construction activities requires, or should the Contractor desire, the removal of the existing lighting before the new lighting is operational, the Contractor shall be responsible for providing temporary lighting of this portion of the roadway.

Prior to installing such lighting, the Contractor shall prepare and submit four sets of the temporary lighting plan to the Engineer for review and approval.

This plan shall show locations of poles, lengths of bracket arms, styles of luminaires, mounting heights, wiring methods and other pertinent information. The temporary lighting shall provide an average initial intensity of 1.2 footcandles with an average to minimum uniformity not to exceed 3:1. Mounting height of temporary luminaires shall not be less than 30 feet (9 meters), and the
minimum overhead conductor clearance shall be 20 feet (6 meters). Temporary overhead construction shall not be less than Grade "A" for strength requirements as defined by the National Electric Safety Code. Wood poles with overhead wiring may be used. However, temporary lighting shall meet Federal and State safety criteria. If breakaway poles are used to meet these criteria, then underground wiring shall be used. Reconditioned or used materials may be furnished for temporary lighting.

All materials necessary to complete the temporary lighting shall be furnished and installed by the Contractor. When no longer needed, the temporary lighting installation shall be removed and properly disposed of by the Contractor.

The Maintaining Agency will pay for electrical energy consumed by existing power services and by proposed permanent power services after acceptance of the lighting work. The Contractor will pay for electrical energy, installation, removal and maintenance of any temporary power services.

The lump sum price bid for Item Special "Maintain Existing Lighting" shall include payment for all labor, equipment, materials and incidentals necessary to maintain the existing lighting as specified herein.

The unit price bid for Item Special "Replacement of Existing Lighting Unit" shall be full payment for the replacement of an existing lighting unit which has been knocked down after the aforementioned inspection and shall include all labor, equipment, materials and incidentals necessary to provide a replacement for such unit.
1100  HIGHWAY LIGHTING  Traffic Engineering Manual

1143  SPECIFICATIONS

ODOT specifications for the furnishing and installation of highway lighting equipment are contained in CMS Item 625 and CMS 725.

1150  CONSTRUCTION

This area has been reserved for specific construction information related to highway lighting that may become available.
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1213-5 Documentation

Table 1297-4 establishes Revision Numbers to be used by each District for Parking Control Zones. These numbers shall be used on Forms 1296-9 and 1296-10.

The District shall retain the reports used in establishing the Parking Zone in their permanent files. Originals of the official document authorizing the regulation shall also be retained permanently in District files.

A copy of the signed authorizations, including date of sign erection, shall be forwarded to the Office of Traffic Engineering (OTE).

For purposes of maintaining a statewide inventory and historical record, an inventory of Parking Zones shall be maintained by OTE. Copies of the listing shall be distributed quarterly to the Districts and the Office of Technical Services and annually to the County Engineers.

1214 OTHER ZONES

As noted in Section 1210, Traffic Control Zones also include Pedestrian Safety Zones, Loading Zones, No-Passing Zones and Temporary Traffic Control Zones (Work Zones). Pedestrian Safety and Curb Loading Zones are addressed in OMUTCD Sections 5F and 5G, respectively. No-Passing Zones are addressed in OMUTCD 3B. Temporary Traffic Control Zones are addressed in OMUTCD Part 7 and in Part 6 of the TEM.
1215 RUMBLE STRIPS IN THE ROADWAY

Rumble strips are composed of a pattern of grooves or depressions made in the roadway or shoulder of the highway to produce an audible and/or vibratory warning to drivers. They are not, by themselves, considered traffic control devices (they are “geometric features of the roadway”). Rumble strips within the roadway (traveled lane) are addressed in this section.

Policy No. 322-001(P), Policy on the Use of Rumble Strips on Shoulders addresses details and procedures for the use of rumble strips on the shoulders of ODOT-maintained highways. L&D Manual Volume One Section 605, SCD BP-9-1 and CMS Item 618 address ODOT standards and specifications related to the use of shoulder rumble strips. For questions on shoulder rumble strips, contact the Office of Roadway Engineering Services.

Rumble strips have been shown to be effective in certain circumstances in slowing and/or alerting drivers for various applications. However, installation of rumble strips should only be considered when all other appropriate standard traffic control devices have failed to resolve the traffic problem satisfactorily.

The use of rumble strips at locations in the roadway shall be at the discretion of the District Deputy Director. This decision should be based on a review and recommendation by the District Safety Review Team. Applications for consideration of rumble strips include the following:

1. Rural stop approaches with high accident rates.
2. Signalized intersections with high accident rates.
3. Exit ramp deceleration lanes.
4. Gore areas.
5. Narrow and one-lane bridges.
6. Locations with abrupt changes in horizontal alignment.
7. Intersections with inadequate stopping sight distance caused by vertical or horizontal alignment.
8. Transitional areas from “high-type” facilities to “low-type.”
9. Construction areas, e.g., median crossovers.
10. Approaches to toll booths.
11. Railroad crossings with sight distance restrictions and accident potential.

Design information is available upon request from the OTE Standards Section; however, detail designs are not currently available for each of the applications noted.

When rumble strips are installed, a RUMBLE STRIPS sign (W-172) should be used. This sign is shown in the Standard Sign Design Manual (Section 295-2)
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